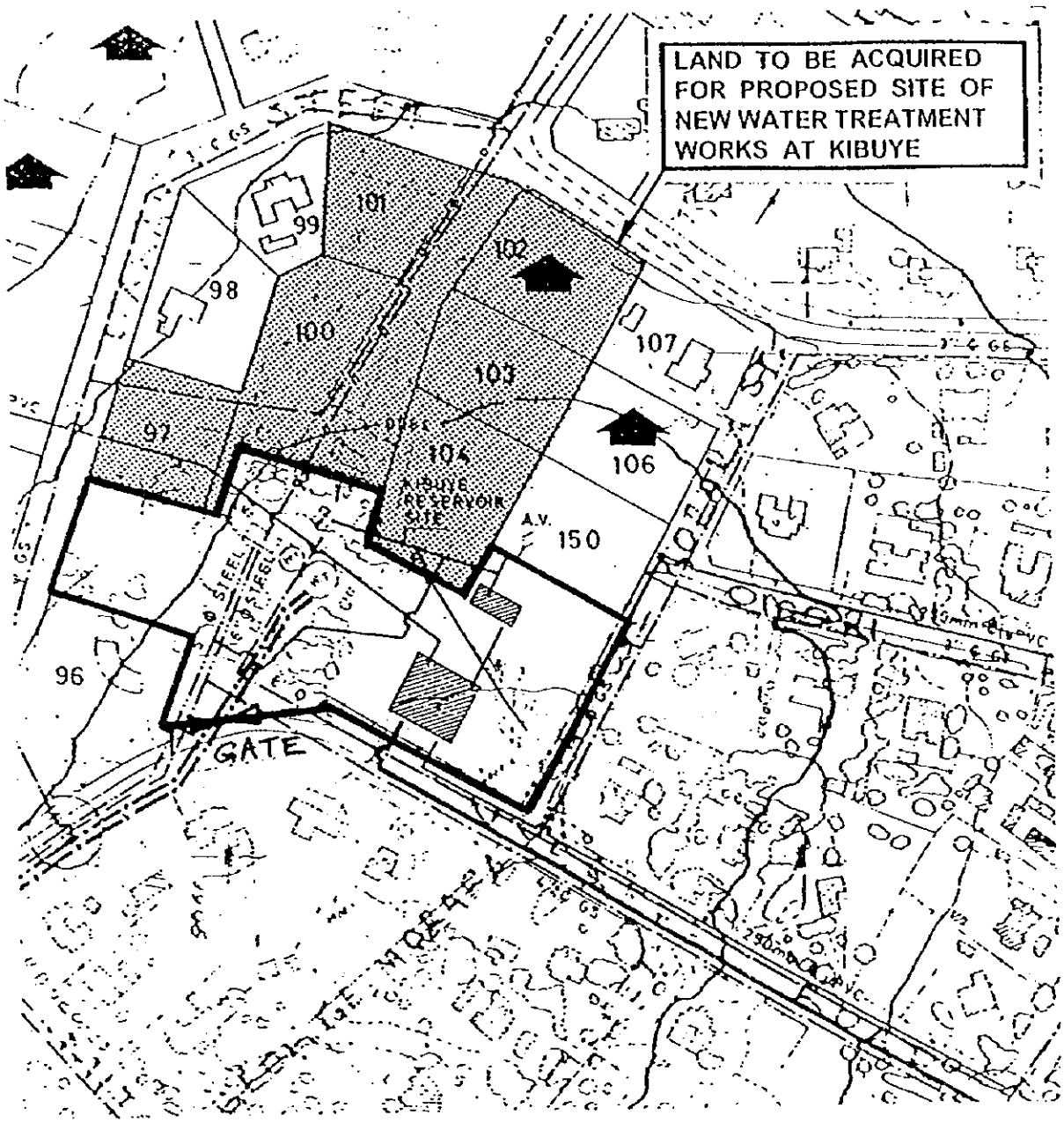
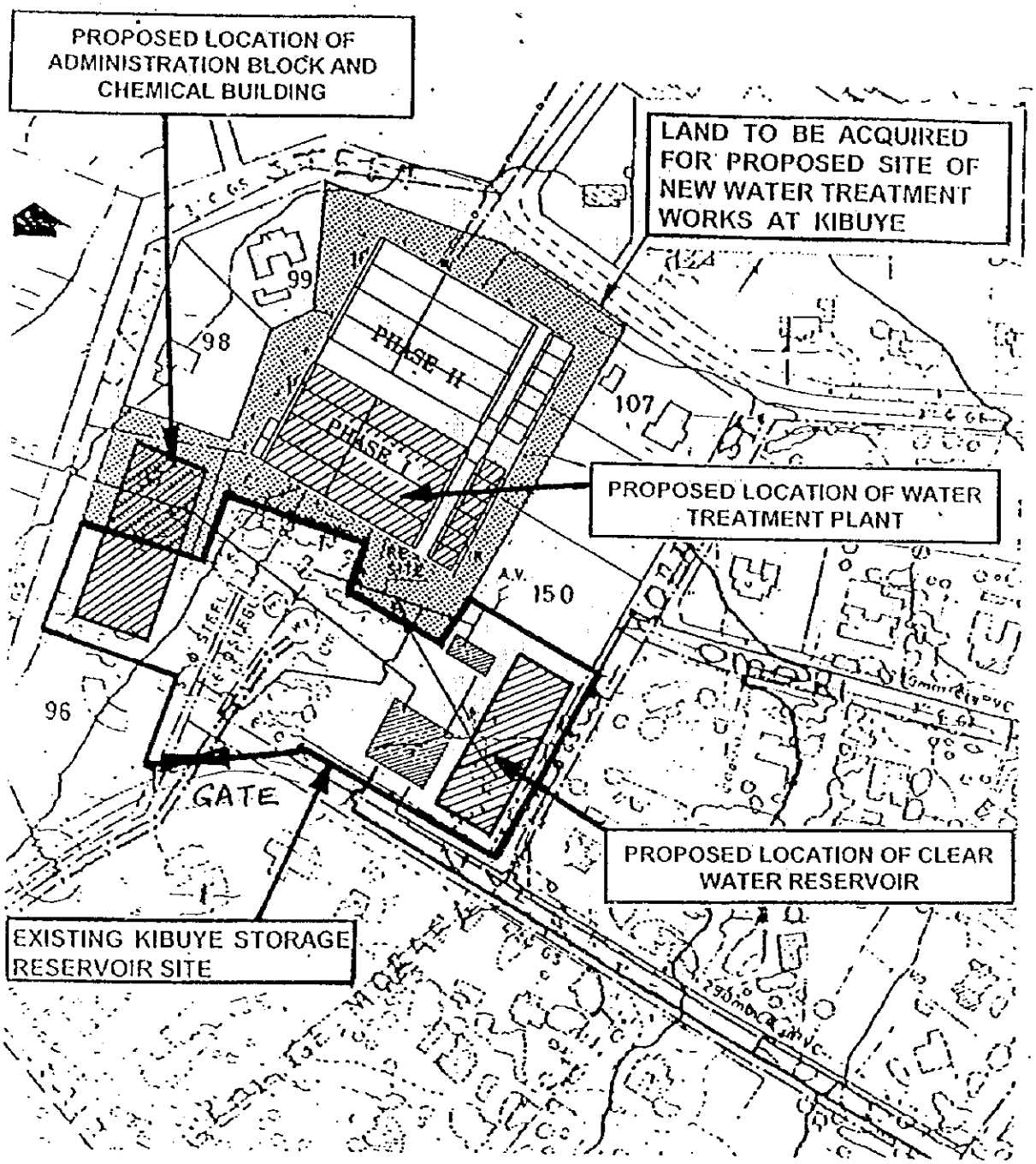
Figure 6-5



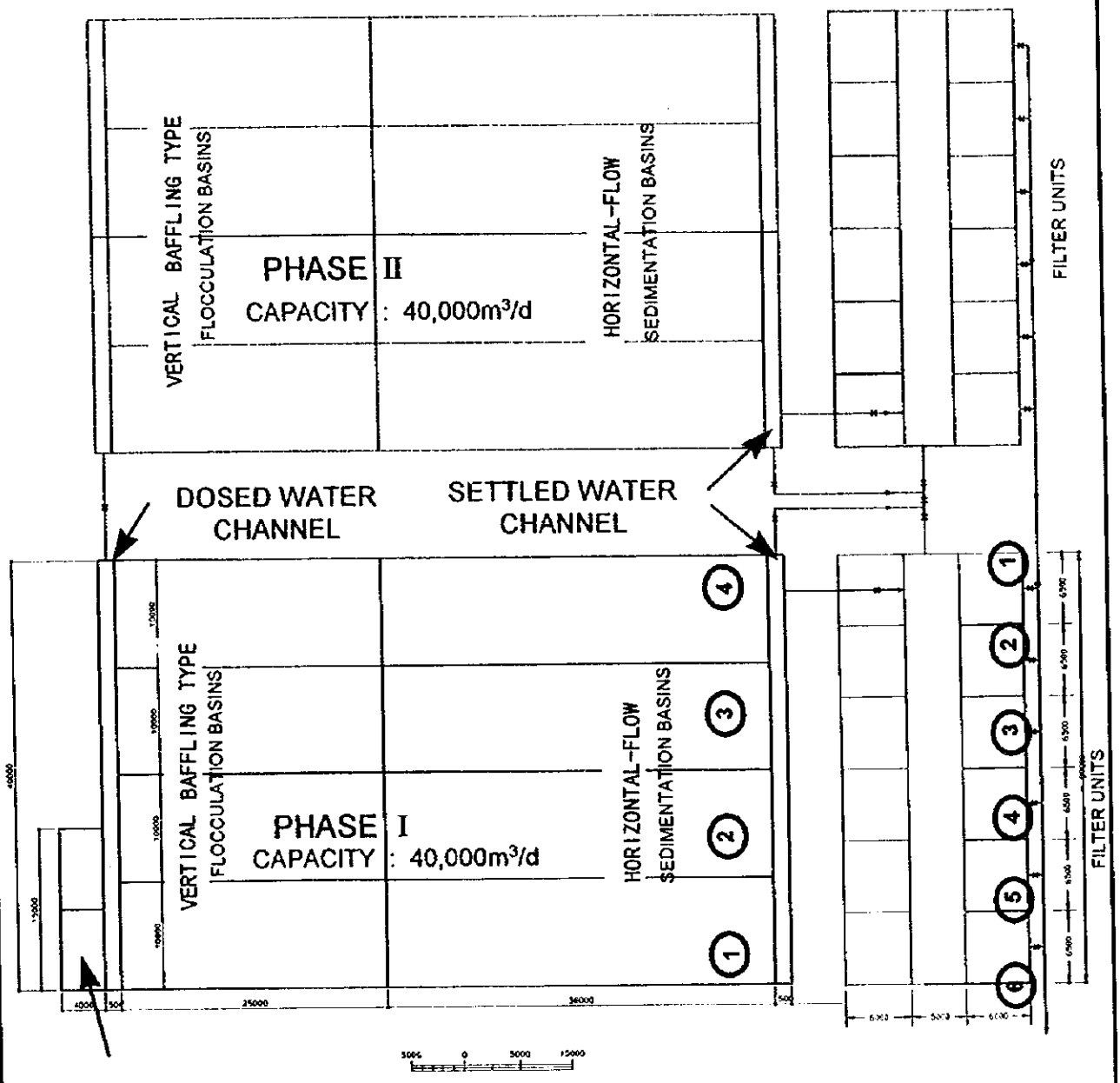
THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE Land to be Acquired for Proposed Kibuye Water Treatment Works

Figure 6-6



THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE Layout of Proposed Kibuye Water Treatment Works

