GOVERNMENT OF MALAWI

PROPOSED IMPROVEMENTS TO 14 DISTRICT WATER SUPPLY SCHEMES

APPRAISAL REPORT

SEPTEMBER 1992

GibbAnglian

under assignment by the

OVERSEAS DEVELOPMENT ADMINISTRATION

Phil Evans. IRC

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EXECUTIVE SUMMARY

1. INTRODUCTION

The ODA has been requested to provide technical assistance and capital aid to improve the water supplies to 14 urban and semi-urban centres supplied from groundwater sources. The location of these district water supply schemes are indicated on the attached map.

The project proposal, submitted by the Water Department of the Ministry of Works, is based on 'The Final Master Plan for Water Supply Development - 44 Semi-Urban Centres', the study for which was conducted between 1986 and 1988.

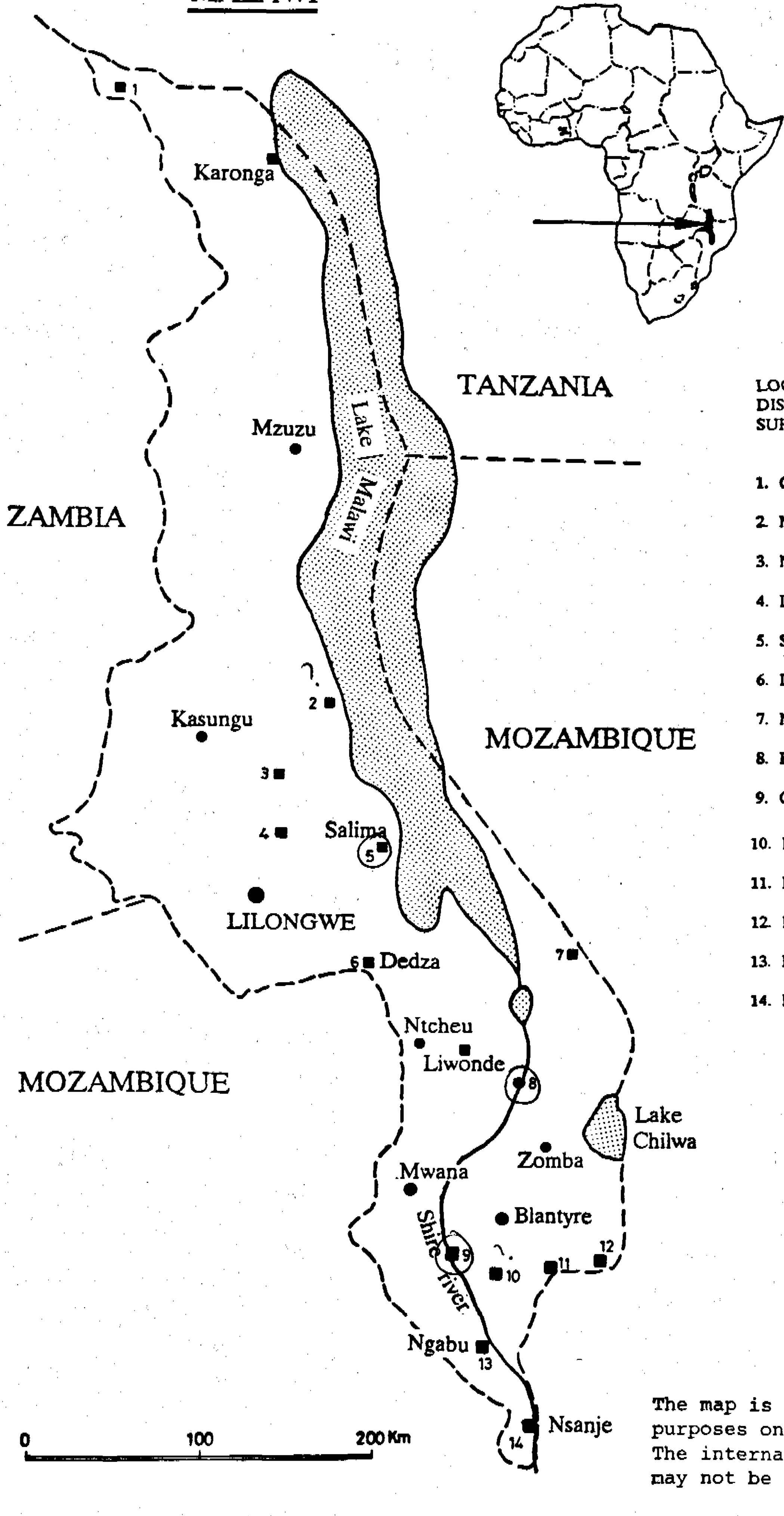
The water demands for the 14 growing urban centres have exceeded the production capacities of the existing water supply systems. There is therefore a great need to upgrade and expand the systems in order to cope with the growing demands. The proposed project will ensure that additional potable water is made available to the centres to alleviate current shortages as well as to meet future water demands up to the year 2005. The emphasis should be on ensuring adequate quantities of water with less stress on quality. Current evidence is that the majority of the cases of endemic diarrhoeal diseases seem to be related to an insufficiency of water rather than to its basic quality.

2. APPRAISAL APPROACH

The objective of this report is to appraise and cost recommended schemes, to advise on their relative sequencing, and to identify and specify any need for complementary measures to ensure that the schemes are sustainable, and achieve the intended benefits at minimum cost, while avoiding or mitigating adverse effects.

Site visits were made to the individual schemes to assess the existing situation with regard to water resources, engineering works and socio-economic conditions, and to evaluate necessary measures for improvement.

MALAWI



LOCATION OF 14 DISTRICT WATER SUPPLY SCHEMES.

1. CHITIPA
2. NKHOTAKOTA
3. NTCHISI
4. DOWA
5. SALIMA
6. DEDZA
7. NAMWERA
8. BALAKA
9. CHIKWAWA
10. NCHALO
11. LUCHENZA
12. MULOZA
13. NGABU
14. NSANJE

The map is for illustration purposes only.
The international boundary may not be accurately drawn.

The design reports presented with the Water Department's request for funding were reviewed in detail. Population projections were revised to match the 1987 census results, and costs estimates were updated to suit 1991 prices. The revised water demand forecasts were used to recommend changes to the design assumptions. Simultaneously, the sanitation issues, and the institutional arrangements for the implementation of the project were examined.

An implementation programme was prepared to take account of the various findings of the study, and to meet the project objectives.

3. EXISTING SITUATION

The existing schemes are based on ground water sources. Water is pumped from boreholes to overhead reservoirs, where it is chlorinated before it is distributed to consumers through communal water points and individual connections. The present situation in the various centres with regard to the availability of water and production facilities is summarised below in Table 1.

It is estimated that approximately 60 % of the population in the 14 towns is provided with water. Of those served about a third have individual connections while the remaining two-thirds depend on communal water points. The water supplies to most of the towns are unsatisfactory, having insufficient capacity and distribution coverage.

40% unserved

No piped sewerage systems exist in the 14 towns, the population using either septic tanks or pit latrines. The majority of the pit latrines, however, are of poor design and condition. The general status of the sanitation facilities available to the population falls well below those of water supply, and there is a clear need to improve this situation and to control areas of potential pollution to water supplies.

TABLE 1

EXISTING SITUATION IN 14 CENTRES

		Centre	1991 Population	Source	Existing Production Capacity M^3/d	Projected 1991 Demand M^3/d	Existing Storage M^3
-	1	Chitipa	6290	B/H	684	688	292
+	2	Nkhotakota	14320	B/H	1450	1185	550
-	3	Ntchisi	3450	River+B/H	222	383	112
+	4	Dowa	2930	Stream+B/H	430	310	114
-	5	Salima	12455	B/H	666	1272	227
-	6	Dedza	20340	Stream+B/H	625	1424	407
-	7	Namwera	2300	B/H	187	240	90
-	8	Balaka	11680	B/H	518	1878	571
+	9	Chikwawa	4760	B/H	1273	381	166
-	10	Nchalo	10775	B/H	176	641	109
+	11	Luchenza	6940	B/H	743	603	227
-	12	Maulzo	790	B/H	36	76	43
-	13	Ngabu	6590	B/H	504	781	235
+	14	Nsanje	10870	B/H	1019	761	182

4. WATER RESOURCES

Surface Water

Due to the marked seasonality of the rainfall in Malawi, stream flows vary considerably, with only the largest rivers and some mountain streams continuing to flow throughout the dry season. The poor reliability of low flows often render it impossible to provide a reliable surface water source without building impounding reservoirs with consequential costs. High flood flows also act to constrain the development of river intakes due to the need to design substantial structures that can withstand destructive flood forces.

Lakes occupy a third of the total area of Malawi, representing a considerable resource. However utilization of this resource also has its problems due to lake level fluctuations, storm damage to lakeshore installations, and sand ingress due to water turbulence.

A further consideration with respect to surface water resources is the need to provide full treatment. The complexities of operating and maintaining these plants are not generally appropriate to smaller centres. If an alternative feasible groundwater resource exists in the area, which only requires chlorination, this is usually to be preferred.

Groundwater

Groundwater aquifers in Malawi occur either within the basement rocks which overlie 85% of the country, or in the alluvial formations associated with the Rift, and Shire valley region. Borehole yields and success rates within the basement are generally low. Borehole yields in the alluvial areas are generally in the order of five times greater than within the basement, and the success rates are also higher.

The Rift Valley Escarpment area, with steeper slopes, thinner aquifer storage depths, higher runoff and lower recharge values are particularly difficult with respect to groundwater development. Three of the centres, Ntchisi, Dowa and Dedza are within this geographical area.

Design Status

The design of water supply facilities to supply the future demand of the centres has reached a preliminary level, sufficient to identify schemes based on alternative sources of supply, and prepare comparative costs. Extensions to the distribution systems tend to be the same for the different alternatives, and therefore very little work has been carried out on evaluating the capacity of the existing distribution systems, and the works required to serve the supply areas.

In most cases, the original cost comparisons assumed optimistic borehole yields and success rates. Adjusting these to reflect more realistic assumptions suggests that in some cases the groundwater alternative is not necessarily still the most economical. Some additional work is therefore required to confirm the most viable alternative for Salima, Dedza, Balaka, Luchenza and Nchalo.

It is recommended that the proposal to take water from the existing rural water supply gravity pipeline at Muloza is reviewed, and that consideration is given to using collector wells at Dowa, and possibly also at Dedza.

5. COST ESTIMATES AND PRIORITIZATION

An initial prioritization of the centres was prepared primarily on the basis of the need for water as defined by the population not served. This ranking is provided in Table 2 below, together with the revised cost estimates for the individual schemes:

other options for priority setting?

TABLE 2

PRIORITY RANKING AND COST ESTIMATES

Study site:-

Ranking	Centre	Cost Estimate MK000
1	Dedza	6,955
2	Balaka	4,952
?. 3	Mchalo	1,451
4	Salima	2,355
?. 5	Nkhotakota	2,708
6	Ntchisi	1,311
7	Chitipa	2,446
8	Namwera	640
9	Dowa	880
10	Muloza	460
11	Luchenza	1486
12	Nsanje	1,002
13	Ngabu	593
14	Chikwawa	566

Should they be re-selected?

6. FINANCIAL ANALYSIS

The Water Department has its own finance section looking after three account areas. Each account area has its own staff and separate financial systems. Two of the areas, the District Water Supply Fund (DWSF) and the Borehole Fund (BF), are required by the Government to operate on a commercial basis and to be ultimately self financing.

The method of accounting and the systems for recording financial information mean that not all expenditure is allocated properly and there is no co-ordinated and integrated approach to financial management. This includes keeping separate the three account areas. A start has been made at examining performance measures and indicators. This information needs to be married up with cost information to give management information on where to improve efficiency.

The Government has a five year rolling Public Sector Investment Programme (PSIP). This incorporates all governmental capital expenditure. The Ministry of Finance produce an annual budget which covers the recurrent expenditure of government departments, agencies and ministries. Neither the budget nor the PSIP adequately cover the annual impact of recurrent costs of investment projects.

The District Water Supply Fund (DWSF) is the Fund from which the 14 Schemes have to be financed. The adjusted financial statements for 1990/91 indicate that the fund is in a healthy financial situation.

	1990/91 (MK000)
Total income	9643
Total Expenditure	7730
Profit	1913

The accounting methods used by the Ministry deduct/add capital expenditure from/to profits or losses respectively. This is not an accepted accountancy approach; normal accounting conventions demonstrate that capital investment is financed via the balance sheet.

The DWSF has improved its financial position from a loss of MK1 million in 1986/87 to a profit of nearly MK2 million in 1990/91. This improvement ignores the governments approach of charging capital expenditure to profits; that method would indicate a MK1.2 million loss in 1990/91.

Charges have been raised every year since 1987/88 to 1991/92 with the level of increase within the tariff varying from 26% to 150%. This variable level of increase within the tariff raises the subsidy to lower consumption customers.

The investment cost of the 14 schemes is estimated to be MK27.8 million with expenditure complete in 2001/02. The financial projections anticipate the 14 schemes are 100% grant aided.

The projections demonstrate at constant prices that DWSF will be financially self sufficient over the period although a 3% increase in tariffs may be necessary in 1993/94. WTP questions should anticipate increase . . . ?

7. COST OF WATER

The cost of water has been assessed based on the average incremental cost (AIC) for the project as a whole. This compares the cost of water comprising both the opportunity cost of water and the marginal cost of supply, with the existing average tariff level.

The total average incremental costs for the project are shown in Table 3 below.

TABLE 3

AVERAGE INCREMENTAL COST

Discount Rate	Capital MK/m^3	O & M MK/m^3	Total MK/m^3
12%	1.11	0.16	1.27
10%	1.03	0.16	1.19
8%	0.95	0.16	1.11

The AICs range from MK1.11 per m^3 at a discount rate of 8% to MK1.27 per m^3 at a discount rate of 12%. The present average tariff of MK0.90 is below the AIC by between 19% and 29% respectively.

Despite the recent large increases the current tariff levels will not completely recover the economic costs of water supply. They would have to be increased significantly to meet this objective.

8. SOCIO-ECONOMIC IMPACT

The existing social infrastructure of the 14 districts has been reviewed, along with their current economic, political and administrative roles. Their potential for development shows significant variation.

cf. selection criteria for study

Centres with high growth prospects are Salima, Balaka and Luchenza which all have important transport links. Agriculture and its products form the economic base of Ntchisi, Namwera, Nchalo and Ngabu. The influx of refugees and reduction in border traffic has had negative effects in Dedza, Muloza and Nsanje. At Chitipa, cross border trade is important, whilst Chikwawa's prospects depend upon the development of hydropower and irrigation. Dowa and Nkhotakota have only limited potential and are likely to stagnate.

A significant proportion of the population in the towns are not adequately served by the existing water supply systems. The poorer households often have to rely on untreated sources. Even when mains water is laid on, affordability is an important issue. The poorer section of the community living in the traditional housing areas will be one of the main beneficiaries of the project.

The provision of improved and extended supplies will benefit the commercial, institutional and economic life of the recipient community. Maximisation of health benefits and time saving can only be achieved by educating and motivating the community to utilise and sustain project facilities and to improve current hygienic and sanitation practices. The project addresses these issues by incorporating a HESP (Hygiene Education and Sanitation Promotion) component, to be undertaken by the Ministry of Health. The objectives of the HESP programme are to convey to the community, at village level, the need for good hygienic practices and the methods by which they can be achieved.

The project will have no overall negative effect on the environment. The greater awareness by both Water Department staff and communities alike, of the need to conserve water resources and reduce the potential for the pollution of water sources, together with the construction of properly designed and maintained sanitary facilities, are seen as providing significant potential benefits to the environment.

9. COMMUNITY PARTICIPATION

Community involvement in the project is important and must be encouraged wherever possible, but this has to be appropriate to the technologies involved. Water committees are the main instrument of community participation in water supply in urban/semi-urban areas and they are a precondition for provision of communal water points.

The health and sanitation component of the project will be an integral part of the project covering both water and sanitation aspects of community involvement. Issues of particular importance will include:

- needs identification
- willingness/ability to pay
- opportunity cost

training inputs!

- Discussion of the project with the community to obtain their views and preferences. (inc. service level..)
- Formation of water committees. — design of tap stands
- Location of water points.
- Personal hygienic practises.
- Health education concerning water related diseases.
- Maintenance of water taps and repairs.
- Collection of payments.

10. ROLE OF WOMEN

study must investigate this..

Traditionally, as in most of Africa, it is the women's task to fetch and carry water. The reduction in time and effort expended by women in collecting water, and the reallocation of this time to other social or economic activities, can be seen as a potential benefit attributable to this project.

Women play a key role in the formation of existing water tap committees, and in subsequent collection and payment of water dues. The project will assist in establishing new tap committees, and will make use of these and existing committees to focus on health education and sanitation promotion. Women will thus be the main target for this programme. The project will therefore contribute to enhancing the welfare of women and their role in the community.

11. POLICIES AND INSTITUTIONS

The ownership of public water in Malawi is vested in the President and responsibility for its control in the Minister. The Water Resources Act (cap. 72.03) which regulates water use, is currently being re-drafted. Principal resource uses, other than public water supply, are irrigation, hydropower and industry. Rights to abstract, and to discharge effluent, are granted by the Minister advised by the Water Resources Board. Government water policy is to make a clean supply accessible to nearly 80% of the population by 1996. Progress to date is consistent with that target.

Sanitation policy is unclear. UNDP have proposed a strategy (1989) targeting 80% improved coverage by the year 2000. Evaluation in not available, but early indications are that the target will not be achieved. Investment in urban sanitation is minimal, presenting a serious risk to public health. The hygiene education (HESP) programme runs parallel to the sanitation strategy and is dependant on aid funding. Health benefits are medium/long term and not yet able to be evaluated.

It is recommended that a Permanent Committee be constituted to formulate, for Government approval, a policy on Water and Sanitation and to subsequently approve a strategy to achieve policy aims.

It is believed that dispersal of responsibilities within the sanitation sector is a principal cause of the absence of a central policy and strategic plan. It is suggested that the organisational framework and institutional pattern for managing and developing water and sanitation services in Malawi be reviewed.

The Ministry of Works Water Department is the operating authority for water supply in the project areas and will be responsible for project implementation. The Department's organisational structure is currently under review. Recommendations provide for a stronger regional operating framework supported by policy, planning and development activities at headquarters, as well as provision of occasional specialist support. The Department is also responsible for managing data collection and analytical services, for evaluating the national water resource and for providing logistical support and administrative facilities to the Water Resources Board. The imposition on the Water Department of a regulatory as well as an operating role is considered to be debatable and could be incorporated in the review.

The Department's manpower needs are principally at professional/management level. At head office, of 22 engineer posts, 2 are expatriate held, and 10 are vacant. There are no accountants at professional level on department establishment. Retention of professional staff is more difficult than graduate recruitment due to skills marketability in the private sector. It was understood (anecdotally) that the Government was considering the payment of an annual premium of MK 6,000 to professional staff in order to restrain "leakage".

The Department has access to Ministry in-house training programmes for staff to technician level. Training at professional/management level depends on donor support. It is recommended that a training needs assessment at professional/sub professional level be undertaken and that a Management Development programme be then formulated.

A Project Design and Implementation Unit (DIU) can be accommodated within the Department. The unit should be controlled by the appointed consultant, but the Department should provide technician staff on secondment and graduate civil engineers as counterparts to the consultant's staff. Counterparts should be included on the management programme. It is considered that the need for expatriate engineering staff will continue through project implementation, on a reducing scale.

12. IMPLEMENTATION PLAN

In order to achieve the objectives of the project, of satisfying the projected water demand to the 14 centres by the design horizon of 2005 and of ensuring that the schemes are sustainable, and that health and other socio-economic benefits are maximised, it is necessary to implement a number of measures including:

- Survey and investigations to be carried out to establish drilling programmes and to determine the most viable alternative options where they may still be in doubt;

- Initiate a sanitation and health education programme in cooperation with the Health Education and Sanitation Promotion (HESP) programme;

- Initiate a drilling programme to provide the required sourceworks requirements to meet the 1995 demand of the centres;

- Establish a Design and Implementation Unit within the Water Department, with a consulting engineer taking responsibility for the design and implementation of the highest priority projects, and to train Water Department staff to take over responsibility for smaller centres with lower priority;

- Tender and construction of the project costing in the order of MK28 million.

Two alternative approaches to achieving these objectives have been considered; an ambitious programme of completing all schemes within a four year time span, requiring consultants to take the primary responsibility for the programme; and a much longer seven year programme placing more emphasis on training and development of the capabilities of the Water Department. Estimated investment requirements for the three year programme are shown below. Some additional phased investments will however be required in the year 2000 to meet the 2005 requirements.

preferable in order to allow time for achievement of broader goals.

	Pounds Sterling x 1,000					Foreign Exchange
Item Description	92/93	93/94	94/95	95/96	Total	%
Equipment	50				50	100
Drilling	63	210	53	135	461	40
Construction		1895	2105	1140	5140	50
Consultancy	100	250	200	101	651	100
Overheads & Vehicles	200	68	60	40	368	50
Total	413	2423	2418	1416	6670	55

13. KEY RECOMMENDATIONS

It is recommended that:

- A programme of Hygiene Education and Sanitation Promotion (HESP) should form a component of the project, to be implemented in all districts. Details of the Programme are given in Annex 9.

- Consideration be given to assisting training of volunteers from within the project areas in broad based ideas and techniques of health education.

- A Permanent Standing Committee (PSC) be constituted in accordance with Annex 10 and that it should in the first place undertake a review and make recommendations to Government on general policy matters in the water and sanitation sectors.

- The review by the PSC include the nature and structure of organisations currently providing water and/or sanitation services in order to appraise the effects of re-distribution of these responsibilities, particularly the transfer of waterborne sanitation and collection services to the Ministry of Works

- A Manpower Plan be formulated for Water Department in accordance with the Terms of Reference given in Annex 8, followed by Training Needs Assessment and a Management Development Programme.

- The financial management and accountancy capability of the Water Department be improved by acquiring a professionally qualified accountancy resource and the implementation of an extensive financial training programme for existing personnel.

- The Water Department should reassess their capital and recurrent spending plans and priorities and seek approval from the Ministry of Finance to spend within the capability of the funds at the Department's disposal. It is further recommended that those spending plans should incorporate, amongst other things, a planned meter replacement programme and an enhanced level of recurrent repair and maintenance expenditure.

?

- The issue of ownership of community run assets is resolved.

CHAPTER 1

INTRODUCTION

1.1 GENERAL

By letter dated 20 June 1991 the Overseas Development Adminstration engaged GibbAnglian, under British technical co-operation arrangement, to undertake for the Government of the Republic of Malawi an appraisal of the proposed improvements to 14 district water supply schemes. The Terms of Reference for the appraisal are set out in Annex 1.

1.2 RESPONSIBILITY FOR REPORT

Although this report has been commissioned by the British Government, under British aid arrangements, the British Government bears no responsibility for, and is not in any way committed to, the views and recommendations expressed herein.

1.3 REPORT CONTENTS

This report gives details of the information gathered and results of the investigations carried out during the appraisal.

The report is divided into 14 chapters and this introductory chapter is preceded by a section presenting an executive summary of the report's main conclusions.

The remaining chapters:

- describe thc existing water supply and sanitation systems in the 14 district centres and assess the need for improvement of these facilities;
- examine the impact of improved water supplies on the urban communities;

- assess the adequacy of water resources and present costs for the development of the schemes;

- provide the basis for establishing the relative priority and phasing of the schemes;

- discuss the policies and institutional issues effecting supply of water and sanitation services;

- present financial analysis and justification for the proposed improvements;

- formulate a plan for management and implementation of the schemes;

- recommend complementary measures for the sustainability of the schemes.

1.4 ACKNOWLEDGMENTS

We gratefully acknowledge the assistance given by, and the co-operation of, the Ministries, organisations and individuals consulted during the course of this appraisal.

CHAPTER 2

BACKGROUND

2.1 ECONOMIC BACKGROUND

The Republic of Malawi is a relatively small, densely populated, landlocked country in southeastern Africa. It shares common borders with Mozambique in the east and south-west, Tanzania in the north and north-west, and with Zambia in the north-west. The country has 119,000 km^2 of land area of which 20% is water, largely constituted by Lake Malawi.

According to the 1987 Population Census, the total population was nearly 8.0 million and it was estimated to be growing at an average rate of 3.7 percent per annum, the growth rate being partly inflated by the influx of refugees from neighbouring Mozambique. The Census showed that only 12 percent of the total population lived in urban areas and that of these nearly two-thirds were concentrated in the four major cities.

The real GDP per capita estimated at approximately US$50 in 1990 places Malawi amongst the poorest group of countries in the world. The structure of the economy is shown in Table 2.1. The agricultural sector dominates the economic activity in the country. It contributes 35 percent of the GDP, employs about 80 percent of the labour force and accounts for nearly 90 percent of the country's exports. The agricultural practices are sub-divided into smallholder and estate sub-sectors. The smallholder agriculture mainly meets the country's demand for staple foods including maize, beans, rice, sweet potatoes and groundnuts, while the estate sector largely produces for exports comprising tobacco, tea and sugar. The importance of agriculture is reinforced by the government's strategy of export-oriented development for the country based mainly on the contribution of the agricultural sector.

The manufacturing share of the GDP is relatively modest contributing about 13 percent and catering mainly for the domestic market. The manufacturing activities are concentrated on the production of consumer goods such a foods, beverages, household utensils and textiles; and on the production of intermediate goods such sawn-timber, basic tools and cement.

The real GDP increased at an average rate of nearly 3 percent per annum between 1985 and 1990, just about keeping pace with the population growth rate. The economic performance recessed significantly in the period 1985-87 due to various adverse external factors including depressed external crop prices, disruptions in the traditional trade routes through Mozambique and unfavourable climatic conditions. Marked improvements in the overall performance since 1987 have largely resulted from the liberalisation measures introduced by the government under the Structural Economic Adjustment Programmes. The growth of GDP averaged 4.5 percent per annum during this period.

In spite of these recent improvements, Malawi continues to face declining living standards resulting largely from limited employment opportunities, low productivity of labour, limited access to land, minimal income transfers and high population growth. In view of these constraints the Government has embarked on shifting its development approach towards "growth through poverty reduction" for the period 1990-95 and beyond. The main elements of the new strategy involve: expansion of employment opportunities; increasing social expenditure for human resource development; controlling the high population growth rate; and enhancing income transfers. One of the priority areas for human resource development involves increasing the supply of potable water to the population. The proposed project consisting of improvements to 14 district water supply schemes would significantly contribute to this objective by improving health conditions, reducing time and energy constraints for the poorer households and generally promoting growth through poverty reduction in the country.

* income data in urban fringe?

TABLE 2.1

GDP BY SECTOR AT 1978 CONSTANT PRICES

(K million)

	1985	1986	1987	1988	1989	1990
Agriculture	307.4	309.9	312.5	318.7	329.7	325.2
Smallholder	241.4	244.5	242.4	243.6	247.4	236.3
Estate	66.0	65.4	70.1	75.1	82.3	88.9
Manufacturing	101.1	106.1	107.1	110.6	119.3	130.8
Construction	39.3	31.2	31.1	38.7	41.5	43.8
Electricity & Water	16.4	17.3	18.7	19.1	21.1	23.1
Transport & Com.	49.5	51.8	49.1	50.1	51.2	57.5
Finance & Prof. Services	54.9	53.8	53.8	56.2	60.1	65.8
Trade/Distribution	113.9	109.9	107.4	106.0	110.2	120.3
* Other	167.1	170.6	188.5	197.4	203.3	215.2
GDP at Factor Cost	849.6	850.6	868.2	896.8	936.4	981.7

* Includes Government, Private Social Services, Real Estate.

Source: Department of Economic Planning and Development

2.2 GENERAL BACKGROUND TO WATER SUPPLY AND SANITATION SECTOR

2.2.1 Geography and Climate

Malawi is located along the East African Rift Valley, which together with Lake Malawi, forms the dominate geographical feature of the country, and influences its water resources. The Shire River flows southward from Lake Malawi, following the course of the Rift Valley and falls from approximately 470 m at the Lake to less than 100 m above sea level in the south. To the west of Lake Malawi the land rises rapidly to over 1,000m, and the majority of land lies between 1,000 and 1,500m rising in the north to 2,500 in the Nyika plateau area, and to 3,000 m in the Mulanje Mountain to the south east of the country.

The climate is tropical, with average annual temperatures being dependant largely on altitude, but generally ranging from 15 deg C in the north to 27 deg C in the south. Rainfall over the country is predominantly associated with easterly rain bearing winds, and the annual average rainfall is approximately 1,200mm. This varies however from below 800mm in the dryer areas in the southern Shire Valley to over 1,800mm in the higher areas such as the Mulanje Mountain and the Nyika Plateau. Rainfall is highly seasonal, 95% falling in the wet season between November and the following March, although this extends to April and May in the north.

2.2.2 Surface Water Resources

The very marked seasonality of rainfall leads to a large variation of flow rates in rivers and streams, with only the largest rivers, and some mountain streams continuing to flow throughout the dry season. The main drainage systems are directed towards or, in the south, away from Lake Malawi.

It has been suggested (ref 1) that the low level of dry season discharges of water courses has been exacerbated in some parts of the country by environmental degradation. However, in order to identify areas of concern and to quantify the problem, further study is required.

Lake Malawi is the third largest freshwater lake in Africa, and is a significant water resource. Historically, lake levels have fluctuated as much as 6 m, which together with the severe storms that are characteristic of the lake shore region, impose a number of problems for the design and operation of water abstraction works.

2.2.3 Groundwater Resources

Aquifers in Malawi occur either within crystalline basement rocks which underlie 85% of the country (Figure 3), or in alluvial formations of Quaternary to Recent age and associated with the Lake Malawi Rift region and the Shire Valley.

The alluvial sequences have thicknesses largely in the range between 40 to 150 metres and are mainly composed of fine-grained heterogeneous sediments, sands, silts and clays. Estimates of recharge range from 10 to 80mm per annum (ref 4). Boreholes located in the alluvial formations have yields which are typically five times greater than those in the basement.

Groundwater in crystalline basement rocks occurs in the residual weathered overburden (regolith) and/or the fractured bedrock. The regolith contains the main groundwater storage in the basement, and may have enough transmissivity to support hand pumped boreholes. Higher permeability tends to occur in the basal regolith or in any intersected residual hard bands, such as vein quartz. Recharge to basement aquifers in Malawi has been calculated to vary between 30 and 150mm per annum which is substantial. The bedrock aquifer component may have high transmissivity if significant fracture systems are intersected, and in favourable circumstances can provide sufficient transmissivity to support high yielding boreholes.

Water quality in basement aquifers tends to be good but some quality constraints occur locally in relation to iron, sulphate and fluoride. Water in the alluvial aquifers varies from good to poor when it may have high contents of chloride, sulphate and dissolved solids.

2.2.4 Health

Malawi has one of the highest child mortality rates in Africa, which for children under five years old is 270 deaths per 1,000 live births. Malnutrition is the leading cause of infant deaths. However, of the ten most common infective and parasitic diseases, three quarters are linked in one way or another to water and sanitation (ref 3).

2.2.5 Water Policy and Strategies

The Government policy objectives, as stated in the "Statement of Development Policies 1987 - 1996" (ref 1), reflect those of the International Water Decade; to provide potable water to all people so as to reduce the incidence of water borne diseases and the time devoted by individuals to collect water.

For urban supplies, the aim is to meet the full demand with treated water, through both individual connections and communal water points.

The present coverage levels (ref 2), and targeted coverage levels (ref 1) are summarised in Table 2.1 overleaf.

Government policy priorities include:

- The extension of rural water supplies
- Maximisation of financial and technical self-sufficiency
- Conservation and protection from pollution of ground and surface water resources.

TABLE 2.3

PRESENT AND TARGETED SUPPLY COVERAGE

	1987			1996		
Category	**Total Population 000'**	**Population Served 000'**	**Coverage**	**Total Population 000'**	**Target coverage**	**Population Served 000'**
Lilongwe, Blantyre	560	470	84%	976	100%	976
Other urban centres	440	230	52%	870	85%	746
Rural Areas	7,000	2,500	36%	7,942	74%	5,860
Total	8,000	3,200	40%	9,788	77%	7,582

The strategies by which these sector development objectives shall be met, with specific reference to urban and semi-urban supplies, are summarised below:

- Planning, monitoring and new studies as required;
- Improve liaison between agencies;
- Investigate and introduce appropriate technologies and institutional arrangements;
- Extend urban supplies, particularly into peri-urban and traditional housing areas;
- Increase the role of the private sector in construction and maintenance of water schemes;
- Staff training;
- Decentralization of programme implementation, and establish regional organizational structure;
- Introduce new legislation.

It is recognised that in order to achieve these objectives, substantial financial assistance from international and bilateral sources will be required.

2.2.6 Organizational Structure - Water

The Department of Water within the Ministry of Works is responsible for the supply of potable water in the rural and urban areas with the exception of the Cities of Lilongwe and Blantyre, which are served by their respective Water Boards.

The division of the Department, and the respective responsibilities are summarised below:

Water Resources Branch

- Surface Water (Hydrology) Section. Maintains river gauging stations, collects and processes data.
- Groundwater Section. Responsible for all aspects of planning and development of groundwater, including the operation of a number of drilling rigs.
- Laboratory. Monitoring water quality and pollution levels.

Water Supply Branch

- Planning and Design. Responsible for the planning and design of new schemes, using consultants when necessary and if funding is available.
- Operation and Maintenance. Operates through a District Water Supply Fund on a commercial basis, divided into regional offices:
  Muzuzu (northern)
  Lilongwe (Central)
  Zomba (South)
  Blantyre (South)
- Rural Piped Water Supply. Responsible for the implementation of rural piped water supply schemes, generally financed by grants.
- Sewerage and Sanitation. The design and implementation of piped sewerage systems and septic tanks on request from local councils.

Water Resources Board

Statutory body for granting rights, and licensing the discharge of effluent.

2.2.7 Organization Structure - Sanitation

Sanitation activities are divided between a number of agencies with no clear demarcation of responsibilities. The main agencies involved in the sector are:

- Ministry of Works, Water Department (WD)
- Ministry of Health (MOH)
- Ministry of Local Government (MOLG)
- Ministry of Community Services (MOCS)

Other agencies which are involved and have interests in the sector include:

- Ministry of Agriculture
- Ministry of Education
- Department of District Administration and Rural Development in the Office of

the President and Cabinet.

- The Rural Housing Project
- The Malawi Housing Corporation

2.2.8 Donor Involvement

Most of the investments in the water sector projects are funded from external sources, and donor activity is consequently high. The position re funding is complex. A general picture is given in Section 10.3.4. Individual funding agencies appraise and assess discrete schemes to establish scheme conformity with their own funding criteria. The following bilateral and multilateral agencies having been involved in recent years (ref 2):

IDA	Rural piped schemes
DANIDA	Rural piped schemes, borehole/handpump programmes
ODA	Technical Assistance, institutional building
USAID	Main contributor to the rural piped water programme
JICA	Groundwater projects
GTZ/KFW	Blantyre sewerage scheme
AFDB	Urban centres water supply scheme
IDA	Lilongwe and Blantyre water supply schemes
UNICEF	Shallow wells/handpump programmes
UNCD	Urban communal water point projects
UNDP	National water resources master plan
World Bank	Low-cost sanitation, handpump testing programme
EEC	Shallow wells/handpump programme

Other international agencies are involved in small scale developments.

[illegible] in 14 towns ???

Low-cost water supply and sanitation facilities are also being provided to the Mozambican refugees in the southern border districts. These activities are being coordinated by UNHCR, however the provision of these emergency supplies inevitably places an extra workload on the Department of Water.

2.3 BACKGROUND TO PROJECT

The Department of Water is responsible for the planning design, construction, operation, and maintenance of all water supply schemes in urban centres other than those of Blantyre and Lilongwe.

The Department now operates over 50 such schemes with a total population of 300,000, supplying water through metered connections and communal water points. These urban schemes are operated through a treasury fund named the District Water Supply Fund (DWSF) which is based on commercial principles with the objective of being self-sufficient. Most of the urban schemes have their origins over 20 years ago, using water from a number of sources, the scheme capacities being augmented from time to time to meet the growing demand.

In order to prepare a development programme for the centres so that investments can be linked to development priorities in a more orderly fashion, the Water Department commissioned Carl-Bro International to conduct a Master Plan study of 44 centres. The Master Plan was followed by a feasibility study of 31 schemes, although for most of the schemes this only involved updating the cost estimates made during the Master Plan.

Eleven of the schemes that are included in the present study were included in the feasibility study. The exceptions being Namwera and Muloza, for which the Water Department prepared reports to a similar level as the Master Plan, and Balaka, which had been omitted from the feasibility stage as it was understood at that time that the town would be supplied from the Mpiri-Balaka rural water supply scheme.

CHAPTER 3

EXISTING SITUATION IN THE PROJECT DISTRICTS

3.1 SOCIO-ECONOMIC CHARACTERISTICS

The social infrastructure of the 14 districts is dependent on the economic, political and administrative roles they play in the national setting. Their economic and administrative roles determine their potential either to grow or to decline and the social services required for their existence.

3.1.1 Chitipa

Chitipa was originally founded as a fortress situated at the North-Western boundary of the country. The British set it up to tackle Germans occupying Tanganyika and Arabs involved in ivory and slave trade based at Karonga. Subsequently, it became an administrative centre with almost all government ministries and departments being represented including the District Commissioner, hospital, police, secondary school, Malawi Young Pioneer base as well as the business community.

The business community at Chitipa is mainly engaged in retail shop trading and trans-border trade with Zambia and Tanzania. The latter has attracted young men and women from other districts who use Chitipa as a transit centre. However, more and more people within the district are converging to the centre to take part in trans-border trade.

are mostly [illegible] appropriate?

Many people at the fringe of the town depend on agriculture, producing maize for sale. Characteristically, the civil servants at Chitipa engage in agriculture more or less at the scale of the surrounding villagers, because land is available. The resident population is dominated by civil servants but with a significant mobile business community. The rest are villagers who are part of the town by residence rather than activities.

The population of Chitipa township is estimated to be growing at 5.2% annually according to the 1987 population census. Factors include natural growth and the influx of trans-border traders in transit. The population might have been more if communication was easy. A Public bus reaches the town three days a week, but in the rainy season, several days or weeks may pass without public transport. Trans-border trade is usually conducted on foot so that many of those involved tend to come from within the district and to act as middlemen for those from other districts. This makes the population at Chitipa town variable. People move between villages where they are engaged in agriculture and the town which they use as a transit centre. Trans-border trade seems to be an important source of income for most young men and women.

3.1.2 Nkhotakota

Nkhotakota town is situated between Salima and Nkhatabay on the western shore of Lake Malawi. Its social infrastructure represents both a village and urban life style with the former dominating. The settlement pattern shows features different to other towns in the country in that village communities are found in the central areas, whereas in other towns such communities tend to occur at the periphery. Administrative institutions such as ministries and other government departments are scattered and mingled with the villages. The Anglican hospital at St Ann is one of the main institutions but it does not fall within a properly planned urban settlement. Nkhotakota has usually been referred to as the "biggest village" in Malawi.

The character it has seem to suggest historical events associated with the establishment of the Anglican Mission. This attracted many adherents from Likoma Island, who settled around the mission, thus becoming urban settlers but living a village life style.

Economically, the people of Nkhotakota depend on agriculture and fishing. Fishing has attracted many people from the up-land area who have contributed to the population increase. However, with the population at 12,149 in 1987 and the annual rate of growth at 1.6%, it has been one of the slowest growing towns in recent years. This is mainly due to the rising economic centre at Dwangwa, north of the town where a sugar factory has been established. Dwangwa, provides employment opportunities which Nkhotakota cannot do. The population at the town therefore includes civil servants, villagers, workers associated with St. Ann Hospital, National Oil Industries Limited, Admarc and Small Scale business enterprises. It is also a port, mainly for passengers using lake transport. Many towns people are low income because opportunities for earning money are severely limited.

3.1.3 Ntchisi

Ntchisi is an agricultural town situated in a fertile tobacco growing area, North-east of Lilongwe. Evidence of its agricultural base is the presence of the main Admarc Warehouse and market, their staff houses occupying the higher ground, over-looking other institutions. The settlement lies along the road from Dowa to Kasungu. About 500 metres to 1 Kilometre away from this road are villages such as Chiwembe I and II, Visanza which have been included in the town's water supply infrastructure.

The social infrastructure includes persons employed in Government administrative offices, the business community and the village agriculturalists. It is evident that the business community depends on agriculture through the production of tobacco. The pattern of life is village rather than urban: residential proximity being convenient rather than due to economic activities.

Because many people depend on agriculture, incomes are very low except for those involved in larger scale tobacco production at estates and those who run town businesses. Land availability around the town is too limited to facilitate productive agriculture by the large town population.

Ntchisi is one of the smallest centres under consideration although its area is greater than that of Chitipa. The town's population, numbering 3,080 in 1989, is scattered except in village community areas. The annual growth rate at 6.2% is one of the highest in the centres. The population, with the exception of the villages referred to, relates to those working for Admarc or running small businesses and those simply attracted to the town either in transit to other areas or in waiting for better non-agricultural income generating activities.

3.1.4 Dowa

Dowa provides a very good example of a town which dies when the economic role it used to play is removed and not replaced. In 1987 it had a population of 2,704.

It is one of the oldest administrative towns in the country. Its growth depended on its role as a labour recruitment centre for the South African mines. Symbols of this are the Wenela and Red Cross settlements between the Nanthomba Catholic Mission and Robert Blake Secondary School. In addition, Dowa had the main hospital for the treatment of tuberculosis (TB). With the stoppage of labour recruitment, the centre has deteriorated visibly. Only the Red Cross centre and some Government departments still operate. Many other institutions show physical decay.

Dowa includes villages such as Malata, Chiguduli, Chileka and Mvula which are within the town's social infrastructure and should be included in the services provided such as water supply.

The main source of livelihood is agriculture, many residents being subsistence farmers with unreliable cash income. Some of those employed in government offices and other organisations grow their own garden produce.

3.1.5 Salima

Salima is 100km east of Lilongwe and about 11km from Lake Malawi. Its social infrastructure reflects its role within the national economy as a centre for agriculture and transportation. These functions, and their associated services means that Salima has the potential to grow in size. According to the 1987 Census it had a population of 10,606.

Prior to the railway line being extended to Mchinji via Lilongwe, Salima was the main depot servicing the Central and Northern Region. Whilst this role is still essential the town is located in a very fertile area where cotton, groundnuts, rice and other agricultural products are produced. It is the Headquarters of the Salima Agricultural Development Division (SLADD). It also has a significant tourism industry which has resulted in the establishment of restaurants, rest houses and related activities. The establishment of a textile factory by David Whitehead and Sons Limited will enhance the economic status of the town and hence further increase the chances of growth.

Although Salima has the economic potential to grow, many residents will remain low income and marginalized to its activities and services. This is because the township incorporates village communities such as Simayera, Chisani, Kalonga, and Sinipha, whose economy is based on agriculture. There are also growing clusters of low-income population in Malimba location, Msangu and at Kamuzu Road junction. Many in these locations have not been able to appreciate an urban way of life; they are incorporated by inclusion as the major settlement expands. However their activities remain governed by village principles which usually do not involve monetary transactions.

The population of Salima town could increase fairly rapidly if the industrial developments started by David Whitehead and Sons Limited are followed by others that generate further employment opportunities. However, even these developments are unlikely to lead to a general improvement in the income of villagers in close proximity to, or within the town boundary. A likely outcome is an increased influx of people in search of employment which will increase the number of poor.

3.1.6 Dedza

Dedza is situated at the western border with Mozambique and along the main road between Blantyre and Lilongwe. The town's importance was initially associated with forestry products, evidence of timber processing being the saw mill at the base of the mountain. In recent years, Dedza town has hosted a large number of refugees whose thatched huts can be seen along the road between Blantyre and Lilongwe, south of the township. Whereas the initial impression may be that refugees from Mozambique live in designated camps, an assessment of the town reveals that many others are renting or squatting within the town. This is evident in an area around Umbwi Secondary School and the District Hospital.

In addition to the refugee population, there are also within the town village communities such as Kapalamula, Kasakaminga and Bokosi II which have to practice urban life while in the village. People in these villages have lost some of their land to refugees thus limiting their agricultural activities and their livelihood. Some are actually worse-off than refugees who are given relief items from time to time. Refugees who are not given money are able to generate cash through the sale of part of what they receive. This appears to be a very common practice in the township and the surrounding area. However, such income is very unpredictable and not sustainable.

The influx of refugees from Mozambique and those subsequently displaced has contributed to a rapid increase in population during the last decade. The Census put the town's population at 16,735 in 1987. The rate of growth at 11.0% per annum is the highest among the towns under consideration; however such a growth will have a limit. Dedza does not have a strong economic base which would support growth in the non-agricultural population in the future. At present it seems that the security problems of the border region have forced some people to the town. This implies that their economic status must be poor and so unable to meet the urban financial obligation which includes payment for water supply.

3.1.7 Namwera

Namwera is not an administrative centre but a service centre associated with the agricultural activities of Estate Farmers, mainly Greek in origin. The main institution is an agricultural station. There is a trading centre which includes machinery factors, some retails shops and rest houses. There is also a Police Station, a Catholic Mission with a primary school and Malawi College of Distant Education (MCDE). Although it is situated well away from Mangochi, it has benefitted from rural electrification.

Apart from those dependent on the above activities and institutions, the majority of residents are villagers whose level of income is very low because they are mainly subsistence farmers. Namwera is still considered rural although it has been included in the project. The core population may not be more than 3 000. The growth rate in the last decade may be high because of the influx of refugees from Mozambique. The Census results for this town are not available.

3.1.8 Balaka

Balaka's importance as a township is based on the transportation role it plays in the national economy. It is the largest settlement in Machinga district and whilst it acts as a sub district it is economically the most important district centre.

The social infrastructure includes the business community, transporters, ADMARC and missionaries. The missionaries are developing educational institutions around the town which must be considered in future plans for service provision.

The main road from Blantyre to Lilongwe passes through Balaka as also does the railway line connecting with the lake service at Chipoka enroute to Mchinji. The Mpira/Balaka Rural Water Project has its Headquarters here. Although the urban centre is distinct, it has village communities around it. There are concentrations of population at the south of the town along the railway line to Blantyre and beyond ADMARC on the road to Mangochi via Toleza Farm. The urban development seems to be pushing westwards across the main road to Lilongwe beyond St Bernadetta Mission. Houses constructed south of the mission tend to be very big and far apart. It is said that the owners are resident either in Blantyre or Lilongwe and the properties have been rented out.

Apart from being a transportation centre, it is also situated in an area where cotton is grown and ginneries exist around the township. Because of these economic activities, particularly business transactions, the town is likely to grow in population. In 1987 it had a population of 9,081. It was also observed that many people carrying out activities within the township reside outside the town and hence they are excluded from population figures. However, this also suggests that for many of them their source of livelihood is agriculture supplemented by business.

3.1.9 Chikwawa

Chikwawa is mainly an administrative centre with very limited economic activities. The centre is dominated by Government Departments such as Ministries of Works, Agriculture, Office of the President and Cabinet and the Secondary School. Outside the government institutions, there is a Muslim Centre, a Catholic Seminary School and Primary School and a Council market. The settlement is scattered without elaborate structure. At the fringes of the town boundary there are village communities who practice a dual economy of farming and small business enterprises.

Although the district is known for the production of cotton, a view supported by the presence of the ADMARC Depot it seems cotton production is located well away from the township. The level of income of the resident population is generally very low.

The population of Chikwawa town, which stood at 4,344 in 1987, includes a small proportion of displaced people. However, future growth will depend on the outcome of the development of Kapichira Falls as a source of electricity, and for irrigation. These developments may stimulate other economic activities which could then result in the growth of Chikwawa into a big town - with an important economic base.

3.1.10 Nchalo

Where will improvement be made?

Nchalo is a township developed as a result of the sugar industry, being the main base of the Sugar Corporation of Malawi (SUCOMA). It has workers from all over the country. Although most of these reside within the Sugar Estate area, a service centre with business establishments has developed on the road about 25 kilometres south of Chikwawa. This place is economically more active than Chikwawa proper.

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Around the Trading Centre, outside the Estate, is the St. Montfort Catholic Hospital, a police station, some settlements of people who cannot be accommodated on the estates and others engaged in selling salt. However, many people not connected with the sugar estates are farmers who have produced very little because of inadequate rains and as such, have low incomes.

The present population of around 10,000 includes the majority working in the sugar estates. Future growth will depend on the expansion of the sugar industry and the possibility of developing other resources.

3.1.11 Ngabu

The social infrastructure of Ngabu is based on agricultural development, mainly the production of cotton. It is the Headquarters of the Lower Shire Agricultural Project known as Ngabu Agricultural Development Division (NADD).

Ngabu is a Traditional Authority whose original settlement has been engulfed by the growing influx of workers attracted by the agricultural project. Whereas the office blocks of the NADD are to the east of the Chikwawa - Nsanje road, the residential houses of staff members are about 1 Kilometre west. In between there is a cluster of houses which include villagers native to the area and workers on the project. The settlement also contains an Agricultural Training Centre, a primary school and a business centre.

The population estimated at 5,678 in 1987, is a conglomeration of employed, unemployed and business people, the businesses including beer brewing and farming, represents a diversity of income groups. The township is more of a village than an urban area and many people may not be able to fulfil the financial obligation of service provision e.g. paying for water.

3.1.12 Luchenza

Luchenza was declared a township two years ago. It is one of the main railway stations between Blantyre and Nsanje. Although the South railway line has declined in economic significance as far as transportation of imported and exported goods is concerned, it remains an important national station for goods and passengers. It is also situated in such a way that it serves the Tea Industry in Mulanje and Thyolo districts by facilitating transport.

In recent years, it has developed as a food processing centre, represented by Nali

Food Processors. A new secondary school has been opened, also a produce market and an attempt is being made with German funding to develop it as a growth centre. Luchenza is on the Thyolo side of the river but across the bridge there is Chonde trading centre which has a tailoring shop for the handicapped on the Mulanje District side. At Chonde there is a Health Centre and the two places are practically the same.

Residents are farmers but most of them have small land holdings because of high population densities. Some have no land and depend on employment in Tea Estates. The majority however have low income and depend on very limited resources.

The population of Luchenza was 4,737 in 1987. Luchenza may have the potential to grow both in population size and settlement. Its viability will depend on the economic activities that may be developed to support the growing population. Otherwise, the system of social service provision may break down with serious socio-economic consequences.

3.1.13 Muloza

Muloza is a trading centre located near the border with Mozambique in Mulanje district. It is located in an agricultural area producing tea and fruits. Many people at the centre and the surrounding villages are subsistence farmers. The area is one where people have small land holdings because there is a high population density. The results of the Census for the population of this town are not available.

The centre is within a rural piped water project but recently, there has been population growth due mainly to the influx of Mozambican refugees. The inclusion of this refugee population may have an important implication on service provision in the long term when the refugees are repatriated.

The potential for economic growth will be limited by the absence of viable non-agricultural activities which could benefit those without adequate land. Agriculture will however remain the main source of livelihood so non-land owners may well become part of the centre, but live in poverty due to lack of the means to earn income.

3.1.14 Nsanje

Nsanje used to be an important railway station between Blantyre and Beira in Mozambique. The civil war in Mozambique has rendered the route under used and hence initiated economic stagnation. However, it is an administrative centre with Government departments represented. There is a hospital, a Catholic Mission and educational institutions both primary and secondary.

Economic activities include rice growing and fishing in Shire River. The majority of the population are agriculturalists dependent on farming. However, the district hosts the largest number of refugees many in the town centre. At the same time, many local people have settled at the centre forced away from their border villages by fighting in Mozambique. Such people are very poor as evidenced by the quality of their houses.

However, it is expected that if peace can be achieved in Mozambique and the railway becomes fully operational again, the population of 10,042 in 1987 will grow. This will create a demand for social services including water supply. Even at this point in time, the town requires improved water supplies because most sources are contaminated through flooding because it is in a low lying area.

3.2 WATER SUPPLY

3.2.1 Inspection tour and assessment

In order to assess the status of facilities in the various project schemes, a programme of visits was arranged together with the Water Department.

The current situation is that households which have limited or difficult access to piped water supply rely on a variety of means to fulfil their requirements. This includes making use of traditional sources such as protected and unprotected wells, streams, lakes, ponds, etc. It was also noted that traditional households with tin roofs tended to supplement their sources by collecting rainwater.

The situation varies throughout the project areas with some districts suffering more acute water shortages than others. However, the poorer members of the communities suffer most in all districts. What is rather important is that the majority of poor households, which have to reply mainly on traditional water sources try to obtain potable water for ~~at least drinking~~ and cooking. This seems to be supported by a recent study (ROC : February 1992) that in places like Chisapo, with problems of inadequate ~~water supply facilities~~, 90% of the traditional households claimed that they used protected sources for drinking and cooking.

available?

The effects of the present water shortages in the project areas are particularly severe for the poorer households. In addition to relying on traditional unprotected sources, the people have to queue for long periods at the existing CWPs or/and walk long distances just to ensure that they have safe water for at least drinking and cooking.

Basic data for each town was collected and compiled to provide basic information on the adequacy of water supplies to each scheme in terms of quantity of water supplied, population served, quality of water and availability, in accordance with ODA's guidelines for appraisal of Water Supply Projects (ref 7).

3.2.2 Population coverage and existing service levels

The population coverage and existing service levels have been assessed by using data collected during the inspection tour. To arrive at the estimated coverage of population within the various centres, it was necessary to make a number of assumptions as follows:

find out reliability existg supplies.

- Production capacity has been assessed assuming 18 hours pumping per day. This allows time for routine maintenance and repair. Gravity schemes assumed 24 hour supply. Where applicable, the additional capacity provided from the recent drilling programme has been added.

- The percentage coverage, and equivalent per capita consumption were calculated from the production figures, after making appropriate allowances for existing institutional and commercial demand, assuming:

- 30 households per communal water point
- 5 people per household
- The per capita consumption from individual connections is five times greater than from communal water points. 20-50. may be less (see Pfeil, p.8).

Due to the necessity of having to make these broad assumptions, some degree of caution is necessary in the interpretation of the results. Nevertheless it is considered that the results of this exercise, as provided in table 3.1 below provide a useful general indication of service levels and coverage in the district centres.

The apparent variation in per capita consumption is probably a reflection of the relative availability of water in each district combined with the influence of factors such as scarcity of alternative traditional sources. The data is not available to precisely determine the consumption patterns according to individual consumer categories in each district. This would require detailed water consumption statistics and extensive observation studies of the water consumption patterns of traditional households. In the absence of this information, the data presented in Annex 7 provides a useful general indication of service levels and coverage in the district centres.

find out how much water is collected.

Based on these figures, approximately 60% of the total population is provided with water, 40% through communal water points and 20% through individual connections.

The number of existing individual connections would appear to correspond roughly with the total number of people living in the low and medium density housing areas.

TABLE 3.1

POPULATION COVERAGE AND SERVICE LEVELS

	Town	Number of		Equivalent consumption		Percentage of population served	
		ICs	CWPs	Ics	CWPs	Ics	CWPs
1	Chitipa	188	17	168	34	15	41
2	Nkhotakota	312	16	130	26	11	17
3	Ntchisi	206	11	85	17	30	48
4	Dowa	190	5	69	14	32	26
5	Salima	428	31	231	46	17	37
6	Dedza	463	24	145	29	11	18
7	Namwera	59	0	128	-	13	
8	Balaka	350	33	256	51	15	42
9	Chikwawa	188	17	153	31	20	54
10	Nchalo	85	16	112	22	4	22
11	Luchenza	167	10	202	40	12	22
12	Muloza	15	0	259	-		
13	Ngabu	279	27	104	21	21	61
14	Nsanje	220	21	166	33	10	29

3.2.3 Existing facilities

Most of the towns are supplied from boreholes delivering water directly to reservoirs, from which water is then supplied by gravity to consumers.

Insufficient attention to the potential of pollution to ground water sources has been given during the original siting of boreholes, and to the maintenance of pollution protection zones. As a consequence, many of the boreholes must be assumed to be polluted to some degree. Boreholes are pumped for sufficient hours each day to meet the demand. Where this is not possible, 24 hour pumping is adopted. This leaves no opportunity for borehole testing, or to conduct preventative maintenance. Treatment of borehole waters is limited to chlorination. Methods adopted for chlorination were found in many cases to be unsatisfactory, particularly in the light of the potential risk of pollution to many of the boreholes. This aspect is discussed in more detail in Chapter 7 on design criteria.

Reservoirs are either elevated, or situated on conveniently located high ground so that water can be supplied by gravity to the surrounding areas. However the extent of the areas supplied from these reservoirs is such that minimum service pressures are rarely achieved throughout the area.

Three of the towns, Ntchisi, Dowa and Dedza have additional supplies from surface water sources, and each uses a different method of treatment. We do not consider that the technology adopted in the design of the works to be particularly appropriate to this size and type of scheme. We would prefer that more attention is paid to the reduction of machinery and plant. This is discussed in more detail in Chapter 7.

Storage provided at the schemes, calculated as the number of hours storage available based on the projected peak daily demand figure for 1991, is indicated on table 3.1 below, and varies from 15 to 4 hours. Storage requirements are also discussed in more detail in chapter 7, however the schemes appear to meet the minimum requirements of 4 hours for multiple source schemes, and 6 hours for single source schemes.

The situation existing in the various centres in terms of production facilities available, compared to the revised projected peak demands for 1991 is also summarised in table 3.2 below.

The capacity of the source works for many of the existing schemes has been augmented through the drilling programme conducted for the Master Plan. This has resulted in most of the schemes having adequate source capacity to meet the existing requirements. Among the exceptions to this are many of the larger towns.

TABLE 3.2

EXISTING FACILITIES AT DISTRICT CENTRES

	Centre	1991 Population	Source	Existing Capacity m3/d	Projected Demand m3/d	Existing Storage m3	Existing Storage hrs
1	Chitipa	6290	B/H	684	688	292	10
2	Nkhotakota	14320	B/H	1450	1185	550	11
3	Ntchisi	3450	River+B/H	222	383	112	7
4	Dowa	2930	Stream+B/H	430	310	114	9
5	Salima	12455	B/H	666	1272	227	4
6	Dedza	20340	Stream+B/H	625	1424	407	7
7	Namwera	2300	B/H	187	240	90	9
8	Balaka	11680	B/H	518	1878	571	7
9	Chikwawa	4760	B/H	1273	381	166	10
10	Nchalo	10775	B/H	176	641	109	4
11	Luchenza	6940	B/H	743	603	227	9
12	Muloza	790	B/H	36	76	43	14
13	Ngabu	6590	B/H	504	781	235	7
14	Nsanje	10870	B/H	1019	761	182	6

The production capacity of the existing boreholes at Salima reduces significantly during the dry season, resulting in shortages, especially in the higher and more distant areas.

The situation at Dedza is not quite as poor as the above figures indicate, since the population figure is probably swollen by the presence of refugees on the periphery of the town. Three new boreholes have been drilled within the area, and when equipped these will help to satisfy much of the refugee demand.

It had been intended to supply the town of Balaka through the Mpiri Balaka rural piped water supply scheme. However pressures to broaden the area of supply of this scheme has resulted in the situation that there is not sufficient capacity remaining to serve the town. The present source capacity of the town is insufficient and additional water is being supplied for the time being from the Mpiri Balaka scheme. Additional sources are therefore urgently needed.

The new boreholes at Nchalo, when equipped will provide additional capacity. However the long term adequacy of groundwater in terms of water quality has yet to be proved.

3.2.4 Operation and Maintenance

The status of many aspects of operation and maintenance of the schemes was found to be encouraging. Pumping stations and treatment plants were generally both clean and tidy, and the painting of most structures was of a high standard although evidence of corrosion on some steel tanks indicates that this has not always been so.

There were however a number of areas where improvement is required:

- Monitoring of boreholes. Equipment and facilities are required at all schemes to enable water levels of boreholes to be monitored.
- The lack of monitoring facilities is partly the reason for poor operational procedures relating to overpumping of boreholes. Better information on drawdown levels, and improved understanding of the effects of overpumping is

likely to increase the life of plant and facilities.

- Meters and flow recording. Many of the larger sized meters, on which an accurate assessment of the water supplied to the schemes are dependant, were either not working or were obviously inaccurate. Operators should generally be more aware of the importance of records, and the need to both check the accuracy of meters and to report faults immediately.
- Awareness of pollution hazards: There appeared to be very little appreciation of the potential for groundwater pollution. Evidence of this includes the location of septic tanks close to boreholes within the Water Departments own yards, and the positioning of boreholes close to the graveyard at Nchalo.
- Chlorination: The actual chlorination residuals, when measured during the inspection visits were generally found to be satisfactory. The trial and error methods adopted for chlorination however do not guarantee this situation.
- Water quality monitoring and control: Staff based at headquarters are responsible for this. However due to limited resources, and the enormous extent of the job, it is not effective.
- Provision of standby facilities that will both allow a more reliable supply, and enable preventative maintenance to be introduced.

3.2.5 Billing and Revenue Collection

All individual connections and communal water points are metered, and are read monthly by Water Department staff. Meter slips are forwarded to the appropriate Regional Office who issue bills to consumers by post. Billing is in the process of being de-centralised, and certain of the larger towns such as Salima have taken over these billing duties from the Regional office.

Communal water points are treated similarly to individual connections, with the elected water point chairman, or usually chairwoman, being billed. It being the chairwoman's responsibility to collect money from users of the water point, normally MK 1 per household. At present tariff levels, this is equivalent to 23 litres per capita per day for a household of 5 people.

In order to limit the quantity of water consumed from a communal water point to that covered by the MK 1 contribution, the tap is normally only opened for limited periods during the day.

The approach adopted towards communal water points appears to work well, although there is inevitably a section of the community who are either unable or not prepared to pay the charges levied. Isolated problems have occurred in some schemes however. This appears to be related to the communities preparedness to pay, when communal water points are located close to alternative sources such as lakes or rivers.

to be verified by study

Running accounts are maintained for each connection, and any private connection in arrears for more than 90 days is disconnected. Reconnection is not made until after full payment is met together with a reconnection charge. This ensures a high percentage revenue collection from the private sector.

Institutions are also billed regularly on a monthly basis. However it is difficult to disconnect such establishments as schools and hospitals, and institutions are not therefore generally subject to disconnection for non payment. As a result, payments from institutions are often in arrears, typically by 6 months, and it was reported that there are currently MK 3 million in debts outstanding from institutions alone.

The fact that institutions account for approximately half of the total bills issued indicates the seriousness of this situation with regard to the fund's cash flow.

3.2.6 Sanitation

None of the 14 urban centres considered in this project have piped sewerage systems, towns with sewerage systems being limited to five urban centres, namely Lilongwe, Blantyre, Zomba, Liwende and Muzuzu. Sanitation facilities in the 14 centres are limited to septic tanks and pit latrines.

