JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF KENYA

MINISTRY OF ENVIRONMENT AND NATURAL RESOURCES

THE STUDY ON INSTITUTIONAL IMPROVEMENT AND REHABILITATION OF WATER SUPPLY SYSTEMS FOR 10 LOCAL TOWNS IN THE REPUBLIC OF KENYA

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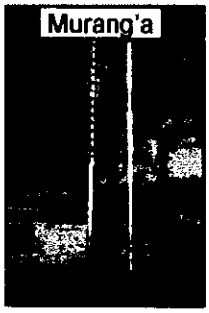

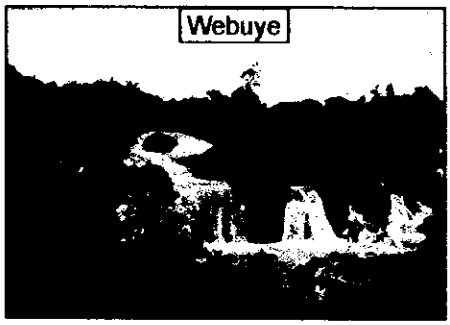

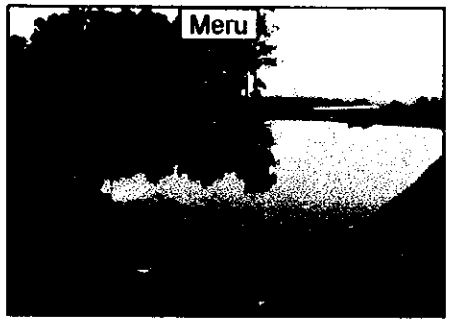

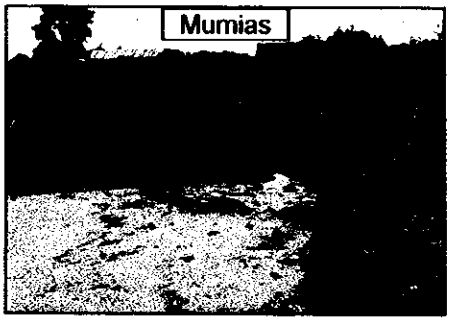

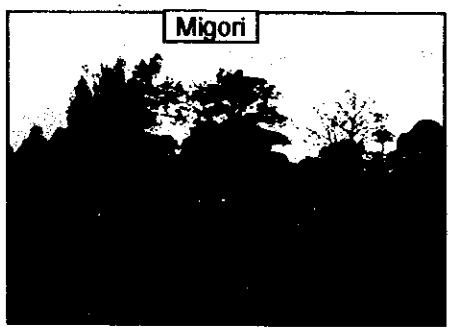

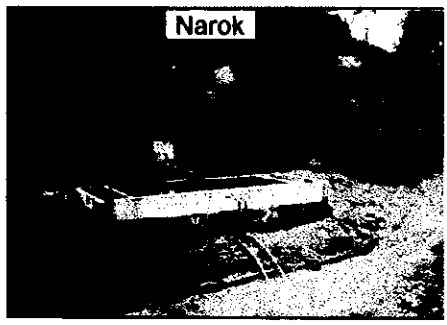

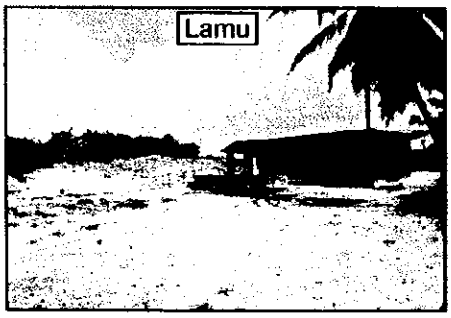

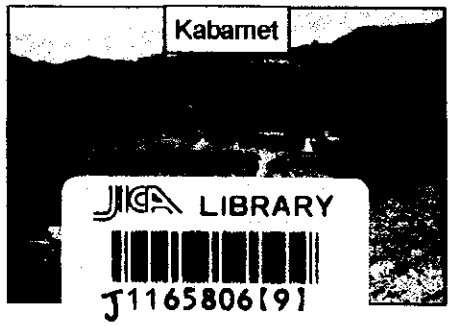

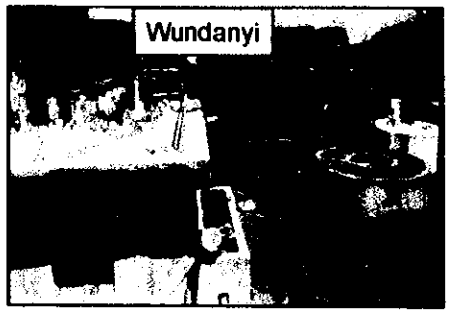

FINAL REPORT

Volume 2D : Main Report (including Appendices) - Kabarnet Town

FEBRUARY 2001

Development Impact Consulting

Engineering and Utility Management Ltd.

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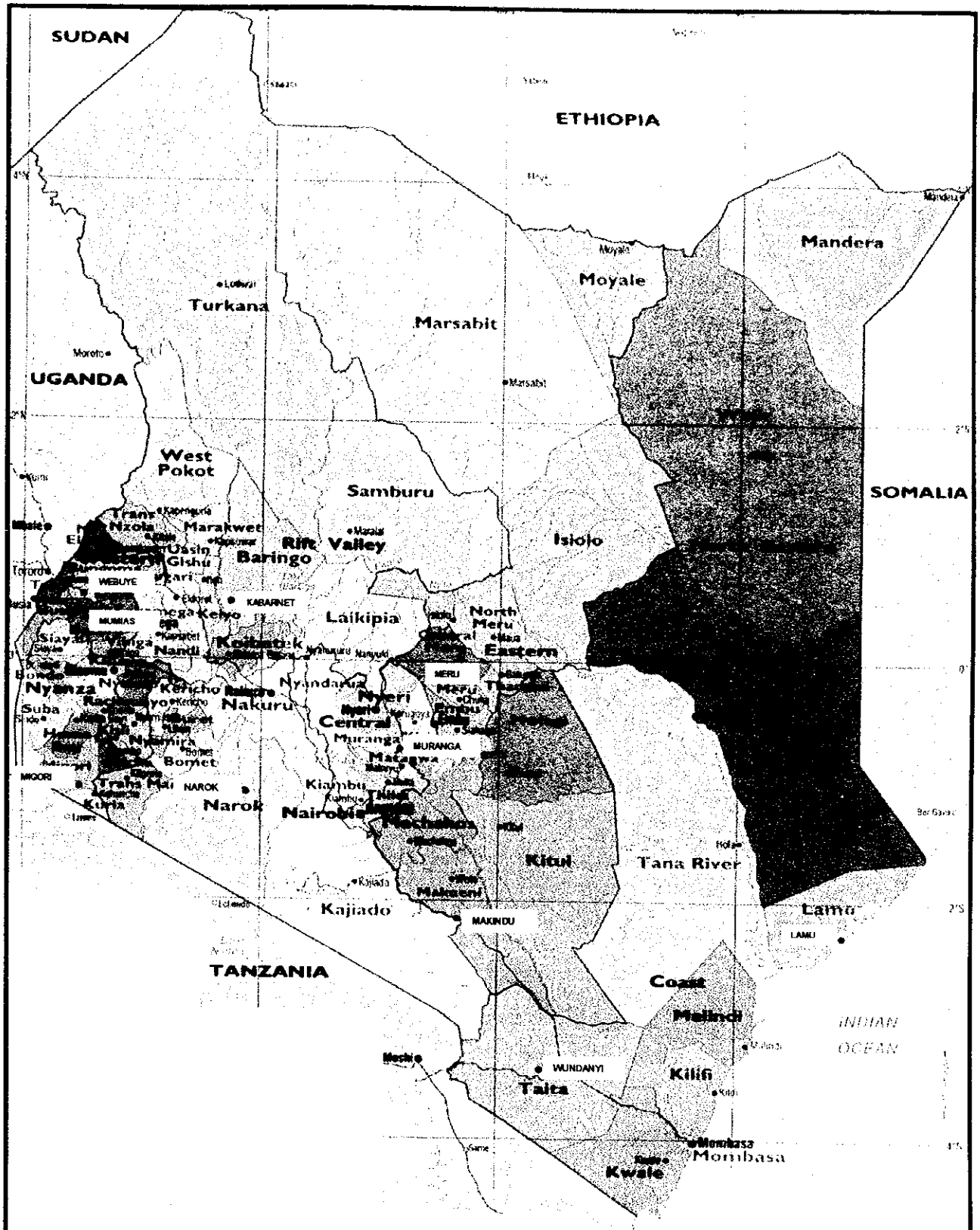

TEN TOWNS WATER & SANITATION STUDY

TOWNS LOCATION MAP

Development Impact Consulting

GIBB Eastern Africa
LawGibb Group Member

KABARNET WATER SUPPLY

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LIST OF ABBREVIATIONS

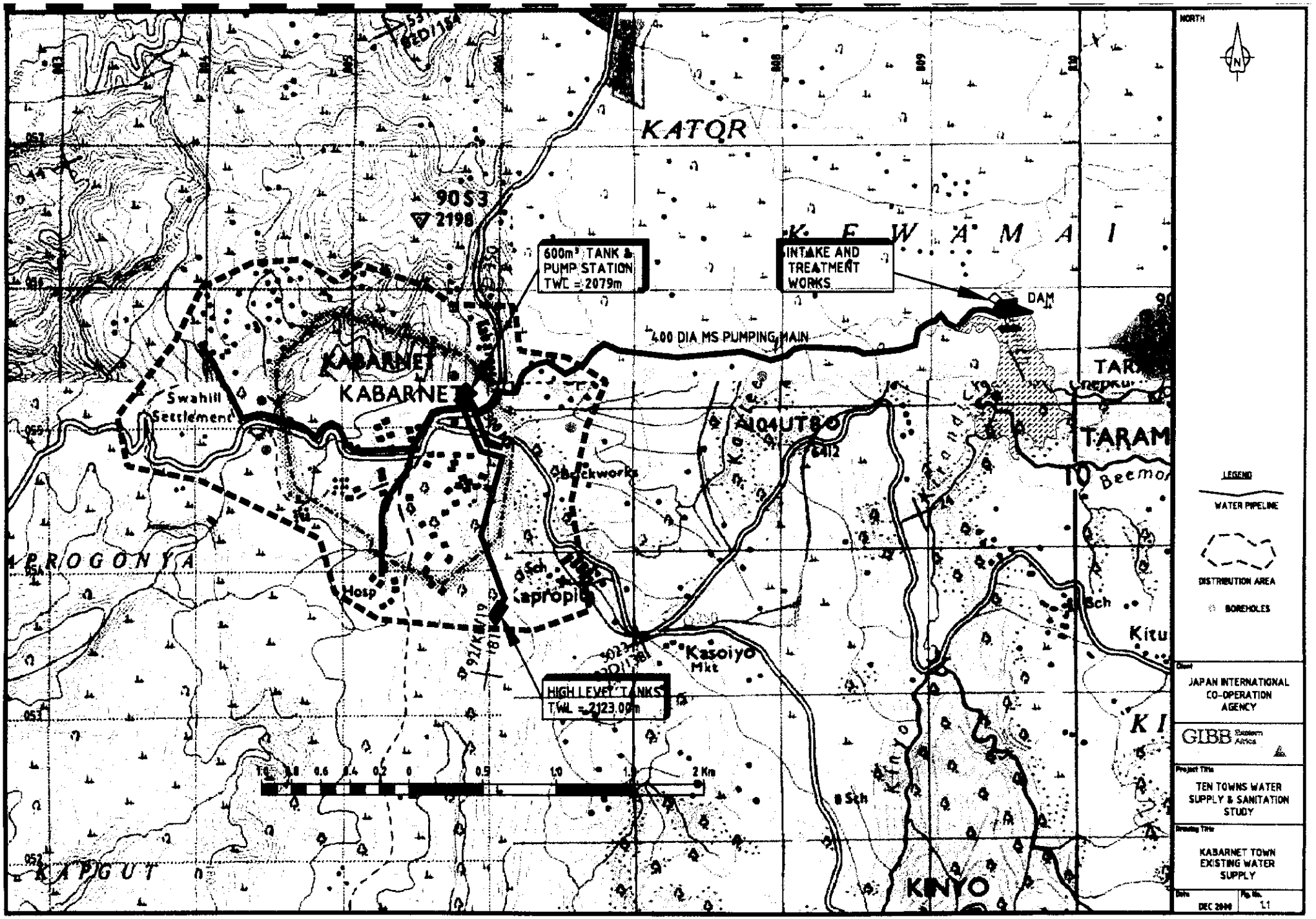
AC	Asbestos Cement (Pipe)
AFW	Accounted for water
AG	Attorney General
AIDS	Acquired Immune Deficiency Syndrome
AIE	Authority to Incur Expenditure
AMREF	African Medical Research Foundation
ASK	Agricultural Society of Kenya
ATP	Ability to Pay
bgl	Below ground level
BH	Borehole
BOT	Board of Trustees
BPT	Break Pressure Tank
CBD	Central Business District
CBR	Cost Benefit Ratio
CIM	Centre for International Migration
CMT	Core Management Team
CTB	Central Tender Board
CV	Contingent Valuation
CWS	Community Water Supplies
DAF	Daily Average Flow
DCO	District Commissioner's Office
DDC	District Development Committee

DWD	Department of Water Development
Dia	Diameter
DTO	District Treasury Office
DWE	District Water Engineer
DWF	Dry Weather Flow
DWO	District Water Office(r)
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
ENEP	El-Nino Emergency Project
FIRR	Financial Internal Rate of Return
FY	Financial Year
GAA	German Agro Action
GI	Galvanized Iron
GoK	Government of Kenya
Gph	Gallons per hour
GPS	Global Positioning System
GTZ	German Technical Assistance
H	Head
Ha	Hectares
HO	Head Office
HQ	Headquarters
IEE	Initial Environmental Examination
ITCZ	Inter-tropical Convergence Zone

JICA	Japan International Cooperation Agency
KEFINCO	Kenya-Finland Co-operation
KEWI	Kenya Water Institute
Km	Kilometer
Km^2	Square Kilometers
KP&LC	Kenya Power and Lighting Company
KR	Kenya Railways
Kshs	Kenya Shillings
L	litre
LA's	Local Authorities
L/c/d	Litres per capita per day
LPO	Local Purchasing Order
L/sec	Litres per second
M^3/day	Cubic meters per day
M^3/hr	Cubic meters per hour
MENR	Ministry of Environment and Natural Resources
MoLG	Ministry of Local Government
MTB	Ministerial Tender Board
MW	Mega-watts
NAWARD	National Water Resources Database
NEAP	National Environment Action Plan
NEMA	National Environmental Management Authority
NGO	Non-Governmental Organisation