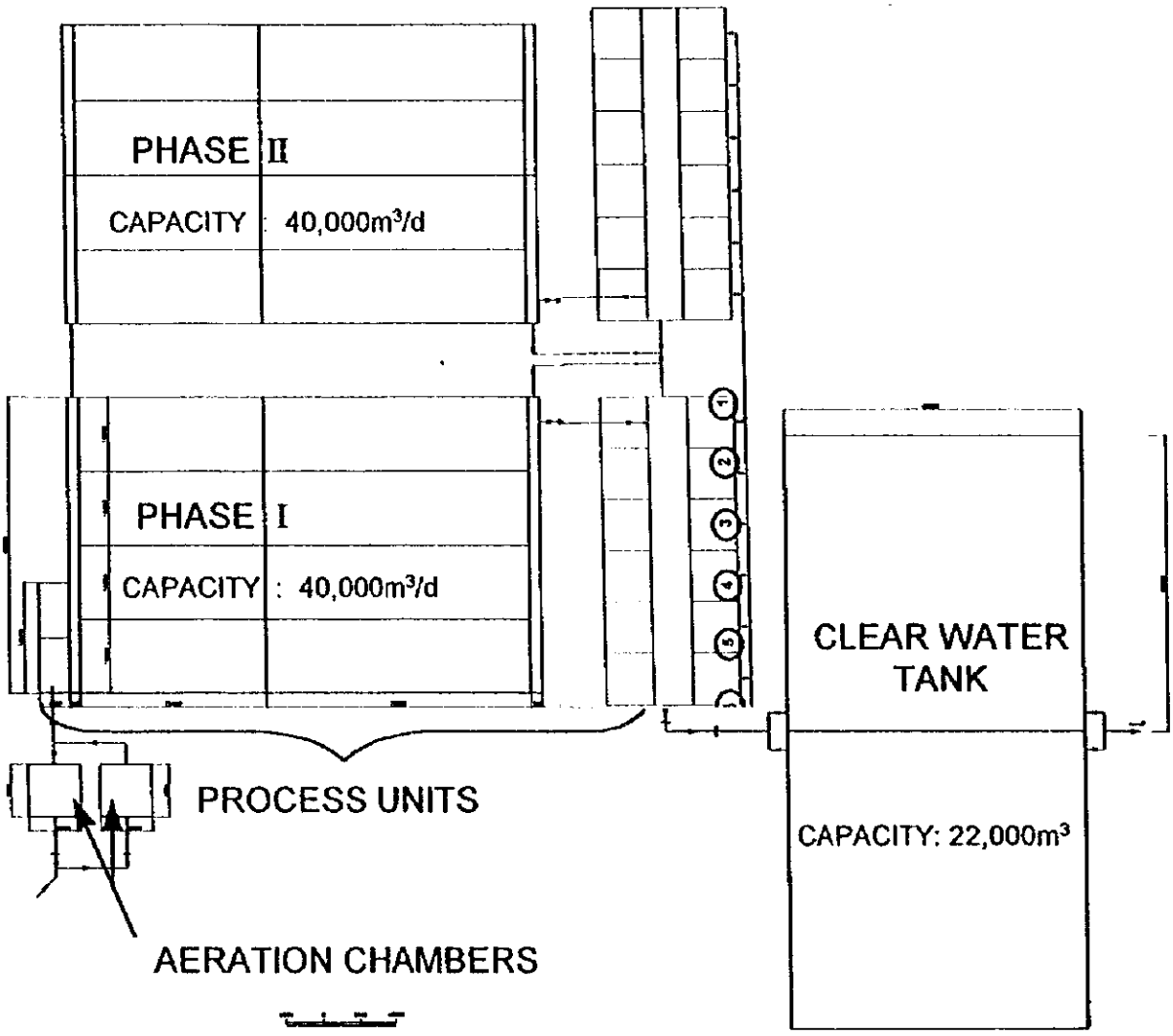
Figure 6 -7



Separation Unit : 10,000 m³/day

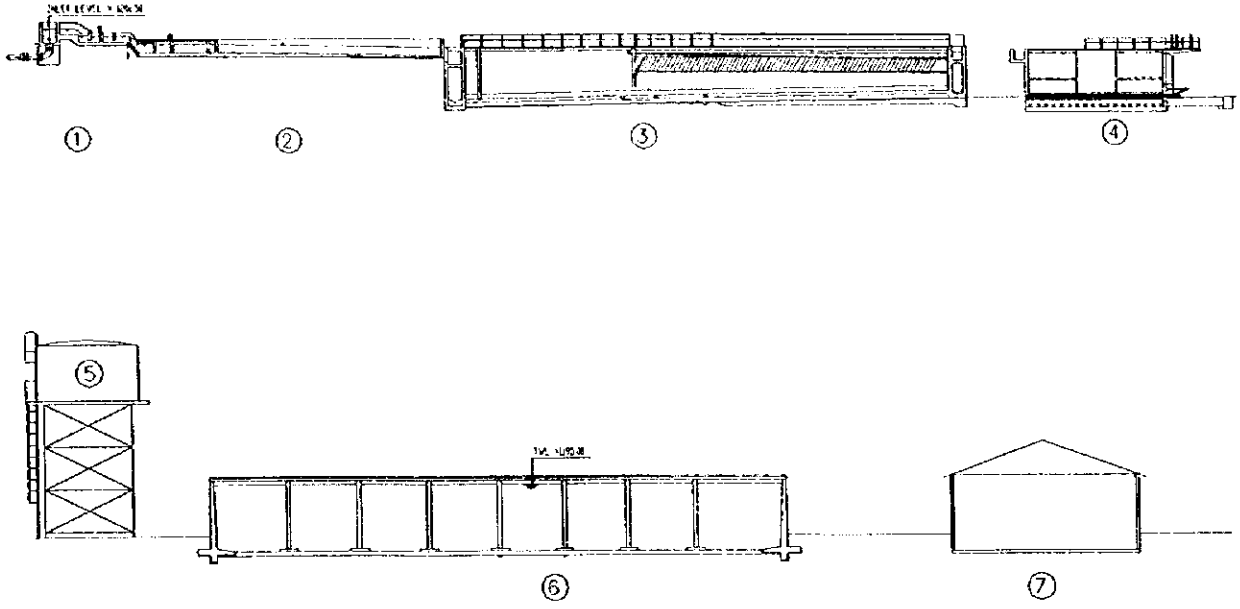
THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE : Outline of Treatment Units - Proposed Kibuye Water Treatment Works

Figure 6-8



THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE : Layout of Treatment Units - Proposed Kibuye Water Treatment Works

Figure 6-9

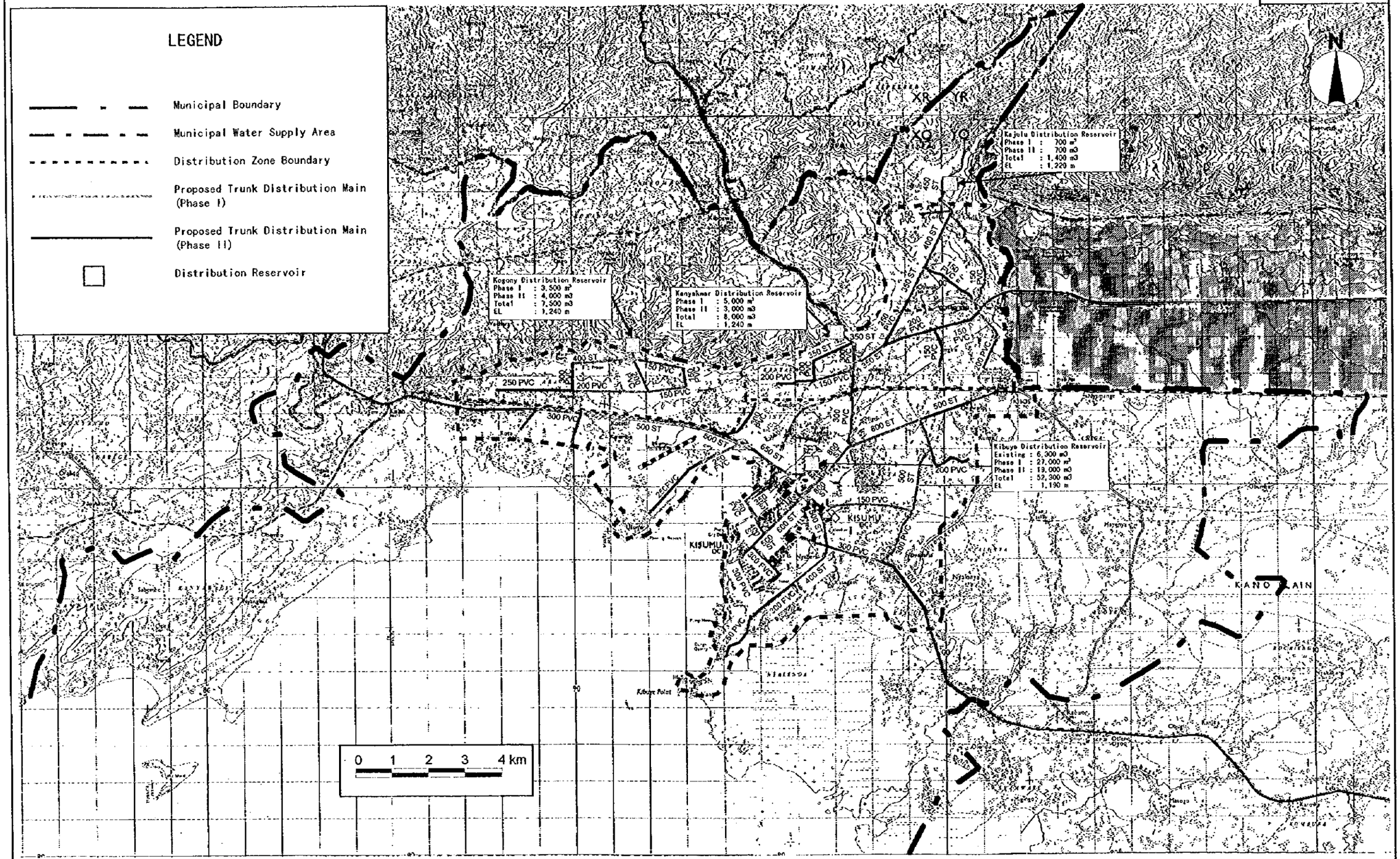


KEY

1. MIXING/MEASURING CHAMBER
2. FLOCCULATION BASIN
3. SEDIMENTATION BASIN
4. RAPID GRAVITY SAND FILTER
5. ELEVATED BACKWASH/SITE WATER TANK
6. CLEAR WATER TANK
7. TREATED WATER PUMPHOUSE

THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE : Sectional Profile of Treatment Units-Proposed Kibuye Water Treatment Works

Figure 6-10



THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE Trunk Distribution Mains of Master Plan

6.1.6 Sub-urban Water Supply

As a result of the surveys on sub-urban water supply conditions, five sub-urban water supply areas have emerged within the Kisumu municipality. They are Dago, Kisian, Kanyagwegi, Orango and Chiga. Their locations are shown in Figure 6-11.

After a careful analysis of socio-economic and institutional situations in these sub-urban areas, it is recommended that water supply for these sub-urban areas be planned and developed, being independent of the municipal water supply system. The reasons for this are summarized as follows:

Difference in Level of Service and Cost Recovery

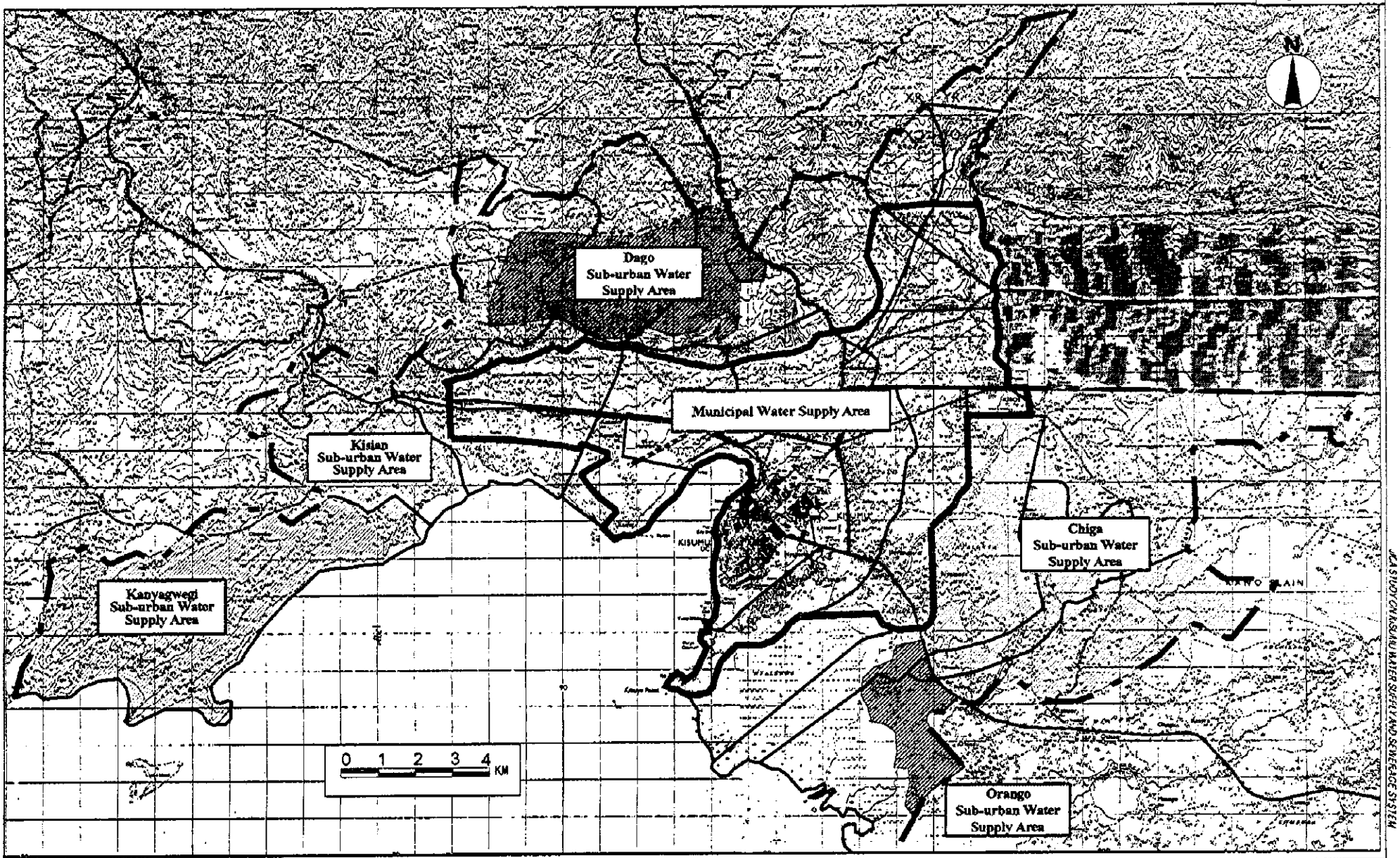
The level of service envisaged for all of these five sub-urban areas is very low in terms of per-capita consumption and cartage distance. It is even lower than the level defined in many developing countries as the minimum requirement to meet Basic Human Needs.

In developing countries, capital costs required for providing BHN level of service often exceed the affordability of local residents. For this reason, capital costs are generally subsidized by central governments in the form of a grant or subsidy, while O&M costs are assumed to be recovered from local residents by means of collecting water charges.

Given the socio-economic conditions prevailing in the five sub-urban areas in Kisumu, the same financial arrangements will be necessary for the realization of new water supply schemes.

Meanwhile, the municipal water supply system in Kisumu is designed to provide higher levels of service and operate more commercially on a financially fully self-supporting basis. It plans to acquire a loan from an international financing agency to finance future capital investment works and recover both capital and O&M costs in the long run, including interest to be incurred on the loan. The financial viability of any future system improvements will therefore need to be evaluated on that basis. This requires such improvements to be cost effective, while the extension of its water supply system to these remote, loosely populated sub-urban areas will be far from a financially viable option for the municipal water supply system. It will be justifiable only when there is no appropriate alternative water source available within those sub-urban areas.

Figure 6 - 11



THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE Location of Deep Wells for Rural Water Supply System

Difference in Operation and Maintenance

Continuous provision of service and a quick response to problems are indispensable to maintain user satisfaction and willingness to pay.

Due mainly to the long distance which exists between these sub-urban areas and the municipal water supply system, it is unlikely that the WSD of Kisumu Municipal Council will be able to maintain continuous monitoring of service or provide timely supports for the operation and maintenance of water supply in these remote sub-urban areas. This in turn suggests that water supply schemes to be installed in these areas, even though they are small and simple ones, will need to be operated and maintained by local residents themselves.

It is a widely accepted view that the involvement of local residents during all planning stages, including financing arrangement and cost recovery, is the most effective way to improve the commitment of local residents to support a local water supply scheme, once it is installed. Community participation is an important factor in a rural-type community water supply, particularly for cost recovery and for the sustainment of a water supply scheme. A community water supply scheme is likely to fail unless there is a strong perception within the community that the scheme is owned, operated and maintained by themselves.

(1) Population Served and Water Demand

Future population served in each of the five sub-urban areas have been estimated as shown in Table 6-9.

Table 6-9 Population Served in Five Sub-urban Water Supply Areas

Sub-urban WS Areas	2005	2015
Chiga	45,995	74,830
Dago	18,806	22,730
Kisian	16,068	40,520
Orango	8,321	13,274
Kanyagwegi	15,310	20,141
Total	104,500	171,495

Assuming an average per-capita water demand of 15 lpcd across all the sub-urban areas, the total potential water demand has been estimated for each of the five sub-urban areas as shown in Table 6-10.

Table 6-10 Potential Water Demand in Sub-urban WS Areas (m3/day)

Chiga		Dago		Kisian		Orango		Kanyagwegi	
2005	2015	2005	2015	2005	2015	2005	2015	2005	2015
690	1,122	282	341	241	608	125	199	230	302

(2) Institutional Situations

a. Policy Framework and Capacity

The institutional situations regarding sub-urban water supplies are somewhat unique in that "rural type" water supplies are required within the Municipality of Kisumu which is an urban local authority.

This situation has arisen because of the governments past policy to greatly extend the municipal boundaries for numerous urban centres in Kenya in the recent past. In the World Bank document "Kenya Local Government Finance study" dated April 23 1992, the World Bank asked that no further extensions take place. Regardless of other considerations in boundary extensions, the additional land and population places a great burden on local authorities which became responsible for providing the usual municipal services to a scattered and largely rural type population.

Where local authorities are also water undertakers, the provision of water and sanitation facilities falls under their jurisdiction. This is precisely the situation that Kisumu finds itself in with a relatively small and scattered population being technically part of the urban municipality.

When the Kisumu boundaries were extended, two small government water supplies ended up inside the municipal boundary. These are located in Dago sub-location (Operated by MLRRWD) and Ojolla sub-location (operated by NWCPC).