Piped sewerage systems are not affordable for the vast majority of the population in the scheme areas, and therefore cannot be considered as an appropriate solution at present. The situation must however be kept in review especially in the centres of some of the larger towns with respect to population densities and potential aquifer pollution.

The occurrence of septic tanks is generally limited to permanent housing and institutional and commercial premises. Traditional housing areas rely extensively on pit latrines. The National coverage of the rural population by pit latrines is 54%, and figures obtained from the Ministry of Health (ref 9), suggest that this is similar in the peri-urban areas. Actual coverage in the urban areas however may be higher due to families sharing facilities. Existing latrines frequently suffer from poor design and maintenance (ref 2). Improvement of existing facilities must therefore be included in any sanitation component within urban centres.

By far the majority of the population live in traditional housing areas, and they are frequently the most rapidly developing sector of urban centres. The promotion and development of appropriate low-cost sanitation facilities for traditional housing areas, is therefore a high priority. Recent sanitation programmes have centred on the use of a squatting slab designed to secure hygienic conditions and child safety, called the "San-Plat". In rural areas, assistance has been given towards the purchase of materials, relying on the communities to provide the necessary labour to complete the installations. In urban areas there has been a tendency to sell completed slabs.

A significant development in the sector has been the Hygiene Education and Sanitation Promotion (HESP) programme, which comes under the MOH, and operates in conjunction with water supply projects mainly in rural areas. It is the intention of the MOH to extend HESP coverage to all urban water supply schemes. This target cannot however be achieved without additional funding and manpower.

3.3 INSTITUTIONAL STRUCTURE

3.3.1 Introduction

The role and policy of institutions involved in the Water Supply and Sanitation sectors, including Health and Education and operation and maintenance, is summarised in the present section.

The ownership of all public water in Malawi is vested in the President, and responsibility for its control is vested in the Minister, in accordance with the Water Resources Act (Cap. 72.03) which provides for the control, conservation, apportionment and use of the resource.

Within the context of the Second Statement of Development Policies, 1987 - 1996, Government accepts a responsibility to ensure the appropriate provision of economic infrastructure, including water supply, and in its concern for equity as well as economic progress supports a rising level of expenditure on social services, in particular primary health care, rural water supply, and low cost housing. Highlights of the policy objectives and strategy for Water Resources (Chapter 3.29) include:-

- In terms of human consumption the provision of a reasonably accessible clear, potable water to the whole population as a means of reducing both disease and the time devoted to water collection. By 1996 this target should be almost 80% realised.

- Financial and technical self-sufficiency within communities are seen as important targets

- Particular attention will continue to be given to a range of priority disease programmes

It is against this background that the policy and strategies of the various institutions active within the water and sanitation sector are set.

3.3.2 Water Department

The Water Department, contained within the Ministry of Works, has roles of primary significance in the Water Sector.

It is the managing authority for the national water resource, responsible for the acquisition of climatological, hydrological and hydrogeological data, and for the recording, analysis and interpretation of the information so obtained. It monitors water effluent quality. This range of activities enables the Department to have principal input to the planning and development of water resources. It has recently published the National Water Master Plan, which gives detailed recommendations on resource development for a range of user interests.

It also provides the administrative facility and the technical and logistical support and advice to the Water Resource Board.

The Department is an operating authority for water supply, being responsible for the supply of water for public purposes to the whole of Malawi other than those areas excepted by special statute, viz. the Lilongwe and Blantyre Water Boards.

Within the urban areas the Department endeavours to operate on a quasi - commercial basis, recovering costs (including development), by revenue income. Consumers are supplied either through individual metered connection or via a communal water point (CWP). In this case, consumers groups are encouraged to elect a "tap committee" responsible for operation and maintenance of the point and payment of water charges. The Department manages an operating account, known as the 'District Water Supply Fund' which provides overall coverage to these installations.

Within the rural areas, whilst the Department implements a water supply scheme (be it ground or surface water) it is then passed into the ownership of the local community, who become responsible for its operation and maintenance. The Department retains an advisory role and provides assistance if more complex technical matters arise. The service to the rural community is free of charge.

A further role of the Department is in the design, operation and maintenance of sewerage systems - by providing technical support/advice where piped waterborne systems exists outside the main conurbations of Lilongwe and Blantyre, and by operation and maintenance of systems at discrete Government institutional complexes.

Implicit within its operating role, the Department is a charging authority for the services of water supply and/or sanitation. It therefore sets tariffs and other standard charges for approval by Government and collects the revenues due.

The principal policies of the Department are:

- The provision of clean potable water to all people so as to reduce the incidence of water borne disease. (50 per cent of all illness in Malawi).

- To reduce the time devoted by individuals to water collection.

- For urban supplies, to meet the full demand for treated water, with individual connections for those who can afford them and either standpipe or kiosk services for those who cannot.

- For the rural population, the target is the provision of 27 litres per head per day from groundwater sources and 36 litres per head per day from piped schemes of safe water at a maximum distance of 500 metres where feasible.

The first priority for available resources will be coverage of the rural areas, including maximum liaison with developments in such fields as agriculture, health and hygiene education.

Future priorities are:

- Maximisation of financial and technical self sufficiency for both urban and rural water supply schemes.

- Conservation and protection from pollution of Malawi's ground and surface water resources.

3.3.3 Ministry of Health

Following a period of rationalisation of the water sector (1979-84) the roles of the Ministry of Health in respect of water and sanitation has been unchanged and are:

- To monitor the quality of water supplies

- To promote the quality of rural water supplies

- To promote the quality of rural sanitation

These latter two roles are confirmed in the statement of Development Policy 1987/1996:

"The Environmental Health Section of the Ministry of Health and the Water Department of the Ministry of Works co-operate in organising the provision of sanitation and water supply systems to the rural communities, where the former provides the sanitation systems and the latter the water supply systems."

The overall policy objectives of the health sector is to raise the level of health of all Malawians by reducing the incidence of illness in the population. The basic philosophy addressing that objective is Primary Health Care (PHC) which inter-alia includes a range of priority programmes to combat disease. Those of relevance to the water/sanitation sector include:

- Hygiene Education and Sanitation Programme (HESP) to promote latrine construction activities, followed up by health education support.

- "Combating Childhood Communicable Diseases" focusing on the reduction of child morbidity/mortality, in particular that caused by diarrhoea.

- "Environmental Health Programme" involving water quality monitoring, food inspection, hygiene in buildings, vector control, public health education and the encouragement of proper sanitation.

- The Bilharzia Control Programme - limited to a few seriously affected districts.

Resources are also devoted to reducing the impact of malaria, involving public education, and better co-ordination between malaria and other disease programmes, in particular that for diarrhoea.

Health Education is to be re-organised as an autonomous division within the Ministry, with Education Units at regional and district level supporting the PHC approach.

3.3.4 The Blantyre and The Lilongwe Boards

These two parastatal bodies have identical roles in the water sector. They are operational authorities charged with the responsibility of providing safe, potable water to consumers in their respective areas of supply at defined levels of risk. They are expected to be commercially viable, with revenues covering both operating and development costs.

The Boards are directly responsible to the Department of Statutory Bodies, in the Office of the President and Cabinet. Performance is assessed in terms of a 'Contract' with Government requiring achievement in accordance with stated parameters dealing with the effectiveness of its operations (degree of supply failures, time to provide services) its efficiency, (unaccounted in water volumes, staff/production ratios) and financial performance (operating profit, rate of return, average debt collection period). Supplies are available to consumers either as private connections or through water kiosks.

The status of the Board is in the nature of a Trustee body, its resolutions requiring verification by the Department of Statutory Bodies after consultation with the Parent ministry, the Ministry of Finance and other appropriate ministries. Representation on the Board by bodies such as the Ministry of Local Government, Malawi Housing Corporation, the City Council and the Ministry of Works facilitate co-ordination of policy and procedures with other Government departments.

Corporate plans, defining the mission, policies and objectives of the Board are updated and issued on an Annual basis.

3.3.5 The Water Resources Board

The Water Resources Board comprising representatives of the Ministry of Agriculture and Natural Resources (2No), the office of the President (1No), Water Resources Division (1No), the Ministry of Trade and Industry (1No), plus 6 other appointees, is empowered and has duties specified in the Water Resources Act (Cap 72.03).

It administers procedured aspects of applications for rights to abstract water and/or to discharge effluent, and makes recommendations to the Minister who is empowered to determine the matter.

It also makes recommendations on the acquistion of easements for holders of water rights, and has power to call for information and to inspect works to ensure that the terms of a right are being met. If the works are not compliant the Board may order modification or demolition.

The Board is empowered to establish hydrometeorlogical stations and to make surveys in the interest of the conservation and best use of water in Malawi.

It is understood that at the present time a modified Water Resources Act has been drafted and awaits Parliamentary approval. The new legislation, as enacted, would enhance powers to act against those who pollute water and provide for the inspection of water quality.

3.3.6 The Ministry of Local Government

This ministry is the parent ministry of the various local Government institutions in Malawi; numbering 36 in total and comprising:-

3 City Councils:	Lilongwe, Blantyre, Mzuzu
1 Municipality:	Zomba
8 Town Council:	Balaka, Dedza, Kasungu, Liwonde, Luchenza, Mangochi, Salima, Karonga
24 District Councils:	Chitipa, Karonga, Nkhatabay, Rumphi, Mzimba, Kasungu, Nkhotakota, Ntchisi, Dowa, Salima, Lilongwe, Mchinji,

Dedza, Ntcheu, Mangochi, Machinga, Zomba, Chiradzulu, Blantyre, Mwanza, Thyolo, Mulanje, Chikwawa, Nsanje.

The ministry provides technical support and advice on sanitation matters to the urban authorities, although in some cases, where reticulation systems are involved either to a treatment works or to a collective septic tank, technical advice has been provided by the Department of Water.

In so far as the District Councils are concerned, whilst principal responsibility is with the Ministry of Health (through the HESP programme), the Ministry of Local Government have input, particular in the promotion of construction of the improved pit latrine (Sanplat) and some logistical support.

The City Councils of Lilongwe and Blantyre are the only authorities having significant sewerage reticulation systems and treatment plants - however in the case of Lilongwe the plant is virtually inoperable and Water Resources Board are initiating action because of pollution to River Lilongwe, and in the case of Blantyre the condition of the plant is such that severe difficulty is experienced in coping with the mixture of domestic and industrial effluent received at the works.

Policy statements in respect of sanitation do not appear to have been promulgated, however a number of studies have been carried out by the UNDP/World Bank Regional Water and Sanitation Group:-

- "Water and Sanitation Sector: Sector Position Paper and Action Plan"
- "Institutional Responsibilities and Collaborative Arrangements in the Water Supply and Sanitation Sector"

As a result of these studies, the government made plans to intensify efforts to improve sanitation coverage within the overall primary health care policy.

The main conclusions/recommendations of the Strategy Paper, Working Documents (August 1989) were:

- Proposed goal for improved sanitation to be 80% coverage by the year 2000.

- The technology choices made by Ministry of Local Government appear to be appropriate and the most affordable

- The Ministry of Local Government and the Ministry of Health should be the primary agents in the delivery of the sanitation service.

- Water development projects should be implemented with due regard to sanitation and health education components.

- A water, sanitation and health sectoral committee is required to co-ordinate the development of these sectors in a rationalised fashion.

3.3.7 The Ministry of Agriculture

The bulk of Malawian agriculture is rain-fed will only 20 000 hectares under irrigation. Ministry policy is to re-habilitate a number of small existing schemes and to undertake further studies in specific areas, and as such the Ministry has a small, but important role in the water sector. Institutional arrangements for planning and support services in the irrigation sub-sectors are stated to require delineation following the transfer, in 1987, of responsibility from Ministry of Works to the Ministry of Agriculture.

However this Ministry has a nationwide extension network, established to provide support services to the farming community. The framework for the services is well established, comprising a multi disciplined, integrated system, decentralised into 8 Agricultural Project Areas (APA) and 180 Extension Planning Areas (EPA). The covering programme of National Rural Development (NRD) has invested heavily in a range of economic and social infrastructure. Extension staff have provided considerable assistance in promoting and implementing later construction projects in some of the ADA's.

3.3.8 The Ministry of Community Services

The Ministry of Community Services initiated and ran a number of successful rural water schemes for more than a decade, and whilst there is little reference within its portfolio to the water supply and sanitation sector this historic attachment, together with its ability to facilitate the integration of community development skills is an important factor in the successful implementation of sectoral programmes.

Through the secondment of Community Development Officers, goals can be set to ensure that communities are trained to support and manage water and sanitation facilities.

3.4 FINANCIAL ANALYSIS

3.4.1 Accounting and Financial Systems

The Water Department of the Ministry of Works has financial staff dealing with, inter alia, accounting, billing, payment of creditors, commitment accounting, cost analysis, asset register and loans. The payroll functions for established staff are carried out by government whilst the payment of wages is normally carried out by the Water Department.

There is a Principal Accountant responsible for three streams of accounting and financial systems. The three strands involve two different accounting regimes. For the District Water Supply Fund and the Borehole Fund commercial accounting conventions are utilised. For the third strand called General and Administration Expenditure and involving revenue expenditure, development accounts and deposit accounts, government budget accounting conventions are used.

For these three streams completely separate prime systems are kept. There is no attempt to group together, for example, creditor payments staff to maximize skills and experience and to concentrate resources.

The reasons for keeping the three separate was to enable the two funds to become, over a period of time, self financing. The General and Administration annual expenditure is seen as being normal governmental expenditure which should be met from other government resources and hence, receives a budget allocation. The other two funds are separate as they have different objectives.

The General and Administration expenditure, besides including the expenses of the Water Department Headquarters, also includes the costs of the 3 regions - namely:- Northern, Central and Southern. Water Department salaries are generally recharged to the District Water Supply Fund or to the Borehole Fund but other expenditure is not. There is, therefore, an element of under charge to the two funds.

Financial statements for the District Water Supply Fund (DWSF) and the Borehole Fund (BF) are produced for every fiscal year - 1st April to 31st March. The financial statements consist of Profit and Loss Accounts and Balance Sheets. No Source and Application of Funds Statements are produced. The submitted statements are audited by the Auditor General and the public then has access to them.

The statements are incorporated into government financial reports such as the 'Budget and Performance Report on Treasury Funds 1990/91'. In these documents the capital expenditure incurred in the year for, respectively, the District Water Supply Fund and the Borehole Fund is added to the accumulated losses from previous years.

There is not an internal audit section within the Water Department, but there are auditors within the Ministry of Works who are assigned from time to time to audit the Water Department.

The financial and accounting processes are mainly clerical systems although the General Ledgers for both the DWSF and the BF are now contained on personal computers. There has to be a significant manual intervention to take the information from the subsidiary primary financial systems to enable input to take place onto the General Ledger Systems. Firm plans do not exist for computerising further applications but it is anticipated that the payment of creditors and commitment system will have the highest priority.

The accounting systems and processes are kept completely separate with different personnel performing the same tasks for each of the three prime areas of activity. There are separate bank accounts maintained at the 3 regional offices and at the Headquarters again split between the three prime areas of activity.

An asset register is maintained but the Water Department recognises that it is incomplete and that the values recorded are not reliable. A study is being undertaken to correct the situation.

3.4.2 Performance and Output Measures

The Water Department has introduced performance indicators for District Water Supply Fund Schemes. These measures include physical indicators such as:

- population;
- no. of meters;
- length of Main;
- volume produced;
- volume supplied;
- leakage rates;
- no of meters repaired.

The above are complemented by level of service indicators such as:-

- number of bursts per Km of main;
- percentage of connections suffering more than 2 hours lack of supply;
- percentage of replies to correspondence within 14 days;
- percentage of bills correct.

At the moment there is no formal system for relating these indicators to their associated costs. Whilst the present accounting system cannot cope with providing such management accounting information at the detail vote level, it should be possible at the per District level.

3.4.3 Public Sector Investment Programme

Project and development expenditure is contained in the Public Sector Investment Programme (PSIP) on a five year rolling basis.

Each ministry puts forward its strategies to meet the objectives of the agreed policies of the Malawi Government. These strategies are reviewed and where appropriate re-profiled by the Economic Planning and Development Department. The agreed changes are incorporated into the PSIP together with an update of actual and refined estimates of project costs. The PSIP records how individual projects within sectors should be financed e.g. by grant or loan. If known, the PSIP indicates the anticipated donor for grant aid and the proportion expected. The water and sanitation sector is considered to be in the 'social' element of the PSIP.

The PSIP when approved by Government is the major mechanism for controlling and influencing capital investment. The Carl Bro proposals are in the PSIP.

3.4.4 Recurrent Expenditure

For recurrent expenditure, sometimes referred to as revenue expenditure, every ministry submits estimate proposals to the Ministry of Finance. These estimates are supported by statements of the intended use of the funds and confirmation that they are to be expended on approved policies.

For the water votes there is a clear route of responsibility. It is from the Water Department via the Ministry of Works to the Ministry of Finance. For sanitation votes the route of responsibility is not clearly defined. The ministries involved are:- Local Government, Community Services, Works and Health. There is no central attempt to aggregate sanitation votes or to see if there is an overlap; it is unlikely that this could be achieved with the existing framework of functions.

It is understood that only a minority of ministries reflect the recurrent impact of project investment. The PSIP attempted to show this on a formula basis but it was decided that ministries should estimate the annual costs arising from capital expenditure and include them in their budget submissions.

3.4.5 District Water Supply Fund - Financial Overview

The DWSF income is mainly derived from sales of water and water connection charges. The expenditure charged includes normal operating costs and depreciation charges. Annex 3 sets out five years Profit and Loss Statements. These Profit and Loss Accounts have been derived from published statements but do not include the capital expenditure apparently treated by Government as a charge directly to profit and loss.

The Annex demonstrates that over the five year period ending 31st March, 1991 there has been a remarkable turnaround in the financial viability of the fund; from a loss of MK 1,044,000 in 1986/87, to a profit in 1990/91 of MK 1,913,000.

The published government statements have deducted/added capital expenditure to profits/losses. This is not the normal accounting convention. Capital expenditure is financed by internal funds and/or by external funds. The provision of a Source and Application of Funds Statement would demonstrate how capital expenditure is financed.

Annex 3 also summarizes the balance sheets for the five years that have been derived from published statements. A number of accounting adjustments were carried out by Government in 1988/89; in particular some of the capital expenditure added to profit and loss balances was adjusted. It is not practical to unscramble what has been done before that fiscal year. The 1989/90 and 1990/91 Balance Sheets reflect the consultants view of the position, but without the benefit of an in depth analysis.

For the above reasons any analysis of the balance sheets needs to be treated with circumspection. The comment can be made that the current liabilities have been maintained at roughly the same level for the five years whereas current assets have doubled. This is due to the increase in the level of debtors. The level of fixed assets has not increased significantly; indeed if one discounts inflation during the period, capital expenditure matches the level of depreciation.

3.4.6 D.W.S.F. - Billing and Collection

The customers of the Fund either have a direct metered supply to their premises or water is obtained from a communal water point. Communal water points are metered and they are controlled by a local committee. It is the local committee that is responsible for the payment of the meter bill.

At 31/3/91 there were nearly 12,500 metered supplies of which 11 780 were for supplies to premises and 644 were for communal water points. Details are set out in Annex 2 and it includes consumption and sales information for 1990/91. Sales amounted to MK8,287,000 from the supply of 10 080 000 cubic metres of water.

The billing process starts with meter readers taking readings between the 10th and 16th of each month. The readings are taken to local billing offices in Districts where the sales invoices are prepared and dispatched by the 20th. The regional office receives a summary of the billing data before the month end. Customers are given 60 days in which to pay following which they may be disconnected.

The sales and cash returns are then sent to the Water Department at the end of the month. The returned information is further analysed including preparing age related data on how long bills are outstanding.

The Water Department Billing System was previously based on a more centralised approach. The changes made since 1986/87 by the Department have improved the ratio of debt outstanding to total sales, although in 1990/91 there was a set back due to staffing difficulties.

Debts outstanding at 31/3/91 were some MK 4,200,000 against total sales of approximately MK 8,300,000. In other words 50% of a year's sales were outstanding. The Water Department recognises that this was too high; indeed the size was attributable in part to the staffing difficulties referred to earlier.

Allowing for these latter problems the debts outstanding were analysed by the Water Department. It was found that over 75% of the debt was due from other government department or agencies. The Water Department is actively pursuing a policy of disconnection to overcome the problems of non payment. This includes cutting off government departments.

The local committees responsible for the commercial water points are generally working well. A sum of one Kwacha per month is collected from each participating household. This is then paid by the committee to meet the water bill. The meter bill may be more than has been collected in which case the arrears are carried forward in the expectation that they will be eradicated by future collections. If consumption continues at too high a level, self imposed restrictions are applied i.e. turning off the supply and only allowing access at fixed times.

The Water Department is keenly aware of the problems of debt collection and is adopting a proactive attitude to reduce the arrears.

3.4.7 DWSF - Tariff

The tariff structures and levels for the five years commencing 1987/88 are contained in Annex 4.

The Government policy is to generate income so that, in the long run all costs, both capital and recurrent, associated with urban supply schemes are recovered.

The tariff is a national tariff and cross subsidy occurs between existing customers and new customers and between one area of supply and another. Cross subsidy also occurs within the tariff structure with high volume customers paying more than low volume customers.

CHAPTER 4

SOCIO-ECONOMIC IMPACT

4.1 INTRODUCTION

The growing urban centres of the project are expected to greatly benefit from the proposed improvements to the water supplies. The development of commercial, industrial and institutional activities would not be possible without the provision of this most basic requirement. In addition to satisfying these urban needs the proposed project will also benefit the very poor members of the urban communities who represent the majority of the household consumers in these district centres. This chapter therefore mainly focuses on the behaviour pattern of these communities in urban areas and the impact of improved water supplies on their welfare.

4.2 COMMUNITY PARTICIPATION

The concept of community participation is based on the belief that people themselves are the basic source of knowledge of the life they lead and their attitude to it, and as such they need full participation in activities that affect their lives. Consultation is often not enough. Full participation develops a sense of community ownership and so promotes greater prospect of project sustainability. (does this apply in urban areas?).

responsibility?

Participation starts with selection of priorities, encouraging people to question things, to see the realities around them in a more critical manner and so enhance the process of prioritization.

4.2.1 Level of Community Participation

The level of community participation depends upon whether their role is reactive, i.e. decisions are taken elsewhere, or proactive i.e. initiating and influencing the way in which the water supply is organised.

An IRC/OECD Compendium paper on community participation (2 p.9) distinguishes between intensities of community participation as follows:-

1 - High Intensity

- Authority and decision making rests with the community. The project provides advice and technical support.

2 Options are discussed and decisions taken jointly by community and project (WD.)

3 Options are discussed at each phase. Final decision rests with the project.

4 Community is delegated certain managing tasks. There is local basic training in relevant skills.

5 - Low Intensity

- Community provides labour and materials.

Information collected from the districts indicates the level to be close to 4 above although there are variations. Communal piped water schemes are managed through water committees formed at each water point.

4.2.2 Community Institutions

In the case of boreholes and protected wells, there are three committees that facilitate community participation in water supply, the Central Water Council, the District Water Co-ordinating Team and the Water Committees.

4.2.3 The Central Water Council

The Central Water Council exist in some districts including Salima and Ntchisi. It is a sub-committee of the District Development Committee or the Town Council. In Ntchisi the CWC comprises 5 members whereas in Salima there are 6. It is chaired by the District Commissioner who is also the chairman of the District Development Committee, a body which receives project proposals from communities for processing through to Government.

Membership of DDC comprises the head of local government departments, traditional chiefs, parastatal and non-governmental organisations involved in development and political party leaders.

The Central Water Council comprises the District Commissioner, and representatives of Water Department, Ministry of Community Services and Health. The secretary is either the Town Clerk or an official from the DC's office.

Its responsibilities are:-

- to mobilize the community through local leaders to support the implementation of the project by involving people in selection.
- to educate the community in appropriate ways of using standpoints water structures;
- to follow-up and take action on complaints either from the community or from water department.
- to ensure that the community cares for and maintains the water points
- to consider requests from communities for the expansion or construction of new water points.

It is evident that community participation should start at the CWC. The CWC supervises the elections of water committees and outlines their responsibilities.

4.2.4 The District Co-ordinating Team

These teams are known to exist in Ntchisi and Salima but not in Dowa, Nkhotakota or Dedza.

It consists of representatives from Ministry of Community Services, Ministry of Health and Water Department. These government departments have extension workers who work at the community level where they are supposed to bring about awareness of the benefits of improved water supplies, good sanitation and hygiene. Ministry of Local Government is also expected to be involved in this multi-sectoral approach to water supply but there was no evidence of its membership within the co-ordinating team.

An integrated approach means that messages of health, sanitation and water supply are provided as a package. The Ministry of Health deal with sanitation aspects - motivating people to build improved latrines. Community Development Assistants (CDA) deal with community mobilization, leadership skills and committee procedures and the water department deals with the maintenance and operation of water points.

In Salima and Ntchisi these activities appeared to have good effect and the communities were aware of the relationship between the work programmes.

Co-ordinating teams do not operate in urban areas; health education being provided by either visiting health personnel or at health centres. They also have health committees to deal with sanitation Community Development Assistants include aspects of health and sanitation in their home management programmes and homecraft workers are expected also to contribute to health education and sanitation.

In Dedza, it was noted that the Ministry of Health has established Health Committees in residential locations. These have the responsibility of encouraging community members to have latrines, improve their personal hygiene and ensure proper care of water points. Some members of the committees were responsible for water chlorination particularly at protected wells. While this ensured community involvement, it was noted that the transfer of knowledge to the community at large was in-adequate, reflected in the lack of support for Health Committee members. As a result some water points were poorly maintained, pools of dirty stagnant water being present around the wells.

The Dedza situation also showed that the formation of a committee to supervise more than one water point is not effective. Some water points had only one member in the committee who could exert influence in the community because members have been appointed by health personnel rather that elected. In this respect health extension workers could facilitate discussions within the community on the benefits of an elected committee.

4.2.5 Water Committees

Water committees (WC) are the main instrument of community participation in water supply and are a precondition for provision of communal water points (CWPs). The system of water committees appears to work reasonably well, with only few known instances of mismanagement by the committees. In some areas the Water Department takes custody of the funds collected by the committees to provide security against misuse.

Water committees are chosen by the households themselves from the locality which is served by a particular CWP. The members are almost always women and are generally those who are more outspoken or dominant in the community. This appears to be an important characteristic as the role of a committee includes tasks such as collection of fees and regulating usage of a CWP. It is difficult to generalise whether a committee would tend to comprise women from more wealthy households. It appears that they certainly have to be "respected" by the community.

A water committee has to:

a) collect user fees and make payment to water department
b) ensure that water points are kept clean
c) collect maintenance funds from users and purchase spare parts
d) for some towns e.g. Salima, have responsibility for financial management of the maintenance fund.

Whereas (d) applies in Salima, the Water Department takes the custody of the funds in other areas, where WC's after collecting money from users, deposit it with the Water Department who deduct the user charge for the month and credit the water committee with the difference. This lowering of the level of community participation has resulted in some complaints and delays. The Salima option appears to be better as water points there were maintained suggesting that committees should have an increased role. In order to ensure security from misuse the water department endorse bank withdrawals.

Although water committees could increase their responsibilities in the communities to include the improvement of sanitation, their tasks have tended so far to be to concentrate around the water point. The Health committees, noted for example in Dedza have better prospect of achieving the integrated objective of improved health by dealing with sanitation and hygiene as well as water. Strengthening of the health committee approach would appear to be advantageous.

4.3 WATER SUPPLY CHARACTERISTICS

Water supply characteristics in the 14 districts are discussed in relation to five water supply systems and these are:

- Household connections;
- Communal Water Piped Supply Points;
- Boreholes;
- Protected/unprotected wells; and
- Stream/Rivers.

Each of these water supply systems has characteristics which affects the health of the population. Many districts have more that one system each serving a defined category. The characteristics of these systems are discussed using data collected in the field.

4.3.1 Household Connections

This refers to water supply by individual metered connection, the householder paying on the basis of the meter records. Such consumers have exclusive access to their supply but in some cases permit friends and relatives free collection of water for drinking. For bathing, cooking and other uses they have to use other sources, usually unprotected wells or streams/rivers.

Some with individual connections sell water, observed costs being between 50 tambala and K1.00 per bucket. This has two effects on water use. Firstly, the outside users tend to restrict water use in their households in order to minimise costs. Secondly, those who cannot afford regular purchase, tend to travel long distances to reach sources which do not require a user fee such as boreholes, wells and rivers. Obviously, this can have serious implications on the health and hygiene of the households without connections.

Those with individual connections often have waterborne sanitation facilities. However, many urban centres experience water shortage in the dry season (August to November), during which time flush toilets cannot be used. Sanitation conditions and hygiene status then deteriorate with consequent health risks.

4.3.2 Communal Piped Water Supplies

This system,which is the most common in these urban areas, is targeted at low income communities. A communal water point (CWP) is situated in such a way that it will serve a number of households. Depending on the concentration of the population, it is usually designed to serve a total of 250 persons or 25 households.

inconsistent with 5 per/HH & design for 30 HH proposed.

There is a high demand for CWPs in project areas where alternative traditional sources are scarce. In areas where traditional sources are available, such as close to the lake at Nkotakota, or near the river at Nsanje and Ngabu, the demand for CWPs is not so desperate.

In every project area visited by the consultants, the team members spoke to people in the localities which were inadequately served by present water supply systems. Without exception, there was an overriding desire by the households to have a convenient access to a reliable, potable water supply system. It appears that even some of the poorest households in the community were aware of the fact that piped water for drinking and cooking reduces the chances of "sickness".

Because the CWP requires a shared responsibility for payment a community institution known as a Water Committee is formed and is assigned tasks such as the collection of user fees, maintenance and cleanliness at the points and purchase of spare parts for repairs. ?

In many of the towns the user fee is K1 per household per month. The rate of K1 seems to have been proposed by the Water Department whereas in Salima the community themselves decided to increase the rate by 30 tambala because they feel that more money was needed to cover both user fees and maintenance.

The Water Committee tends to exert some control on water use. For example some charge extra for water to be used for brick making. In Ntchisi, in an attempt to start a maintenance fund, households pay K12 for water used for building a small house and K24 for a large one.

Some committees place time restrictions on CWP use, particularly during the months of water shortage. Although the times vary they range between 6 and 10 a.m and 3 to 6 p.m.. This appears not to cause inconvenience to users because the hours suit the normal practice of collection.

An examination of the reasons why some people do not use CWP's revealed that-

a) They prefer 'free' water because they are used to such supplies;
b) They seem to be unaware of health risks-especially those using unsafe sources;
c) Lack of affordability was also given as a reason in a few cases.

Problems caused by non-users affect the community as a whole because outbreaks of diseases can affect the whole community. Attempt should therefore be made to motivate the non-users by addressing the factors listed above.

4.3.3 Hand Pumps

This system is looked down upon by some urban dwellers because of the labour needed to operate a hand pump, and they are used mainly by low-income groups because the supply is free. However, in some towns frequent breakdowns occur due to over use. Delays in maintenance, due often to lack of spares, forces people to use streams/rivers and/or unprotected wells. The health risks affect the whole community not just those associated with the supply.

Hand pumps are generally accessible to anyone and there is therefore no Water Committee. The lack of a responsible community organisation often results in poor maintenance and cleanliness. For example, in Salima and Dowa, whereas CWPs had flowers planted around with soakaway pits and drainage being well maintained, boreholes usually were dirty and surrounded by stagnant water. Such pools act as breeding grounds for mosquitos, and malaria tends to be common.

In providing free access to water boreholes have an important role to play.

4.3.4 Protected/Unprotected Wells

In some towns protected and unprotected wells are used as sources of water. In Dedza, for example, a few wells have been fitted with pumps in the past but these have been removed following breakdown. There are two types of protected wells, those with a raised surround to prevent ingress of surface water, and usually fitted with a lid, and those having sealed casing fitted with a pump. Unprotected wells are traditional sources which has neither cover nor surround. However, all these sources provide free water.

Protected wells fitted with pumps require the community to form a water committee responsible for cleanliness at the point and the purchase of replacement spare parts. Some such wells appeared to be clean but still to have many problems, the most serious being that pumps after breaking down have not been repaired due to lack of spare parts. This forces users to open the well so as to gain access.

Open wells, even those with raised surrounds are not safe from contamination. In Dedza collection of water from a former protected well involved the use of a tin or plastic container tied to a rope. Most users did not wash their hands before handling the containers and were forced to step close to the opening, the water spilling on their feet and falling back into the well. Because of the possibility of contamination, a woman was assigned to chlorinate the well. It appears this was not done very often; at the time of the visit several days had passed without treatment because the woman was suffering from diarrhoea - possibly caused by poor water.

The use of streams and rivers appeared to be a last resort when alternative improved sources were inaccessible. However, control of water use at the CWPs has forced some people to use poor sources such as streams, rivers and unprotected wells. Many people are unaware of the risk. Creation of such awareness is needed supported by improved sources giving adequate supplies. If the benefits from improvements are to be maximised water supply projects should be integrated with health education and sanitation programmes and this is the recommendation in this case.

4.4 HEALTH PRACTICES

Health practices focus on what people do to ensure that they live a healthy life and also what they do when they are faced with a health problem.

Practices followed include for example child immunisation and ante natal and post-natal services and seeking medical treatment for an ailment at the right time. However, observation shows that many households do not have their children immunised, many pregnant women do not attend clinics and some sick persons had not sought treatment. Others visited traditional healers because they considered them to be more effective, believing that their ailments were man-caused through witchcraft and sorcery.

These practices have implication on the delivery of health education; people not attending health facilities are not reached by messages given at health centres and as a result, remain unaware of the benefits of improved water supply and other services.

Also important is the preparation of household food, inadequacy and lack of variety producing malnutrition in some low-income locations within urban centres.

Health practices include refuse disposal and sanitation. Although some households have pit latrines, it was found that young children were often not encouraged to use them because they feared they might fall-in. The achievement of good sanitation and hence health eludes them.

Many houses are not ventilated, and are overcrowded, thus counteracting health benefits from improved sanitation and water supplies.

The dependence on traditional healers for treatment and advice tends to constrain proper health messages. Traditional healers themselves are usually characterised by poor hygiene, thus there is little chance of encouraging their customers to adopt good health practices.

The Government's Primary Health Care philosophy addresses this through a number of programmes, including Hygiene Education and Sanitation Promotion (HESP). The implementation of this programme within the Project Areas is considered to be a necessary project component.

4.5 TIME SAVING

Quantification of the benefits produced by time saved through easier accessibility to water supplies is problematic, particularly in a project area over 14 districts with diverse characteristics.

Talking into account that the principal beneficiaries of the easier accessibility are the women and children who carry the water time saved in that activity can release a time availability for other social, domestic, or economic activity or for leisure.

In its policies on community development Government includes various types of training programmes for the advancement of the social and economic status of women. Specifically, home economics and homecraft courses involving sewing, cooking, childcare, nutrition, and health education are organised and conducted by female Community Development Assistants and Homecraft workers (Ref. See 17.10) who assist at mother and child health clinics.

The number of adult illiterates in Malawi in 1987 was 2.25 million, of which 1.4 million were women, and so a key factor in stimulating progress is to increase basic literacy. Among the priority targets of the National Adult Literacy Programme are women, out of school youth and young adults.

Additionally, about one third of all smallholder farm families are headed by women, the proportion being almost 50 per cent for the smallest units. Farmer training courses therefore lay strong emphasis on assisting women farmers.

It is clear therefore that the time saved can be put to good use, consistent with and increasing the prospects of success of the national policies. It is suggested that co-ordination with Ministry of Community Services at project completion could assist in the realisation of benefits from the time saving.

4.6 COMMUNITY INVOLVEMENT IN THE FUTURE

Future community involvement in the sanitation component of the project will involve a considerable component of "self-help" work in digging pits and constructing latrine superstructures.

The Sanitation and Health component of the project will include the appointment of a professionally qualified community developer/health advisor, with a team of Health Surveillance Assistants, trained to provide community motivation and health education targeted to identified issues within the sector.

To achieve the maximum potential health benefits of the programme it should cover the whole community. However to achieve this target each household has to be persuaded to participate. A process which can take a considerable time, and which may never be completed. Promotion and motivation on a community basis to achieve a communal consensus can therefore greatly assist in this process.

Health eduction, targeting on water and sanitation related diseases, through appropriate media and techniques is seen as an important vehicle for motivation of the communities. Community involvement in the water supply component is also important and must be encouraged wherever possible, but this has to be appropriate to the technologies involved, and to the fact that the Water Department is charged to make their operations commercially viable. This was discussed at some length with the Water Department.

There are important areas with respect to Water Department public relations that have been largely neglected in the past, and which need to be addressed in any future expansion programme. It is therefore envisaged that the staff appointed for the health and sanitation component of this project will also be involved in the preparation of communities in relation to water supply issues. Plans for pipeline routes and siting of reservoirs and stand posts should be discussed with the communities. If feasible the designs should take account of the communities opinions, and if not feasible, the reasons should be explained.

Public relations, community involvement, and the awareness of the needs of the community, on the part of the Water Department is therefore also important, and these aspects of the project will benefit from the community development and health educational activities of the sanitation programme, whose responsibilities will be extended to cover water supply factors. Such an integration of the sanitation and water supply components is seen to be mutually beneficial.

Issues that are of particular importance are:

– choice of service level??

- Public relations; discussing the project with the community to obtain their views and preferences, and to take these into account. If this is not possible, explain the reasons to the community.
- Formation of tap committees — consultation on how these should be formed!..
- ~~Location of water~~ points
- Personal hygienic practices
- Health education related to water related diseases
- Dangers of pollution
- Dangers of pollution to water storage in the homesteads
- Providing adequate drainage around water points
- Cleanliness of the water points and surrounding areas
- Maintenance of the taps and repairs of any leaks
- Collection of payment

Standpost design (involvement of women)

CHAPTER 5

POPULATION AND WATER DEMAND PROJECTIONS

5.1 POPULATION PROJECTIONS

5.1.1 Methodology

The Master Plan population projections were made during 1986, and were prepared by applying population growth rates to the 1977 census figures. These projections are included in Table 5.1 below, together with the more recent 1987 census results for each of the centres.

It can be seen from Table 5.1, that in a number of cases, the 1987 population figures were significantly different than those estimated for the Master Plan, varying from +58% to -25%, with only two centres varying less than 10%. The Master Plan population projections for most of the centres are therefore not sufficiently accurate to form a basis for future planning, and clearly need to be adjusted in the light of the information provided by the 1987 census.

In an addenda to the Master Plan report, (Volume II; Page 3.16), it is explained that in many cases the divergence was due to different town boundaries being used in the 1977 and 1987 censuses, rather than incorrect growth rates applied. It has been suggested that the very high population increase in Dedza has been due to the influx of Mozambique refugees into the adjacent camps. Taking all the centres together, without Dedza, the overall growth rate assumed in the Master Plan, and that obtained from the census results were 4.55% and 4.54% respectively, indicating an overall agreement, despite the large individual variations.

The population growth rates used for the Master Plan were derived after consultation with the Town and Country Planning Department of Malawi. The various characteristics of each centre were considered together with its development potential before the adoption of appropriate population growth rates. The growth rates thus derived were established during 1986, and for the present purposes it has been assumed that these provide a reasonable basis from which to make future projections.

TABLE 5.1

POPULATION PROJECTIONS

	Town	Master Plan Projection 1987	Census Figure 1987	Variation	Master Plan Growth Rate %	Revised Projection 2005
1	Chitipa	4,900	5,255	+ 7	4.6	11,807
2	Nkhotakota	14,000	12,149	-13	4.2	25,478
3	Ntchisi	2,300	3,080	+33	2.9	5,119
4	Dowa	2,300	2,704	+18	2.0	3,862
5	Salima	7,024	10,606	+51	4.1	21,861
6	Dedza	10,696	16,735	+56	5.0	40,275
7	Namwerwa *					4,200
8	Balaka	10,500	9,081	-14	6.5	28,212
9	Chikwera	3,800	4,344	+14	2.3	6,541
10	Nchalo	6,342	9,500	+50	3.2	16,743
11	Luchenza	4,800	4,737	- 1	3.8	8,953
12	Muloza *					1,600
13	Ngabu	7,551	5,678	-25	3.8	11,111
14	Nsanje	9,018	10,042	+11	2.0	14,342

* Centres not included in the Master Plan.

The revised population projections have therefore been made on a basis of the 1987 census figures, together with the growth rates derived by the Master Plan together with the Town and Country Planning Department.

Before completing the final design of the schemes however, it is recommended that the population forecasts are reviewed in more detail, particularly for the towns of

Salima, Dedza and Nchalo.

5.1.2 Population Distribution by Housing Category

The Master Plan included a break down of the existing population into different categories of Housing, as follows:

TABLE 5.2

POPULATION DISTRIBUTION BY HOUSING CATEGORY

	Master Plan		WD Guidelines
	1987	2005	
Low density -	0-7	1-10	5
Medium density -	7-20	9-20	7
High density -	10-25	15-35	20
Traditional housing	50-80	40-70	68

It was assumed that the percentages of the low, medium and high density housing will increase with time, at a rate higher than the traditional housing. The percentages adopted for the Master Plan for each of the centres was investigated in some detail, and was agreed with the Town and Country Planning Department. They are in reasonable agreement with the Water Department's present Design Guidelines, and have therefore been used when calculating the revised water demand projections.

5.2 WATER DEMAND AND SERVICE CRITERIA

5.2.1. Domestic Supply Service Levels

The present and future per capita consumption rates assumed for the different categories of consumers are shown below in Table 5.3. These assume that low, medium and high density housing will be provided with individual connections, and that people living in traditional housing will use communal water points.

TABLE 5.3

UNIT CONSUMPTION RATES

	Per Capita Master Plan		Consumption WD Draft	(l/c/d) Guidelines
Housing Category	1987	2005	Urban	Semi-Urban
Low Density	200	250	250	200
Medium Density	150	150	180	125
High Density	75	100	100	75
Traditional Housing	25	30	50	30

These figures for semi-urban areas agree fairly closely with the present Draft Design Guidelines used by the Water Department, they also agree with the levels of supply adopted in other African countries for urban and semi-urban areas, and they bear a fairly good agreement with the actual consumption levels found in the centres visited. These levels have therefore been used when preparing the revised water demand estimates.

The estimates presented in the Master Plan assume, that by the year 2005, all people living in traditional housing will be able to afford the water charges for communal water points, and that there are sufficient water points to provide reasonable accessability. This is clearly not the case at present. However it is considered that this is a reasonable assumption for design purposes, a 10% over-estimation of the traditional housing water demand will only result in approximately 2% over-estimation of the overall production requirements.

Hand pumps are not recommended for the project areas. These are not necessarily a least-cost solution, and their administration and maintenance would be difficult if run in parallel with a piped system. Experience from other projects such as the Karonga Integrated Groundwater Project has shown maintenance to be a particular problem.

Kiosks require a higher level of management and supervision than the proposed CWPs. They were not included in the original masterplan proposal presumably for this reason. It is possible that situations could arise in some localities where they could be considered. The price of water, however, would be higher. There is no evidence to suggest that in practice kiosks are favoured by the community. They are both time consuming and expensive to operate as attendants are required at all times to record each time a consumer collects water.

The Master Plan adopted a maximum spacing criteria for communal water points of 500m, with the numbers of consumers per tap of 140 (as recommended by the International Water and Sanitation Decade criteria). However the establishment and positioning of each water point is partly dependant on the community. For water points to be established, a tap committee has to be formed and indicate its desire and willingness to pay, and it also has to be feasible for the Water Department to make the connection from the existing distribution system. This means that certain areas are without supplies, and the spacing of water points often greater than 500m. This however can be regarded as an interim situation, and the adoption of the Master Plan criteria justified for design purposes.

5.2.2 Institutional and Commercial Demand

The Institutional and commercial water demand represents a very significant proportion of the water supplied to the centres. The Master Plan estimates were based firstly on the category of centre with regard to its character and development potential, and secondly on the domestic demand. A review of the actual water consumptions based on water supply records was also made. The Master Plan figures have therefore been adopted in making the revised water demand estimates. These should be updated from an analysis of the bills invoiced for each centre, during the final design stage.

5.2.3 Water Demand Projections

The water demand projections are prepared using the population projections and the per capita consumption levels established in the preceding sections.

The resultant revised average demand projections are summarised in Table 5.4 below.

Balaka and Dedza have the largest projected demands, and they are also amongst those centres with the most urgent need for additional water resources.

TABLE 5.4

PROJECTED AVERAGE DAILY WATER DEMANDS

	Town	1995 (m^3/d)	2000 (m^3/d)	2005 (m^3/d)
1	Chitipa	702	899	1148
2	Nkhotakota	1412	1834	2433
3	Ntchisi	381	469	563
4	Dowa	359	410	463
5	Salima	1625	2142	2798
6	Dedza	1804	2497	3582
7	Namwera	217	276	350
8	Balaka	2434	3654	5368
9	Chikwara	465	536	623
10	Nchalo	960	1172	1437
11	Luchenza	799	999	1250
12	Muloza	70	93	123
13	Ngabu	800	1014	1289
14	Nsanje	1022	1192	1395

CHAPTER 6

PUBLIC HEALTH AND SANITATION

6.1 SANITATION FACILITIES

The existing sanitation facilities within the schemes are restricted to on-site disposal using septic tanks and pit latrines.

The simplest and cheapest method of sanitation, and that used by far the majority of the people living in the 14 urban centres is the pit latrine. This consists essentially of a squatting slab placed over a pit sized at approximately 0.4 m3 per year of expected life per family. Basic design features should include a method of excluding flies and mosquitoes from the latrine, of reducing smells, and providing some strengthening to the top of the pit to guard against collapse, especially in sandy soils.

Poor design or lack of maintenance of latrines can reduce the potential benefits of a sanitation programme to the local community, not just the individual household concerned, emphasising the need for health education and community development in the areas.

Latrine improvement programmes in Malawi have concentrated on the Ventilated Pit Latrine (VIP) which reduces smells and fly problems using a fly screened ventilation pipe, and more recently, due to the lower costs involved, efforts have concentrated on the promotion of the San-Plat. However, due to constraints of funds and manpower, the coverage of sanitation programmes in Malawi has been generally limited to areas where there is an on-going water supply project.

VIPs and San-Plat latrines can be found in many of the towns visited, but these were generally isolated cases, due to individual initiatives, and not as a result of a sanitation programme. It would appear that very few of the pit latrines existing in the urban areas would satisfy the design requirements of a properly formulated sanitation programme.

The disposal of waste into the ground from pit latrines presents a potential danger to groundwater resources, especially in high water table areas, or where fractured rock may be encountered. The dangers need to be assessed on a project basis, but generally the risk of pollution from pit latrines is generally far less than from septic tanks, which discharge far greater volumes of liquid.

Septic tanks are normally provided where permanent housing have individual water supply connections. Septic tanks are usually sized at about three times the expected daily water usage of the household. Solids are settled out in the tank where digestion takes place. The strength of sewage is usually expressed in terms of Biological Oxygen Demand (BOD), and after having passed through a properly designed and maintained septic tank, the resultant liquid effluent will have approximately half the BOD of the raw sewage. This effluent is usually disposed of in soakaways. However, as this effluent still contains high levels of BOD it is important that septic tanks are located well away from boreholes or other sources of water.

In areas where soil conditions are favourable and the population density is less than 100/ha, septic tanks can operate satisfactorily, provided the accumulated sludge in the tank is periodically removed.

6.2 HEALTH SITUATION AND TARGETING HEALTH EDUCATION

The relative importance of different diseases in Malawi, is illustrated by the Ministry of Health's list of ten leading causes of out-patients as provided in Table 6.1.

TABLE 6.1

LEADING 10 CAUSES OF OUT-PATIENTS

Disease/Condition	Cases per 10,000 population by Region - 1991 North	Central	South	Total
Malaria	4,829	4,368	4,722	4,595
Respiratory symptoms	3,740	2,101	1,954	2,209
Gastro intestinal and Abdomen symptoms	987	761	849	830
Skin conditions	705	678	824	754
Other diarrhoeal diseases	638	562	670	624
Inflammatory eye diseases	621	574	591	587
Traumatic conditions	634	384	516	477
Venereal disease	328	331	387	358
Limb and joint symptoms	325	365	347	352
Hookworm and other helminthiasis	-	-	395	327

The figures reflect the very serious problem of Malaria within the country, and the importance of the inclusion of a mosquito control element in any development programme, particularly where an impounding dam is being considered as at Dedza.

Specific control measures can be assisted by a knowledge of the particular species of mosquito vector. However in general, malarial mosquitoes only feed at night, they lay eggs in water often with preference to shallow overgrown areas, and their dispersal range is usually below 2 km. Antimalarial measures should therefore include the promotion of using mosquito nets at night, and the removal of vegetation from shorelines within 2 km of villages. Other measures can include controlled fluctuations of the lake level, and trimming the reservoir shoreline to avoid large shallow areas.

The incidence of gastro intestinal and diarrhoeal diseases, which are both water borne and water washed diseases, can be reduced by improved water quality and hygiene practices. Skin and eye disease can be reduced by making increased volumes of water available together with improved personal hygiene. Schistosomiasis, although not featuring in Table 6.1, is also important in the Shire valley and other areas particularly associated with irrigation schemes. This disease can also be reduced through improved hygiene practices, and knowledge of how the disease is transmitted.

A recent study at Champhira has shown how 'safe' water, collected from taps, can be polluted by using contaminated containers and storage vessels, with the result that water consumed within the household can be heavily polluted. Thus any potential health benefits of the 'safe' water supply is immediately lost. This aspect is not thought to be a local occurrence, and needs to be addressed within any health education campaign.

The promotion of improved personal hygiene through health education, emphasising targeted diseases and hygienic practices, can therefore be seen as being an important component of any programme aimed at reducing the incidence of water related diseases in the scheme areas.

6.3 SANITATION PROGRAMME

The Health Education and Sanitation Promotion (HESP) programme of the Ministry of Health appears to have operated successfully in relation to a number of water supply development projects. It would therefore seem to be sensible to build upon this proven capability and include a similar HESP component in this programme.

The final details of the programme will need to be worked out during the initial phase of the programme after consultation with all the relevant parties. However the outline of a suggested programme is provided in Chapter 13, Implementation Programme, and includes the following basic provisions:

- Establish a Sanitation Component to the 14 town Water Supply Improvement Project, that will be an integrated part of the project.

- Establishment of responsibilities of all interested parties, and if necessary form a steering committee
- Appointment of staff
- Establish a strategy for both the promotional and the implementation aspects of the programme
- Training of staff
- Survey of centres to determine existing situation and factors to take account in the design of the programme
- Construction of demonstration units, and training communities and small contractors in the construction of pit latrines.
- On-going community motivation and health education
- Assistance with the provision of non-traditional materials, consideration of mass production of slabs, their distribution and cost recovery.
- Improvements to existing latrines
- Improvements and control of refuse disposal

The integration of a HESP component into the water supply project will have a number of mutual benefits, and will increase the chances of successfully improving the environmental health conditions within the 14 urban centres.

6.4 HEALTH AND SANITATION ISSUES

The role of different ministries in co-ordinating health, sanitation and water supply developments, is discussed below with regard to the following issues:.

1. **The Statement of Government Policies gives clean, well defined policies and strategies for the Water Sector. Sanitation policies do not receive the same degree of definition.**

Government policy for water supply is to provide potable water to the whole population in order to reduce disease and the time taken for collection. A target is set: nearly 80% cover by 1996, and priority is allocated to the rural population. This clear statement enables the implementing bodies to develop in-house strategies accordingly. There has been measurable progress as summarised in Table 6.2.

TABLE 6.2

POPULATION REACHED BY WATER SUPPLY SYSTEMS
(MILLION)

	1985	1991		1996 Target
Urban				
Blantyre WB	0.36	0.40		0.64
Lilongwe WB	0.14	0.23		0.34
Water Dept.	0.30	0.26		0.75
Urban total	0.80	0.89		1.73
Rural				
Piped	1.01	2.14	}	
Borehole	1.46	2.00	}	5.86
Wells	0.40	0.75	}	___
Rural total	2.87	4.89		5.86
Total Rural + Urban	3.67	5.78		7.59
Population (Est)	7.06	8.90		9.79
Degree of coverage	52%	65%		78%

Source: Statement of Government Policies 1987-96 and Mid Term Review by Water Department.

The mid-term (1991) out-turn indicates approximately 50% progress towards achievement of target and confirms the emphasis on the rural sector where coverage has increased by 70% compared with 11% in the urban sector.

Reference to the Sanitation sector within the Policy Statement are concerned with co-ordination aspects (See 15.11) and with delegation and technical resource deficiency (Sec 18.3, 18.7). This reflects the dispersal of sector responsibilities across Ministries and Departments (See issue 2), which seems to have had the effect of inhibiting the formulation and issue of a clear policy statement. The issue has been addressed by the UNDP/World Bank sector strategy studies, and by their inputting of technical advisory support. This has resulted in target-setting for sections of the sanitation sector where the programme is directed at improving the pit-latrine component of sanitation activities in terms of quantity and quality. No programme can be identified for improvements to the capacity of urban reticulated systems.

2. The dispersement of sanitation responsibility to various Authorities leads to a lack of cohesion in programming investment needs in the sector.

The Ministry of Health are responsible for sanitation in the 24 rural districts. In the 12 urban areas the relevant local Authority is responsible, but shortage of skilled manpower and a weak financial base means that many are unable to tackle their responsibilities. A brief review in MLG revealed that:

Lilongwe:	Sewage treatment works final effluent frequently does not comply with agreed standards. Plans prepared for major refurbishment, but funds not yet allocated.
Blantyre:	Sewage Treatment works operative, but difficulties with treatment of Trade Effluent. Donor (KFW) aided Master Plan nearly complete.
Mzuzu:	Army barracks system maintain by Water Department. No city reticulation. Ministry of Works provides tanker collection service. Disposal to sewage ponds. Aid funded (Japanese) study under way for sanitation KFW/Danida interest expressed in Water Supply, subject to progress in sanitation matters. Brewing and Bottling industries present.
Zomba:	Limited reticulation system, but Treatment works inoperative, so effluent quality is "raw" Canadian interest expressed in works rehabilitation. Project proposal submitted to Japanese Aid.
Balaka: Dedza:	No reticulation or treatment. Collection service operated by Town Council-Disposal arrangements unknown.
Kasunga: Liwonde:	As Balaka, but disposal to stabilisation ponds Partial reticulation, partial collection, by Town Council. Disposal to ponds ineffective due to pump failure. System design and construction by Water Department

Luchenza) No reticulation or treatment. Collection service operated by Town
Mangochi) Council disposal arrangements not known. Project proposals prepared
Salima) for Mangochi, Salima and Karonga due to risk of effluent seepage to
Karonga) lake.

3. **Increasingly, an integrated approach is promoted to water and sanitation projects. The treatment of affordability by the beneficiary varies between the component sectors and may prejudice project success.**

This is best illustrated by an example. Suppose that implementation of the District Water project makes available a supply of water of reasonable quantity/quality and at reasonable distance. In order to utilise the benefits the consumer contributes to the "Tap Committee" a monthly sum covering water charges and point maintenance. Typically, this is currently MK 1 per household per month. When, as part of the integrated project approach the HESP programme is introduced, advice is obtained on the construction of a pit latrine and the use of the 'San Plat'.

The cash element of construction costs (i.e. material purchase only - no Labour cost) is likely to be at MK 20 (UNDP/WHO Sector Strategy, 1989) Urban standards and or the need for lining etc. would increase cost. Maintenance of the Water supply system, other than the CWP itself is a charge upon the water supplier, the user in this case benefiting from a cross-subsidised tariff structure. Latrine maintenance is at cost to the user, the level of cost often being proportional to the quality of materials and workmanship in the original structure.

Sustainability of project benefits therefore is dependent on the affordability by the consumer of total system costs.

Promotion of sanitation programmes based on sanplat propagation and use has been tried by different organisations.

Liwonde Agricultural Development Division (LWADD) incorporated a sanitation programme based on Primary Health Care. Sanplats were promoted in three areas, namely Mwinama, Mbera and Ganyela. The programme was first implemented in

Mwinama, where the construction of Sanplats was undertaken by the LWADD technical units. The local community was simply invited to watch with no direct involvement in the construction. The households were asked to contribute sand, stones and water in exchange for constructed sanplats. The LWADD provided technical staff, reinforcement steel and cement.

Large number of sanplats were taken away for use in the homes. However, an evaluation of "Low Cost Sanitation" undertaken in 1989 concluded that the programme had not had any long-term impact and this may have been due to the lack of community participation.

The approach of the programme was radically changed in Mbera, where the local households not only provided basic materials such as sand, stones and water but were also asked to construct their own sanplats assisted by LWADD technical teams. It appears that the programme has been much more successful in Mbera in promoting the usage of sanplats. It was noted that the PHC committee was also better organised and more effective in providing health education.

The evidence from these two areas appears to suggest that community participation together with provision of construction materials could make positive contributions to the promotion of sanitation facilities in the project areas.

4. **Hygiene Education and Sanitation Promotion (HESP) exists as a National Programme and also as a Project Specific programme within the Mpira/Balaka Water Supply Project. Which arrangement is more conducive to effective achievement of project objectives?**

The Mpira/Balaka project began in February, 1987 and was directed at supplying a rural population of 200 000 with safe water. The project (AFDB funded) included a HESP component in order to maximise health benefits. A review was undertaken by DANIDA funded consultants in July, 1991 following concern expressed in project reports on lack of progress with the HESP component.

The review indicates:

- Delay was due to lack of allocation of funds to the Ministry of Health.

- No guidelines had been produced for the National HESP programme, nor were the project plans adequate for the HESP component.

- Budget allocation for the HESP component is MK 1.05 million, with MK 0.54 million being allocated to training. Expenditure during 1990/91 (Project Co-ordinator appointed July 1990) was MK 0.18 million, including MK 0.09 million for training.

- Staff requirement is 2 full time and 44 part-time (from Ministry of Health) Resourcing is not yet complete, provision of support facilities has been inadequate.

- A viable village Health Committee (VHC)-recommended to become the Village Health and Water Committee (VHWC) - is essential to successful implementation and maintenance. There are 592 villages in the project area with an average population of 340.

At the 1987 census the total population contained within the 14 districts was nearly 94 000 while the present estimate is 116 000. In 1987, individual district population ranged from 2704 to 16735. Whilst this puts into context the comparative scale of a HESP component it does not affect the validity of the programme objectives, which are to ensure:

- well planned and budgeted implementation.
- the adequacy and durability of low-cost sanitation components (within the area concerned).
- the relevance of training in latrine construction.
- the relevance of sanitation and water related health education.
- the monitoring of public health impact.

(Source: Review Document: Taylor/Makumbu, Danida July 1991)

The prospect of achieving these objectives will be influenced by:

- Resource Availability - within Ministry of Health and Water Department.

- Programme implementation - concurrency of schemes within the Project.
- Degree of overlap (if any) with the National Programme

It was stated that to date, HESP has been undertaken only as a water project related programme, and funding has been from the project. Experience has established significant differences between rural and urban HESP programmes, where influencing factors are

- the higher density of population and dwellings.
- the lower level of community participation.

6.5 DISEASE CONTROL

Table 6.3 indicates the scale of the Malaria problem in Malawi. Statistics relate to the year 1990. The number of outpatients treated during the same period was 4,046,433 i.e. 46% of the total population.

In terms of vector control there are 2 possible approaches, namely control at the mosquito breeding habitat or control of the living habitat. The warm, humid climate of Malawi, with large areas of water surface is an ideal environment for mosquito breeding, and the scale of the problem alone presents insurmountable cost obstacles. Chemical spraying, using larvicides or insecticides, in addition to being costly may well affect fish life which is the principal source of protein for the Malawian population. On these 2 grounds therefore, vector control is not being actively considered at present.

TABLE 6.3

In - Patients

	of total population				of under 5 population			
Type	**No. of Cases**	**% of Adms.**	**No. of Deaths**	**% of Mort**	**No. of Cases**	**% of Adms.**	**No. of Deaths**	**% of Mort.**
Cerebral Malaria	8259	2%	1081	6%	4633	5%	762	8%
Other Malaria	44489	14%	1505	9%	21567	24%	1001	11%
Total	57748	16%	2586	16%	26209	29%	1763	19%

As part of an attempt to control mosquito presence in residential areas, Lilongwe, Blantyre and Mzuzu used larvicide in city areas, but later abandoned the project on cost grounds. An alternative which is being considered is the use of pesticide impregnated mosquito nets, to prevent bites. Less than 4% of the population use nets, and the constraints to the programme are the difficulty of persuading people to change lifelong habits and cost.

It is understood that in 1985 the World Health Organisation concluded that the environmental situation in Africa effectively prevented vector control. The present strategy, therefore, rests upon treatment of the illness, but at the above table shows, the casualty rate is high.

6.6 HYGIENE BEHAVIOUR

Water Hygiene includes personal washing at appropriate times, bathing, and washing of clothes and dishes. People are concerned that drinking water should come from a safe source but often consider other activities can be served from any source, even those considered unsafe.

Observations during field visits indicated a general awareness that preparation of food requires good hygiene, ensuring clean crockery etc. and the use of clean containers for water storage. However, at the water point, practices appeared not to be always hygienic. Buckets were sometimes filled without cleaning and in many cases the same water was used to clean several containers. There was also a tendency to dispose of dirty water near the source, stagnant water then accumulating around the water point.

Water collection practices and storage have been shown by the study of Water Quality carried out in Champhira Area of Mzimba South to be important in ensuring health. Improved water could be contaminated through poor storage, unhygienic use of containers and poor personal hygiene. Similar results apply in urban areas because the practices are the same.

The use of soap when bathing and washing appears to be subject to income levels. Low income people indicated that they do not use soap very often. It is used only when they bathe. The use of soap and washing of hands after latrine usage appeared to be less common in the low-income group. However, in areas like Salima and Nkhotakota, Muslim believers, in accordance with religious practice use water freely. Even then however, it was observed that a bucket of water and cup were kept inside the latrines but no soap. The water was not well protected and as a result, provided a breeding place for mosquitoes.

Latrines in traditional housing areas are often poorly constructed and children are discouraged to use them, being directed to use the nearby bushes, or even the bath rooms. It was noted in some low-income areas that disposal facilities were poor.

The "san-plat" improved latrines presented a much lower risk to child safety. However many of the 14 districts do not yet have a san-plat programme. The programme has not been initiated on a district basis. Principal programmes have been associated with water projects, eg Mpiri-Balaka. The need for a health education programme, designed on the Primary Health Care concept and involving committees, was evident.

The Primary Health Care concept stipulates that the achievement of health is the responsibility of the communities themselves by following better sanitation, hygiene and feeding practices. The emphasis is on preventive measures which include the improvement and construction of pit latrines and other measures. It has a strong health education component implemented through community based volunteers and Health Surveillance Assistants. In some rural areas where implementation procedures have been followed properly, a positive impact has been experienced. It has also confirmed the importance of integrated approach.