NPV	Net Present Value
NTU	Nephelometric Turbidity Units
NWC&PC	National Water Conservation and Pipeline Corporation
NWMP	National Water Master Plan
ODA	Official Development Assistance
O&M	Operation and Maintenance
PE	Polyethylene Pipe
PSP	Private Sector Participation
PVC	Polyvinyl Chloride
PWO	Provincial Water Office(r)
Q	Discharge
RDF	Rural Development Fund
RER	Revenue Expenditure Ratio
RGS	River Gauging Station
RHS	Random Households Survey
SIDA	Swedish International Development Agency
SS	Subordinate Staff
STD	Subscriber Trunk Dialing
STW	Sewage Treatment Works
TDS	Total Dissolved Solids
ToT	Training of Trainers
T-Works	Treatment Works
UFW	Unaccounted for water

UNICEF	United Nations Children's Fund
WHO	World Health Organization
WMS	Welfare Monitoring Survey
WRAP	Water Resources Assessment Project
WS	Water System
WSS	Water Supply System
WTP	Water Treatment Plant


KATQR
K E W A M A I
90S3
2198
600m³ TANK & PUMP STATION TWL = 2079m
INTAKE AND TREATMENT WORKS
DAM
400 DIA MS PUMPING MAIN
KABARNET
KABARNET
Swahili Settlement
Backworks
Hosp
Kapropita
HIGH LEVEL TANKS TWL = 2123.00m
Kasoiyo Mkt
TARAM
Kitu
KI
KAPGUT
KINYO
PROGONYA
0 0.2 0.4 0.6 0.8 1.0 0.5 1.0 1.5 2 Km
NORTH
LEGEND
WATER PIPELINE
DISTRIBUTION AREA
BOREHOLES
Client
JAPAN INTERNATIONAL CO-OPERATION AGENCY
GIBB Eastern Africa
Project Title
TEN TOWNS WATER SUPPLY & SANITATION STUDY
Drawing Title
KABARNET TOWN EXISTING WATER SUPPLY
Date
DEC 2000
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1.1

1 INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Kenya's water and sanitation sector is in critically poor condition. Like in many developing countries, the sector is plagued by a series of problems. These problems have arisen because of lack of technically sound operation and maintenance practices resulting in a backlog in rehabilitation, and above all, poor utility management. The existing institutional framework and organizational procedures result in bottlenecks and failure to create required authority and responsibility capacity at the most beneficial levels. Lack of autonomy for the managers of water utilities at all levels is one of the key causes for sustained inferior performance.

The tremendous pressure occasioned by population increase, rural-urban migration and unplanned settlements have strained the water and sewerage schemes beyond the original design capacities.

Periodic technical and financial reviews of water services in Kenya and the Aftercare Study on Kenya's National Water Master Plan have revealed that there is need for serious re-evaluation of management of water and sanitation utilities to meet the targets of effective service delivery in support of the integrated development plans. Decentralization of decision making and management to the local levels and transferring to the private sector activities that can be carried out without compromising social, health or vital economic requirements of the population are of cardinal importance.

Against this background, the Government of Kenya recently approved the National Water Policy paving the way for legislative changes in the Laws of Kenya that touch on water activities. The changes aim at rationalizing management, decentralizing operations to the local level, creating the necessary regulatory framework and activating private sector participation in the sector, in order to obtain a more responsive management system that ensures efficient service delivery and project sustainability at the most economical cost.

JICA, one of Kenya's leading development partners, would like to help create a sustainable environment for water and sanitation service delivery systems, by supporting formulation and development of workable management arrangements in the water sector.

The Study on Institutional Improvement and Rehabilitation of Water Supply Systems for Ten Local Towns is being undertaken in order to provide Kenya with feasible, viable and implementable options that are sensitive to local conditions, especially social, environmental, economic and political.

The findings, recommendations and work plans derived from this study may then be used to develop a more comprehensive framework for rehabilitation and extension of water services to meet development objectives as enshrined in the National Poverty Eradication Plan for the rest of the nation.

The use of local initiatives such as Kitale and Nakuru to investigate the potential and/or constraints for commercialization of water services within local authority setting will be a useful barometer for the future of the National Water Policy, which envisions decentralization of water activities to local authorities in urban areas. Malindi, which is under a partnership between the National Water Conservation and Pipeline Corporation and Gauff Utility Services, will provide another alternative for comparison of performance and benchmarking.

1.2 OBJECTIVES OF THE STUDY

The objectives of the study are:

(1) To obtain the baseline information regarding the water supply systems for the ten local towns;

(2) To recommend the institutional arrangement for effective water service delivery and rehabilitation plan of the relevant facilities in the project areas;

(3) To give advice on the application of the recommendation to the other areas in the Republic of Kenya.

1.3 SCOPE OF THE STUDY

The fundamental philosophy of this study hinges on the fact that without appropriate intervention in the water supply and sanitation sector, no major improvements in service delivery will be realized. This study focuses on ten (10) towns in the Republic of Kenya namely: Meru, Lamu, Kabarnet, Webuye, Mumias, Migori, Narok, Muranga, Makindu, and Wundanyi as a pilot programme of implementing the desirable interventions which will serve as a show case for replication in the rest of the country.

The interventions entail three main components, which must go hand in hand:

(1) To restore the water supply and sanitation facility to its original technical and functional capacity by undertaking the necessary physical rehabilitation.

(2) To put in place an appropriate institution to run the water supply and sanitation facility. This institution should be more responsive to the needs of, and directly answerable to the consumers. The institution should have the legal backing and formed in line with the current National Water Policy, which advocates active private sector participation in the water sector for more efficient service delivery.

(3) To put in place an appropriate technical team of operators, with the necessary skills and equipment and tools to take over the day to day operation and maintenance of the rehabilitated facility. It is envisaged that a team starting with an efficiently functioning facility free of major repairs and replacements, and with a good management backing,

stands a better chance of achieving a self-sustaining facility within a reasonable time span.

In order to achieve the foregoing intervention goals and the overall project objectives, the study entails a two-phase strategy for collecting the relevant data and information: a Preliminary and a Pre-feasibility phase.

The preliminary study covers review of relevant data and information, diagnostic survey of existing water supply and sanitation facilities, water demand projection, revision of water supply facility plan, cost estimation and evaluation, identification of the laws and regulations of environmental impact assessment, legal and regulatory framework on facility performance. It entails basic data collection, field reconnaissance and field inspection of the utilities to assess the current condition and situation of the water supply and sanitation schemes.

The pre-feasibility study phase covers establishing the socio-economic characteristics of the study area, assessment of surface water and groundwater potential, identification of institutional and legal constrains that affect improvement in operations of water facilities and determination of viable financial and commercial plans that ensure long-term sustainability of the facilities.

The pre-feasibility phase includes review of existing data, evaluation of the technical, socio-economic, institutional and financial aspects, formulation of water supply and sanitation facility rehabilitation plans, and formulation of preliminary technical and institutional development plans on which recommendations will be based.

In addition to the ten towns that constitute the pilot programme, operational experiences have been obtained from the towns which have been undergoing the commercialization approach, promoted by GTZ, i.e. Malindi, Kitale and Nakuru, for comparison purposes. The year 2010 has been chosen as a planning horizon.

1.4 COMPOSITION OF THE FINAL REPORT

The final report comprises of a total of two volumes as follows:

Volume 1: Executive Summary
Volume 2: Main Report

As indicated by their titles, Volume 1 is a summary of the study while Volume 2 is a presentation of the full town report including supporting and back-up data.

2 EXISTING PHYSICAL AND SOCIO-ECONOMIC CONDITIONS

2.1 GEOGRAPHY OF THE STUDY AREA (CLIMATE, TOPOGRAPHY, GEOLOGY, ETC.)

2.1.1 Location

Kabarnet is the District Headquarters for Baringo District in the Rift Valley Province. The municipal area is 20 km^2.

2.1.2 Topography

Kabarnet is located in the Tugen Hills overlooking the Kerio Valley. Ground levels within the town range from 2,075 m AMSL at the main reservoir site to 1,950 m AMSL at the turnoff to the agricultural showground. High level storage on a hilltop to the south of the town is at 2,120 m AMSL.

The town's main water source, Kirandich dam, has a full supply level of 1,774.4 m AMSL and a lowest drawoff level of 1,755 m AMSL.

2.1.3 Geology

The town lies on a shield comprising Quaternary volcanic rocks, mainly trachytes, trachyphonolites, pumice and welded tuffs.

2.1.4 Climate

Rainfall in Kabarnet is plentiful, averaging over 1,400 mm per annum.

2.2 PHYSICAL INFRASTRUCTURE

2.2.1 Communications

2.2.1.1 Road links

Kabarnet is reached by taking the B4 tarred road from Nakuru to Marigat then following the C51 tarred road to Kabarnet. The town and its hinterland is served by an extensive network of good quality classified and unclassified roads.

2.2.1.2 Air transport

There is an air strip at Kipkochil to the north of the town centre. There are no scheduled flights, but light aircraft may be chartered to reach the town.

2.2.1.3 Telecommunications

Telephone services and fax facilities are available in the town.

2.2.2 Power Supply

Kabarnet is connected to the national power grid.

2.2.3 Water supply and sanitation infrastructure

This is the subject of the present study and a detailed evaluation of the water supply and sanitation infrastructure is included in the chapters that follow.

2.3 SOCIO-ECONOMIC CONDITIONS

2.3.1 Administration

Kabarnet is a cosmopolitan town located in Koibatek district in Rift valley province approximately 250 Kilometres West of Nairobi and 90 kms from Eldoret town along the Marigat-Eldoret road. The town was elevated to a municipality status in 1992 under six wards and ten sub locations. It is the administrative headquarters of Koibatek district and its Central Business District (CBD) houses offices of the district commissioner, other district departmental heads, municipal, county council and offices of a various non-governmental organizations operating in the locality. (See appendix D 1-1 for a map of the study area)

2.3.2 Population Structure and Distribution

Based on the 1999 housing and population census, the population of Kabarnet town was 16931[1] people as at 1999. These results contrast with the 1979 and 1989[2] censuses that placed the total urban population at 3,621 and 10,042 respectively. The number of households almost doubled from 2,807 in 1989 to a provisional figure of 5,700 units in 1999. The distribution of the population and number of households on the basis of sub locations is shown in table 2.1 below. Also see appendix D 1-1 for a map of the study town showing population densities.

Table 2.1 Population Structure and Distribution (1999)

Sub-Location	Number of Households	Population in urban council	Population in Service area
Kinyo	458	2,442	9803
Kapsoo / Borowoni	356	1,816	
Chebano	218	1,191	
Mosop / Kewamoi	1,158	4,689	
Special Population	-	261	
Seguton	736	2,528	
Kaprogonya	1,036	3,793	
Special Population	-	211	
Total	**3,962**	**16,931**	

Source: District Statistical Office, Kabarnet and Central Bureau of Statistics, 2001

[1] This excludes the non-residential population but includes the special population. Special population in this regard based on the 1999 census enumeration protocol includes though not restricted to people in hotels/lodgings, bus stops, police cells, on transit, idlers and street urchins found within the town as at mid-night of the census enumeration day.
[2] This census reported an under coverage of 6.3%

2.3.3 Population Projections to the Year 2010

The principal determinants of urban population growth are fertility rates and availability of job opportunities. It is assumed that the fertility rates and rural-urban migration in the area declined over the 1989-1999 inter censal period in line with the national trend and related to the stated government policy objective of setting up small and medium scale enterprises in rural areas in order to stem urban population pressure. The total effect is therefore a population growth rate that is more or less similar to the 1979-1989 inter censal growth rate of 3.6%. Other factors considered include improved access to medical services, high literacy rate among women, improved infrastructure facilities as well as growth in formal and informal sectors among others. The District Development Committee and the municipal town planning department uses this rate for their planning purposes. Table 2.2 below therefore gives the annualized population projections for the town over a ten year period based on the provisional results of the 1999 housing and population census.

Table 2.2 Population Projection[3] to the year 2010.

Year	**Area under Municipal Council**
2000	17500
2001	18200
2002	18800
2003	19500
2004	20200
2005	20900
2006	21700
2007	22500
2008	23300
2009	24100
2010	25000

2.3.4 Economic and Commercial Activities

The major economic activities in Kabarnet town are restricted commercial enterprises such as the jua kali sector, retail and wholesale businesses, hotels, bars, colleges, bank as well as non-bank financial institutions. Another growing industry is the transport business involving use of matatus. The cumulative effect of these economic activities is population growth and a derived demand for water and other urban utilities. Peri urban households engage mainly in pastoralist related activities such as keeping cattle and goats. These activities primarily form a capital base for the local residents who converge in the town on market days putting pressure to an already over stretched water supply network. Table 2.3 gives a summary of the major commercial and business activities in Kabarnet town

[3] Projections based on the following formula [$P_{projected} = P_{actual}(1+r)^t$] where r=rate of pop growth and t= year and the base year is the 1999 estimated population rounded off to the nearest 100.

Table 2.3 Summary of Commercial and Business Activities

Business type	1994	1995	1996	1997	1998	1999
Slaughter Houses/ Slabs	1	1	1	1	1	1
Hotels	1	1	2	2	3	3
Bakeries	1	1	1	1	1	1
Petrol Stations	1	1	1	2	2	2
Laundries	1	2	2	1	1	1
Lodgings	3	3	5	6	6	6
Bars	4	8	8	9	10	11
Caterers Inns	16	12	25	22	21	25
Dairies	-	1	2	2	6	6
Salons	5	8	9	10	18	33
Butcheries	8	8	19	17	25	25
Total	**41**	**46**	**75**	**73**	**94**	**114**

Source: District Trade Office, Kabarnet

2.3.5 Social Infrastructure

2.3.5.1 Communication

The town is served by an all weather road classification B from Marigat to Eldoret and plans are underway to build to bitumen standard in all adjoining roads. The town also has an airstrip for light planes. The town is therefore well connected to all the major towns within the region. Electrical power supply for the town is from the national grid. Other services include subscriber trunk dialing (STD) telephone services, fax facilities as well as Internet service bureaus.

2.3.5.2 Social Institutions

The growth of Kabarnet town is dependent on the favourable environment created for investment especially from the locals who mainly own the small to medium scale enterprises. The outreach activities of non-governmental organisations also have a positive influence on the town through their poverty-focussed programmes. The growth in establishment of such institutions as schools and health facilities has been phenomenal. The main types of institutions and their numbers are summarized in the tables 2.4 and 2.5.