Other small scale water supplies are operated by community groups or individuals, but many have to fend for themselves from shallow wells and surface water. Sources of water are scarce particularly during the dry season. There are over 300 known wells in the sub-urban areas, and there is a Kisumu Well Owners Development Group which has a chairman.

Basically, despite their inherited responsibility, KMC have not involved themselves in water supply in the sub-urban areas.

The MLRRWD is the Ministry with overall responsibility for water resources management and the enforcement of the Water Act. These responsibilities are executed through the Water Development Department. The MLRRWD currently operates about 376 schemes, 309 of which are rural and therefore has a wealth of knowledge and experience in this sector. The MLRRWD has no role in the development or operation of sewerage and sanitation, and as can be seen in Kisumu sanitation is achieved by the individual constructing his own pit latrine.

The National Water Policy was approved by GOK in late 1997 and a Sessional Paper is now being prepared. The Policy aims "at achieving sustainable development and management of the water sector by

providing a framework in which the desired targets/goals are set, outlining the necessary measures to guide the entire range of actions and to synchronise all water related activities and actors."

The revision of responsibilities referred to in the National Water Policy would, in the long term, concentrate the responsibilities of MLRRWD and other ministries on overall sector policy and strategy, planning and regulations. The development, implementation and operation of schemes would be handled by the NWCPC, the municipalities and any other undertakers. This has been accepted by GOK in principle.

In other related policy statements GOK have indicated their readiness to involve communities in the development of water supply schemes.

Considerable emphasis has lately been given to community water supplies because of their large coverage of the population, the potential for disease due to the use of untreated and polluted water, and their important role in irrigation and other agricultural use.

Communities generally do not wish to be associated with GOK mainly due to fears over metering and high tariffs, although they would welcome technical and financial support without strings.

With all the reforms and studies still in progress the future of small scale supplies is not clear in the institutional framework, except that there is strong leaning to community operated supplies. This certainly could be applied to the sub-urban areas within Kisumu municipality.

b. Planning

Whilst the studies continue on the institutional direction that small scale water supplies will take, it is clear that policy planning will take some time to resolve. Equally clearly, small-scale water supplies are unlikely to be high on the priority list, but they can and should be planned now within the overall GOK policy in the Water Sector.

In the case of Kisumu, the government is not responsible for water supplies to the "rural" population within the Municipal boundary. The Municipality itself is currently not capable of developing small-scale water supplies due to lack of capacity and finance. The extension of the municipal water supply system to these remote, loosely populated sub-urban areas is not a financially viable option for the Municipality.

Since there are already some strong community groups operating small-scale water supplies within the municipal boundary, and other communities have shown strong interest in being involved in such projects, this would indicate the way ahead.

The use of Community Based Organisations (CBO's) is therefore recommended, with technical assistance from the WSD of Kisumu. By this arrangements the GOK policy framework is met, the municipality honours its obligations to the people, and communities will get their wish to become more involved in water supply. With the desire to succeed the communities can be organised without waiting for government action in this sector.

c. Implementation

Implementation of the planned sub-urban water supply schemes detailed in this report can only commence when funds are made available for a study of the ground water resources, and for the strengthening of communities to operate the schemes.

Implementation should be undertaken by the communities themselves, as far as possible, with the support of agencies in Kisumu, and the key stakeholders.

There is an opportunity for linking the implementation of this programme with the proposed action plan being developed under the DFID financed PAMNUP project which will select settlements for community participation in the high density peri-urban areas of Kisumu. Detailed Co-ordination between the JICA Phase I Project and PAMNUP will be required for the development of water and sanitation in its selected peri-urban districts which will form a base for the attachment of the sub-urban areas to the same planning structure.

Key stakeholders identified by the PAMNUP study for all infrastructure projects are:-

- Kisumu Municipal Council
- Non-Governmental Organisations
  - National/International NGO's represented in Kisumu
  - Kisumu Based NGO's
  - Service Clubs (e.g Lions, Rotarians)
  - Business Club (e.g tourism, hotel associations)
  - Religious organisations
- Provincial and district Administrations
  - DDC as coordinating body
  - District line officers as technical support agents.

The NGO "Care" is already involved in the development and implementation of water and sanitation projects in informal settlements to improve the capacity of community members and to improve access to water and sanitation.

The first year of the PAMNUP project, scheduled to commence in May 1998 will basically focus on training. Baseline information must be collected on communities, and existing community based organisations must be strengthened with capacity building at community level.

If, as has been suggested in the PAMNUP project, a Project Coordination Unit (PCU) is located within KMC, this would form a likely vehicle for the implementation of sub-urban water supplies schemes.

Whereas no firm timing can be given, much will depend upon the success of the initial phases of the PAMNUP project; this project is scheduled over a period of five years which coincides with the implementation of the JICA Phase I Project.

Clearly, there will be a mechanism in Kisumu for the successful implementation of sub-urban water supplies by integration with the PAMNUP Project.

In the Kisumu's Community Infrastructure Programme (CIP), there will be a need for capacity building within community based organisation (CBO's) to facilitate implementation of the sub-urban water supply schemes.

The main partners in the sub-urban water programme would be:-

- The Donor Agency
- The CBO's formed in Five Sub-urban Areas
- Kisumu Water and Sewerage Department.

In order to achieve the objective of providing selected communities with an adequate quantity and quality of water, the specific objectives will be:-

- To enhance the capacity of CBO's and to educate the people on the importance of clean water supply
- To assist selected communities to establish their own water system.
- To assist selected communities, through training, to monitor the supply of water, and the quality in a sustainable manner.

The sub-urban water supply schemes envisaged will comprise deep wells (boreholes). The availability of groundwater will be checked by a study of the groundwater resources to ensure sustainability of supply.

d. Operation and Maintenance

After construction of the water system the management, operation and maintenance will be the responsibility of the CBO's. This will be done through a water committee if the CBO is involved in other infrastructure

projects.

Day to day operation will be carried out by member of the community, under the control of the CBO. This will include operation of the deep well and the sale of water. Depending upon the safe yield of the source, a distribution system could be added at a later date.

Regular routine maintenance will also be carried out by selected members of the community under the umbrella of the CBO. Technical assistance will be rendered by the WSD of Kisumu to ensure the facilities are maintained and to assist with major maintenance matters, particularly breakdowns.

Training for operation and maintenance is available at KEWI particularly through the GTZ support programme. This programme can provide grass roots training on all facilities from borehole operation, to maintenance of engines and to fixtures and fittings.

It is recognised that all members of a community do not speak English, and GTZ have ensured that training can be done in Swahili. In addition, the training can be carried out on the job, rather than at the KEWI in Nairobi.

e. Cost Recovery

No project can be sustainable without some form of cost recovery. People who do not have access to the municipal piped system in Kisumu have demonstrated their willingness to pay for water from vendors, private supplies, and community operated schemes.

In the PAMNUP study, the provision of a safe water supply features high on the priority list prepared by the communities themselves, usually ranked either first or second. There can be no doubt on the need to pay for water from the planned sub-urban water supplies, and the willingness to pay, provided that the charges are affordable.

Since the poorest in the communities always pay the highest unit cost, often twenty times more than water from a municipal piped supply, there is little doubt that an affordable charge can be set to cover operation and maintenance at least. Depending on the economics of each small supply scheme, highly dependent on borehole yield, it may even be possible to generate surplus funds for capital development.

Water will be charged at an agreed market rate. The finances will be controlled by a finance committee within the CBO and will be used to pay the stand pipe attendants and for the maintenance and security of the water system.

Suggested financial controls and procedures are outlined in a draft financial management document given as follows.

FINANCIAL MANAGEMENT DOCUMENT FOR COMMUNITY INFRASTRUCTURE PROGRAMME WATER PROJECT

The CBO Finance Committee will generally exercise complete control over the finances which accrue out of the above water project.

Bank Account

1. Each community participating in CIP will have a separate account for the water project managed by the Finance Committee in addition to its other account.
2. Bank accounts must bear the name of the CBO and refer to the water project.
3. Three signatures are required per cheque, names to be agreed by the executive.
4. All cheques must be accounted for. Any cancelled cheque must be marked "cancelled" and attached to the cheque stub.
5. Monthly bank reconciliation must be prepared and approved.
6. Lost or out-of-date cheques must be notified to the bank immediately. When written confirmation is received from the bank that the payment has been stopped, a replacement cheque may then be issued.
7. Where possible, all transactions will be made by cheque. Cash payments should be the exception.

Accounting Procedure

1. The CBO Finance Committee is responsible for preparing the annual accounts which will be submitted to the Executive Committee for approval.
2. The annual accounts should be completed using a standard format showing the income and expenditure statement.
3. Bank reconciliation statement.
4. The Finance Committee will be responsible for properly maintaining all books and records of accounts as are referred to in this document. There is one main book of accounts that has to be properly maintained by the Finance Committee namely:

   The Project receipts and payment book
   The petty cash book.

The project receipts and payments book records, for each month, details of all receipts of money by the project receipts and payments book records, for each month details of all receipts of money by the project and details of all payments from the project bank account. The details are recorded under the various headings, e.g. date payee, description of payment, cheque number and total amount.

Project receipts and payments book will be written up immediately when a lodgement is made or when cheques are signed from the project bank account.

The project receipts and payments book may be written up by the Treasurer of the CBO and reviewed regularly by the CIP accountant.

(3) Water Supply Options

As mentioned earlier in Section 6.16, the extension of the municipal water supply system to the sub-urban areas is far from a financially viable option and will be justifiable only when there is no appropriate alternative water source available within those sub-urban areas.

For this reason, two technical options (Option 1 and Option 2), both based on local ground water were developed for the planning of water supply in the sub-urban areas.

Option 1 will include drilling of a deep well around 50 m in depth and equipping the well with a hand pump. It is assumed in this option that sustainable yield from the well is 10 m3/day, and that one well can serve approximately 700 persons.

Option 2 will be similar to Option 1 except that the deep well will be equipped with a submergible pump and a diesel generator. In addition, an elevated storage tank will be also provided. In this option, sustainable yield of the well is assumed to be 100 m3/day, and that one well can serve approximately 6,700 persons.

In either of the above two options, the deep well is planned to be operated as a point water source without reticulation pipes. This will facilitate operation and maintenance of the scheme, minimize the chance of contamination and wastage/leakage, and allow the price of water being within the affordability of beneficiaries. It is expected that water vendors will play an important role in distributing water to consumers in a wider extent of area.

A typical layout is shown for each of these two options in Figures 6-12 and 6-13.

The total number of deep wells to be required under each of these two options is shown in Table 6-11.

Although the location of these deep wells should be determined on the basis of a ground water study and the availability of a CBO for the management of the water supply scheme, they can be preferably located:-

- on main roads (for ease of maintenance and security)
- in relatively high population density areas
- near from schools.

Table 6-12 Number of Deep Wells Required under Each Option

Option	Chiga		Dago		Kisian		Orango		Kanyagwegi	
	2005	2015	2005	2015	2005	2015	2005	2015	2005	2015
1	69	113	29	35	25	61	13	20	23	31
2	7	11	3	4	3	6	1	2	2	3

Capital works to be required for each option are shown in Table 6-12 with estimated costs.

Table 6-13 Capital Works and Costs

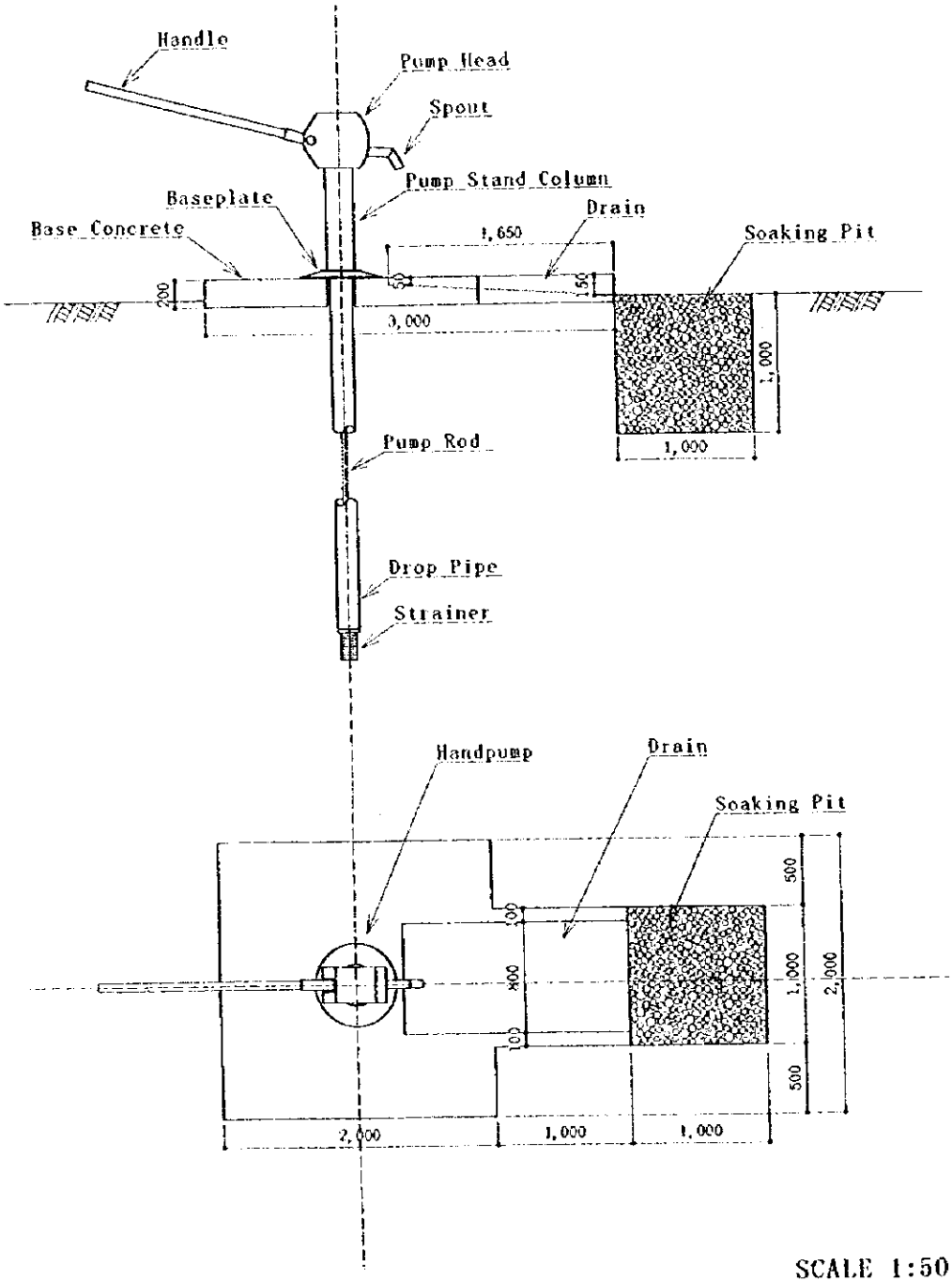
Option 1

Item	Description	Cost (Ksh)
Deep Well	d = 50 m	400,000
Hand Pump		100,000
Others	Base concrete, etc.	50,000
Total Capital Cost for Option 1		**550,000**