The PHC concept is implemented through village health committees where members are trained to facilitate and support the functioning of volunteers.

6.7 HEALTH EDUCATION

In Malawi, there are a number of health education programmes, by the Ministry of Health and also by non- governmental organisations. Implementation occurs through either a health centre based or a community based Primary Health care. The Hygiene Education and Sanitation Promotion (HESP) programme is one of these. A review of these programmes is given below and recommendations made.

6.7.1 Ministry of Health and Private Hospital Association of Malawi (PHAM)

Ministry of Health and private hospitals, mainly those run by missionaries include health education in their health delivery systems. This education is implemented at health centres and so it serves those who visit the centre. The impact therefore is restricted.

The content concentrates on anti-natal, under-five and pre-natal aspects with some nutritional education. In recent years, the message includes AIDS and sexual behaviour issues, the latter aimed at controlling population growth through child spacing programmes. Attenders at these programmes are usually already aware of the health benefits of service provision accompanied by good hygiene.

6.7.2 Primary Health Care

[illegible] also linked to clinic outreach

Primary Health Care is an approach based on the principle that communities should take the responsibilities for their own health by improving water supplies, sanitation and household hygiene. A key to this principle is the belief that prevention is better than cure. For this idea to be appreciated it must have a very strong health education component which is directed to the community through volunteers.

Volunteers and committees are trained in health activities relevant to their own communities. However, the programmes focus on rural areas rather than urban because rural people are less able to attend health centres. Particular successes of the PHC approach are programmes for Child immunization, ant-natal and under-five clinic attendance, and sanitation. Through PHC volunteers and PHC committees, protected wells to provide safe water have been constructed and pit latrines have been constructed and are being used.

The PHC Committees, in many cases are similar to village health committees.

However, PHC committees tend to include more than one village whereas village health committees are specific. These committees appear to have been very effective avenues for health education. Unfortunately, they are not present in urban areas.

It is considered that an examination should be made of the organisation and activities of PHC and the feasibility assessed of establishing PHC in urban areas. Where health committees exist, e.g. Dedza, an attempt should be made for them to adopt the PHC concept in the implementation of programmes. PHC has an advantage in that it is a multi-sectoral programme which can facilitate an integrated role for ministries and non-governmental organisations. At district level, the role of the District Technical sub-committee of the District PHC committee could be examined to assess the possibility of facilitating urban based structures and activities.

It is recommended that consideration be given to assisting the training of volunteers from within the project areas in broad based ideas and techniques of health education.

6.7.3 Health Education Sector

This section is in the Ministry of Health and it has the task of preparing education materials. It produces publications of booklets, visual aids, radio programmes and drama. The use of visual aids seems to be most popular for reaching illiterates, followed by radio health programmes.

In respect of visual aids, at almost all health centres and other public places there are pictures illustrating sanitation, hygiene and other health messages. Even though the interpretation of visual aids may vary with the observer, benefit is obtained by discussion about the pictures and their meanings. The production of visual aids, including videos for urban centres should be considered as being more effective than publications.

Publications are however important as reference materials for those educated and for health practitioners. However they reach only a small proportion of the population, because in the 14 district centres more than 60% of the population may be considered illiterate.

The use of radio programmes assumes that people have radio and listen to programmes of health at the time they are aired. Evaluation of programme impact is not available, however it is known that less than 30% of people have radios. The majority population therefore requires a more direct contact with the health educators. It has been noted, however, that the Ministry of Health does not have the capacity in terms of personnel to undertake health education in communities without affecting staffing at health centres.

It seems clear from the discussion above that the most effective health education programmes are those which involve community participation through volunteers and health committees. These structures understand better the issues affecting their communities and perhaps can help in the formulation of solutions conducive to the existing behavioral pattern of the people.

6.7.4 Hygiene Education and Sanitation Promotion (HESP)

HESP's strategy depends on the involvement of the community in the implementation of its programmes. It has a very strong awareness creation component which includes health education, environmental preservation, sanitation and diseases. It works through village health committees and volunteers. The programme trains volunteers to educate the community about various aspects conducive to the achievement of health.

As members of the District Technical sub-committees, HESP co-ordinators have access to all ministries, such as Local Government, Forestry and Natural Resources, Office of the President and Cabinet, PHAM and other organisations like Malawi Red Cross.

CHAPTER 7

WATER RESOURCES AND DEVELOPMENT ISSUES

7.1. INTRODUCTION

7.1.1 Introduction

The Ministry of Works proposal is for the implementation of water supply systems for 14 towns to the year 2005 and also on the general assumption that groundwater will be the main, or in many cases the only, resource to be developed. This assumption is based in some cases on comparative cost analyses of potential groundwater and surface water schemes and in others on general considerations of the limitations of surface water source availability or on their prohibitive costs of development. However in the preliminary meeting with the Water Department Controller, the Consultants were asked to review again as far as may be feasible in the time available, the potential of both types of resource for the 14 towns.

The Master Plan studies do not appear to have given sufficient emphasis to many factors which become more critical in an urban supply context. These are briefly reviewed here but discussed in more detail later in the report.

(i) Pollution: The urban centres under consideration make use of on-site sanitation systems (pit latrines and septic tanks) which in densely populated areas are more likely to create a risk of pollution to shallow groundwater supplies. The field visits have demonstrated that there is often insufficient attention paid to minimising such risks. Proper guidelines are needed on the designs and relative locations of both sanitary and groundwater supply systems which also takes account of soil, water level and other aquifer characteristics. Reliance is clearly placed on the effectiveness of chlorination which fails to take account of possible inadequacies of procedure or shortage of chemicals.

(ii) Well interference and recharge constraints: Since urban supply boreholes are designed to be high-yielding, the cost advantages and convenience of a close siting must be viewed in the context of increasing drawdowns and pumping costs as a result of well interference. Production wells were quite commonly seen to be located in groups only a few metres apart and being pumped simultaneously. A related feature could be constraints on areal recharge which is likely to be most critical in the case of the more discontinuous aquifers but can also be significant in the sedimentary aquifers, particularly when these are of relatively low transmissivity as they are in Malawi. Calculations can show that well fields to supply the larger towns could require to draw upon annual recharge over quite a large area (10-20 sq km). In such cases, a significant spacing will be essential.

(iii) Community involvement: There is obviously less scope, compared to rural areas, for direct community involvement in the operation and maintenance of urban piped distribution systems and motorised pumps. There is however need to review and finalise policy decisions on the use of existing wells and boreholes commonly fitted with handpumps in the traditional housing areas which tend to be used by people who feel unable or unwilling to pay the communal water charges.

(iv) Optimisation: Procedures are needed to optimise on production costs which take account of borehole spacings, depths, yields and success rates, etc.

(v) Comparisons with surface water schemes: The preliminary cost comparisons are often fairly marginal and in such cases, fuller evaluations would seem to be merited to take account of the sensitivity to phased implementation, borehole success rates, treatment costs, minimum flow accuracy etc. These and other sources of error in cost estimates will be discussed in more detail later.

7.2. WATER RESOURCES

7.2.1 Climate

Malawi has a tropical climate with relatively small regional variations in annual temperature and humidity. There is however considerable spatial variability in mean annual rainfall from less than 800mm to more than 1800mm (Figure 7.1 - end of chapter). The distribution has a strong orographic control in relation to the predominantly easterly rain-bearing winds. There is a marked seasonality with the bulk of the rainfall occurring between November and the following April.

7.2.2 Surface Water Resources

The main drainage systems are directed towards or, in the south, away from Lake Malawi (Figure 7.2). The larger rivers are perennial but the smaller streams tend to be ephemeral or with very low flows in the dry season. Exceptions are those streams draining from upland areas with both high rainfall and of sufficient areal extent and low relief to contain significant storage in the surface weathered rocks, e.g. the Nyika and Zomba plateaux. The low seasonal flows also partly reflect the nature of the bedrock which is mostly of crystalline basement type. Baseflows cannot always be correlated with groundwater recharge since there is often a substantial groundwater discharge and evaporation from marginal 'dambo' areas which does not appear in the baseflow runoff. The generally low seasonal flows of the smaller streams constrains their use for urban sources without additional storage.

7.2.3 Groundwater Resources

Aquifers in Malawi occur either within crystalline basement rocks which underlie 85% of the country (Figure 7.3), or in alluvial formations of Quaternary to Recent age associated with the Lake Malawi Rift region and the Shire Valley. Of the 14 towns under consideration (Figure 7.4), 7 are on basement rocks and 7 on alluvial sediments. The alluvial sequences have thicknesses in the main range between 40 to 150 metres and are mainly composed of fine-grained sediments, sands, silts and clays. They overlie basement rocks other than in the Lower Shire region where they overlie

Karoo sandstones and basalts (the Lupata Series). Recharge to the alluvial aquifers is by direct infiltration of rainfall and locally by runoff. The low rainfall of the Lower Shire Valley exercises a constraint on recharge.

Groundwater in crystalline basement rocks occurs in the residual weathered overburden (regolith) and/or the fractured bedrock (Figure 7.5). The regolith tends to be more clayey in the upper levels and where saturated, has low permeability but relatively high storativity. Higher permeability tends to occur in the weathered basement and basal regolith or in any intersected residual hard bands, such as vein quartz. The regolith has lateral continuity and typically a phreatic water level which is sub-parallel to the ground surface, although the feature is masked during drilling as a consequence of the low permeability of the upper clayey regolith. Although recharge is constrained by the low permeability of the upper regolith, various vertical or steeply dipping channel ways are common which assist downward movement (Figure 7.6). The surface soils, relief, vegetation and rainfall characteristics and amount also exercise controls on runoff and infiltration. Recharge to basement aquifers in Malawi has been calculated to vary between 30 and 150mm per annum (Ref 1 and 2) which is substantial. In practical terms, however, local variations in aquifer storage, permeability and recharge exercise important controls on groundwater development.

The bedrock aquifer component may have high transmissivity if significant fracture systems are intersected. These are of two types:-

(i) Pressure release fractures which tend to be sub-horizontal and more abundant in the vicinity of the regolith/bedrock interface, and

(ii) Tectonic fractures which typically occur in zonal concentrations which are of medium to high dip. Lineament features observed in air photographs usually relate to tectonic fracture zone occurrence.

To summarise, crystalline basement aquifers consist of two main components - the regolith which contains the main storage and may have enough transmissivity to support hand pumped boreholes, and the fractured bedrock which in favourable circumstances can provide sufficient transmissivity to support high yielding boreholes provided the cone of depression is able to interact with sufficient storage in the regolith. Conditions of recharge and size of catchment area can also exercise some control in this respect. The borehole design must take account of the need for this interaction. If the regolith and the upper friable fractured bedrock is cased out and no fractures occur at greater depth, a sustained yield will not be assured because of the lack of interaction with the main storage. Where the saturated regolith is thin, the limitations on storage can also inhibit sustained test yields unless the cone of depression is very flat and able to draw upon a very large area. Thin regolith occurs most notably in the Rift Scarp zone (Figure 7.7) in which Ntchisi, Dowa and Dedza occur.

The alluvial aquifers in Malawi tend to be fine grained and heterogeneous which constrains analytical solutions to borehole spacings etc. The UNDP Master Plan give recharge estimates in the main range of 10 to 80mm per annum.

Water quality in basement aquifers tends to be good but some quality constraints occur locally in relation to iron, sulphate and fluoride. High sulphate content is probably an interaction with bedrock containing sulphide minerals as in the Dowa district. High fluorides in basement aquifers are commonly attributed to contamination by deeper groundwater moving upwards along fault zones although it has been known to have more random distributions. High iron content in basement aquifer groundwater is fairly common in Malawi but the Master Plan studies have concluded that the occurrence relates more to the dissolution of iron from borehole and pump materials than from within the aquifer and the content in the groundwater can be controlled by appropriate borehole design and operating procedures. Water in the alluvial aquifers varies from good to poor when it may have high content of chloride, sulphate and dissolved solids. The causes of high salinity in the groundwater of the alluvial aquifers have not been clearly established and this deficiency constrains a prediction of development potential. This uncertainty of water quality prevails in the vicinity of Nchalo and is affecting decisions on programme implementation.

7.3. REVIEW OF THE MASTER PLAN METHODOLOGY

7.3.1 Surface Water

Surface water availability in Malawi is constrained by high seasonal variability of runoff, aggravated by periodic droughts. Significant baseflow is largely limited to streams draining from the highland plateaux with high annual rainfall. Most of the potential surface water sources for the 14 towns, other than the Shire River and Lake Malawi, are from ungauged catchments for which the minimum flows have had to be derived from spot gaugings and comparisons with data from a gauged catchment with similar relief, vegetation and rainfall. More quantitative correlations would also be possible using various geomorphological indices of relief, drainage density, dambo areas and type etc. There is a current national network of some 150 gauging stations in Malawi and past records are also available for other stations which are now closed. Flow data of monthly mean discharges are available in computerised form and daily values are on file. All correlations in the Master Plan study have been based on the mean monthly flow data which limits the resolution for scheme comparison. Improvements to the correlations could be obtained by using daily discharge data but this would require considerably more work. When considering the safe yield of surface water sources, the Master Plan adopts different return periods for different schemes and catchments. We understand however, that the Water Department now use the 95% probability daily low flow figure, (once in 20 year return period), when assessing the adequacy of potential surface water sources. This figure appears reasonable for the urban centres that are the subject of this report. For gauged catchments, the Weibull plotting technique has been used to determine minimum flow probabilities and the return periods. Correlations with the ungauged catchments have been made using the specific yield of the gauged catchment and extrapolating on the basis of area. Surface water quality is generally adequate in chemical composition although sometimes with high iron content and aggressive carbon dioxide. The main problems for supply use relate to turbidity and bacteriological content.

7.3.2 Groundwater Resources

The Master Plan yields and probability predictions which are fundamental to groundwater scheme cost estimates are based on the statistical analysis of available borehole data for a number of geohydrological regions, combined with extrapolations and weightings based on more local information. The geohydrological regions include two erosion surfaces apparent in the basement outcrop areas in Malawi (African and Post-African) and the alluvial sedimentary basins as a single group. The Master Plan probability plots are reproduced here as Figures 7.8, 7.9, and 7.10.

The older erosion surface (African) will tend to have thicker regolith and therefore higher groundwater potential than the younger Post-African surface although the two statistical plots are not greatly different. A more important geohydrological region which has not been analysed is the Rift Valley Escarpment (Figure 7.7) which resulted from upwarping and tilting and the development of a wide zone with significant relief, thin regolith and with constraints on groundwater recharge due to high runoff. Three of the 14 towns, Ntchisi, Dowa and Dedza all occur in this critical zone with relatively low groundwater potential.

Predictions of yield probabilities and corresponding success rates are based initially on these plots with the assumption of a 15m available drawdown. In the case of basement aquifers on the African surface, design yields of 3.6m3/h are considered appropriate which is equivalent to a specific capacity of 0.24 m3/h/m and a success probability of 38%. In some cases, the Master Plan projections indicate a higher yield but with the same success probability. The predicted yields have been based probably on more recent drilling results but the validity of the extrapolation is unclear and questionable. For example in the case of Chitipa which is on the African surface, the Master Plan projections are for a borehole yield of 5.0m3/h with the success probability retained at 38%, thus departing from the standard plot. The Master Plan cost estimates are based on these weighted assumptions. In the re-evaluated cost projections made for the appraisal review, the original Master Plan weighted probabilities and yields are shown along with yields and a success probability corresponding to the original statistical plots. This more conservative approach is preferred for the preliminary cost estimates, although it is obviously hoped to improve both yields and success probabilities with more advanced exploration methodology.

7.3.2.1 Exploration Methodology

For groundwater exploration of basement aquifers, the Master Plan procedure has involved the use of air photographs and geoelectrical surveys. For the alluvial aquifers, geoelectrical methods only were used. The geoelectrical surveys in basement aquifers included both constant separation traverses and vertical electric soundings (VES). The former indicate general areas with favourable characteristics and the latter are designed to obtain more detailed depth relations at a site. The sounding method responds essentially to horizontal layering and hardly at all to vertical discontinuities unless these are very wide. Thus the soundings provide information on the regolith thickness and its general potential. Soundings might possibly be expected to identify the regolith/fractured bedrock transition zone which would be expected to have an intermediate resistivity below that of the fresh bedrock. The sounding results observed do not appear to have identified this layer and are therefore mainly characterising the regolith. High yielding boreholes mainly need to target on fracture zones which tend to be steeply dipping or vertical. Air photograph lineaments give some indication of their location but more precise siting of boreholes on such features requires the use of techniques such as electro-magnetic traversing (EM) and/or radon surveys. The EM surveys should also be combined with VES soundings with a view to identifying whether there is sufficient thickness of regolith above the transmissive fracture zone to provide the necessary storage.

A second constraint which is frequently referred to in Malawi is the presence of conductive bedrock,such as graphitic schist, which results in a spuriously low value of rock resistivity which is unrelated to the hydraulic characteristics. Although EM surveys will also be affected by this feature, relative differences may enable fracture zones to be identified.

7.3.3 Sources of Possible Errors

Dry boreholes affecting statistical plots.

The statistical plots shown in Figures 8.9 and 10 are based on relatively few borehole numbers and only those for which specific capacity data are available. The majority of these will be successful boreholes with yields in excess of 1 m3/h (=specific capacity >0.06 m3/h/m). The inclusion of dry/low yielding boreholes will increase the percentage of lower specific capacity values and therefore decrease the probabilities of obtaining the higher yields required for the urban supply boreholes. The Water Department computerised records are not comprehensive enough to provide this data at short notice but some indications of the possible magnitude of the correction factor can be obtained from the borehole data base in Uganda which show the average numbers of failed boreholes in basement aquifers to be around 18% (geophysical siting).

Well interference and recharge constraints.

It has been noticed during the site visits that production wells are often located only very short distances apart - a few metres only in many cases. This contiguity is doubtless convenient and cheaper for the distribution connections but will result in interference effects with simultaneous pumping (as commonly occurs) with consequential higher pumping costs because of increased drawdowns. Spacings should be optimised to minimise present value costing for both operational and capital costs. More critical perhaps are possible constraints on spacing due to limitations on recharge and this aspect has not been given consideration in the Master Plan. Basement aquifers are essentially discontinuous and borehole performance more affected by localised recharge. Areal annual recharge to basement aquifers has been estimated in a general range from 30 to 100mm. Total projected abstractions must be related to this limiting value and taking account also of the period of recharge. In the case of Chitipa, for example, the 2005 peak demand is equivalent to a 30mm recharge over some 20 sq.km. Precise analytical solutions for the spacings of the 22 boreholes which may be required are not feasible to obtain because of the uncertainties of recharge and of the hydraulic parameters but clearly a significant dispersion is likely to be required. The same issues apply to the higher yielding alluvial aquifers although it may be easier to apply analytical solutions because of their greater continuity. According to the UNDP Master Plan recharge to the alluvial aquifers will be in the range from 1-7% of mean annual rainfall.

Quality constraints

Groundwater in the basement aquifers of Malawi is generally of good quality other than in localised areas such as the Dowa district where sulphate-rich groundwater occur as a consequence of interaction with sulphide-bearing bedrock. Groundwater development should aim to intercept the more shallow circulating groundwater systems in such circumstances. High fluoride values are thought to be associated with mineralised water moving upwards from depth in fault zones. These occurrences do not normally constitute a major constraint to development of the basement aquifers. The situation is different in the alluvial aquifers where overall not only is the groundwater more mineralised than in the basement aquifers but the distribution of saline waters is characterised by considerable heterogeneity and variable quality occurrence. Borehole water quality can change with time due to coning in of more mineralised water with continuing development. Until the geometry and hydraulic parameters of the aquifers with saline water is better understood, predictive larger scale abstraction rates cannot be assured. This applies particularly to the lower Shire Valley where a number of the proposed schemes are located. The results of recent drilling in this area suggest however that by drilling deeper a hydraulic continuity with the Shire river may be obtained, with improvements to both the yields and water quality of the boreholes.

Sustained yield recommendations based on short term pumping tests.

The sustained yields of exploration boreholes recommended in the Master Plan projections have been based on pumping tests with a maximum 3 days duration. The main aquifers in Malawi are either discontinuous (basement aquifers) or highly heterogeneous (alluvial aquifers) and longer term predictions based on these short tests must be regarded with caution. There is frequent reference in Water Department reports to declining yields of boreholes, some of which may relate to faulty extrapolation of short term test drawdowns. Significant changes in production yields have also been observed at different seasons, such as the boreholes at Salima. The form of the drawdown curves is commonly difficult to interpret. There is often a rapid equilibration (Figures 7.11/7.12) which is suggestive of the cone of depression having reached a recharge boundary such as a surface water body. This boundary may not persist with time. Other tests have clearly not reached equilibrium and continued drawdown on the log cycle should be assumed during the period of nil recharge (Figure 7.13). For urban supply, longer term tests of the order of 14 days or more are to be recommended. During subsequent production, there should be continuing monitoring of yields, drawdowns and water quality in order to obtain confirmation of predicted performance. This is not being done and in many cases the borehole installation does not allow water levels to be measured.

The trend towards reducing yields of boreholes in some areas may however be due to lower annual rainfall over the last three years, and consequent reduction of groundwater levels.

<u>Mean monthly discharge data for low flow predictions</u>

The use of mean monthly discharge data for low flow predictions is probably acceptable where there is a good positive differential between estimated low flows and the demand, but in more marginal cases, a smaller time resolution is to be preferred, particularly when the demand is high. A short return period may also be more acceptable for towns with relatively small populations and low projected growth rates.

7.4. WATER SUPPLY PLANNING FOR THE 14 TOWNS

7.4.1 Introduction

Separate discussions on the 14 towns water supply are set out below and a table (Table 7.1) is attached which gives summary details of potential water supply schemes on the assumption of groundwater as a main or probable resource but with alternative surface water sources where these are clearly appropriate.

The projected borehole numbers for the immediate requirements, (1995) and the projected requirements to meet the 2000 and 2005 demands, are based on the Master Plan weighted yields and success rates and also on the more conservative values obtained from the probability plots.

The final recommendations have been divided into three categories, A, B and C, as follows:

Category A: Those schemes for which groundwater is clearly the most feasible solution to meet the future water of the urban centres. These schemes include:

Chitipa
Nkhotakota
Ntchisi
Namwera
Nsanje

Implementation should be preceded by a short survey and study period which would cover the following aspects:

- The recharge potential of the different areas.
- Evaluation of pollution potential to existing boreholes, and establishing pollution protection guidelines specific to each town.

- Conducting geophysical surveys using modern techniques.
- Optimisation of borehole locations.
- Preparation of the required drilling programme and contract documents
- Establish a monitoring programme of the existing and new boreholes to more accurately assess the groundwater potential, and assist in the design of future well fields.

Following this initial study period, a drilling programme can be initiated to meet the 2000 requirements of these schemes, although consideration could be given to a more phased programme. A further programme being required to be implemented by the year 2000 to meet the projected 2005 requirements.

Category B: Those schemes where there remains doubt as to the long term feasibility of groundwater compared to surface water, and where source augmentation cannot be delayed until after a surface resource has been adequately investigated, designed and constructed.

A programme similar to Category A schemes is suggested, but to meet only the 1995 demands. At the same time, further studies and cost estimates, as necessary should be undertaken to establish the most appropriate long term water resource.

Category B schemes include:

Salima
Dedza
Balaka
Nchalo
Ngabu
Luchenza

Category C: Those schemes which do not fit into the above categories, and requiring special consideration:

Dowa (collector wells)
Muloza (review proposal recommendations)
Chikwawa (Sufficient capacity to meet requirements)

It should be stressed that a major advantage of groundwater is its capacity for being phased, and a maximum us of this advantage should be made with continuing re-assessments of the situation. In carrying out such additional work, any need for short term implementation should be borne in mind.

7.4.2. Chitipa

Chitipa town overlies basement rocks on the African surface and has a thick regolith cover. It should be feasible to obtain boreholes with yields in excess of 3.6 m3/h and probably better than the projected 38% success rate. An estimated total of 15 additional successful boreholes will be needed to meet the 2005 demand. Recharge could be a constraint unless the boreholes are appropriately separated. Spacing issues could be helped by the monitoring of the existing well fields. Alternative surface water sources are 20 km+ away on the Chisasu river but no low flow details are provided so it can be assumed to be fully adequate.

7.4.3. Nkhotokhota (alluvial aquifer)

There is a good current supply of groundwater from boreholes and comparatively few additional boreholes (4-10) may be needed to meet the 2005 demand. Recharge should not be a constraint although the boreholes should not be placed too close together since aquifer transmissivity is quite low (11m2/d). Interference effects should be evaluated from the existing well field performance and spacings should take account of recharge,piezometric gradients etc. Water quality in the existing boreholes is good but high fluorides are known to occur in other boreholes in the general vicinity.

7.4.4. Ntchisi (basement aquifer)

Ntchisi has a small supply from a surface source in a nearby stream and examination of this and other streams in the same general area would indicate the need for surface storage although gauging data are small. Ntchisi lies in the Rift Escarpment area which has rapid runoff and restricted recharge. The two recently drilled boreholes have only a modest yield (2/2.5m3/h) which is less than normal design yields from basement aquifers. The total estimated borehole numbers for the full design yield is 9 and it is probable that improved exploration methodology could identify better boreholes than have hitherto been drilled.

7.4.5. Dowa (basement aquifer)

Dowa also occurs in the Rift Escarpment zone which creates difficulties in obtaining both ground and surface water. There are also local constraints of poor water quality (high sulphate).

However, current and projected demands are very small. The combination of the surface water source, the two existing wells being pumped at half the current rate and the new borehole which has a recommended sustained yield of 7 m3/h should in theory provide for the 1995 demand. The lithological log of the new borehole shows only a thin regolith, c. 4m, and the sustained yield based on the test pumping may prove to be in error. The pump test drawdown curve (Figure 7.12) is also unusual in that at 2.5 l/sec there is a breakaway drawdown as compared with the rapid equilibrium at 2.28 l/sec. The latter might indicate that the cone of depression has reached a nearby recharge boundary which is not apparent at the site and could perhaps be due to recycling of the pumped discharge. Monitoring of this borehole when it is put into production will be essential. It may also be noted that the chemical quality is hardly acceptable without, mixing having a sulphate content of 481 mg/l and 6.6 mg/l of fluoride.

An alternative source is a pumped supply from the Lingadzi river which is perennial with apparently adequate low flows but generally turbid and highly polluted and may also contain high sulphate content at low flows The pumping scheme costs are not provided but are said to be very high. The alternative groundwater requirement would be for four (4) successful boreholes having an average design yield of 3.6 m3/h.

7.4.6. Salima (alluvial aquifer)

The situation in Salima is unusual in that there is a marked seasonal change in the yields of the three production boreholes. According to the Master Plan report, production capacity is 1584 m3/d which is correct for the wet season but reduces in the dry season to 666 m3/d. This has been confirmed by the Water Department staff at the time of the site visit and corresponds with the metered production data. Further confirmation of this unusual circumstance is needed and if possible a technical explanation. It could relate to major seasonal changes in water levels but might also indicate that abstraction is exceeding recharge and the change is progressive and not seasonal. To meet the 1995 shortfall, a further 3/4 boreholes each providing between 20/25 m3/h would be needed.

The Master Plan on the assumption of a current production capacity of 1584 m3/d projects a further 3 boreholes at 25 m3/h to meet the 2005 demand at an investment cost of 158,800 kwacha. Taking account of the reduced dry season yield, a total of some 8/9 boreholes would be required for the 2005 demand with sustained yields in the range of 20/25 m3/d (Table 7.1). This requirement would triple the investment costs.

7.4.7. Dedza (basement aquifer)

Dedza is a town with an exceptionally high demand, both current and projected, which has been strongly influenced by the influx of refugees within the town boundary. The situation could conceivably change in the future if the security situation in Mozambique should improve. The existing town piped system is supplied by a small surface water system with a minimum dry season offtake of 7 m3/h and groundwater from 2 boreholes sited close together in a valley to the east at the foot of Dedza mountain. Six boreholes were drilled in the Master Plan drilling programme but all 6 yielded less than design minimum yields of 3.6 m3/h. More recently, the Malawi Government has constructed 4 boreholes with reputed (needs confirmation) average yields of 6.5 m3/h in the Linthipe valley and one of these has already been connected directly into the town piped distribution system. The two original production boreholes are piped to a tank and chlorinated before distribution. The refugee camps which are mainly concentrated on the south bank of the Linthipe river make use of a limited supply from one communal water point but otherwise draw upon springs and dug wells in the Linthipe valley sides. These sources are quite certainly polluted. Even when three of the four new boreholes (one is planned as a standby) come into production, there will still be a major shortfall of 1387 m3/d for the 1995 peak demand. There is therefore some urgency for short term augmentation. Additionally the new Linthipe boreholes are fairly vulnerable to pollution since they are not too distant from the refugee settlements (40 m in the case of the one being produced). It is planned that the discharge will be directly chlorinated in the trunk mains. As far as is feasible, protection zones with restricted land usage should be established around all these boreholes. Water level details are not immediately available to assist identification of vulnerability but the regolith is said to be thick and probably clayey in the upper levels which is a favourable feature in this respect.

Alternative schemes are as follows:

1. Groundwater. Projected borehole yields are estimated at 3.6 m3/h, intermediate between those completed in the Linthipe valley (6.5) and the 6 exploration boreholes drilled by Master Plan programme (<1.5). Dedza town area has moderate relief and occurs in a transitional zone of 2/3 geomorphological surfaces. The regolith thickness is not thought to be great, other perhaps than in the Linthipe valley and there must be limited scope for many more additional boreholes in this valley within the town

boundary. 22 boreholes are estimated to be required to meet the 1995 demand and most of these would probably need to be completed outside the town boundary which would increase the standard costs. Collector wells are a possibility and one or more could be constructed in the vicinity of the mainly unsuccessful well field constructed by Master Plan to the west of the town centre. However, since the drilling equipment is not available in Malawi, they probably cannot be considered as a short term solution.

2. Surface Water. An earth dam site has been located on the Linthipe River immediately downstream of the refugee camp and therefore very vulnerable to pollution. The Linthipe is said to be very turbid in the wet season and full treatment would be necessary. Heavy siltation in the dam can also be anticipated. According to the height of the dam wall, the pumped supply yield could either be 1555 or 4500 m3/d. The smaller supply in conjunction with the existing sources of supply would meet the peak 1995 demand. The larger supply would meet the **total** peak demand for 2005.

7.4.8. Namwera (basement aquifer)

Namwera is not in the list of towns studied in the Master Plan but information is included in the MOW proposal, although not to feasibility level. The existing supply is from three(3) boreholes with a reported average yield of 3.5 m3/h. Borehole test yields in the Water Department data base generally confirm this figure other than for one borehole which apparently yielded 24 l/sec. Water quality is said to be good with a fairly high iron content as the only constraint. For projection purposes, a design yield of 3.6 m3/h is used and a 38% success rate.

Potential surface water sources include the Masongoli and the Lasongwasi rivers. Peak demand for 2005 is equivalent to 6 l/sec and low flow estimates are as follows:

(i) Masongoli : 7 l/sec with 50 year return period.

(ii) Lasongwasi: 5 l/sec with 50 year return period.

Both rivers therefore represent feasible sources but no information is presented on water quality.

7.4.9. Balaka (alluvial/basement aquifer)

Balaka was originally excluded from the 14 towns on the assumption that it would be supplied by the Mpiri-Balaka Rural Water Supply Scheme. This is no longer the case, and supplying Balaka even with the current maximum of 340 m3/d jeopardizes the rural system in some places. However, the groundwater potential needs to be assessed in more detail. The one borehole operating at the time of the visit is very high yielding but apparently penetrates a marble band below the alluvial sequence and may well be atypical. The 35 boreholes in the data bank show vary variable parameters of water levels, specific capacity and water quality, sometimes excessively high in chloride, sulphate and fluoride. The town lies on the boundary between the basement and the alliuvial, however there is potential to locate boreholes with a potential for recharge from the Rivi Rivi River. On the assumption of fairly high yields c.15m3/h, a substantial number of boreholes (23) will be needed to meet the 2005 demand, and there could be constraints of both recharge and water quality. The data bank needs detailed interrogation to improve the assessment of potential.

The only potentially viable surface water resource in the area would appear to be the Rivi-Rivi River, which has zero flows once every 10 years, and would therefore require storage. However, due to the flat terrain and the nature of the river, there are no obviously suitable dam site locations that could be developed locally. This situation needs to be reviewed in more detail along with the hydrogeological investigations mentioned above, before a long term development plan for the town can be prepared.

7.4.10. Chikwawa (alluvial aquifer)

The existing and confirmed groundwater supply from 3 older production boreholes and 3 recently drilled Master Plan exploration boreholes exceeds the 2005 water demand. Water quality in the new boreholes is within WHO limits but one of the older boreholes (T3) has excessively high amounts of chloride and dissolved solids but this in counteracted by mixing in the storage tanks. The Master Plan report recommended that all the older boreholes except RK294 should be abandoned because of sand pumping problems and even if this recommendation is followed, the remaining supply will still be sufficient for the 2005 demand. The older boreholes are more vulnerable to pollution than the newer exploration boreholes in that they occur in more built-up areas with pit latrines and septic tanks in the general vicinities. However, water levels are generally deep,c.30m, which is favourable in this respect. Alternative surface water sources do exist in the area which include the Shire and Mwamphazi rivers but are not being given serious consideration at the present time.

7.4.11. Nchalo (alluvial aquifer overlying the Karoo Lupata Series)

The existing supply from two older production boreholes in combination with the recommended sustained yields from two new exploration boreholes which have yet to be equipped would almost meet the 1995 peak demand. However, there are serious water quality constraints. The older boreholes with yields around 5m3/h have high chloride contents and also pump sand. The new boreholes have contents of chloride, sodium and fluoride, all in excess of WHO limits but marginally within the Malawi Government temporary standards. The older production boreholes are also likely to be polluted from nearby septic tanks and pit latrines. Alternative surface water sources include the Shire river and irrigation canals. Serious consideration has not been given as yet to the potential of surface water sources.

7.4.12. Luchenza (basement aquifer)

The situation has changed significantly since the Master Plan studies in consequence of the drilling of three high-yielding boreholes, although since two are only a few metres apart, alternative production use is to be preferred. Although individual borehole yields appear to have sustained potential of around 18m3/h, the lithological log shows penetration into highly fractured vein quartz and dolerite dyke rocks which could well be atypical of the basement aquifer. Indeed the other exploration boreholes and the older production boreholes have much lower yields. For planning and cost estimations, a standard rate of 3.6m3/h and a 38% success rate is used.

A well point system constructed in the bed of the Luchenza River has apparently operated satisfactorily until it was comprehensively destroyed during flood flows in the river. Considerably more attention would be required to protection and siting of the well points if this system is to prove viable.

Alternative schemes include groundwater to meet the 1995 demands (1 borehole) and 2005 demands (4-15 boreholes) as compared with a pumped supply from the Luchenza river. Flow records indicate a minimum flow of 90 l/sec in 20 years which is more than sufficient for the **total** 2005 peak demand of 20 l/sec but account has also to be taken of existing water rights of 107 l/sec. If it is feasible to reduce these latter demands during dry season or drought periods, the surface water source could be used to meet the 2005 demand.

7.4.13. Muloza (basement aquifer)

Muloza was not included in the Master Plan studies. The MOW proposal of 1990 provides only limited information which is insufficient to plan and design implementation programmes. However, on the assumption (requires confirmation) that the refugee population in settlements close to Muloza are not to be included in the demand estimates, total projected demands for 1995 and 2005 are quite small.

Muloza is a small scheme requiring only 3 additional boreholes to meet the 2005 demand. Alternatives include a connection to the adjacent rural water supply scheme, which pipes partially treated surface water by gravity to the area, and a water intake on the nearby Muloza river. The Water Department proposal was to connect to the existing rural piped water supply scheme on the grounds that it was the least cost solution.

Surface water sources include the Muloza and Limbuli rivers. The Muloza river supplies the Muloza Rural Water Supply scheme which is said to be feasible to upgrade to provide 149m3/d to the Muloza town Trading Centre. Observations on the scheme performance, pipe sizes and standpipe discharges would throw this conclusion into some doubt. No information is available in the MOW report on the Muloza river low flows. Gaugings on the Limbuli river indicate a low flow of 20 l/sec in 50 years which is more than adequate for the 2005 demand (2 l/sec).

7.4.14. Ngabu (alluvial aquifer overlying Lupata Series)

Existing supply is from 5 boreholes whose combined yield represents about 50% of the 1995 peak demand. Water quality is within acceptable limits and the majority of the boreholes are fairly well protected against surface pollution. Average yields are of the order of 7m3/h but the Master Plan considers that 20m3/h would be realisable. In the event, the two exploration boreholes constructed in the Master Plan drilling programme were both 'dry' (no actual yield figures given). A more recent successful borehole has been reported to have been pump tested at 36 m3/hr. For projection planning however, a yield of 15m3/h has been considered.

Potential surface water sources include the Shire River and one stream which would require significant storage. Neither source of supply has been costed. The failure of the exploration boreholes implies that a feasibility survey has not been achieved and it seems that there is insufficient understanding of the potential of the thin alluvial sequence overlying the Lupata Series.

7.4.15. Nsanje (alluvial aquifer)

The existing supply comes from 5 boreholes (two in one closely spaced group) but the Master Plan figures for sustained yields of 695m3/d is more than the current production figures which are of the order of 500m3/d. Even this figure must also be in some doubt since it is based on the tank outlet meter whereas the inlet meter for the same period (one month) do not agree. Further checks and calibration of the meters are needed to finalise production figures. A new borehole which has yet to be equipped has a recommended sustained yield of 18m3/h and in combination with the supply from existing boreholes should be sufficient for the 1995 peak demand. Water quality from all boreholes is within WHO limits. The Master Plan recommended that all the older boreholes should be abandoned because of sand pumping and replaced by new boreholes. The Master Plan projected yield of 20m3/h and 90% success seems strongly weighted by the one exploration borehole and a more conservative projection of 15m3/h and 55% success rate is preferred for costing purposes. The older boreholes are currently being used and it may also be noted that some are vulnerable to pollution with septic tanks and pit latrines in the close vicinity (30-70m) and water levels are shallow. Bacteriological tests have confirmed the probability.

Alternative surface water sources include the Shire and Nyamadzere rivers but the latter would require storage and both would need full treatment. Costs have not been estimated and use is not under consideration.

7.5 CONCLUSIONS AND SUMMARY OF RECOMMENDATIONS

7.5.1 Conclusions

Groundwater development is a potential and probably the most appropriate option for the water supply for the majority of the 14 towns but cost estimates of implementation must still be regarded with caution and there are various constraints to development which could prove significant in certain cases and require re-consideration of the choice of source type. The use of groundwater has apparent advantages in both cost and phasing over surface water development but the supply aquifers are discontinuous and/or heterogeneous and there are uncertainties attendant on larger scale development, notably in respect to recharge and water quality (mainly in the alluvial aquifers). These uncertainties may be resolvable by further surveys and site investigations and by careful monitoring of the performance and effects of the existing well fields, including any new production boreholes.

Three categories of implementation have been proposed, Category A for immediate surveying and design planning to meet the 2000 demands, Category B which require additional resource surveys to establish the most feasible source for long term planning, but for which additional boreholes are required to meet the immediate needs, Category C which do not fit into Category A or B, and require some special consideration. It must be emphasised that even for implementation in Category A towns, geophysical surveys and drilling are needed in several cases. This work has been omitted from the MOW proposal and it would seem that MOW was unaware that it would be needed.

7.5.2 Summary of Recommendations

Various recommendations have been given throughout the report for improvements to Master Plan methodology and analysis procedures and are summarised briefly below. They include the following:

1. Optimisation of borehole locations and design for the production well fields. Final decisions may need to be deferred until after numbers of exploration boreholes have been constructed.

2. Pollution: guidelines to be prepared for the site conditions at **each town**. The guidelines should include the design also of on-site sanitation systems as well as their relative locations.

3. Data base: an improved computerised data base to be set up in the Water

Department which should include more advanced search, retrieval, analytical and graphics facilities.

4. Exploration methodology: because of the need to locate high yielding boreholes in basement aquifers, fracture system identification is essential; EM (and possibly radon) equipment should be used in conjunction with geoelectrical surveys.

5. Sustained yield evaluation: pumping tests of longer duration than the Master Plan procedures of three days are recommended for urban supply boreholes. 14 day tests are suggested.

6 Monitoring programmes: routine monitoring is strongly recommended and measurements should include abstractions, duration of pumping, pumping and static water levels, water quality both chemical and bacteriological. The appropriate measuring and sampling equipment should be available at each town with sufficient equipment backup to ensure no lack of continuity.

7. Collector wells: with particular value in areas of thin regolith.

8. Additional surveys and statistical evaluations:

(i) Basement aquifers. These aquifers have developed as a result of groundwater circulation at shallow levels and the aquifers are therefore closely related to surface and shallow sub-surface features. Important correlations which can assist in planning and exploration can be obtained by statistical analysis of a range of parameters -yields, borehole depths, regolith thickness, fracture occurrences and distributions. Geohydrological and geomorphological locations, rainfall, rest water levels, drainage patterns, catchment basin areas, topographic locations, relief, bedrock type and water chemistry. All these parameters can be readily included in the borehole data base. Computerised groundwater resource and development maps are an obvious adjunct.

(ii) Sedimentary aquifers: facies changes and trends are likely to be of particular value and a better understanding of the controls to water quality variations is particularly critical. Fluid conductivity and geochemical logging and depth sampling of boreholes and monitoring during production are recommended.

TABLE 7.1

SUMMARY DETAILS FOR PROVISIONAL GROUNDWATER IMPLEMENTATION SUPPLY FOR 14 TOWNS AND SURFACE WATER WHERE ALTERNATIVES ARE IDENTIFIED Page: 1

	Town		Required Production Capacity 1995 m3/d	Required Production Capacity 2005 m3/d		Source Type	Nr.	Nr. Eq'd	Prob Yield m3/h	Total Yield m3/h	h/d	Total Cap. m3/d	Cum Cap m3/d	B/H Success Rate	B/H Fails
1	Chitipa		631	1579	a) Existing Supply	GW	3		4	14.5	18	261	261		
					b)Recent boreholes	GW	6	5	2.9	23.5	18	423	684		
		Phase 1 Projections:			i)C-B Master Plan	GW	2		5	10	18	180	864	38%	3
					ii)C-B Prob Plot	GW	2		3.6	7.2	18	130	814	38%	3
		Phase 2 Projections			i)C-B Master Plan	GW	8		5	40	18	720	1584	38%	13
					ii)C-B Prob Plot	GW	12		3.6	43.2	18	778	1591	38%	20
2	Nkhotakota		1669	2246	a) Existing Supply	GW	3			36.4	18	655	655		
					b)Recent boreholes	GW	4	4		44.2	18	795	1450		
		Phase 1 Projections:			i)C-B Master Plan	GW	1		25	25	18	450	1900	75%	<1
					ii)C-B Prob Plot	GW	1		11	11	18	198	1648	60%	<1
		Phase 2 Projections			i)C-B Master Plan	GW	3		25	75	18	1350	3250	75%	1
					ii)C-B Prob Plot	GW	9		11	99	18	1782	3430	60%	6
3	Ntchisi		460	775	a) Existing Supply	SW	1			6.25	24	150	150		
					b)Recent boreholes	GW	2	2		4.5	18	72	222		
		Phase 1 Projections:			i)C-B Master Plan	GW	4		3.6	14.4	18	259	481	38%	7
					ii)C-B Prob Plot	GW	4		3.6	14.4	18	259	481	38%	7
		Phase 2 Projections			i)C-B Master Plan	GW	5		3.6	18	18	324	805	38%	8
					ii)C-B Prob Plot	GW	5		3.6	18	18	324	805	38%	8
4	Salima		1855	3847	a) Existing Supply	GW	3			37	18	666	666		
					b)Recent boreholes	GW							666		
		Phase 1 Projections:			i)C-B Master Plan	GW	3		25	75	18	1350	2016	75%	1
					ii)C-B Prob Plot	GW	4		20	80	18	1440	2106	48%	4
		Phase 2 Projections			i)C-B Master Plan	GW	4		25	100	18	1800	3816	75%	1
					ii)C-B Prob Plot	GW	5		20	100	18	1800	3906	48%	5
5	Dowa		393	636	a) Existing Supply	GW	2			7	18	126	126		
						SW				7.42	24	178	304		
					b)Recent boreholes	GW	4	1		7	18	126	430		
		Phase 1 Projections:			i)C-B Master Plan	GW	0			0	18	0	430		
					ii)C-B Prob Plot	GW	0			0	18	0	430		
		Phase 2 Projections			i)C-B Master Plan	SW	1		18.7	18.7	18	337	767		
		(Alt)			ii)C-B Prob Plot	GW	3		3.6	10.8	18	194	624	38%	5

TABLE 7.1

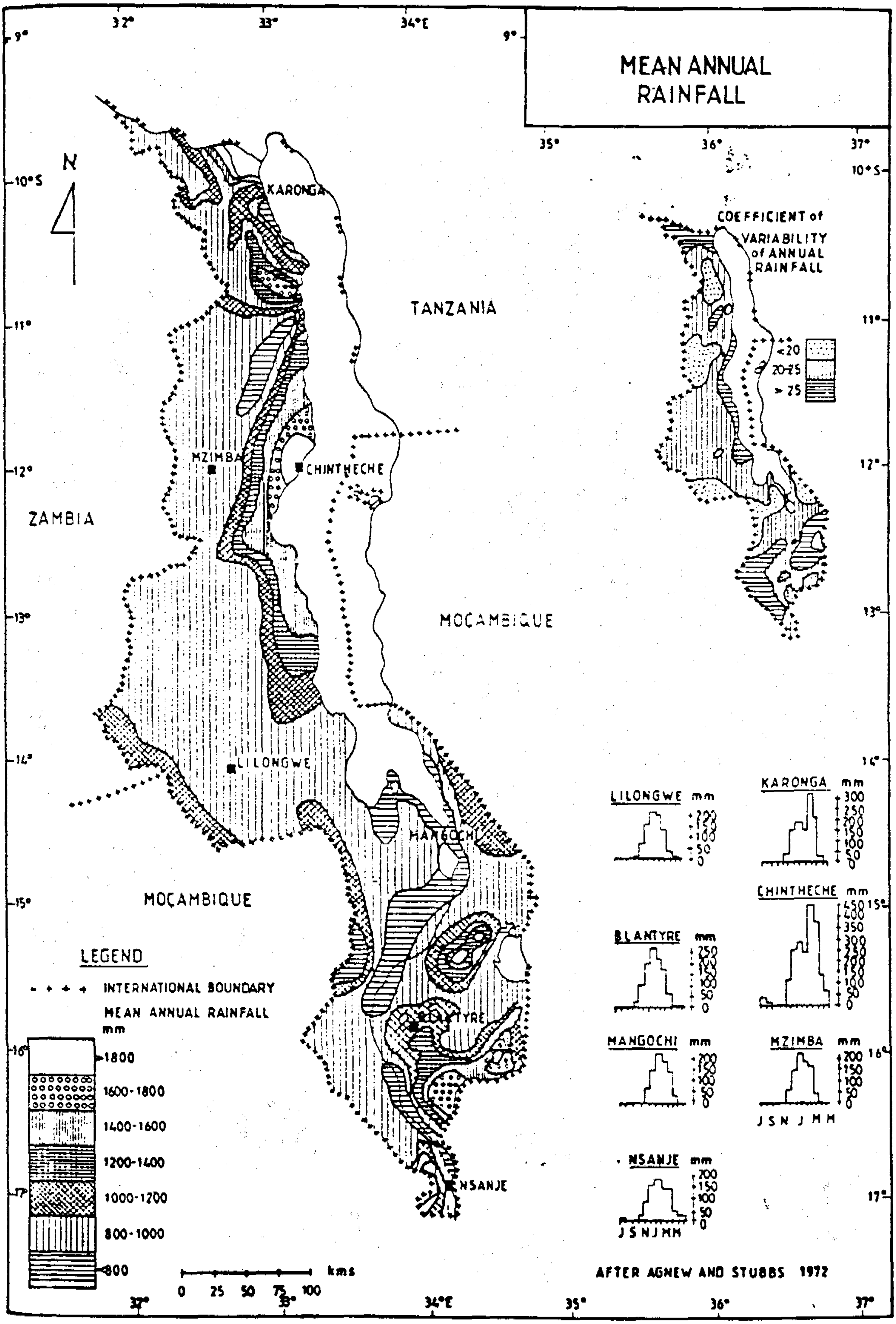
SUMMARY DETAILS FOR PROVISIONAL GROUNDWATER IMPLEMENTATION SUPPLY FOR 14 TOWNS AND SURFACE WATER WHERE ALTERNATIVES ARE IDENTIFIED **Page 2**

Town			Required Production Capacity 1995 m3/d	Required Production Capacity 2005 m3/d		Source Type	Nr.	Nr. Eq'd	Prob Yield m3/h	Total Yield m3/h	h/d	Total Cap. m3/d	Cum Cap m3/d	B/H Success Rate	B/H Fails
6	Dedza		2012	4925	a) Existing Supply	GW	2			5.9	18	106	106		
						SW	1			7	24	168	274		
					b) Recent boreholes	GW	6	0		0	18	0	274		
						GW	4	3		19.5	18	351	625		
		Phase 1 Projections:			i) C-B Master Plan	GW	0		0	0	0	0			
					ii) C-B Prob Plot	GW	22		3.6	79.2	18	1426	2051	38%	36
		Phase 2 Projections			i) C-B Master Plan	GW			0	0	0	0			
					ii) C-B Prob Plot	GW	45		3.6	162	18	2916	4967	38%	73
					Alternative	SW	1			120	24	2880	4931		
7	Namwera		295	481	a) Existing Supply	GW	3			10.4	18	187	187		
					b) Recent boreholes	GW				0	18	0	187		
		Phase 1 Projections:			i) C-B Master Plan	GW				0	0	0			
					ii) C-B Prob Plot	GW	2		3.6	7.2	18	130	317	38%	3
		Phase 2 Projections			i) C-B Master Plan	SW			0	0	0	0			
					ii) C-B Prob Plot	GW	3		3.6	10.8	18	194	511	38%	5
8	Balaka		3064	7381	a) Existing Supply	GW	1			28.8	18	518	518		
						SW	1			15.6	24	360	898		
					b) Recent boreholes	GW	1	1		15	18	270	1168		
		Phase 1 Projections:			i) C-B Master Plan	GW	4		25	100	18	1800	2968	75%	1
					ii) C-B Prob Plot	GW	7		15	105	18	1890	3058	55%	6
		Phase 2 Projections			i) C-B Master Plan	GW	10		25	250	18	4500	7468	75%	3
					ii) C-B Prob Plot	GW	16		15	240	18	4320	7378	55%	13
9	Chilowawa		521	888	a) Existing Supply	GW	2			10.7	18	193	193		
					b) Recent boreholes	GW	3	3		60	18	1080	1273		
		Phase 1 Projections:			i) C-B Master Plan	GW	No shortfall			0	18	0			
					ii) C-B Prob Plot	GW			0	0	18	0			
		Phase 2 Projections			i) C-B Master Plan	GW			0	0	18	0			
					ii) C-B Prob Plot	GW			0	0	18	0			
10	Nchalo		917	1975	a) Existing Supply	GW	2			9.8	18	176	176		
					b) Recent boreholes	GW	2	2		36	18	648	824		
		Phase 1 Projections:			i) C-B Master Plan	GW	1		15	15	18	270	1094	75%	0
					ii) C-B Prob Plot	GW	1		15	15	18	270	1094	55%	1
		Phase 2 Projections			i) C-B Master Plan	GW	3		15	45	18	810	1904	75%	1
					ii) C-B Prob Plot	GW	4		15	60	18	1080	2174	55%	3

TABLE 7.1

SUMMARY DETAILS FOR PROVISIONAL GROUNDWATER IMPLEMENTATION SUPPLY FOR 14 TOWNS AND SURFACE WATER WHERE ALTERNATIVES ARE IDENTIFIED

Town			Required Production Capacity 1995 m3/d	Required Production Capacity 2005 m3/d		Source Type	Nr.	Nr. Eq'd	Prob Yield m3/h	Total Yield m3/h	h/d	Total Cap. m3/d	Cum Cap m3/d	B/H Success Rate	B/H Fails
11	Luchenza		801	1719	a) Existing Supply	GW	1			7.28	18	131	131		
					b) Recent boreholes	GW	7	2		34	18	612	743		
		Phase 1 Projections:			i) C-B Master Plan	GW	1		10	10	18	180	923	38%	2
					ii) C-B Prob Plot	GW	1		3.6	3.6	18	64.8	808	38%	2
		Phase 2 Projections			i) C-B Master Plan	GW	4		10	40	18	720	1643	38%	7
					ii) C-B Prob Plot	GW	15		3.6	54	18	972	1780	38%	24
12	Muloza		95	170	a) Existing Supply	GW	1			2	18	36	36		
					b) Recent boreholes	GW	0	0		0	0	0	36		
		Phase 1 Projections:			i) C-B Master Plan	GW	0		0	0	0	0	36		
					ii) C-B Prob Plot	GW	1		3.6	3.6	18	64.8	101	38%	2
		Phase 2 Projections			i) C-B Master Plan	GW	0		0	0	0	0	0		
					ii) C-B Prob Plot	GW	2		3.6	7.2	18	130	230	38%	3
					Alternative	SW	Extension to RWS scheme					149			
13	Ngabu		898	1772	a) Existing Supply	GW	5			28	18	504	504		
					b) Recent boreholes	GW	3	1		36	18	648	1152		
		Phase 1 Projections:			i) C-B Master Plan	GW	2		20	40	18	720	1872	90%	0
					ii) C-B Prob Plot	GW	0		15	0	18	0	1152	55%	0
		Phase 2 Projections			i) C-B Master Plan	GW	2		20	40	18	720	2592	90%	0
					ii) C-B Prob Plot	GW	3		15	45	18	810	1962	55%	2
14	Nsanje		1053	1918	a) Existing Supply	GW	4			38.6	18	695	695		
					b) Recent boreholes	GW	3	2		18	18	324	1019		
		Phase 1 Projections:				GW	0	No shortfall							
		(Alt)				GW	0	Replace existing boreholes:							
					i) C-B Master Plan	GW	1		20	20	18	360	1379	90%	0
					ii) C-B Prob Plot	GW	1		15	15	18	270	1289	55%	1
		Phase 2 Projections			i) C-B Master Plan	GW	3		20	60	18	1080	2459	90%	0
					ii) C-B Prob Plot	GW	3		15	45	18	810	2099	55%	2



MEAN ANNUAL RAINFALL
TANZANIA
ZAMBIA
MOÇAMBIQUE
MOÇAMBIQUE
KARONGA
MZIMBA
CHINTHECHE
LILONGWE
MANGOCHI
BLANTYRE
NSANJE
COEFFICIENT of VARIABILITY of ANNUAL RAINFALL
<20
20-25
> 25
LEGEND
INTERNATIONAL BOUNDARY
MEAN ANNUAL RAINFALL mm
>1800
1600-1800
1400-1600
1200-1400
1000-1200
800-1000
<800
0 25 50 75 100 kms
LILONGWE mm
KARONGA mm
BLANTYRE mm
CHINTHECHE mm
MANGOCHI mm
MZIMBA mm
NSANJE mm
J S N J M M
AFTER AGNEW AND STUBBS 1972

FIGURE 7.1

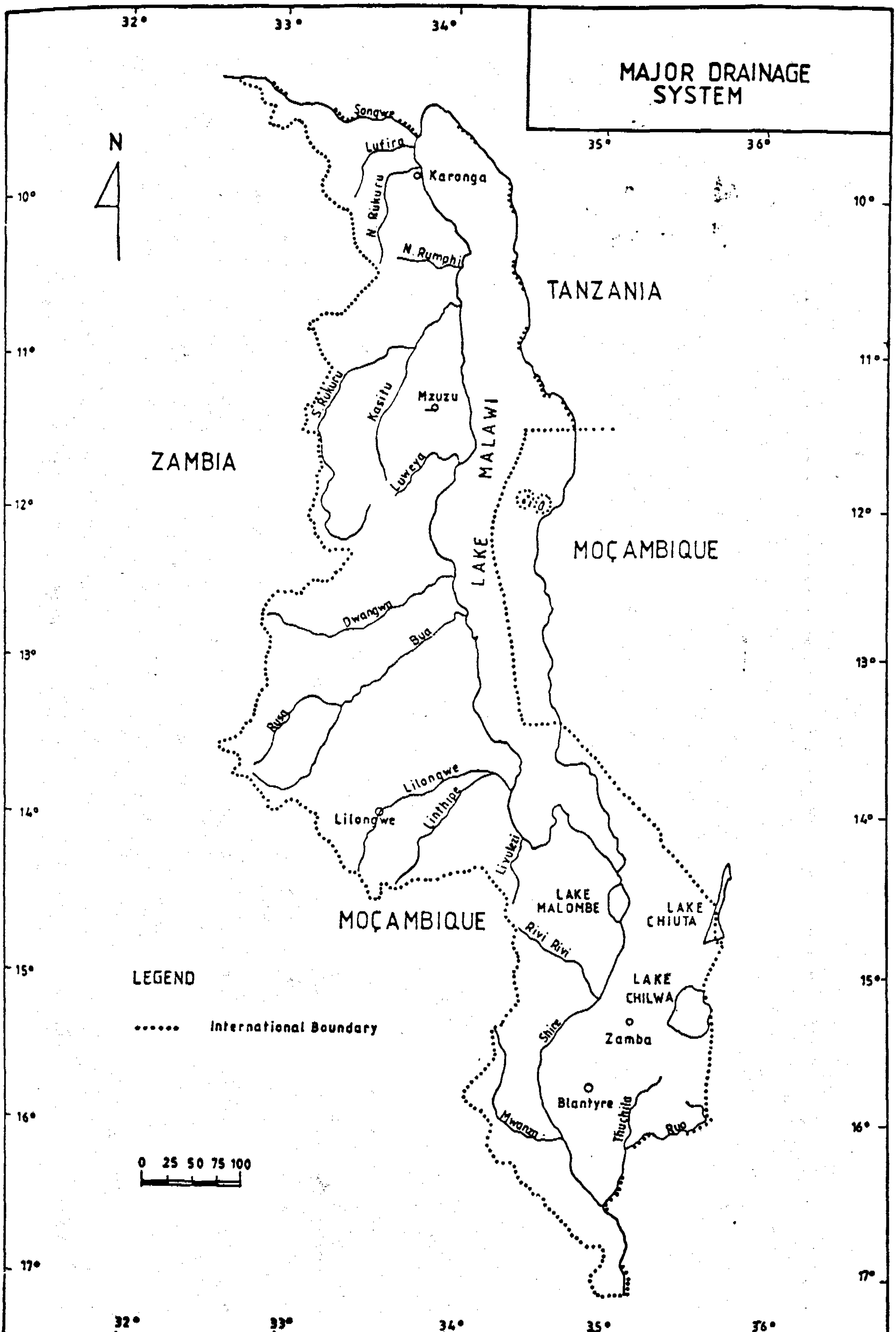

MAJOR DRAINAGE SYSTEM
N
32°
33°
34°
35°
36°
10°
11°
12°
13°
14°
15°
16°
17°
Songwe
Lufira
Karonga
N. Rukuru
N. Rumphi
TANZANIA
S. Rukuru
Kasitu
Mzuzu
ZAMBIA
Luweya
LAKE MALAWI
MOÇAMBIQUE
Dwangwa
Bua
Bua
Lilongwe
Linthipe
Lilongwe
Liyulezi
LAKE MALOMBE
LAKE CHIUTA
MOÇAMBIQUE
Rivi Rivi
LAKE CHILWA
LEGEND
International Boundary
Shire
Zomba
Blantyre
Thuchila
Mwanza
Ruo
0 25 50 75 100

FIGURE 7.2

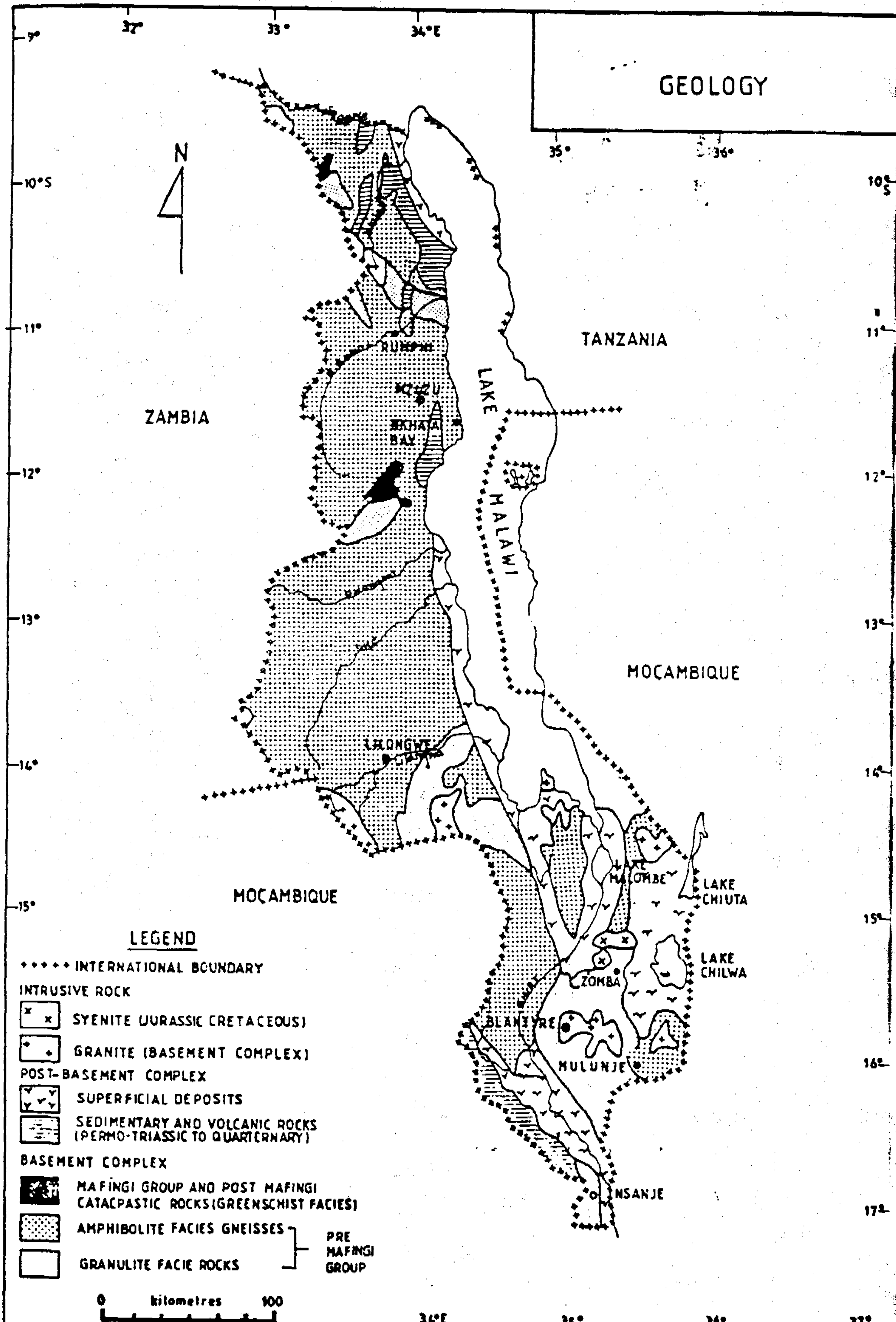
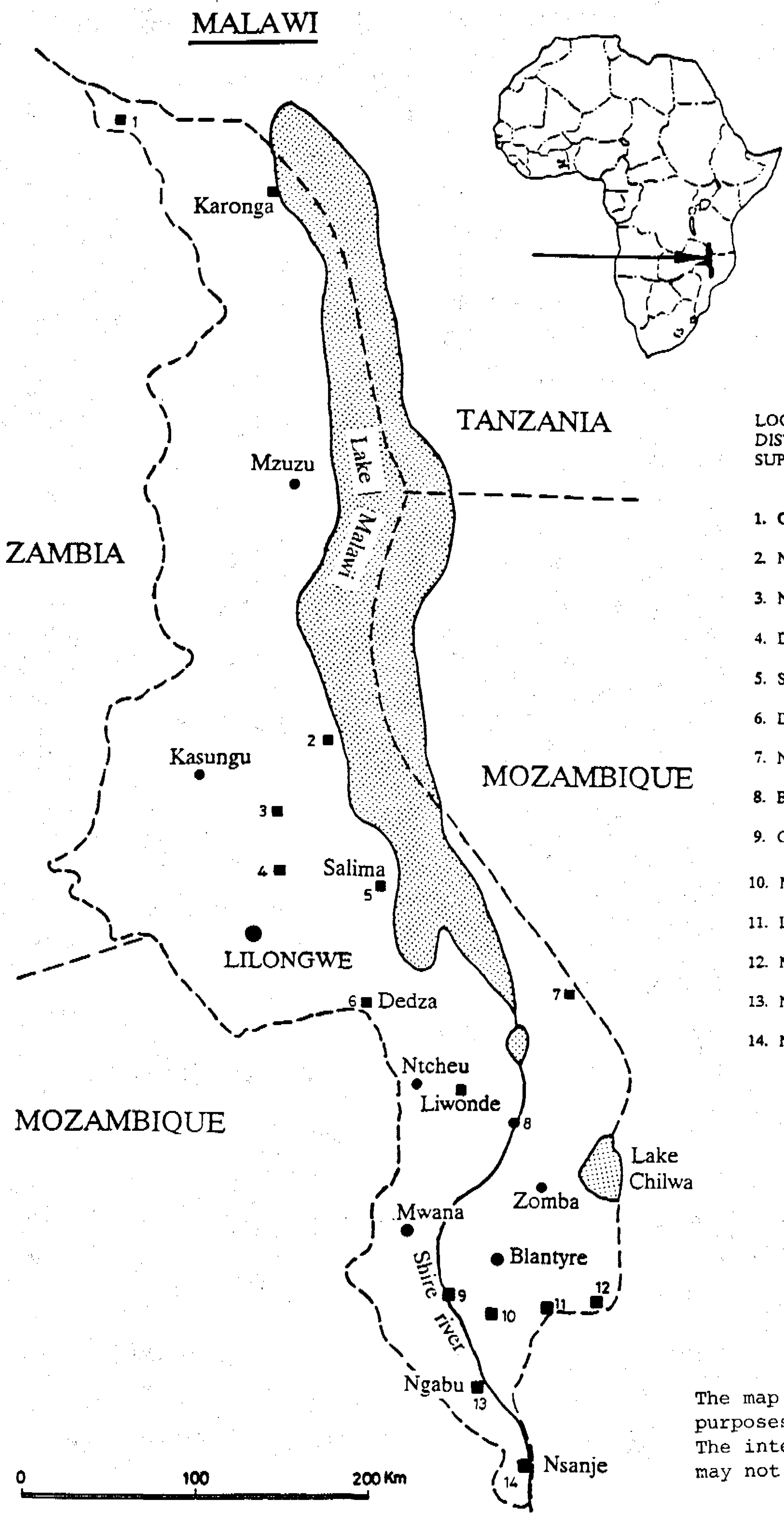

GEOLOGY
N
ZAMBIA
TANZANIA
MOCAMBIQUE
MOCAMBIQUE
LAKE MALAWI
RUMPHI
MZUZU
NKHATA BAY
LILONGWE
MALOMBE
LAKE CHIUTA
ZOMBA
LAKE CHILWA
BLANTYRE
MULUNJE
NSANJE
LEGEND
INTERNATIONAL BOUNDARY
INTRUSIVE ROCK
SYENITE (JURASSIC CRETACEOUS)
GRANITE (BASEMENT COMPLEX)
POST-BASEMENT COMPLEX
SUPERFICIAL DEPOSITS
SEDIMENTARY AND VOLCANIC ROCKS (PERMO-TRIASSIC TO QUARTERNARY)
BASEMENT COMPLEX
MAFINGI GROUP AND POST MAFINGI CATACPASTIC ROCKS (GREENSCHIST FACIES)
AMPHIBOLITE FACIES GNEISSES
GRANULITE FACIE ROCKS
PRE MAFINGI GROUP
0 kilometres 100

FIGURE 7.3

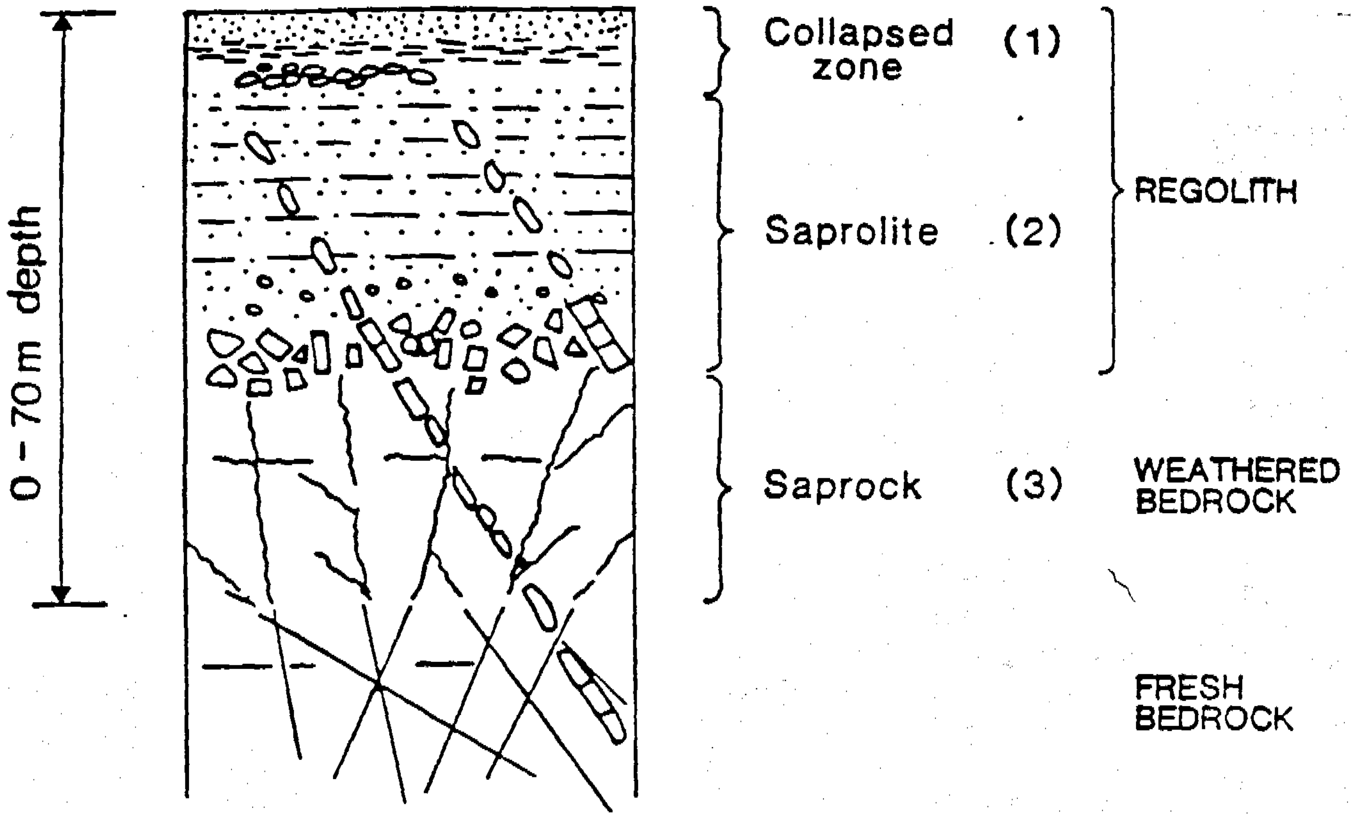


LOCATION OF 14 DISTRICT WATER SUPPLY SCHEMES.