Table 2.4 Educational Institutions

Type of institution	Number
Pre-Primary Schools	29
Primary Schools	14
Secondary Schools	7
Medical Training College	1
Youth Polytechnics	6
Total	**57**

Source: District Development Office Kabarnet, 1999

Table 2.5 Other Social Institutions

Facility	Number
District Hospital	1
Dispensaries (GoK)	1
Private Clinics	13
Mosques	1
Community hall	1
Fire fighting equipment	2
Total	**19**

Source: District Development Office Kabarnet, 1999

2.3.6 Income Levels

The distribution of income in the town is quite uneven. Though there are numerous non-governmental organizations with offices within the town that cumulatively address the rapidly rising levels of poverty, their focus has over the time been on rural households. It is considered that urban households earn more income (through wages, salaries and profits) than their peri urban counterparts who mainly rely on agriculture and sale of livestock products. According to the findings of the Welfare Monitoring Survey (WMS) II, the mean monthly household income for Kabarnet is estimated to be Kshs. 9,532.9 and an annual per capita income estimated at Kshs. 27,556 per annum Table 2.6 below the mean monthly household incomes

Table 2.6 Mean Monthly Household Incomes

Income source	Mean income
Wages/salaries/profits	3623.8
Other Non-agriculture income	2712.9
Agriculture income	2924.4
Crop income	271.9
Total household income	**9532.9**

Source: Welfare Monitoring Survey II, 1994

About 46% of the urban households mean monthly income is drawn from wages, salaries and profits. Despite the absence of slums in the town, there still exist some economically disadvantaged people. However in times of water shortage, most peri-urban population rely on rural water schemes such as boreholes to supplement the shortfalls.

2.3.7 Willingness and Ability to Pay for Water Services

2.3.7.1 Ability to Pay

Ability to pay is a function of level of household incomes, the acceptable share of water/sewerage services in total expenditures, tariffs and the target consumption levels. The main consideration in the ability to pay for water in this study is the household level of income vis a viz their commitment to access safe and clean drinking water. Generally, the ceiling on the proportion of income that may be spent by an average household to access water and/or sewerage services is usually taken to be 5% of their total income. This figure normally varies from one income group to another. However, households in the lower income bracket spent a higher proportion of their income in real terms on water than households in the middle to high-income group who spent a paltry 2.2% and 1.4 % of their incomes respectively.

About 30% of the designated urban population of Kabarnet town lives in the low-income bracket under poor sanitary conditions based on crude poverty estimates. This group mainly draws water from rural based community water schemes and boreholes with a few drawing water from the nearby stream in times of acute water shortage. Therefore, a re-evaluation of their income levels and W/ATP is integral and forms an important component of the perceived water and sanitation improvement plan.

2.3.7.2 Willingness to pay

To get information on willingness to pay[4], the study team carried out a random survey on a sample of 80 households mainly within the service area. Three methodologies were adopted and this were mainly focus group discussions especially with key personal dealing with water in the town, individual observations as well as use of elaborate questionnaires. Through questionnaire based interviews, each household head was asked questions on how much they would be willing and able to pay for a cubic meter of water under two scenarios. Questions asked in scenario one were based on the household's willingness to pay for water under existing circumstances where as in scenario two, households were asked questions relating to how much they would be willing top pay if the existing water supply conditions were improved. In both cases, the general conclusion of the survey was that most households were willing to pay more for an improved water service delivery system commensurate with the level of tariff. This was also found to be in tandem with consumer expectations and perception of the problem in a particular service area since not all consumers faced similar service delivery problems.

The preliminary analysis of information collected indicated that over 80% of the households interviewed were willing to pay up to Kshs. 700 for actual water consumption compared to an average monthly bill of Kshs. 300 based on guestmates. A similar survey in the areas not currently serviced established that a majority of the households would be willing to pay for water at the current general water tariff of Kshs. 30/m^3.

[4] The appropriate methodology in estimating willingness and ability to pay (W/ATP)/ willingness and ability to accept (W/ATA) is to use the contingent valuation (CV) approach. This approach is validated through asking water consumers at the household level hypothetical questions (which are a true reflection of actual water consumption levels) how much they are paying for water as compared to how much they would be WTP if existing water supply externalities are internalized.

Simulations to establish the threshold tariff beyond which people would not be willing to pay revealed that even with increment of up to 30% in the tariff, people would still be willing to pay.

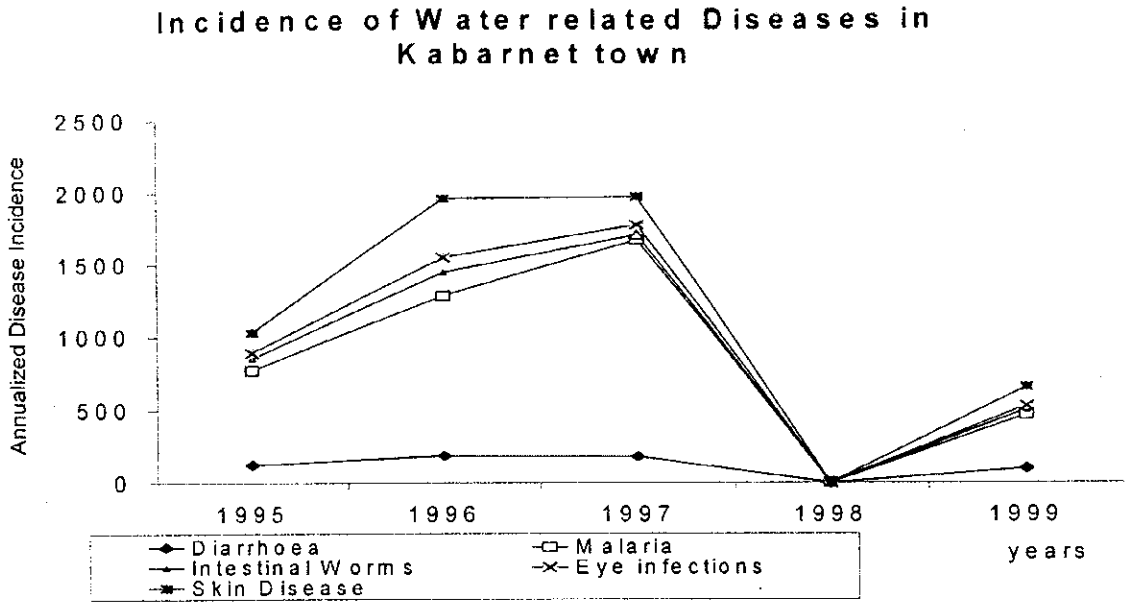
2.3.8 HEALTH AND SANITATION SITUATION.

The water and sanitation situation was critically analyzed and the incidence of water related diseases appropriately examined with the guidance of the local district public health officer. It was noted that the incidence and occurrence of water borne diseases was mild mainly due to high literacy levels within the urban population as well as the positive people's health seeking behaviour (both rural and urban). However, the incidence and prevalence of diarrhoea adjusted for seasonality on an annual basis was found to be quite low but constant over a retrogressive period of five years from 1999. Occurrence of malaria in the town was found to be major cause of morbidity after coughs as the town lies within a hypo-endemic malaria zone. Community participation in public health campaigns is enhanced by their good fundraising efforts through merry-go-rounds. Resulting arrangements enable communities to charge a prepaid economic price for clean water. However, mobilization of rural folks is much easier than in urban areas.

Table 2.7 Cases of Water related diseases for the year 2000

Month	Number of cases
January	1072
February	1337
March	1942
April	2224
May	2464
June	2231
Total	**11,270**

Source: Public Health Office, Kabarnet



Source: Health Information Systems Unit, MoH and PHO's Kabarnet, 2000

2.3.9 TYPES OF SETTLEMENTS

The predominant features of housing structures especially within the peri urban areas of town are mud walled structures that lack piped water. There are no slums in Kabarnet town and the settlement pattern follow initial development plans for the civil servants housing. For more information on patterns of settlement, see appendix D 1-1 in annex.

The following are the housing estates in Kabarnet town.

Table 2.8 Housing patterns

Estate	Status
Hospital	(M)
Game (KWS)	(A)
Milimani	(A)
Bondeni	(L)
Police	(L&M)
Kapropita	(M&A)
Kaptimbor	(L)
Choboli	(L&M)

Source: District Development Office, Kabarnet

Key: A -High Income housing; M -Medium income housing; L -Low-income

Within the peri urban areas, housing conditions not deplorable, as the town has no slum dwellings. However, mud walled semi permanent structures and prevalent. The distribution of the population on the basis of incomes within the municipality are as shown below

Table 2.9 Distribution of income on broad income categories for Kabarnet

Income category	Number	Percentage
High income	4063	24
Middle income	7788	46
Low income	5080	30
Total	**16931**	**100**

2.3.10 Situation of Women in Society

Women make up a disproportionately large share of the poor and very poor in urban areas as they are particularly vulnerable to many factors that create and perpetuate poverty. Most families whether poor or not may not be able to survive without the help of female family members. However, for the urban population, water collection remains a preserve of women and only forms one of their major social roles among many other economic activities within the household. Therefore, women in Kabarnet like other parts of Kenya are traditionally responsible for collecting water for domestic use in the household. This when weighed against other domestic chores such cooking and tendering calves makes them a major vulnerable group in society. It is considered that inadequate access to water in a household can therefore have negative repercussions on the length and hardship of an average day of a poor woman's working day. This therefore means that the rehabilitation exercise planned for the towns must meet societal expectations. Such that the impact of the planned programmes on an average woman's workload will remain as a key indicator since it affects their priorities in family care. Other than situations where donkeys are used, the burden for carrying water requires women to have a substantial amount of energy irrespective of whether one's focus is on urban or peri-urban focus. This condition is energy sapping and causes considerable stress especially to pregnant women leading to multiple complications at childbirth. Other causes of stress include headaches, backaches, sometimes and deformation of the spine. Accidents do occur and these include slipped discs, paralysis, injury to children carried on the back to extreme cases such as strangulation by the head strap. Improved water supply conditions would change all these and ease the burden on women, releasing time and energy for other development activities necessary in nation building.

2.4EXISTING WATER RESOURCES, MANAGEMENT AND UTILISATION

2.4.1 Hydrogeology and occurrence of groundwater

Hydrogeological conditions in the Kabarnet area can be summarised as follows:

- Depth range to the main aquifer: 50 – 130 m.
- Depth range of water rest level: 5 – 100 m.
- Discharge range: 10 – 25 m^3/hr.
- Water quality: generally fresh, neutral sodium bicarbonate waters, but some waters may exhibit alkalinity. The ionic concentrations of silica and iron are occasionally high.

Aquifers are either confined or leaky, and comprise intercalated sediments, volcaniclastic material, weathered or fractured rock. Recharge to the aquifers occurs by lateral underflow from recharge catchments, especially the Tugen Hills which are higher than the Kabarnet Ridge. Local infiltration on the ridge also contributes to recharge. The occurrence of lateral recharge assumes hydraulic continuity between the two areas, but this has to be proven. Otherwise, groundwater recharge in the Kabarnet would be limited to local infiltration only, as it is at a topographical high.

Analysis of test pumping data leads to the conclusion that the boreholes near the town struck limited aquifers (i.e. aquifers with negligible or no recharge). This is consistent with the recharge characteristics outlined above.

2.4.2 Status of existing boreholes

There are known to be six existing boreholes that were once operated by the Ministry of Environment and Natural Resources (MENR) or the National Water Conservation and Pipeline Corporation (NWCPC). These are serialised as follows:

- Borehole No. C 3506 (opposite District Water Office).
- Borehole No. C 4722 (within District Water Office compound).
- Borehole No. C 4780 (abandoned borehole at Kator).
- Borehole No. C 10196 (Kabarnet Deaf Blind School).
- Borehole No. C 11197 (Stadium).
- Borehole No. C 11261 (river borehole, drilled 1996 but not equipped).

Borehole Nos C 3506 and C4722 are located at the District Water Office. Borehole No. C 4722 has been abandoned, but Borehole No. C 3506 is still in production. The boreholes discharge to a masonry tank where disinfection is carried out using calcium hypochlorite. Disinfected water is then pumped into the distribution system. The current production of Borehole No. C 3506 was reported as 12 m^3/hr, although at the time of construction it was tested at 13.6 m^3/hr. Borehole No. C 4722 was initially tested at 17.2 m^3/hr, but was reported to be pumped at 16 m^3/hr when in production.

Table 2.10 presents data for the existing MENR and NWCPC boreholes.

Table 2.10
Completion Data: MENR and NWCPC Boreholes

SERIAL No.	Total depth (m)	Water strike levels (m)	Rest level (m)	Tested yield (m^3/hr)	Completion date
C 3506	152	23 103	13.1	13.6	27.07.68
C 4722	155	30 64 132	15.9	17.2	18.03.80
C 4780	150	64	4.6	13.5	14.05.81
C 11197	179.6	79 110	97.5	22.3	20.11.95
C 11261	195	13 107 125	18.3	11.1	10.01.96

Data source: NAWARD, MENR, Nairobi.

2.4.3 Groundwater potential

2.4.3.1 Hydrogeological units

The groundwater bearing strata of the Kabarnet area are limited to pyroclastics intercalated in the volcanic flows (mainly volcanic sand and pumiceous fragments), volcanic sediments sandwiched between successive flows, weathered trachytic or tuffaceous rocks and fractured trachytic rocks. Weathered tuff does not particularly rate as a good aquifer, due to the formation of clay minerals in the last stage of the weathering process. Trachyte can develop good secondary porosity when fractured. Aquifers in volcanic sand and sediments often are better than in weathered volcanic rock, except where the sediments are clayey.

2.4.3.2 Recharge

Recharge to the aquifers at high elevation on the Kabarnet catchment is mainly through local infiltration. Lower elevation aquifers at the foot of the ridge get additional recharge from lateral underflow from the Kabarnet catchment. The catchment area is small, which in turn leads to insufficient recharge. This is perhaps demonstrated best by the test pumping results for Borehole Nos. C-11197, C-11261 and C-4722, which all indicate limited aquifers. In contrast, however, Borehole No. C-4780 showed recharge during the pumping test. This apparently indicates it is hydraulically connected to the Kapleel River where it was drilled.

2.4.3.3 Outlook for sustained groundwater abstraction

Although the aquifers are high yielding, they are largely limited and do not get sufficient recharge in normal rainfall years. The effect of continued

groundwater abstraction would be to permanently lower the groundwater table. In order to continue using the existing boreholes longer, it would be wise to set up a monitoring programme so that water level time series data can be collected. These will help in determining the optimum abstraction rate for aquifers in the area.