Option 2

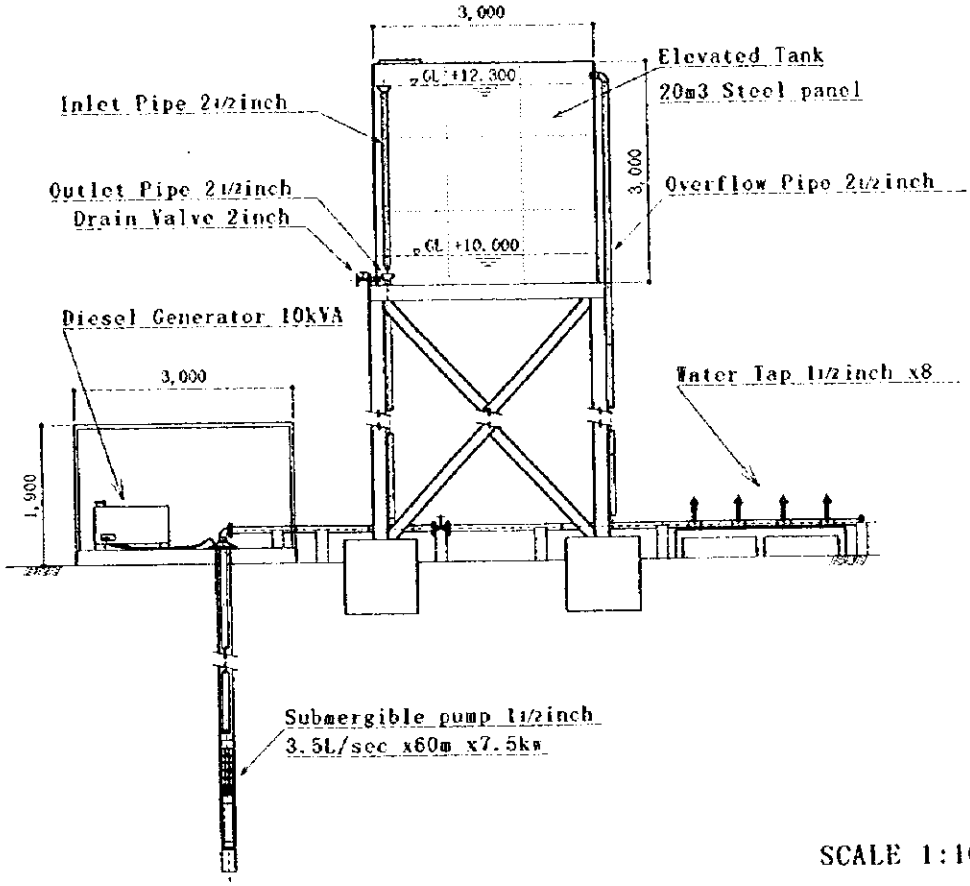
Item	Description	Cost (Ksh)
Deep Well	d = 50 m	400,000
Submergible Pump	3.5L/sec x 60m x 7.5 kw	250,000
Diesel Generator	10 kVA	540,000
Elevated Tank	20 m3 x 10 m H	750,000
Others	Pump House, Piping, etc.	100,000
Total Capital Cost for Option 2		**1,940,000**

Figure 6-12



THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE : Sub-urban Water Supply Option 1 Handpump

Figure 6-13



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THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE : Sub-urban Water Supply Option 2 Submergible Pump

Operation and maintenance costs will include salary for a water tariff collector, costs for periodical overhauling/replacement of equipment, and fuel costs (in case of Option 2). The costs of water to fully recover the costs for operation and maintenance are estimated below for each of the two options.

Option 1:

Tariff Collector :	1.5 Ksh/m3
Pump Overhaul (every 6 years) :	0.046 Ksh/m3
Pump Replacement (every 12 years) :	2.283 Ksh/m3
Total :	**17.329 Ksh/m3**
	(0.35 Ksh/20 liter)

Option 2:

Tariff Collector :	1.5 Ksh/m3
Pump Overhaul (every 3 years) :	0.685 Ksh/m3
Pump Replacement (every 12 years) :	0.571 ksh/m3
Generator Overhaul (every 3 years) :	0.685 Ksh/m3
Generator Replacement (every 12 years) :	1.233 Ksh/m3
Fuel	8.160 Ksh/m3
Total:	**12.834 Ksh/m3**
	(0.26 Ksh/20 liter)

The following should be noted from the above analyses:

- Option 2 will be more cost effective in terms of operation and maintenance costs; hence it should be given a priority in areas where ground water is sufficiently available.
- Operation and maintenance costs will be further reduced if the replacement cost for pump and generator is excluded.
- In either option, the cost of water to recover operation and maintenance costs will be lower than the average water rate of approximately 30 Ksh/m3 which is currently being charged in the municipal water supply system; it is almost ten times less than the price people are generally paying to water vendors.
- With the initial capital investment cost being financed by a grant or subsidy, either option can be operated and maintained on a financially self-supporting basis.
- A community, if it has an adequate planning capacity, may be able to set the price of water at a higher rate and to further develop the scheme by themselves by setting aside part of water sale revenues.

(4) Priority for Implementation

Of the five sub-urban areas, two areas, namely Chiga and Kanyagwegi are considered to have a higher

priority for implementation over the other areas.

Both Chiga and Kanyagwegi areas are essentially rural in nature and currently contains no significant industry. Although some residents commute to jobs in the central part of the municipality, most rely on subsistent agricultural and cattle farming activities.

Reasons for Chiga being selected are as follows:

- Population is high.
- Despite its large area coverage, there is only one reliable source of water, which is a deep well operated by a Catholic Church. Local ponds are used during the rainy season but they dry up in the dry season.
- There is a strong local water initiative; the Catholic Church is sending water samples to the University of Nairobi for quality testing once a month and is also willing to manage water supply schemes in other locations.

A pipeline was extended from the municipal water supply system to part of the Chiga area a few years ago under the initiative of UNICEF. This was done as an emergency countermeasure against the outbreak of cholera and other epidemic diseases in the area. Water supply through this pipeline, however, has been discontinued for some time until today, due to the lack of an adequate water pressure at the off-take from the municipal system.

All of the existing wells in Kanyagwegi are shallow wells and they dry up in the dry season. There is no other existing alternative water source available in the area, except buying water from water vendors. Sources of water are scarce particularly during the dry season, and the potential for disease due to the use of untreated, polluted water is extremely high. When the Kisumu boundaries were extended in 1992, two small government water supply schemes ended up inside the municipal boundary. One of the schemes is located in the Ojolla Sub-location being operated by NWCPC. Although a pipeline from this scheme has been extended to part of the Kanyagwegi area, water from the scheme is currently available only once in a long while.

Current water supply situations in the Dago, Kisian and Orango areas are less serious than in Chiga and Kanyagwegi, and hence the implementation of a new water supply scheme in these three sub-urban areas can be delayed until the prevailing water constraints in the former two are improved and funds are available for the other areas.

The total capital costs to be required for Chiga and Kanyagwegi to meet the water demand in 2005 under Option 1 are estimated as follows:

- Chiga : Ksh 13,580,000 (7 deep wells)

- Kanyagwegi : Ksh 3,880,000 (2 deep wells)

In actual implementation, it will be not necessary to construct all the deep wells at one time or in one year. They can be increased year by year, depending on the availability of funds.

(5) Implementation Schedule

The following describes the steps to be taken for the materialization of the sub-urban water supply schemes in the Chiga and Kanyagwegi areas. It is particularly important that Kisumu municipality provides all necessary supports and guidance to CBO's and/or communities during and after the implementation of water schemes.

An overall implementation schedule of the sub-urban water supply schemes is presented in Figure 6-14.

Step 1
Work in the initial stage will comprise a ground water study and a community survey.

The objective of the ground water study will be to select the locations of deep wells to be constructed in each of the two localities. For this purpose, the study should collect and review all the existing hydrological, geohydrological and other relevant data and information which have been produced from previous studies and investigations. Based on the review, the study should select the locations where ground water will be most likely available at a rate of approximately 100 m3/day or more when a borehole is actually sank. Where possible, those locations can be preferably selected:

- Alongside of a main road (for ease of operation and maintenance)
- In a relatively high population density area (village or community)
- Near from a school, clinic or church

The community survey can be carried out simultaneously. The initial objective of the survey is to identify communities and/or CBO's (Community Based Organizations) within each of the two localities. The survey will then inform the communities and/or CBO's about the proposed water supply schemes. The final objective of the survey will be to identify CBO's which are well accepted by local communities and are being capable and willing to manage, on behalf of the communities, a water scheme once it is installed. The survey will also collect baseline information on communities, such as population, the number of households and potential size of water demand.

Step 2
Once prospective deep well locations are selected and CBO's identified, an application for grant assistance

can be made by a CBO for the construction of a deep well. Given the relatively small amount of capital costs required, the application can be made for a grass root type assistance provided by bilateral donor agencies. The work to be financed by such assistance should include the drilling of an exploratory borehole/s, including sampling/testing of water quality and test pumping to confirm the sustainable yield from the borehole. The drilling should be continued up to a depth of approximately 100 m unless there is an aquifer at a shallower depth, which is adequate in terms of yield and water quality. If the exploratory borehole is found successful, then it should be properly equipped with a casing, submergible pump, diesel engine, elevated tank, plumbing and other necessary equipment to serve as a production well. A typical layout of the scheme is shown in Figure 6-13. If the borehole is found unsuccessful, the next exploratory borehole should be drilled at the second nearest location to the CBO. For this reason, the total cost applied for the assistance should include a contingency for drilling at least three exploratory boreholes.

Step 3

If the application is accepted and an agreement was reached between a CBO and a donor agency, the CBO can employ a contractor for the drilling/equipping of a borehole. In the meantime, the CBO, in close consultation with relevant communities, should establish a management structure, which will be responsible for the day-to-day operation and maintenance of the water system once it is installed. Water tariff should be determined and a tariff collector be appointed. Needs for strengthening their capacity should be identified and informed to Kisumu municipality for the provision/arrangement of necessary training.

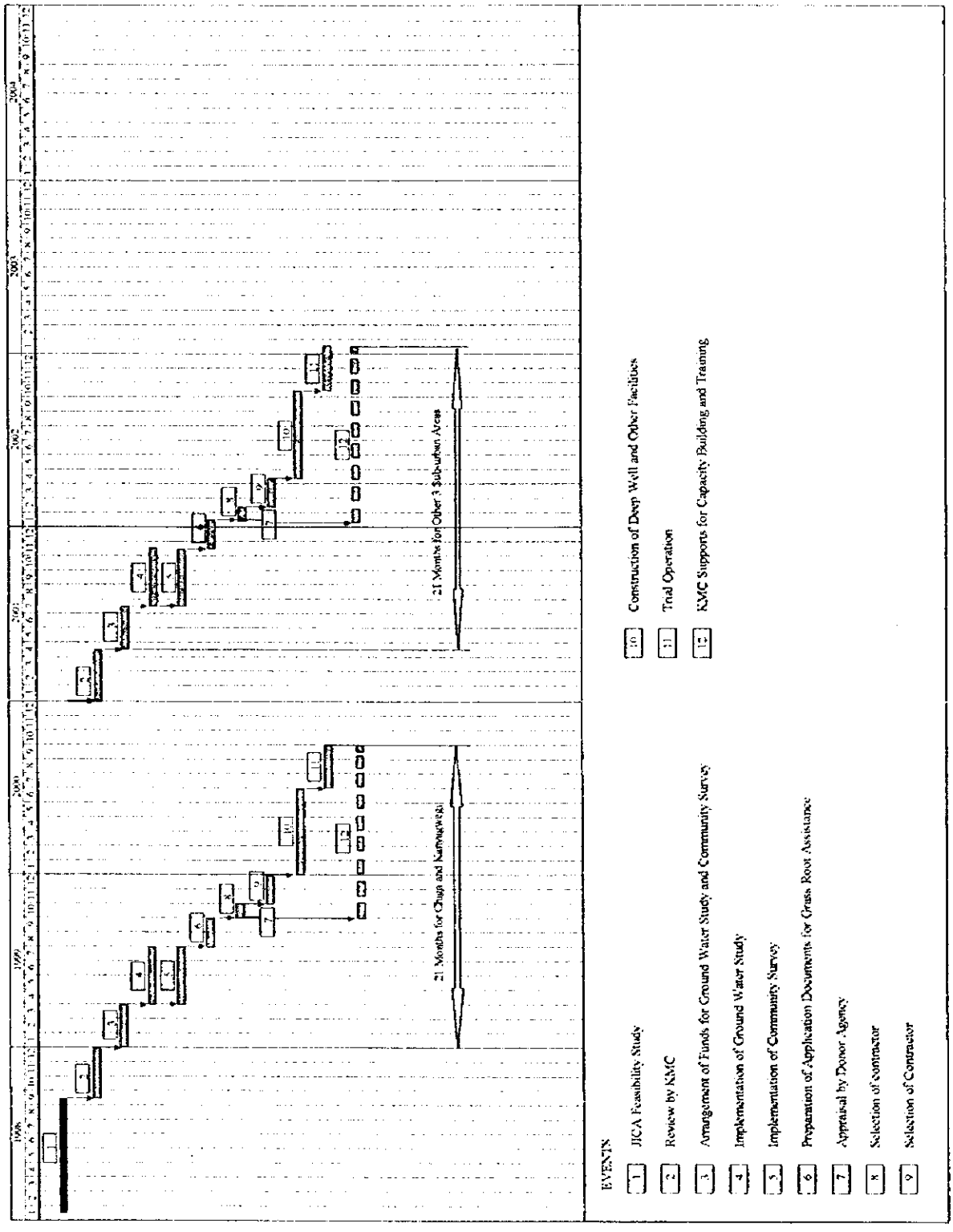
(6) Recommendations on Funding

If there is a donor agency who agrees to include the ground water study and community survey as part of its supporting scheme, it is preferable to apply to the agency for assistance. Otherwise, the costs required for Step 1 (a total cost of approximately Ksh 2,500,000) may need to be subsidized by the Kisumu Municipal Council.

With respect to the community survey, however, there is a possibility that the survey be conducted as part of the PAMNUP project which is scheduled to commence in May 1998. If, as has been suggested in the PAMNUP project, a Project Coordination Unit (PCU) is located within the Kisumu Municipal Council, this would form a likely vehicle to achieve the objectives of the survey within the framework of the PAMNUP project.

As stated earlier, the costs required for Step 2 can be applied for grass root assistance provided by bilateral donor agencies.

Figure 6-14



THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE : Implementation Schedule of Sub-urban Water Supply Schemes

6.2 WASTEWATER MANAGEMENT SYSTEM

6.2.1 Sewerage System

(1) Wastewater Collection Facilities

1) Design Flows

Domestic and non-domestic wastewaters which will be collected by the municipal sewerage system are presented in Table 5-18 of Chapter 5. This wastewater collection schedule is conceived that that the municipal sewerage system, with the combined use of conventional sewerage system and shallow sewers, will be able to collect 60 % of the total wastewater generation in 2005, and that the percentage will increase to 83 % in 2015. In this context, conventional sewerage system is assumed to collect most of non-domestic wastewaters as well as domestic wastewater from households whose water consumption rates are 100 lcd or greater, shallow sewers will collect domestic wastewater from those who consume 50 to 60 lcd, and those who consume 15 to 20 lcd will remain with on-site sanitation facilities.

Daily average flows shown in Table 6-12 are the same information being broken down into three wastewater treatment districts, namely Central, Eastern and Western WTDs. In estimating the total daily average flow for each WTD, an allowance for groundwater infiltration which is assumed to be 25 % of the total volume of domestic and non-domestic wastewaters is added.