1. CHITIPA
2. NKHOTAKOTA
3. NTCHISI
4. DOWA
5. SALIMA
6. DEDZA
7. NAMWERA
8. BALAKA
9. CHIKWAWA
10. NCHALO
11. LUCHENZA
12. MULOZA
13. NGABU
14. NSANJE

The map is for illustration purposes only.
The international boundary may not be accurately drawn.

FIGURE 7.4



TYPICAL WEATHERED PROFILE ABOVE CRYSTALLINE BASEMENT ROCKS

Notes:

(1) Collapsed zone. This may show marked lateral variations but is generally sandy on watershed areas with illuviated clay near the base and sometimes a 'stone line'; on valley slopes, colluvial material accumulates and in dambos, secondary clay minerals predominate. Slope bottom laterites may also occur which can result in perched water tables. Permeabilities vary in accordance with lithology although on watersheds the collapsed zone normally occurs above the water table.

(2) Saprolite is derived by in-situ weathering from the bedrock but is disaggregated. Permeability commonly increases at lower levels due to paucity of secondary clay minerals.

(3) Saprock is weathered bedrock. Original features are likely to be more open than in the fresh bedrock and in the absence of illuviated clay, permeability could be high.

FIGURE 1.3
WEATHERED PROFILE ABOVE
CRYSTALLINE BASEMENT RO

FIGURE 7.5

Schematic hydrogeological cross-section

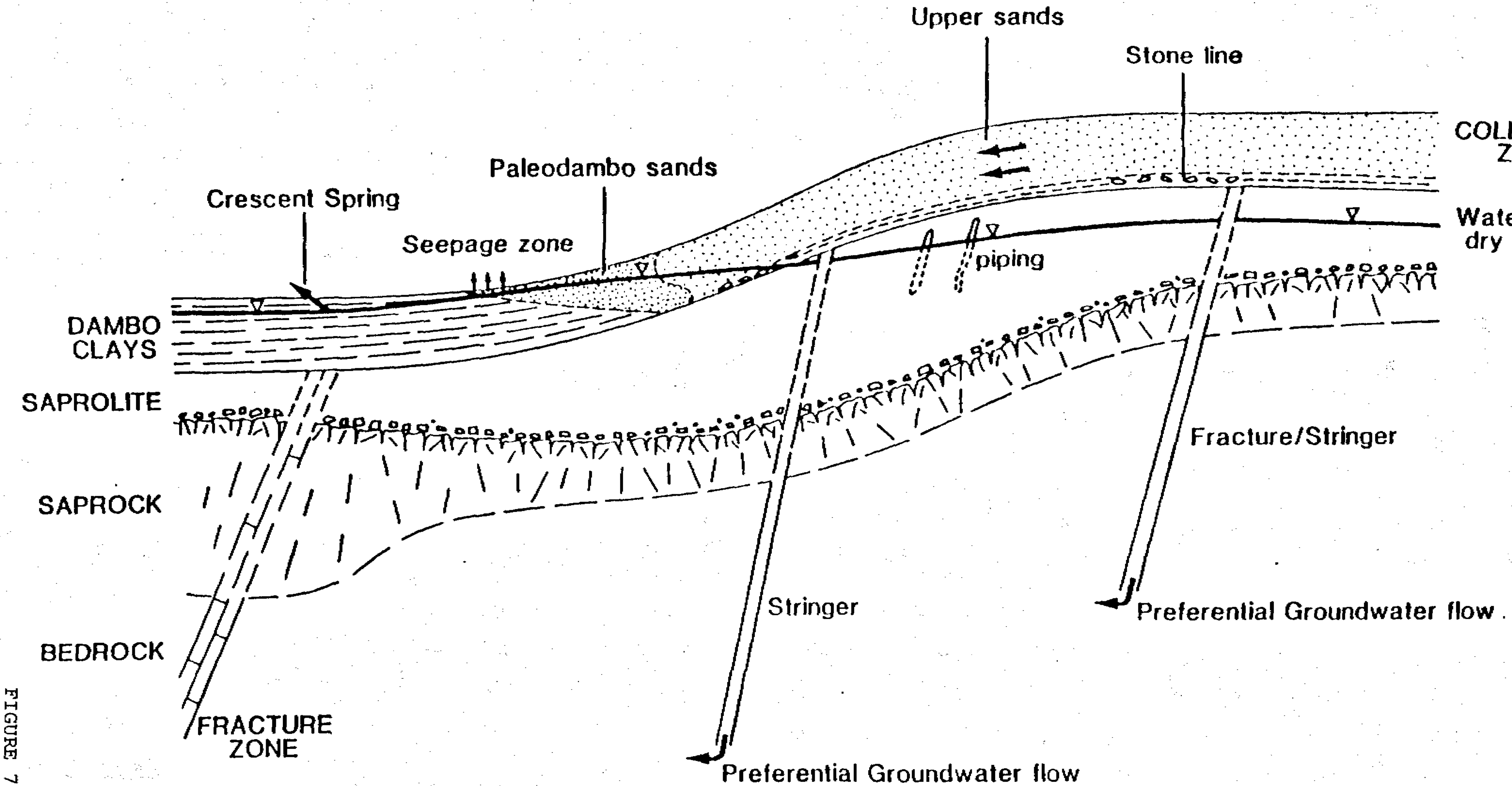


FIGURE 7.6

SCHEMATIC HYDROGEOLOGICAL CROSS-SECTION

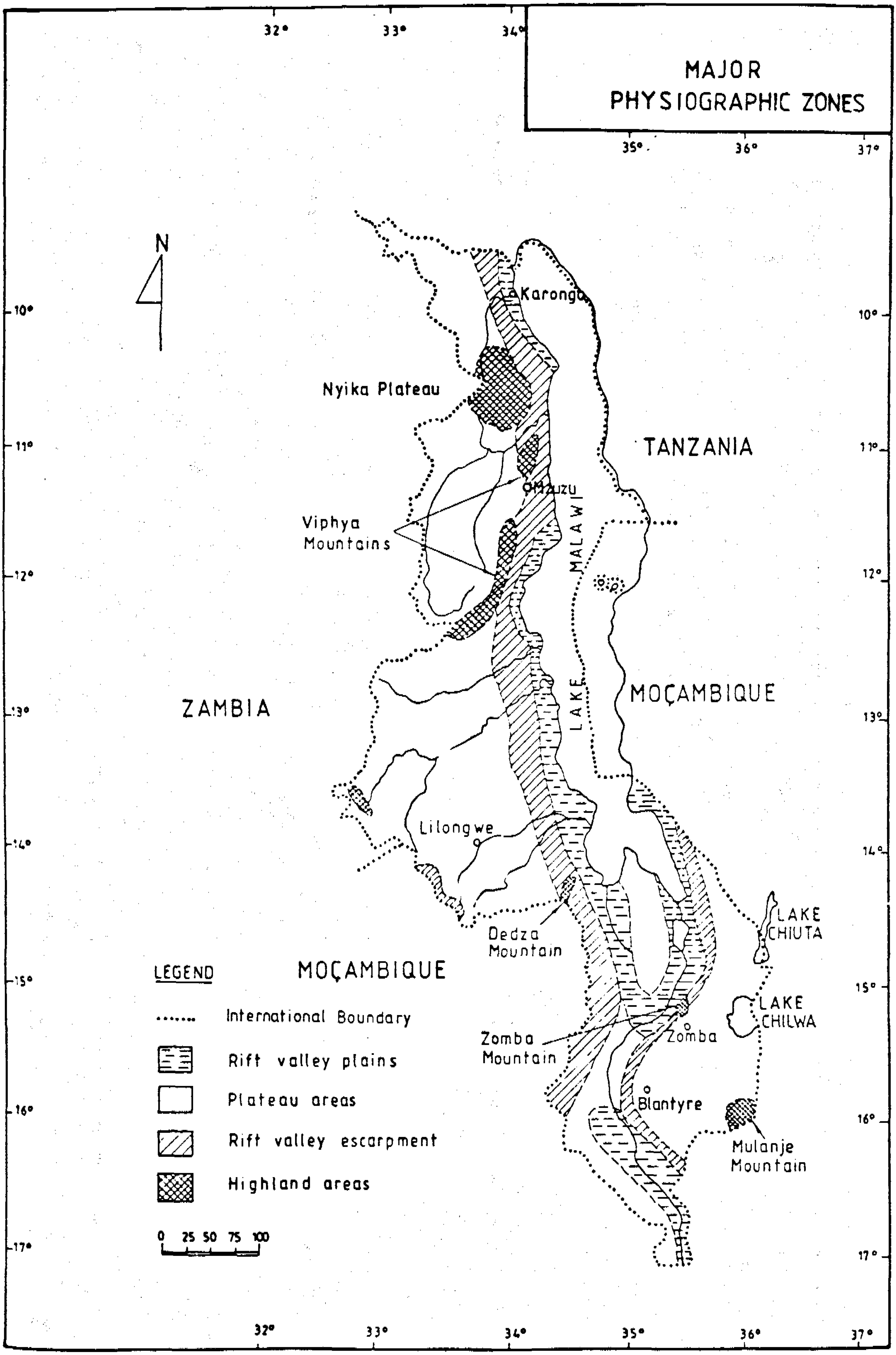
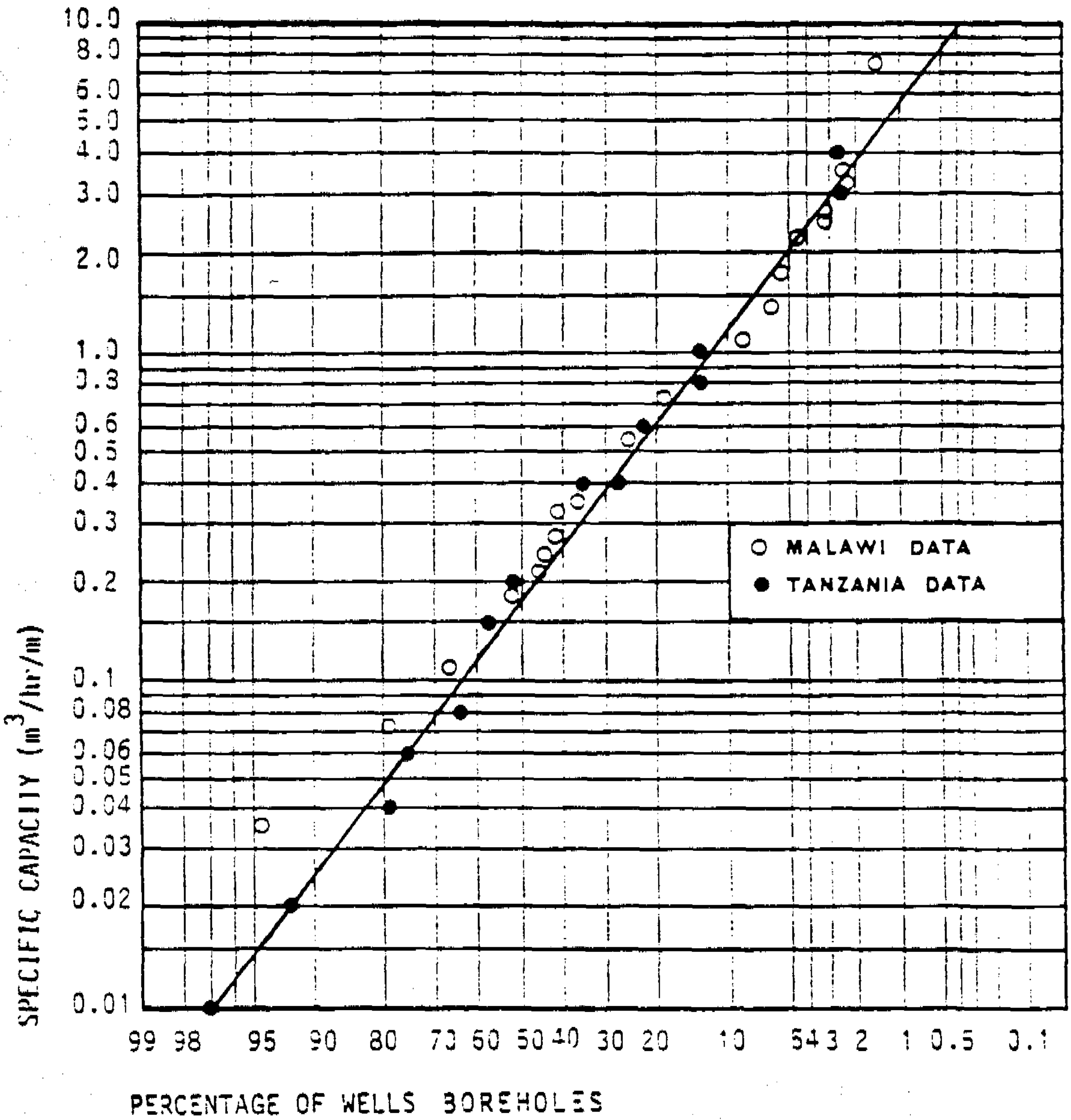
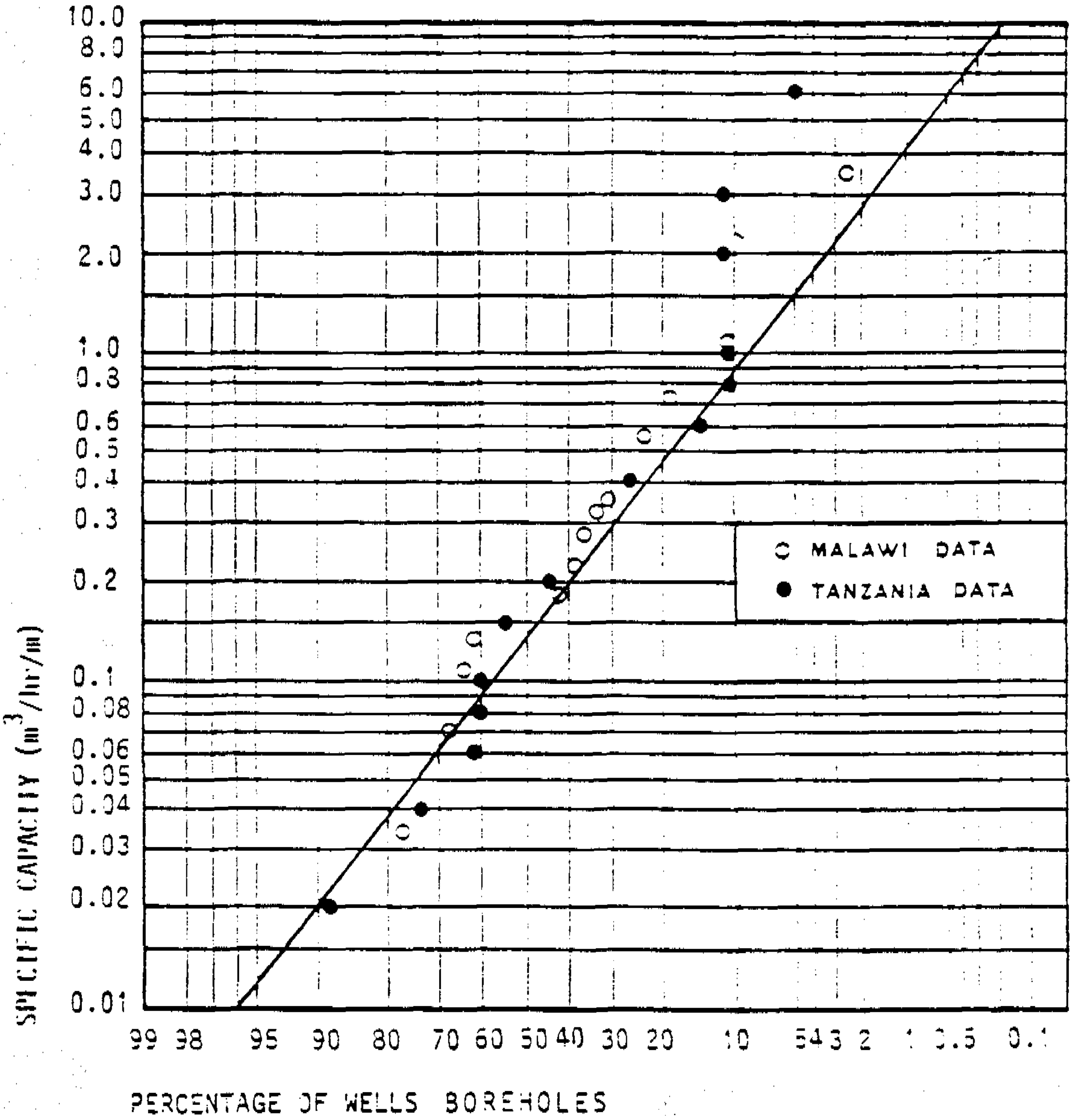

MAJOR
PHYSIOGRAPHIC ZONES
N
Karonga
Nyika Plateau
TANZANIA
Mzuzu
Viphya
Mountains
LAKE MALAWI
ZAMBIA
MOÇAMBIQUE
Lilongwe
Dedza
Mountain
LAKE
CHIUTA
LAKE
CHILWA
Zomba
Mountain
Zomba
Blantyre
Mulanje
Mountain
MOÇAMBIQUE
LEGEND
International Boundary
Rift valley plains
Plateau areas
Rift valley escarpment
Highland areas
0 25 50 75 100

FIGURE 7.7



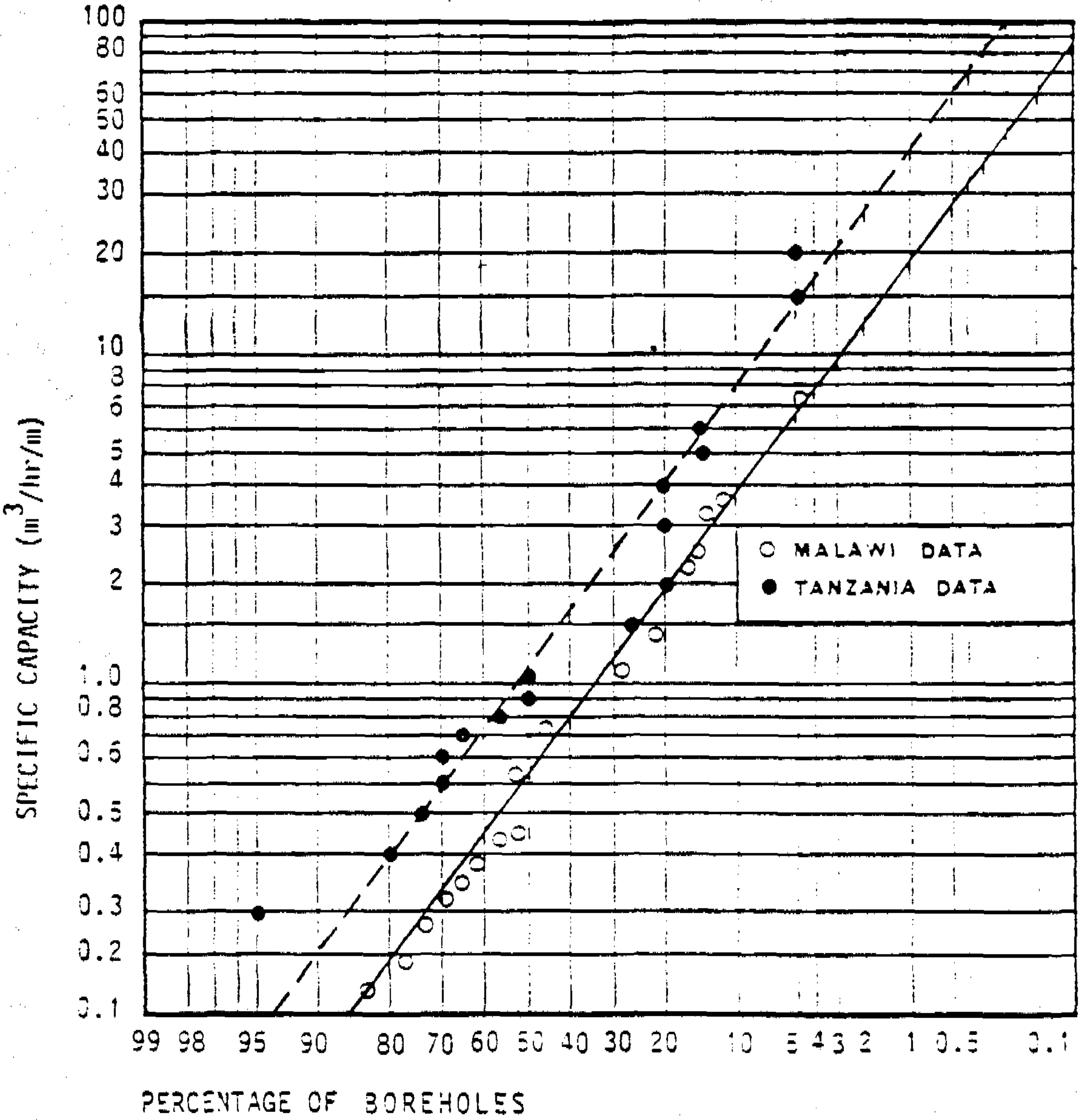
Specific capacity frequency distribution for boreholes across the African Surface in Malawi and Tanzania. Data from 128 boreholes in Malawi and 38 boreholes in Tanzania. From CCKK (1981).

FIGURE 7.8



Specific capacity frequency distribution for boreholes drilled across the post-African surface in Malawi and Tanzania. Data from 35 boreholes in Malawi and 18 boreholes in Tanzania. Tanzania data from CCKK (1981).

FIGURE 7.9



Specific capacity frequency distribution for boreholes in Alluvium, Colluvium and Lake Bed deposits in Malawi and Tanzania. Data from 84 boreholes in Malawi and 21 boreholes in Tanzania. Partly from CCKK (1981).

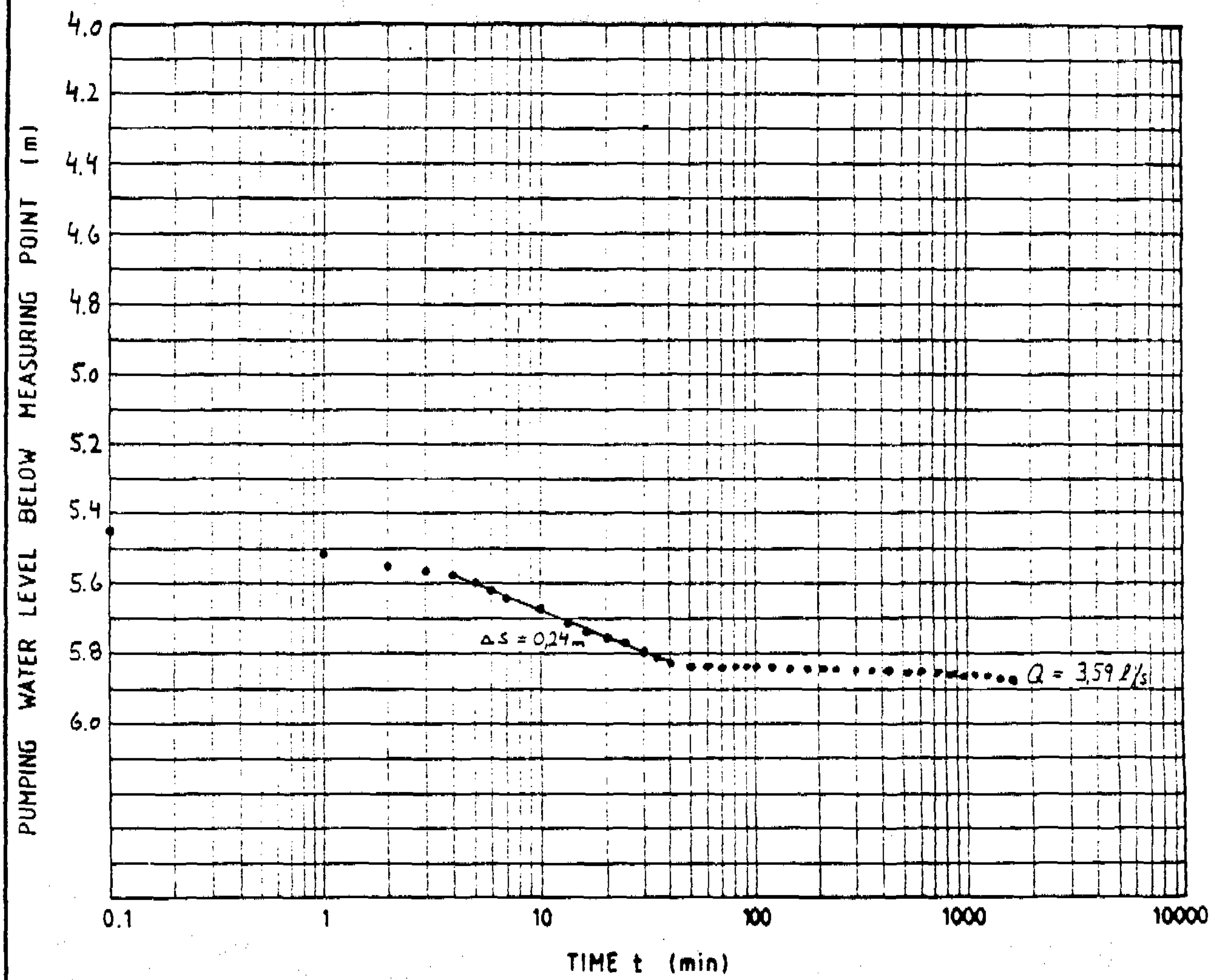
FIGURE 7.10

PUMPING TEST ON BOREHOLE EXP 43

NCHALO WATER SUPPLY

Carl Bro International with I. Krüger

APPENDIX B 12.1



Pumping period	:	11-12th of May, 1989
Measuring point MP over ground level	:	0,29 m
Static water level below MP	:	5,45 m
Constant discharge rate	:	3,59 l/s = 12,9 m³/h
Pump suction below MP	:	45
Transmissivity $T = \frac{0.183 \times Q}{\Delta s}$	:	$2{,}7 \times 10^{-3}$ m²/s
Specific capacity	:	28,7 m³/h per m drawdown

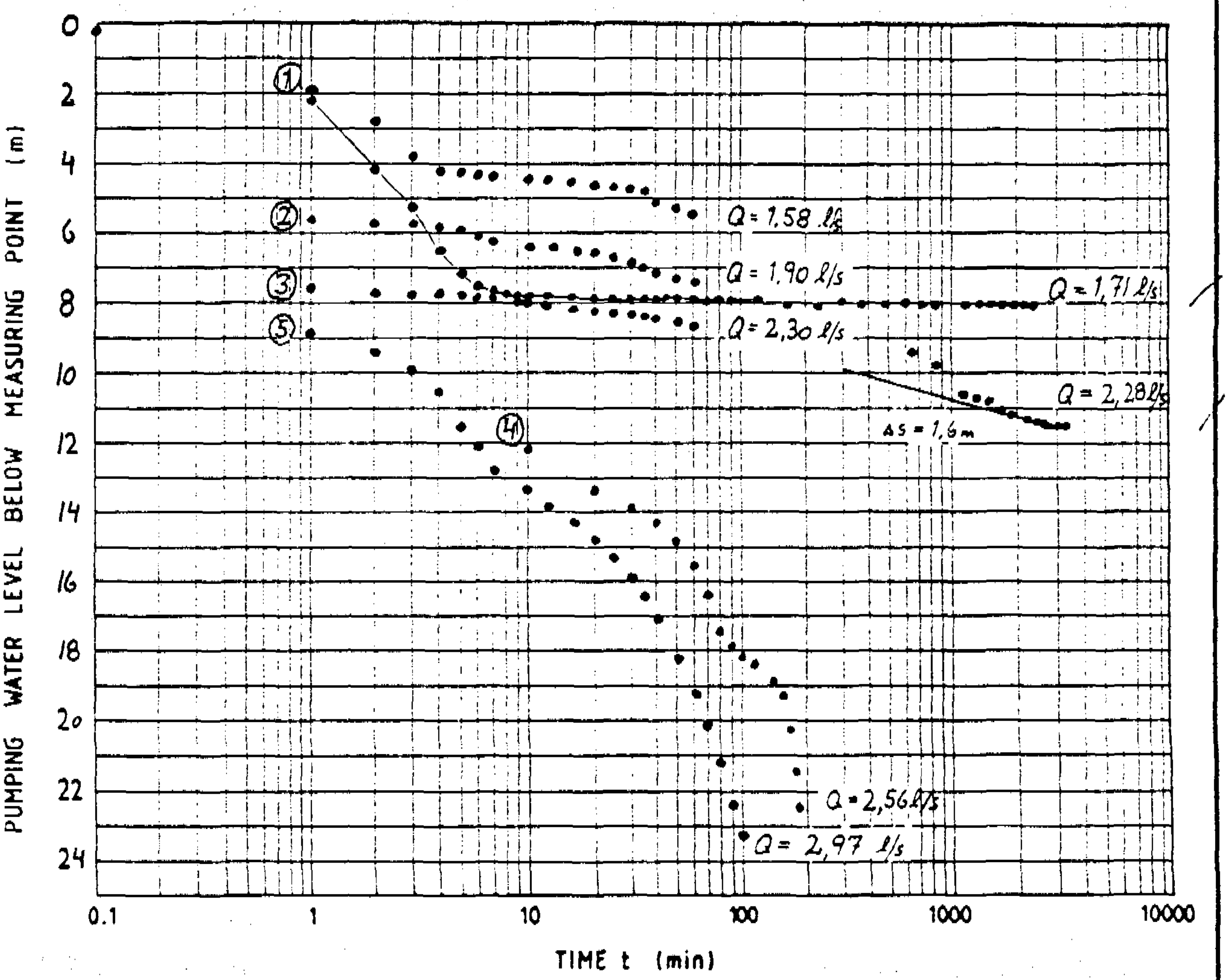
FIGURE 7.11

PUMPING TEST ON BOREHOLE EXP 14

DOWA WATER SUPPLY

Carl Bro International with I. Krüger

APPENDIX B 4.1



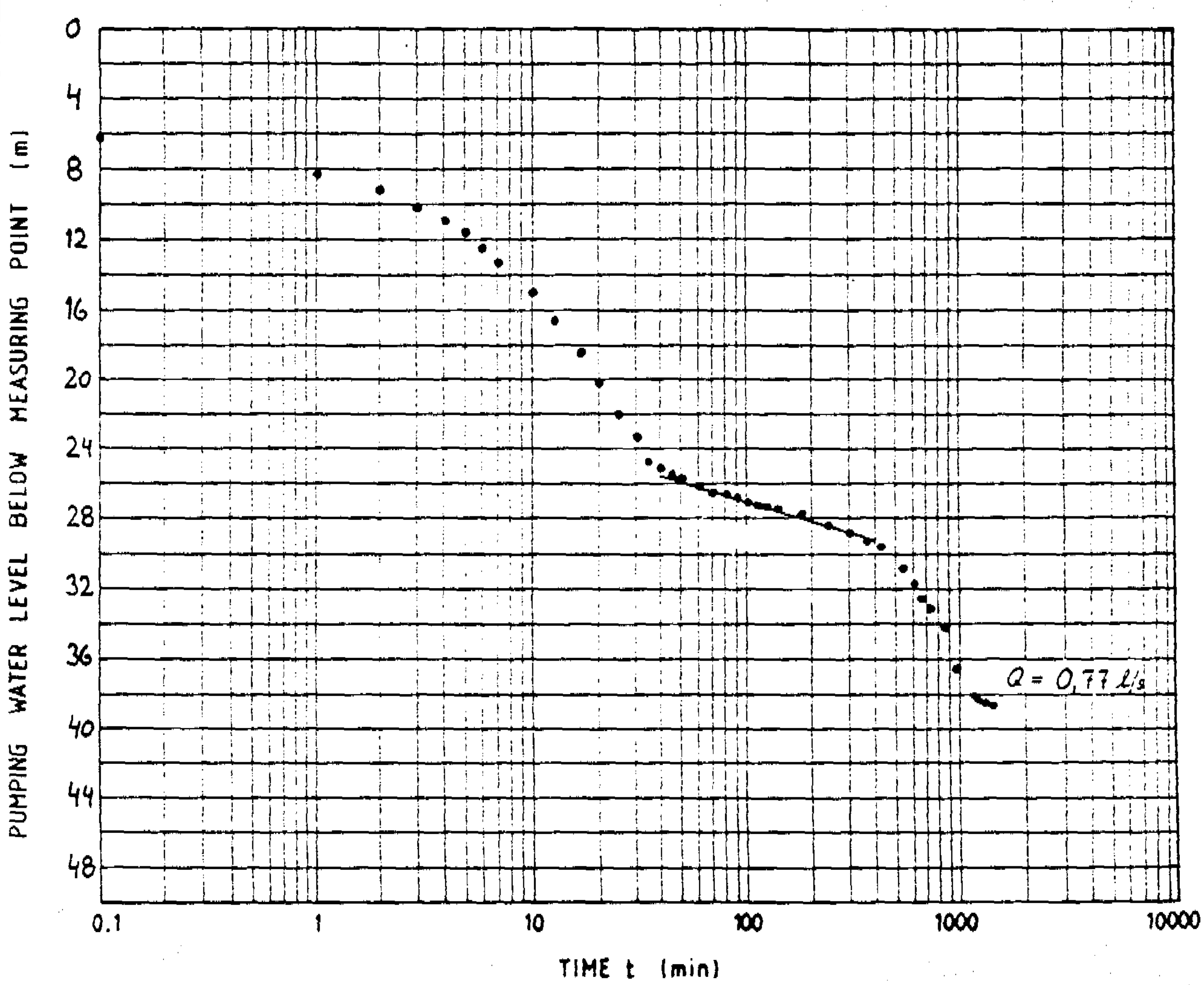
Pumping period	:	23-28th of March, 1989
Measuring point MP over ground level	:	0,75m
Static water level below MP	:	0,4 m
Constant discharge rate	:	1,71 l/s=6,2 m³/h & 2,28 l/s=8,2 m³/h
Pump suction below MP	:	26 m
Transmissivity $T = \frac{0.183 \times Q}{\Delta s}$	:	$2,6 \times 10^{-4}$ m²/s with Q = 2,28 l/s
Specific capacity	:	0,82 m³/h per m drawdown

FIGURE 7.12

PUMPING TEST ON BOREHOLE PP 73 | APPENDIX B 1.5

CHITIPA WATER SUPPLY

Carl Bro International with I. Krüger



Pumping period : 25-26th of June, 1989

Measuring point MP over ground level : 0,1 m

Static water level below MP : 6,14 m

Constant discharge rate : 0,77 l/s = 2,8 m³/h

Pump suction below MP : 45,0 m

Transmissivity $T = \frac{0.183 \times Q}{\Delta s}$: $3,7 \times 10^{-5}$ m²/s

Specific capacity : 0,13 m³/h per m drawdown

Main supply from 30-34 m b.g., ref. borehole construction report

FIGURE 7.13

CHAPTER 8

ENGINEERING DESIGN AND COSTS

8.1 GENERAL REVIEW OF PROJECT PROPOSAL

The project proposal submitted to the ODA consists of outline engineering designs and cost estimates for 14 district centres in Malawi. Twelve of the schemes were abstracted directly from the 'Master Plan for 44 District Centres'. The remaining two schemes, Muloza and Namwera, were prepared by the Water Department to a similar level of detail.

The Master Plan Study was essentially an identification exercise which has been useful in providing an indication of the existing situation in the centres, and to give a first estimate of the scale of works required to satisfy the water demand of the centres by the year 2005. Because of the nature of such an exercise, covering a wide range of schemes in a limited period, the time available for investigations into the adequacy of sources and for engineering detail is very limited, and this is reflected in the details provided in the project proposal.

Subsequently, the Consultants responsible for the Master Plan were requested to prepare feasibility studies for 31 of the 44 schemes. However, investigations were primarily limited to water resource studies of 13 schemes, only two of which, Dowa and Dedza, are included in the present project.

The investigations for Dedza and Dowa concentrated on the reliability of water resources. The extent and detail of the engineering works required for treatment and distribution of the water was not investigated further. The overall level of detail provided by the feasibility study in terms of engineering, and hence accuracy of cost estimation therefore remained the same as at the Master Plan stage.

An exploratory drilling programme was initiated to investigate and augment the supplies to a number of the remaining schemes. However, no further design work was conducted into aspects other than water resource exploration, except for

8.3.2 Groundwater Pollution

Guidelines for the location of boreholes in relation to sources of potential pollution, and the establishment of pollution protection zones appear to have been omitted.

Each centre needs to be considered separately so that the soil and water table characteristics in the area can be taken into account, and realistic guidelines established during the design stage of the projects.

8.3.3 Water Losses

Section 9.1.5 in volume II of the Master Plan is headed "Peak Periods and Losses, however the subject of system losses is not discussed. Nevertheless, the water demand calculations presented in the scheme reports include for losses increasing from zero at commissioning stage, to 10% by the year 2005.

A similar figure of 10% has been used for updating the water demand projections, but this needs to be reviewed in discussion with the Water Department during the final design stage, to reflect the actual losses occurring on the different schemes. This appears to be closer to 20%, but could possibly be improved with more attention to waste detection and loss prevention.

8.3.4 Water treatment Technology

a) Chlorination

Simple chlorine drip feeders located on the reservoirs would be appropriate for the smaller towns. The roof of reservoirs however should be protected from the corrosive nature of spilled chlorine, by the application of a suitable protective paint, together with adequate drainage.

Small chlorine dosing pumps have recently been installed at some of the schemes visited. The dosage rate can be adjusted more readily, and their use avoids the necessity of having to climb to the top of reservoirs to replenish chlorine solutions. Nevertheless there were a number of disadvantages related to their installation, and we would not normally recommend their use, except in large towns, unless the following conditions can be met:

- a standby and adequate spares are available.
- operating staff are fully capable of maintaining the pumps.
- they are located so that chlorine spillage will not cause damage.
- the connecting pipework, which is under pressure, is of adequate strength.
- that adequate washing facilities are available in case of bursts.

b) Full Water Treatment

The Master Plan suggestions for the major components of water treatment plants, such as the hopper bottomed sedimentation tank and the use of rapid gravity filters reflect standard practice with the use of conservative loading rates, and we endorse this approach.

However the ancillary equipment which is implied in the design criteria relates to the type of plant that places a heavy reliance upon imported machinery and plant. This type of arrangement is appropriate to major utilities who have a high standard of operation and maintenance, and where they are constrained by the availability of land.

Relatively small modifications to the design, using simple technologies, tried and tested in other developing countries, can reduce the amount of machinery and operating expenses, and result in a more reliable treatment plant with a longer lifespan.

During the design stage we therefore suggest that further consideration is given to the introduction of the following measures:

- The provision of gravity dosers for all chemicals.
- Flash mixing using non mechanical techniques
- Flocculation using sinuous channels
- Hopper bottomed reinforced concrete sedimentation tanks, similar to those

dependant upon the vulnerability of the scheme to breakdowns, the importance and sensitivity of the town, and to the funds available.

This subject should be addressed in more detail in consultation with the Water Department during the final design stage of the schemes. For the present purposes of calculating financial projections of alternative schemes, a basic minimum of 4 hrs of the peak seasonal demand has been used for groundwater schemes, and 6 hrs for surface water schemes or where water has to be pumped from a single source,

A subject regarding storage which does not appear to have been addressed at all in the Master Plan, is the relative economics of providing storage to reduce peak flows in trunk mains, thereby economising on pipeline diameters. Such storage will be spread more evenly over the distribution system and will add considerably to the overall reliability of supply. This aspect needs to be investigated during the final design of the distribution systems.

8.3.6 Pipe Materials and Friction Coefficients

The Master Plan assumed the use of imported Asbestos Cement pipes for the larger sizes of pipes due to their cheaper purchase price. However these pipes have performed poorly in certain areas of Malawi, and are currently being replaced by uPVC. This appears to have been partly due to the aggressiveness of certain waters, (which could be combated using appropriate pipe protection measures), and partly due to the pipe's inability to withstand the cyclic stresses imposed by expansive soils. Some concern over the potential health problems associated with the use of asbestos fibre has also been mentioned during discussions with Water Department personnel. It has therefore been assumed that, for the present purposes, uPVC pipes which are now manufactured locally to over 200 mm dia, will be used throughout.

We endorse the use of the Colebrook White formula for calculating the head losses in the pipe network systems. However the friction coefficients are too conservative for use with uPVC pipes, and if correctly used would lead to oversized systems. We suggest a roughness coefficient of 0.1 mm, which is commonly recommended for use with uPVC pipes.

8.3.7 Distribution System and Rising Main Design

There are no supporting calculations to indicate how the rising mains and the main distribution pipelines have been sized, or how the lengths have been established. Our own calculations of the requirements indicate that these have been underestimated.

The hydraulic gradients and velocities in rising mains were found to be generally higher than those normally regarded as being economic. Lower investment costs are therefore achieved at the cost of higher energy costs.

In order to make an assessment of the adequacy of the sizing and the lengths of pipelines included in the distribution systems, we prepared original designs for selected schemes, and compared the results with the Master Plan proposals.

Chitipa and Nchalo were selected for this exercise. The system friction losses were calculated using a roughness coefficient of 0.1mm applicable to uPVC pipes.

a) Chitipa

At Chitipa, there is a significant a fall in altitude across the town away from the main storage tank, which allows the use of relatively small pipe sizes, nevertheless, certain key pipe sections need to be enlarged in order to maintain minimum service pressures.

If a roughness factor of 0.6 mm is applied, as recommended in the Master Plan, the system would become quite significantly under designed.

The two rising mains are also just adequate if the scheme incremental flow is evenly divided between the two. The frictional head loss gradients are rather higher than are normally regarded as economical, resulting in head losses of up to 30m.

In order to cover the supply area, our outline design included a total length of 4600m of trunk mains, compared to 3000m allowed for in the Master Plan. Without going into more details of the town development plan and the existing piped system it is perhaps difficult to say which is more correct. A contingency added to the cost estimate should however be provided in case of this eventuality, and to allow for the apparent undersizing of the pipelines.

b) Nchalo

At Nchalo, which is located on the relatively flat flood plain of the Shire River, the total cumulative head losses to meet the design demand was calculated to come to over 30 m.

With the provision of only a 10m high tower for the elevated tank, it becomes clear that the distribution system is significantly undersized.

In addition, we estimated the length of trunk mains necessary to cover the service area to be approximately 4450m, compared to 2250m provided in the Master Plan estimates. Similar comments to Chitipa are appropriate, and a significant contingency should be applied to the cost estimates.

8.3.8 Pumping Stations

In order to allow time for routine maintenance and repair of pumping installations, we recommend that they should be designed for pumping 18 hours per day.

Although this results in slightly larger sized rising mains, it has the advantage of requiring slightly smaller storage volumes to meet daily fluctuations in demand, and provides a certain amount of flexibility in the operations of the system.

8.4 BASIS FOR ESTIMATE REVISIONS

8.4.1 Methodology and Database

The methodology adopted for updating the Master Plan cost estimates, has been based on the ODA's "Guide to Cost Estimating for Overseas Construction Projects" (ref 6), using Unit Rates.

Unit rates for construction of water supply components have been obtained from a number of sources, as follows:

a. Tender for Mangochi Water Supply Scheme, March 1991

b. Tender for Karonga Water Supply Scheme, 1991

c. Water Department Invoices for borehole Construction, from Contractors and groundwater section, December 1990 to August 1991.

d. Successful quotation for the supply of borehole and conventional centrifugal pumps from Fleetline Enterprises (Pty) Ltd, dated July 1991.

e. Quotation for the supply and installation of 108 m3 elevated reservoir, October 1989.

f. Rates for the Construction of two service reservoirs, Blantyre Water Board, September 1991.

g. Current Transport hire rates to the Water Department

h. Current fuel costs

i. Current chemical costs from the Controller of Stores

j. Water Department current staff wage structure

k. Quotation for Chemical dosing pumps from International Imports Exports Co, Oct 1991.

l. Government Notice No. 38 giving electricity tariff, March 1991.

8.4.2 Unit Rates

The unit rates for the most common building and construction items were derived by analysing the tender rates for a number of contracts, (A,B and F above) , and averaging out those rates that appeared both realistic and competitive. The results of this exercise, compared to the Sept 1986 rates used in the Master Plan feasibility study, are indicated below:

TABLE 8.2

UNIT CONSTRUCTION PRICES

Description	Unit	Rate MK (Master Plan)	Rate MK (Revised)
Excavation general	m3	2.5	4.0
Excavation rock	m3	22.5	112.0
Fill	m3	2.5	6.0
Reinforced Concrete	m3	235.0	380.0
Reinforcement	t		2700.0
Formwork	m2	20.0	45.0
Sand cement screed	m2	6.0	15.0
Pipework, incl excavation, laying, specials, valves etc:			
200 dia uPVC Class 10	m	58.0	140.0
160 dia uPVC Class 10	m	38.0	75.0
110 dia uPVC Class 10	m	21.6	45.0

8.4.3 Civil Engineering and Building Works

The Master Plan cost estimates did not include quantities of materials used for civil engineering and building works. It simply provided lump sums for the different component parts of each project. In order to gain an accurate idea of the effect of the revised unit construction prices on the costs of the scheme components, it was therefore necessary to take off appropriate construction quantities for the most frequently used components, and to price these using both the 1986 prices and the revised 1991 prices.

The results of this exercise are summarised below:

TABLE 8.3

CIVIL ENGINEERING AND BUILDING COMPONENT COSTS

Component	1986 MK	1991 MK	Inflation factor
250 m3 RC service reservoir	43,000	76,000	1.77
150 m3 Blockwork reservoir	20,000	34,000	1.70
Pumping Station	4,150	5,830	1.40
Pipelines and fittings			2.00

Similar inflation factors were therefore adopted for other water retaining reinforced concrete structures, smaller blockwork reservoirs and buildings as appropriate.

The available data on costs of elevated tanks is not so detailed. Only one 108 m3 capacity tank having been constructed over the last three years. The cost of this tank, including 12m tower, ancillaries, transport and inflation came to MK 129,000 in October 1989, representing a 30% increase over the equivalent figure obtained from table 3.13 of the Master Plan Final Feasibility Report, Volume VII. Assuming the same rate of inflation to continue, the overall inflation factor for elevated storage tanks comes to 1.54. This figure has therefore been applied to the Master Plan figures in table 3.13 to arrive at current construction prices.

8.4.4 **Pipework**

It was not possible to take the same approach with respect to pipework, due to the fact that we recommend that consideration is given to changing the preferred material for the larger pipe sizes.

To allow for the significant under estimation of the quantities and diameters assumed in the Master Plan designs, we have applied a factor to the Master Plan quantities in order to derive revised cost estimates.

8.4.5 **Boreholes**

The prices obtained from the Water Department for the construction of boreholes, including drilling, testing, casing, filter and yield testing averaged out at MK 17,500 per borehole when using contractors. This will obviously vary with the ground conditions and depth of borehole. Nevertheless the Mater Plan used a universal rate of MK 10,840 per borehole, and for the present purposes we have therefore adopted a similar approach.

The costs quoted by the Water Department, using their own rigs and personnel came to approximately 70% of the average contractor's price. However it is understood that the Department's plant and personnel are fully committed to the Government's ongoing drilling programme, and there is no capacity to undertake any additional workload.

The cost of unsuccessful boreholes was assumed to have increased in the same ratio as completed boreholes, and came to MK 6,900.

8.4.6 **Borehole pump and Motors**

One major change from the Master Plan is that all the projects will shortly have a mains electricity supply. By removing all diesel generators and engines the projects will benefit significantly both in terms of energy cost and reliability. For the present purposes it means that we only have to look at the costs of electric borehole pumps.

The CIF Lilongwe costs for the supply of borehole pumps and motors, (including all rising main pipework, valves, starters and instrumentation), were taken from recent quotations submitted to the Water Department. The costs were plotted against the motor power rating in kW, which indicated a reasonably linear relationship with a +/- accuracy of 8% as follows:

Cost = MK 3,800 + 750 x kW rating

The installation and commissioning costs of the borehole pumping plant, are dependant upon the distance of the project away from the principal cities of Lilongwe and Blantyre, the timing, staffing and plant requirement for installation and commissioning. The costs have therefore been derived using unit rates for transport and personnel, and the time requirements as discussed with the Water Department and distances assumed in table 8.4:

TABLE 8.4

PUMP INSTALLATION AND COMMISSIONING COSTS

Centre	Distance from Lil'Bln Km	Costs MK
Chitipa	560	7,800
Nkotakota	190	4,000
Ntchisi	100	2,360
Dowa	60	2,060
Salima	110	2,430
Dedza	90	2,280
Namwera	220	4,240
Balaka	150	2,730
Chikwera	50	1,980
Nchalo	90	2,280
Luchenza	70	2,130
Muloza	100	2,360
Ngbu	120	2,510
Nsanje	200	4,090

These rates are comparable to those used in the Master Plan, without any allowance for inflation. Nevertheless we consider that the use of these rates will still be conservative, due to the fact that the installation and commissioning exercises for most of the projects will be undertaken for a group of boreholes rather than a single isolated installation. With economies in transport and time requirements, a reduction in costs should be possible.

The cost of chemical dosing pumps were obtained from recent quotations obtained by the Water Department. A typical value for a chlorine dosing unit came to MK 1,150. However, to allow for the use of a better quality model, the supply and installation of associated mixing tanks and pipework, and simple test equipment, a figure of MK 6,000 has been adopted. We recommend that consideration is given to the use of simple gravity drip feeder, where appropriate at the smaller centres.

8.4.7 Spares

To allow for the costs of spares for mechanical plant over an operating period of 5 years, a similar allowance as that made in the Master Plan, of 15% of the cost of the equipment has been included.

8.4.8 Secondary Distribution and House Connections

The master plan defined secondary distribution as all pipes below 100 mm diameter, and estimated the costs of secondary distribution by designing and costing typical systems for the different type of housing and plot sizes. These costs have been revised using the appropriate inflation figure from table 8.3. These costs have been distributed evenly over the planning period to the year 2005, and are assumed to be met by the consumers.

8.4.9 Preliminaries and General

From an analysis of similar sized schemes in the sector, it appears that an allowance of between 20 and 30 % of the overall cost should be made for preliminary and general items such as contractors establishment, insurance, offices and vehicles etc.

The Master Plan estimates were equivalent to 20% plus 2.5% for every 100km distance from Lilongwe and Blantyre, which appears to be in reasonable agreement, and has therefore been adopted for this exercise of price updating.

TABLE 8.5

PRELIMINARY AND GENERAL COSTS

Centre	**Distance from Lil' or Bln'** Km	**Percentage of capital works** %
Chitipa	560	34
Nkotakota	190	25
Ntchisi	100	22.5
Dowa	60	21.5
Salima	110	22.5
Dedza	90	22.5
Namwera	220	25
Balaka	150	24
Chikwera	50	21
Nchalo	90	22.5
Luchenza	70	22
Muloza	100	22.5
Ngabu	120	23
Nsanje	200	25

8.4.10 Contingencies

To allow for the preliminary nature of the design of the schemes and some identified short comings, such as in the distribution systems, an allowance of 20% has been made for physical contingencies.

8.5 OPERATION AND MAINTENANCE COSTS

8.5.1 Operational Costs

a) Power

The power requirements for each scheme has been estimated and the power costs assessed using the current tariff for maximum demands less than 25kW as follows:

		MK
(a)	Fixed charge per month	12.44
(b)	for each of the first 600 kWh per month	0.23
(c)	For each kWh in excess of 600 kWh per month	0.14

b) Chemicals

The dosage rates assumed in the Master Plan have been used together with revised chemical costs obtained from the Controller of Stores, with 20% added for transport, as indicated below:

Chemical	**Dosage Rate mg/1**	**Chemical Cost MK/kg**	**Cost per m3 MK/m3**
Aluminium Sulphate	50	1.62	.081
Chlorine (HTH)	2	8.9	.018
Soda	40	2.2	.090

c) Labour

The labour costs derived in the Master Plan have been taken with an inflation factor of 1.7 to allow for increases in wages.

8.5.2 Maintenance Costs

The Master Plan yearly maintenance costs were calculated on a basis of 0.25% of the cumulative capital costs together with an incremental production cost of MK 0.01 per m3. We endorse the method of linking the maintenance costs to both capital expenditure and production levels, however it was considered that the resultant figures for maintenance appear to be on the low side. A conservative inflation factor of 2.0 was therefore been applied to the production component to provide some compensation, giving MK 0.02 per m3.

CHAPTER 9

COMPARATIVE EVALUATION

9.1 INDIVIDUAL SCHEME REQUIREMENTS AND COMPARISON OF ALTERNATIVES

9.1.1 Introduction

An outline of the existing facilities, future requirements, and the investigations, development measures and investments required to meet the demands for water at the 14 centres is provided in the following sections of this report.

The capacity of the existing works, including the recent boreholes drilled in the area, have been calculated, assuming pumping for 18 hours per day. The required production capacities for implementation in the years 1993, 1995 and 2000, have been based on the estimated requirements for the years 1995, 2000 and 2005 respectively.

The criteria adopted in Chapter 7 of this report for the probable yields and borehole success rates have resulted in increased costs of groundwater alternatives. The comparative costs of alternatives were therefore revised accordingly to allow for the additional works indicated.

However, due to the lack of detail in the preliminary comparative costs provided with the Master Plan, it is not possible to update these figures to 1991 prices without introducing an additional possible source of error. The comparative costs of the alternatives provided in the following section have therefore been based on the Master Plan estimates, amended where appropriate to reflect the higher investment costs for groundwater alternatives, using 1986 prices.

The Master Plan, when calculating the present value of the operation and maintenance costs of alternative schemes used the estimated annual operating costs for the year 2005 for the complete schemes, including the operating costs of the existing works. This value was then treated as being constant for the 20 year design horizon, and discounted to arrive at present values. This method provides incorrect information for two reasons:

- It does not reflect the increase in production costs with increasing demand.
- It provides an indication of the **total** operating costs of the scheme, not the incremental operating costs that are related to the additional works considered.