2.4.4 Groundwater quality

An analysis of groundwater from Borehole No. C 3506 made on 8 March 1994 showed:

- A pH of 7.6.
- Alkalinity of 46 mg/l as calcium carbonate.
- Hardness of 30 mg/l as calcium carbonate.
- Dissolved carbon dioxide of 10 mg/l.

The reported anions and cations, and the calculated ionic balance assuming all alkalinity is bicarbonate, given in Table 2.11.

Table 2.11
Reported groundwater quality – Borehole No. C 3506

Cation	mg/l	meq/l	Anion	mg/l	meq/l
NH_4^+	ND	0.000	Cl^-	14	0.406
Na^+	16	0.696	NO_2^-	0.01	0.000
K^+	5.8	0.148	NO_3^-	ND	0.000
Ca^{2+}	8	0.399	F^-	0.4	0.021
Mg^{2+}	2.5	0.206	HCO_3^-	56	0.918
$Fe^{2+,3+}$	ND	0.000	CO_3^{2-}	ND	0.000
Mn^{2+}	ND	0.000	SO_4^{2-}	4.6	0.096
			PO_4^{3-}	0.01	0.000
Sum		1.449	Sum		1.441

The ionic balance is excellent. Although iron and manganese concentrations were not determined, they must be close to zero as the hardness calculated from calcium and magnesium alone tallies with the reported hardness. Chemically, the water is sodium bicarbonate type.

Soft waters are often aggressive. The charts given in the 1986 MENR Design Manual show that water with a hardness of 30 mg/l and a carbon dioxide content of 10 mg/l will be extremely aggressive towards concrete and very aggressive towards steel. The calculated ion activity product for calcite shown below supports this.

Table 2.12
Groundwater saturation with respect to calcite

Temperature (°C)	10	15	20	25
$[Ca^{2+}]$ (mol/l)	2.00E-04	2.00E-04	2.00E-04	2.00E-04
$[CO_3^{2-}]$ (mol/l)	1.19E-06	1.36E-06	1.53E-06	1.71E-06
$IAP_{calcite}$	2.37E-10	2.71E-10	3.06E-10	3.41E-10
Dissociation constant for calcite	6.37E-09	5.82E-09	5.33E-09	4.9E-09
Saturation	3.7%	4.7%	5.7%	6.9%

The sample is undersaturated with respect to calcite, and will attack concrete, asbestos cement pipes, etc.

2.4.5 Hydrology

Kabarnet is located in the Tugen Hills, an area of dramatic mountainous topography. The hills were formed by faulting and tilting of the Rift Valley. Rocks are thus of volcanic origin. Soil cover is thin, slopes are steep, and the potential storm water runoff is high. There is forest cover on the hilltops with significant cultivation. Cultivation can be seen developing on the steep slopes with consequent erosion

The western slopes of the Tugen Hills drain into the Kerio River, whilst the eastern slopes drain into the Lake Baringo catchment. Surface water sources near Kabarnet are limited. The 1985 *"Central Baringo Water Development Plan"* identified dam sites on the Kapleel and Kirandich rivers respectively. They are in Drainage Area 2-the Rift Valley and in Sub-Drainage Area 2EH. These two sites are to the east of Kabarnet, and the Kirandich site has recently been developed. The general layout of geographical features in and around Kabarnet are shown in the figure 2.1.

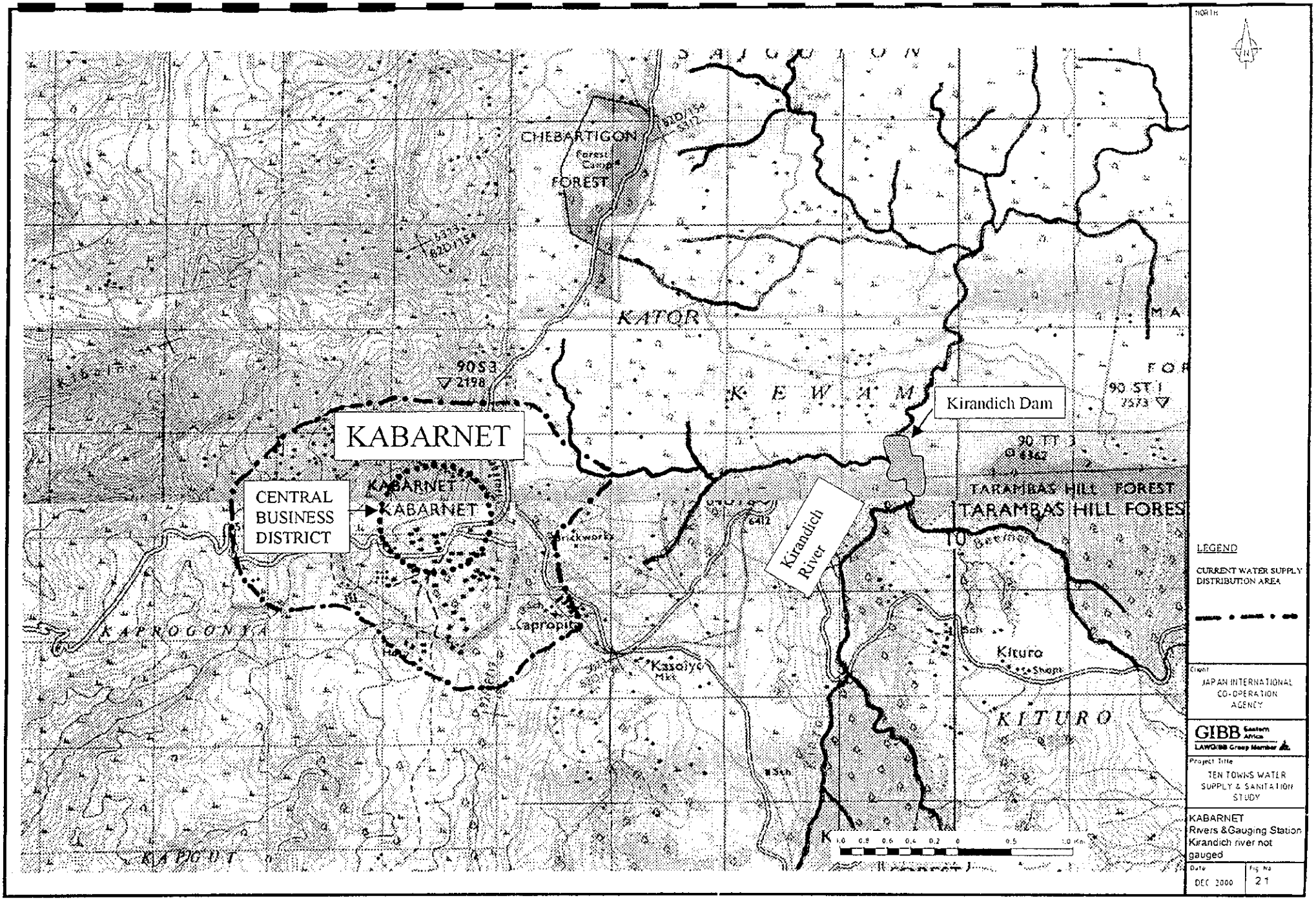
The catchment of Kirandich Dam comprises three rivers draining a total area of 30 km^2, as follows:

- Kinyo River.
- Beemoi River.
- Kapleel River.

The only gauging station is located on the Kinyo River with details summarised in Table 2.13.

Table 2.13
River gauging station on Kinyo River

River	Gauge Ref. No.	Catchment area km^2	Record Period	Rated
Kinyo	RGS 2EH2	9.25	1976 –1981	Yes


NORTH
CHEBARTIGON
Forest Camp
FOREST
KATOR
K E W A M
Kirandich Dam
KABARNET
CENTRAL BUSINESS DISTRICT
KABARNET
KABARNET
Kirandich River
TARAMBAS HILL FOREST
TARAMBAS HILL FORES
Capropita
Kasaiyo
Kiturq
KITURO
KAPROGONYA
KAPCHUT
LEGEND
CURRENT WATER SUPPLY DISTRIBUTION AREA
Client
JAPAN INTERNATIONAL CO-OPERATION AGENCY
GIBB Eastern Africa
LAWGIBB Group Member
Project Title
TEN TOWNS WATER SUPPLY & SANITATION STUDY
KABARNET
Rivers &Gauging Station
Kirandich river not gauged
Date
DEC 2000
Fig No
21

The catchment hydrology was studied in a report entitled *"Emergency Water Supply Programme, Kabarnet Water Supply, Kirandich River Dam Project, Hydrological Study"*, prepared in 1989 by G&G S.p.A Consulting Engineers for the Ministry of Water Development. In view of the short period of available record, the design consultants simulated river discharges from rainfall by means of the *Pitman* model. The simulated average monthly discharges at the Kirandich dam are presented in Table 2.14.

Table 2.14
Simulated monthly discharges at Kirandich River Dam

Month	Runoff m^3
January	165,000
February	79,000
March	213,000
April	499,000
May	919,000
June	968,000
July	1,170,000
August	1,713,000
September	1,086,000
October	406,000
November	599,000
December	376,000
ANNUAL	**8,193,000**

The annual total averages 8,193,000 m^3 per annum, but varies within the range 510,000 m^3 p.a. to 26,880,000 m^3 p.a. The Kirandich reservoir was constructed to regulate flows and provide a sustainable yield.

The Kirandich dam was built to the maximum storage capacity afforded by the site topography. The design consultants assessed the sustainable yield to be 12,800 m^3/day. The yield is contrasted with demand in Table 2.15.

Table 2.15
Comparison of Kirandich dam yield and water demand

	m^3/day
Yield from Kirandich dam	12,800
Water demand in 2000	2,746
Projected water demand in 2010	4,053

The yield is more than adequate to meet future demand.

The Kirandich reservoir is however liable to pollution from the upper catchment of the Kapleel tributary as this lies within Kabarnet municipality. This is seen as a long-term drawback for which appropriate drainage and sewerage measures will be required in Kabarnet.

3 EXISTING WATER SUPPLY CONDITIONS

3.1 WATER SOURCES

Kabarnet has two surface water sources:

- Kirandich dam and water treatment plant.
- Kapchemuswo dam and water treatment plant, which can be used to supply Kabarnet agricultural showground and surrounding areas.

There are also four boreholes pumping groundwater into the town's distribution system. The various water supply systems are shown schematically in Figure 3.1 and described in the following sections.

3.2 KIRANDICH DAM AND WATER TREATMENT WORKS

3.2.1 General

This water supply scheme, funded by the Government of Italy, was completed in 1999. The main works are under maintenance by the Contractor, who is also grouting at a fault under the dam, and constructing sediment traps in the catchment.

3.2.2 Kirandich dam

Kirandich dam is a 55 m high rockfill dam impounding a reservoir of 4,000,000 m^3.at a full supply level of 1,744.4 m AMSL. The live storage above the minimum drawoff level of 1,755 mAMSL is 3,250,000 m^3. The reservoir was part full at the time of inspection and is still filling. The reservoir outlet consists of two gravity mains leading to a water treatment works constructed at the toe of the dam.

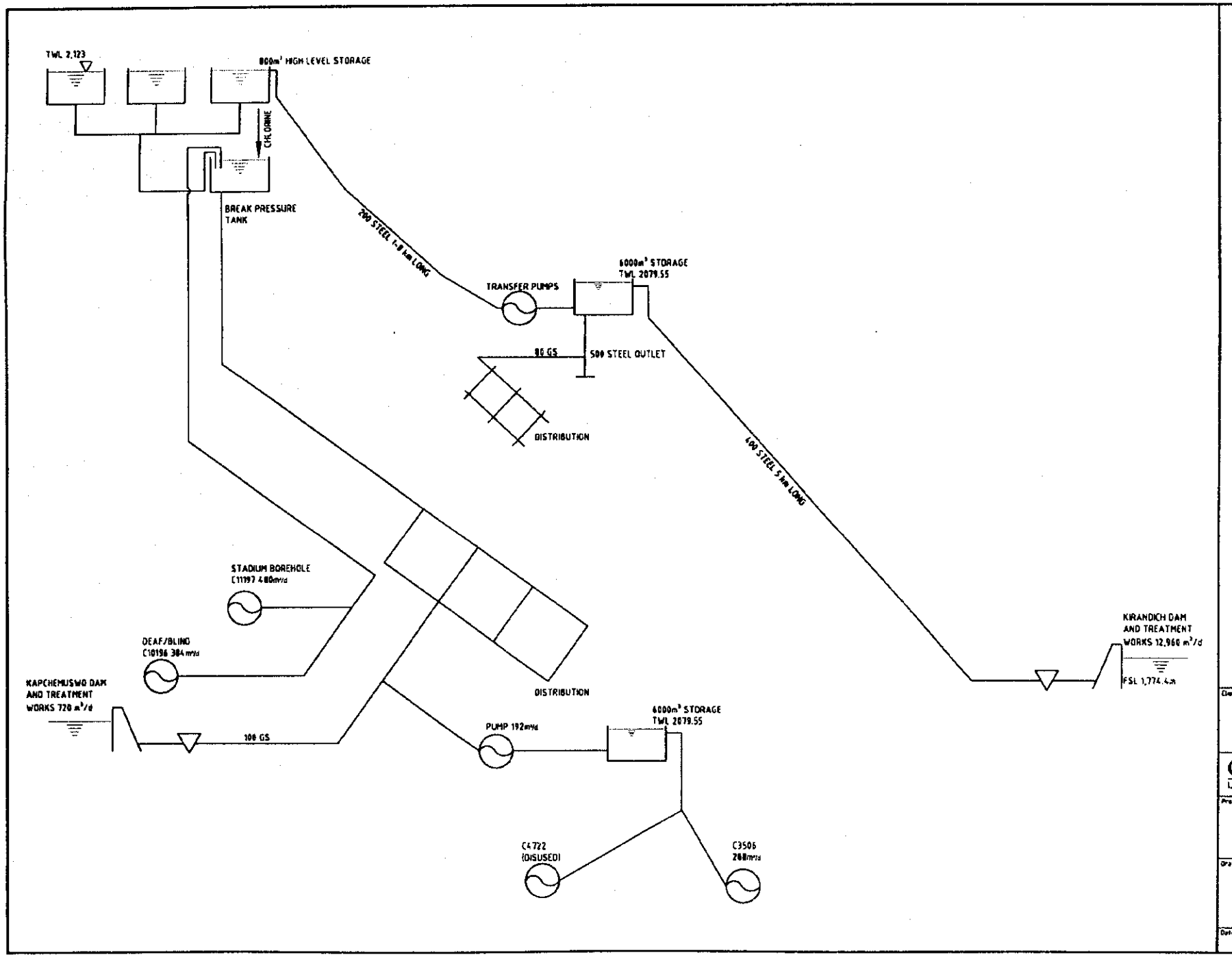
3.2.3 Kirandich Water Treatment Works

The water treatment plant, shown schematically in Figure 3.2, has a reported capacity of 14,000 m^3/d. The treatment process is as follows:

- Aeration.
- Clarification in upward-flow, sludge-blanket clarifiers.
- Rapid gravity filtration.
- Disinfection.