Table 6-14 Design Flows for Planning of Sewerage Infrastructure Unit: m^3/day

WTD	Daily Average Flow		Daily Maximum Flow		Hourly Maximum Flow	
	2005	2015	2005	2015	2005	2015
Central WTD						
Domestic	2,540	3,110	2,800	3,420	5,080	6,220
Commercial	2,130	3,040	2,340	3,340	4,260	6,080
Institutional	500	1,140	550	1,250	1,000	2,280
Industrial	4,700	3,510	5,170	3,860	9,400	7,020
Sub total	9,870	10,800	10,860	11,870	19,740	21,600
Ground Water	2,470	2,700	2,470	2,700	2,470	2,700
Total	12,340	13,500	13,330	14,570	22,210	24,300
Design Flow	12,400	13,500	13,400	14,600	22,300	24,300
Eastern WTD						
Domestic	8,870	14,580	9,760	16,040	17,740	29,160
Commercial	1,790	2,670	1,970	2,940	3,580	5,340
Institutional	1,250	2,840	1,380	3,120	2,500	5,680
Industrial	1,440	2,480	1,580	2,730	2,880	4,960
Sub total	13,350	22,570	14,690	24,830	26,700	45,140
Ground Water	3,340	5,640	3,340	5,640	3,340	5,640
Total	16,690	28,210	18,030	30,470	30,040	50,780
Design Flow	16,700	28,300	18,000	30,500	30,100	50,800
Western WTD						
Domestic	0	12,570	0	13,830	0	25,140
Commercial	0	1,280	0	1,410	0	2,560
Institutional	0	1,140	0	1,250	0	2,280
Industrial	0	6,720	0	7,390	0	13,440
Sub total	0	21,710	0	23,880	0	43,420
Ground Water	0	5,430	0	5,430	0	5,430
Total	0	27,140	0	29,310	0	48,850
Design Flow	0	27,200	0	29,300	0	48,900
Total						
Domestic	11,410	30,260	12,560	33,290	22,820	60,520
Commercial	3,920	6,990	4,310	7,690	7,840	13,980
Institutional	1,750	5,120	1,930	5,620	3,500	10,240
Industrial	6,140	12,710	6,750	13,980	12,280	25,420
Sub total	23,220	55,080	25,550	60,580	46,440	110,160
Ground Water	5,810	13,770	5,810	13,770	5,810	13,770
Total	29,030	68,850	31,360	74,350	52,250	123,930
Design Flow	29,100	68,900	31,400	74,400	52,300	124,000

Daily Maximum Flows and Hourly Maximum Flows are estimated using the same ratios as that applied in the estimate of water supply demands, which are:

Daily Average Flow : Daily Maximum Flow : Hourly Maximum Flow = 1.0 : 1.1 : 2.0

Out of the above three wastewater treatment districts, two namely the Central and Eastern WTDs are currently existing although wastewater collection systems in these districts are not functioning properly and require extensive improvements under Phase I. The Western WTD is proposed to be installed in Phase II to increase the wastewater collection from 60 % after Phase I to 83 % in its target year 2015.

2) Design Criteria

The Study Team developed the following criteria for the design of wastewater collection facilities, taking the local conditions of Kisumu municipality and criteria adopted in Kenya and the neighbouring countries into account.

a) Sewers

In determining sewer capacities, the Manning Equation is used for gravity sewers with n-value of 0.013 for new concrete pipes and 0.015 for existing concrete pipes. Hazen-Williams Equation is used for force mains with C-value of 110. Hourly maximum flow is used for calculation of capacities for all pipes and conduits with the allowance for future uncertainties which is 100% for pipes 600 mm and less in diameter or 75% for pipes 700 mm and larger.

A diameter 250 mm is adopted as the minimum size for trunk sewers. This however excludes pressure pipes and branch sewers. All sanitary sewers are designed to maintain a mean flow velocity, when flowing full or half full, of not less than 60 cm/sec based on the Manning equation. However, to prevent hydrogen sulphide built-up in sewers, a slightly higher velocity is used for the design of sewers.

To prevent sewer erosion , all sewers are designed to have a flow velocity not exceeding 3.0 m/sec. Where ground slope is steep and flow velocity is expected to exceed 3.0 m/sec, drop manholes will be provided to decrease the velocity.

A sufficient earth covering depth should be provided between the top of sewers and the road surface to protect the sewers from traffic loads and to avoid undue interference with other underground utilities. A minimum of 1.5 meter should be provided for trunk sewers, except in special situations where a shallower depth is feasible.

b) **Pump Stations**

The flow used for the design of pump stations is hourly maximum flow. All pipings and conduits will be designed to carry design hourly maximum flows. Capacity and number of pump units will be determined that there will be at least one standby unit even under the hourly maximum flow conditions.

Two identical pump units, one duty and one standby, will be provided for small pump stations. In case of large pump stations, two or more units of identical pumps including one standby will be provided.

In general, the plan of pump stations will be rectangular. When screw volute pumps are used, a separate dry well which will accommodate the pumps will be provided. Wet wells should be provided with an adequate storage capacity to prevent frequent on-off of the pumps.

Pumps will be electric motor driven. Provision of emergency power supply equipment will depend on the importance of pump stations.

3) **Proposed Wastewater Collection Facilities**

a) **Trunk Sewers**

The sewerage system improvements proposed up to the year 2015 are shown in Figure 6-14. Trunk sewers are planned that they will follow major drainage basin patterns in the area. To do otherwise will require excessively deep excavation and branch sewers or many pump stations.

The proposed trunk sewers will be 125 to 1,100 mm in diameter and 52 km in total length and will be laid over the three wastewater treatment districts, namely Central, Eastern and Western WTDs.

Table 6-13 presents a summary of the sewers proposed for each of the three wastewater treatment districts.

Figure 6 - 15

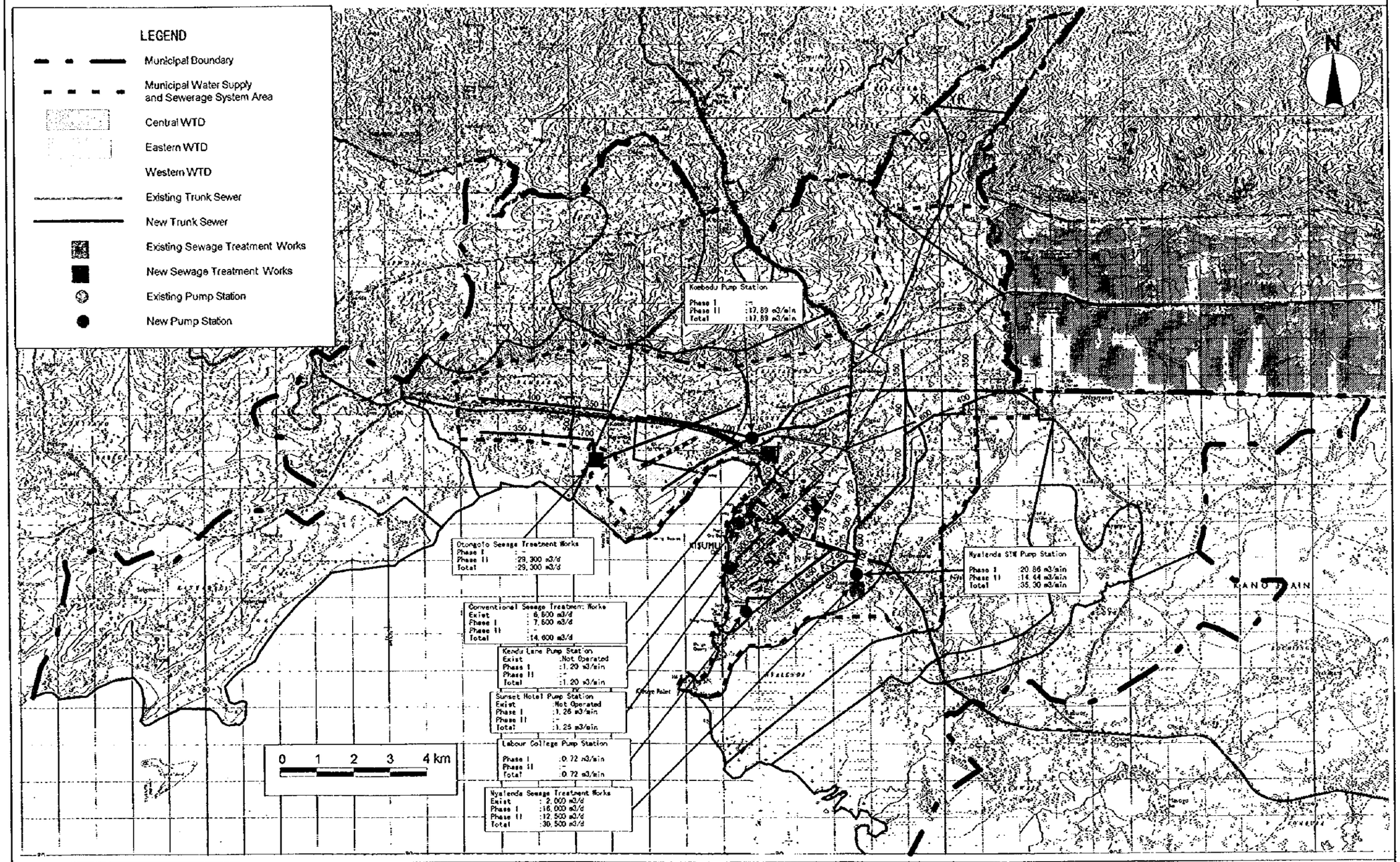


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Table 6-15 Summary of Trunk Sewers Proposed for Each WTD

Wastewater Treatment District		Unit Design Flow Rate (m^3/sec/ha)	Phase I		Phase II	
			Diameter (mm)	Length (km)	Diameter (mm)	Length (km)
Central WTD		0.000525	250 to 400	2.6	200 to 700	2.9
Eastern WTD	Sub-district A	0.000292	125 to 1,100	23.1	-	-
	Sub-district B	0.000227				
	Sub-district C	0.001105				
Western WTD	Sub-district A	0.000256	-	-	250 to 1,000	23.2
	Sub-district B	0.000227				
	Sub-district C	0.000159				
Total			125 to 1,100	25.7	200 to 1,000	26.1

In the Central and Eastern WTDs, some of the existing trunk sewers have been found broken or too small in size to meet the estimated future design flows. The lengths of the proposed trunk sewers shown in Table 6-13 for each of these two WTDs include the lengths required for replacement of these existing trunk sewers.

b) Pump Stations

None of the exiting three pump stations in the Central WTD, namely the Sunset Hotel Pump Station, Kendu Lane Pump Station and Mumias Road Pump Station, is currently functioning. Urgent rehabilitation of these pump stations is necessary. In addition, another three pump stations will need to be constructed in the future. They are the Kombedu Pump Station in the Western WTD and the Labour College Pump Station and Nyalenda STW Pump Station in the Eastern WTD. Once the Kombedu Pump Station is constructed, it will collect wastewater from the area currently served by the Mumias Road Pump Station, and the latter pump station will be abandoned.

The outlines of these pump stations are summarised as follows:

i) Existing Sunset Hotel Pump Station in Central WTD (rehabilitation & improvement)

Design Flow: 1.26 m^3/min
Pump Capacity (per unit) : 1.26 m^3/min
Total Head : 40 m
Number of units : 2 (including 1 standby)
Motor Power : 18.5 kW

ii) Existing Kendu Lane Pump Station in Central WTD (rehabilitation and improvement)

Design Flow: 1.20 m^3/min
Pump Capacity (per unit) : 1.20 m^3/min
Total Head : 13 m
Number of units : 2 (including 1 standby)
Motor Power : 5.5 kW

iii) Existing Mumias Road Pump Station in Central WTD (rehabilitation only)

Design Flow: 1.62 m^3/min
Pump Capacity (per unit) : 1.62 m^3/min
Total Head : 10 m
Number of units : 2 (including 1 standby)
Motor Power : 7.5 kW

iv) Proposed Kombedu Pump Station in Western WTD

Design Flow: 17.89 m^3/min
Pump Capacity (per unit) : 4.47 m^3/min
Total Head : 30 m
Number of units : 5 (including 1 standby)
Motor Power : 37 kW

v) Proposed Labour College Pump Station in Eastern WTD

Design Flow: 0.72 m^3/min
Pump Capacity (per unit) : 0.72 m^3/min
Total Head : 9 m
Number of units : 2 (including 1 standby)
Motor Power : 3.7 kW

vi) Proposed Nyalenda STW Pump Station in Eastern WTD

Design Flow: 35.30 m^3/min
Pump Capacity (per unit) : 17.7 m^3/min
Total Head : 2 m
Number of units : 3 (including 1 standby)
Motor Power : 11 kW

(2) Sewage Treatment Works

1) Existing Conventional Sewage Treatment Works in Central WTD

This sewage treatment works has been subjected to severe overloading in terms of sewage volume and loads, the quality of effluent is more than 100 mg/l in terms of BOD, which far exceeds the wastewater standards. Therefore the rehabilitation of existing facilities is highlighted to raise their efficiency and is proposed to be taken place as early as possible. The inlet, primary sedimentation tanks and secondary sedimentation tanks will need to be expanded to cope with the projected inflows to the plant. During the rainy season, inflows into the plant have been measured at 13,000 m^3/day.

The following rehabilitation and expansion works will have to be completed in Phase I:

a) Rehabilitation Works
   i) Rehabilitation of the mechanical/electrical equipment
   ii) Construction of 1 No high rate plastic media trickling filter
   iii) Replacement of top 1.2 m of stone media with super rate (SR) plastic media in trickling filters 1-4
   iv) Construction of 1 No 13.2 m diameter secondary sedimentation (humus) tank
   v) Construction of 1 No sludge thickening tank
   vi) Provision of 4 No lightweight covers for sludge drying beds
   vii) Minor alterations to inlet works

b) Expansion Works
   i) Inlet works to be extended
   ii) Construction of new storm bypass structure
   iii) Construction of 1 No primary sedimentation tank
   iv) Construction of 1 No super rate (SR) media trickling filters
   v) Construction of 2 No secondary sedimentation (humus) tanks
   vi) Provision of 6 No lightweight covers for sludge drying beds

A layout of uprating the Conventional STW is shown in Figure 6-15. The proposed rehabilitation and expansion works are planned that they will enable the STW to meet not only the design inflow in 2005 but also that in 2015, as the incremental inflow to the STW during the decade is estimated marginal.

2) Existing Nyalenda Sewage Treatment Works in Eastern WTD

The Nyalenda Sewage Treatment Works needs to be uprated to cope with the estimated design daily average inflows of 16,700 m3/day in 2005 and 28,300 m3/day in 2015. This will be done in two phases, i.e., Phase I and Phase II. The existing inlet works will require extensive refurbishing to cope with the new flows and three anaerobic ponds will be required. Each pond will be served individually from the new inlet works and will discharge to downstream facultative ponds in series.

a) Phase I

The works proposed for implementation under Phase I are listed below. They will mainly concentrate on the refurbishment of the existing facilities with a view to enabling the plant to cope with the projected design daily average inflow of 16,700 m3/day in 2005.