Where comparative operating costs have been estimated in the Master Plan, these have therefore been revised to provide the projected annual incremental costs of supplying water to the alternative schemes. The results are included in the appropriate sections below.

A slightly more detailed cost estimate was provided in the Master Plan for the recommended alternatives. These have been used to revise the proposed scheme costs to 1991 prices, and are provided in Section 9.2.

9.1.2 Chitipa

The comparative costings of the groundwater and surface water alternatives for Chitipa, as presented by the Master Plan are shown below, together with revisions. All costs are in Malawi Kwacha and all cost comparisons are for 1986 values, unless stated otherwise.

Operation and maintenance costs have been revised for both alternatives, based on the projected annual incremental production provided by the scheme, and discounted at 10 percent.

	(MP)	Alt. 1 (Revised)	Alt. 2 (19 km pipeline)
Boreholes	14	15	
Unsuccessful	16	23	
Investment costs	596,620	690,920	1,286,850
Present value O/M	N/A*	200,371	261,216
Revised totals		891,291	1,548,066

* Note: As discussed in section 9.1.1, the Master Plan's figure for the present value of the operation and maintenance costs are not applicable (N/A).

The criteria we suggest for estimating potential borehole yields and success probability, as presented in section 7 above, result in a marginal increase in the overall cost of the groundwater alternative, and does not affect the overall viability of groundwater as a potential resource in the area. The cost of the alternative surface water scheme remains significantly higher.

Subject to our reservations about available recharge in the area, and optimisation and spacing of boreholes, we therefore agree with the Master Plan recommendation, to proceed with the development of groundwater resources for this scheme.

The capacity of the existing works, including the recent boreholes drilled in the area, and the production requirements are indicated in Table 9.1 below.

TABLE 9.1

PRODUCTION CAPACITIES FOR CHITIPA

Production capacity	**m3/d**	**Boreholes**	
		Existing	**Required**
Existing	684	8	
Required by 1993	831		2
Required by 1995	1169		4
Required by 2000	1579		9

Recommendations: Category A.

1. A relatively short hydrogeological survey is required to assess the groundwater recharge potential of the area, establish required spacings and locations for drilling.
2. Preparation of tender for drilling programme, and its implementation
3. Design of water reticulation system to suit the location of successful boreholes, preparation of contract documents, and construction.

9.1.3 Nkhotakota

The cost comparisons of groundwater with Lake Malawi provided by the Master Plan, and as revised are shown below:-

	(MP)	Alt. 1 (Revised)	Alt. 2 (Lake Malawi)
Boreholes	5	10	
Unsuccessful Bhs	1	6	
Investment costs	419,000	594,000	724,300
Present val. O/M	N/A	469,126	510,116
		1,063,126	1,234,416

Our suggested criteria for estimating potential borehole yields and success probability, result in an increase in the number of required boreholes from 5 to 10, and unsuccessful boreholes from 1 to 6. The overall cost of the groundwater alternative, after making due allowance for these changes however, remains less than the alternative scheme based on a lake intake. In addition, adverse operating experiences with lake intakes, such as variations in the lake level, suspended sand in the water, and damage due to storms have a negative effect on their viability.

Therefore, subject to our reservation regarding the optimisation of borehole spacing, we agree with the Master Plan recommendation, to proceed with the development of groundwater resources.

Problems have been experienced in revenue collection from communal water points located close to the lake shore. Planning of new works should place greater emphasis on the areas further from the lake, where the need for water, and the willingness to pay appears to be greater.

The capacity of the existing works, including the recent boreholes drilled in the area, assuming that all these will be equipped, and the further production requirements are indicated in Table 9.2 overleaf

TABLE 9.2

PRODUCTION CAPACITIES FOR NKHOTAKOTA

Production capacity	m3/d	Boreholes	
		Existing	Required
Existing	1450	7	3 (not equipped)
Required by 1993	1689		2
Required by 1995	2395		3
Required by 2000	3346		5

Recommendations: Category A:

1. There is a current shortfall between supply and demand, which could be largely satisfied by equipping the remainder of the boreholes which were drilled recently.
2. A relatively short hydrogeological survey is required to assess the groundwater recharge potential of the area, establish required spacings and locations for drilling.
3. Preparation of tender for drilling programme, and its implementation
4. Design of water reticulation system, preparation of contract documents, and construction.

9.1.4 Ntchisi

Our review of the Master Plan indicated that 9 boreholes may be required to meet the projected demands for Ntchisi, compared to 7 estimated in the Master Plan. The cost implications are indicated below:

	(MP)	Alt. 1 (Revised)	Alt. 2 (Dam)
Boreholes	7	9	
Unsuccessful Bhs	11	15	
Investment costs	314,400	347,200	797,600
Present val. O/M	N/A	95,059	161,475
		442,259	959,075

The resultant increase in costs of the borehole scheme is marginal compared to the much higher costs of the alternative surface water scheme. In addition, we consider that improved exploration methodology and proper attention to recharge potential and locating boreholes should improve the resultant yields.

We therefore agree with the Master Plan recommendation, to proceed with the development of groundwater resources.

TABLE 9.3

PRODUCTION CAPACITIES FOR NTCHISI

Production capacity	m3/d	Boreholes Existing	Boreholes Required
Existing (Surface)	150		
Existing (Boreholes)	72	2	(to be equipped)
Required by 1993	460		4
Required by 1995	613		3
Required by 2000	775		2

Recommendations: Category A:

As for Nkhotakota. The situation may need to be re-assessed after the initial drilling programme.

9.1.5. Dowa

Constraints exist within the area for the development of both surface and groundwater resources. However the demands of the centre are small, and in theory, the 2005 demand should be met by the addition of four more boreholes.

The Master Plan did not provide details of costs for an alternative surface water scheme, considering the potential costs to be too high. Providing a groundwater source can be proved, we support this view, and in addition, we consider that a surface source, together with the attendant complications for operating and maintenance would not be very appropriate for such a small scheme.

We therefore agree with the Master Plan recommendation, to proceed with the development of groundwater resources. However we recommend that the yield of the new borehole is confirmed, and that consideration is given to the construction of collector wells, which are particularly suitable for the type of strata found at Dowa. Collector wells can draw upon the shallower levels of the basement aquifer and increase the chances of maintaining better quality water. A collector well is also more appropriate to draw upon the storage in thin regolith.

TABLE 9.4

PRODUCTION CAPACITIES FOR DOWA

Production capacity	m3/d	Boreholes	
		Existing	Required
Existing (Surface)	178		
Existing (Borehole)	126	2	
Recent (Borehole)	126	(to be	
Required by 1993	393	confirmed)	0
Required by 1995	514		2
Required by 2000	636		2

Assuming that the capacity of the new borehole can be confirmed, the existing demand can be satisfied by equipping this borehole. Immediate works should however concentrate on providing reliable chlorination.

Recommendations: Category C.

1. Provision of adequate and reliable chlorination equipment
2. Evaluation and monitoring of the various production boreholes.
3. Geophysical surveys with improved technology.
3. Prepare tender documents for the construction of collector wells
4. Monitoring collector wells

9.1.6. Salima

Our suggested criteria for estimating potential borehole yields and success probability, result in an increase in the number of required boreholes from 3 to 9, and unsuccessful boreholes from 1 to 9. This represents a considerable increase in costs. Comparative costs for a surface water alternative was not provided in the Master Plan, but relative costings to the 3 borehole scheme were provided as follows:

(i) Lake Malawi: 8.5 times the borehole scheme.

(ii) Pumped supply from the Linthipe River: 3 times Bhs

(iii) Gravity supply from the Linthipe River: 7.5 times Bhs.

On the basis of the original calculations, the borehole scheme was preferred as being the most economic. However, on the basis of the revised requirements, the pumped supply from the Linthipe may be of comparable cost. Before proceeding with the long term planning of a groundwater scheme, the feasibility of providing the town with surface water from the Linthipe River should be reassessed.

The Lake Malawi scheme is certainly more expensive but would become more favourable for longer term solutions and if the projected scale of growth for Salima is higher than has been originally estimated. However the comments on the viability of a lake intake at Nkhotakota is equally appropriate to this scheme.

However, there is an existing shortfall of supply, and augmentation works are required urgently, long before any potential surface source could be implemented. We therefore recommend that a drilling programme for new boreholes is initiated to meet these immediate needs. These boreholes will be retained regardless which long term strategy is to be adopted.

The capacity of the existing works appears to decrease in the dry season. Reasons for this variation need to be established so that boreholes can be located and spaced in accordance with recharge, or other constraints.

Water quality in the existing production boreholes is good but other boreholes in the vicinity of Salima are known to have unacceptably high sulphate or chloride contents. The water quality aspects must be properly assessed in relation to the projected large demands for an urban supply.

The existing production capacity, based on dry weather yields are provided in table 9.5 below together with additional production requirements.

TABLE 9.5

PRODUCTION CAPACITIES FOR SALIMA

Production capacity	m3/d	Boreholes	
		Existing	Required
Existing	666		
Required by 1993	1885		4
Required by 1995	2769		2
Required by 2000	3847		3

Recommendations: Category B.

1. Investigations into reasons for decreased yields in the dry season, and assessment of groundwater quality aspects. Location of boreholes with regard to available recharge.
2. Planning and implementation of an immediate drilling programme (Phase 1).
3. Investigation into the feasibility of surface water resources.
4. Planning and design of further water supply development

9.1.7. Dedza

The limited groundwater resources in the area prompted the Master Plan to recommend a combined surface and ground water scheme.

There are various factors involved in the final decision. Groundwater is hardly feasible for the long term demand shortfall and probably not also for the full 1995 requirements, at least within the confines of the town boundary, but it has the advantage that it can be developed more rapidly than a surface source. A geophysical investigation programme using modern siting techniques is envisaged. A collector well drilling equipment is currently in Zimbabwe and could conceivably be used. Depending on the results of these surveys and test drilling, the decision on which size of dam to be constructed could have a better basis.

The drilling programme initiated by the Master Plan drilled 6 boreholes in the area, all of which were unsuccessful. A subsequent programme drilling in the Linthipe valley area for UNHCR, produced 4 successful boreholes.

Our design review for Dedza, indicates a significant increase in the projected water demand for the town by approximately 50% over the Master Plan estimates. We also consider that potential borehole yields will be much lower. The resultant number of required boreholes therefore increases very substantially, and the problems and logistics of operating this number of boreholes becomes a constraint on future operations.

Surface water resources in the area are however also limited, and the construction of a dam to provide the required storage is necessary. The dam site alternatives need to be properly costed. The time required to conduct the investigations, design and construction of such a scheme is however large, and in the interim period the additional production capacity to meet the existing and growing demand of the centre will need to be met by the use of groundwater.

The existing production capacity, including recent borehole drilling are provided below in Table 9.6, together with the projected requirements.

TABLE 9.6

PRODUCTION CAPACITIES FOR DEDZA

Production capacity	m3/d	Boreholes	
		Existing	Required
Existing (Surface)	106		
Existing (Borehole)	457	5	
Required by 1993	2012		22
Required by 1995	3196		
Required by 2000	4925		

Recommendations: Category B, but with an urgent need for short term implementation

1. Hydrogeological investigations to optimise the locations and spacing of boreholes.
2. Hydrological study to determine the required size of impounding reservoir, and cost estimates.
3. Environmental and sociological studies, site investigations, etc to determine the optimum location for the dam.
4. Final design of impounding reservoir, and distribution system, followed by implementation.

9.1.8. Namwera

The design review for Namwera, indicates a possible increase in numbers of required boreholes from those included in the WD report from 3 to 5, and in unsuccessful boreholes from 2 to 8. This would result in a considerable increase in the overall cost of the groundwater alternative, which would then become comparable to the cost of the alternative surface water scheme.

Cost estimates for two alternative schemes, together with discounted incremental costs are as follows:

	(MP)	Alt. 1 (Revised)	Alt. 2 (Pumping from Masongoli)
Boreholes	3	5	
Unsuccessful Bhs	2	8	
Investment costs	495,000	885,000	759,000
		112,539	120,817
		997,539	915,817

However the operational complexities of running a full water treatment plant for such a small capacity, together with its remote locality weigh heavily against the choice of a surface water source, particularly since the existing scheme is based on groundwater. We therefore support the Master Plan recommendation to develop groundwater resources for this scheme.

The capacity of the existing works, and the production requirements are indicated in Table 9.7 below.

TABLE 9.7

PRODUCTION CAPACITIES FOR NAMWERA

Production capacity	m3/d	Boreholes	
		Existing	Required
Existing	817	3	
Required by 1993	295		2
Required by 1995	377		1
Required by 2000	481		2

Recommendations: Category A:

1. A relatively short hydrogeological survey is required to assess the groundwater recharge potential of the area, establish required spacings and locations for drilling. Borehole yields need confirmation, more particularly in relation to the apparently very high yielding borehole.
2. Preparation of tender for drilling programme, and its implementation
3. Design of water reticulation system to suit the location of successful boreholes, preparation of contract documents, and construction.

9.1.9. Balaka

It was originally intended to supply Balaka from the Mpiri-Balaka rural water supply scheme. Alternative sources of water were therefore not investigated during the Master Plan study.

Although water is currently being provided from the Mpiri-Balaka scheme to supplement the significant shortfall in the town's supply, this source will not be available in future. It is therefore now necessary to investigate alternative sources of water.

The only potentially viable surface water resource would appear to be the Rivi-Rivi river, which has zero flows once every 10 years, and would therefore require storage. However, due to the flat terrain of the land, and the nature of the river, there are no obviously suitable nearby locations where an impounding reservoir would be feasible. Water resource investigations should therefore concentrate on groundwater.

In the unlikely event of a feasible surface water source being identified, the time necessary to develop it will be substantial. The existing shortfall in supply is serious however, and augmentation cannot wait for the development of a surface source.

We therefore recommend that the two production boreholes that are indicated in Table 9.8 below are developed immediately.

TABLE 9.8

PRODUCTION CAPACITIES FOR BALAKA

Production capacity	**m3/d**	**Boreholes**	
		Existing	**Required**
Existing	788	2	
Required by 1993	3064		8
Required by 1995	4878		7
Required by 2000	7381		8

Balaka is the largest of the 14 schemes, and the serious shortfall in production capacity underlines the importance of providing an early implementation programme.

Recommendations: Category B

1. As Chitipa
2. Investigation to confirm most likely sources for water.
3. Design of distribution system and ancillary works
4. Preparation of tender documents

5. Construction.

9.1.10. Chiwara

Three successful boreholes have recently been drilled at Chikwawa, one of which has been equipped. This together with three existing boreholes are capable of meeting all present demands, although problems with sand pumping and potential pollution effect the older boreholes.

The remainder of the new boreholes therefore need to be equipped so that the older pumps can be either abandoned, or left as a standby. The capacity of the three new boreholes will be sufficient to meet the 2005 demands.

The capacity of the existing works, and the production requirements are indicated in Table 9.9 below.

TABLE 9.9

PRODUCTION CAPACITIES FOR CHIKWAWA

Production capacity	m3/d	Boreholes	
		Existing	Required
Existing	193	3	
Recent Boreholes	1080	3	(1 equipped)
Required by 1993	521		0
Required by 1995	677		0
Required by 2000	856		0

Recommendations: Category A.

1. Equip one more of the recent boreholes to enable pumping from the older boreholes to be stopped.
2. Continued monitoring of production boreholes - drawdowns, yields and water

quality.

3. Assess performance and pollution of existing boreholes.
4. Survey and final design for distribution system.

9.1.11. Nchalo

A major constraint to the development of water supplies for Nchalo is the groundwater quality. Chloride, Sodium and Fluoride levels are generally above WHO guidelines, but are marginally within the Malawi Government temporary standards.

High salinity is suspected to occur in shallow horizons as a result of evapotranspiration and high mineralisation in the deeper Lupata Series but neither supposition has been confirmed. Surveys could include fluid logging of boreholes and geochemical monitoring during test pumping and normal production.

Further hydrogeological studies are required to identify the distribution and causes of the poor water quality, and possible alternative surface sources investigated before further development is initiated.

The pumping test on one of the new exploration boreholes shows an equilibrium condition after 40 minutes suggestive of interaction with a surface water recharge boundary, suggesting that the borehole yield needs to be checked.

The Master Plan report estimated that 12 boreholes would be required to meet the 2005 demand, with 3 failures. Our revised estimates comes to 5 boreholes with 3 failures. The overall comparative cost of a borehole option thus becoming less than the alternative considered in the Master Plan, of using water from an irrigation canal.

The capacity of the existing works, and the production requirements are indicated in Table 9.10 below.

TABLE 9.10

PRODUCTION CAPACITIES FOR NCHALO

Production capacity	m3/d	Boreholes	
		Existing	Required
Existing	176	2	
Recent Boreholes	648	2	(not equipped)
Required by 1993	817		1
Required by 1995	1409		2
Required by 2000	1975		2

Recommendations: Category B

1. Equip new boreholes to meet immediate needs
2. Investigate reasons for poor quality, and select appropriate source for future development.
3. Plan and implement drilling programme if groundwater is indicated in (2).
3. Survey and final design of distribution system, and of intake and treatment plant if indicated by (2).
4. Tender and Construction of augmentation works.

9.1.12. Luchenza

Three high-yielding boreholes have been completed, and equipped since the master plan study.

Our revised estimate of the number of boreholes required to meet the 2005 demand comes to 16, compared to the Master Plan estimated requirement of 7 boreholes only. Using the figures presented in the Master Plan, the surface water source, becomes the lowest cost alternative, as indicated below:

	(MP)	Alt. 1 (Revised)	Alt. 2 (Stream Intake)
Boreholes	7	16	
Unsuccessful Boreholes	11	26	
Investment costs	240,480	493,680	368,200
Present value O/M	N/A	223,457	290,528
		717,137	658,728

However, the stream alternative was costed assuming that no storage was required, a conclusion that according to verbal communications, cannot be supported from recent observations of the river. This therefore needs to be checked in more detail.

Water quality could prove a constraint to groundwater development, since of the 7 exploration boreholes drilled in the Master Plan exploration programme, one was highly mineralised and two of the equipped production wells have a sulphate content fairly close to the maximum WHO limit. Hardness is also high to excessive.

The older production borehole (J28) has pit latrines close by and since the discharge is pumped straight into the distribution system without chlorination, there is an inevitable risk. The surrounds to the new production wells present less pollution risk at present but protection zone guidelines need to be issued to guard against possible future deleterious developments.

The capacity of the existing works, and the production requirements are indicated in Table 9.11 below.

TABLE 9.11

PRODUCTION CAPACITIES FOR LUCHENZA

Production capacity	m3/d	Boreholes	
		Existing	Required
Existing	131	1	
Recent Boreholes	612	2	
Required by 1993	801		1
Required by 1995	1223		7
Required by 2000	1719		8

One additional borehole is required to meet the estimated needs of the scheme to the year 1995. Before further development work is carried out, the comparative feasibility of a source based on surface water should be further investigated.

Recommendations: Category B

1. Survey and implementation of first phase implementation consisting of one additional borehole
2. Technical and financial feasibility study into alternative sources, including hydrological and hydrogeological surveys sufficient to refine the cost estimates of alternatives. Monitoring of existing borehole production (drawdowns and water quality) in order to assess the feasibility of significant additional groundwater development. Some geophysical surveys and limited test drilling may be appropriate to include in this feasibility survey.
3. Final design of recommended alternative
4. Tender and construction of recommended alternative.

9.1.13. Muloza

Muloza is a small scheme requiring only 3 additional boreholes to meet the 2005 demand. Alternatives include a connection to the adjacent rural water supply scheme, which pipes partially treated surface water by gravity to the area, and a water intake on the nearby Muloza river. The Water Department proposal was to connect to the existing rural piped water supply scheme on the grounds that it was the least cost solution as indicated below:

Cost comparisons for the 2005 demand are as follows:

		Alt. 1	Alt. 2	Alt. 3
	(MP)	**(Revised)**	**(RWS)**	**(Limbuli)**
Boreholes	3	3		
Failed Boreholes	2	5		
Investment costs (1990)	662,000	799,250	357,000	737,000

However, we have a number of reservations about this recommendation including the following:

1. At the time of visiting this scheme the rural piped supply was operating poorly, and could not satisfy its existing consumers. No information was provided in the report on the capacity of the existing scheme, and the existing and projected water demands. The spare capacity of the system, (if any), would therefore appear not to have been established.
2. The fact that the rural scheme was constructed on a "self-help" basis may lead to difficulties of acceptance by the local community of the proposals.
3. We would not normally support the provision of water that is not adequately treated to an urban environment. Such a plant was not included or costed in the proposals.
4. Treatment plants introduce operating complications that are not particularly appropriate to small schemes. From an operational point of view therefore, an alternative viable groundwater source, where treatment can be limited to chlorination would be preferred.

Groundwater on the assumption of one borehole for Phase 1 and one for Phase 2 would have a comparable cost to the upgrade but more information is needed on the

24 wells and 3 boreholes which supply the refugee settlements in order to see whether these might conflict with further groundwater developments for Muloza town. There would be merit in abandoning the existing borehole in the centre of Muloza town when an augmented supply is assured. The borehole is almost certainly polluted and has a very poor yield.

The capacity of the existing works, and the production requirements are indicated in Table 9.12 below.

TABLE 9.12

PRODUCTION CAPACITIES FOR MULOZA

Production capacity	m3/d	Boreholes	
		Existing	Required
Existing	36	1	
Required by 1993	95		1
Required by 1995	127		1
Required by 2000	170		1

Recommendations: Category C

1. Review project proposals as indicated above.
2. Survey and implementation of drilling if recommended from (1)
3. Survey and final design of distribution system.

9.1.14. Ngabu

A recently successful borehole giving a reported yield of 36 m3/hr together with the five existing boreholes will meet the present demands for the town. We estimate another 3 boreholes will be necessary to meet the 2005 demand.

The Master Plan recommended developing groundwater resources, and did not provide costs for alternative surface water schemes.

The capacity of the existing works, and the production requirements are indicated in Table 9.13 below.

TABLE 9.13

PRODUCTION CAPACITY FOR NGABU

Production capacity	m3/d	Boreholes	
		Existing	Required
Existing	504	5	
Recent Borehole	648	1	
Required by 1993	998		0
Required by 1995	1344		1
Required by 2000	1772		2

Recommendations: Category B

1. Confirmation of yield, and equip new borehole
2. Survey, monitoring and drilling programme as necessary.
3. Final design of distribution system to suit borehole locations
4. Tender and construction

9.1.15. Nsanje

Three boreholes have been constructed since the Master Plan report, two of which have been equipped. The present production capacity, assuming pumping for 18 hours per day has been estimated to be 754 m3/d

The capacity of the existing works, and the production requirements are indicated in Table 9.14 below.

TABLE 9.14

PRODUCTION CAPACITIES FOR NSANJE

Production capacity	m3/d	Boreholes	
		Existing	Required
Existing	376	3	
Recent Borehole	378	2	
Unequipped Borehole	270	1	
Required by 1993	1053		1
Required by 1995	1452		1
Required by 2000	1918		2

Recommendations: Category A.

1. Evaluate pollution risks to existing boreholes, and necessity for closing them down.
2. Installation of pumping equipment in new exploration borehole.
3. Survey, monitoring of production boreholes to evaluate recharge rates and groundwater potential, and implementation of drilling programme
4. Survey and design of distribution system.

9.2 SCHEME STATUS SUMMARY

The position regarding the status of each of the schemes is summarised in Table 9.1 below:

TABLE 9.15

STATUS OF PRESENT SCHEMES

	District	Cat	Early Drilling Prog Nr.	(Fails)		Work required before Final Design
1	Chitipa	A	2	(3)	*	Assess recharge potential, and borehole spacing.
2	Nkhotakota	A	2	(1)	*	As Chitipa.
3	Ntchisi	A	4	(6)	*	As Chitipa.
4	Dowa	C			*	Construct collector wells.
5	Salima	B	4	(4)	*	Identify reasons for decreased yields from boreholes.
					*	As Chitipa.
					*	Check feasibility of surface sources.
6	Dedza	B	22	(36)	*	Water resource and environmental study.
7	Namwera	A	2	(3)	*	Review cost and feasibility of alternatives.
					*	As Chitipa.
8	Balaka	B	8	(7)	*	Review alternative water resources.
					*	As Chitipa.
9	Chikwawa	C			*	Assess pollution and performance of existing boreholes.
10	Nchalo	B	1	(1)	*	Identify reasons for poor water quality, if necessary investigate alternatives.
11	Luchenza	B	1	(2)	*	Review costs and feasibility of next phase alternatives.
12	Muloza	C	1	(2)	*	Review project proposals, and probably include 2 boreholes in early implementation programme.
13	Ngabu	B			*	As Chitipa.
14	Nsanje	A	1	(1)	*	As Chitipa.

9.3 REVISED COST ESTIMATES OF RECOMMENDED ALTERNATIVES

Revised cost estimates of the most feasible development alternatives identified in section 9.1 above were prepared, using the 1991 prices established in Chapter 8.

For comparative purposes, the average incremental cost (AIC) of the different schemes were also calculated, giving the discounted investment and operational costs per discounted cubic metre of water consumed. To provide a uniform base for comparative purposes it is necessary to assume all projects start at the same time. This assumption is not however correct when considering the programme as a whole, when investments, and benefits will be phased in accordance with priorities and constraints, and the figures provided below should therefore be viewed accordingly.

9.4 PRIORITIZATION OF SCHEMES

An initial prioritization of the 14 schemes was prepared for the Inception Report, based on information provided in the Mater Plan series of reports.

The initial criteria for ranking was based on appropriate data that can be quantified, and compared for each scheme, as follows:

1. The shortfall in demand in terms of **population** not served by the scheme. The scheme with the largest unserved population being ranked 1, as the most needy.

2. The shortfall in demand in terms of the **percentage** of the population not served. The scheme with the highest percentage unserved being ranked 1.

3. The **unit cost** of producing water for each scheme, with the cheapest scheme being ranked 1.

TABLE 9.16

REVISED ESTIMATED COSTS OF SCHEMES (i)

	Centre	Malawi Kwacha	AIC Mk/m3		
			12%	10%	8%
1	Chitipa	2,446,000	2.31	2.20	2.09
2	Nkhotakota	2,708,000	1.78	1.69	1.60
3	Ntchisi	1,311,000	2.43	2.14	1.93
4	Dowa	880,000	2.09	1.95	1.81
5	Salima	2,355,000	1.12	1.06	0.99
6	Dedza	6,955,000	2.07	1.94	1.81
7	Namwera	640,000	1.23	1.18	1.13
8	Balaka	4,952,000	1.15	1.07	1.00
9	Chickwawa	566,000	1.35	1.27	1.19
10	Nchalo	1,451,000	1.10	1.04	0.98
11	Luchenza	1,486,000	1.19	1.15	1.11
12	Muloza	460,000	2.40	2.28	2.16
13	Ngabu	593,000	1.12	1.08	1.04
14	Nsanje	1,002,000	0.86	0.82	0.78
	Total	27,805,000			

(i) Projected costs for a three year implementation programme

Table 9.17 provides a revised ranking, using the same criteria, but using data updated by this appraisal study.

TABLE 9.17

PRIORITIZATION OF 14 SCHEMES

	Town	Population Not Served		Percentage Suppressed demand		Cost per Cu.m of Water
		1995	2005	1995	2005	
1	Chitipa	7	8	10	10	11
2	Nkhotakota	5	3	7	6	5
3	Ntchisi	6	10	6	7	11
4	Dowa	9	13	9	11	13
5	Salima	4	4	4	4	2
6	Dedza	1	1	3	3	9
7	Namwera	8	11	8	8	10
8	Balaka	2	2	1	1	3
9	Chikwawa	14	12	14	13	8
10	Nchalo	3	5	2	2	4
11	Luchenza	11	7	11	9	7
12	Muloza	10	14	5	5	14
13	Ngabu	13	9	13	14	1
14	Nsanje	12	6	12	12	6

Other relevant factors include health, development potential of the centres, and socio-economic issues. These are difficult to quantify, however, the relative importance of these factors can also be related directly to the unserved population of each centre.

All schemes have high incidences of water related diseases, especially malaria and diarrhoeal. Nsanje, Chikwawa and Nkhotakota have had problems in the past with cholera.

9.5 NATIONAL PRIORITY

The National policies have been towards improving water supplies and sanitation to the rural sector, and to the major cities and towns within the country. As a result, these areas within the sector have either already been largely covered by implementation programmes, or are in the process of being studied.

In contrast, the development of water supplies in the smaller urban, and semi-urban centres have tended to be neglected, despite the fact that housing and living conditions within the peri-urban areas are frequently of a poorer standard than in rural areas.

In many other developing countries, the outbreak of water related diseases have frequently been associated to peri-urban areas, where a poorer standard of infrastructure prevails. Whilst there is little evidence to point to this occurring within Malawi, this is no reason to be complacent about the situation, and there is an urgent need to improve the situation.

CHAPTER 10

INSTITUTIONAL ISSUES

10.1 SECTORAL RESPONSIBILITIES

Within Malawi, 3 bodies operate as water suppliers - Blantyre Water Board, Lilongwe Water Board and the Water Department of the Ministry of Works. Each has obligations in respect of sufficiency and purity of supply. Rights of abstraction are monitored by the Water Resources Board and water quality by the Ministry of Health.

The Water Resources Board is dependent upon the Water Department for technical and logistic input and for discharge of its administrative functions.

The Ministry of Health does not have water testing facilities available internally, making use, when required, of external facilities, particularly those in Water Department. The Water Department therefore becomes effectively Regulator of its own operating functions.

The Water Resources Board, which is charged with the responsibility of measuring, allocating and protecting one of Malawi's principal national resources is contained within a Ministry which is predominantly operational and public-works based - roads, vehicles and plant, buildings and water services.

The Ministry of Health has responsibility for sanitation in the rural areas where the dominant type of facility is the pit latrine. These are required to be:

a) Located so as not to endanger ground water sources and in suitably drained soils

b) Constructed so as to minimise health risks (e.g. using sanplat) and so as not to collapse.

The particular inputs required revolve around building and soil engineering matters, for which technical facilities are not available within the Ministry.

Agency funding is being directed increasingly to integrated, rather than separated water/sanitation projects. The segregation of these sectors at national level is the prime generator of the problems of co-ordination.

The provision of a clean water supply is an essential, but however not a sufficient condition for improving and sustaining public health standards: personal hygiene and adequate sanitation are equally vital programme components. The absence of any one prejudices the achievement of the broad aims of Governments health policy, and project work in the sector is being directed increasingly to simultaneous implementation of all 3 components, so that maximum health benefits may be obtained from the investment.

The water supply programme, devised to produce nearly 80% coverage by 1996 is on course for target achievement. Within the UNDP 'Sanitation Sector Strategy Paper' similar goals are set, but for achievement 4 years later, in 2000. Table 10.1 has been compiled from information contained in that report and assumes that the figures for septic tank and pit latrine facilities are based on a household of 5, as in the UNDP document.

Using the 'best case' scenario, i.e. that existing facilities do not require upgrading, and excluding additional industrial effluent the workload for the decade (1991-2000) is to:

- increase present sewage treatment capacity by a factor of 3.
- construct + 102 000 septic tanks
- construct + 1 200 000 pit latrines

Put another way, this implies an average rate of construction of new pit latrines of the order of 2300 per week for the next 10 years. The provision of sanitation facilities will lag the provision of water supply facilities by of 4 years.

TABLE 10.1

SANITATION COVERAGE - NATIONAL (I.E. URBAN + RURAL)

	1987		2000		Increase/Decrease	
	Population	%	Population	%	Population	Facility
Sewerage Systems	109,500	1	321,092	2	211,592	193% capac.
Septic Tank	290,600	4	801,695	6	511,095	102,000 No.
Pit Latrine	4,608,100	58	10,650,832	79	6,042,731	1,200,00 No.
No facility	2,973,800	37	1,762,901	13	(1,210 899)	
	7,982,000		13,536,520			

The preparation and implementation of an integrated project within such a programme will require input for policy formulation, strategic planning, budget preparation, project planning and component implementation, cash allocation and performance monitoring from one or more of the following organisations depending on the component to be provided with advisory assistance from the Ministry of Community Services..

Water Component	**Sanitation Component**	**Hygeine Education Component**
Lilongwe Water Board	Min. of Health	Min. of Health
Blantyre "	Min. of Agric.	Min. of Local Govt.
Water Department	Min. of Loc. Gov.	
	Blantyre City Ccl.	
	Lilongwe City Ccl.	
	Mzuzu City Ccl.	
	Zomba Manicipality	
	8 Town Councils	
	Water Dept.	

The programme for extending district water supplies is several years ahead of complementary programes in hygiene education and sanitation. Indications are that these will continue to lag further behind, and that action is required if the health benefits of improved water supplies are to be maximised.

The main reasons for the disparity are:

First, In 1987 Water Department strategies were drawn up which targetted the Government's policy objective of 80% coverage by 1996. The strategy has been successful and the prospect of achievement is good.

In contrast, no policy objective was set for sanitation, due possibly to the dispersal of responsibilities across a wide spectrum of organisations who had other services to provide, minimal technical capacity and a weak financial base. The UNDP 1989 sector studies addressed the problem, set targets, directed particularly at extending and improving pit latrine facilities. The sanitation programme started late, addressed the dominant sector in terms of population coverage, and concentrated on a facility which minimized the element of public investment. It was dependent, for success, on consumer motivation. Whatever the success rate of the programme, the time required to achieve it was unpredicatable.

Secondly, significant variation occurs between the water and sanitation sectors, and sometimes within the sanitation sector, in the approach to consumer affordability. In water supply capital, is outlayed by the authority and a cross-subsidised tariff structure assists the primary use consumer. In the sanitation sector, the consumer has to be motivated to the benefits of hygiene sufficient to outlay capital (MK20 or more) and labour on the construction of a pit latrine. The incidence of success on use of the water supply (costing typically MK 1 per month per household) is greater than that for sanitation provision.

The third reason concerns investment programming. Within the Water Department virtually all investment is directed at water supply improvements. Priority is based upon water supply/health benefit. Sanitation, lying within Ministry of Health or a local council authority is but one of a range of services being provided by the Authority. It must therefore compete over a spectrum of needs within the district and within the Department, both for fund allocation and priority. Additionally, whilst water service provision generates a specific level of revenue income which accommodates an investment programme the receipts from the provision of sanitation services are much less distinct and do not include an element of investment.

The need therefore is for a statement of policy on sanitation, or preferably on water/sanitation, incorporating the existing water policy. This will then enable an investment strategy to be drawn up which will address policy aims, and where services are provided generate a revenue income based on equity and affordability.

The principal element of the policy will concern the extent and level of services to be provided. In formulating these it will be necessary to review and determine the nature of the organisation(s) that will provide the service, the level of manning and manpower availability, and the level of investment appropriate to the organisation.

Further elements of the policy may concern the need to reduce pollution, and to protect, conserve and/or enhance the environment. However, these will be influenced by the provisions of the new Water Resources Act.

It is to cover the water/sanitation sector, the process of policy formulation will require input from a wide spectrum of interests. Using the Standing Committee principle previously referred to it is suggested that it should contain representation from the following ministries:

> OPC (Chair), Health, Works, Local Govenment, Forestry and Natural Resources, Finance, Community Services.

The duties of the committee would be to-

a) To make recommendations to government on matters of general policy in the water/sanitation sector.

b) To establish an overall strategy by which policy objectives can be met.

It would then be for the relevant ministry to determine and implement its internal policy objectives and strategy, with the standing committee co-ordinating inter-ministerial activities.

It is mentioned above that in formulating policy recommendations it will be necessary to review and determine the nature of the organisations providing the service. Having regard to the problems described it is suggested that a Sectoral Review should be undertaken which would appraise the effects of transfering responsibilities for the provision of sanitation services to the Ministry of Works. Some advantages identified during the current review are:

1. It has technical resources distributed through the regions, which are compatible with operational needs of waterborne sanitation systems.

2. It is the operator of groundwater sources and so is required to monitor and identify pollution risks.

3. The need for inter-ministerial co-ordination on a mult-level basis would reduce - so releasing a management time-resource.

4. The water/sanitation investment programme could be assembled, prioritised and promoted on an integrated, sectoral basis. This would provide assurance to Donor Agencies.

5. Measurement of ingoing water supply is closely related to volume of effluent discharged. Part of the framework (meter reading, billing accounting) already exists therefore for a revenue collection system for the provision of sanitation services to industrial premises.

10.2 RECOMMENDATIONS

It is recommended that-

1. A Permanent Standing Committee be constituted, representing the following ministries:

   OPC. (Chair), Health, Works, Local Government Forestry and Natural Resources, Finance, Community Services + WRB and that its first task would be to undertake a review (Recc.2 below), then to consider and make recommendations to Government on general policy matters in the water and sanitation sector.

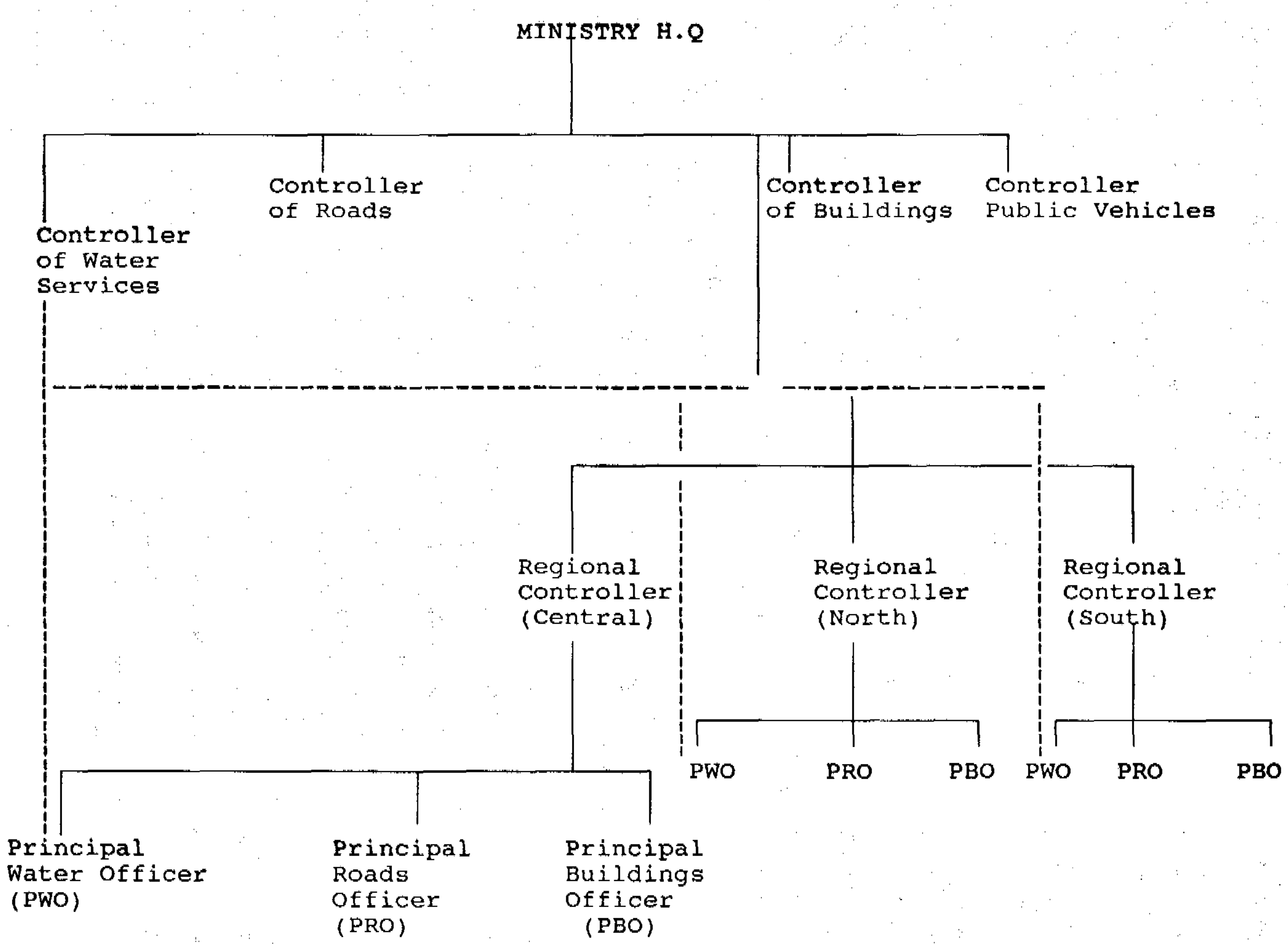
2. That a review be undertaken of the nature and structure of organisations currently providing water and/or sanitation services in order to appraise the effects of a re-distribution of these responsibilities - pariticularly the transfer of waterborne sanitation and collection services to the Ministry of Works.

10.3 THE MINISTRY OF WORKS WATER DEPARTMENT

10.3.1 The Ministry of Works

The Ministry of Works is one of 14 Government Ministries, its particular responsibility being the provision and maintenance of public works and services. The Ministry Building is located at Capital Hill, Lilongwe and it has a regional and district framework. Controllers are appointed to the various functional departments.

The diagram below shows the principal structural arrangement within the Ministry and the reporting paths for the Regional Water Offices, which one functionally to Water Department Headquarters and administratively to the Regional Controller of Works.



10.3.2 The Water Department

The principal functions of the Water Department are to evaluate and protect the national water resource, to provide public water supplies in areas other than those of the Blantyre and Lilongwe Water Boards, and in fulfilling these functions to monitor water quality.

The Organisational Structure is given in Figure 10.1.

Management of the Department rests with the Controller of Water Services. The present incumbent is a capable manager who has been in post for about 6 months, having previously been in the Roads Department.

He is assisted by three Divisional Managers:

Water Resources:	As Deputy Controller the incumbent
Water Supply:	Again as Deputy Controller, the incumbent
General Support Services:	Headed by an Under-Secretary

There is also a Water Quality Branch, headed by the Chief Water Chemist, who has a dual reporting role to the Deputy Controller, Water Supply in respect of laboratory services provided for the purpose of process monitoring and control and to the Deputy Controller - Water Resources for water quality monitoring and evaluation generally and quality testing of effluents.

10.3.3 The Water Resources Division

This Division is concerned with the assembly of national hydrometric records, for monitoring water quality, rights of abstraction and effluent discharge, and for the planning function in respect of the allocation, development and control of the national water resource. It provides logistic support to the Water Resources Board.

Data is collected from a nationwide network of hydrometric stations and pan evaporation points. Particular attention is paid to monitoring the levels of Lake

Malawi and flows in the Shire River. The data is analysed and published. Routine sampling is carried out on principal rivers and groundwater sources, and of Lake Malawi.

A series of UNDP funded studies with in-house support led to the preparation and issue, in 1986, of a 10 volume National Water Master Plan. Liaison with the Ministry of Forestry and Natural Resources is taking place to study the effects of environmental degradation on dry-season river flows.

Structurally, the Division has 2 branches - Surface Hydrology and Groundwater. The Surface Branch has a staff establishment of 112 comprising:

Professional (Hydrologists, Chemists)	14
Technician	19
Technical Assistant	61
Admin/Clerical	18

The Ground Water Branch has an establishment of 92, comprising:

Professional (Hydrogeologists)	13
Technician	15
Technical Assistant	30
Admin/Accts/Clerical	34

All posts are filled by Malawian citizens.

10.3.4 The Water Supply Division

This Division has 3 branches - Planning and Design, Construction and Operations and Maintenance.

The Planning and Design Branch is concerned with project identification, evaluation and preparation either in-house or by appointment of consultants. It is estimated that the value of work currently in hand at various stages of preparation/implementation is ± MK 150 million;

Work under construction	: Project Value		MK 22 mill
Work out to tender	: Engr Est		MK 50 mill
Awaiting Design	: Funding identified		MK 16 mill
Developmental	: Funds not identified		MK 60 mill
Small Schemes in-house managed			MK 2 mill
		Total	MK 150 mill

Staff Establishment is 34,

Professional (Engineers)	12	
Technician		14
Technical Assistant		7
Admin		1

At present there are 2 expatriates in this Branch, and 7 posts are unfilled, 4 at Professional level and 3 at Technician.

The Construction Branch undertakes project management of longer schemes and direct labour construction of smaller projects. It also provides a back up support and advisory service to the direct labour construction teams based in the Regions, who undertake minor local works.

Staff establishment is 84,

Professional (Engineers, Accountant)	12
Technician	10
Technical Assistant	17
Admin/Finance/Clerical	45

At present there are 4 Posts unfilled, 2 at Professional level (Engineer) and 2 in Finance (Asst. Accountant). There are no Expatriate post-holders.

The Operations and Maintenance Branch provides support and monitoring services to the Regional Operations limit, and it is intended that a Leak Detection Unit and a unit dealing with Community Management of Water Supplies be formed to provide support, as required, in these areas in the Regions.

The Staff Establishment is currently 56, comprising:

Professional (Engineer)	9
Technician	16
Technical Assistant	31

At present 5 posts are unfilled, 4 at Professional level, and 1 at Technician (CTO).

The consolidated establishment figures for the Division are therefore:

Professional	33 (2 exp) (10v)
Technician	40 (4v)
Technical Assistant	55
Admin/Accounts/Clerical	46 (2v)
	174

10.3.5 The General Support Services Division

This Division provides and manages the support services to the Department. In personnel matters, including recruitment and training it links up as required with the Public Service Commission and the Department of Personnel Management and Training within Central Government.

The Accounts Section is responsible for maintaining the departmental accounts and also has units specifically devoted to the District Water Supply Fund and the Borehole Fund. The District Water Supply Fund provides for financial management of all urban water supply schemes within the Department. Within this context urban does not mean a declared Town Council area but refers to the 52 discrete areas based upon urban/peri-urban district centres. It is policy that these should, in consolidated form, be self financing.

The Staff Establishment is 117 and although there are presently some vacancies at lower levels all senior and professional posts are filled by citizens.

10.3.6 Regional Water Offices

The Regional Offices present the facility for managing and operating District and Rural Water Supply Schemes, and for administering, monitoring and collating data from the local hydrometric and pan evaporation stations.

Organisational structures are consistent between the offices and reflect activity separation at Head Office. Revisions are being prepared which are aimed at strengthening the structure. They include a reduction in number of sections from 6 to 4, with Water Quality becoming part of the Water Resource Section and the Workshop part of Water Supply. Groundwater scheme maintenance will also join water supply, and a new community water service unit will be formed.

At Blantyre, the existing Leak Detection Unit will be retained, but at Lilongwe and Mzuzu this facility will be provided by a Mobile facility from Head Office.

Also at Blantyre is a special unit dealing with the Mpin/Balaka Water Scheme which is currently being implemented.

10.3.7 Manpower Planning and Development

Manpower planning for all Ministries is undertaken at the Department of Personnel and Management Training (DPMT) in the office of the President and Cabinet. Proposals are formulated by Water Department Management and submitted via the Ministry of Works to DPMT. Once approved, funds for interface training are then authorised.

Internal training is carried out at the Ministry of Works Training Centre at Zomba. Its activities are directed particularly towards staff at lower Technician and Assistant level as the programme for 1991/92 shows:-

Course	For	Duration (days)
Refresher	Accounts Asst	20
Upgrading	Drilling Overseers	10
Upgrading	Well Maintenance Overseers	10
Skills	Water Plant Operator Grade 3	10
Skills	Water Plant Operator Grade 2	10
Skills	Water Plant Operator Grade 1	10
Refresher	Water Plant Operation-in-Charge	10
Refresher	Water Project Assistants	10
Seminar	Wells Maintenance Officers	10
Sup/Skills	Management of Water Supplies for Chief, Senior and Ordinary Technical Offices	10
Skills	Clerical Officer and Storekeeper	20

In addition to the above, newly recruited Accounts Clerks etc receive induction and introductory training for about 2 weeks by Ministry personnel prior to being assigned to their post.

Training at management and professional level is arranged by DPMT. An opinion that the Management Development programme was aimed at technical, rather than Professional staff. In the latter case there has been a historic dependence on donor-funding to meet needs in this area.

The Department endeavours to provide newly recruited graduate engineers with the exposure and experience necessary for them to qualify as registered engineers. Guidelines issued under the Engineers Act have been adopted. However there is substantial leakage of Engineers and Higher Technicians to the Private Sector.

10.4 OPERATIONAL EFFICIENCY

A number of stations were visited and the general impression gained was that the standard of upkeep of buildings, plant and grounds were high, and consistent with good waterworks practice. Station staff were positive in their knowledge and upkeep of their lines of reporting, and record keeping was good. In some instances the nature and level of plant performance indicated a requirement for more effective operational management - this confirming a need expressed at senior management level.

10.5 DISCUSSION

Proposals have been made to revise the organisational structure of the Water Department, a principal objective being to strengthen the operational features of the Regional Framework. This objective is supported and the existing and proposed structures are set out in Figure 10.2.

The Department has manpower problems in the engineering cadre, particularly at professional level and also, to an extent, at the professional accountant level where it is recommended that a post be established. It is considered also that skills at middle management/senior supervisory level need development and that the techniques of operational management need enhancement.

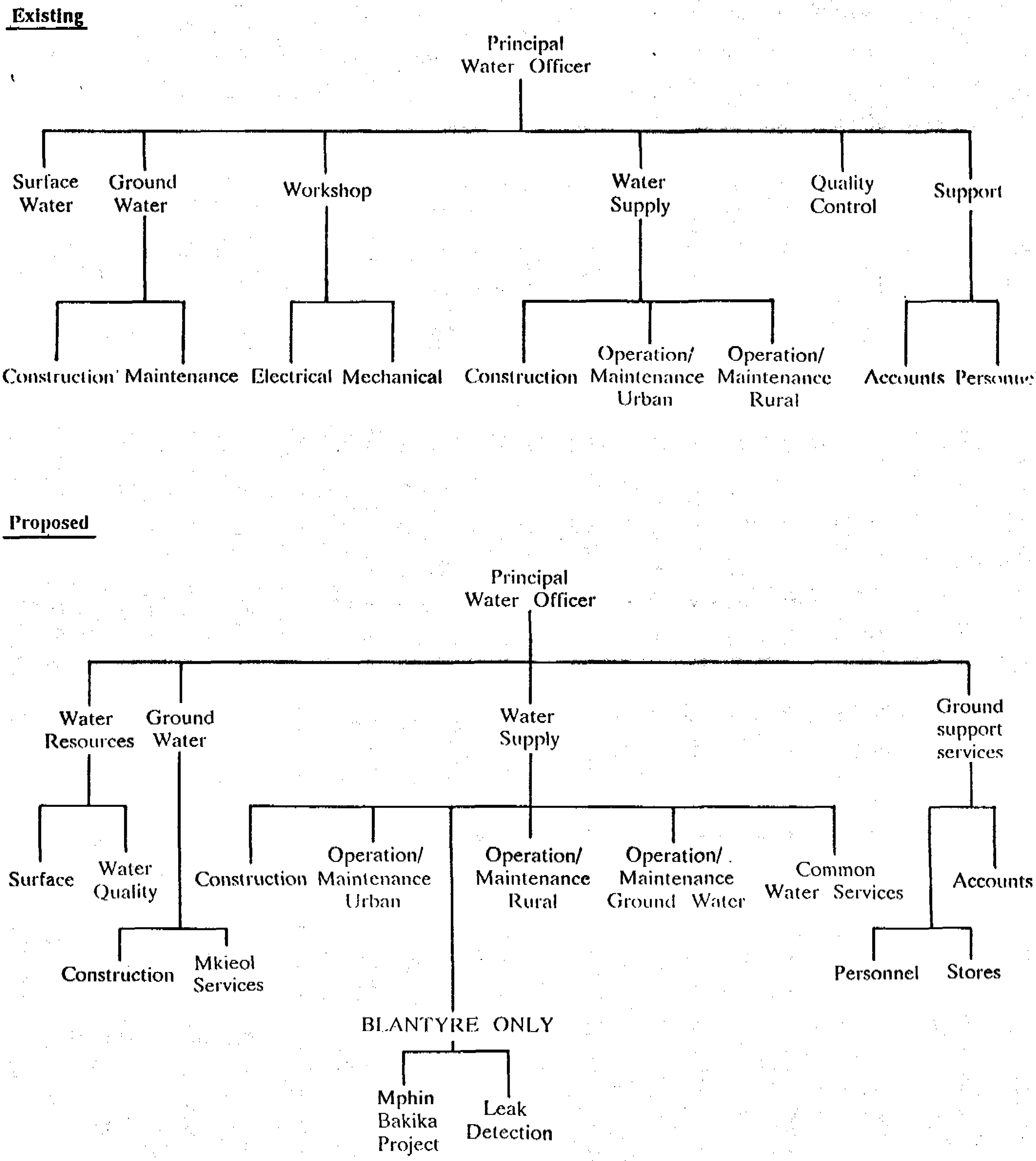
The imposition of the extended supply network over the next 5 years, superimposed upon natural expansion of demand reinforces the expressed need for improved skills and techniques in operational management.

It was also noted during discussions that management intend to prepare a Corporate Plan for DWSF activities, to be done in-house by the management team with assistance from an external Financial Advisor. It is suggested that corporate planning, as an ongoing activity, should have a place in the organisational structure, and that consideration should therefore be given to the appointment, at an early stage, of a suitably qualified person who would be able to benefit from involvement in the process from its inception.

It is also recommended that parallel with this activity, and as soon as possible, a Manpower Plan be constructed for the Department, and that from this the training needs, particularly at senior supervisory and middle management levels, be assessed. This would then enable the formulation of a Management Development Programme.

FIGURE 10.2

INSTITUTIONAL STRUCTURE OF THE WATER DEPARTMENT



Note: There are no expatriates working in the Regional Offices and all professional posts are filled.

Whilst this would normally be an activity of the Department of Personnel and Management Training, it is considered that the special nature of the Department, and the intention that the DWSF progresses towards ultimate operation on a commercial, performance - led basis makes it advisable that specialist consultants be appointed to undertake the assignment.

Details of the 1990/91 workload and the proposed Staffing levels are given below:

	Blantyre	Lilongwe	Mmzuzu
Number of Meters	5 251	3 374	3 155
Numbers of CWP's	329	124	191
Total No of supply points	5 580	3 498	3 346
1990/91 volume sales T.C.M.	4 442	3 419	2 219
Number of Water Supply Staff proposed	149	83	78
Ratio supply staff/1000 points	27	24	23
Ratio supply staff/1000 TCM sales	34	24	35
Number of Regional Klater staff	282	186	169
1990/91 value of water sales MK00	3 681	2 658	1 948

It has been calculated that the effect of Project Implementation would be to increase the workload - in terms of volume sales and total number of supply points as follows:

	Blantyre	Lilongwe	Mzuzu
Increase in Volume of Sales	22%	23%	4%
Increase in No of Supply Points	15 to 22%	10 to 23%	3 to 4%

The range in Supply Points depends upon the ration of CWP's to Total Points. The lower figure assumes that all the incremental sales are via CWP's - the upper figure assumes the present ratio is maintained.

The sale of increase - phased over 5 years - does not warrent major changes in the operational structure, and it is considered that the additional demands can be absorbed by the normal development process.

CHAPTER 11

FINANCIAL ANALYSIS

11.1 INSTITUTIONS AND FINANCIAL CONTROL

The Ministry of Finance holds the pivotal financial control position for the Malawi Government controlling the financial and fiscal polices that have been determined by government. It exercises this control through the issue of approved budgets to spending departments and agencies. It also issues approved budgets for Treasury Funds that are required, generally, to operate on a commercial basis. These approved budgets cover the water and sanitation sectors.

The government has recently determined that there should be a change of incidence in expenditure from the infrastructure classified votes to the social classified votes. Water and Sanitation, although of an infastructure nature, are classified as being within the health sector and therefore within the social classification. Although increases cannot be guaranteed, there is more chance of extra funding for the water and sanitation sector than for the Ministry of Works generally.

One of the principal methods of control used by the Ministry of Finance is through spending department bank accounts. The principle that is followed is that no bank account should be overdrawn. An integrated accounting system could provide the control information but would not perhaps be so efficient in making departments directly accountable. Control of cash via bank accounts where there is not an adequate accounting system is a good control arrangement.

The Ministry of Finance and the Economic Planning and Development Department, between them need to improve the mechanism for evaluating and determining the impact of completed projects on recurrent expenditure and income. If proper provision is not made for the operating costs of projects then the assets will fall into disrepair and the investment, in effect, squandered. If bids are not included in departmental submissions, existing budgets will have to fund the costs at the expense of other maintenance expenditure .

The Water Department as part of the Ministry of Works receives budget allocations for its non Treasury Fund activities. The allocations will be based on the Ministry of Works bids or submissions to the Ministry of Finance.

Likewise the ministries of Health, Local Government, Works, and Community Services will be submitting their estimates for sanitation activities. It is not practical for the Ministry of Finance to co-ordinate the overall water and sanitation budgets due to their disparate nature. However, one of the ministries does need to take a lead to ensure that there is not duplication of resources with its consequent financial implications.

The Water Department is considering the need for a corporate plan. This is urgently needed for two reasons. Firstly, to define the department's objectives and goals in a clear and concise manner and secondly to bring together the seperate areas of activity so that they are managed as a single entity. Legally the three activities will need to be kept separate financially but that requirement should not determine how the water service is managed.

The Water Department through the various programmes and schemes is acquiring assets in various parts of the country. Whilst these assets, particulary in rural areas, are handed over to the local community they are at the end of the day the property of the Malawi Government. These assets may fall into disrepair and become liabilities, the liability being to repair and maintain or demolish. This matter is a policy issue and the department needs to decide who is to own these assets. If it is to be the Water Department then the assets should be recorded in the asset register.

11.2 FINANCIAL MANAGEMENT

The lack of accountancy expertise within government departments is acknowledged but urgent steps need to be taken to provide advice on how commercial funds should operate on a financial basis. The introduction of cash flow statements and source and application of funds statements are two areas where accountancy techniques will aid financial control.

The Water Department does not contain a qualified accountant, although some employees have many years practical technician experience. This lack of professional expertise needs to be addressed. The department has recognised the deficiency and realizes the need for training as well as obtaining outside recruits. The department's financial training plan needs to be completed and implemented.

The systems for accounting, exchequer, financial management and internal control are very basic and need strengthening. A corporate approach needs to be adopted for all these systems in the Water Department. A corporate approach will not inhibit the need to maintain separate funds and their associated bank accounts. The head of the department will be responsible for all bank accounts and will therefore continue to be accountable to the Ministry of Finance.

A corporate strategey will aid the management accounting requirements of the Department, will deploy exchequer and accounting staff more effectively and will enable systems and procedures to be combined. Further analysis is required but a corporate financial section of the Water Department could be organised on the basis of three areas of activity - namely accountancy, exchequer and computer functions. Exchequer would include such duties as payroll, payment of creditors, transport costs, billing etc and would include most of the staff in regional finance sections. These staff should continue to report to the Principal Accountant.

The management accounts of the Water Department need improving. Valuable steps have been taken by the department in obtaining performance indicators and levels of service information. This information, at say the global district and/or regional level, needs to be reconciled to the equivalent costs for an indicator. For example, by taking the volumetric data and determining the cost per cubic metre of water produced, it will be possible to compare the relative cost performance of districts and/or regions. Cost differences are bound to occur because of topography, population densities, etc, but these differences should be identified in a broad manner and the residual variations then normally require management intervention.

Management accounts will aid the day to day operation of the Water Service. Where, for example, direct labour is used recorded costs will enable comparison with outside contractors. Steps have recently been taken to improve the District Water Supply Funds budget structure, and this will be particularly helpful in providing line managers with budgetary control information.

The financial systems of the department need to be developed and, where appropriate, operated on a computer system. An implementation plan is needed with a combined creditor payments and commitment system together with bank reconciliation having the highest priority. The asset register should also have a high priority. Billing is a complex system to run on a computer; sufficient time should be allocated to planning and investigating requirements. A computer specialist, or access to one, is needed by the department to maintain and oversee operation of the systems.

11.3 DISTRICT WATER SUPPLY FUND. FINANCIAL OVERVIEW

The 1990/91 Profit and Loss Account for the Fund shows a healthy profit of MK 1 913 000; this represents 20% of that years income and is 26% of net assets.

The details of Profit and Loss Accounts and Balance Sheets are contained in Annex 3 and these show that 1990/91 culminates a five year improvement in the profit and loss situation. The profits and losses were:-

	MK000
1986/87 Loss	(1044)
1987/88 Loss	(305)
1988/89 Profit	335
1989/90 Profit	761
1990/91 Profit	1913

During that same period loans have not increased. (Adjustments to the Accounts were made in 1988/89 so the comparison over the 5 year period needs to be treated with caution).

Unfortunately the governments accounting practice is to add a years capital expenditure to the accumulated profit and loss account. Using the governments approach there is an accumulated loss of MK 1 222 000 whereas in reality, using normal accounting conventions, there is an accumulated profit of MK 1 518 000. This government accounting approach has ramifications beyond the scope of this report.

Debtors are high in 1990/91 at MK4 288 000 or 45% of turnover. These debts are broadly being financed by creditors and water deposits as the bank overdraft is modest at MK379 000. The improvement in the financial situation has arisen from increases in charges but also cutting back on or not carrying out necessary work. This is particularly true of repair and maintenance where there has been nearly a 60% reduction in expenditure without allowing for inflation.

11.4 DISTRICT WATER SUPPLY FUND - CHARGES

The water rate tariff for the years 1987/88 to 1991/92 are contained in Annex 4. The 1987/88 tariff had been in place since 1st April, 1985. Charges were increased on 1st April, 1988 and each subsequent year up to and including 1st April, 1991.

The level of increases varied in the five year period as demonstrated by the following table:-

TABLE 11.1

TARIFF CHANGES 1987-1991

Consumption		Percentage increase from 1987/88		
		to 1989/90	to 1990/91	to 1991/92
		%	%	%
a)	Minimum charge	39	38	59
b)	8m3 to 30m3	95	105	135
c)	Over 30m3	96	117	150
d)	Communal Water Points	-	9	26

From 1986/87 total water rate income increased from MK3 054 000 to MK8 287 000 in 1990/91 or 171%. This for a period when charges had only risen at most by 117%. The reason for this discrepancy has not been investigated but it is likely that in the earlier years all income due was not collected or recorded. There is nothing to indicate without a deep investigation that the 1990/91 declared income is materially wrong. However the difference is worrying.

Looking at the above table and the tariff in the Annex, there has been a progressive increase in the subsidy by the higher consumers. The higher the consumption, the greater the unit charge. In normal situations one would expect the higher the usage the lower the charge. This policy of subsidy is committed government policy according to which the average financial price will not be passed onto the low income customer. The average financial price to the customer in 1990/91 is derived from Annex 3. For total sales the average price is 82 tambala/m3 whilst the averages for private connections and communal water points are 88 tambala/m3 and 21 tambala/m3 respectively.

For 1991/92 the estimated financial price on total sales is 90t/m3 assuming a 5% annual increase in consumption.