At the time of inspection, the plant was not in operation.

The aerator at the head of the works is a simple, tray aerator with no contact media. After aeration, raw water is dosed with aluminium sulphate at a rate of



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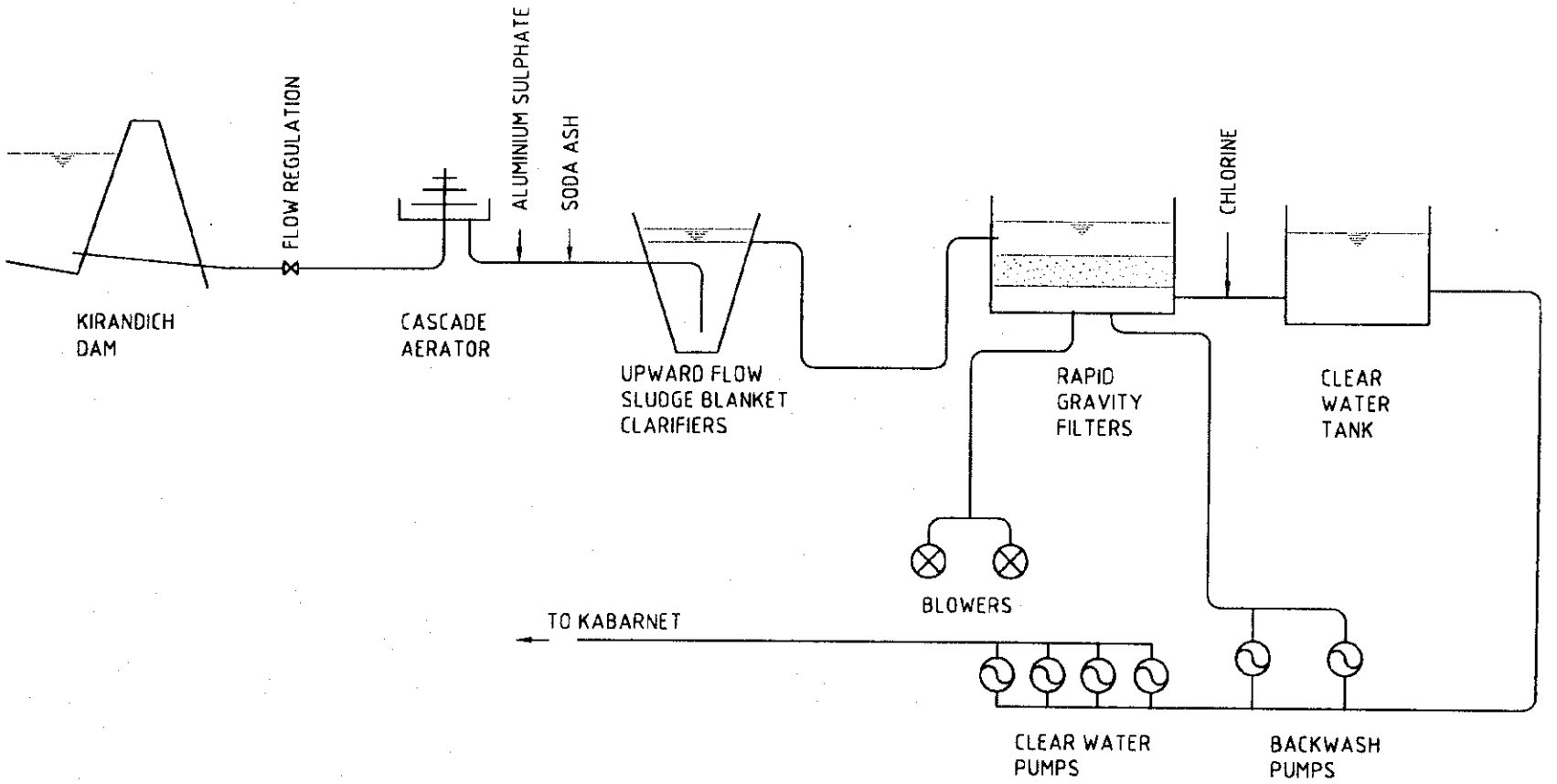
LAWGIBB Group Member

Project Title
TEN TOWNS WATER SUPPLY & SANITATION STUDY

Drawing Title
KABARNET WATER SUPPLY

Date: DEC 2009
Fig. No.: 3.1



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LAWGIBB Group Member

Project Title:
TEN TOWNS WATER SUPPLY & SANITATION STUDY

Drawing Title:
KABARNET(KIRANDICH) TREATMENT PROCESS 14,000m³/d

Date: DEC 2000

Fig. No. 3.2

20 mg/l and soda ash at a rate of 16 mg/l. The dosing point is above an overflow weir: there is no other provision for chemical flash mixing.

The clarifiers comprise eight reinforced concrete upward flow units, each some 6 m square. After clarification, water is passed through six rapid gravity filters.

The filters are washed using one duty plus one standby KSB Italia 80-160 end suction pumps rated for 200 m^3/hr against 24 m head. The pumps are driven at two-pole speed by D180M frame size motors rated for 22 kW. The pumps are located in the main machinery room next to the clarifiers.

The filters are scoured using one duty plus one standby Robuschi KRB-D1 70 blowers rated for 1,100 m^3/hr against 6 m water head. The blowers are located at the end of the filter gallery.

After filtration, water passes to an underground reinforced concrete clear water tank next to the main machinery room. A spiral ramp on the roof of the tank serves no apparent purpose.

The chemical preparation and dosing facilities are located on a plateau above the treatment works. Chemicals are dosed under gravity.

The works are manually operated: there are no solenoid-controlled valves, etc.

There are no facilities for sludge thickening or disposal. The intention appears to be to discharge back into the river downstream. This will need to be addressed from an environmental perspective.

3.2.4 Kirandich clear water pumps and rising main

Treated water is pumped to Kabarnet through a 400 mm nominal diameter steel main with a pressure rating of 40 bar. The pipeline is laid across country with no access road, but the NWCPC Area Manager reports that it is some 4 km long. The treated water pumps, located in the main machinery room, comprise three duty plus one standby KSB Italia WKF 125/5 horizontal multistage units driven at two-pole speed by 280 kW low voltage motors. Each pump is rated for 180 m^3/hr against a head of 351 m, giving a rated station output of 12,960 m^3/d. The NWCPC Area Manager reports that the static lift from Kirandich to Kabarnet is 333 m and that the pumps generate a head of 370 m when in operation.

3.2.5 Standby generator and Kirandich water treatment works

The Kirandich water treatment site is provided with standby diesel generating plant, but the NWCPC Area Manager reports that this is too expensive to operate.

3.3 KAPCHEMUSWO DAM AND WATER TREATMENT WORKS

3.3.1 Kapchemuswo Dam

This "dam" is a length of road embankment without a drainage culvert that impounds water against the upstream face. Operations staff report that the dam is used as a source of water for the Kabarnet agricultural showground. At the time of inspection, the source was not being used. A schematic layout of the system is given as Figure 3.3.

3.3.2 Kapchemuswo raw water pump

Water is abstracted from the dam using a Flygt submersible pump suspended from a raft in the impoundment. The pump delivers through 4" galvanised steel tubing to a package treatment plant on the downstream side of the road. The pump was installed in 1993, since when it has been operated for 1,622.50 hours.

3.3.3 Kapchemuswo package treatment plant

The package treatment plant comprising two circular steel clarifiers and two pressure filters was supplied and erected by Davis and Shirtliff in 1993. The nominal capacity of the plant is 30 m^3/hr.

3.3.4 Kapchemuswo clear water pumps and rising main

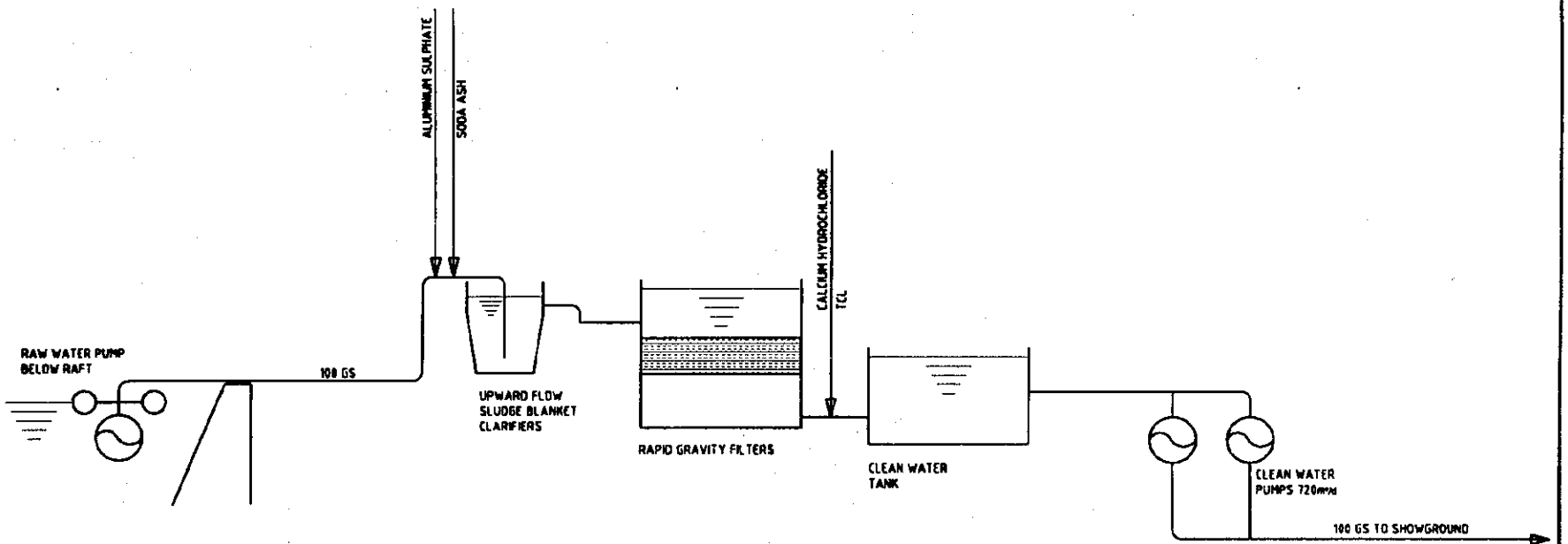
The clear water pumps are one duty plus one standby Grundfos CR30-160 vertical multistage units, each rated for 30 m^3/hr against 171.7 m head. The pumps are driven at 2-pole speed by D180M frame size motors rated for 22 kW. Since installation in 1993, the clear water pumps have operated as follows:

- Clear water pump 1 591.13 hours
- Clear water pump 2 1,498.64 hours

The rising main from the package treatment plant to the showground in 4" galvanised steel tubing. Beyond the showground, the pipe continues as 2" galvanised steel tubing to join the town distribution system below the District Water Office.

3.3.5 Standby generator at Kapchemuswo

There is a standby generator rated for 60 kVA at the Kapchemuswo treatment plant site. This generator has only been operated for 5.81 hours.



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TEN TOWNS WATER SUPPLY & SANITATION STUDY

Drawing Title
KABARNET KAPCHEMUSWO TREATMENT PROCESS

Date: DEC 2000
Fig. No.: 3.3

3.4 BOREHOLES

3.4.1 Boreholes at the District Water Office

A schematic layout of this system is given as Figure 3.4. There is one abandoned borehole in the District Water Office yard (C 4722) and a production borehole (C 3506) in the compound on the opposite side of the road. Borehole No. C 4722 had a reported yield of 16 m^3/hr, and the current production Borehole No. C 3506 reportedly yields 12 m^3/hr. At the time of inspection, Borehole No. C 3506 was in use.

Borehole No. C 3506 delivers to a circular tank in the same compound. The tank has an outside diameter of 6.2 m and an overall height of 2.14 m. Calcium hypochlorite solution is dosed into the tank under gravity. The building housing the borehole switchgear also houses a Grundfos CP8-200H horizontal multi-stage pump that delivers chlorinated groundwater into the distribution system.

3.4.2 Borehole at Kabarnet School for Deaf Blind Children (Serial No. 10196)

This borehole is equipped with an electro-submersible pump that delivers water to break pressure tanks at Kabarnet Secondary School for disinfection. The borehole, with a reported abstraction rate of 16 m^3/hr, was drilled and equipped in 1998. The borehole headworks pipework includes a 3" flow meter that indicates 25,524 m^3 of water has been pumped. Operational staff report that the borehole is used as an emergency standby facility and is not in regular use.

At the time of inspection, operational staff could not gain access to the switchgear house as the lock had been changed.