1. Construction of a new venturi-flume in lieu of the existing Parshall flume and alter the profiles of the grit channels to a trapezoidal shape designed to match the new flume.
2. Construction of new desludging ramps for the facultative ponds
3. Replacement of anti-erosion slabs
4. Reconstruction of 50 m of division embankment between maturation ponds M2 and M3.
5. Desludging of facultative ponds
6. Construction of 3 No. anaerobic ponds upstream of facultative ponds

b) Phase II

The works proposed for Phase II comprise the construction of an additional treatment stream with 5 No. maturation ponds. This will enable the works to cope with the projected design daily average inflow of 28,300 m3/day in 2015.

A layout of uprating the Nyalenda STW to treat 2015 inflows is shown in Figure 6-16.

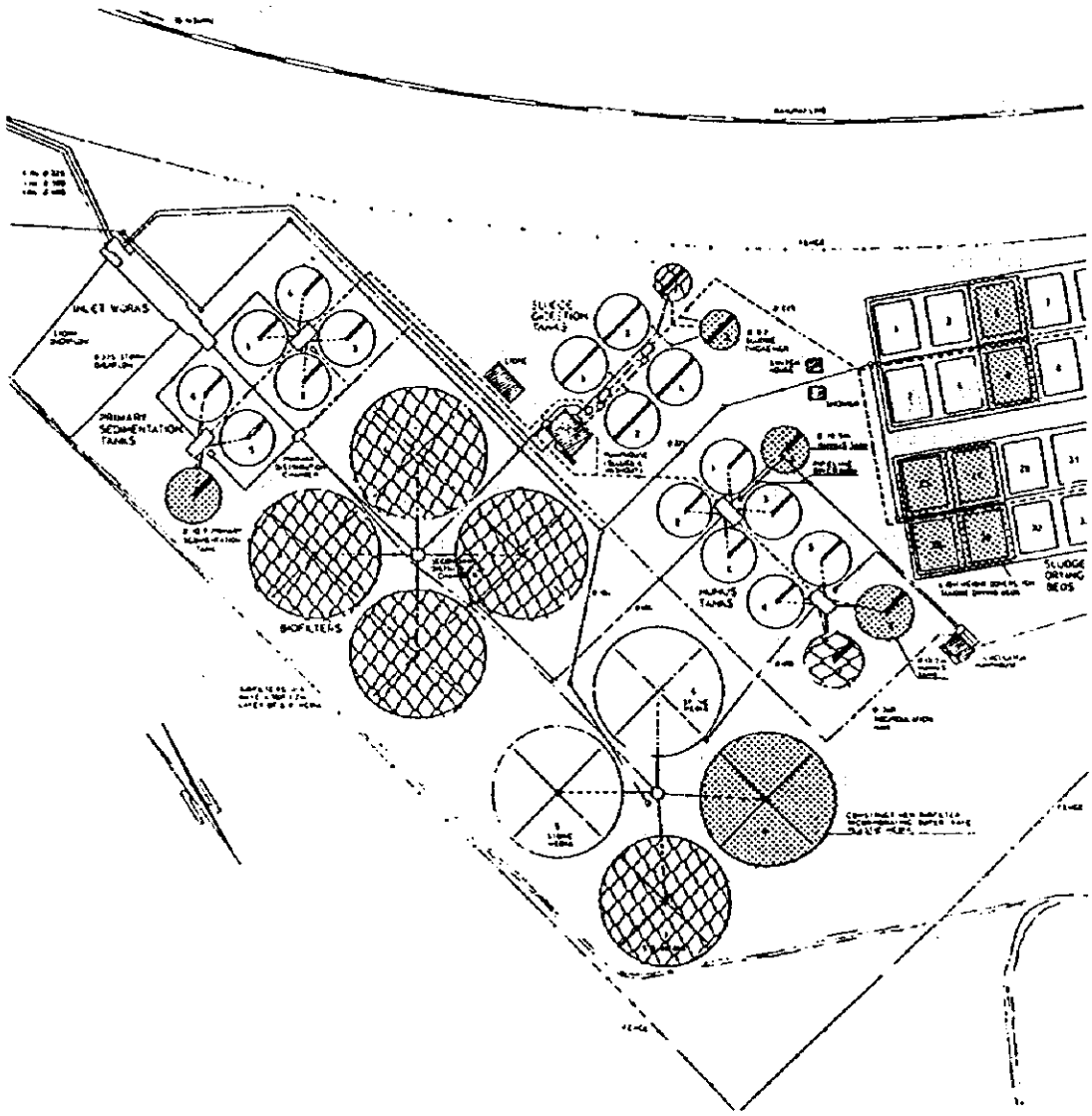
3) Proposed Otongolo Sewage Treatment Works in Western WTD

Under Phase II, a new wastewater treatment district called "Western WTD" will be installed. This district will cover most of residential areas in Kanyakwar, Korando and Kogony and part of industrial area in Kibuye near the Kisumu Airport and Otongolo Industrial Estate. The Otongolo STW will be located to the west of the Kisumu Airport and treat wastewaters to be collected in this newly installed wastewater treatment district. To meet the projected design daily average inflow of 27,200 m^3/d in 2015, the works will need to be provided with 2 No. anaerobic ponds, 2 No. facultative ponds and 4 No. maturation ponds, all preceded by an inlet works for screening and grit removal. This treatment process is selected on the basis of the following assessment:

- Ease of operation and maintenance
- Low operation and maintenance costs
- Availability of land for construction

A layout of the proposed works is shown in Figure 6-17.

Figure 6 - 16



LEGEND

Existing Works

Rehabilitation Works

Expansion Works

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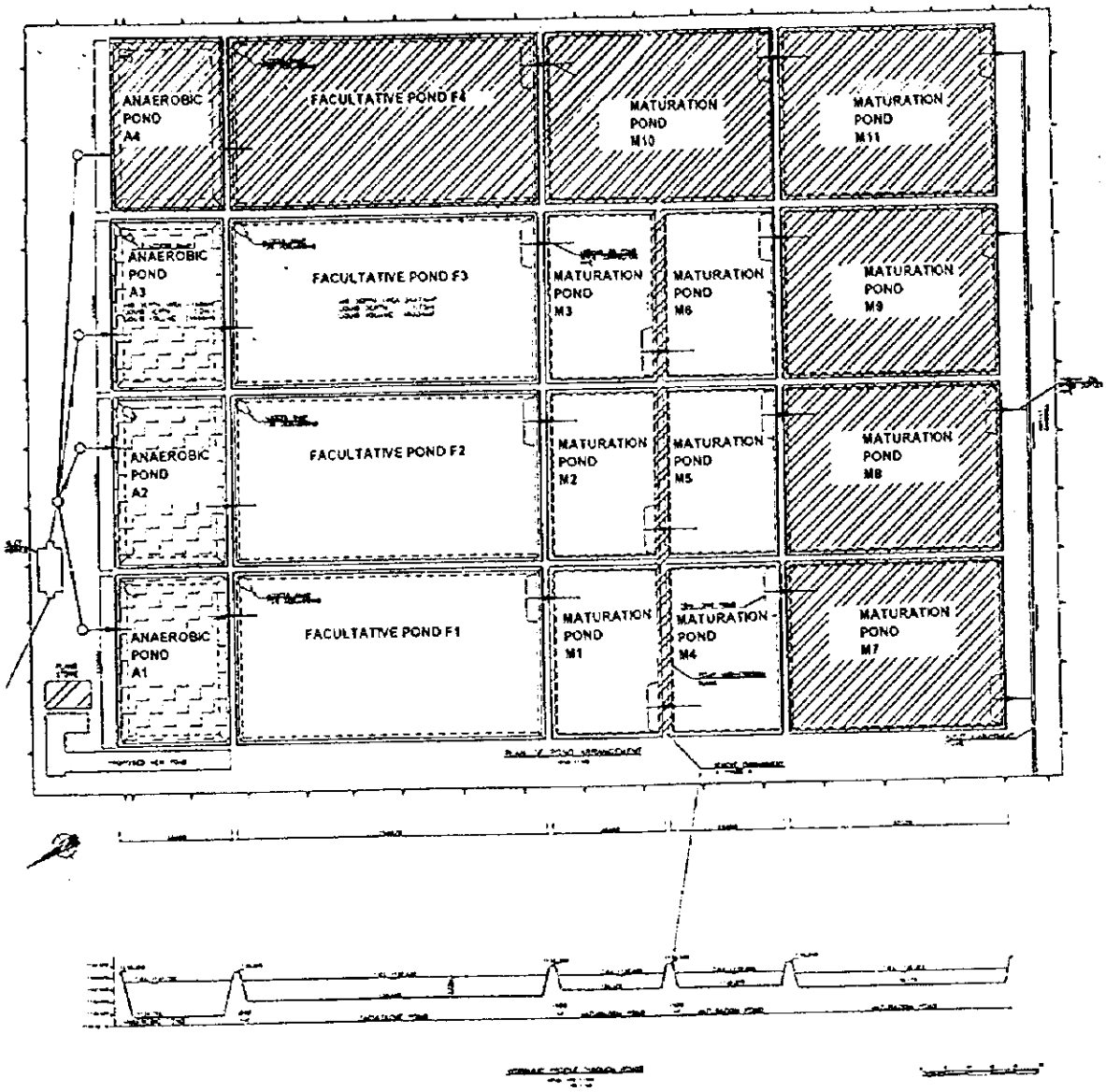
	JAPAN INTERNATIONAL COOPERATION AGENCY	

Figure 6 - 17



LEGEND

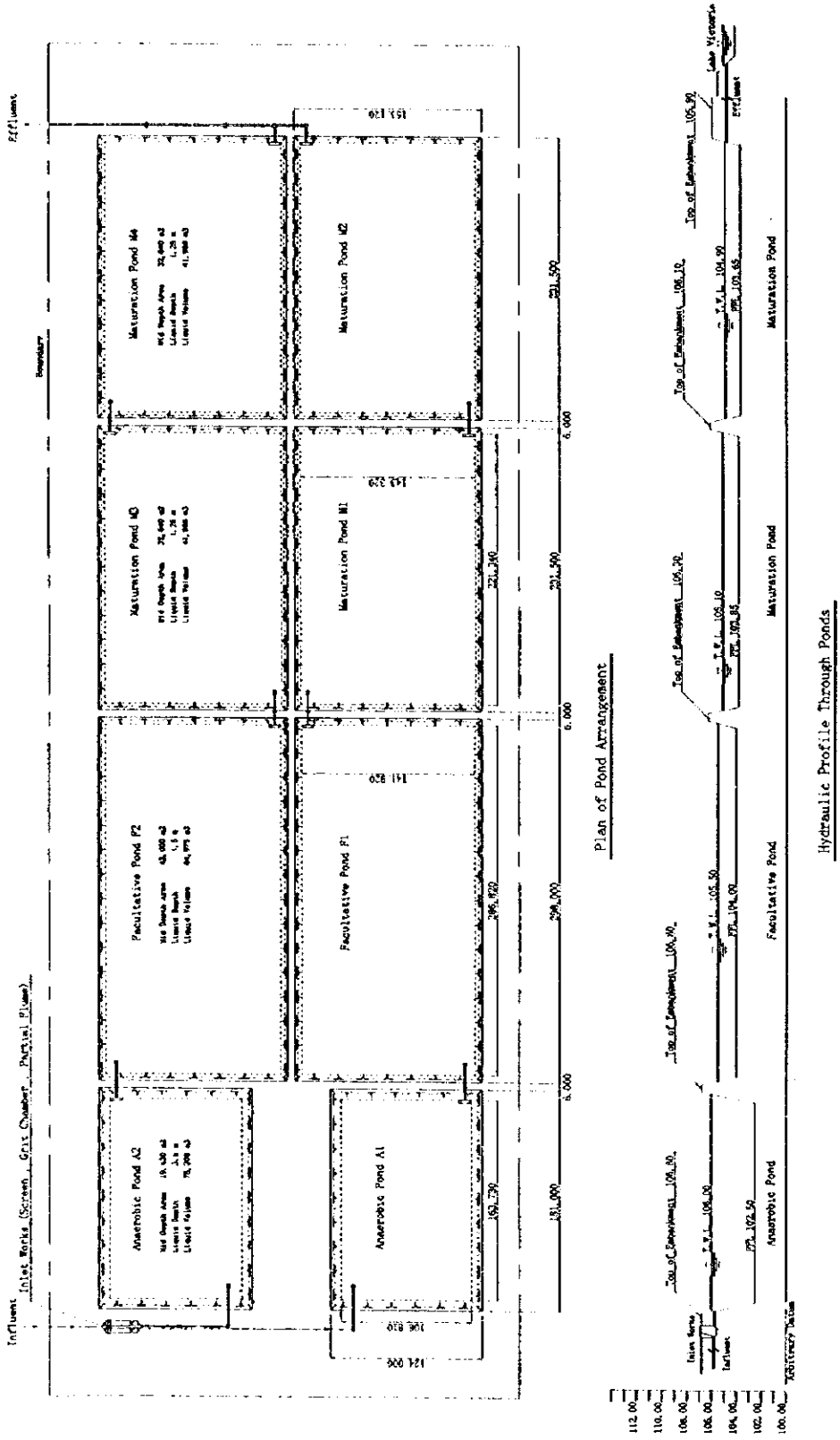
Existing Works

Phase I

Phase II

THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE : Layout of Nyalenda STW

Figure 6 - 18



THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM	TITLE : Layout of Otongolo WSP
	JAPAN INTERNATIONAL COOPERATION AGENCY	

6.2.2 On-site Sanitation

It is proposed that households consuming 15 to 20 lcd of water will remain with on-site sanitation facilities in the future. These facilities will comprise: VIP latrines, single pit or double pits; Modified latrines, preferably VIP latrines, especially for areas of high groundwater; and Septic Tanks.

The following site-specific conditions need to be taken into account when selecting an appropriate on-site sanitation method:

- Groundwater condition (Groundwater level)
- Housing Densities
- Water Supply (Water Availability)
- Ground conditions
- Others

(1) Groundwater conditions

In case of high groundwater conditions, modified latrines are proposed. Two key modifications suggested are raising the latrine above ground and introducing double pit latrines. These measures reduce the depth of the pit required which is an advantage in areas of high groundwater. Both modifications provide extra storage, prevents flow of surface water into the pit and increases the time between emptying or relocating the pit. Further protection of groundwater can be provided by incorporating filter of either a sand and gravel bed or a 300 mm thick layer of mass concrete.

(2) Housing Densities

Single pit VIP latrines are suitable for use in areas of up to about 300 people per hectare. At higher densities alternating twin pit VIP latrines may be more feasible.

(3) Water Supply (availability of water)

In areas where available of water is on average 20 lcd and the water source is remote from the household VIP latrines are very suitable, as they require no water for operation, often than minimal amounts of cleaning.

(4) Ground conditions

Pit latrines are suitable in soils of low permeability i.e. in soils where septic tank and soakage pit

system would not function. Soils with a permeability of 2.5mm per hour are acceptable, provided expansive clays are not present.

Rocky areas are generally not suitable for single pit latrines, however, shallow alternating twin pit latrines raised above ground level can be used in these areas.

(5) others

VIP latrines are recommended to reduce odour and insects problems occurred for pit latrines commonly used in all the settlements

6.3 OPERATION AND MAINTENANCE PLAN

6.3.1 O/M Guidelines for Major Water Supply Facilities

The management of water supply facilities falls into three main areas, i.e., water quantity management, water quality management, and operation and maintenance of facilities.