The billing data shows the arrears for the CWP users to be relatively small, suggesting that the low income households are prepared to pay the present tariffs. The government's approach therefore appears to be successful in keeping the water consumers away from their traditional sources of water. It is estimated that 75% of the arrears outstanding at 31/3/91 is from government departments or agencies.

At the moment there is not a programme for the replacement of meters. Over time meters tend to under record consumption and it becomes necessary to replace them. Domestic meters should be replaced every seven years with larger consumer meters being replaced every year. A programme of planned meter replacement will increase sales revenue.

11.5 DWSF - FINANCIAL VIABILITY

The financial projections for the impact on the DWSF of the 14 Schemes is set out in Annex 5. The Annex sets out the assumptions used for the projections in the Profit and Loss Statement and the Source and Application of Funds Statement.

In addition to allowing for the impact of the 14 Schemes, the opportunity has been taken to include extra operating expenditure to cover for previous reductions in the level of repair and maintenance expenditure and the increased standards advocated in this report.

The projections are based on a total investment of MK27 805 000 that is 100% grant aided. This total cost compares with the MK19 080 000 included in the PSIP phased as follows:-

	1993/94	1994/95	1995/96	1996/97	Total
MK000	5850	5950	4920	2360	19080

This profile of expenditure is shorter than that anticipated by this report which plans for expenditure to be complete in 2001/02; 5 years after that envisaged by the Water Department. The extra significant investment cost and the rephasing is discussed elsewhere in this report but the changes have a significant effect on previous financial projections.

The statements show an overall favourable position at the end of the project period. Both the profit and loss statement and the source and application of funds statement indicate a positive cumulative balance in 2001/02 at MK3 082 000 and MK6 040 000 respectively. These positions demonstrate the self sufficiency of the Fund; this would not of course occur if the 14 Schemes were not 100% grant aided.

The beneficial position on the Profit and Loss Statement is helped by the cumulative profit and loss brought forward from 1990/91. The reason for this helpful start has been explained elsewhere. However that good situation is improved by the sales of water starting in 1994/95 and increasing by 40% by the end of the period. The sensitivity of this additional income projection is discussed below. The 14 Schemes operating and depreciation costs increase to MK2,080,000 by the end of the period. At the same time annual income from the Schemes is running at nearly twice that level at MK3,854 000.

Whilst the cumulative profit and loss statement always has a positive balance, for the period 1994/95 to 1997/98 the funds statement shows a negative position. There is a maximum deficiency of MK913 000 in 1996/97. This can be overcome by a short term loan or by an increase in charges. It is likely that an increase in charges would be the Government's preferred route in which case an average 3% increase in tariffs in 1993/94 will meet the deficiency. Such a rise in charges will increase by over MK3 million, the availability of funds in the latter half of the projection period. These funds will be available to meet capital expenditure on other schemes.

The financial analysis is sensitive to the extra income stream relative to the funding of the capital expenditure. For this reason the projections show an alternative extreme scenario with the income from water sales starting a year later, i.e capacity provided without any demand from new customers. Losses are larger and last for longer and while profits are made by the end of period the cumulative position is negative. Funds projections show a positive position at the end of the period. In the unlikely event that this scenario were to materialize, increases of 3% would be necessary in each of the three years commencing 1993/94.

11.6 DSWF AVERAGE INCREMENTAL COST

The average incremental costs (AIC) for all 14 schemes are set out in the table below.

TABLE 11.2

AVERAGE INCREMENTAL COST

Discount Rate %	Investment AIC MK/m3	O & M A I C K/M3	Total MK/m3
12	1.11	0.16	1.27
10	1.03	0.16	1.19
8	0.95	0.16	1.11
6	0.88	0.16	1.04

The total average incremental cost is above the average tariff for 1991/92 of MK0.90 at all the discount rates.

The average incremental costs would be higher if it were not for the fact that the majority of the extra capacity created will be utilised immediately. A delay between the completion of an increase in production capacity and its distribution will have an adverse effect on the average incremental costs.

The average incremental costs are not going to be recovered by the present tariff and over time it will have to rise. However the financial performance of the DWSF is such that it is capable of standing the additional costs to 2001/02 as discussed above.

11.7 DWSF AFFORDABILITY

The government policy is that the District Water Supply Fund should be self financing in the long term. At the same time it wants to encourage the low income portion of the population to use provided potable water sources. To meet these apparently conflicting policies, the tariff structure has been skewed so that high consumption group subsidise the low income group.

If large increases in tariffs are imposed on the low income group, the likelihood is that a number will return to their traditional tainted water sources. This in turn will impose costs on the economy in terms of the health care needed as a result of diseases contracted from such sources. There is clearly a benefit in ensuring the tariff is kept low enough for the low income group to continue to use the potable water.

In the longer term the low income group are likely to become more dependent on the potable water as attitudes change and experience of the benefits is gained. It will then be possible to reduce the level of cross subsidy, but beyond the projections covered in this report.

There is no doubt that the low income group, judged by sample evidence from the billing system, are willing to pay for clean water. The level they are able to pay is a matter of judgement as there is no reliable evidence. In that situation, if the government is to continue its policy, increases at the low end must be marginal and as infrequent as possible depending on the elasticity of demand of the higher consumption group. There is a point when the latter group will seek to reduce their consumption and /or seek alternative water sources with its adverse impact on sales income.

Looking at the present financial performance of the District Water Supply Fund it is felt that, in real terms, there is scope to continue to skew the charges; in particular, because of the large increase from 1/4/91, there should be no significant increase at the low end for three years.

CHAPTER 12

PROJECT JUSTIFICATION

12.1 INTRODUCTION

This chapter briefly discusses the main features of the project and sets out the case for its justification.

The water demands for the 14 growing urban centres have exceeded the production capacities of the existing water supply systems. There is therefore a great need to upgrade and expand the systems in order to cope with the growing demands. This project will ensure that additional potable water is made available to the centres to alleviate current shortages as well as to meet future water demands up to the year 2005.

12.2 WATER RESOURCES

Groundwater resources have been established as the most viable solution for seven of the centres (Chitipa, Nkhotakota, Ntchisi, Namwera, Ngabu, Nsanje and Chikwawa). Groundwater is also likely to be the main source for another six schemes (Salima, Balaka, Nchalo, Luchenza, Dowa and Muloza), however additional brief investigations and cost analysis are required before this can be confirmed. For the last scheme, Dedza, it appears that the most feasible option will be to develop a surface water potential by construction of a small dam. This will also require further investigations. All these necessary investigations are included in the implementation plan for the proposed project.

12.3 FINANCIAL IMPLICATIONS

The financial justification of the project has been assessed based on its impact on the DWSF. The fund is required to operate on sound commercial and self-financing basis in the long term.

The investment costs for the project are estimated to be MK27.8 million with expenditure complete in 2001/202. On the basis of the assumption that the project will be 100 percent grant aided, the financial projections demonstrate that the DWSF will be financially self sufficient over the period. In other words, the revenue generated will be sufficient to enable DWSF to meet the recurrent cost recovery objective.

12.4 COST OF WATER

The cost of water has been assessed based on the average incremental cost (AIC) for the project as a whole. This compares the cost of water comprising both the opportunity cost of water and the marginal cost of supply, with existing average tariff level.

The total average incremental costs for the project are shown in the Table below.

TABLE 12.1

AVERAGE INCREMENTAL COST

Discount Rate	Capital MK/m3	O&M MK/m3	Total MK/m3
12%	1.11	0.16	1.27
10%	1.03	0.16	1.19
8%	0.95	0.16	1.11

The AIC range from MK1.11 per m^3 at a discount rate of 8% to MK1.27 per m^3 at a discount rate of 12%. The present average tariff of MK0.90 is below the AIC by a range of 19% to 29% respectively. Despite the recent large increases the current tariff levels will not completely recover the economic costs of water supply. They would have to be increased significantly to meet this objective.

The project areas mainly comprise small urban and semi urban district centres where the majority of the consumers are in the low income brackets and are supplied from the communal water points. At present about 67% of the households depend on the commercial water points in the project areas. Application of high tariff rates may force these consumers to resort to traditional water supply sources, thus mitigating the basic objective of providing potable water supply to such communities.

12.5 SOCIO-ECONOMIC BENEFITS

The district centres are expected to make increasing contribution to the national economy. In growing urban centres such as these, the extension and development of commercial and industrial enterprises, institutions such as schools and hospitals, and administration and housing are inevitable and hence require provision of adequate and reliable water supplies. The poorer members of the community living in traditional housing, which form the majority of the households in the district centres, will be one of the main target groups, and beneficiaries of the project.

Quantified benefits as measured by tariffs are only a proxy since these benefits largely understate the real socio-economic returns on water supply schemes of this nature. Additional benefits such as time savings in obtaining water from traditional sources, better health from using potable water supply and development of economic ventures in the towns are expected to be important contributions of the water supply schemes.

The existing sources of supply do not cover the whole service areas, they are often intermittent and mostly inadequate. This project will extend the service areas and improve the reliability of water supplies for these centres. Moreover, the availability of this important infrastructure will enhance the potential for economic development of the towns.

12.6 ROLE OF WOMEN

Traditionally, as in most of Africa, it is the women's task to fetch and carry water. The reduction in time and effort expended by women to collect water as a result of this project can be seen as a potential benefit, by releasing this time for other social or economic activities.

Women play a key role in the formation of existing water tap committees, and in subsequent collection and payment of water dues. The project will assist in establishing new tap committees, and will make use of these and existing committees to focus on health education and sanitation promotion. Women will thus be the main target for this programme. The project will therefore contribute to enhance the welfare of women and their role in the community.

12.7 SANITATION AND HEALTH

The proposed project makes clean water accessible in areas where current sources of supply include hand-dug wells, boreholes and similar unprotected sources.

The provision of accessible clean water supply is only the first step in the wider aim of improving the health and health prospect of the scheme beneficiaries. Those benefits can be impaired or frustrated by un-hygienic utilisation of water and/or unsafe disposal of effluent.

This project addresses these issues by incorporating a HESP (Hygiene Education and Sanitation Promotion) component, to be undertaken by the Ministry of Health. The objectives of the HESP programme are to convey to the community at village level the need for good hygienic practices and the methods by which they can be achieved. This health education process is accompanied by promotion, including technical assistance, partial provision of materials, and advice, on the improvement and/or construction of pit latrines in such a way as to minimise risks to health and safety and reduce nuisance and pollution.

The HESP component is co-ordinated with the National HESP programme contained within Malawi Government's approach to Primary Health Care.

12.8 POLICIES AND INSTITUTIONS

The Water project contains health and sanitation components directed at maximising health benefits. A number of institutions are involved in the provision of services through the three sectors of health, water and sanitation, and so co-ordination of policies and activities is necessary for project success.

Policies in the water and health sectors are strong and compatible. In the sanitation sector a dispersement of responsibilities has led to unco-ordinated policy aims and development strategies.

The project addresses this by requiring the establishment of a Permanent Standing Committee, responsible for formulating recommendations on national policy in the water and sanitation sectors, for establishing a broad strategy and for co-ordinating principal sectoral policies and activities.

The Water Department, which is the implementing agency, is undergoing changes in its organisational structure which strengthens its regional framework and enhances its ability to sustain the project. The need to strengthen the professional, sub-professional and management resources has been identified and will be addressed by means of a Manpower Development Programme. The first stage is included in the project recommendations, and its implementation is suggested as a supporting programme.

12.9 ENVIRONMENTAL IMPACT

The project is not expected to have a negative effect on the environment. The greater awareness to the conservation of water resources and the need to reduce the potential for pollution of water sources, that the project will bring to the Water Department staff and communities alike, together with the construction of properly designated and maintained sanitary facilities, are seen as providing significant potential benefits to the environment.

However, this aspect of the project will be studied by the consultants who will prepare detailed designs and assess the environmental impact of the project.

12.10 PROJECT RISKS

A range of assumptions have been made to prepare the water demand projections. However, these are typical assumptions made on many similar schemes and they pose no unusual risks to the project. As the schemes will be designed by internationally qualified consultants in the sector, and the construction works would be contracted to pre-qualified firms experienced in the construction of similar projects, the risks of failure due to design/construction errors are expected to be negligible. The designs of different components in the proposed system are essentially duplications of existing proven systems, and therefore will not impose any operation and maintenance problems.

Other risks that may adversely affect the performances of the project are related to the issues of sustainability. A number of key recommendations are made for "additional support" to the project in this report to ensure that these risks are minimised.

Clearly not every household will benefit from the project. However, it has to be assumed that a very large proportion would make use of the improved piped supplies. There was little evidence from the field that affordability was a major issue. It could be that households who have not had to pay for water in the past, had little appreciation of the impact the payments would have on their modest income in the future. But it is difficult to draw firm conclusions about the question of affordability in this situation.

There is, however, sufficient evidence to suggest that provisions of improved water supplies together with emphasis on health education would encourage poor households to switch from traditional sources to piped supplies. This approach is consistent with the Government policy objective of bringing potable water supplies to all urban areas so as to reduce the incidence of water borne diseases and the time and energy devoted by individuals to collect water.

CHAPTER 13

PROJECT IMPLEMENTATION

13.1 INTRODUCTION

The final timing of development of the project is dependant upon a number of factors including:

- Status of design
- Priority of schemes
- Scheme requirements
- Human resources available
- Financial constraints

Each scheme is different, and its individual requirements need to be carefully assessed along the lines indicated in Chapter 9.

Two scenarios have been considered; an ambitious programme of completing all schemes within a three year time span, requiring consultants to take the primary responsibility of the programme; and a much longer seven year programme placing more emphasis on training and development of the capabilities of the Water Department. / + others (Local gov, Health, C dev)

but still not long!

The initial stages of the project however will be common to both scenarios. It is envisaged that the project will commence with an initial period of approximately six months, when initial surveys and the preparation of a drilling programme will be the major components. This will be followed by a 10 month period when the drilling programme will run concurrent with the final design phase of the priority schemes. At the end of this period, site supervision will commence, and will coincide with the design of the less urgent schemes.

what about pop'l Comm'ty issues, H&SP prog.

No!

It is envisaged that a firm of consulting engineers will be retained to establish a Design and Implementation Unit (DIU), and will take responsibility for its operations over the first two years of the project. At this point, in the longer term scenario, it is suggested that the progress and success of the project is reviewed, with the intention that the Water Department takes over the responsibility for the DIU, with the consultants taking a more supportive and advisory role. A further review is suggested at the end of the fourth year to determine what further inputs may be required for the remainder of the project. For the short term scenario, due to the limited time available, it will be necessary for the consultant to retain overall responsibility until the end of the three years, and only hand over responsibility on completion of the project.

13.2 INITIAL SURVEYS, INVESTIGATIONS AND MONITORING

In order to optimise the design of groundwater and surface water abstraction works, more knowledge of the available resources is generally required. Safe yields of boreholes, data on water quality and groundwater recharge potential, low flow analyses of surface water resources all need to be defined in more detail.

An initial period, estimated to last approximately 6 months, is required to cover all schemes, including the following aspects:

a) Prepare specifications and request quotations for survey, monitoring and data retrieval equipment, including: (2 weeks)
   - Electro-Magnetic groundwater survey equipment
   - Computer(s), IBM compatible, with 386 chip, 120 megabyte hard disk minimum configuration to suit required software applications, together with colour monitor, graphics printer and plotter.
   - Database software with Geographical Information Systems capability.
   - Well dipping equipment.
   - Replacement flow meters
   - Water quality field testing equipment and reagents.
   - Staff gauges and control structures for surface water resources.

b) Prepare specifications and obtain quotations for pumps, motors and rising mains for boreholes which at present are not equipped. (3 months)

c) Establish monitoring facilities and procedures. Operational staff for all schemes to be given training in monitoring techniques and provided with simple well dipping tools. Flow meters to be checked and replaced as necessary, and gauging stations established on potential surface water sources.(3 months)

d) Re-assess safe yields of existing production boreholes by reviewing existing pump test data, and measurement of drawdown. (4 months)

e) Estimate potential groundwater recharge for each scheme from a review of the existing soil conditions, topography, geology, rainfall statistics and borehole production records. (4 months, but review continuously)

f) Assess water quality problems as necessary, using appropriate techniques. (4 months)

g) Conduct hydrogeological and geophysical survey using appropriate modern techniques such as electro-magnetic equipment to identify potential borehole sites for immediate programme. (5 months)

consultants? contracts

h) Optimise borehole spacing in light of probable yields and recharge potential.(5 months)

i) Preparation of drilling programme and contract documents.(5 months)

j) Establish computerised database system, incorporating Geographical Information System capability.(6 months)

k) Establish guidelines for pollution protection zones to boreholes.(5 months)

Many of the above activities will be ongoing throughout the duration of the project, however the initial period of six months will be designed to concentrate on establishing a sound basis for the immediate drilling programme. All equipment required will be provided within the first two months of the project.

The contract documents will be prepared, and issued to drilling Contractors for tendering during the fifth month of the project, so that submission of tenders will coincide with the end of the initial six month period.

It is assumed that operational staff located at the various schemes will be responsible for the ongoing monitoring programme, once they have been provided with any necessary equipment and training.

Would consumers rather (a) high charge & receive all services, or low charge & meet repair costs on time?

13.3 HEALTH AND SANITATION PROGRAMME

The final details of the sanitation programme will need to be determined during the initial phase of the programme after consultation with all the relevant parties. However the outline of a suggested programme would be as follows:

No

- Appointment of a health advisor/community developer and two assistants to manage and coordinate the programme.
- Clearly establish the responsibilities of the various interested Government bodies, and if necessary form a steering committee.
- The establishment of a promotional and implementation strategy, along the lines established for the Mpiri-Balaka HESP programme, including the consideration of using alternative forms of promotional material and media.

Yes - by Govt

- Employment of one Health Surveillance Assistant (HSA) for each of the 14 urban centres. HSAs in sub-regions being encouraged to work together, and alongside existing staff from the Ministries of Community Affairs, Health and Local Government.
- Training of HSAs to encourage community participation, to provide health education to combat targeted diseases, and in the construction of pit latrines appropriate to the conditions at each of the urban centres
- Survey of the 14 schemes to determine social, health and physical factors and beneficiary preferences that need to be taken into account in the design of the programme.
- Provision of appropriate educational aids such as flip charts and magazines targeted at school children.
- Construction of demonstration units, and training communities and possibly small contractors in the construction of pit latrines.
- On-going community motivation and health education, formation of community groupings such as tap committees.
- Assistance with the provision of non-traditional materials
- Consideration of mass production of slabs, their distribution and cost recovery.
- Improvements to existing latrines
- Improvements and control of refuse disposal

The sanitation programme will commence with the appointment of the sanitation coordinator at the beginning of the overall project, however the initial period will be spent in preparing the detailed programme, establishing responsibilities of the various ministries, employing health assistants and training them. It is expected that after six months, the sanitation programme will be ready to start the campaign, which could coincide with the commencement of the drilling programme.

The sanitation programme will also be reviewed every two years to assess its success. It is however expected to continue throughout the duration of the project, remaining receptive to any changing requirements of the individual communities, and adjusting its methods and targets accordingly. and continue beyond!

It is envisaged that the Sanitation Coordinator will be a professional Malawian health advisor/community developer, seconded to the project for its duration, reporting to the project manager. All health assistants will be employees of the Ministry of Health and also seconded to the project, so they report directly to the project coordinator. ?

13.4 DRILLING PROGRAMME

The drilling programme, to meet the 1995 sourceworks requirements, will be phased to meet the prioritisation requirements of the different schemes, and will include the following:

- Evaluation of tenders
- Drilling supervision
- Test pumping supervision
- Preparation of specifications and contract documents for equipping boreholes.
- Review proposals for future development in the light of the additional information available from the drilling programme.

On receipt of tenders for the drilling contract(s) these will be evaluated, and recommendations made to the Water Department. It should be possible to award drilling contracts within two months of receipt of tenders, and for drilling to commence one month afterwards. On the assumption that two rotary rigs will be used to complete 32 successful basement boreholes, and a percussion rig for 16 successful alluvial boreholes, we estimate that the total period for the contract will be approximately 10 months. This period could be shortened, by using additional rigs, however this is not considered advantageous at this stage, as this would result in additional staff being required for supervision, and impose a constraint on the capacity of the design unit.

During the programme, contract documents will be prepared for equipping the boreholes with appropriate pumps and these contracts will be tendered, evaluated and awarded in appropriate batches as the work proceeds. An additional drilling programme will be prepared and implemented during 1995 to meet the year 2000 requirements of each of the schemes.

13.5 ADDITIONAL INVESTIGATIONS AND STUDIES

During the course of both the initial survey period and the drilling programme, additional investigations, as identified in Chapter 9, will be undertaken in order to establish the most feasible development strategy and to assess the environmental impact for each scheme. These will include:

Dowa: In the light of further information gathered from monitoring existing boreholes, obtain quotations, and assess the feasibility of constructing collector wells.

Salima: Investigate reasons for reduced borehole yields, and review cost comparisons with surface water sources

Dedza: Detailed hydrological investigations to assess more accurately the available surface water resources. Investigations into impounding reservoir, including geological, environmental and sociological. Assess feasibility of using collector wells.

Balaka: Review of alternative water resources, establish most viable alternative, and conduct appropriate surveys to enable design to proceed.

Nchalo: Investigate reasons for poor water quality.

Luchenza: Review of alternative water resources, as Balaka.

Muloza: Together with Water Department, review scheme proposals.

The extent of the work required for each of these schemes, except for Dedza, is envisaged as being limited to the refinement of the information and cost estimates provided in the Master Plan. Detailed investigations are not foreseen as being required at this stage, and the work should be completed in a six month period of time after the basic data is available.

At Dedza however, where the preliminary investigations indicate that an impounding dam is required, a different approach will be needed, including:

- Hydrological investigations
- Geological site investigations including the preparation and award of a drilling contract to establish foundation conditions.
- Environmental and social investigations to assess and mitigate any adverse effects of the development
- Review of design parameters and cost estimates

13.6 FINAL DESIGN

Although final designs of the schemes can commence before completion of the drilling programme, they cannot be finalised until after the locations of the successful boreholes have been established. The final design of schemes have therefore been assumed to be phased after completion of the boreholes in the different schemes. Each scheme design will however contain the following components:

Existing system - details of the existing distribution systems for each of the schemes are available at the Water Department's Headquarters in Lilongwe. These however need to be checked and updated as necessary before additional requirements can be assessed and designed.

Topographical survey - work will be required, and it has been assumed that this will be provided by Water Department staff.

Design Parameters - these will need to be reviewed to confirm the final design capacity of the systems.

Distribution Systems and Storage - this will need to be analysed and sized to take account of the existing works, their condition, and the locations of the successful boreholes, or sourceworks. Reservoir storage locations will need to be assessed to provide adequate pressures within the distribution system, and in order to economise on pipeline sizes.

Treatment Plants - schemes appropriate to the different schemes will be sized and designed.

The requirements of the designs in terms of draughtsmen will be substantial, it is assumed that these will be provided by the Water Department and will be attached to the DIU.

13.7 TENDER

Tender documents, including detailed bills of quantities, will be prepared for the implementation of each of the schemes, in accordance with the normal practices in Malawi.

The DIU will be responsible for the preparation of a pre-qualified list of contractors, answering questions during the tender period, and for the evaluation of tenders.

Grouping a number of the smaller schemes located close to one another, into single contracts, needs to be considered in order to limit the administrative burden of the project, especially with the short termed scenario.

13.8 SUPERVISION OF CONSTRUCTION

The schemes are generally small, and do not require the presence of expatriate staff. A possible exception being Dedza, where the construction of an impounding dam requires carefully controlled supervision.

It is suggested that the consulting engineering firm remains responsible for the supervision of the two largest projects, Dedza and Balaka, which are also programmed for construction first, but using Water Department staff as Resident Engineers. The Water Department should take over the responsibility for the supervision of the remainder of the schemes, but with the provision of one engineer from the consulting engineering firm who will provide overall advice on quality control and contractual matters.

13.9 ESTABLISHMENT OF DESIGN AND IMPLEMENTATION UNIT (DIU)

The design and implementation of the 14 urban schemes proves an ideal opportunity for establishing, equipping and training a unit within the Water Department that, by the end of the project period, will be capable of providing most of the engineering and other professional requirements for the development and improvement of future similar water supply and sanitation schemes.

The strategy by which such a unit can be established essentially envisages that the unit will initially consist of specialist staff from a consulting engineering firm, together with engineering staff from the Water Department. For the short termed scenario, the responsibility for the design and implementation of the work required for the initial two years will be the consulting engineers, who will also be responsible for training Water Department staff.

– unit should not be established. If necessary, design work shall be contracted out. (short post consultants in the water dept. except perhaps coordinator)

After two years the initial drilling programme will be completed, and the designs of the largest and most urgent schemes should be finalised, and progressing towards implementation. At this stage it is suggested that new scheme designs will become the main responsibility of the Water Department, with the consulting staff taking a more supportive role.

The programming, and required staffing for the DIU is estimated as shown on Tables 13.1 and 13.2.

13.10 COMMUNITY PARTICIPATION

The sanitation component of the project will most likely involve a considerable component of "self-help" work in digging pits and constructing the superstructure. To

TABLE 13.1

PROJECT STAFFING - LONG TERM

country programme?

		Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
Initial Survey Period		===				
Drilling Programme			===	===		
Detailed design			===	===	===	===
Construction				===	===	===
Sanitation programme		===	===	===	===	===
Consultant Staffing:						
Project Manager/Water Engineer		===	===	===		
Hydrogeologist		===	===	===		
Water Engineer (design)			===	===	===	===
Engineer (Supervision)				===	===	===
Short term Consulting Staff						
Senior Hydrogeologist		===	===	===		
Dam Design Specialist		===	===	===	===	
Hydrologist		===	===			
Sociologist /c.d. specialist		===	===			
Environmental Specialist		===	===			
Health Education Specialist			===	===		===
Electrical & Mechanical Engineer		===	===	===		
Other Specialists as required		===	===	===	===	
Water Department Staff:						
Water Engineer	(1)	===	===	===	===	===
Water Engineer	(2)		===	===	===	===
Hydrogeologist		===	===	===		
Sanitation co-ordinator		===	===	===	===	===
Supervising Engineers	(1)			===	===	===
	(2)			===	===	===
	(3)				===	===
	(4)				===	===
Topographical Survey Team			===	===	===	===
Draughtsman	(1)	===	===	===	===	===
	(2)		===	===	===	===
	(3)		===	===	===	===
Health Assistants (14 nr)		===	===	===	===	===

OK

others to be kept? contracted to be or in-house.

TABLE 13.2

PROJECT STAFFING - SHORT TERM SCENARIO

	Yr 1	Yr 2	Yr 3	Yr 4
Initial Survey Period	===			
Drilling Programme		===	===	===
Detailed design		===	===	
Construction		===	===	===
Sanitation programme	===	===	===	===
Consultant Staffing:				
Project Manager/Water Engineer	===	===	===	===
Hydrogeologist	===	===	===	===
Water Engineer (design)	===	===	===	===
Water Engineer		===	===	
Short term Consulting Staff				
Senior Hydrogeologist	===	===	===	
Dam Design Specialist	===	===	===	
Hydrologist	===	===		
Sociologist	===	===		
Environmental Specialist	===	===		
Health Education Specialist		===	===	
Electrical & Mechanical Engineer	===	===	===	
Other Specialists as required	===	===	===	
Water Department Staff:				
Water Engineer (1)	===	===	===	===
Water Engineer (2)		===	===	===
Hydrogeologist	===	===	===	===
Sanitation co-ordinator	===	===	===	===
Supervising Engineers		===	===	===
Topographical Survey Teams	===	===	===	===
Draughtsman	===	===	===	===

achieve the maximum potential health benefits of the programme it should cover the whole community. However to achieve this target each household has to be persuaded to participate. A process which can take a considerable time, and which may never be completed. Promotion and motivation on a community basis to achieve a communal consensus can therefore greatly assist in this process.

Health eduction, targeting on water and sanitation related diseases, through appropriate media and techniques is seen as an important vehicle for motivation of the communities.

Public relations, community involvement, and the awareness of the needs of the community, in the water supply component of the project is also important, and these aspects of the project will benefit from the community development and health educational activities of the sanitation programme, whose responsibilities will be extended to cover water supply factors.

Issues that are of particular importance are:

- Public relations; discussing the project with the community to obtain their views and preferences, and to take these into account. If this is not possible, explain the situation to the community.
- Formation of tap committees
- Location of water points
- Personal hygienic practices
- Health education related to water related diseases
- Dangers of pollution
- Dangers of pollution to water storage in the homesteads
- Providing adequate drainage around water points
- Cleanliness of the water points and surrounding areas
- Maintenance of the taps and repairs of any leaks
- Collection of payment

Repeat & 4.13

13.11 IMPLEMENTATION PLAN

The timing and duration of the various components of the programme, and the responsibilities and obligations of the different parties towards the project have been discussed in the preceding sections of this chapter. These are all put together in an overall implementation plan, taking the priority ranking of the schemes into account as shown in Table 13.3 overleaf for the long term scenario.

It should be stressed that the relative timing of implementation of the schemes should remain flexible to allow for circumstances such as failure of existing facilities, and developments that will occur during the course of the project, and which will affect the relative priority of the schemes.

Estimated investment requirements for the three year programme are shown below in Table 13.4

TABLE 13.4

INVESTMENT REQUIREMENTS FOR SHORT TERM SCENARIO

	Year					
	Pounds Sterling x 1,000					Foreign Exchange
Item Description	**92/93**	**93/94**	**94/95**	**95/96**	**Total**	**%**
Equipment	50				50	100
Drilling	63	210	53	135	461	40
Construction		1895	2105	1140	5140	50
Consultancy	100	250	200	101	651 ?	100
Overhead & Vehicles	200	68	60	40	368	50
	413	2423	2418	1416	6670	55

* Exchange rate used : MK 4.75 to 1.00 pound sterling

TABLE 13.3

OVERALL IMPLEMENTATION PLAN

		1992	1993	1994	1995	1996	1997	1998	1999
Overall Programme									
Initial surveys etc		==							
Drilling Programme			==	==					
Final design of projects		==	==	==	==	==	==	==	
Construction					==	==	==	==	==
Sanitation Programme		==	==	==	==	==	==	==	==
Project Review				>		>	>	>	
Scheme Implementation									
Dedza	Drilling		xx						
	Design		==	==					
	Construction				cc	cc			
Balaka	Drilling		xx		xx				
	Design		==	==					
	Construction				cc	==			
Nchalo	Drilling			xx		xx			
	Design		==	==					
	Construction					cc			
Salima	Drilling			xx		xx			
	Design		==	==	==				
	Construction					cc			
Nkhotakota	Drilling		xx						
	Design		==	==	==				
	Construction					cc	cc		
Ntchisi	Drilling			xx					
	Design		==	==	==				
	Construction					cc	cc		
Chitipa	Drilling		xx						
	Design		==	==	==	==			
	Construction					cc	cc		
Namwera	Drilling								
	Design		==	==	==	==			
	Construction						cc		
Dowa	Drilling			xx					
	Design		==	==	==	==	==		
	Construction						cc	cc	
Muloza	Drilling								
	Design		==	==	==	==	==		
	Construction							cc	
Luchenza	Drilling			xx		xx			
	Design		==	==	==	==	==		
	Construction							cc	
Nsanje	Drilling			xx		xx			
	Design		==	==	==	==	==	==	
	Construction								cc
Ngabu	Drilling			xx		xx			
	Design		==	==	==	==	==	==	
	Construction								cc
Chikwawa	Drilling					xx			
	Design		==	==	==	==	==	==	
	Construction								cc

CHAPTER 14

RECOMMENDATIONS FOR ADDITIONAL SUPPORT

Additional measures required to ensure the full benefits of the project, as identified in the relevant sections of this report include the following:

14.1 ESTABLISHMENT OF DESIGN AND IMPLEMENTATION UNIT (DIU)

There already exists a design section

The design and implementation of the 14 urban schemes proves an ideal opportunity for establishing, equipping and training a design and implementaion unit within the Water Department.

The strategy by which such a unit can be established essentially envisages that the unit will initially consist of specialist staff from a consulting engineering firm, together with engineering staff from the Water Department. The consulting engineers will be responsible for the design and implementation of the work required for the initial period.

Estimated requirements and costs for the support to the DIU, to cover the first 3 year period are given below:

	Pounds Sterling
Staffing	601,000
Transport	230,400
Housing	137,500

The work that will be covered by the DIU will include the following:

14.1.1 Initial Surveys

In order to optimise the design of groundwater and surface water abstraction works, more knowledge of the available resources is generally required.

An initial period, estimated to last approximately 6 months, is required to cover all schemes, including the following aspects:

14.1.2 Health and Sanitation Programme

A health and sanitation programme, based on existing HESP programmes is recommended to be initiated in all centres to improve the envionmental health and sanitation conditions.

The sanitation programme will commence with the appointment of the sanitation coordinator at the beginning of the overall project, however the initial period will be spent in preparing the detailed programme, establishing responsibilities of the various ministries, employing health assistants and training them. It is expected that after six months, the sanitation programme will be ready to start their campaign, which could coincide with the commencement of the drilling programme,

It is envisaged that the Sanitation Coordinator will be a professional Malawian health advisor/community developer, seconded to the project for its duration, reporting to the project manager. All health assistants will be employees of the Ministry of Health and also seconded to the project, so they report directly to the project coordinator.

14.1.3 Drilling Programme

A drilling programme, designed to meet the 1995 sourceworks requirements of each of the schemes, will be phased to meet the prioritisation requirements.

An additional drilling programme will be prepared and implemented during 1995 to meet the 2000 requirements of each of the schemes.

14.1.4 Additional Investigations and Studies

During the course of both the initial survey period and the drilling programme, additional investigations will be undertaken in order to establish the most feasible development strategy for Dowa, Dedza, Salima, Balaka, Nchalo, Luchenza and

Muloza.

14.1.5 Final Design

The final design of schemes will be phased in accordance with the drilling programme in the different schemes. Each scheme design will however contain the following components:

- Survey of existing system
- Topographical survey for new work
- Design of water procurement, appropriate treatment and distribution systems

14.1.6 Tender

Tender documents, including detailed bills of quantities, will be prepared for the implementation of each of the schemes, in accordance with the normal practices in Malawi.

14.1.7 Supervision of Construction

It is suggested that the consulting engineering firm remains responsible for the supervision of the two largest projects, Dedza and Balaka, which are also programmed for construction first, but using Water Department staff as Resident Engineers. The Water Department should take over the responsibility for the supervision of the remainder of the schemes, but with the provision of one engineer from the consulting engineering firm who will provide overall advice on quality control and contractual matters.

14.2 WATER QUALITY MONITORING

The staffing, transport and equipment of the Water Department's Laboratory is inadequate to fulfill its present duties. Additional transport and equipment is required for it to become an effective unit. The Water Department intends eventually to locate laboratories at their regional centres. Assuming staff can be recruited to fill the necessary posts this move will improve the efficiency of sample collection, and feedback of information to the schemes.

It is recommended that additional support is considered to establishing regional laboratories, when the Water Department finalises its proposals for de-centralising.

14.3 HYDROGEOLOGICAL SURVEY EQUIPMENT AND DATA BASE

To increase the probability of success of the borehole development programme it is recommended to purchase the following equipment for the programme:

- Electro-magnetic survey equipment
- An additional set of resistivity survey equipment
- Computer with GIS capabilities and supporting data base software and ancillary printer and plotter.
- Equipping each scheme with dipping equipment for monitoring borehole water levels.
- Replacement flow meters

14.4 ADDITIONAL SUPPORT

In several sections of the Report reference is made to the manpower needs of the Water Department, e.g. in the D.I.U., in the Water Supply Branch, and in the Finance Section, as progress is made towards commercial viability.

The Manpower study (Annex 8) will quantify Training Requirements, and their associated costs. No provision has been made either for funding or for 'cover' support whilst incumbents are on courses, or during the period of general manpower deficit. It is recommended therefore that consideration be given, on completion of the Manpower Study, to funding of the Training Programme and the provision of Support in Engineering and Finance at professional level.

In terms of Community Support the present study identified possible contraints to the affordability of Pit Latrines when the HESP programme is implemented. This issue could possibly have significance in the project areas, which by being peri-urban may well result in increased construction costs. It is recommended that this aspect be examined in more detail, parallel with the HESP Programme so that possible means of support to the provision of improved sanitation facilities be identified for consideration by ODA.

14.5 FINANCIAL RECOMMENDATIONS

It is recommended that:

1 Treasury Funds operating on a commercial basis should have financial statements that follow normal accounting conventions and in particular Sources and Application of Funds Statements should be produced.

2 The Ministry of Finance and the Economic Planning Development Department need to develop a system that identifies the recurrent impact of capital investment and the financial resources that need to be made available to operate and maintain the new assets. These financial resources to be recognised in budget allocations.

3 The Finance Sections in the Water Department are rationalized and integrated on a corporate basis with a view to maximizing efficiency and effectiveness and streamlining financial management resources.

4 The financial and management accounting systems and the subsidiary exchequer system and the financial recording mechanism are integrated. Where appropriate these systems should be computerized following an agreed implementation strategy.

5 The financial management and accountancy capability of the Water Department be improved by acquiring a professionally qualified accountancy resource and the implementation of an extensive financial training programme for existing personnel.

6 The Water Department should reassess their capital and recurrent spending plans and priorities and seek approval from the Ministry of Finance to spend within the capability of the funds at the Department's disposal. It is further recommended that those spending plans should incorporate, amongst other things, a planned meter replacement programme, a enhanced level of recurrent repair and maintenance expenditure, and a provision to meet the agreed recommendations in this report.

7 The issue of ownership of community run assets is resolved.

Why?

ANNEXES

ANNEX 1

TERMS OF REFERENCE

TERMS OF REFERENCE FOR AN APPRAISAL OF THE PROPOSED IMPROVEMENT OF 14 DISTRICT WATER SUPPLY SCHEMES

OBJECTIVES

1. The ODA wishes to provide technical assistance and capital aid in support of the extension of potable water supplies in Malawi and has received a request for support for the implementation of 14 district water supply improvements. The location of these schemes are indicated on the attached map.

2. The main objective of the project is to provide improved water supplies to meet increased demand in certain towns and to extend these services to unserved communities in traditional housing areas through the installation of communal water points.

3. A consultancy is required to advise the ODA on the relative priority and sequencing of the specified schemes and to identify and specify any need for complementary measures to ensure that the schemes are sustainable and achieve the intended benefits at minimum cost while avoiding or mitigating adverse effects.

4. The consultants are also required to appraise and cost recommended schemes in detail and to give detailed recommendations on management of implementation and proposed phasing and sequencing.

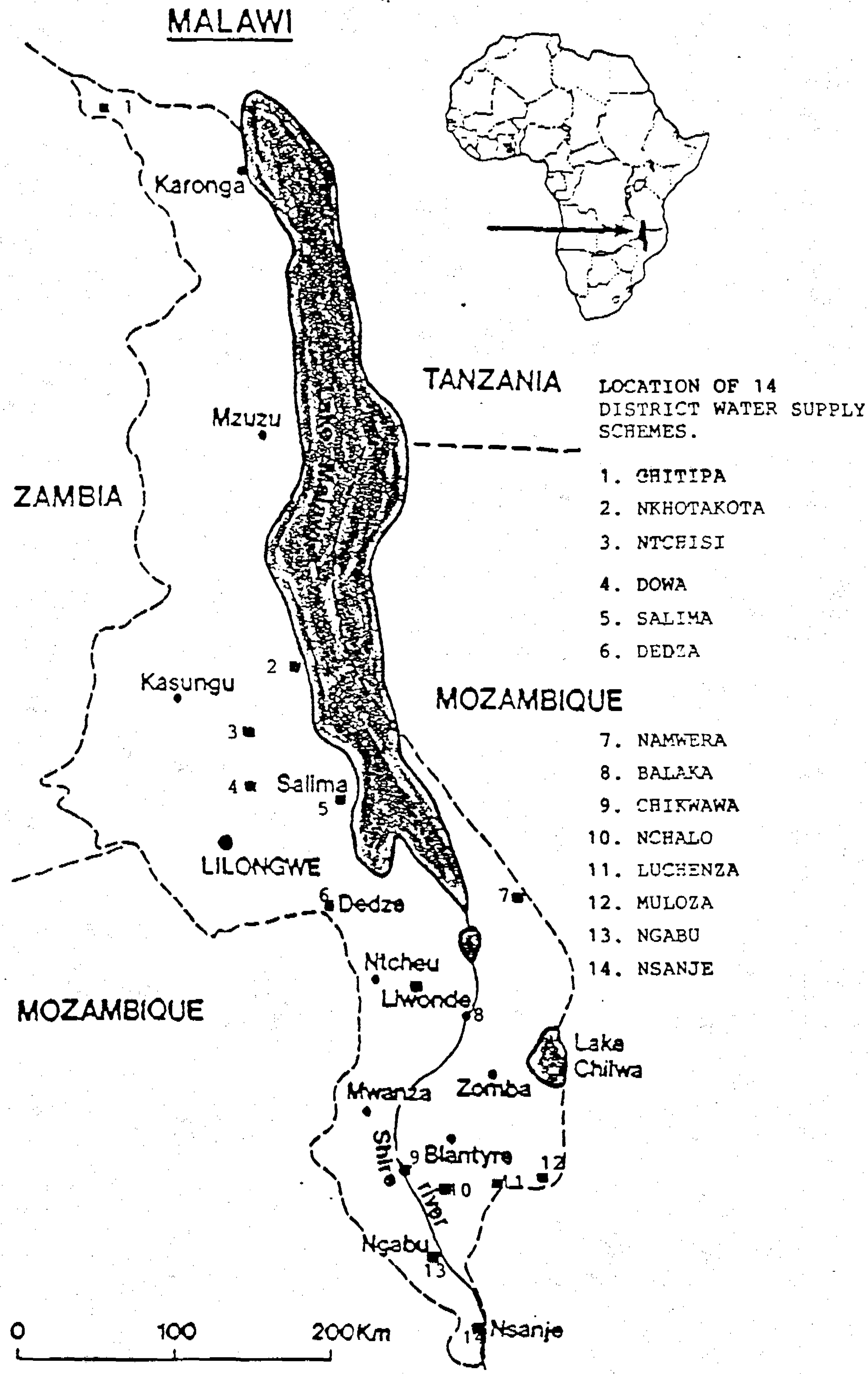
BACKGROUND TO WATER AND SANITATION SECTOR.

5. The Department of Water in the Ministry of Works (MoW) is responsible for potable water supply in urban and rural areas with the exception of Lilongwe and Blantyre which are served by Water Boards operating as parastatal entities.

6. Rural water supply can be categorised into two groups: gravity piped schemes using water from mountain streams and groundwater schemes extracting from aquifers by pumping via boreholes or dug wells. Presently, the two types of schemes are the responsibility of different sections in the Water Department.

7. Piped water schemes have been implemented with a high degree of community involvement. Capital costs and some major renovations have, in the main, been funded by donors. Many of these piped water supply schemes are now coming to the end of their useful life and need renewal of facilities beyond the maintenance capacity of participating communities.

8. The groundwater programme has, in the past, been characterised by technical complexity, centralised maintenance procedures and little community involvement. Many of the boreholes are over 50 years old and need rehabilitation. However, there are a growing number of more recent schemes, many of them run as part of Integrated Rural Development Projects under the Ministry of Agriculture and with community involvement. Appropriate technology has been applied leading to cheaper maintenance and fewer breakdowns.


MALAWI
TANZANIA
ZAMBIA
MOZAMBIQUE
MOZAMBIQUE
Karonga
Mzuzu
Kasungu
Salima
LILONGWE
Dedza
Ntcheu
Liwonde
Mwanza
Zomba
Lake Chilwa
Blantyre
Shire river
Ngabu
Nsanje
0
100
200Km
LOCATION OF 14 DISTRICT WATER SUPPLY SCHEMES.
1. CHITIPA
2. NKHOTAKOTA
3. NTCHISI
4. DOWA
5. SALIMA
6. DEDZA
7. NAMWERA
8. BALAKA
9. CHIKWAWA
10. NCHALO
11. LUCHENZA
12. MULOZA
13. NGABU
14. NSANJE

Institutions involved in the Water and Sanitation Sectors

9. The Ministry of Local Government (MoLG) has acquired experience in the technical, managerial and commercial aspects of low cost on-site sanitation options through the work of the UNDP funded "Low cost Sanitation Unit". Sanitation centres have been set up, under local authority direction, to promote and demonstrate several low cost non-water-borne sanitation options, to advise householders on technical alternatives and to sell the essential components required to construct or improve household sanitation facilities.

10. The Ministry of Community Services (MCS) has wide and varied responsibilities ranging from adult literacy education to promotion, mobilisation and support for community construction, community development and income generating initiatives.

11. The Ministry of Health (MoH) follows a flexible strategy of action which strengthens particular aspects of the health services as the need arises by means of designed programmes. These special programmes develop, organise and oversee the effort to change or improve particular aspects of health care. Of the programmes presently in effect, "Combating Childhood Communicable Disease" which focuses on the prevention and treatment of diarrhoeas; "Bilharzia Control" and "Environmental Health and Sanitation" are clearly aimed at aspects of the Water Supply and Sanitation Sector.

Perceived Weaknesses

12. The principal constraints in the collaboration of ministries lie at the national level and have their roots in:-

(a) A struggle for scarce resources between ministries and a lack of visibility of the sector as an entity for consideration at the project planning stage;

(b) A centralising of policy decision making which taxes the effective time of senior ministerial staff;

(c) The lack of a clear and agreed demarcation of responsibility in the sector between the role of one ministry and another;

(d) The lack of a central decision making forum which can assess a suitable balance of factors for a successful project and can provide arbitration for problems as they arise.

13. The Malawi Government (MG) is recognising the need for co-ordination between the water, sanitation and health sectors and is reassessing the roles various ministries and departments play in the provision of water and sanitation services. The MoLG, supported by UNDP, is taking the lead in this process and is instituting a water, sanitation and health intersectoral committee. Short term training is planned to sensitise government officers to the need for co-ordination between sectors.

Donor Activity

14. External donors have played a significant role in the development of the Water and Sanitation Sector. 85% of total sector investments originates from external sources. In recent years, the following agencies have been involved in the sector:

IDA------------	rural piped schemes
DANIDA----------	rural piped schemes, handpumps
ODA------------	technical assistance, institution building
USAID----------	rural piped water programme
JICA-----------	groundwater projects
AFDB-----------	urban centres water supply schemes
UNICEF---------	shallow well/handpump programmes
UNCDF----------	urban communal water points project
UNDP-----------	National Water Resources Master Plan
World Bank------	low cost sanitation
EEC------------	shallow well/handpump programmes

15. In addition to the international and bilateral organisations listed above, a number of other agencies and non-governmental organisations are also involved in the sector carrying out small scale development projects, notably the International Reference Centre (IRC) for Community Water Supply and Sanitation (the Netherlands) and the Christian Service Committee (CSC).

Financing of Urban Water Supplies

16. The financial operation of urban water supplies is controlled by the District Water Supply Fund (DWSF). The fund has the format of a treasury fund and was set up to operate on a commercial basis. The purpose is eventually to make urban water supplies self financing without the injection of external subsidies or grants.

PROJECT IMPLEMENTATION

17. A Master Plan has been developed by the Department of Water for the implementation of improvements to water supply schemes covering 44 population centres throughout Malawi. Of these schemes, 14 rely on groundwater extraction and an exploratory/production borehole drilling campaign has been carried out which was funded by DANIDA. In 1986, the MoW employed consultants Carl Bro/I.Kruger AS to carry out preliminary engineering design of the 14 schemes under consideration, together with an economic and financial analysis. Details are presented in a project document. The Overseas Development Administration (ODA) has now been asked by the MG to support the final design and implementation of the 14 groundwater schemes.

18. MoW have proposed the setting up of a Design and Implementation Unit (DIU) consisting of specialist staff from a consulting engineering firm together with engineering staff from the Water Department. The DIU would be responsible for the detailed survey and design of the 14 groundwater schemes. Final cost estimates will be prepared based on bills of quantities and a decision taken as to whether to undertake the works by contract or by direct labour. The choice is likely to be based on which method will give best value for money. The DIU will be responsible for supervision of the works.

19. Before reaching a decision with regard to funding of the project, ODA requires a detailed appraisal and the preparation of a project document for submission to its Project Evaluation Committee (PEC). To this end, it is intended to seek proposals from suitable firms of consultants.

TERMS OF REFERENCE

20. The tasks of the consultants fall into two main fields of work, concerning firstly the overall policy and institutional context of water and sanitation in Malawi, and secondly the detailed appraisal of the 14 specific schemes. As guidance on the methodology of approach, the consultant should refer to the ODA Manual on Rural Water Supply Schemes.

Water and Sanitation Policies and Institutions

21. With a primary focus on the requirements for successful and sustainable implementation of the proposed project, the consultants will:-

(a) Review the strengths and weaknesses of relevant policies and institutions, and arrangements for co-ordination between institutions. Specifically, they will assess the efficacy of the MoLG, who are being assisted by UNDP, in co-ordinating inputs from the Water and Health Departments and whether such co-ordination will be available for the 14 water supply schemes. If necessary, recommendations for strengthening the coordination should be given.

(b) Make recommendations on policy and operational changes for consideration by MG to enhance the prospects of achieving sustainable, cost-effective water supply projects which maximise changes in hygiene behaviour and convenience from improved access to potable water supplies. In framing recommendations, consultants will draw mainly upon existing reports and discussions with MG institutions and donors involved in the sector.

(c) Make recommendations for consideration by ODA and the MG for support in the form of training and/or expert services in order to help achieve the objectives indicated at (b) above. Recommendations for technical co-operation will include outline TORs, and indications of phasing and cost estimates.

22. In framing their recommendations, the consultants will concentrate on measures to overcome constraints of particular relevance to the proposed ODA Project, but their recommendations should be directed towards achieving sustainable improvements in the overall capacity of Malawi institutions, and <u>not</u> special arrangements to secure improved implementation and operation of the specific ODA project.

23. Recommendations will take full account of actions being taken by Malawian institutions to improve the effectiveness of water supply policies and institutions, and of support being made available by other donors. The consultants will ensure that their recommendations can be co-ordinated with existing programmes without duplication and without conflict of objectives or approach.

24. In reviewing the policies, plans and institutions relevant to the proposed water supply project, and framing their recommendations the consultant will consider (though need not be limited to) the following aspects:-

(a) The financial viability of institutions and programmes within the water supply and sanitation sector, the quality of financial management and any need for policy measures or TC to improve financial systems and management, the terms on which assistance should be on-lent, and the appropriateness of the level and structure of end user charges in relation to cost-recovery objectives;

(b) Arrangements to ensure community involvement in the design and operation and maintenance of water supply schemes, and to give adequate attention to social issues including ensuring that management arrangements are compatible with existing behaviour patterns of men, women and children;

(c) Arrangements for operation and maintenance, paying attention to managerial, operational and financial constraints, in the light of the ODA draft proposal for manpower support to the Department of Water;

(d) Health and sanitation issues, including the role of the Ministry of Local Government in co-ordinating health, sanitation and water supply proposals; the need to consider environmental health issues including the control of the mosquito vector and the implementation capacity to effect changes in hygiene behaviour, water consumption, handwashing with soap, latrine usage by children, etc. Full account should be taken of UNDP and other donor support to MG.

Proposed District Water Supply and Sanitation Schemes

25. The consultants are required to study the Carl Bro/I.Kruger AS report and to verify, or revise as may be necessary, the existing and future estimate of demand for each of the 14 schemes. In the light of any revision being required, the consultants should specify any changes needed to the preliminary engineering design.

26. Subject to the findings under paragraph 25 above, the consultants are required to revise the cost estimates for the schemes and to update the economic and financial analysis prepared by Carl Bro/I.Kruger AS. It should be borne in mind that since the preliminary engineering was carried out, costs of labour, materials, etc have increased.

27. The consultants will assess the socio-economic, financial, technical and institutional viability of the proposals and produce a detailed, fully costed design and implementation plan for the improvements.

28. Recommendations should be made for any additional support in the areas of community management of water supplies, institutional support to the Department of Water, health and sanitation issues, and other areas necessary to ensure the full benefits of the project are realised.

29. The consultants will address the water supply characteristics in the towns and consider issues of accessibility and water use practice, such as collection by women and children and at what times of day.

30. A qualitative assessment is required of current relevant health practices such as handwashing, use of soap, water consumption and latrine usage by children together with the time saving benefits to be expected on project implementation. Time saving should be quantified and valued whenever possible. The assessment should be of sufficient value to form a basis for prioritisation of the schemes. An indication of who will be the main beneficiaries in the different districts is also required. The consultants should also recommend practical methods of measuring changes in hygiene behaviour for project monitoring and evaluation.

31. An assessment of the sanitation facilities in the project areas is required, with recommendations on whether improvements are needed to the design and siting of such facilities and how these improvements should be integrated into the project as a whole. Any recommended improvements should be cost effective, affordable and maintainable by the communities. In their deliberations the consultants will give due regard to the SANPLAT latrine which is being developed by MoW. The consultants will also examine existing management methods for the control of urban/per-urban mosquito vectors of disease and make recommendations for improvements.

32. The consultants are required to consider the need and to make recomemndations for providing support to communities, such as training, in the management of community water point schemes taking into account the experience of the Dutch funded PSWSP. Community participation is required in the siting of tanks, standposts, as well as maintenance of water points, and the consultants will make recommendations as to the coordination of the engineering design with community participation.

33. The consultants should appraise the managerial, operational and financial constraints to adequate maintenance of the schemes and make recommendations for ODA support if necessary. In this respect, the consultants should examine the draft manpower project proposal by the Water Department which is being considered by BDDSA.

34. The consultants are required to demonstrate the cost-effectivess of all the recommendations made, such as choice of pumps and construction materials. The financial implications of the proposed investments should be demonstrated (incremental revenue compared with capital and incremental operating costs). The medium term impact of the project on the DWSF (paragraph 16 above) should be considered and recommendations made for tariff changes taking into account affordability and willingness to pay.

35. The justification accorded the 14 groundwater based schemes covered by the project and the priority over other unfunded water supply projects, whether in the Master Plan or elsewhere, should be assessed. The basis of this consideration shall be relevant criteria including the net present cost per person served (or per M3), the time-saving benefits achievable and the prospects for community participation and sustainability;

36. The consultants are expected to visit all the sites of the schemes.

Consultancy Input Required

37. The consultancy teams will include expertise in water engineering, hydrogeology, environmental health, socio-economics, and institutional aspects of water supply and sanitation planning and management.

38. It is for each consultant to estimate the man months required in order to complete the task, but as a guideline we provisionally anticipate that the assignment will require 6 man months of consultancy time and can be completed within a period of 2 months.

Reporting

39. The consultant will deliver to the ODA an Interim Report on the water supply sector, including an assessment of the relative priority of the 14 schemes, and a recommended work-plan for the remainder of the assignment, within 3 weeks of starting work. The report will also identify key policy and institutional issues to be further addressed in the remainder of the consultancy.

40. At the end of the assignment, the consultants shall produce a Final Report. Appendixed to this report will be the draft PEC document to be prepared using the attached guidelines, and a full and final design and implementation brief. The brief should define the structure of the DIU (Paragraph 18) and indicate the engineering expertise required to carry out the work. The brief should also indicate the split between UK supplied and Water Department inputs, and should take account of the assessment of the managerial/organisational and operational capacity of the Department of Water to implement the project.

REFERENCES

UNDP/World Bank Regional Water and Sanitation Group: Republic of Malawi, Water and Sanitation Sector, 1989.

UNDP/World Bank Regional Water and Sanitation Group: Institutional Responsibilities and Collaborative Arrangements in the Water supply and Sanitation Sector in Malawi, 1989.

UNDP/World Bank Regional Water and Sanitation Group: Republic of Malawi, Sanitation Sector Strategy Paper, 1989.

OUTLINE OF TYPICAL PROJECT SUBMISSION TO PEC

PART 1 (to be passed to recipient government)

1. SUMMARY

A statement of all basic details of the project-outline objectives, location, total cost (in both cash and constant price terms), funding proposals, offshore and local costs (including recurrent local costs), on-lending (if any) operating agency etc.

The Project Framework (PF) should set out in concise and systematic form the project's key components: the inputs, outputs and objectives, indicators of achievement and any conditions, risks and assumptions. See Policy Guidance Note 38 for an outline of the PF, guidance on its preparation and examples of completed PFs.

2. RECOMMENDATIONS

3. PROJECT DESCRIPTION

Describing the main components and including a clear statement of the detailed objectives of the project, in as precise, comprehensive, quantified and timebound a form as possible.

4. BACKGROUND

Origin of proposals and negotiations to date; how it fits into the UK aid programme and aid strategy; pre-investment work to date any further work to be done prior to the final design stage.

5. THE PROJECT AND THE DEVELOPMENT PROGRAMME

Relationship to the country's development programme. If project is not poverty-orientated, reasons should be given, eg the project's place in overall aid programmes for the country and in the recipient governments priorities (see IIIA 3.04.8a).

6. TECHNICAL APPRAISAL

Physical background of the project, suitability of the location.

Conclusions of assessment by ODA advisers, consultants and feasibility studies (perhaps appendices) including adequacy of planned inputs and of the quality, availability and appropriateness of method/process involved. Is the phasing of implementation realistic? Will the project meet the objectives set for it?

Cost-effectiveness - wether the benefits of the project could be secured at less cost.

Reliability of cost estimates detailed in Section 9.

7. LABOUR INPUTS AND SERVICES REQUIRED

Arrangements for labour, raw materials and other inputs eg power, water, and other necessary services not part of the project itself (from recipient government or other donor). Whether construction and operation will depend on the completion of other projects.

8. ECONOMIC JUSTIFICATION

Summary of conclusions and recommendations of economic appraisal made or approved by the Economic and Social Division. (Usually this will be supported by an annex detailing a cost-benefit or cost-effectiveness analysis in social opportunity cost terms). Does the project represent the least cost means of achieving the stated objectives?

Assessment of poverty-orientation of project.

Cash flow projection, illustrating where appropriate effects on government's budget and debt position.

9. SOCIAL AND ENVIRONMENTAL ASPECTS

Social and environmental issues arising from the project. Population and family planning aspects. See IIIA 3.04.0b).

Who are the major beneficiaries of the project? Will any groups be disadvantaged by it? What will be the effects on employment? What other changes in social patterns might the project bring about (See PGN No 26 for general guidance and IIIA-2 Annex 5 for detailed check-list.)

10. FINANCING OF PROJECT* (see also Section 17)

Cost based on constant prices as near as practicable to date of submission (give source, basis and date of estimate). Show off-shore, local and recurrent costs. Total cash or financial cost derived by applying, to constant price estimates, forecasts of price movements supplied by Statistics Division (usually Treasury forecast of Export Prices). Exceptionally, give any reasons why future project prices might deviate from national average.

British aid proposed (grant or loan and how tied). For TC projects the procedures in III C-10 should be followed.

Arrangements and state of negotiations for any additional external finance.

Source and availability of finance for local costs including, where these are to be met from aid funds, reference to the accounting and auditing arrangements to be made (see II C-2.05 and II E-2). Finance Department should be consulted on any proposal to depart from the normal reimbursement method.

Estimated annual disbursement of total expenditure and aid requested; relationship to agreed commitments.

Arrangements for cost over-runs.

NB: Aid Framework proposals or figures must not be mentioned in this section. Such details should be confined to the Finance Section in Part II of the submission.

11. ARRANGEMENTS FOR IMPLEMENTATION*

Expected timing of implementation; obligations and capability of implementing agency.

Tendering, use of Crown Agents.

Arrangements for technical supervision of design and construction phases.

Detailed arrangements for implementation which provide baseline data for monitoring, eg bar charts of expected project progress, organisation charts, lists of staff to be provided, report formats etc should normally be in appendices to the submission.

12. ARRANGEMENTS FOR OPERATION OF COMPLETED PROJECT*

Obligations of agency responsible and of recipient government.

Other special measures (eg customs, tariffs, hire charges, legal provisions) required.

Source of operating cost finance if external to the project.

Arrangements for management and training.

Arrangements for maintenance of construction projects.

Any supporting TC.

> * Note to Sections 10, 11 and 12
>
> A bar chart should be annexed to the submission indicating the phasing of finance, construction and commencement and the agencies responsible for each phase.

13. MONITORING OF PROJECT

What criteria have been established for measuring progress in achieving the objectives of the project (set out in the Project Framework and Section 2).

Detailed monitoring arrangements for the project as agreed with the recipient government at the project appraisal stage, in compliance with the instructions in IIIA - 6.02. Whether an ex-post evaluation of the project is recommended. Arrangements for data collection for monitoring and/or evaluation (eg baseline surveys).

Whether any special monitoring of social or environmental indicators is required.

ANNEX 2

DISTRICT WATER SUPPLY FUND

ANNEX 2

DISTRICT WATER SUPPLY FUND

1990/91 SALES SUMMARY	NO. OF CUSTOMERS	CONSUMPTION	SALES
		000M3	MK000
Water Rates			
Mzuzu	3155	2 014	1 900
Lilongwe	3374	3 116	2 600
Zomba	3492	3 033	2 692
Blantyre	1759	1 009	906
Totals	11,780	9,172	8,098
Communal Water Points			
Mzuzu	191	205	48
Lilongwe	124	303	58
Zomba	194	262	45
Blantyre	135	138	38
	644	908	189
Total Sales	12,424	10,080	8,287
Debtors as at 31/03/91			4 168

Notes:

i. The total sales differ from that shown in the 1990/91 Profit and Loss Account. The difference is understood to be accounting year end adjustments.

ii. Debtors also differ for the above reason. In addition there is no accrual for water consumed since the March 1991 meter reading.

iii. The above differences are not considered significant in the overall context of the appraisal.