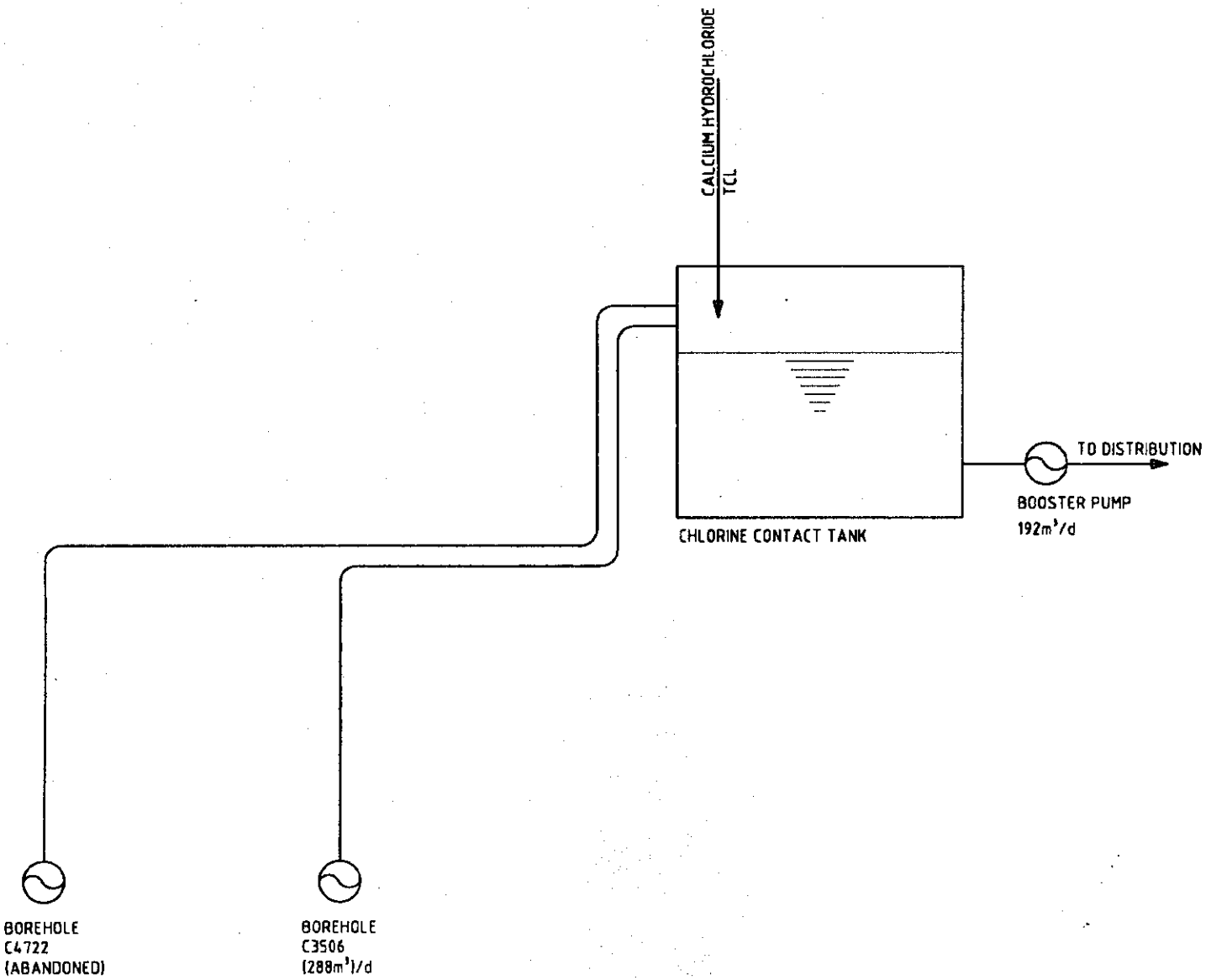
3.4.3 The 'Stadium' borehole (Serial No. C 11197)

This borehole is located next to the town's football pitch. It was also drilled and equipped in 1998 and again pumps to break pressure tanks at Kabarnet Secondary School for disinfection. The reported abstraction rate is 20 m^3/hr and the total hours run was 12,866.37 at the time of inspection. The 3" flow meter on the delivery pipework has a broken cover and the meter cannot be read. At the time of inspection, the borehole pump was not being used.

3.5 STORAGE

3.5.1 Main storage site

The clear water pumps at Kirandich dam deliver water to a newly constructed 6,000 m^3 reinforced concrete service reservoir adjacent to the NWCPC offices in Kabarnet. The reservoir has a top water level of 2,079.55 m AMSL. The main outlet from the tank is 500 mm nominal bore, but this terminates at the bottom of the access road.



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Project Title
TEN TOWNS WATER SUPPLY & SANITATION STUDY

Drawing Title
KABARNET
BOREHOLES C3506 & C4722
WATER
SUPPLY

Date
DEC 2008

Fig. No.
3.4

3.5.2 Booster pump station

There is a booster pump station adjacent to the main service reservoir. This contains:

- One generator set driven by a Deutz diesel engine rated for 10 kW at 1,500 rpm.
- Three KSB Italia WKF 65/2 horizontal multi-stage pumps rated for 56 m^3/hr against 57 m head, one driven by a Deutz diesel engine rated for 27 kW at 3,000 rpm and the others by D180M frame size 22/25 kW two-pole electric motors.

The pumps deliver to high level storage tanks through a 200 mm nominal bore steel main some 1,600 m long.

3.5.3 Upper storage tanks

The booster pumps deliver water to three high-level storage tanks on the hilltop behind Kabarnet Secondary School. These tanks have reported capacities of 400 m^3, 200 m^3 and 200 m^3, or 800 m^3 in total. The top water level for these reservoirs is 2,123 m AMSL.

3.5.4 Break pressure tanks at Kabarnet Secondary School

At present, the town is being supplied from the high-level storage tanks. To avoid excessive pressures in low-lying areas, the pressure is being broken at Kabarnet Secondary School.

3.6 DISTRIBUTION

3.6.1 Distribution pipework

The town's distribution system is small-bore galvanised steel tubing laid on or just below, the ground. Operational staff report that the gravity flow from the 6,000 m^3 service reservoir is severely restricted by the size of the outlet pipework (500 mm reducing to 3" then 1"). Most consumers are supplied from the high level tanks on the hill behind Kabarnet Secondary School. The NWCPC Area Manager reports that it has been necessary to break pressure at two tanks within the secondary school compound to limit heads in the lower part of the system.

3.6.2 Consumer connections

Operational staff report that there are 769 connections to the reticulation system, of which 600 are active. Examination of the billing records in Appendix 2 shows that bills are raised for 583 active connections.

3.7 EXISTING O&M

3.7.1 Administrative structure

The National Water Conservation and Pipeline Corporation (NWCPC) operate the Kabarnet water supply system. The NWCPC office has 29 staff as shown in the organisation chart in Appendix 3.

3.7.2 Water production

At the time of inspection, Borehole No. C3506 opposite the District Water Office was the only source in use. This borehole has a potential production of 288 m^3/d, but the high lift pump that pumps into the distribution system has a capacity of only 192 m^3/d.

The NWCPC Area Manager reports that the treatment plant at Kirandich is operated for two days per week to fill the 6,000 m^3 service reservoir. Assuming only one clear water pump is used, the pump rate from Kirandich will be 180 m^3/hr. Assuming that the daily water consumption is constant, the water balance when filling the tank becomes:

Table 3.1
Water balance when filling the 6,000 m^3 service reservoir

Pump rate (m^3/hr)	180
Time run (hours)	45.842
Volume delivered (m^3)	8,252
Tank capacity (m^3)	6,000
Excess production (m^3)	2,252
Daily demand while filling tank (m^3/d)	1,179
Daily demand while emptying tank (m^3/d)	1,179

The average water production from Kirandich is approximately 1,179 m^3/d. Adding the production from Borehole No. C 3506, the total estimated production is 1,371 m^3/d.

3.7.3 Distribution practice

The booster pumps next to the main service reservoir are in regular use to transfer water to the high level tanks on the hill above Kabarnet Secondary School. From here, water is gravitated to the town distribution system after breaking pressure at the secondary school tanks.

The booster pump in the compound opposite the District Water Office seems to be used to locally boost pressures in the distribution system near the surrounding government offices.

3.7.4 Metering and water sales

Examination of the available billing records shows that there are 583 bills raised per month, of which 207 are for metered water consumption. The remaining 376 bills are for estimated water consumption.

Sales in June 2000 at the 207 metered connections were 5,402 m^3, or 180.1 m^3/d. The estimated sales at the 376 unmetered connections were 6,098 m^3 in June 2000, or 203.3 m^3/d.

3.7.5 Unaccounted for water

Out of a water supply of some 1,371 m^3/d, only 380.4 m^3/d is sold to consumers. Unaccounted for water is 987.6 m^3/d, or 72% of the water produced. This extremely high figure reflects poor water management within Kabarnet.

3.7.6 Facilities and equipment

The NWCPC offices in Kabarnet were recently constructed under the same contract as Kirandich Dam. The buildings are in good condition and are provided with basic hard furnishings.

The offices are supplied with electricity and there is a telephone, although the telephone can only be used to receive calls.

The only transport available to the scheme is a 1990 motorcycle.

3.8 LEVELS OF SERVICE

3.8.1 Major consumers

There are eighteen metered connections in Kabarnet consuming more than 40 m^3 per month, and a further nine unmetered connections with estimated consumptions of over 40 m^3 per month. These twenty seven connections account for a monthly water consumption of 4,571 m^3, in the following charge bands:

Table 3.2
Monthly consumptions for large consumers

Charge band	Consumption (m^3/month)
0-10 m^3/month minimum charge band	270
10-20 m^3/month band	270
20-50 m^3/month band	784
50-100 m^3/month band	763
100-300 m^3/month band	1,305
Over 300 m^3/month band	1,179
Total	4,571

3.8.2 Population served

The remaining 556 connections in Kabarnet are assumed to supply domestic consumers. The results of the 1999 census show Kabarnet has a population of 16,931 in 3,962 households. This gives a mean household size of 4.27. Therefore, approximately 2,374 people benefit from piped water supplies, or 14.0% of the total population within the municipality.

3.8.3 Per capita supplies

The 556 domestic connections in Kabarnet consumed an estimated 231 m^3/d in June 2000. This represents an average consumption of 415 l/connection or approximately 97.3 lcd.

3.9 ON-GOING OR PLANNED EL NIÑO WORKS

There are no works planned in Kabarnet under the El Niño project.

3.10 OTHER WORKS AND PROJECTS

Kirandich dam, the treatment works, pipeline, 6,000 m^3 service reservoir, booster pump station, NWCPC offices and staff housing were constructed under Phase I of a project being funded by the Government of Italy. Phase II of this project is to cover the town's distribution system. Survey work is underway for the design of the necessary improvements under Phase II.

4 PROPOSED STRATEGY FOR WATER SUPPLY REHABILITATION

4.1 DEMAND/CONSUMPTION PROJECTIONS TO 2010

4.1.1 Population projections

As discussed in Section 2.6, the population of Kabarnet municipality is projected to increase at 3.6% per annum to reach 25,000 in the year 2010. The projected population for the municipality is given in Table 4.1.

Table 4.1
Population projection

Year	Population
1999	16,931
2000	17,500
2001	18,200
2002	18,800
2003	19,500
2004	20,200
2005	20,900
2006	21,700
2007	22,500
2008	23,300
2009	24,100
2010	25,000

4.1.2 Water demand projections

4.1.2.1 Unit water consumption

Unit consumptions are taken from the then Ministry of Water Development Design Manual (1986) and are reproduced as Table 4-8 of the Appendix.

4.1.2.2 Levels of service

It is assumed that the Government of Kenya achieves its goal of providing piped water to one hundred per cent of the urban population by the year 2010. It is further assumed that the classes of housing within Kabarnet will reflect the current broad levels of income.

Table 4.2
Projected levels of service

Income level/housing class	Percentage in category
High	24
Medium	46
Low	30

4.1.2.3 Domestic water demand

The domestic water demand projection for Kabarnet is shown in Table 4.3.

4.1.2.4 Institutional and commercial water demand

The estimated current institutional and commercial water demand is summarised below.

Table 4.4
Institutional and commercial water demands

Activity	Nr	l/unit/d	total
Commercial			
Shops	40	100	4,000
Hotel low class (assume 10 beds each)	160	50	8,000
Hotel high class (assume 10 beds each)	20	600	12,000
Butcheries	26	500	13,000
Laundry	1	5,000	5,000
Bars and restaurants	36	500	18,000
Garages	2	500	1,000
Total commercial			61,000
Institutional			
Hospital (assume 200 beds)	200	200	40,000
Boarding schools	500	50	25,000
Day schools	10,000	5	50,000
Dispensaries	1	5,000	5,000
Total institutional			120,000
Industrial			
No known industrial demand			0
Total commercial, institutional and industrial demand	l/d		181,000
	m^3/d		181.0
	say		**181 m^3/d**

The institutional and commercial water demand is taken as 181 m^3/d, and is projected to increase in line with the town's population.

4.1.2.5 Demand projection

The water demand projection for Kabarnet is summarised in Table 4.3.

4.1.3 Comparison of projected demand with existing capacity

Table 4.3 compares the projected water demand with the capacities of the Kirandich scheme. The tabulated Kirandich production capacity is the reported safe yield of Kirandich dam, which is less than the installed treatment plant capacity. The tabulated transmission capacity is the nominal capacity of three clear water pumps operating in parallel. The tabulated storage capacity is calculated as the total storage volume of 6,800 m^3 divided by 1.25 to give the supply for which storage is equal to eighteen hours emergency capacity plus twelve hours balancing capacity.

Table 4.3
Projected Water Demands and Current System Capacities

Year	Population	Income brackets		Population	Demand rate lcd	Demand m^3/d	Institutional demand m^3/d	Total demand m^3/d	Production capacity m^3/d	Transmission capacity m^3/d	Storage capacity m^3
		Status	%								
1999	16,931	High	24	4,063	250	1,016					
		Middle	46	7,788	150	1,168	181	**2,746**	12,800	12,960	5,440
		Low	30	5,079	75	381					
2000	17,500	High	24	4,200	250	1,050					
		Middle	46	8,050	150	1,208	187	**2,838**	12,800	12,960	5,440
		Low	30	5,250	75	394					
2001	18,200	High	24	4,368	250	1,092					
		Middle	46	8,372	150	1,256	194	**2,951**	12,800	12,960	5,440
		Low	30	5,460	75	410					
2002	18,800	High	24	4,512	250	1,128					
		Middle	46	8,648	150	1,297	201	**3,049**	12,800	12,960	5,440
		Low	30	5,640	75	423					
2003	19,500	High	24	4,680	250	1,170					
		Middle	46	8,970	150	1,346	208	**3,162**	12,800	12,960	5,440
		Low	30	5,850	75	439					
2004	20,200	High	24	4,848	250	1,212					
		Middle	46	9,292	150	1,394	215	**3,275**	12,800	12,960	5,440
		Low	30	6,060	75	455					
2005	20,900	High	24	5,016	250	1,254					
		Middle	46	9,614	150	1,442	223	**3,389**	12,800	12,960	5,440
		Low	30	6,270	75	470					
2006	21,700	High	24	5,208	250	1,302					
		Middle	46	9,982	150	1,497	231	**3,519**	12,800	12,960	5,440
		Low	30	6,510	75	488					
2007	22,500	High	24	5,400	250	1,350					
		Middle	46	10,350	150	1,553	239	**3,648**	12,800	12,960	5,440
		Low	30	6,750	75	506					
2008	23,300	High	24	5,592	250	1,398					
		Middle	46	10,718	150	1,608	247	**3,777**	12,800	12,960	5,440
		Low	30	6,990	75	524					
2009	24,100	High	24	5,784	250	1,446					
		Middle	46	11,086	150	1,663	256	**3,907**	12,800	12,960	5,440
		Low	30	7,230	75	542					
2010	25,000	High	24	6,000	250	1,500					
		Middle	46	11,500	150	1,725	265	**4,053**	12,800	12,960	5,440
		Low	30	7,500	75	563					

The projected water demand for Kabarnet can be comfortably met from Kirandich. The current demand on source of 1,371 m^3/d would need to increase by 25% per annum for demand to outstrip supply by 2010.