(1) Water Quantity Management

The purpose of water quantity management is to deliver the amounts of water required to various parts of the service area. For the purpose, water quantity needs to be measured and recorded at various points in the water supply system starting from raw water intake, raw water transmission, water treatment, treated water transmission, distribution to house connection.

The water quantity management can be undertaken through:

- forecast of daily water demand
- measurement of water flow and water pressure at strategic points
- throttling control valves and adjusting the number of pumps in operation.

(2) Water Quality Management

The purpose of water quality management's to maintain tap water safe for human consumption and compatible to established water quality standards. This can be achieved by testing water quality before and after the water treatment process and by feeding the test results back on the treatment process.

(3) Maintenance of Equipment

Proper maintenance of equipment can be achieved through the following:

- Responsibilities should be clearly defined and assigned to each personnel
- Each personnel should be thoroughly informed about maintenance procedures and objectives.
- Proper tools, spare parts, testing instrument, and maintenance shop facilities should be provided.
- Preventive maintenance must be planned and scheduled for each important equipment.
- A system of written records and reporting must be practiced

Basically, maintenance will consist of inspection, adjustment and repair.

6.3.2 Leakage Reduction/Prevention Plan

(1) Need for Leakage Reduction/Prevention

Need for leakage reduction/prevention cannot be overemphasised. As shown below, reducing the potential leakage of 45% in the year 2015 to 25% is an option equivalent to an expansion project of 18,080 m^3/d, which otherwise would be necessary to meet the estimated water demand in the year 2005.

Capacity, m3/d	% Leakage	Leakage, m3/d	Consumption, m3/d
67,800	45	30,510	37,290
49,720	25	12,430	37,290
18,080			

- In terms of supply capacity required for 2015, it could avert an expansion project of 29,000 m^3/d.

(2) Causes of Leakage

Figure 6-18 shows the causes of leakage. As can be seen in the figure, they are related to all aspects of water management. Prevention therefore need to be challenged by the management as

a whole, not by a single section or department.

(3) Leakage Reduction/Prevention Measures

a) Construction

- Standard Service Pipe Installation Designs : Water distribution pipes can be broadly divided into distribution main and service pipe. Generally, leakage through service pipe is higher than that through distribution main. Effective improvement can be made if standard service pipe installation designs (drawings) are prepared and adhered to during construction. Those standard service pipe installation designs have to be completed and adopted before the implementation of Master Plan.
- Replacement of Aged Distribution Pipes : All of the existing distribution mains of about 110 km in Kisumu are more than 20 years old and are in need of replacement. It is proposed that a manual for pipe construction under different construction environments and for different pipe materials be prepared before implementation of Master Plan.

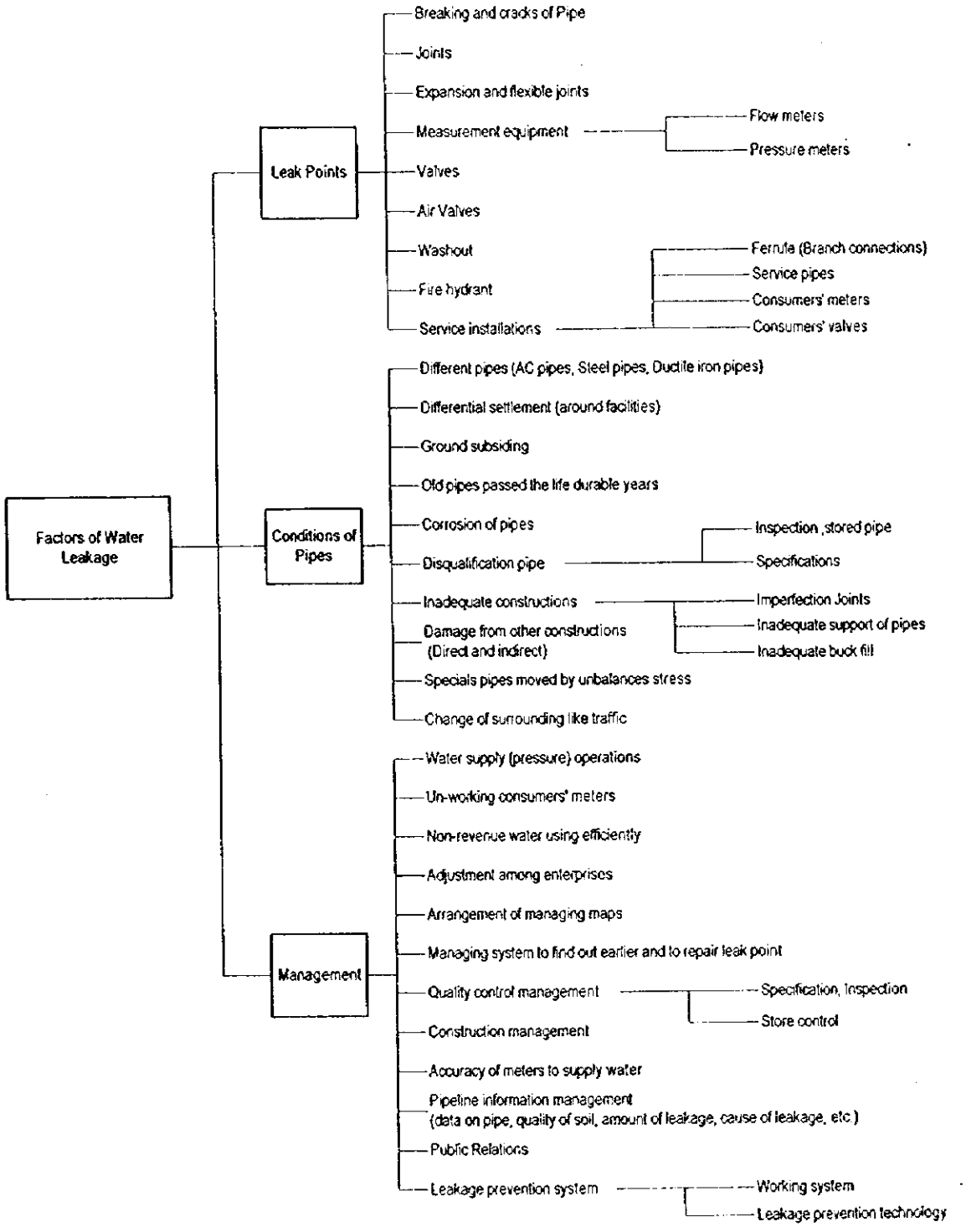
b) Maintenance

Facility (Pipeline) Register : To facilitate maintenance, latest information of facilities is essential. A register must be prepared and maintained for each pipeline, showing 1) pipe location 2) pipe material and diameter 3) year of construction, etc. for easy reference. Such register should be prepared for each of distribution and service mains and should be updated every year. Information maintained on the registers will become useful inputs when a computerised mapping system is introduced in the future.

Pressure Control : Amount of leakage increases as the pressure in the distribution system rises. As discussed in Section 4.2.3, pressure increases during the night when consumption is low. By reducing pressure in the distribution system during the night, leakage can be reduced.

Pressure control isn't an immediate necessity, since the current water pressure in peripheral areas of distribution system is very low and the consumers receive water only during the night. However, in the long term, with the improvement of water supply system, pressure will increase. Pressure control during the night by installing a control valve at the distribution reservoir will then become necessary.

Figure 6 - 19



THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE : Schematic of Factors Causing Leakage and its Management

c) **Public Relations and Preventive Leak Detection**

Public Relations : Leakage can take place anywhere in the distribution system, making the Water and Sewerage Department difficult to locate and repair leaks promptly. Cooperation of consumers in this respect is essential and the department should encourage the consumers to report leaks immediately upon finding. Prompt response is also necessary to maintain its credibility, and, the department should therefore keep necessary spare parts and human resources. Establishment of communication channel with the consumers is the shortest way to detect visible leaks.

Preventive Maintenance of Distribution Mains and Service Mains : Routine detection and repair of leaks is necessary for distribution mains, service mains etc. Major visible leaks are easy to locate and can be repaired promptly if consumers are cooperative. Invisible leaks and small visible leaks can be detected through routine detection work. Small visible leaks and invisible leaks usually exist on service pipes. Therefore, leak detection and repair should initially be concentrated around house connection and could be extended to other sections of the distribution system at later stages.

This exercise shall be carried out systematically with prior planning and should cover at least the entire service area.

6.3.3 Water Meter Improvement Plan

Roughly one third of the 11,000 customer meters currently existing in Kisumu are not working properly. Most of the remaining two third have a tendency of under-registration.

(1) Causes of Meter Malfunctioning

Meter malfunctioning can be emanated from the following:

- unsuitable structure and mechanism of the meter
- inappropriate method of installation
- poor maintenance

Structure and mechanism of the meter : There are two types of meters, namely analogue and digital types. Characteristics of both types are shown in Table 6-14 below. In Kisumu, digital ones which are rather unsuitable for use under poor water quality conditions are used at

present.

Table 6-16 Characteristics of Analogue and Digital Type Meters

Main Classification	Analogue-type Meter	Digital-type Meter
Sub-classification	Multi jet water meter	volumetric
Measurement method	indirect measure - rotation of blades or pressure balance is proportional volume of water passing through meter	direct measure - water fills in sectioned compartments inside meter consecutively and the water flow volume is measured
Advantage	durable for long time under variable water quality	superior precision and high reliability of accuracy over short term
Disadvantage	accuracy is lower than digital-type	- vulnerable to scale formation and trapping of particles etc. - faulty meters can be found working over short to medium term
Precision and durability in the field	8 - 10 years	2 - 5 years
Recommended usage	consumer meter	test meter

Digital meters record the rotation of sectioned compartments and the rotation could be interfered by scaling and other foreign particles contained in the water. This type of meters performs well when tested at the factory, but is generally problematic when used under deteriorated water quality.

Installation method : Problem areas of meter installation are as follows:

- location of the meter (can be easily damaged if installed along foot paths, etc.)
- connected to a sloping pipe (meter works correctly when installed horizontal)
- when meter is installed at a higher elevation and the pressure in the system is low, in which case air goes into meter and causes under-registration

Maintenance of meter : Three main areas are 1) lack of awareness in customers, 2) delay in repair when breakdown and 3) absence of a regular replacement program.

Maintaining meters to avoid damage requires proper installation. Cooperation of consumers is required for this and should be obtained through public relations.

(2) Recommendation for Improvement

With the implementation of Master Plan, the number of house connections is estimated to increase from the existing 11,000 to more than 50,000 by the year 2005. A systematic approach which keeps this large number of water meters functioning therefore appears to b e mandatory.

In order to achieve this followings are recommended,

- Use analogue type meters (mainly multi jet type) including replacement of the existing digital type meters
- Install meters away from roads and streets, horizontally and at a lower elevation than the taps
- Prompt replacement of meters when breakdown (especially during monthly reading)
- Maintenance of meter registers showing location, date of installation repair, replacement etc. (using personal computer would be efficient)
- Meters should be replaced within 10 years of service at the longest. In the long term, replacement within 8 years is recommended. Experience of the developed countries show that even after 8 years of service 99% of the meters can be used again with repair. A program for regular replacement should be devised and adhered to.

6.3.4 O/M Guidelines for Major Wastewater Management Facilities

(1) Sewers

a) General

The sewer facilities are to collect and transport the wastewater to the treatment plant and consist of pipes, manholes, diversions, inspection chambers, house connections, etc. Because the sewerage system has a direct bearing on the daily lives of citizens, it is important that the responsible agency is always aware of the condition of the facilities and carries out proper operation and maintenance.

b) Purpose of O/M

The purpose of O/M of a sewerage system is to maintain the various elements in the condition intended at the design stage to achieve the following aims:

- to maintain the design capacity of sewers,
- to prevent damage of facilities by other construction work,

- to prevent accidents caused by physical breakdown and corrosion of pipes,
- to extend the useful life of the sewers.

Where sewer O/M is not performed properly, sand may be deposited in the sewer invert, corrosion may occur, odour problems may arise etc., therefore it is imperative that inspection of sewers be routinely carried out and that the wastewater quality be monitored to prevent the inflow of wastewater harmful to the proper functioning of the pipes, pumping stations and treatment works.

c) **O/M Work**

In order to achieve the purpose of O/M of sewer pipes, an appropriate management plan, including preventive maintenance, is mandatory. Systematic maintenance is required to make the sewer system function in the most efficient way. The sewer O/M work should include the activities listed in Table 6-15.

Table 6-17 Scope of O/M of Sewers

Purpose of Work	Scope of Work Necessary
Survey of Present Condition	• Visual Inspection and logging of condition of inside and outside of sewers and diversion manholes. • Inspection of internal condition of pipes by staff • Transfer of constructed facilities from regulatory agencies and /or private sector. • Investigation of flooding problems including lifting or manhole covers due to surcharging. • Investigation of odour problems and establishment of counter measures.
Maintenance of Sewer Functions	• Sewer cleaning work • Supervision of construction work in proximity to sewers. • Repair of damaged facilities and pipes
Improvement of Sewers	• Improvement and rehabilitation work to renovate pipes and other facilities. • Improvement measures to prevent flooding.

(2) Pumping Stations

Pumping stations are designed to lift up sewage by pumping facilities in case that sewers would be extremely deep by gravity flow and influent sewage cannot be treated by gravity flow in wastewater treatment works. They also have a function of flow equalisation to operate wastewater treatment facilities effectively as well as quick discharge of wastewater. Daily Operation and Maintenance is required to fulfil their function sufficiently.

O/M of pumping stations can be roughly distinguished into daily O/M and repair of equipment. When mechanical and/or electrical facilities become out of order and a stand-by machine is operated, the troubled facilities must be repaired immediately.

If pumping facilities stop, wastewater overflows to roads and damages living environment of residents. Therefore, when operators have to stop pumping facilities, they must implement it according to a suitable plan to prevent any troubles.

Special care for protecting surrounding environment, i.e. countermeasures for odor, noise and vibration, should be taken in the O/M of pumping stations. In case of transportation and disposal of screenings and sludge, sufficient care also be taken to preserve surrounding environment.

(3) Sewage Treatment Works

Waste Stabilisation Ponds

Waste stabilisation ponds are unique among sewage treatment systems in their ability to continue in operation, providing a high quality effluent, despite poor or even non-existent maintenance; although such neglect may cause mosquito, fly and odour nuisance. Pond systems require only minimal simple maintenance and if they cannot be properly maintained, then there is no hope whatsoever that any other type of mechanically intensive sewage treatment plant can be maintained properly.

The operation and maintenance duties for a typical waste stabilisation pond system include the following items :

1. Where manual bar screens and /or grit channels are used, regular cleaning and daily burial or burning of screenings should be carried out.
2. Embankment vegetation should be kept short and not be allowed to extend into the ponds. Grass may be permitted to grow down to the edge protection slabs where these are used. Otherwise the water's edge should be sprayed with weed killer.
3. Scum on facultative ponds should be removed and broken up. Scum and algae mats should be dried and disposed of by burial nearby. Scum on anaerobic ponds aids the treatment process and should be left to form a hard crust, but sprayed to prevent any fly breeding.
4. Inlets and outlets should be kept free from accumulating solids;
5. Any vegetation emerging through the hard edge protection or from the pond liquid should be removed.

6. Where appropriate, regular records should be kept of flow rates into and out of the pond system, and the influent and effluent quality should be regularly monitored.
7. A careful watch should be kept for evidence of embankment damage caused by burrowing rodents, snakes, ants etc. Fencing should keep out larger animals such as water buffalo or hippopotamus, although if the fencing is continually broken down by these animals it may be necessary to tolerate them using the ponds occasionally.