DISTRICT WATER SUPPLY FUND

FINANCIAL STATEMENTS: PROFIT AND LOSS ACCOUNTS MK000

	1986/87	1987/88	1988/89	1989/90	1990/91
INCOME					
Water Rates	3054	3454	4951	6194	8699
Water connections		368	379	320	601
Other income	134	223	185	275	343
Total Income	3188	4045	5515	6789	9643
OPERATING COSTS					
Employment costs	1132	976	969	1575	1743
Cost of materials	476	734	910	980	1691
Utilities	336	455	515	524	793
Fuel & Lubricants	479	479	451	369	396
Transport costs	696	672	1008	1285	1787
Repair Maintenance	468	253	349	281	192
Other miscelleneous	238	346	354	466	453
Provision for or bad debts	28	2	50	11	194
Depreciation	302	382	384	435	451
Total operating costs	4155	4299	4990	5926	7700
PROFIT (LOSS) BEFORE INTEREST	(967)	(254)	525	863	1943
INTEREST	77	51	190	102	30
PROFIT/(LOSS)	(1044)	(305)	335	761	1913

DISTRICT WATER SUPPLY FUND

FINANCIAL STATEMENTS: BALANCE SHEET MK000

	1986/87	1987/88	1988/89	1989/90	1990/91
CURRENT ASSETS					
Debtors	1952	1731	2235	2347	4288
provision for bad debts	159	161	212	223	416
	1793	1570	2023	2124	3872
Stock	626	806	946	1264	1083
Other	49	304	-	-	-
	2468	2680	2969	3388	4955
CURRENT LIABILITIES					
Bank Overdraft	178	329	252	603	379
Creditors	2157	1889	2681	2273	2067
Water deposits	89	96	103	113	124
	2424	2314	3036	2989	2570
NET CURRENT ASSETS(LIABILITIES)	44	366	(67)	399	2385
FIXED ASSETS					
Buildings	1545	1757	1687	1619	1555
Treatment works	-	495	475	456	438
Plant	1643	1553	1932	2030	1975
Boreholes	-	110	66	45	58
Vehicles	84	63	47	206	245
Other	284	26	36	85	119
Preliminary Expenses	827	744	670	603	542
	4383	4748	4913	5044	4932
NET ASSETS	4427	5114	4846	5443	7317
FINANCED BY					
ADF Loan	1750	1750	4570	4406	4368
Loans	4264	4264	1431	-	-
Reserves	784	1792	1835	-	-
Equity - Malawi Government	-	-	-	1431	1431
Accumulated Profit (Loss)	(2371)	(2692)	(2990)	(394)	1518
NET CAPITAL	4427	5114	4846	5443	7317

DISTRICT WATER SUPPLY FUND

WATER RATES - TARIFF

	Unit	1987/88	1988/89	1989/90	1990/91	1991/92
		T	T	T	T	T
a) Consumption up to 8m3/month	minimum charge	232	240	322	320	368
b) Consumption over 8m3/month up to and including 30m3/month	m3	40	65	78	82	94
c) Consumption over 30m3/month	m3	46	75	90	100	115
d) Commercial Water Points	m3	23	23	23	25	29

Notes on minimum charges

1) In 1987/88 the minimum charge was 100 tambala with 29 tambala/m3 being the charge up to 8m3.

2) In 1988/89 the minimum change was 200 tambala with 30 tambala/m3 being the charge up to 8 m3

3) In 1989/90 the minimum charge was 250 tambala with consumption in excess of 6m3 up to including 8m3 charged at 36t/m3.

DISTRICT WATER SUPPLY FUND

FINANCIAL PROJECTIONS
FOR THE IMPROVEMENTS TO 14 DISTRICT WATER SCHEMES

A. ASSUMPTIONS FOR PROJECTIONS

1. Constant mid 1991 prices apply throughout the projections
2. Water connection income is assumed to grow by 5% per annum.
3. The increase in water rate income arising from the 14 schemes is derived from the increased cubic metre consumption shown in ANNEX C. at an assumed average rate of 80 tambala. 80 tambala/m3 has been taken rather than the 1991/92 average price of 90 tambala/m3 to recognise that the income will be skewed towards the lower consumption customers and to reflect a probable relative increase in bad debts. In addition it has been assumed that not all the extra capacity created in the early years will be sold.
4. From the investment viewpoint, only the financial impact of the 14 schemes is considered together with the impact of routine minor and replacement capital expenditure.
5. Operating and maintenance costs assume that the present 1991/92 level will rise by 5% per annum for 4 years in real terms to increase repairs and maintenance expenditure and standards by 20%.
6. Operating and maintenance costs arising from the schemes are assumed to occur in the year after the completion of the appropriate capital work.
7. Depreciation on existing assets and routine minor and replacement capital expenditure is assumed to rise by 5% per annum on a net basis.
8. The average life of the 14 schemes is estimated to be 20 years so depreciation on the schemes is assumed to equate to 5% p.a.

9. The schemes are assumed to be 100% grant aided with the grant being received in the same year as the expenditure.
10. No loans are assumed in the period other than the ADF loan being maintained at the 1990/91 level.
11. Changes in working capital are assumed to be in equilibilium
12. No improvement in the level of unaccounted for water is assumed.

B. Summary Profit and Loss Projections

MK000	ACTUAL 1990/91	ESTIMATE 1991/92	PROJECTIONS 92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/2000	2000/01	2001/02
INCOME												
Water rate sales at 1991/92 level	8699	9516	9516	9516	9516	9516	9516	9516	9516	9516	9516	9516
Water rate sales from schemes			-	-	297	1015	1526	2240	2561	2945	3502	3854
Connection charges	601	546	573	602	632	664	697	732	768	807	847	889
Other income	343	324	324	324	324	324	324	324	324	324	324	324
TOTAL INCOME	9643	10386	10413	10442	10769	11519	12063	12812	13169	13592	14189	14583
OPERATING COSTS												
Operating & maintenance costs	7249	8840	9282	9746	10233	10746	10745	10745	10745	10745	10745	10745
O & M arising from schemes	-	-	-	-	67	401	450	502	568	632	724	791
Depreciation- existing	451	460	483	507	532	559	587	616	647	680	714	749
Depreciation-schemes	-	-	-	16	148	380	707	916	1072	1205	1280	1289
Interest	30	125	125	125	125	125	125	125	125	125	125	125
TOTAL OPERATING COSTS	7730	9425	9890	10394	11105	12210	12614	12904	13157	13387	13588	13699
NET PROFIT (LOSS)	1913	961	523	48	(336)	(691)	(551)	(92)	12	205	601	884
CUMULATIVE PROFIT(LOSS)	1518	2479	3002	3050	2714	2023	1472	1380	1392	1597	2198	3082
Delay of 1 year in Sales receipts												
Net Profit/(Loss)	1913	961	523	48	(633)	(1409)	(1062)	(806)	(309)	(179)	44	532
Cummulative Profit/(Loss)	1518	2479	3002	3050	2417	1008	(54)	(860)	(1169)	(1348)	(1304)	(772)

DHSF FINANCIAL PROJECTIONS

C. Summary Sources and Applications of Funds

MK000	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/01	2001/01
Sources of Funds Intend										
Years Profit	523	48	(336)	(691)	(551)	(92)	12	205	601	884
Add Depreciation	483	523	680	939	1294	1532	1719	1885	1994	2038
Total Internal Sources	1006	571	344	248	743	1440	1731	2090	2595	2922
External										
Grants	315	2642	4637	6558	4183	3109	2658	1499	171	2033
Loans	-	-	-	-	-	-	-	-	-	-
Total External Sources	315	2642	4637	6558	4183	3109	2658	1499	171	2033
TOTAL FUNDS	1321	3213	4981	6806	4926	4549	4389	3589	2766	4955
APPLICATION OF FUNDS										
Capital Expenditure -										
replacement etc.	765	765	765	765	765	765	765	765	765	765
-14 schemes	315	2642	4637	6558	4183	3109	2658	1499	171	2033
TOTAL APPLICATION OF FUNDS	1080	3407	5402	7323	4948	3874	3423	2264	936	2798
NET FLOW OF FUNDS	241	(194)	(421)	(517)	(22)	675	966	1325	1830	2157
CUMULATIVE FLOW OF FUNDS	241	47	(374)	(891)	(913)	(238)	728	2053	3883	6040
Delay of 1 year in sales receipts										
Net Flow of Funds	241	(194)	(718)	(1235)	(533)	(39)	645	941	1273	1805
Cummulative Flow of Funds	241	47	(671)	(1906)	(2439)	(2478)	(1833)	(892)	381	2186

ANNEX 3

FINANCIAL STATEMENTS:

PROFIT & LOSS ACCOUNTS

DISTRICT WATER SUPPLY FUND

FINANCIAL STATEMENTS: PROFIT AND LOSS ACCOUNTS MK000

MK000	1986/87	1987/88	1988/89	1989/90	1990/91
INCOME					
Water Rates	3054	3454	4951	6194	8699
Water connections		368	379	320	601
Other income	134	223	185	275	343
	-----	-----	-----	----	----
Total Income	3188	4045	5515	6789	9643
	----	----	----	----	----
OPERATING COSTS					
Employment costs	1132	976	969	1575	1743
Cost of materials	476	734	910	980	1691
Utilities	336	455	515	524	793
Fuel & Lubricants	479	479	451	369	396
Transport costs	696	672	1008	1285	1787
Repair Maintenance	468	253	349	281	192
Other miscelleneous	238	346	354	466	453
Provision or bad debts	28	2	50	11	194
Depreciation	302	382	384	435	451
	----	----	----	----	----
Total operating costs	4155	4299	4990	5926	7700
PROFIT (LOSS) BEFORE INTEREST	(967)	(254)	525	863	1943
INTEREST	77	51	190	102	30
	----	----	----	----	----
PROFIT/(LOSS)	(1044)	(305)	335	761	1913
	----	----	----	----	----

DISTRICT WATER SUPPLY FUND

FINANCIAL STATEMENTS: BALANCE SHEET

MK000	1986/87	1987/88	1988/89	1989/90	1990/91
CURRENT ASSETS					
Debtors	1952	1731	2235	2347	4288
provision for bad debts	159	161	212	223	416
	1793	1570	2023	2124	3872
Stock	626	806	946	1264	1083
Other	49	304	-	-	-
	----	----	----	----	----
	2468	2680	2969	3388	4955
	----	----	----	----	----
CURRENT LIABILITIES					
Bank Overdraft	178	329	252	603	379
Creditors	2157	1889	2681	2273	2067
Water deposits	89	96	103	113	124
	----	----	----	----	----
	2424	2314	3036	2989	2570
	----	----	----	----	----
NET CURRENT ASSETS(LIABILITIES)	44	366	(67)	399	2385
FIXED ASSETS					
Buildings	1545	1757	1687	1619	1555
Treatment works	-	495	475	456	438
Plant	1643	1553	1932	2030	1975
Boreholes	-	110	66	45	58
Vehicles	84	63	47	206	245
Other	284	26	36	85	119
Preliminary Expenses	827	744	670	603	542
	----	----	----	----	----
	4383	4748	4913	5044	4932
	----	----	----	----	----
	----	----	----	----	----
NET ASSETS	4427	5114	4846	5443	7317
	----	----	----	----	----
FINANCED BY					
ADF Loan	1750	1750	4570	4406	4368
Loans	4264	4264	1431	-	-
Reserves	784	1792	1835	-	-
Equity - Malawi					
Government	-	-	-	1431	1431
Accumulated					
Profit (Loss)	(2371)	(2692)	(2990)	(394)	1518
NET CAPITAL	4427	5114	4846	5443	7317

ANNEX 4

WATER RATES - TARIFF

ANNEX 4

DISTRICT WATER SUPPLY FUND

WATER RATES - TARIFF

	Unit	1987/88	1988/89	1989/90	1990/91	1991/92
		T	T	T	T	T
a) Consumption up to $8m^3$ month	minimum charge	232	240	322	320	368
b) Consumption over $8m^3$ month up to and including $30m^3$/month	m^3	40	65	78	82	94
c) Consumption over $30m^3$ /month	m^3	46	75	90	100	115
d) Commercial Water Points	m^3	23	23	23	25	29

Notes on minimum charges

1) In 1987/88 the minimum charge was 100 tambala with 29 tambala/m3 being the charge up to $8m^3$

2) In 1988/89 the minimum change was 200 tambala with 30 tambala/m3 being the charge up to 8 m^3

3) In 1989/90 the minimum charge was 250 tambala with consumption in excess of 6 m^3 up to including $8m^3$ charged at 36t/m3.

ANNEX 5

FINANCIAL PROJECTIONS FOR THE IMPROVEMENTS TO 14 DISTRICT WATER SCHEMES

ANNEX 5

DISTRICT WATER SUPPLY FUND

FINANCIAL PROJECTIONS FOR THE IMPROVEMENTS TO 14 DISTRICT WATER SCHEMES

A. ASSUMPTIONS FOR PROJECTIONS

1. Constant mid 1991 prices apply throughout the projections.
2. Water connection income is assumed to grow by 5% per annum.
3. The increase in water rate income arising from the 14 schemes is derived from the increased cubic metre consumption shown in ANNEX C at an assumed average rate of 80 tambala. 80 tambala/m^3 has been taken rather than the 1991/92 average price of 90 tambala/m^3 to recognise that the income will be skewed towards the lower consumption customers and to reflect a probable relative increase in bad debts. In addition it has been assumed that not all the extra capacity created in the early years will be sold.
4. From the investment viewpoint, only the financial impact of the 14 schemes is considered together with the impact of routine minor and replacement capital expenditure.
5. Operating and maintenance costs assume that the present 1991/92 level will rise by 5% per annum for 4 years in real terms to increase repairs and maintenance expenditure and standards by 20%.
6. Operating and maintenance costs arising from the schemes are assumed to occur in the year after the completion of the appropriate capital work.
7. Depreciation on existing assets and routine minor and replacement capital expenditure is assumed to rise by 5% per annum on a net basis.
8. The average life of the 14 schemes is estimated to be 20 years so depreciation on the schemes is assumed to equate to 5% p.a.
9. The schemes are assumed to be 100% grant aided with the grant being received in the same year as the expenditure.
10. No loans are assumed in the period other than the ADF loan being maintained at the 1990/91 level.
11. Changes in working capital are assumed to be in equilibrium.
12. No improvement in the level of unaccounted for water is assumed.

B. Summary Profit and Loss Projections

MK000	ACTUAL 1990/91	ESTIMATE 1991/92	PROJECTIONS 92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/2000	2000/01	2001/02
INCOME												
Water rate sales at 1991/92 level	8699	9516	9516	9516	9516	9516	9516	9516	9516	9516	9516	9516
Water rate sales from schemes			-	-	297	1015	1526	2240	2561	2945	3502	3854
Connection charges	601	546	573	602	632	664	697	732	768	807	847	889
Other income	343	324	324	324	324	324	324	324	324	324	324	324
TOTAL INCOME	9643	10386	10413	10442	10769	11519	12063	12812	13169	13592	14189	14583
OPERATING COSTS												
Operating & maintenance costs	7249	8840	9282	9746	10233	10745	10745	10745	10745	10745	10745	10745
O & M arising from schemes	-	-	-	-	67	401	450	502	568	632	724	791
Depreciation- existing	451	460	483	507	532	559	587	616	647	680	714	749
Depreciation-schemes	-	-	-	16	148	380	707	916	1072	1205	1280	1289
Interest	30	125	125	125	125	125	125	125	125	125	125	125
TOTAL OPERATING COSTS	7730	9425	9890	10394	11105	12210	12614	12904	13157	13387	13588	13699
NET PROFIT (LOSS)	1913	961	523	48	(336)	(691)	(551)	(92)	12	205	601	884
CUMULATIVE PROFIT(LOSS)	1518	2479	3002	3050	2714	2023	1472	1380	1392	1597	2198	3082
Delay of 1 year in Sales receipts												
Net Profit/(Loss)	1913	961	523	48	(633)	(1409)	(1062)	(806)	(309)	(179)	44	532
Cummulative Profit/ (Loss)	1518	2479	3002	3050	2417	1008	(54)	(860)	(1169)	(1348)	(1304)	(772)

DWSF FINANCIAL PROJECTIONS

C. Summary Sources and Applications of Funds

MK000	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/01	2001/01
Sources of Funds Intend										
Years Profit	523	48	(336)	(691)	(551)	(92)	12	205	601	884
Add Depreciation	483	523	680	939	1294	1532	1719	1885	1994	2038
Total Internal Sources	1006	571	344	248	743	1440	1731	2090	2595	2922
External										
Grants	315	2642	4637	6558	4183	3109	2658	1499	171	2033
Loans	-	-	-	-	-	-	-	-	-	-
Total External Sources	315	2642	4637	6558	4183	3109	2658	1499	171	2033
TOTAL FUNDS	1321	3213	4981	6806	4926	4549	4389	3589	2766	4955
APPLICATION OF FUNDS										
Capital Expenditure -										
replacement etc.	765	765	765	765	765	765	765	765	765	765
-14 schemes	315	2642	4637	6558	4183	3109	2658	1499	171	2033
TOTAL APPLICATION OF FUNDS	1080	3407	5402	7323	4948	3874	3423	2264	936	2798
NET FLOW OF FUNDS	241	(194)	(421)	(517)	(22)	675	966	1325	1830	2157
CUMULATIVE FLOW OF FUNDS	241	47	(374)	(891)	(913)	(238)	728	2053	3883	6040
Delay of 1 year in sales receipts										
Net Flow of Funds	241	(194)	(718)	(1235)	(533)	(39)	645	941	1273	1805
Cummulative Flow of Funds	241	47	(671)	(1906)	(2439)	(2478)	(1833)	(892)	381	2186

ANNEX 6

REVISED POPULATION, WATER DEMAND AND COST ESTIMATES

ANNEX 6

REVISED POPULATION, WATER DEMAND AND COST ESTIMATES

The following tables give details of the population, water demand, incremental consumption, and cost estimates for each of the 14 schemes.

The tables are basically a repetition of the work produced in the Master Plan, with the following revisions:

- Population figures revised to suit the 1987 census values.
- Water demand figures amended in accordance with the revised population projections.
- Production requirements revised to suit new projected water demands.
- Cost estimates revised to mid 1991 prices.
- Pump replacement assumed after 10 years operation.
- Phased construction for boreholes:

Construction year:	To meet estimated demand in year:
1993	1995
1995	2000
2000	2005

The same years were taken for construction of the various phases so that all schemes can be compared using a common datum. It must be stressed however, that this will not be possible due to many constraints. The effect will be to spread the overall investment over a number of years, giving a more favourable overall AIC value.

1 - CHITIPA			1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
POP'N x 1000	4.60%	4.0%	6.3	6.0	6.3	6.5	6.8	7.0	7.3	7.5	7.8	8.2	8.5	8.8	9.3	9.6	10.0	10.4	10.8
Pop. dist'n	Low		3%	3%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
	Med		8%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
	High		18%	19%	19%	19%	20%	20%	20%	20%	20%	21%	21%	21%	21%	21%	22%	22%	22%
	Trad		71%	68%	68%	68%	67%	67%	67%	67%	67%	66%	66%	66%	66%	66%	65%	65%	65%
Consumption	Low	lcd	200	200	203	206	209	212	216	218	221	224	227	230	234	238	242	246	250
	Med		160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160
	High		76	80	81	81	82	82	83	84	84	85	86	86	87	88	98	98	100
	Trad		26	27	27	27	28	28	28	28	28	29	29	29	29	29	30	30	30
Domestic demand		m3/d	269	340	368	373	381	410	430	451	473	486	520	546	572	600	630	661	683
Institutional Y =	1	m3/d	109	128	133	139	148	162	169	168	174	182	190	198	207	216	226	236	246
Commerce Y =	1.7	m3/d	66	76	83	90	87	105	112	120	129	138	147	156	166	177	187	198	210
TOTAL DEMAND		m3/d	423	543	672	603	634	667	702	739	778	816	856	899	945	992	1042	1094	1148
Consumption		m3/d	263	410	445	457	523	570	613	653	706	763	803	866	909	968	1024	1086	1148
Losses			1.7%	6.4%	6.8%	7.2%	7.6%	8.0%	8.4%	8.6%	8.9%	8.0%	9.2%	9.4%	9.6%	9.6%	9.9%	9.9%	10%
Peak	1.25	m3/d	334	646	698	663	710	769	831	883	968	1026	1090	1168	1246	1323	1405	1480	1679
Existing Prod Cap'y		m3/d	251	423															
Existing Storage		m3	282																
Production required		m3/d					147		280					376					
Production supplied		m3/d					184.4		324					368.8					
Storage required		m3	(4 hr)						none										
Inc. Production		m3/yr x 1000					110	127	146	163	182	202	222	244	266	289	313	338	363
Inc. consumption		m3/yr x 1000					97	112	129	144	161	179	197	218	236	256	278	300	323

INVESTMENT COSTS		Unit	Rate	Quantities Ph 1	Ph 2	Ph 3	INVESTMENT COSTS 1993	1994	1995	1996	1997	1998	1999	2000	MK x 1,000 2001	2002	2003	2004	2005
Recent B/hs	85	m3/d/nr	17.5	5			87.5												
Boreholes @	64.8	m3/d/nr	17.5	3	5	6	52.5		87.5					105					
Unsuccessful	38%	nr	6.9	5	8	10	34.5		55.2					69					
Pumping St'ns		nr	7.1	8	5	6	56.8		35.5					42.6					
Pump & Mtr	1.8	kW | nr	5.5	8	5	6	44		27.5					33			44		27.5
Dosing Equipment		nr	5	2	1	2	10		5					10			10		5
Installation		nr	7.8	8	5	6	62.4		39					46.8			62.4		39
Spares		nr	1.6	8	5	6	12.8		8					9.6					
T.Wks		m3/h|nr																	
200 dia rising main		m	0.14	0			0		0					0					
160 dia rising main		m	0.076	0			0		0					0					
100 dia rising main		m	0.047	1500		0	70.5		0					0					
75 dia rising main		m	0.037	0			0		0					0					
100m3 resr x 15m		m3	170				0		0					0					
75 m3 resr'		m3	33				0		0					0					
30 m3 resr'		m3	26				0		0					0					
200 dia Trunk mains		m	0.14	1000			140		0					0					
160 dia Trunk mains		m	0.076	1000			76		0					0					
110 dia Trunk mains		m	0.047	1400			66		0					0					
Housing			35.0	1			35												
Prelims & General			34.0%				264	0	92	0	0	0	0	107	0	0	40	0	24
Contingencies			21%				210	0	73	0	0	0	0	89	0	0	33	0	20
TOTAL CAPITAL COSTS							1211	0	418	0	0	0	0	512	0	0	189	0	116
Distribution and connections			1634					128	128	128	128	128	128	128	128	128	128	128	128
Cumulative investments							1211	1211	1629	1629	1629	1629	1629	2141	2141	2141	2330	2330	2446
OPERATION AND MAINTENANCE COSTS	MK x 1,000																		
Power head=	30	K/kWh=	0.16					10	11	13	14	15	17	18	20	22	24	26	29
Chemicals	Cl	K/m3=	0.018					2	3	3	3	4	4	4	5	5	6	6	7
Labour		K/m3=	0.04					6	6	6	7	8	8	10	11	11	12	13	14
Maintenance co		0.25%	0.02					6	7	7	8	8	8	10	11	11	12	13	13
TOTAL OPERATION AND MAINTENANCE COSTS								23	26	28	32	35	33	43	46	50	54	58	62
TOTAL CASH OUTFLOWS x 1000							1211	150	572	157	160	163	166	583	174	178	371	186	306
NET CASH FLOWS x 1000							-1211	-150	-572	-157	-160	-163	-166	-583	-174	-178	-371	-186	-306
Cummulative Cash Flow x 1000							-1211	-1361	-1933	-2091	-2251	-2414	-2580	-3263	-3437	-3616	-3986	-4171	-4477
Expenditure already committed x 1000							266												
Discounted consumption (m3 x 1,000) at						12%	1116	AIC O&M costs				0.20							
Discounted cash outflow (MK x 1,000) at						12%	2577	Average incremental Costs MK/m3				2.31							

S - NTCHISI			1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
POPULATION x 1000		2.8%	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.5	4.6	4.7	4.9	5.0	5.2
Pop. dist'n	Low		3%	4%	4.0%	4.0%	4.0%	4.0%	4.0%	4.2%	4.4%	4.6%	4.8%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
	Med		11%	12%	12%	12%	13%	13%	13%	13%	14%	14%	15%	15%	15%	15%	15%	15%	15%
	High		15%	16%	16%	16%	17%	17%	17%	18%	18%	18%	19%	20%	20%	20%	20%	20%	20%
	Trad		71%	68%	67%	67%	66%	66%	65%	64%	64%	63%	63%	62%	62%	61%	61%	60%	60%
Consumption	Low	lcd	200	200	203	206	209	212	215	218	221	224	227	230	234	238	242	246	250
	Med		160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160
	High		76	80	81	81	82	82	83	84	84	85	86	86	87	88	88	89	100
	Trad		25	27	27	27	28	28	28	28	28	28	29	29	29	29	30	30	30
Domestic demand		m3/d	169	187	206	214	222	231	240	256	268	285	301	318	329	340	352	364	378
Institutional Y =	0.3	m3/d	69	72	73	74	76	77	78	79	80	82	83	85	88	88	88	91	92
Commerce Y =	1.35	m3/d	42	49	52	54	57	59	62	66	68	71	74	77	81	84	88	91	86
TOTAL DEMAND		m3/d	270	318	330	342	354	367	381	399	418	438	458	480	498	512	528	546	563
Consumption		m3/d	186	266	272	282	306	322	338	361	386	408	433	459	478	498	520	541	563
Losses			1.7%	6.4%	8.8%	7.2%	7.6%	8.0%	8.4%	8.8%	8.8%	9.0%	9.2%	9.4%	9.5%	9.6%	9.8%	9.9%	10%
Peak	1.25	m3/d	242	341	363	380	410	434	460	481	523	557	582	628	656	684	714	744	776
Existing Prod Capy		m3/d	150	72															
Existing Storage		m3	112																
Production required		m3/d					238		147					99					
Production supplied		m3/d					269		194					130					
Storage required		m3	(4 hr)						none										
Inc. Production		m3/yr x 1000					47	54	62	71	80	90	100	111	119	127	136	146	154
Inc. consumption		m3/yr x 1000					40	48	63	81	69	78	87	96	104	111	119	126	134

INVESTMENT COSTS				Quantities			INVESTMENT COSTS								MK x 1,000				
		Unit	Rate	Ph 1	Ph 2	Ph 3	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Recent B/hs	36	m3/d/nr	17.5	2			35												
Boreholes @	64.8	m3/d/nr	17.5	4	3	2	70		52.5					35					
Unsuccessful	38%	nr	6.9	7	6	3	48.3		34.5					20.7					
Pumping St'ns		nr	7.1	4	3	2	28.4		21.3					14.2					
Pump & Mtr	1.2	kW | nr	5.2	6	3	2	31.2		15.6					10.4			31.2		15.6
Dosing Equipment		nr	5	2	1	1	10		5					5			10		5
Installation		nr	2.36	6	3	2	14.16		7.08					4.72			14.16		7.08
Spares		nr	1.5	6	3	2	9		4.5					3					
T.Wks		m3/h|nr																	
200 dia rising main		m	0.14				0		0					0					
160 dia rising main		m	0.076				0		0					0					
100 dia rising main		m	0.047	3000		0	141		0					0					
75 dia rising main		m	0.037				0		0					0					
100m3 resr x 15m		m3	170				0		0					0					
120 m3 resr		m3	43	1			43		0					0					
60 m3 resr		m3	22	1			22		0					0					
200 dia Trunk mains		m	0.14				0		0					0					
160 dia Trunk mains		m	0.076	1000			76		0					0					
110 dia Trunk mains		m	0.047				0		0					0					
Housing			36.0	1			36												
Prelims & General			22.5%				128	0	32	0	0	0	0	21	0	0	12	0	6
Contingencies			21%				148	0	36	0	0	0	0	24	0	0	14	0	7
TOTAL CAPITAL COSTS							842	0	203	0	0	0	0	138	0	0	82	0	41
Distribution and connections			182					15	15	15	15	15	15	15	15	15	15	15	15
Cumulative investments							842	842	1060	1060	1060	1060	1060	1168	1168	1168	1270	1270	1311
OPERATION AND MAINTENANCE COSTS		MK x 1,000																	
Power head=	60	K/kWh=	0.15					3	4	4	5	5	6	6	7	7	8	8	9
Chemicals	Cl	K/m3=	0.018					1	1	1	1	2	2	2	2	2	2	3	3
Labour		K/m3=	0.04					2	2	3	3	4	4	4	5	5	5	6	6
Maintenance co		0.25%	0.02					3	4	4	4	4	5	5	5	6	6	6	6
TOTAL OPERATION AND MAINTENANCE COSTS								9	11	12	13	15	16	18	19	20	22	23	24
TOTAL CASH OUTFLOWS x 1000							842	26	234	27	28	30	31	171	34	36	118	38	80
NET CASH FLOWS x 1000							-842	-26	-234	-27	-28	-30	-31	-171	-34	-36	-118	-38	-80
Cummulative Cash Flow x 1000							-842	-867	-1101	-1128	-1157	-1187	-1218	-1389	-1424	-1463	-1578	-1616	-1696
Expenditure already committed x 1000							85												
Discounted consumption (m3) x 1,000 at						12%	478	AIC O&M costs				0.20							
Discounted cash outflow (MK x 1,000) at						12%	1168	Average Incremental Costs MK/m3				2.43							

2 - NKHOTAKOTA			1987	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
POPULATION x 1000		4.2%	12.1	13.7	14.3	14.9	15.5	16.2	16.9	17.6	18.3	19.1	19.9	20.7	21.6	22.5	23.5	24.6	25.6
Pop. dist'n	Low		2%	2%	2.2%	2.4%	2.6%	2.8%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.2%	3.4%	3.6%	3.8%	4.0%
	Med		8%	8%	8%	8%	8%	8%	8%	8%	8%	10%	10%	10%	10%	10%	11%	11%	11%
	High		10%	12%	12%	12%	13%	13%	13%	13%	13%	14%	14%	14%	14%	14%	15%	15%	16%
	Trad		80%	78%	77%	77%	76%	76%	76%	76%	74%	74%	73%	73%	72%	72%	71%	71%	70%
Consumption	Low	lcd	200	200	203	206	209	212	216	218	221	224	227	230	234	238	242	246	250
	Med		160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160
	High		76	80	81	81	82	82	83	84	84	85	86	86	87	88	88	89	100
	Trad		26	27	27	27	28	28	28	28	28	29	29	29	29	29	30	30	30
Domestic demand		m3/d	623	668	700	746	792	842	888	946	998	1063	1111	1172	1248	1326	1409	1498	1592
Institutional Y =	0.86	m3/d	244	273	283	294	306	318	330	343	358	370	386	400	416	432	450	467	486
Commerce Y =	1.8	m3/d	84	125	137	148	161	173	187	201	215	230	246	262	279	297	315	336	356
TOTAL DEMAND		m3/d	866	1066	1120	1187	1258	1333	1412	1489	1569	1663	1742	1834	1942	2055	2174	2300	2433
Consumption		m3/d	668	807	959	872	1059	1151	1246	1340	1436	1537	1642	1761	1876	2005	2141	2284	2433
Losses			1.7%	8.4%	6.8%	7.2%	7.6%	8.0%	8.4%	8.6%	8.8%	9.0%	9.2%	9.4%	9.6%	9.6%	9.8%	9.9%	10%
Peak	1.25	m3/d	722	1073	1186	1302	1426	1564	1689	1818	1954	2086	2242	2386	2557	2743	2937	3137	3346
Existing Prod Cap'y		m3/d	858	788															
Existing Storage		m3	660																
Production required		m3/d					239		648					906					
Production supplied		m3/d					396		694					880					
Storage required		m3	(4 hr)						none										
Inc. Production		m3/yr x 1000					206	243	282	320	360	401	444	488	539	592	647	705	766
Inc. consumption		m3/yr x 1000					179	213	249	282	317	364	382	432	477	534	574	626	681

INVESTMENT COSTS				Quantities			INVESTMENT COSTS							MK x 1,000					
		Unit	Rate	Ph 1	Ph 2	Ph 3	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Recent B/hs	188	m3/d | nr	17.5	4			70												
Boreholes @	188	m3/d | nr	17.5	2	3	5	35		52.5					87.5					
Unsuccessful	60%	nr	6.9	1	2	3	6.9		13.8					20.7					
Pumping St'ns		nr	7.1	2	3	5	14.2		21.3					35.5					
Pump & Mtr	3.0	kW | nr	6.7	6	3	5	40.2		20.1					33.5			40.2		20.1
Dosing Equipment		nr	5	2	1	1	10		5					5			10		5
Installation		nr	4	6	3	5	24		12					20			24		12
Spares		nr	1.8	6	3	5	10.8		5.4					9					
T.Wks		m3/h | nr																	
200 dia rising main		m	0.14	400			56		0					0					
160 dia rising main		m	0.076	0			0		0					0					
100 dia rising main		m	0.047	0		0	0		0					0					
75 dia rising main		m	0.037	400			14.8		0					0					
100m3 resr x 16m		m3	170	1			170		0					0					
75 m3 resr'		m3	33	0			0		0					0					
30 m3 resr'		m3	26	0			0		0					0					
200 dia Trunk mains		m	0.14	3400			476		0					0					
160 dia Trunk mains		m	0.076	3500			266		0					0					
110 dia Trunk mains		m	0.047	2400			113		0					0					
Housing			36.0	1			36												
Prelims & General			25.0%				336	0	33	0	0	0	0	63	0	0	18	0	9
Contingencies			21%				351	0	34	0	0	0	0	65	0	0	19	0	10
TOTAL CAPITAL COSTS							2024	0	197	0	0	0	0	318	0	0	112	0	68
Distribution and connections			3273					273	273	273	273	273	273	273	273	273	273	273	273
Cumulative investments							2024	2024	2221	2221	2221	2221	2221	2640	2640	2640	2652	2652	2709
OPERATION AND MAINTENANCE COSTS				MK x 1,000															
Power head=	60	K/kWh=	0.16					12	14	15	17	19	21	23	26	28	31	34	37
Chemicals	Cl	K/m3=	0.018					4	6	6	6	7	8	9	10	11	12	13	14
Labour		K/m3=	0.04					10	11	13	14	16	18	19	21	23	26	28	30
Maintenance co		0.25%	0.02					10	11	12	13	14	14	16	17	18	20	21	22
TOTAL OPERATION AND MAINTENANCE COSTS								36	41	46	51	56	61	68	74	81	88	96	103
TOTAL CASH OUTFLOWS x 1000							2024	309	511	318	324	329	334	660	347	354	473	368	432
NET CASH FLOWS x 1000							-2024	-309	-511	-318	-324	-329	-334	-660	-347	-354	-473	-368	-432
Cummulative Cash Flow x 1000							-2024	-2333	-2844	-3163	-3488	-3816	-4150	-4810	-5157	-5511	-5984	-6353	-6785
Expenditure already committed x 1000							160												
Discounted consumption (m3 x 1,000) at						12%	2218	AIC O&M				0.16							
Discounted cash outflow (MK x 1,000) at						12%	3567	Average Incremental Costs MK/m3				1.78							

4 - DOWA			1987	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
POPULATION x 1000		2.0%	2.7	2.8	2.8	3.0	3.0	3.1	3.2	3.2	3.3	3.4	3.4	3.5	3.6	3.6	3.7	3.8	3.8
Pop. dist'n	Low		0%	0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.4%	0.6%	0.8%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
	Med		7%	8%	8%	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%	9%	10%	10%	10%
	High		18%	19%	19%	20%	20%	21%	21%	21%	21%	22%	22%	22%	22%	22%	23%	23%	23%
	Trad		76%	73%	73%	72%	72%	71%	71%	70%	70%	69%	69%	68%	68%	67%	67%	66%	66%
Consumption	Low	lcd	200	200	203	206	209	212	216	218	221	224	227	230	234	238	242	246	250
	Med		160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160
	High		76	80	81	81	82	82	83	84	84	85	86	86	87	88	88	89	100
	Trad		26	27	27	27	28	28	28	28	28	28	29	29	28	29	30	30	30
Domestic demand		m3/d	118	140	144	149	163	158	163	169	176	183	181	196	206	211	218	226	233
Institutional Y =	0.83	m3/d	167	161	163	164	166	167	169	170	172	174	176	177	179	181	182	194	188
Commerce Y =	1.8	m3/d	17	21	22	23	25	26	28	29	31	32	34	36	37	39	40	42	44
TOTAL DEMAND		m3/d	290	322	329	336	344	361	369	369	379	389	400	410	420	431	441	462	463
Consumption		m3/d	166	218	232	246	261	276	290	307	323	341	368	376	383	410	427	446	463
Losses			1.7%	9.4%	8.9%	7.2%	7.6%	8.0%	8.4%	8.8%	9.8%	8.0%	8.2%	8.4%	8.6%	9.8%	9.9%	9.9%	10%
Peak	1.26	m3/d	210	280	310	330	351	372	393	416	440	464	489	514	538	562	586	611	636
Existing Prod Cap'y		m3/d	394	126															
Existing Storage		m3	114																
Production required		m3/d					0		94					77					
Production supplied		m3/d					0		130					130					
Storage required		m3	(4 hr)						none										
Inc. Production		m3/yr x 1000					41	47	64	60	67	74	81	88	96	103	110	117	126
Inc. consumption		m3/yr x 1000					36	40	48	62	68	64	70	77	83	89	98	102	109

INVESTMENT COSTS				Quantities			INVESTMENT COSTS							MK x 1,000					
		Unit	Rate	Ph 1	Ph 2	Ph 3	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Recent B/hs	126	m3/d|nr	17.6	1			17.6												
Boreholes @	64.8	m3/d|nr	17.6	0	2	2	0		36					36					
Unsuccessful	38%	nr	6.9	0	3	3	0		20.7					20.7					
Pumping St'ns		nr	7.1	0	2	2	0		14.2					14.2					
Pump & Mtr	1.1	kW | nr	5.1	1	2	2	5.1		10.2					10.2			5.1		10.2
Dosing Equipment		nr	6	1	1	1	6		6					6			6		6
Installation		nr	2.06	1	2	2	2.06		4.12					4.12			2.06		4.12
Spares		nr	1.5	1	2	2	1.5		3					3					
T.Wks		m3/h|nr																	
200 dia rising main		m	0.14				0		0					0					
150 dia rising main		m	0.076				0		0					0					
100 dia rising main		m	0.047	5000		0	236		0					0					
75 dia rising main		m	0.037				0		0					0					
100m3 resr x 15m		m3	170				0		0					0					
120 m3 resr'		m3	43				0		0					0					
50 m3 resr'		m3	26	1			26		0					0					
200 dia Trunk mains		m	0.14				0		0					0					
150 dia Trunk mains		m	0.076				0		0					0					
110 dia Trunk mains		m	0.047	1600			76		0					0					
Housing			36.0	1			36												
Prelims & General			21.6%				87	0	20	0	0	0	0	20	0	0	3	0	4
Contingencies			21%				103	0	24	0	0	0	0	24	0	0	3	0	5
TOTAL CAPITAL COSTS							682	0	136	0	0	0	0	136	0	0	19	0	28
Distribution and connections			140					12	12	12	12	12	12	12	12	12	12	12	12
Cumulative investments							682	682	727	727	727	727	727	863	863	863	861	881	908
OPERATION AND MAINTENANCE COSTS				MK x 1,000															
Power head=	66	K/kWh=	0.16					2	3	3	4	4	4	6	6	6	8	8	7
Chemicals	Cl	K/m3=	0.016					1	1	1	1	1	1	2	2	2	2	2	2
Labour		K/m3=	0.04					2	2	2	3	3	3	4	4	4	4	5	6
Maintenance cc		0.25%	0.02					2	3	3	3	3	3	4	4	4	4	6	6
TOTAL OPERATION AND MAINTENANCE COSTS								8	9	10	11	11	12	14	15	16	17	17	18
TOTAL CASH OUTFLOWS x 1000							682	20	157	22	23	24	26	162	27	28	47	30	69
NET CASH FLOWS x 1000							-682	-20	-157	-22	-23	-24	-26	-162	-27	-28	-47	-30	-69
Cummulative Cash Flow x 1000							-692	-612	-769	-790	-813	-837	-862	-1023	-1050	-1079	-1126	-1166	-1214
Expenditure already committed x 1000							32												
Discounted consumption (m3 x 1,000) at						8%	603	AIC O&M costs				0.17							
Discounted cash outflow (MK x 1,000) at						8%	919	Average Incremental Costs MK/m3				1.81							

SALIMA			1987	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
POPULATION x 1000		4.1%	10.6	12.0	12.6	13.0	13.5	14.1	14.6	15.2	15.8	16.5	17.2	17.8	18.6	19.4	20.2	21.0	21.8
Pop. dist'n	Low		7%	8%	9.2%	8.4%	8.8%	8.8%	9.0%	9.2%	9.4%	9.6%	9.8%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
	Med		18%	18%	18%	18%	18%	18%	19%	18%	19%	19%	19%	19%	19%	19%	20%	20%	20%
	High		21%	22%	22%	22%	23%	23%	23%	23%	23%	24%	24%	24%	24%	24%	25%	25%	25%
	Trad		64%	62%	61%	61%	60%	60%	49%	49%	48%	48%	47%	47%	47%	46%	46%	46%	46%
Consumption	Low	lcd	200	200	203	206	209	212	215	218	221	224	227	230	234	238	242	246	260
	Med		160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160
	High		76	80	81	81	82	82	83	84	84	85	86	86	87	88	89	89	100
	Trad		26	27	27	27	28	28	29	28	28	29	29	29	29	28	30	30	30
Domestic demand		m3/d	746	819	872	1029	1086	1148	1213	1278	1347	1420	1496	1577	1661	1750	1843	1941	2044
Institutional Y =	1.1	m3/d	36	40	42	44	46	49	51	53	56	58	61	64	67	70	73	76	79
Commerce Y =	1.75	m3/d	187	246	267	288	312	338	361	387	414	442	472	502	534	567	601	637	676
TOTAL DEMAND		m3/d	967	1205	1281	1361	1446	1535	1626	1718	1817	1920	2029	2142	2262	2386	2517	2654	2798
Consumption		m3/d	646	864	863	1056	1163	1276	1381	1508	1630	1766	1888	2026	2169	2316	2470	2631	2788
Losses			1.7%	8.4%	6.6%	7.2%	7.6%	8.0%	8.4%	8.8%	8.8%	9.0%	9.2%	9.4%	9.5%	9.6%	9.8%	9.8%	10%
Peak	1.26	m3/d	693	1135	1272	1416	1585	1721	1886	2047	2217	2383	2577	2769	2966	3174	3389	3613	3847
Existing Prod Cap'y		m3/d	888	0															
Existing Storage		m3	227																
Production required		m3/d					1219		883					1021					
Production supplied		m3/d					1440		720					1080					
Storage required		m3	(4 hr)						288										
Inc. Production		m3/yr x 1000					266	300	343	386	446	487	550	606	684	726	787	853	921
Inc. consumption		m3/yr x 1000					229	269	309	362	398	442	490	540	592	646	703	761	822

INVESTMENT COSTS				Quantities			INVESTMENT COSTS								MK x 1,000				
		Unit	Rate	Ph 1	Ph 2	Ph 3	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Recent B/Hs	0	m3/d/nr	17.5				0												
Boreholes @	360	m3/d/nr	17.5	4	2	3	70		35					52.5					
Unsuccessful	40%	nr	6.9	4	2	3	27.6		13.8					20.7					
Pumping St'ns		nr	7.1	4	2	3	28.4		14.2					21.3					
Pump & Mtr	6.4	kW / nr	8.6	4	2	3	34.4		17.2					25.8			34.4		17.2
Dosing Equipment		nr	6	1	1	1	6		6					6			6		6
Installation		nr	2.43	4	2	3	9.72		4.86					7.29			9.72		4.86
Spares		nr	2	4	2	3	8		4					6					
Tanks		m3/h/nr																	
200 dia rising main		m	0.14				0		0					0					
160 dia rising main		m	0.076				0		0					0					
100 dia rising main		m	0.047	100		0	4.7		0					0					
75 dia rising main		m	0.037				0		0					0					
300 m3 Reservoir		nr	120	1			120		0					0					
		nr					0		0					0					
250 dia Trunk mains		m	0.18	400			72		0					0					
200 dia Trunk mains		m	0.14	3500			490		0					0					
160 dia Trunk mains		m	0.076	4200			319		0					0					
110 dia Trunk mains		m	0.047	800			38		0					0					
Housing			36.0	1			36												
Prelims & General			24.3%				306	0	23	0	0	0	0	34	0	0	12	0	7
Contingencies			21%				328	0	26	0	0	0	0	36	0	0	13	0	7
TOTAL CAPITAL COSTS							1881	0	141	0	0	0	0	209	0	0	74	0	41
Distribution and connections			1750					148	148	148	148	148	148	148	148	148	148	148	148
Cumulative investments							1881	1881	2033	2033	2033	2033	2033	2241	2241	2241	2316	2316	2356
OPERATION AND MAINTENANCE COSTS	MK x 1,000																		
Power head=	60	K/kWh=	0.15					14	17	19	21	24	26	29	32	35	38	41	44
Chemicals	Cl	K/m3=	0.015					6	6	7	8	9	10	11	12	13	14	16	17
Labour		K/m3=	0.04					12	14	16	18	20	22	24	26	29	31	34	38
Maintenance co		0.25%	0.02					11	12	13	14	16	16	18	19	20	22	23	24
TOTAL OPERATION AND MAINTENANCE COSTS								42	49	56	61	67	74	82	89	97	106	113	122
TOTAL CASH OUTFLOWS x 1000							1881	195	338	201	207	213	220	436	235	242	324	269	308
NET CASH FLOWS x 1000							-1881	-195	-338	-201	-207	-213	-220	-436	-235	-242	-324	-269	-308
Cummulative Cash Flow x 1000							-1881	-2076	-2416	-2618	-2823	-3036	-3256	-3692	-3927	-4168	-4494	-4762	-5080
Expenditure already committed x 1000							0												
Discounted consumption (m3 x 1,000) at						8%	3663	A/C O&M costs				0.14							
Discounted cash outflow (MK x 1,000) at						8%	3661	Average Incremental Costs MK/m3....				0.99							

9 - DEDZA			1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
POPULATION x 1000		5.0%	18.7	19.4	20.3	21.4	22.4	23.5	24.7	26.0	27.3	28.6	30.1	31.6	33.1	34.8	36.5	38.4	40.3
Pop. dist'n	Low		2%	2%	2.2%	2.4%	2.6%	2.8%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.2%	3.4%	3.6%	3.8%	4.0%
	Med		8%	11%	11%	11%	12%	12%	12%	12%	13%	13%	14%	14%	14%	16%	16%	16%	16%
	High		11%	23%	21%	20%	18%	17%	16%	16%	16%	18%	17%	17%	18%	18%	18%	19%	20%
	Tred		78%	74%	73%	72%	72%	71%	70%	69%	68%	67%	66%	65%	64%	63%	62%	61%	60%
Consumption	Low	lcd	200	200	203	206	209	212	216	218	221	224	227	230	234	236	242	246	250
	Med		160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160
	High		76	80	81	81	82	82	83	84	84	86	86	88	87	88	89	89	100
	Tred		26	27	27	27	28	28	28	28	28	29	28	29	29	29	30	30	30
Domestic demand		m3/d	767	1186	1232	1280	1330	1381	1434	1632	1638	1747	1866	1990	2148	2316	2497	2692	2900
Institutional Y =	0.86	m3/d	114	132	138	146	153	160	168	177	186	196	204	216	225	236	248	261	274
Commerce Y =	1.7	m3/d	86	130	143	156	171	186	201	216	236	253	272	292	313	336	358	383	408
TOTAL DEMAND		m3/d	966	1447	1613	1682	1663	1727	1804	1926	2067	2186	2341	2497	2686	2888	3104	3336	3682
Consumption		m3/d	382	869	1067	1167	1270	1375	1456	1638	1801	1872	2160	2337	2565	2792	3040	3303	3682
Losses			1.7%	8.4%	6.8%	7.2%	7.6%	8.0%	8.4%	8.8%	8.8%	9.0%	9.2%	9.4%	9.6%	9.8%	9.8%	9.9%	10%
Peak	1.25	m3/d	486	1288	1424	1564	1709	1855	2012	2226	2450	2658	2835	3186	3602	3827	4171	4637	4926
Existing Prod Cap'y		m3/d	274	361															
Existing Storage		m3	407																
Production required		m3/d					1337		1148					2874					
Production supplied		m3/d					1426		0					0					
Storage required		m3	(4 hr)						260										
Inc. Production		m3/yr x 1000					363	387	442	604	670	638	712	788	877	872	1072	1178	1293
Inc. consumption		m3/yr x 1000					321	369	399	466	614	677	642	710	781	878	967	1082	1184

INVESTMENT COSTS				Quantities			INVESTMENT COSTS								MK x 1,000				
COMBINED SCHEME		Unit	Rate	Ph 1	Ph 2	Ph 3	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Recent B'hs	117	m3/d/nr	17.5	5			62.5												
Boreholes @	64.8	m3/d/nr	17.5	22	0	0	385		0					0					
Unsuccessful	38%	nr	6.9	39	0	0	249.4		0					0					
Pumping St'ns		nr	7.1	22	0	0	156.2		0					0					
Pump & Mtr	3.1	kW | nr	8.7	25	0	0	187.5		0					0			187.5		
Dosing Equipment		nr	6	6	3	0	25		15					0			25		
Dam			886		1				886										
Intake & PS			82.4		1				82										
T.Wks	118.8	m3/h|nr	669.1		1				669										
Pump&Mtr	26.09	kW | nr	40.12		3				120										
Installation		nr	2.28	25	3	0	57		7					0			57		
Spares		nr	1.8	25	3	0	45		5.4					0					
200 dia rising main		m	0.14	4020			571.2		0					0					
75 dia rising main		m	0.037	3750			138.85		0					0					
150 m3 Reservoir		nr	65	1			65		0					0					
75 m3 Reservoir		nr	32	1			32		0					0					
30 m3 Reservoir		nr	24.79	1			24.79		0					0					
200 dia Trunk mains		m	0.14	760			106		0					0					
150 dia Trunk mains		m	0.076	3880			295		0					0					
110 dia Trunk mains		m	0.047	3180			149		0					0					
Housing			35.0	1			35												
Prelims & General			22.5%				673	0	426	0	0	0	0	0	0	0	68	0	0
Contingencies			21%				668	0	487	0	0	0	0	0	0	0	64	0	0
TOTAL CAPITAL COSTS							3778	0	2807	0	0	0	0	0	0	0	370	0	0
Distribution and connections			2036					170	170	170	170	170	170	170	170	170	170	170	170
Cumulative investments							3778	3778	6585	6585	6585	6585	6585	6585	6585	6585	6955	6955	6955
OPERATION AND MAINTENANCE COSTS				MK x 1,000															
Power head=	160	K/kWh=	0.15					61	68	77	87	96	109	121	136	149	164	181	198
Chemicals	Cl	K/m3=	0.018	Full	K/m3=	0.159		7	8	24	37	50	63	78	86	113	132	162	173
Labour		K/m3=	0.04					16	19	20	23	26	28	31	36	38	42	47	51
Maintenance co		0.25%	0.02					17	25	27	28	29	31	32	34	36	38	41	43
TOTAL OPERATION AND MAINTENANCE COSTS								101	119	148	174	202	231	262	296	336	377	420	466
TOTAL CASH OUTFLOWS x 1000							3778	271	3096	318	344	372	401	432	466	506	917	590	636
NET CASH FLOWS x 1000							-3778	-271	-3096	-318	-344	-372	-401	-432	-466	-506	-917	-590	-636
Cummulative Cash Flow x 1000							-3778	-4049	-7144	-7462	-7806	-8178	-8579	-9011	-9478	-9984	-10901	-11491	-12126
Expenditure already committed x 1000							245												
Discounted consumption (m3 x 1,000) at						12%	3691	AIC O&M costs				0.33							
Discounted cash outflow (MK x 1,000) at						12%	7626	Average Incremental Costs MK/m3				2.07							

7 - NAMWERA			1987	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
POPULATION x 1000		4.4%		2.2	2.3	2.4	2.5	2.6	2.7	2.8	3.0	3.1	3.2	3.4	3.5	3.7	3.8	4.0	4.2
Pop. dist'n	Low			6%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
	Med			7%	7%	7%	7%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%
	High			20%	20%	20%	21%	21%	21%	21%	21%	22%	22%	22%	22%	22%	23%	23%	23%
	Trad			68%	68%	67%	67%	67%	66%	66%	66%	65%	65%	65%	64%	64%	64%	63%	63%
Consumption	Low	lcd		200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
	Med			160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160
	High			76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76
	Trad			30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Domestic demand		m3/d		123	128	136	142	149	156	164	172	180	189	193	208	218	228	240	251
Institutional Y =	1.05	m3/d		30	31	33	36	38	38	40	42	44	46	43	60	63	65	63	60
Commerce Y =	1.1	m3/d		16	18	20	21	22	23	24	26	27	28	30	31	33	34	36	38
TOTAL DEMAND		m3/d		171	178	188	198	207	218	228	239	251	263	276	289	303	318	334	360
Consumption		m3/d		171	178	188	198	207	218	228	238	251	263	276	288	303	318	334	360
Losses				6.4%	6.8%	7.2%	7.6%	8.0%	8.4%	8.6%	8.8%	9.0%	9.2%	9.4%	9.6%	9.8%	9.9%	9.9%	10%
Peak	1.25	m3/d		227	240	252	266	280	296	310	326	342	359	377	396	416	436	458	481
Existing Prod Cap'y		m3/d	187	0															
Existing Storage		m3	80																
Production required		m3/d					108		61					39					
Production supplied		m3/d					130		65					130					
Storage required		m3	(4 hr)						none										
Inc. Production		m3/yr x 1000					73	82	88	90	95	100	106	110	116	121	127	134	140
Inc. consumption		m3/yr x 1000					72	76	79	83	87	92	96	101	106	111	116	122	128

INVESTMENT COSTS				Quantities			INVESTMENT COSTS							MK x 1,000					
		Unit	Rate	Ph 1	Ph 2	Ph 3	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Recent B/hs	0	m3/d/nr	17.5	0			0												
Boreholes @	64.8	m3/d/nr	17.5	2	1	2	35		17.5					35					
Unsuccessful	38%	nr	6.9	3	2	3	20.7		13.8					20.7					
Pumping St'ns		nr	7.1	2	1	2	14.2		7.1					14.2					
Pump & Mtr	1.1	kW / nr	5.1	2	1	2	10.2		5.1					10.2			10.2		5.1
Dosing Equipment		nr	6	1		1	6		0					6			6		0
Installation		nr	4.24	2	1	2	8.48		4.24					8.48			8.48		4.24
Spares		nr	1.5	2	1	2	3		1.5					3					
T.Wks		m3/h/nr																	
200 dia rising main		m	0.14				0		0					0					
150 dia rising main		m	0.076				0		0					0					
100 dia rising main		m	0.047	800		0	37.6		0					0					
75 dia rising main		m	0.037				0		0					0					
150 m3 Reservoir		nr	66				0		0					0					
75 m3 Reservoir		nr	32				0		0					0					
30 m3 Reservoir		nr	24.78				0		0					0					
200 dia Trunk mains		m	0.14				0		0					0					
160 dia Trunk mains		m	0.076				0		0					0					
110 dia Trunk mains		m	0.047	1600			75		0					0					
Housing			35.0	1			35												
Prelims & General			26.0%				61	0	12	0	0	0	0	24	0	0	6	0	2
Contingencies			21%				64	0	13	0	0	0	0	26	0	0	6	0	2
TOTAL CAPITAL COSTS							370	0	74	0	0	0	0	146	0	0	36	0	14
Distribution and connections			380					33	33	33	33	33	33	33	33	33	33	33	33
Cumulative investments							370	370	444	444	444	444	444	650	690	690	626	626	840
OPERATION AND MAINTENANCE COSTS				MK x 1,000															
Power head=	55	K/kWh=	0.16					4	6	6	6	6	6	6	6	6	7	7	7
Chemicals	Cl	K/m3=	0.018					1	2	2	2	2	2	2	2	2	2	2	3
Labour		K/m3=	0.04					3	3	4	4	4	4	4	6	6	6	6	6
Maintenance co		0.26%	0.02					3	3	3	3	3	3	4	4	4	4	4	4
TOTAL OPERATION AND MAINTENANCE COSTS								12	12	13	13	14	15	16	17	17	18	19	20
TOTAL CASH OUTFLOWS x 1000							370	44	118	46	46	47	47	184	48	50	86	61	67
NET CASH FLOWS x 1000							-370	-44	-118	-46	-46	-47	-47	-184	-48	-50	-86	-61	-67
Cummulative Cash Flow x 1000							-370	-414	-533	-578	-624	-671	-718	-913	-962	-1012	-1098	-1160	-1216
Expenditure already committed x 1000							0												
Discounted consumption (m3 x 1,000) at						12%	652	AIC O&M costs				0.14							
Discounted cash outflow (MK x 1,000) at						12%	718	Average Incremental Costs MK/m3				1.23							

8 - BALAKA				1987	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
POPULATION x 1000			6.5%	8.1	11.0	11.7	12.4	13.3	14.1	15.0	16.0	17.0	18.2	19.3	20.6	21.9	23.4	24.9	26.5	28.2
Pop. dist'n	Low			6%	6%	6.2%	6.4%	5.8%	5.8%	6.0%	6.2%	6.4%	6.6%	6.8%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%
	Med			20%	20%	20%	20%	18%	18%	18%	18%	18%	18%	18%	18%	18%	18%	18%	18%	18%
	High			25%	27%	27%	28%	28%	28%	29%	30%	30%	31%	31%	32%	33%	33%	34%	34%	35%
	Trad			50%	48%	48%	47%	47%	46%	46%	46%	46%	44%	44%	43%	42%	42%	41%	41%	40%
Consumption	Low	lcd		200	200	203	206	208	212	215	218	221	224	227	230	234	238	242	246	260
	Med			160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160
	High			75	80	81	81	82	82	83	84	84	85	86	86	87	88	88	89	100
	Trad			26	27	27	27	28	28	28	28	28	29	29	29	28	28	30	30	30
Domestic demand		m3/d		647	847	912	981	1066	1136	1221	1316	1418	1629	1649	1777	1916	2063	2224	2396	2681
Institutional Y =	1	m3/d		63	78	81	88	92	98	104	111	118	126	134	143	162	162	173	184	198
Commerce Y =	1.8	m3/d		439	851	732	817	902	1005	1109	1218	1336	1460	1583	1734	1885	2046	2216	2393	2691
TOTAL DEMAND		m3/d		1149	1676	1724	1884	2066	2238	2434	2646	2872	3116	3376	3654	3961	4270	4612	4877	5368
Consumption		m3/d		838	1316	1492	1668	1848	2048	2261	2480	2734	2984	3271	3567	3882	4218	4577	4960	5368
Losses				1.7%	8.4%	8.8%	7.2%	7.6%	8.0%	8.4%	8.8%	8.8%	9.0%	9.2%	9.4%	9.6%	9.8%	9.8%	9.8%	10%
Peak	1.26	m3/d		1066	1749	1878	2223	2486	2764	3064	3360	3718	4078	4466	4878	5315	5781	6220	6612	7381
Existing Prod Capy		m3/d		518	270	<-- Recent borehole capacity														
Existing Storage		m3		671																
Production required		m3/d		-------------------->				2278		1880					2273					
Production supplied		m3/d		-------------------->				2430		1890					2430					
Storage required		m3	(4 hr)	------------------------------>						413										
Inc. Production		m3/yr x 1000						416	496	684	878	776	880	893	1113	1241	1377	1623	1878	1844
Inc. consumption		m3/yr x 1000						369	442	619	603	692	787	888	996	1111	1234	1385	1504	1664

INVESTMENT COSTS				Quantities			INVESTMENT COSTS							MK x 1,000					
		Unit	Rate	Ph 1	Ph 2	Ph 3	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Recent B/hs	270	m3/d/nr	17.5	1			17.5												
Boreholes	270	m3/d/nr	17.5	9	7	9	167.5		122.5					167.5					
Unsuccessful	55%	nr	6.9	7	6	7	48.3		41.4					48.3					
Pumping St'ns		nr	7.1	9	7	9	63.9		49.7					63.9					
Pump & Mtr	8.6	kW / nr	9.6	10	7	3	96		66.6					38.6			96		66.6
Dosing Equipment		nr	5	2	2	2	10		10					10			10		10
Installation		nr	2.73	10	7	9	27.3		19.11					24.57			27.3		19.11
Spares		nr	2.2	10	7	9	22		15.4					19.8					
T/Wks		m3/h/nr																	
200 dia rising main		m	0.14	3000			420		0					0					
150 dia rising main		m	0.075	1000			75		0					0					
100 dia rising main		m	0.047	2000		0	94		0					0					
75 dia rising main		m	0.037				0		0					0					
150 m3 Reservoir		nr	55	2			110		0					0					
75 m3 Reservoir		nr	32				0		0					0					
30 m3 Reservoir		nr	24.72				0		0					0					
200 dia Trunk mains		m	0.14	3520			493		0					0					
160 dia Trunk mains		m	0.075	4800			360		0					0					
110 dia Trunk mains		m	0.047	6600			310		0					0					
Housing			35.0	1			35												
Prelims & General			24.0%				661	0	73	0	0	0	0	99	0	0	32	0	23
Contingencies			21%				609	0	85	0	0	0	0	107	0	0	34	0	26
TOTAL CAPITAL COSTS							3609	0	487	0	0	0	0	616	0	0	193	0	143
Distribution and connections			2244					187	187	187	187	187	187	187	187	187	187	187	187
Cumulative investments							3608	3608	3896	3896	3896	3896	3896	4610	4810	4810	4809	4809	4952
OPERATION AND MAINTENANCE COSTS MK x 1,000																			
Power head=	80	K/kWh=	0.16					38	46	52	59	67	76	86	95	106	117	129	141
Chemicals	Cl	K/m3=	0.016					9	11	12	14	16	18	20	22	25	27	30	33
Labour		K/m3=	0.04					20	25	27	31	36	39	44	49	55	60	66	73
Maintenance co		0.25%	0.02					18	22	24	26	28	30	34	38	38	42	48	48
TOTAL OPERATION AND MAINTENANCE COSTS								85	100	114	130	146	163	183	203	224	247	271	297
TOTAL CASH OUTFLOWS x 1000							3609	272	774	301	317	333	360	896	390	411	632	468	627
NET CASH FLOWS x 1000							-3609	-272	-774	-301	-317	-333	-360	-896	-390	-411	-632	-468	-627
Cummulative Cash Flow x 1000							-3609	-3781	-4555	-4856	-5173	-5506	-5866	-6841	-7231	-7642	-8274	-8732	-9360
Expenditure already committed x 1000							40												
Discounted consumption (m3 x 1,000) at						12%	4896	AIC O&M costs				0.17							
Discounted cash outflow (MK x 1,000) at						12%	6713	Average incremental Costs MK/m3				1.16							