4.2 CONFIRMATION OF REHABILITATION OPTIONS

4.2.1 Upgrading of distribution system

4.2.1.1 Distribution pipework

This is the most pressing priority for ensuring adequate water supplies in Kabarnet. This is being addressed under the Italian-funded Phase II Project. As a contingency, however, allowance is made for upgrading the existing distribution system up to the year 2010.

For a projected water demand in 2010 of 4,053 m^3/d and a peak hourly flow factor of 2.0, the peak hourly demand on storage is 84.4 m^3/hr. Using a 200 mm nominal bore main to convey this flow, the velocity is 0.75 m/s. Allowance is made under this project for 2 km of 200 mm reservoir outlet pipework, together with 10 km of smaller distribution pipework.

In view of the shallow depth of soil in Kabarnet, an extra allowance is made for trench excavation in rock.

4.2.1.2 Break pressure tanks

The level difference between the main storage tank and the lowest lying areas of the limits of supply is some 125 m. Allowance is made for two 25 m^3 break pressure tanks to limit maximum heads to 50 m.

4.2.1.3 Metering improvements

Of the 583 active water connections in Kabarnet, 376 consumers receive bills based on estimated water consumptions. Defective consumer meters should be replaced immediately to improve management of unaccounted for water.

4.2.2 Decommissioning superfluous water sources

4.2.2.1 Stadium and Deaf Blind School boreholes

While these boreholes may have played a valuable role in augmenting water supplies during the construction of Kirandich dam, they are no longer needed.

4.2.2.2 Borehole C3506, opposite District Water Office

Water from this borehole is chlorinated before being pumped into supply. When the borehole is in use, distribution pressures near the District Water Office will be satisfactory, despite the small distribution pipework.

In Section 0, it was shown that water from this borehole is very soft and potentially aggressive to concrete and steel. Once the distribution system has been upgraded under the Italian-funded Phase II project, the borehole will no longer be required to maintain pressures and should be decommissioned.

4.2.2.3 Kapchemuswo Dam

This surface water source is operated intermittently, primarily to ensure supplies to the agricultural showground. It too should be decommissioned once the distribution system has been upgraded.

4.3 COSTING OF RECOMMENDED REHABILITATION PLAN

The proposed works to rehabilitate the Kabarnet water supply system are given in Table 4.5.

Table 4.5
Rehabilitation costs

Description	Unit	Quantity	Rate	Amount (KShs)
Distribution system				
200 mm pipework	m	2,000	6,500	13,000,000
Pipework 150 mm and smaller	m	10,000	1,800	18,000,000
E.O. excavtion in rock	m^3	9,200	6,800	62,560,000
25 m^3 break pressure tanks	nr	2	400,000	800,000
New consumer meters (replacement and stock)	nr	400	3,000	1,200,000
subtotal				95,560,000
Logistical facilities and equipment				
4WD twin-cab pickups	nr	1	2,500,000	2,500,000
Motorcycles for line patrols, meter readings, etc.	nr	3	250,000	750,000
Desk top computer setups	nr	3	200,000	600,000
Printers	nr	1	100,000	100,000
Licensed standard computer software	Sum			200,000
subtotal				4,150,000
Overall Total				99,710,000
Add 20% P&G				19,942,000
Sub-total				119,652,000
Add 15% Contingencies				17,947,800
Sub-total				137,599,800
Add 20% consultancy design fees				27,519,960
GRAND TOTAL				165,119,760

4.4 EXPANSION OF WATER SUPPLY FACILITIES

There is no need to expand water supplies to Kabarnet. The supply from Kirandich, limited by the installed clear water pump capacity is 12,960 m^3/d. The distribution system does require upgrading to cope with the increased supply from Kirandich, but this is being addressed under the Italian-funded Phase II project.

4.5 O&M COSTS AFTER REHABILITATION

4.5.1 General

The yield from Kirandich far exceeds the projected water demand in Kabarnet, so the plant will not be operating at full capacity. Chemical and power costs are dependent on the quantities of water being produced, so it is necessary to develop water sales and production forecasts to assess these costs.

4.5.2 Water sales and production forecasts

4.5.2.1 Existing connections and unit consumptions

The consumption pattern given in Table 3.2 is applied to the 27 connections consuming more than 40 m^3/month. The 556 domestic connections are assumed to be:

Table 4.6
Assumed domestic connections

Housing category	Number of connections	Household size	Per capita consumption (lcd)	Consumption per household (m^3/month)
High class housing	83	4.27	250	32.47
Medium class housing	125	4.27	150	19.48
Low class housing	348	4.27	75	9.74

4.5.2.2 Future connections

For developing the water sales forecast, it is assumed that sixty new connections are made per annum: forty-two to low class housing and eighteen to medium class housing.

4.5.2.3 Water sales forecasts

The water sales forecast is given in Table 4.7.

4.5.2.4 Allowance for unaccounted for water

It is assumed that once all legal consumers are metered, the volume of unaccounted for water will decline to 20% of water production.

4.5.2.5 Water production forecasts

The forecast of water production requirements is also given in Table 4.7.

4.5.3 Power tariffs and costs

4.5.3.1 Tariffs

Power charges are calculated using the tariffs and levies prevailing in December 2000. These are shown in Table 4.8.

Table 4.8
KPLC power tariffs

Charge band	A1	B1	B2
Monthly consumption not exceeding (kWh)	7,000	100,000	100,000
Supply voltage (V)	415	415	11,000
Monthly standing charge	150.00	600.00	2,000.00
Monthly maximum demand charge per kVA	0.00	300.00	200.00
High rate tariff per kWh	6.70	6.10	5.50
Low rate tariff per kWh	6.70	3.75	3.25
Fuel cost adjustment per kWh	4.07	4.07	4.07
Forex adjustment per kWh	0.16	0.16	0.16
ERB levy per kWh	0.03	0.03	0.03
REP levy at 5% on high rate tariff per kWh	0.3350	0.3050	0.2750
REP levy at 5% on low rate tariff per kWh	0.3350	0.1875	0.1625
VAT at 18% on high rate tariff per kWh	1.2060	1.0980	0.9900
VAT at 18% on low rate tariff per kWh	1.2060	0.6750	0.5850
Total high rate tariff per kWh	12.5010	11.763	11.025
Total low rate tariff per kWh	12.5010	8.8725	8.2575

4.5.3.2 Running load at Kirandich

The total running load at Kirandich water treatment plant, with only one clear water pump in use, will be some 338.5 kVA, made up as follows.

Table 4.9
Running load at treatment plant

Item	One clear water pump	One washwater pump	One air scour blower	Lighting and small power, say	Total running load
Flow (m^3/hr)	180	200			
Head (m)	351	24			
Efficiency	70%	70%			
Power (kW)	245.9	18.7	35.0	5.0	304.6
Power (kVA) at cosF = 0.9	273.2	20.8	38.9	5.6	338.5

At a daily water production of 569 m^3/d, the monthly power consumption of one clear water pump is 23,326 kWh, so charge band B2 applies.

4.5.3.3 Power costs at Kirandich

Using the above running loads and the B2 tariff band, the standing charge is Kshs 24,000 per annum and the maximum demand charge is Kshs 812,400 per annum. At present, the Kirandich plant is operated for two days per week to fill the 6,000 m^3 reservoir. It is assumed that this mode of operation will continue, but with the clear water pump operated for a maximum of 42 hours per weekend during the low charge period. It is further assumed that filters are washed and scoured for fifteen minutes per day during the high charge period. Under these assumptions, the annual power costs and Kirandich are summarised in Table 4.10 below.

Table 4.10
Annual power costs at Kirandich

Year	Daily water production (m^3/d)	Hours run by pump per week	Annual power costs (Kshs)						
			Standing charge	Maximum demand charge	Clear water pump kWh charge	Wash/ water kWh charge	Blower kWh charge	Small power kWh charge	Total
2000	538	21	24,000	812,400	2,215,140	18,813	35,211	180,839	3,286,403
2001	569	22	24,000	812,400	2,343,704	18,813	35,211	180,839	3,414,967
2002	600	23	24,000	812,400	2,472,269	18,813	35,211	180,839	3,543,532
2003	632	25	24,000	812,400	2,600,833	18,813	35,211	180,839	3,672,096
2004	663	26	24,000	812,400	2,729,398	18,813	35,211	180,839	3,800,661
2005	694	27	24,000	812,400	2,857,962	18,813	35,211	180,839	3,929,226
2006	725	28	24,000	812,400	2,986,527	18,813	35,211	180,839	4,057,790
2007	757	29	24,000	812,400	3,115,092	18,813	35,211	180,839	4,186,355
2008	788	31	24,000	812,400	3,243,656	18,813	35,211	180,839	4,314,919
2009	819	32	24,000	812,400	3,372,221	18,813	35,211	180,839	4,443,484
2010	850	33	24,000	812,400	3,500,785	18,813	35,211	180,839	4,572,048

The relative magnitude of the maximum demand charge is significant. The above costs are calculated for a single duty pump being used. If two pumps are operated simultaneously, the running load increases by 273 kVA and the maximum demand charge increases by Kshs 54,640 per month or Kshs 655,680 per annum. The penalty for running three pumps simultaneously is twice this amount.

4.5.3.4 Running load at the Kabarnet transfer pump station

The total running load at the Kabarnet transfer pump station, with only one pump in use, will be some 17.1 kVA, made up as follows.

Table 4.11
Running load at the Kabarnet transfer pump station

Item	One transfer pump	small power, say	Total
Flow (m^3/hr)	56		
Head (m)	57		
Efficiency	65%		
Power (kW)	13.4	2.0	15.4
Power (kVA) at cosF = 0.9	14.9	2.2	17.1

At a daily water production of 569 m^3/d, the monthly power consumption of one transfer pump is 4,085 kWh, so charge band A1 applies.

4.5.3.5 Power costs at Kabarnet transfer pump station

Using the above running loads and the A1 tariff band, the standing charge is Kshs 1,800 per annum. No maximum demand charge is payable for this tariff.

Table 4.12
Annual power costs at Kabarnet transfer pump station

Year	Daily water production (m^3/d)	Hours run by pump per week	Annual power costs			
			Standing charge	Transfer pump kWh charge	Small power kWh charge	Total
2000	538	67	1,800	587,392	96,579	685,771
2001	569	71	1,800	621,484	96,579	719,863
2002	600	75	1,800	655,575	96,579	753,954
2003	632	79	1,800	689,667	96,579	788,046
2004	663	83	1,800	723,759	96,579	822,138
2005	694	87	1,800	757,850	96,579	856,229
2006	725	91	1,800	791,942	96,579	890,321
2007	757	95	1,800	826,034	96,579	924,413
2008	788	98	1,800	860,125	96,579	958,504
2009	819	102	1,800	894,217	96,579	992,596
2010	850	106	1,800	928,309	96,579	1,026,688

4.5.4 Chemical costs

Estimated chemical costs are shown in Table 4.13.

Table 4.13
Estimated chemical costs

Chemical	Cost Kshs/kg	Dosage (mg/l)	Cost (Kshs/m^3)
Aluminium sulphate	28	20	0.56
Soda ash	7	16	0.11
Calcium hypochlorite	245	3	0.74
Total		39	1.41

The annual chemical costs are given below for the forecast water production.

Table 4.14
Annual chemical costs

Year	Daily water production (m^3/d)	Annual chemical costs (Kshs per annum)
2000	538	276,876
2001	569	292,946
2002	600	309,015
2003	632	325,085
2004	663	341,155
2005	694	357,224
2006	725	373,294
2007	757	389,364
2008	788	405,433
2009	819	421,503
2010	850	437,572

5 EXISTING WASTE WATER DISPOSAL & SANITATION CONDITIONS

5.1 SEWERAGE SYSTEM

There is no waterborne sewerage system in the town.

5.2 SEWERAGE SYSTEM (O&M)

Not applicable.

5.3 SEWAGE TREATMENT WORKS (O&M)

Not applicable.

5.4 OTHER DISPOSAL FACILITIES

Waste disposal is by means of septic tanks, cess pits and/or pit latrines and is the responsibility of Kabarnet Town Council. The municipality does not have a vacuum tanker for emptying septic tanks and hires one from Eldoret when needed. Ground conditions in Kabarnet are rocky, making pit latrines difficult to dig and giving poor infiltration capacity.

5.5 ON-GOING OR PLANNED EL NINO WORKS

No improvements are being carried out under the ongoing El Niño project.

5.6 OTHER WORKS AND PROJECTS

During 1986, the Municipality commissioned a design for a sewerage system for the town, but this was never constructed. NWCPC has been asked to solicit funds and include the construction of the sewerage system under the Italian-funded Phase II project.

5.7 SUMMARY OF SHORTCOMINGS AND PRELIMINARY RECOMMENDATIONS FOR REHABILITATION

Construction of a waterborne sewerage is outside the scope of this study and will be an expensive undertaking, given that appropriate collection and treatment techniques will be used.

6 PROPOSED STRATEGY FOR WASTEWATER DISPOSAL AND SANITATION REHABILITATION

6.1 DEMAND FOR SANITATION SERVICES

Waste disposal is by means of septic tanks, cess-pits and/or pit latrines. The municipality does not have a vacuum tanker for emptying septic tanks and hires one from Eldoret when needed. Septage is discharged into waste stabilisation ponds at Kabarnet District Hospital.

Once the water distribution system is improved so that consumers have access to water at adequate pressures, the wastewater generation rate may exceed the infiltration capacity of the soil and rock in the more densely settled portions of the town. In the low population density areas, on-plot sanitation for households will continue to suffice.

6.2 DEMAND FOR WASTEWATER DISPOSAL SERVICES

There is no waterborne sewerage in the town. A design of a sewerage system has been prepared and its construction may be included under the Italian funded Phase II project. It is important to ensure that the Kirandich catchment is protected from wastewater contamination.

6.3 CONFIRMATION OF REHABILITATION OPTIONS

Construction of a waterborne sewerage system is outside the scope of this study and it is being considered under another source of funding.

6.4 PRELIMINARY DESIGN OF RECOMMENDED OPTION

This is not applicable as rehabilitation or new sewerage works are not proposed under this study.

6.5 COSTING OF RECOMMENDED REHABILITATION PLAN

This is not applicable as rehabilitation or new sewerage works are not proposed under this study.

7.0 LAWS AND REGULATIONS OF ENVIRONMENTAL IMPACT ASSESSMENT

7.1 GENERAL

The current Government of Kenya policy requirement stipulates that before any major development project is undertaken in the public or private sector, there is need to carry out Environmental Impact Assessment (EIA) on the project in order to ensure that each component conforms to good environmental management. This study involves mainly the identification of laws and regulations that govern the environmental impact assessment of water supply and sanitation projects.