B - CHIKWAWA			1987	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
POPULATION x 1000		2.3%	4.3	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.5	5.6	5.7	5.8	6.0	6.1	6.3	6.4	6.5
Pop. dist'n	Low		2%	2%	2.2%	2.4%	2.6%	2.8%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
	Med		10%	10%	10%	10%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	12%	12%	12%
	High		19%	19%	19%	19%	19%	19%	19%	19%	19%	19%	19%	19%	19%	19%	20%	20%	20%
	Trad		70%	69%	69%	68%	68%	67%	67%	67%	67%	66%	66%	66%	66%	66%	66%	65%	65%
Consumption	Low	lcd	200	200	203	206	208	212	215	218	221	224	227	230	234	238	242	246	250
	Med		160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160
	High		76	80	81	81	82	82	83	84	84	85	86	86	87	88	88	89	100
	Trad		26	27	27	27	28	28	28	28	28	29	29	29	29	29	30	30	30
Domestic demand		m3/d	217	266	266	276	288	298	308	318	327	336	346	356	368	382	398	410	426
Institutional Y =	0.8	m3/d	80	82	83	84	86	86	88	87	88	89	90	91	92	93	94	95	96
Commerce Y =	1.4	m3/d	48	56	58	61	63	66	69	72	76	78	81	84	87	91	94	98	101
TOTAL DEMAND		m3/d	345	392	406	420	434	448	466	477	490	503	516	530	545	566	584	603	623
Consumption		m3/d	200	271	293	316	338	361	384	405	426	447	468	490	515	541	568	596	623
Losses			1.7%	6.4%	6.8%	7.2%	7.6%	8.0%	8.4%	8.6%	8.8%	9.0%	9.2%	9.4%	9.6%	9.8%	9.9%	9.9%	10%
Peak	1.25	m3/d	264	361	381	422	464	487	521	543	578	608	639	670	705	742	778	817	856
Existing Prod Cap'y		m3/d	193	1090	<=Recent borehole capacity														
Existing Storage		m3	766																
Production required		m3/d	---->				0		0					0					
Production supplied		m3/d	---->				0		0					0					
Storage required		m3	(4 hr)	---->					none										
Inc. Production		m3/yr x 1000					68	68	78	86	95	103	112	121	132	142	153	164	176
Inc. consumption		m3/yr x 1000					60	69	67	76	82	90	98	108	116	125	134	144	164

INVESTMENT COSTS				Quantities			INVESTMENT COSTS							MK x 1,000					
		Unit	Rate	Ph 1	Ph 2	Ph 3	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Recent B/H	500	m3/d/nr	17.6	3			52.8												
Boreholes &		m3/d/nr	17.6	0	0	0	0		0					0					
Unsuccessful	0%	nr	8.9	0	0	0	0		0					0					
Pumping B'ne		nr	7.1	0	0	0	0		0					0					
Pump & Mtr	8.7	kW | nr	11.4	3	0	0	34.2		0					0			34.2		
Dosing Equipment		nr	6	1	0	0	6		0					0			6		
Installation		nr	1.88	3	0	0	5.64		0					0			5.64		
Spares		nr	2.5	3	0	0	7.5		0					0					
T.Wks		m3/h|nr																	
200 dia rising main		m	0.14				0		0					0					
160 dia rising main		m	0.075				0		0					0					
100 dia rising main		m	0.047			0	0		0					0					
75 dia rising main		m	0.037	1000			37		0					0					
150 m3 Reservoir		nr	66				0		0					0					
75 m3 Reservoir		nr	32				0		0					0					
50 m3 Reservoir		nr	24.72				0		0					0					
200 dia Trunk mains		m	0.14				0		0					0					
160 dia Trunk mains		m	0.075				0		0					0					
110 dia Trunk mains		m	0.047	3500			165		0					0					
Housing			35.0	1			35												
Prelims & General			21.0%				72	0	0	0	0	0	0	0	0	0	9	0	0
Contingencies			21%				87	0	0	0	0	0	0	0	0	0	11	0	0
TOTAL CAPITAL COSTS							600	0	0	0	0	0	0	0	0	0	66	0	0
Distribution and connections			410					34	34	34	34	34	34	34	34	34	34	34	34
Cumulative investments							600	600	600	600	600	600	600	600	600	600	666	666	666
OPERATION AND MAINTENANCE COSTS MK x 1,000																			
Power head=	50	K/kWh=	0.16					6	6	7	7	8	8	9	10	11	12	13	13
Chemicals	Cl	K/m3=	0.018					1	1	2	2	2	2	2	2	3	3	3	3
Labour		K/m3=	0.04					3	3	3	4	4	4	5	6	6	6	7	7
Maintenance co		0.25%	0.02					3	3	3	3	3	3	4	4	4	4	5	5
TOTAL OPERATION AND MAINTENANCE COSTS								12	13	15	16	17	19	20	22	23	25	27	29
TOTAL CASH OUTFLOWS x 1000							600	46	47	49	50	51	53	54	56	57	125	61	63
NET CASH FLOWS x 1000							-600	-46	-47	-49	-50	-51	-53	-54	-56	-57	-125	-61	-63
Cummulative Cash Flow x 1000							-600	-646	-694	-642	-692	-744	-796	-851	-906	-964	-1089	-1150	-1213
Expenditure already committed x 1000							84												
Discounted consumption (m3) x 1,000 at						12%	659	A/C O&M costs				0.16							
Discounted cash outflow (MK x 1,000) at						12%	763	Average Incremental Costs MK/m3				1.36							

10 - NCHALO			1987	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
POPULATION x 1000	3.2%		8.6	10.4	10.8	11.1	11.5	11.8	12.2	12.6	13.0	13.4	13.8	14.3	14.8	15.2	15.7	16.2	16.7
Pop. dist'n	Low		3%	3%	3.2%	3.4%	3.6%	3.8%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%
	Med		8%	8%	8%	9%	10%	10%	10%	10%	10%	11%	11%	11%	11%	11%	12%	12%	12%
	High		16%	16%	16%	16%	17%	17%	17%	17%	17%	18%	18%	18%	19%	19%	19%	19%	19%
	Trad		74%	72%	71%	71%	70%	70%	69%	69%	69%	68%	67%	67%	67%	66%	66%	65%	66%
Consumption	Low	lcd	200	200	203	206	209	212	215	218	221	224	227	230	234	238	242	246	250
	Med		160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160
	High		76	80	81	81	82	82	83	84	84	86	86	86	87	88	88	89	100
	Trad		26	27	27	27	28	28	28	28	28	28	28	29	29	29	30	30	30
Domestic demand		m3/d	464	567	588	617	648	683	718	760	784	818	856	893	934	976	1020	1066	1114
Institutional Y =	0.8	m3/d	164	162	166	169	171	174	178	181	185	188	192	196	200	204	208	213	217
Commerce Y =	1.6	m3/d	40	48	52	55	58	61	65	69	72	76	80	84	88	92	96	101	105
TOTAL DEMAND		m3/d	648	769	803	840	878	918	960	999	1040	1083	1127	1172	1221	1272	1326	1380	1437
Consumption		m3/d	137	342	406	471	538	609	677	744	813	884	956	1031	1109	1187	1268	1361	1437
Losses			1.7%	6.4%	6.8%	7.2%	7.6%	8.0%	8.4%	8.8%	8.8%	9.0%	9.2%	9.4%	9.6%	9.8%	9.8%	9.8%	10%
Peak	1.25	m3/d	174	456	641	631	723	818	917	1010	1109	1205	1306	1408	1516	1627	1740	1856	1876
Existing Prod Cap'y		m3/d	179	849	<--Recent borehole capacity														
Existing Storage		m3	108																
Production required		m3/d	---------->				93		316					341					
Production supplied		m3/d	---------->				270		640					640					
Storage required		m3	(4 hr) ---------->						164										
Inc. Production		m3/yr x 1000					160	188	217	244	272	301	330	361	392	424	457	491	526
Inc. consumption		m3/yr x 1000					149	171	197	222	247	273	299	326	364	383	413	443	474

INVESTMENT COSTS				Quantities			INVESTMENT COSTS							MK x 1,000					
		Unit	Rate	Ph 1	Ph 2	Ph 3	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Recent B/hs	324	m3/d|nr	17.5	2			35												
Boreholes @	270	m3/d|nr	17.6	1	2	2	17.6		35					35					
Unsuccessful	65%	nr	6.9	1	2	2	6.9		13.8					13.8					
Pumping St'ns		nr	7.1	1	2	2	7.1		14.2					14.2					
Pump & Mtr	4.5	kW | nr	7.9	3	2	2	23.7		15.8					15.8			23.7		15.8
Dosing Equipment		nr	6	1	1	1	6		6					6			6		6
Installation		nr	2.28	3	2	2	6.84		4.56					4.56			6.84		4.56
[illegible]		nr	1.9	3	2	2	5.7		3.8					3.8					
[illegible]		m3/h|nr																	
200 dia rising main		m	0.14				0		0					0					
160 dia rising main		m	0.075	2500			187.5		0					0					
100 dia rising main		m	0.047	2000		0	94		0					0					
75 dia rising main		m	0.037				0		0					0					
150 m3 Reservoir		nr	66	1			66		0					0					
75 m3 Reservoir		nr	32				0		0					0					
30 m3 Reservoir		nr	24.79				0		0					0					
200 dia Trunk mains		m	0.14				0		0					0					
160 dia Trunk mains		m	0.075	1500			113		0					0					
110 dia Trunk mains		m	0.047	3000			141		0					0					
Housing			35.0	1			35												
Prelims & General			22.5%				165	0	21	0	0	0	0	21	0	0	8	0	6
Contingencies			21%				188	0	24	0	0	0	0	24	0	0	9	0	7
TOTAL CAPITAL COSTS							1086	0	137	0	0	0	0	137	0	0	63	0	38
Distribution and connections			1034					86	86	86	86	86	86	86	86	86	86	86	86
Cumulative investments							1086	1086	1223	1223	1223	1223	1223	1368	1368	1368	1412	1412	1450
OPERATION AND MAINTENANCE COSTS				MK x 1,000															
Power head=	65	K/kWh=	0.16					10	11	13	14	16	17	19	21	22	24	26	28
Chemicals	Cl	K/m3=	0.018					3	4	4	5	5	6	6	7	8	8	8	8
Labour		K/m3=	0.04					7	8	10	11	12	13	14	16	17	18	19	21
Maintenance co		0.25%	0.02					6	7	8	8	8	10	11	11	12	13	13	14
TOTAL OPERATION AND MAINTENANCE COSTS								27	31	36	38	42	46	50	54	58	63	68	72
TOTAL CASH OUTFLOWS x 1000							1086	113	263	120	134	128	131	272	140	144	201	153	196
NET CASH FLOWS x 1000							-1086	-113	-263	-120	-134	-128	-131	-272	-140	-144	-201	-153	-196
Cummulative Cash Flow x 1000							-1086	-1199	-1462	-1572	-1696	-1824	-1955	-2227	-2367	-2511	-2712	-2865	-3060
Expenditure already committed x 1000							72												
Discounted consumption (m3 x 1,000) at						12%	1686	AIC O&M costs				0.36							
Discounted cash outflow (MK x 1,000) at						12%	1869	Average Incremental Costs MK/m3....				1.10							

11 - LUCHENZA			1987	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
POPULATION x 1000		3.5%	6.8	6.8	6.9	7.1	7.3	7.5	7.8	8.2	8.5	8.8	9.1	9.4	9.7	10.1	10.5	10.8	11.2
Pop. dist'n	Low		6%	6%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
	Med		16%	16%	16%	16%	17%	17%	17%	17%	18%	18%	18%	18%	18%	19%	20%	20%	20%
	High		16%	16%	16%	16%	17%	17%	17%	17%	18%	18%	19%	19%	19%	19%	20%	20%	20%
	Trad		66%	63%	63%	62%	62%	61%	61%	60%	60%	58%	58%	58%	57%	57%	56%	56%	56%
Consumption	Low	lcd	200	200	203	206	209	212	216	219	221	224	227	230	234	236	242	246	250
	Med		160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160
	High		76	80	81	81	82	82	83	84	84	85	86	86	87	88	88	89	100
	Trad		26	27	27	27	28	28	28	28	28	29	29	29	29	29	30	30	30
Domestic demand		m3/d	366	432	462	474	487	620	646	674	606	637	670	706	738	773	809	847	886
Institutional Y =	1	m3/d	24	27	28	29	30	31	32	33	34	36	37	38	39	41	42	44	46
Commerce Y =	1.04	m3/d	152	182	189	186	204	211	219	228	237	246	256	266	276	286	286	307	318
TOTAL DEMAND		m3/d	642	640	688	689	730	762	796	836	876	918	962	1009	1063	1099	1147	1198	1260
Consumption		m3/d	187	327	377	428	480	633	685	847	706	772	837	804	969	1037	1108	1177	1260
Losses			1.7%	6.4%	6.9%	7.2%	7.6%	8.0%	8.4%	8.6%	8.8%	9.0%	9.2%	9.4%	9.6%	9.8%	9.8%	9.9%	10%
Peak	1.25	m3/d	212	435	503	573	646	718	795	878	864	1062	1142	1238	1327	1421	1517	1517	1718
Existing Prod Cap'y		m3/d	131	612	<--Recent borehole capacity														
Existing Storage		m3	227																
Production required		m3/d	------>				63		429					468					
Production supplied		m3/d	------>				66		464					618					
Storage required		m3	(4 hr) ------>						2										
Inc. Production		m3/yr x 1000					126	148	171	186	219	246	272	299	326	363	381	410	440
Inc. consumption		m3/yr x 1000					114	134	164	176	199	221	246	269	293	317	343	368	396

INVESTMENT COSTS				Quantities			INVESTMENT COSTS							MK x 1,000					
		Unit	Rate	Ph 1	Ph 2	Ph 3	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Recent b/hs	306	m3/d | nr	17.5	2			35												
Boreholes @	64.3	m3/d | nr	17.5	1	7	8	17.5		122.5					140					
Unsuccessful	38%	nr	8.8	2	11	13	15.5		76.9					89.7					
Pumping St'ns		nr	7.1	1	7	8	7.1		49.7					56.8					
Pump & Mtr	1.2	kW | nr	5.2	3	7	8	15.6		36.4					41.6			15.6		36.4
Dosing Equipment		nr	5	1	2	2	5		10					10			5		10
Installation		nr	2.13	3	7	8	6.39		14.91					17.04			6.39		14.91
Spares		nr	1.5	3	7	8	4.5		10.5					12					
T/Wks		m3/h | nr																	
200 dia rising main		m	0.14				0		0					0					
160 dia rising main		m	0.076				0		0					0					
100 dia rising main		m	0.047			0	0		0					0					
75 dia rising main		m	0.037	1200			44.4		0					0					
150 m3 Reservoir		nr	55				0		0					0					
75 m3 Reservoir		nr	32				0		0					0					
30 m3 Reservoir		nr	24.75				0		0					0					
200 dia Trunk mains		m	0.14				0		0					0					
160 dia Trunk mains		m	0.076				0		0					0					
110 dia Trunk mains		m	0.047	1000			47		0					0					
Housing			36.0	1			36												
Prelims & General			22.0%				61	0	70	0	0	0	0	81	0	0	6	0	13
Contingencies			21%				69	0	92	0	0	0	0	84	0	0	7	0	16
TOTAL CAPITAL COSTS							341	0	472	0	0	0	0	642	0	0	40	0	91
Distribution and connections			1144					96	96	96	96	96	96	96	96	96	96	96	96
Cumulative investments							341	341	814	814	814	814	814	1366	1366	1366	1395	1395	1486
OPERATION AND MAINTENANCE COSTS				MK x 1,000															
Power head=	60	K/kWh=	0.16					9	10	11	13	14	15	17	18	20	22	24	26
Chemicals	Cl	K/m3=	0.018					3	3	4	4	4	5	6	6	6	7	7	8
Labour		K/m3=	0.04					6	7	8	9	10	11	12	13	14	15	16	17
Maintenance co		0.25%	0.02					4	5	6	6	7	7	8	10	10	11	12	13
TOTAL OPERATION AND MAINTENANCE COSTS								21	25	29	32	35	39	44	47	51	55	58	63
TOTAL CASH OUTFLOWS x 1000							341	119	653	124	127	130	134	651	143	149	190	164	249
NET CASH FLOWS x 1000							-341	-119	-653	-124	-127	-130	-134	-651	-143	-149	-190	-164	-249
Cummulative Cash Flow x 1000							-341	-469	-1060	-1174	-1301	-1431	-1565	-2217	-2369	-2536	-2726	-2890	-3128
Expenditure already committed x 1000							64												
Discounted consumption (m3 x 1,000) at						12%	1364	AIC O&M costs				0.15							
Discounted cash outflow (MK x 1,000) at						12%	1822	Average Incremental Costs MK/m3				1.19							

12 - MOLOZA			1987	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
POPULATION x 1000		6.3%		0.8	0.8	0.8	0.8	0.9	1.0	1.0	1.1	1.1	1.2	1.3	1.3	1.4	1.5	1.6	1.6
Pop. dist'n	Low			6%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
	Med			7%	7%	7%	7%	8%	8%	8%	8%	8%	8%	8%	8%	8%	10%	10%	10%
	High			20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Trad			66%	66%	66%	67%	67%	67%	67%	67%	66%	66%	66%	66%	66%	65%	65%	65%
Consumption	Low	lcd		200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
	Med			160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160
	High			76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76
	Trad			30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Domestic demand		m3/d		42	44	47	48	52	55	58	62	66	69	74	78	82	87	82	87
Institutional Y =	1.06	m3/d		4	4	4	6	6	6	8	8	8	7	7	7	8	8	8	8
Commerce Y =	1.1	m3/d		7	7	8	8	9	9	10	11	11	12	13	13	14	15	15	17
TOTAL DEMAND		m3/d		53	55	59	63	66	70	74	78	83	88	93	98	104	110	117	123
Consumption		m3/d		53	55	59	63	66	70	74	78	83	88	93	98	104	110	117	123
Losses				6.4%	6.8%	7.2%	7.6%	8.0%	8.4%	8.8%	8.8%	9.0%	9.2%	9.4%	9.6%	9.8%	9.8%	9.9%	10%
Peak	1.25	m3/d		70	75	79	84	89	95	101	107	113	120	127	135	143	161	160	170
Existing Prod Cap'y		m3/d	36	0															
Existing Storage		m3	43																
Production required		m3/d					69		27					4					
Production supplied		m3/d					66		66					66					
Storage required		m3	(4 hr)						none										
Inc. Production		m3/yr x 1000					26	26	28	29	31	33	35	37	39	42	44	47	50
Inc. consumption		m3/yr x 1000					23	24	26	27	29	30	32	34	36	38	40	43	46

INVESTMENT COSTS				Quantities			INVESTMENT COSTS								MK x 1,000				
		Unit	Rate	Ph 1	Ph 2	Ph 3	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Recent B/H	0	m3/d|m	17.6	0			0												
Boreholes @	84.6	m3/d|m	17.6	1	1	1	17.6		17.6					17.6					
Unsuccessful	38%	m	6.9	2	2	2	13.8		13.8					13.8					
Pumping B/ne		m	7.1	1	1	1	7.1		7.1					7.1					
Pump & Mtr	1.1	kW | m	6.1	1	1	1	6.1		6.1					6.1			6.1		6.1
Dosing Equipment		m	6	1		1	6		0					6			6		0
Installation		m	2.36	1	1	1	2.36		2.36					2.36			2.36		2.36
Spares		m	1.6	1	1	1	1.6		1.6					1.6					
T.Wks		m3/h|m																	
200 dia rising main		m	0.14				0		0					0					
dia rising main		m	0.076				0		0					0					
dia rising main		m	0.047	200			9.4		0					0					
75 dia rising main		m	0.037				0		0					0					
160 m3 Reservoir		m	66				0		0					0					
75 m3 Reservoir		m	32				0		0					0					
30 m3 Reservoir		m	24.78				0		0					0					
200 dia Trunk mains		m	0.14				0		0					0					
160 dia Trunk mains		m	0.076				0		0					0					
110 dia Trunk mains		m	0.047	2000			94		0					0					
Housing			36.0	1			36												
Prelims & General			22.5%				43	0	11	0	0	0	0	12	0	0	3	0	2
Contingencies			21%				49	0	12	0	0	0	0	13	0	0	3	0	2
TOTAL CAPITAL COSTS							283	0	70	0	0	0	0	78	0	0	18	0	11
Distribution and connections			200					17	17	17	17	17	17	17	17	17	17	17	17
Cumulative investments							283	283	353	353	353	353	353	431	431	431	449	449	460
OPERATION AND MAINTENANCE COSTS				MK x 1,000															
Power head=	66	K/kWh=	0.15					1	1	2	2	2	2	2	2	2	2	2	3
Chemicals	Cl	K/m3=	0.018					0	0	1	1	1	1	1	1	1	1	1	1
Labour		K/m3=	0.04					1	1	1	1	1	1	1	2	2	2	2	2
Maintenance co		0.25%	0.02					1	1	1	2	2	2	2	2	2	2	2	2
TOTAL OPERATION AND MAINTENANCE COSTS								4	4	6	6	6	6	6	6	7	7	7	8
TOTAL CASH OUTFLOWS x 1000							283	21	91	21	22	22	22	100	23	23	42	24	36
NET CASH FLOWS x 1000							-283	-21	-91	-21	-22	-22	-22	-100	-23	-23	-42	-24	-36
Cummulative Cash Flow x 1000							-283	-304	-395	-416	-438	-460	-482	-582	-605	-628	-670	-694	-728
Expenditure already committed x 1000							0												
Discounted consumption (m3 x 1,000) at						8%	244	AIC O&M costs				0.16							
Discounted cash outflow (MK x 1,000) at						8%	626	Average incremental Costs MK/m3				2.16							

TJ - NGABU			1987	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
POPULATION x 1000		3.3%	6.7	6.4	6.6	6.8	7.1	7.4	7.7	7.8	8.2	8.6	8.9	9.2	9.5	9.8	10.3	10.7	11.1
Pop. dist'n	Low		4%	4%	4.0%	4.0%	4.0%	4.0%	4.0%	4.2%	4.4%	4.6%	4.8%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
	Med		8%	8%	8%	10%	10%	11%	11%	11%	11%	12%	12%	12%	12%	13%	13%	14%	14%
	High		16%	16%	16%	16%	17%	17%	17%	17%	18%	18%	18%	18%	18%	19%	20%	20%	20%
	Trad		73%	71%	70%	70%	68%	68%	68%	67%	66%	66%	66%	64%	63%	63%	62%	62%	61%
Consumption	Low	lcd	200	200	203	206	208	212	216	218	221	224	227	230	234	238	242	246	260
	Med		160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160
	High		76	80	81	81	82	82	83	84	84	86	86	86	87	88	88	88	100
	Trad		26	27	27	27	28	28	28	28	28	29	29	29	28	29	30	30	30
Domestic demand		m3/d	281	360	369	380	412	436	455	486	516	546	577	611	646	681	718	757	798
Institutional Y =	0.8	m3/d	166	166	170	174	178	182	187	192	196	201	207	212	218	224	230	236	243
Commerce Y =	1.36	m3/d	84	113	120	127	134	142	150	158	167	176	186	196	205	216	226	237	248
TOTAL DEMAND		m3/d	530	628	659	681	724	768	798	836	878	923	969	1018	1067	1119	1173	1230	1289
Consumption		m3/d	416	534	570	603	642	688	732	775	827	876	931	986	1042	1100	1160	1223	1289
Losses			1.7%	6.4%	6.8%	7.2%	7.6%	8.0%	8.4%	8.6%	8.8%	8.0%	8.2%	8.4%	8.6%	8.6%	8.8%	8.8%	10%
Peak	1.25	m3/d	528	708	761	816	872	931	882	1057	1126	1187	1271	1349	1427	1508	1582	1660	1772
Existing Prod Cap'y		m3/d	504	0	<= Recent borehole capacity														
Existing Storage		m3	236																
Production required		m3/d	---->				488		306					188					
Production supplied		m3/d	---->				640		640					270					
Storage required		m3	(4 hr) ---->						1										
Inc. Production		m3/yr x 1000					100	117	136	164	174	196	217	240	262	288	311	336	363
Inc. consumption		m3/yr x 1000					95	100	116	132	150	169	188	203	229	250	272	295	319

INVESTMENT COSTS				Quantities			INVESTMENT COSTS								MK x 1,000				
		Unit	Rate	Ph 1	Ph 2	Ph 3	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Recent B/hs	0	m3/d nr	17.6	0			0												
Boreholes @	270	m3/d nr	17.6	2	2	1	36		36					17.6					
Unsuccessful	66%	nr	6.8	2	2	1	13.8		13.8					6.8					
Pumping St'ns		nr	7.1	2	2	1	14.2		14.2					7.1					
Pump & Mtr	4.3	kW nr	8.2	2	2	1	18.4		18.4					9.2			18.4		18.4
Dosing Equipment		nr	6	1	1	0	6		6					0			6		6
Installation		nr	2.61	2	2	1	6.02		6.02					2.61			6.02		6.02
Spares		nr	2	2	2	1	4		4					2					
T.Wks		m3/h nr																	
200 dia rising main		m	0.14				0		0					0					
160 dia rising main		m	0.076				0		0					0					
100 dia rising main		m	0.047	700		0	32.9		0					0					
75 dia rising main		m	0.037				0		0					0					
160 m3 Reservoir		nr	66				0		0					0					
75 m3 Reservoir		nr	32				0		0					0					
30 m3 Reservoir		nr	24.78				0		0					0					
200 dia Trunk mains		m	0.14				0		0					0					
160 dia Trunk mains		m	0.076				0		0					0					
110 dia Trunk mains		m	0.047	1000			47		0					0					
Housing			36.0	1			36												
Prelims & General			23.0%				48	0	21	0	0	0	0	10	0	0	6	0	6
Contingencies			21%				64	0	24	0	0	0	0	11	0	0	7	0	7
TOTAL CAPITAL COSTS							310	0	139	0	0	0	0	68	0	0	39	0	39
Distribution and connections			1286					107	107	107	107	107	107	107	107	107	107	107	107
Cumulative investments							310	310	448	448	448	448	448	616	616	616	664	664	694
OPERATION AND MAINTENANCE COSTS			MK x 1,000																
Power head=	60	K/kWh=	0.16					7	8	8	10	11	12	14	16	16	18	19	21
Chemicals	Cl	K/m3=	0.018					2	2	3	3	4	4	4	5	6	6	6	7
Labour		K/m3=	0.06					6	6	6	7	8	8	8	10	11	12	13	14
Maintenance co		0.25%	0.02					3	4	4	6	6	6	5	7	7	8	8	8
TOTAL OPERATION AND MAINTENANCE COSTS								17	18	22	26	27	30	34	37	40	43	47	51
TOTAL CASH OUTFLOWS x 1000							310	124	266	129	132	136	138	207	144	147	190	164	197
NET CASH FLOWS x 1000							-310	-124	-266	-129	-132	-136	-138	-207	-144	-147	-190	-164	-197
Cummulative Cash Flow x 1000							-310	-434	-698	-829	-960	-1096	-1233	-1439	-1583	-1730	-1920	-2074	-2271
Expenditure already committed x 1000							0												
Discounted consumption (m3 x 1,000) at						12%	1061	AIC O&M costs				0.16							
Discounted cash outflow (MK x 1,000) at						12%	1174	Average Incremental Costs MK/m3....				1.12							

14 - NSANJE			1987	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
POPULATION x 1000		2.0%	10.0	10.7	10.9	11.1	11.3	11.5	11.8	12.0	12.2	12.5	12.7	13.0	13.3	13.5	13.8	14.1	14.3
Pop. dist'n	Low		3%	3%	3.2%	3.4%	3.6%	3.8%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.2%	4.4%	4.6%	4.8%	5.0%
	Med		7%	8%	8%	8%	8%	8%	8%	9%	9%	10%	10%	10%	10%	10%	11%	11%	11%
	High		16%	16%	16%	16%	17%	17%	17%	17%	17%	18%	18%	18%	18%	18%	18%	19%	18%
	Trad		76%	73%	73%	72%	72%	71%	71%	70%	70%	69%	69%	66%	67%	67%	66%	66%	66%
Consumption	Low	lcd	200	200	203	206	209	212	215	218	221	224	227	230	234	238	242	246	250
	Med		160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160
	High		76	80	81	81	82	82	83	84	84	85	86	86	87	86	88	89	100
	Trad		26	27	27	27	28	28	28	28	28	29	29	29	29	29	30	30	30
Domestic demand		m3/d	467	556	578	603	627	653	680	702	724	747	771	795	827	861	896	931	969
Institutional Y =	0.9	m3/d	203	207	209	210	212	213	215	216	218	219	221	223	225	226	228	230	232
Commerce Y =	1.36	m3/d	101	114	118	124	129	134	139	144	149	154	160	165	171	177	183	188	195
TOTAL DEMAND		m3/d	771	877	906	938	969	1000	1033	1062	1091	1121	1152	1183	1223	1264	1306	1350	1396
Consumption		m3/d	329	606	682	617	673	730	788	841	894	949	1004	1060	1124	1180	1257	1326	1396
Losses			1.7%	6.4%	6.8%	7.2%	7.6%	8.0%	8.4%	8.8%	8.8%	9.0%	9.2%	9.4%	9.6%	9.8%	9.9%	9.9%	10%
Peak		1.26 m3/d	418	676	761	627	805	886	1067	1141	1216	1283	1371	1450	1639	1631	1724	1820	1918
Existing Prod Cap'y		m3/d	696	324	<=Recent borehole capacity														
Existing Storage		m3	182		NOTE: Existing boreholes to be abandoned														
Production required		m3/d	---------------------->				743		318					244					
Production supplied		m3/d	---------------------->				810		640					270					
Storage required		m3	(4 hr)	-------------------------------->					74										
Inc. Production		m3/yr x 1000					142	186	190	211	233	266	278	301	327	364	391	408	438
Inc. consumption		m3/yr x 1000					126	149	167	187	208	229	248	267	290	314	339	364	

INVESTMENT COSTS				Quantities			INVESTMENT COSTS							MK x 1,000					
		Unit	Rate	Ph 1	Ph 2	Ph 3	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Recent B/hs	324	m3/d|nr	17.6	1			17.6												
Boreholes @	270	m3/d|nr	17.6	3	2	1	52.8		35					17.6					
Unsuccessful	66%	nr	6.8	2	2	1	13.6		13.8					6.8					
Pumping St'ns		nr	7.1	3	2	1	21.3		14.2					7.1					
Pump & Mtr	4.6	kW | nr	7.9	4	2	1	31.6		15.8					7.9			31.6		15.8
Dosing Equipment		nr	6	1	1	1	6		6					6			6		6
Installation		nr	4.09	4	2	1	16.36		8.18					4.09			16.36		8.18
Spares		nr	1.9	4	2	1	7.6		3.8					1.9					
T.Wks		m3/h|nr																	
200 dia rising main		m	0.14				0		0					0					
160 dia rising main		m	0.076				0		0					0					
100 dia rising main		m	0.047			0	0		0					0					
75 dia rising main		m	0.037				0		0					0					
150 m3 Reservoir		nr	66				0		0					0					
75 m3 Reservoir		nr	32	1			32		0					0					
50 m3 Reservoir		nr	24.76				0		0					0					
200 dia Trunk mains		m	0.14	800			112		0					0					
160 dia Trunk mains		m	0.076	1200			90		0					0					
110 dia Trunk mains		m	0.047				0		0					0					
Housing			36.0	1			36												
Prelims & General			26.0%				109	0	34	0	0	0	0	13	0	0	13	0	7
Contingencies			21%				114	0	26	0	0	0	0	13	0	0	14	0	8
TOTAL CAPITAL COSTS							667	0	146	0	0	0	0	76	0	0	80	0	44
Distribution and connections			374					31	31	31	31	31	31	31	31	31	31	31	31
Cumulative investments							667	667	802	802	802	802	802	879	879	879	959	959	1002
OPERATION AND MAINTENANCE COSTS MK x 1,000																			
Power head=	66	K/kWh=	0.16					9	10	11	12	13	15	16	17	18	20	22	23
Chemicals	Cl	K/m3=	0.018					3	3	4	4	6	5	6	6	6	7	7	8
Labour		K/m3=	0.04					7	8	8	9	10	11	12	13	14	15	16	17
Maintenance co		0.26%	0.02					6	6	6	7	7	8	8	9	9	10	11	11
TOTAL OPERATION AND MAINTENANCE COSTS								23	27	30	32	36	39	41	46	49	62	68	60
TOTAL CASH OUTFLOWS x 1000							667	64	203	61	64	68	69	148	76	80	163	87	136
NET CASH FLOWS x 1000							-667	-64	-203	-61	-64	-68	-69	-148	-76	-80	-163	-87	-136
Cummulative Cash Flow x 1000							-667	-712	-916	-976	-1039	-1106	-1176	-1324	-1400	-1479	-1642	-1729	-1864
Expenditure already committed x 1000							58												
Discounted consumption (m3 x 1,000) at						12%	1314	AIC O&M costs				0.16							
Discounted cash outflow (MK x 1,000) at						12%	1129	Average incremental Costs MK/m3				0.86							

ANNEX 7

ASSESSMENT OF EXISTING WATER SUPPLIES

ANNEX 7

ASSESSMENT OF EXISTING WATER SUPPLIES

The following forms provide a quick assessment of the existing situation at each of the urban centres. The forms have been prepared to provide information, as suggested in the ODA's "Manual for the Appraisal of Rural Water Supplies", on Quantity, Quality, Accessibility and Reliability

ASSESSMENT OF EXISTING WATER SUPPLIES

TOWN		CHITIPA	1
Estimated 1991 Population		6290	
Source		Boreholes	
Treatment		Chlorination	
Quantity			
Average Daily Production (m3/d)		400	m3/d
Production capacity, including recent boreholes		684	m3/d
Nr of Individual Connections (ICs)		188	
Nr of Communal Water Points (CWPs)		17	
Institutional and commerce demand		39%	
Equivalent per capita consumption from ICs (approx)		168	l/c/d
Equivalent per capita consumption from CWPs (approx)		34	l/c/d
Quality			
Water table depth		9	m
Contamination risk to boreholes			
Water quality			
Accessibility			
Percentage of Population served by ICs (5 people/Household)		15%	
Percentage of population served by CWPs (5 people/Househol		41%	
Ave. distance between CWPs			
ICs:	Flat rate	3.68	MK
	9 - 30 m3	0.94	MK/m3
	Over 30m3	1.15	MK/m3
CWPs		0.29	MK/m3
Reliability	Rationing	Pressure	
Dry season			hr*
Wet season			hr*
Suspected reduction in groundwater levels due to low annual rainfall over the last three ye			
has reduced the borehole yoields			
Sanitation			
Comments			

ASSESSMENT OF EXISTING WATER SUPPLIES

TOWN	NKHOTAKOTA		2
Estimated 1991 Population		14320	
Source	Boreholes		
Treatment	Chlorination		
Quantity			
Average Daily Production (m3/d)		435	m3/d
Production capacity including recent boreholes		1450	m3/d
Nr of Individual Connections (ICs)		312	
Nr of Communal Water Points (CWPs)		16	
Institutional and commerce demand		39%	
Equivalent per capita consumption from ICs (approx)		130	l/c/d
Equivalent per capita consumption from CWPs (approx)		26	l/c/d
Quality			
Water table depth		6	m
Contamination risk to boreholes		slight	
Water quality		good	
Accessibility			
Percentage of Population served by ICs (5 people/Household)		11%	
Percentage of population served by CWPs (5 people/Househol		17%	
Ave. distance between CWPs		300	m
ICs: Flat rate		3.68	MK
9 - 30 m3		0.94	MK/m3
Over 30m3		1.15	MK/m3
CWPs		0.29	MK/m3
Reliability	Rationing	Pressure	
Dry season			hr*
Wet season			hr*
Sanitation: HESP programme has stared in the rural areas, but not in the town			
A sna-plat programme had commenced this year			
Comments			
Large areas of traditional housing, located away from the lakeshore within the town bound			
are without water supplies. A difficulty exists in obtaining revenue from CWPs located clos			
the lake			

ASSESSMENT OF EXISTING WATER SUPPLIES

TOWN		NTCHISI		3
Estimated 1991 Population			3450	
Source			River	
Treatment			Slow Sand Filter	
Quantity				
Average Daily Production			195	m3/d
Production Capacity			222	m3/d
Nr of Individual Connections (ICs)			206	
Nr of Communal Water Points (CWPs)			11	
Institutional demand			40%	
Equivalent per capita consumption from ICs (approx)			86	l/c/d
Equivalent per capita consumption from CWPs (approx)			17	l/c/d
Quality				
Range of water table depths			0 - 15	m
Contamination risk to boreholes			slight	
Accessibility				
Percentage of Population served by ICs (5 people/Household)			30%	
Percentage of population served by CWPs (5 people/Househol			48%	
Ave. distance between CWPs			350	m
ICs:	Flat rate		3.68	MK
	9 - 30 m3		0.94	MK/m3
	Over 30m3		1.15	MK/m3
CWPs			0.29	MK/m3
Reliability		Rationing	Pressure	
Dry season		none	24	hr*
Wet season		none	24	hr*
*Provided there are no breakdowns				
Comments				
1. Sand in filters overdue for replacement				
2. No DPD tablets available to check Chlorine residual				
3. Shortages of water at time of visit due to problems with the raw water gravity main.				

ASSESSMENT OF EXISTING WATER SUPPLIES

TOWN	DOWA		4
Estimated 1991 Population		2930	
Source	Boreholes/Stream		
Treatment	Chlorination only		
Quantity			
Average Daily Production		166	m3/d
Production capacity including recent boreholes		430	m3/d
Nr of Individual Connections (ICs)		190	
Nr of Communal Water Points (CWPs)		5	
Institutional demand		54%	
Equivalent per capita consumption from ICs (approx)		69	l/c/d
Equivalent per capita consumption from CWPs (approx)		14	l/c/d
Quality			
Range of water table depths		1 - 13	m
Contamination risk to boreholes		high	
Contamination risk to stream		high	
Accessibility			
Percentage of Population served by ICs (5 people/Household)		32%	
Percentage of population served by CWPs (5 people/Househol		26%	
Ave. distance between CWPs			
ICs: Flat rate		3.68	MK
9 - 30 m3		0.94	MK/m3
Over 30m3		1.15	MK/m3
CWPs		0.29	MK/m3
Reliability	Rationing	Pressure	
Dry season	Yes	3	hr*
Wet season		24	hr*
* Provided there are no breakdowns			
Sanitation			
No latrine building or sanplat programme in town.			
Comments			
(1) Diesel pumping station in the process of being converted to electricity			

ASSESSMENT OF EXISTING WATER SUPPLIES

TOWN		SALIMA		5
Estimated 1991 Population			12455	
Source			Boreholes	
Treatment			Chlorination	
Quantity				
Average Daily Production			888	m3/d
Production capacity (in dry season) (1)			666	m3/d
Nr of Individual Connections (ICs)			428	
Nr of Communal Water Points (CWPs)			31	
Institutional demand			20%	
Equivalent per capita consumption from ICs (approx)			231	l/c/d
Equivalent per capita consumption from CWPs (approx)			46	l/c/d
Quality				
Range of water table depths			5 - 10	m
Contamination risk to boreholes			moderate	
Accessibility				
Percentage of Population served by ICs (5 people/Household)			17%	
Percentage of population served by CWPs (5 people/Househol			37%	
Ave. distance between CWPs				
ICs:	Flat rate		3.68	MK
	9 - 30 m3		0.94	MK/m3
	Over 30m3		1.15	MK/m3
CWPs			0.29	MK/m3
Reliability		Rationing	Pressure	
Dry season		Yes		hr*
Wet season				hr*
* Areas distant from tanks have daily shortages				
Comments				
1. Production capacity decreases significantly in the dry season				
2. No latrine building or sanplat programme in town.				

ASSESSMENT OF EXISTING WATER SUPPLIES

TOWN	DEDZA	6
Estimated 1991 Population		20340 (1)
Source	Stream/Boreholes	
Treatment	Presure Filter/Chlorination (2)	
Quantity		
Average Daily Production (m3/d)		550 (3)
Production capacity including recent boreholes		625 m3/d
Nr of Individual Connections (ICs)		463
Nr of Communal Water Points (CWPs)		24
Institutional demand		20%
Equivalent per capita consumption from ICs (approx)		145 l/c/d
Equivalent per capita consumption from CWPs (approx)		29 l/c/d
Quality		
Range of water table depths		1.5 - 5.2 m
Contamination risk to boreholes		high
Accessibility		
Percentage of Population served by ICs (5 people/Household)		11% (4)
Percentage of population served by CWPs (5 people/Househol		18% (4)
Ave. distance between CWPs		
ICs: Flat rate		3.68 MK
9 - 30 m3		0.94 MK/m3
Over 30m3		1.15 MK/m3
CWPs		0.29 MK/m3
Reliability	Rationing	Pressure
Dry season		24 hr*
Wet season		24 hr*
* Subject to breakdowns		
Comments		
1. Based on 1987 census which probably includes a significant number of refugees		
2. New borehole delivering directly into distribution system without chlorination		
3. Includes new boreholes		
4. Refugee areas are mostly fed from alternative sources		

ASSESSMENT OF EXISTING WATER SUPPLIES

TOWN		NAMWERA	7
Estimated 1991 Population			2300
Source		Boreholes	
Treatment		Chlorination	
Quantity			
Average Daily Production (m3/d) (1988 figure)			63 m3/d
Production capacity			187 m3/d
Nr of Individual Connections (ICs) (1988 figure)			59
Nr of Communal Water Points (CWPs)			0
Institutional demand			40%
Equivalent per capita consumption from ICs (approx)			128 l/c/d
Equivalent per capita consumption from CWPs (approx)			26 l/c/d
Quality			
Range of water table depths		1.8 to 11.6 m; average 8.8 m	
Contamination risk to boreholes			
Accessibility			
Percentage of Population served by ICs (5 people/Household)			13%
Percentage of population served by CWPs (5 people/Househol			0%
Ave. distance between CWPs			
ICs:	Flat rate		3.68 MK
	9 - 30 m3		0.94 MK/m3
	Over 30m3		1.15 MK/m3
CWPs			0.29 MK/m3
Reliability		Rationing / Pressure	
Dry season			hr*
Wet season			hr*
* Subject to breakdowns			
Comments			

ASSESSMENT OF EXISTING WATER SUPPLIES

TOWN	BALAKA		8
Estimated 1991 Population		11680	
Source	Boreholes		
Treatment	Chlorination		
Quantity			
Average Daily Production (m3/d)		1253	m3/d
Production capacity		518	(1)&(2)
Nr of Individual Connections (ICs)		350	
Nr of Communal Water Points (CWPs)		33	
Institutional and commerce demand		44%	
Equivalent per capita consumption from ICs (approx)		256	l/c/d
Equivalent per capita consumption from CWPs (approx)		51	l/c/d
Quality			
Range of water table depths		3 - 18	m
Contamination risk to boreholes		slight	
Accessibility			
Percentage of Population served by ICs (5 people/Household)		15%	
Percentage of population served by CWPs (5 people/Househol		42%	
Ave. distance between CWPs			
ICs: Flat rate		3.68	MK
9 - 30 m3		0.94	MK/m3
Over 30m3		1.15	MK/m3
CWPs		0.29	MK/m3
Reliability	Rationing	Pressure	
Dry season		24	hr*
Wet season		24	hr*
* Relies on additional water supplied from the Mpiri Balaka Rural Gravity Scheme			
Comments			
1. Scheme's reliability vulnerable due to only one pump working most of the time, and this is located on the banks of the Rivi-Rivi River, which is liable to be washed away during floods.			
2. It had originally been thought that this town would be linked to the Mpiri- Balaka Rural Supply Scheme. This now appears to have been ruled out. Additional capacity needed.			

ASSESSMENT OF EXISTING WATER SUPPLIES

TOWN		CHIKWAWA	9
Estimated 1991 Population		4760	
Source		Boreholes	
Treatment		Chlorination	
Quantity			
Average Daily Production (m3/d)		352	m3/d
Production capacity including recent boreholes		1273	m3/d
Nr of Individual Connections (ICs)		188	
Nr of Communal Water Points (CWPs)		17	
Institutional and commerce demand		37%	
Equivalent per capita consumption from ICs (approx)		153	l/c/d
Equivalent per capita consumption from CWPs (approx)		31	l/c/d
Quality			
Range of water table depths		7 - 40 m, average 25 m	
Contamination risk to boreholes		Medium	(1)
Water quality		high chloride content	(2)
Accessibility			
Percentage of Population served by ICs (5 people/Household)		20%	
Percentage of population served by CWPs (5 people/Househol		54%	
Ave. distance between CWPs			
ICs:	Flat rate	3.68	MK
	9 - 30 m3	0.94	MK/m3
	Over 30m3	1.15	MK/m3
CWPs		0.29	MK/m3
Reliability		Rationing	Pressure
Dry season		24	hr*
Wet season		24	hr*
* Difficulties being met at time of visit due to two of the production boreholes being out of order.			
Sanitation			
20% of traditional housing with unimproved pit latrines. No Sanplat programme			
Comments			
(1) Water Department's own septic tank located 17m from borehole T3 in main compou			
(2) Complaints of taste due to high Chloride content			

ASSESSMENT OF EXISTING WATER SUPPLIES

TOWN		NCHALO	10
Estimated 1991 Population		10775	
Source		Boreholes	
Treatment		Chlorination	
Quantity			
Average Daily Production (m3/d)		145	m3/d
Production capacity excluding new boreholes yet to be equiped		178	m3/d
Nr of Individual Connections (ICs)		85	
Nr of Communal Water Points (CWPs)		16	
Institutional and commerce demand		30%	
Equivalent per capita consumption from ICs (approx)		112	l/c/d
Equivalent per capita consumption from CWPs (approx)		22	l/c/d
Quality			
Range of water table depths		6 - 19 m, average 10.5 m	
Contamination risk to boreholes		High	(1)
Accessibility			
Percentage of Population served by ICs (5 people/Household)		4%	
Percentage of population served by CWPs (5 people/Househol		22%	
Ave. distance between CWPs			
ICs:	Flat rate	3.68	MK
	9 - 30 m3	0.94	MK/m3
	Over 30m3	1.15	MK/m3
CWPs		0.29	MK/m3
Reliability	Rationing	Pressure	
Dry season		24	hr*
Wet season		24	hr*
* If no there are no breakdowns			
* Low pressure problems in Western areas close to ADMARC			
Sanitation			
25% of traditional housing with unimproved pit latrines. No Sanplat programme			
Comments			
1. Grave yard located 40m from Borehole RB151			

ASSESSMENT OF EXISTING WATER SUPPLIES

TOWN		LUCHENZA		11
Estimated 1991 Population			6940	
Source		Boreholes		
Treatment		Chlorination		
Quantity				
Average Daily Production (m3/d)			347	m3/d
Production capacity including recently equiped boreholes			743	m3/d
Nr of Individual Connections (ICs)			167	
Nr of Communal Water Points (CWPs)			10	
Institutional and commerce demand			34%	
Equivalent per capita consumption from ICs (approx)			202	l/c/d
Equivalent per capita consumption from CWPs (approx)			40	l/c/d
Quality				
Range of water table depths		2 - 22 m, average 11 m		
Contamination risk to boreholes			Slight	
Accessibility				
Percentage of Population served by ICs (5 people/Household)			12%	
Percentage of population served by CWPs (5 people/Househol			22%	
Ave. distance between CWPs				
ICs:	Flat rate		3.68	MK
	9 - 30 m3		0.94	MK/m3
	Over 30m3		1.15	MK/m3
CWPs			0.29	MK/m3
Reliability		Rationing	Pressure	
Dry season			24	hr*
Wet season			24	hr*
* Existing demand can be satisfied by pumping 12 hours a day				
Comments				

ASSESSMENT OF EXISTING WATER SUPPLIES

TOWN		MULOZA	12
Estimated 1991 Population			790
Source		Borehole (1)	
Treatment		Chlorination	
Quantity			
Average Daily Production (m3/d)			23 m3/d
Production capacity			36 m3/d
Nr of Individual Connections (ICs)			15
Nr of Communal Water Points (CWPs)			0
Institutional and commerce demand			16%
Equivalent per capita consumption from ICs (approx)			258 l/c/d
Equivalent per capita consumption from CWPs (approx)			0 (2)
Quality			
Water table depth (average)			11 m
Contamination risk to boreholes			high (3)
Accessibility			
Percentage of Population served by ICs (5 people/Household)			N/A
Percentage of population served by CWPs (5 people/Househol			0% (2)
Ave. distance between CWPs			
ICs:	Flat rate		3.68 MK
	9 - 30 m3		0.94 MK/m3
	Over 30m3		1.15 MK/m3
CWPs			0.29 MK/m3
Reliability		Rationing	Pressure
Dry season			24 hr*
Wet season			24 hr*
* 15 to 18 hrs pumping a day to meet demand			
Comments			
(1) Alternative RWS gravity main appeared to be undersized for demand			
(2) Borehole feeds Border Customs Offices and houses.			
(3) Septic tank 60m from borehole, and pit latrine 30m away			

ASSESSMENT OF EXISTING WATER SUPPLIES

TOWN		NGABU	13
Estimated 1991 Population			6590
Source		Boreholes	
Treatment		Chlorination	
Quantity			
Average Daily Production (m3/d)			347 m3/d
Production capacity			504 m3/d
Nr of Individual Connections (ICs)			279
Nr of Communal Water Points (CWPs)			27
Institutional and commerce demand			34%
Equivalent per capita consumption from ICs (approx)			104 l/c/d
Equivalent per capita consumption from CWPs (approx)			21 l/c/d
Quality			
Range of water table depths		3 - 18 m, average 10 m	
Contamination risk to boreholes		High	(1)
Complaints due to water hardness			
Accessibility			
Percentage of Population served by ICs (5 people/Household)			21%
Percentage of population served by CWPs (5 people/Househol			61%
Ave. distance between CWPs			
ICs:	Flat rate		3.68 MK
	9 - 30 m3		0.94 MK/m3
	Over 30m3		1.15 MK/m3
CWPs			0.29 MK/m3
Reliability		Rationing	Pressure
Dry season			24 hr*
Wet season			24 hr*
* Provided there are no breakdowns			
Sanitation			
25% of traditional houses have unimproved pit latrines - no sanplat programme			
Comments			
(1) Borehole D44 is in main compound which has a septic tank, a pit latrine is also located 15 m from borehole. Risk to other boreholes - slight			
(2) Problems encountered with AC pipe breakages in expansive soils			

ASSESSMENT OF EXISTING WATER SUPPLIES

TOWN		NSANJE	14
Estimated 1991 Population		10870	
Source		Boreholes	
Treatment		Chlorination	
Quantity			
Average Daily Production (m3/d)		480	m3/d
Production capacity including recently equiped borehole		1019	m3/d
Nr of Individual Connections (ICs)		220	
Nr of Communal Water Points (CWPs)		21	
Institutional and commerce demand		40%	
Equivalent per capita consumption from ICs (approx)		166	l/c/d
Equivalent per capita consumption from CWPs (approx)		33	l/c/d
Quality			
Range of water table depths		2 - 9 m, average 5 m	
Contamination risk to boreholes		High	(1)
Accessibility			
Percentage of Population served by ICs (5 people/Household)		10%	
Percentage of population served by CWPs (5 people/Househol		29%	
Ave. distance between CWPs			
ICs:	Flat rate	3.68	MK
	9 - 30 m3	0.94	MK/m3
	Over 30m3	1.15	MK/m3
CWPs		0.29	MK/m3
Reliability		Rationing	Pressure
Dry season		24	hr*
Wet season		24	hr*
* Provided there are no breakdowns otherwise rationing has to take place			
Sanitation			
25% of traditional houses have unimproved pit latrines - no sanplat programme			
Comments			
(1) DC Office's septic tank is located 80m from Boreholes K168A & B			

ANNEX 8

MANPOWER PLAN, TRAINING NEEDS ASSESSMENT AND MANAGEMENT DEVELOPMENT PROGRAMME

ANNEX 8

Outline Terms of Reference

MANPOWER PLAN, TRAINING NEEDS ASSESSMENT AND MANAGEMENT DEVELOPMENT PROGRAMME

OBJECTIVE

The objective is to establish a programme by which the Water Department of the Ministry of Works may be reasonably assured of meeting its Human Resource needs in 1996-97 in the areas of Registered Engineer, Professional Accountant, Middle Management and Senior Supervisor.

TASKS

The principal tasks of the consultant will be as follows:

A. Forecast manpower requirement

Examine/develop a Business Plan for the Department and assess the 1996 manpower requirement in terms of post category (with job description), number of people, and timescales for

(i) Professional Engineers (i.e. Malawi Registered Engineer and above)
(ii) Professional Accountants (i.e. Malawi Registered Engineer and above)
(iii) Chief and Senior Technical Officer (CTO, STO)
(iv) Section Managers at level P and above.

taking into account

- the revised structure of the Department
- the increasing complexity of its operations, e.g. multiple source works, complex control systems, extended distribution network, computerisation, management

information systems, corporate planning

- progression of District Water Supply Fund towards commercial performance
- the level and extent of service provision required.

Consideration should also be given to a possible extension of the Department's activities to include provision of waterborne sanitation services.

B. Survey of existing manpower resources

Develop a profile of Department staff currently appointed within the cadres and disciplines in A above, assessing in each case performance mastery and/or deficiency, vis-a-vis the job descriptions referred to above.

Assess the extent of availability to the Department of graduates/diplomates having the essential base qualifications for the posts described (a) in-house and (b) external from local educational institutions.

Identify and make recommendations regarding constraints to the recruitment/retention process. Quantify staff turnover during the last 2-3 years.

C. Develop a manpower plan

(i) Identify the areas of surplus/deficiency in the Department's projected manpower requirements in 1996/97 taking into account the current availability of human resource

(a) Qualified and In Post
(b) In Post and capable of career development.

(ii) Assess the type and extent of deficiency between requirements and posts so filled and make recommendations on a recruitment policy for consideration by Malawi Government.

D. **Training needs assessment**

Consolidate the training needs arising from the Manpower Plan developed in C above in respect of in-house staff.

Prepare a Schedule of Training Objectives aimed at developing the professional competence of newly recruited graduates and diplomates. The objectives to be consistent with achievement of Registered Status under the laws of Malawi.

Prepare a Schedule of Training Objectives aimed at upgrading Technical Officers to Senior and Chief Technical Officer level respectively.

Identify the availability of suitable local and external courses and/or resources which can address the needs obtained above, assess the financial costs involved and determine funding sources.

E. **Management development programme**

Discuss the findings of the Training Needs Assessment with the Water Department.

Construct a programme, geared both to the needs of the individual and to the Department which will address to the maximum extent possible the manpower deficiencies at 1996/97.

The programme should focus on the development of management techniques and skills by education and by a process of exposure and experience involving planned movement within the department, within Government and within industry, and promotion at appropriate stage points.

Advise and make recommendations on a system of monitoring progress and appraising performance both of the individual and of the programme.

REPORTING

The consultant to prepare interim reports at

- Completion of Phase C - Manpower Plan
- Completion of Phase D - Training Needs Assessment

and a final report within 2 weeks of completion of Phase E - Management Development Programme.

COSTS

It is estimated that the input required is of the order of 10 man weeks: 2 weeks by a Job analyst and 8 weeks by a Manpower Consultant.

On this basis the anticipated cost range is £stg 40,000 to 50,000.

ANNEX 9

TERMS OF REFERENCE FOR THE HYGIENE EDUCATION AND SANITATION PROMOTION COMPONENT OF THE PROJECT

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OBJECTIVE

The project for improvements to the 14 District Water Supply Schemes will make a supply of piped water available for the first time to a population of around 115,000 spread through the peri-urban and urban areas of the 14 districts. The Hygiene Education and Sanitation Promotion (HESP) programme is a component of the project which aims to maximise health benefits by reducing the incidence of water related diseases and to improve the quality of life of the project beneficiaries through the provision of safe water supplies, improved sanitation and washing facilities and hygiene education.

The programme promotes the process of self-help and sustainability in addressing the hygiene and sanitation problems in peri-urban and urban communities. This is effected by establishing/training Health and Water Committees in their role of mobilising and advising the communities served by the project and of managing and maintaining water supply and other facilities facilitated as a result of the project implementation.

PROJECT CO-ORDINATION

The 14 District Water Supply Project is managed by a Project Manager based in Water Department Headquarters at Lilongwe. Part of the Financial Support given to the project will be allocated to the Ministry of Health, who will be responsible for implementing the HESP component of the project. The HESP programme will be headed by a HESP co-ordinator, at project level based in the Project Design and Implementation Unit (DIU) at the Water Department Headquarters. Assistant co-ordinators will be based in field offices at Balaka and Blantyre, district coverage being: ??

? a) From Lilongwe (HESP Co-ordinator) - Chitipa, Nichotakota, Ntchiss, Dowa, Salima.
b) From Balaka (Assistant Co-ordinator) - Dedza, Namwera, Balaka, Chikwawa.
c) From Blantyre (Assistant Co-ordinator) - Nchalo, Luchenza, Muloza, Ngabu, Nsanje.

For the purpose of co-ordination of the HESP component and the water supply works there will be a monthly meeting between the HESP co-ordinator, the Assistant Co-ordinators and the Project Manager. A monthly report from each Assistant Co-ordinator will be submitted to the HESP Co-ordinator, who will then arrange for a consolidated report to be provided to the Project Manager.

Additionally, the programme is part of a National HESP programme and the HESP co-ordinator at National level must be kept advised of progress on a monthly basis. A detailed quarterly report should be supplied to the Ministry of Health by the Project HESP Co-ordinator.

Within the areas of urban councils (Salima, Dedza, Balaka, Luchenza) co-ordination will be required with the Public Health Department. This is to be effected with the co-operation of the Ministry of Health through the National HESP programme.

STAFF AND OTHER RESOURCES

The appointment of the following staff will be supported from component funds:

- Project HESP Co-ordinator
- 2 no. Assistant HESP Co-ordinators
- ? 1 4 no. Health Surveillance Assistants.

All these staff will be recruited and appointed by the MOH and will be actively engaged full time on the HESP programme:

The following resources will be provided with the HESP programme:

- 3 no. Pick up trucks and operational costs.
- 14 no. bicycles.
- Office equipment including computer and stationary
- Constructional materials (cement, steel moulds for "Sanplant" manufacture).
- Training and promotional materials.

IMPLEMENTATION

The Project HESP co-ordinator will be appointed by the M.O.H. at a time to be advised by the Project Manager.

The co-ordinat~~ion~~or's first responsibilities will be to establish

a) an implementation plan and programme
b) a training programme for health surveillance assistants
c) forms and procedures for the collection of baseline data.

In drawing up the programmes the co-ordinator will pay particular reference to the conclusions and recommendations of the "Review of the HESP component of the Inpin Balaka project" and "Implementation Plan for the HESP component" (Ref 7 Taylor and Makimba July 1991 for Ministry of Health and Ministry of Works), making due allowance for the differences in community attitude and conditions that may occur across the project area.

The detailed Implementation Plan shall be submitted for the joint approval of the Project Manager and the National HESP Co-ordinator at the MOH.

FINANCES

The estimated cost of the HESP programme component is:

	MK'000
• Equipment - pick ups, bicycles, moulds, tools etc.	180
• Office equipment	40
• Transport operating costs	100
• Materials: cement, steel, reagents, stationery	240
• Salaries and subsistence	600
• Training and promotion	200
• Specialist input	80
	1440

say MK 1.5 million

Resources purchased for the HESP programme will be allocated and managed by the Project Manager. Detailed records shall be maintained by the MOH of Fund receipts and expenditure and a Financial Statement shall be submitted at monthly intervals to the Project Manager, together with a commitment register.

ANNEX 10

PERMANENT STANDING COMMITTEE FOR THE WATER/SANITATION SECTOR

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1 MEMBERSHIP

The Committee shall be chaired by the Office of the President and Cabinet and its members shall represent the following Ministries:

- Health, Works, Local Government, Forestry and Natural Resources, Finance, Community Services.

The Water Resources Board will also have representation.

2 PURPOSE

The Committee will be responsible for making recommendations concerning, for co-ordinating and for monitoring Government policy in the Water and Sanitation Sector and for establishing a co-ordinated strategy to achieve policy aims.

3 TASKS

The duties of the Committee will be

a) To review activities in the water and sanitation sectors in terms of the nature and responsibility of organisations and institutions operating within either sector, of the manpower availability, and of the levels of investment capable of being supported from time to time.

b) Following the review in (a) above to make recommendations to Government on practical policies for the water and sanitation sectors, including particularly

(i) The level and extent of services to be provided.

(ii) The delegation of responsibilities for service provision within the sectors.

(iii) Such aspects of other National policies as may be relevant to the sectors.

c) To establish an outline strategy by which policy objectives may be successfully achieved.

d) To monitor and review the implementation process and its effects and to initiate such action as may be necessary to promote successful achievement of Sectoral Policy aims, and to make recommendations to Government on amendments or extensions.

e) To co-ordinate the activities of Ministries and other organisations operating in the Sector in so far as they have effect on sectoral policies and strategies.

4. MEETINGS

Meetings shall be convened by the Office of the President, and the Committee shall meet as required, but at intervals no longer than 6 months.

ANNEX 11

CONDENSED BIBLIOGRAPHY

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1. Statement of Development Policies 1987 - 1996, GOM, 1991.

2. Water and Sanitation Sector - Position Paper and Action Plan, UNDP/World Bank Project RAF/86/038 Nairobi, January 1989.

3. Institutional Responsibilities and Collaborative Arrangements in The Water Supply and Sanitation Sector in Malawi, UNDP/World Bank Regional Water and Sanitation Group, Nairobi, first draft, August 1989.

4. Sanitation Sector Strategy Paper, UNDP/World Bank Regional Water and Sanitation Group, Nairobi, April 1989.

5. National Water Resources Master Plan. UNDP, 1986.

6. A Guide to Cost Estimating for Overseas Construction Projects, ODA, UMIST, August 1989.

7. ODA Manual for Rural Water Supply Project Appraisal.

8. Master Plan for Water Supply Development - 44 Semi-Urban Centres. Water Department/Carl-Bro International, 1986.

9. Sanitation and Water Supply Data, Chikwawa District, 1990.

10. National Water Resources Master Plan Water Dept MOW and UN Department of Technical Co-operation for Development, November 1986.

11. Sanitation Sector Strategy Paper Prepared for MLG by UNDP/World Bank Regional Water and Sanitation Group Nairobi, August 1989.

12 Part 1 - Review of the HESP Component of the Mpira - Balaka Project Part 2 - Implementation Plan for the HESP component by Panel Taylor and Barle Makumba, financed by DANIDA for Ministry of Health, Ministry of Works, July 1991.

13. First Draft - Institutional Responsibilities and Collaborative Arrangements in the Water Supply and Sanitation Sector in Malawi Prepared for the Government of Malawi by the UNDP/World Bank Regional Water Supply and Sanitation Group, Nairobi, August 1989.

14. Mid-Term Review of the Statement of Development Policies 1987-1996.

15. Statement of Development Policies 1987-96. Office of the President and Cabinet, Department of Economic Planning and Development.

16. Laws of Malawi - Volume X Cap 72.03 - Water Resources Act Ministry of Works - 1991/92 Financial Year Interim Training Programme-Board of Engineers Guidelines for Selected Registered Engineers Selected for Training of Graduate Engineers.

17. Ministry of Works Water Dept Public Standpost Water Supplies Project Overview by Fabiano Kwaule, October 1989.

18. Lilongwe Water Board - Corporate Plan 1992-97 Lilongwe Water Board - Annual Report 1990, September 1991.

19. Overseas Development Adminstration - Manual for the Appraisal of Rural Water Supplies.

20. Final Master Plan for Water Development to 44 Semi-urban Centres with Final Feasibility Report. Carl Bro - International as Kruger 1/a with Danish Hydraulic Institute, May 1988.