7.2 LEGISLATION/REGULATIONS GOVERNING ENVIRONMENTAL IMPACT ASSESSMENT

7.2.1 General

A large number of Acts and organizations deal with issues of pollution, environmental degradation and conservation. These include among others:

- Constitution of Kenya (especially Section 71)
- Water Act (Cap 372)
- Agriculture Act (Cap 318)
- Irrigation Act (Cap 347)
- Forests Act (Cap 385)
- Lakes and Rivers Act (Cap 409)
- Maritime Zone Act (Cap 371)
- River Basin Development Authorities Act (e.g. Cap 443)
- Land Tenure and Land Use Legislation
- Wildlife (Conservation and Management) Act (1976 and 1989 Amendment)
- Public Health Act (Cap 242)
- Local Government Act (Cap 265)
- Environmental Management and Co-ordination Act (1999)

Effectiveness in enforcement has not been commensurate with the many acts and regulations; in some instances there have been contradictions when an institution has evoked its act at the expense of proper operation of facilities belonging to another institution. The reason for the foregoing situation is that each sector utilizing water, apart from the water authority, has different objectives; their primary focus is not water development. The need to harmonize the application of the various Acts and Regulations, for effective protection of the environment, has been felt and expressed for a long time; hence the birth of the Environmental Management and Co-ordination Act of 1999.

7.2.2 Environmental Management and Co-ordination Act (1999)

The most significant Act that specifically addresses environmental impact is the newly enacted Environmental Management and Co-ordination Act, 1999. Among the specific issues related to EIA procedures are stipulated in the Act as follows:

- Establishment of Environmental Management Authority (NEMA) to administer the Act.
- Submission of an EIA Report to NEMA by developers before undertaking any new project specified in the Act.
- Issue of an Environmental Impact License by NEMA if it is satisfied with the EIA Report.
- Environmental Impact Assessment to be conducted in accordance with the EIA guidelines and procedures provided in the 4th schedule of the Act.

7.2.3 Laws Relating Specifically to Water Supply and Sanitation

Within the Environmental Management and coordination Act, a number of sections dealing specifically with water and sanitation can be identified as follows:

- Part V Section 42 dealing with protection of rivers, lakes and wetlands,
- Part VIII Section 72 dealing with water pollution prohibition,
- Part VIII Section 74 dealing with effluents to be discharged into the sewerage system,
- Part VIII Section 86 dealing with standards for waste,
- Part VIII Section 87 dealing with prohibition against dangerous handling and disposal of wastes,
- Part VIII Sections 88 and 89 dealing with waste licenses and licensing of waste disposal sites,
- Part VIII Sections 91 – 93 dealing with hazardous wastes and their disposal,
- Part XIII dealing with environmental offences and related penalties.

In order to minimize the conflicts in enforcement (due to the many different Acts and Regulations) as mentioned before, the Environmental Management and Coordination Act stipulates that where the provisions of any existing law conflicts with the provisions of this Act, then the provisions of this Act shall prevail. The foregoing proviso, in conjunction with the multi-disciplinary or composition of the Environmental Committees will hopefully enhance the effectiveness of administration and enforcement of the Act.

7.2.4 Environmental Impact Assessment (Guidelines and Administrative Procedures)

The format of the EIA Report has been set out in the guidelines and should include the following sections:

- Introduction
- Title of the Project
- Project Initiator
- Statement of Need
- Project Description
- Project Options
- Description of Existing Environment
- Results of Preliminary Assessment
- Detailed Examination of Impacts
- Suggested Mitigation and Abatement measures
- Residual Impacts
- Project Evaluation
- Summary Conclusions

In addition, the EIA guidelines and procedures describe procedures to be used in environmental planning and management in Kenya. It also gives a checklist of sectors, which can provide guidance to the public and private sector agencies involved in initiating development projects.

7.2.5 Objectives of Environmental Impact Assessment

The objectives of Environmental Impact Study for this project are identified as follows:

- To identify the existing environmental concerns which need to be taken into account in the proposals for rehabilitation of water supply and sanitation system.

- To evaluate the environmental impacts of the proposed rehabilitation works.

- To propose the counter measures to mitigate the impacts.

- To make recommendations for environmental conservation.

7.3 INITIAL ENVIRONMENTAL EXAMINATION

7.3.1 Water Quality of Existing Supplies

The main water source for Kabarnet town is Kirandich Dam located on Kirandich River. The National Water and Pipeline Conservation Corporation in addition to a number of productive boreholes formerly run by MENR manage this source. The programme for monitoring water quality both at source and within the distribution systems is in place; however, implementation is generally poor because of lack of appropriate and adequate laboratory equipment and reagents. Water quality analysis results were not available for the Kirandich source, but the borehole water is soft and may be naturally aggressive to concrete and steel.

7.3.2 Existing Sanitation Situation

The town depends on on-site sanitation systems comprising mainly pit latrines, cess-pits and septic tanks. These are difficult to put up because of the rocky nature of the terrain. Pit latrines cannot be dug deeper than 2.5 to 3.5 m so they fill very fast particularly under public use. The District Hospital has a sewerage system terminating in waste stabilization lagoons. These are functioning well and even under-utilized. The on-site systems generally provide inadequate service especially in public places like markets, institutions and bus parks.

A comprehensive sewerage system design for Kabarnet town was undertaken by the Industrial Research and Consultancy Unit of the University of Nairobi in 1986 but implementation has stalled for lack of funds.

7.3.3 Screening and Scoping for Environmental Impact Assessment

Many guidelines have been used in Kenya for EIA but especially those of the World Bank. Often, the sponsor of a development has stipulated the standards to be met, because in the past Kenya did not have specific guidelines. However, as mentioned before, the Environmental Management and Coordination Act (1999) has set out the guidelines for EIA in its 4th Schedule. The guidelines propose the checklist method for screening and scooping for EIA.

The general environmental concerns and a checklist for every town have been summarized in the sections that follow. A more comprehensive EIA will be done at the feasibility stage; however, it is envisaged that almost all the project components will be of such small scale that their impacts will not be serious. Impacts arising from construction activities will mainly affect the human environment but can be minimized by proper construction methods.

7.4 ENVIRONMENTAL CONCERNS IN KABARNET TOWN

1. The town is growing fast but does not have a sewerage system for wastewater disposal

2. Disposal of effluents is by pit latrines, soak pits and septic tanks which do not function well because the ground is generally rocky. The latrines cannot be dug deep enough (not more than 3m) and the ground does not provide adequate soakage, therefore these facilities take a relatively short time to fill up.

3. The town does not have an exhauster and when services of such facility are needed, the council has to hire from Eldoret at high cost, which is passed t the residents. The incidence of overflowing pit latrines and septic tanks with attendant environmental pollution is therefore, prevalent because most people cannot afford the exhauster services.

4. The council does not have a disposal point for exhausted wastes and has to use the Kabarnet District Hospital waste stabilization lagoons for a fee of Kshs.1000.00 per exhauster discharge. Such charges are passed on to the residents, further causing disincentive to use such services.

5. Some septic tanks and pit latrines are not accessible for exhauster services, so when they fill up they continue to discharge freely into the environment.

6. A large number of people do not have access to the existing piped water scheme because of its limited distribution network. Therefore such people depend on the small streams traversing the town, which are threatened by pollution potential from the waste discharges.

7. Sullage, storm water and wash water from commercial establishments drain on the surface to the lower end of the town into water sources for populations not served by the water supply scheme.

8. Solid wastes are disposed of by open dumping in the midst of residential estates without proper management. Although the council burns the waste, not all of the refuse is combustible and poses danger to public health.

9. The council has a tendency of not involving the public health office in its planning committees for fear of being stopped from undertaking certain activities that would be condemned by the public health department.

7.5 RESULTS OF INITIAL ENVIRONMENTAL EXAMINATION

The existing water supply source, treatment and storage are more than adequate for Kabarnet Town but the distribution is limited that many residents still fetch water from traditional sources because they cannot be served.

Initial Environmental Examination checklist for the water supply component is given in Table 7.1 while Table 7.2 shows the IEE checklist for the sanitation component.

Table 7.1 IEE Checklist - Water Supply Component

ITEM	EVALUATION	COMMENT
1. Resettlement	5	No negative impact expected.
2. Economic activities	5	Increased water supply service will have a positive impact.
3. Transport	4	During construction, this will need attention especially pipelines crossing the main roads. Many distribution pipelines are lying on the surface or close to the surface and are therefore prone to breakage by traffic.
4. Water and Common Rights	5	These will not be affected.
5. Sanitation	5	Improved safe water supply shall improve sanitation in areas currently not served or using untreated water.
6. Waste disposal	4	Poor performance of pit latrines and septic tanks due to rocky ground not providing soakage.
7. Dangers / Hazards	4	Will need attention during construction.
8. Topography and Geology	5	Whereas rehabilitation may not include any huge structures to give a significant impact, the rocky terrain will require blasting to excavate, careful attention is needed during construction.
9. Soil Erosion	4	Disturbance of shallow soils may lead significant soil erosion; attention is

		Needed during construction.
10. Groundwater	5	No negative impact expected.
11. River and Wetlands	5	Catchment of the major source at Kirandich dam need protection; no Wetlands in project area.
12. Coastline and Sea	5	These don't exist in the project area.
13. Flora and Fauna	5	No impact expected.
14. Weather	5	No components of the project will Affect the weather.
15. View	5	The project does not contain components that will influence the natural view.
16. Air pollution	4	Control will be needed during construction as a result of dust, especially during the dry season.
17. Water pollution	3	Drainage is to the lower end of the Town, which is not served by the water supply creating potential for pollution of the traditional water sources. Sewage amount shall be increased by increased water supply. This will increase non-point effluent discharges e.g. from overflowing septic tanks, sullage, etc.
18. Soil contamination	5	No impact expected.
19. Noise and Vibration	5	Will need attention during Construction.
20. Ground subsidence	5	No impact expected.
21. Noxious Odours	5	No impact expected.
22. Cultural Assets & Archeology	5	Project does not affect these
23. Conflict with Community Aspirations	5	No negative influence expected.

KEY:

1. Serious impact expected
2. Minor impact expected
3. Uncertain (investigation to clarify needed)
4. Almost no impact expected if construction undertaken properly
5. Almost no impact expected (no need for EIA)

Table 7.2 IEE Checklist - Sanitation Component

ITEM	EVALUATION	COMMENT
1. Human Settlement	5	No impact expected.
2. Economic Activities	5	No negative impacts expected
3. Transport	5	No impacts expected.
4. Water and Common Rights	3	Improvement in sanitation will reduce degradation of rivers and springs used by part of the population.
5. Sanitation	5	The project aims at improving sanitation.
6. Waste	5	Spread of wastes shall be checked by improved sanitation.
7. Hazards / Dangers	4	No impact expected.
8. Topography and Geology	5	No impact expected
9. Soil Erosion	4	Needs control during construction.
10. Groundwater	2	On-site sanitation systems may degrade groundwater quality.
11. River and Wetlands	5	Improved sanitation reduces pollution of rivers and wetlands.
12. Coastline and Sea	5	Such sites do not exist in project area.
13. Flora and Fauna	5	No negative impact expected.
14. Weather	5	No impact expected.

15. View	5	No impact expected.
16. Air Pollution	5	No impact expected.
17. Water Pollution	5	Improved sanitation will reduce incidence of water pollution.
18. Soil Contamination	3	No impact expected
19. Noise and Vibration	5	No impact expected.
20. Ground Subsidence	5	No impact expected.
21. Noxious Odours	5	No impact expected.
22. Cultural and Archeological Assets	5	No impact expected.
23. Conflict with Community Aspirations	5	No conflict expected.

KEY:

1. Serious impact expected
2. Minor impact expected
3. Uncertain (investigation to clarify needed)
4. Almost no impact expected if construction undertaken properly
5. Almost no impact expected (no need for EIA)

7.7 INITIAL ENVIRONMENTAL IMPACT ASSESSMENT

By and large, the proposed rehabilitation project will have positive impacts by providing improved sanitation, reducing incidence of disease, and general improvement of the environment. However, from the results of IEE, four main items of potential impacts of the proposed rehabilitation works are be identified for study as listed below:

(i) Impacts resulting from abstraction of water from river or groundwater sources during operation.

(ii) Impacts arising from the increase in wastewater generation that would result from the improved water supply.

(iii) Impacts resulting from the operation of wastewater management and sanitation facilities.

(iv) Impacts resulting from construction activities during implementation of rehabilitation works.

7.7.1 Impacts Resulting from Water Abstraction

The 2010 demand for water in the existing developed area of Kabarnet town is much less than the available sources, however, the storage capacity of the dam indicates that future expansion of the water supply from this source will require the development of further storage.

7.7.2 Impacts from Increased Wastewater Generation

Improved water service to be wrought by the rehabilitation will definitely make more water available to the consumers. The resulting increased wastewater flow will present disposal problems by putting pressure on the capacity of the existing on-site sanitation systems.

In addition, Kabarnet town is located in the upper catchment of the Kapleel tributary of Kirandich River. This implies that the reservoir is liable to pollution by increased wastewater flows from the town. Increased wastewater flow may also have a negative impact on groundwater quality because of poorly functioning on-site sanitation facilities. Installation of a sewerage system, coupled with intensified public education on proper waste management is needed for protection of the environment.

7.7.3 Impacts from Operation of Sanitation Facilities

Operation of the on-site sanitation facilities with increased wastewater flow will worsen environmental degradation and probably contribute waste load into Kirandich dam. There is need to install a sewerage system to forestall this possibility. There is also a need to monitor operation of the on-site sanitation facilities by invoking the Public Health Act.

7.7.4 Impacts from Construction

At the rehabilitation stage construction will be concentrated in the areas of existing treatment works and along the pipelines and these constructions will not be of any large scale as to adversely affect human settlements. Excavations for pipelines may cause interruption to traffic flow but this will be on a temporary scale. Serious traffic inconveniences will be avoided by appropriate construction methods.

Disturbance of the soil during construction may also give rise to soil erosion but this will be minimal because no large-scale earthworks are anticipated in the rehabilitation phase. The noise and vibrations are common features of most construction works and there are no unusual works that need special attention with respect to noise and vibration.

7.8 ISSUES FOR FURTHER INVESTIGATION

1. The control of waste generated from the town to ensure it does not reach the Kirandich reservoir.

2. Since a substantial section of the population is not served by the current water supply scheme and therefore draws water from traditional sources, the full impact of on-site sanitation systems on the degradation of water quality in such sources needs to be studied.