Pond cleaning should be undertaken when the pond is approximately half full of sludge, although the liquid depth should not be allowed to reduce to less than 1 m in facultative ponds. This will generally occur every two years with an anaerobic pond, or every twenty years or more for a primary facultative pond. Estimation of the quantity of sludge to be removed has been found to cause problems for contractors. A solids content of about 25 % can be expected after drying, although sludge bulking might mean a volume of dry sludge equal to about 50 % of the volume of wet sludge.

Sludge removal can be carried out by raft mounted sludge pumps or by manual removal and carting away, which appears to be a more common method. The main problems appear to be provision of sludge drying beds in the first option and achieving complete sludge drying in the case of the second.

6.4 ORGANISATION PLAN

6.4.1 Legal and Institutional Policy Recommendations

As regards legislation concerning water and sewerage, recommendations have already been put forward through other studies which will lead to strengthening of the Laws. The major examples are:-

- Revisions to the Water Act
- Introduction of the Environmental Management and Co-ordination Bill

However at the local level KMC must take appropriate action to ensure that their General By-laws are up to date, and as regards the WSD, the By-laws recently drafted in respect of both water and sewerage must be finalised and gazetted.

With regard to water supply by-laws, consideration should be given to the sale of water from kiosks by Agents with control over the selling price, and for the operation of community run

water supplies. Water supplies may involve both deep borcholes and shallow wells drawing from groundwater sources, as well as major surface water sources.

Sewerage By-laws must also reflect the full involvement of the WSD with regard to wastewater disposal. This will include the conventional sewerage system and the shallow sewer shemes.

Recommendations on institutional reform at the national level will be made via the ongoing Kenya Local Government Reform Programme (KLGRP) and institutional matters related to water will be dealt with by the Water Sector Actors Survey.

A matter which requires attention is the role of the NWCPC as a bulk water supplier in respect to the KLGRP Phase I towns.

It would not be appropriate for this study to make further recommendations at the National level with the large number of reforms already proposed or under consideration

6.4.2 Structure of the Water and Sewerage Department

The first step in strengthening the WSD is to attend to the many vacancies and appoint suitably qualified and experienced staff to key posts. KMC have the approval of MOLA to progress with recruitment, and appointments should be made on contract terms to provide for improved remuneration and also to allow for flexibility when the staffing structure is later reviewed.

Key issues to be catered for are: -

(i) The Block Mapping Exercise

This will require action on the data collected for re-registration of all meters, updating of billing records, correction of faulty meter reading entries, meter repair, action on illegal connections, and attention to leakage at household connections.

(ii) Restoration of Direct Pumping to Kibuye

Direct connections off the 350 mm dia. Pumping main to Kibuye will need to be relocated. A plan for supply to dry areas needs to be drawn up on a zonal basis for regular but intermittent supply. When this has been achieved there will be a need for attending to all of the problems of leakage and reinstatment of disconnected meters.

Both of these exercises will result in increased revenue which must be collected to finance the

extra operating and maintenance costs, and to make meaningful transfers to the councils General Fund.

To achieve this, there is an urgent need to recruit the following staff: -

- Deputy General Manager (Commercial)
- Deputy General Manager (Operation and Maintenance)
- Engineer (For the distribution system, Unaccounted for water reduction, and metering)
- Accountant (For revenue collection)
- Computer Operators (For the revised billing)
- Public Relations (To deal with the public on matters arising from zoning and block mapping)

The above personnel must then ensure that suitable support staff is available for the numerous departments involved. It is expected that this structure will carry the WSD through to full operational and financial autonomy by mid 1999 at the latest.

In year 2000 there will be two major consultancies under the Phase I project, both of which will enhance the structure of the WSD: -

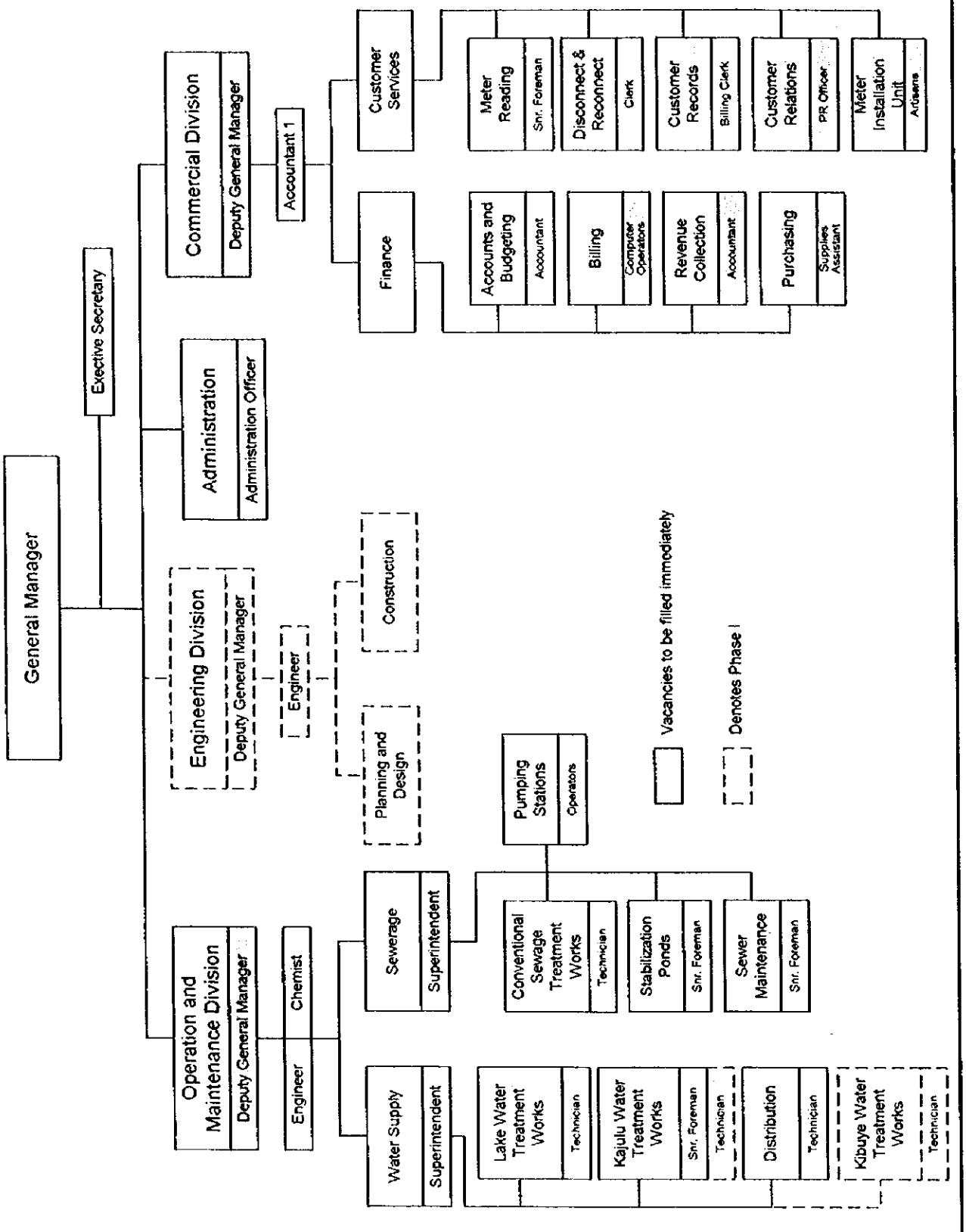
(iii) UFW Reduction Programme

The consultant for this programme will be responsible for the formation of two task forces, one to mount a leakage detection programme, and one to replace all 11 000 existing meters.

(iv) Management/Institutional Improvement Programme

This consultancy will commence with the setting up of a Project Implementation Unit (PIU) to co-ordinate the Phase I project. The structure of the WSD will be examined, and strengthen as necessary through a management consultancy and the introduction of a computerised commercial accounting system. Figure 6-19 Shows the proposed structure of the WSD. The Engineering Division will be formed in 2002 when it will be required to design and plan the thousands of water connections that will be required when Phase I comes on stream. The division will also be responsible for conventional sewer connections and may have a special unit for the shallow schemes if it is decided to handle them in-house, rather than through an NGO.

Figure 6 - 20



THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE : PROPOSED STRUCTURE OF THE WATER & SEWERAGE DEPARTMENT

6.4.3 Recommended Future Direction

It is intended that the WSD becomes completely autonomous, both operationally and financially by mid 1999 at the latest. The WSD will then operate for about 9 months, prior to the commencement of the Management and Institutional (M/I) improvement programme, provided under the Phase I project and commencing in the year 2000.

Improvements to the management and financial systems, including the installation of computers, will convert the autonomous WSD to a commercially oriented service provider. The WSD will then be a self-financing, sustainable autonomous body, able to cope with operation and maintenance, accounts and finance, design and construction, and customer service. It will develop business plans, performance targets, capital works programmes including financing, and implement such programmes with its own staff, and liaise with consultants and contractors on capital works projects.

The final task of the M/I programme will be to arrange for the legal formation of a private Water Company, wholly owned by the council, but operated on commercial principles.

An implementation schedule of the institutional improvements that will provide for a sustainable water and sewerage supply service in Kisumu is given in Figure 6-20.

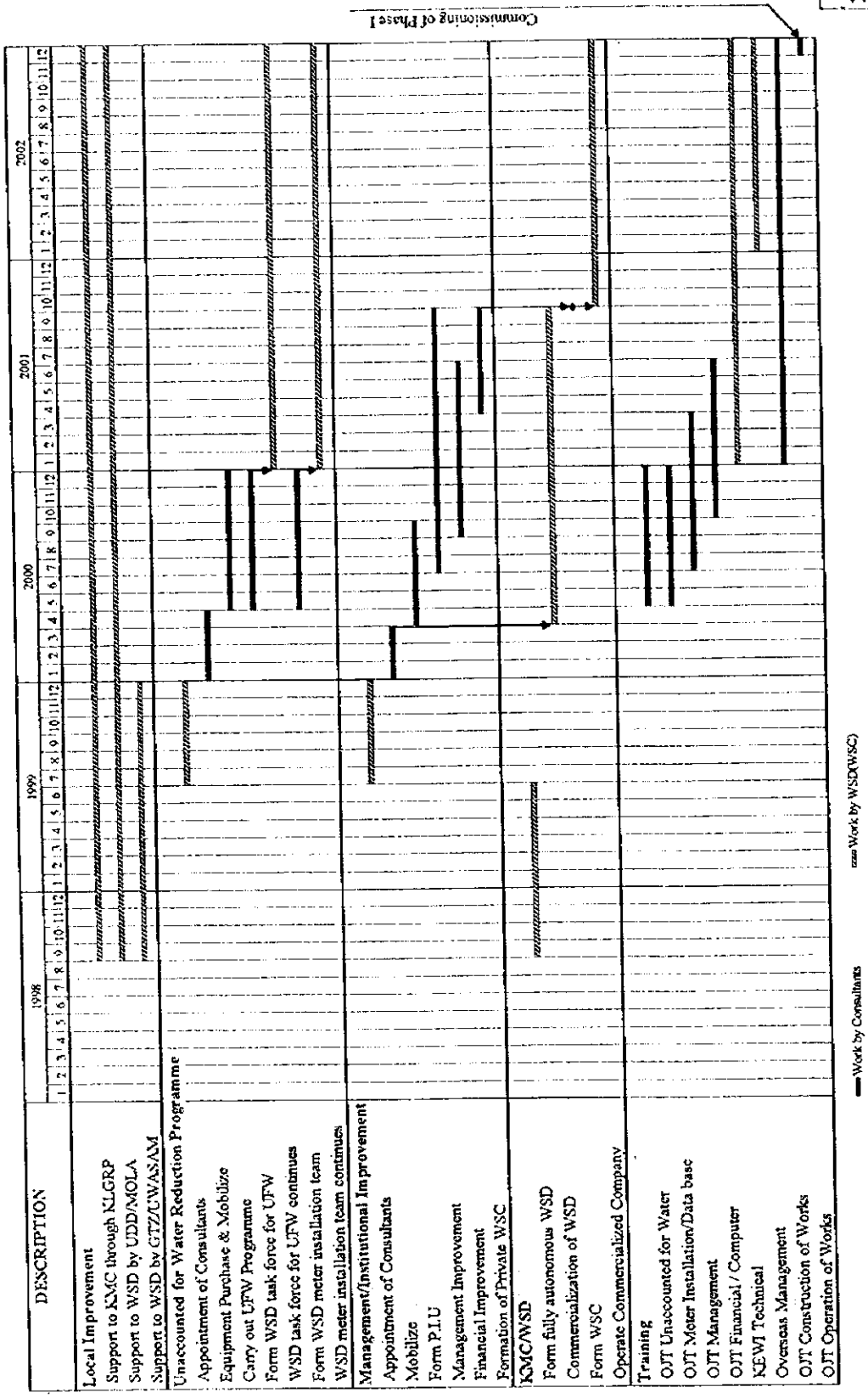
6.5 HUMAN RESOURCES DEVELOPMENT PLAN

6.5.1 Personnel Development and Management

All past efforts to attend to personnel development through the central government system have been unsuccessful. The Public Service Commission has not been able to recruit the personnel required for the Kisumu WSD, and KMC were recently given the authority to advertise for and recruit the necessary staff to develop the WSD.

It is important that this initial development plan is closely monitored by MOLA to ensure that the senior posts are filled with suitably qualified and experienced personnel.

Figure 6 - 21



THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE : IMPLEMENTATION SCHEDULE OF INSTITUTIONAL IMPROVEMENT

The next development plan will be carried out under the Phase I Management/Institutional improvement programme, and will create a management team capable of running a commercialised private company. This will require the preparation of job specifications, terms and conditions of service, and an appropriate salary structure. Recruitment will be carried out as necessary to ensure that a strong management team is in place, able to manage the day to day running and the expansion of the system.

Further development will be required prior to the Phase I works coming on stream, with the creation of the Engineering Division to initially handle the increase in water and sewerage connections.

By 2005 a strong commercially oriented company will be in place capable of carrying out its own manpower development and succession planning programme as further expansion works take place.

6.5.2 Personnel Training Programme

The personnel training programme may be sub-divided into 3 major areas namely:-

- On the Job Training
- Local Training for Technical Staff
- Overseas Training for Management Staff.

On the Job (OTJ) training will be achieved by a variety on inputs. Initially, the Management/Institutional Consultants will liaise closely with the staff of the PIU and WSD. on its services in the fields of recruitment, staffing structure, Annual Budget and Corporate Plan preparation, and the preparation and introduction of a computerised commercial accounting system.

In parallel with the above, OTJ training will be provided under the UFW reduction programme, with the establishment of the special task forces for meter installation and leak detection/repair. Training on personal computers for this programme will also be provided.

Further OTJ training will be provided during the Phase I project, when the staff of the WSD are seconded to the construction contracts. In addition, on completion of all new works, operatives will receive training on operation and maintenance during the commissioning period.

Training for the majority of the Technical Staff is available within Kenya and centered on the Kenya Water Institute (KEWI) in Nairobi. Due to the large number of vacancies that exist within the WSD, it is not possible to draw up a staff training list at this point in time, this will be done under the M/I improvement programme.

Capacity building at KEWI has been on going for sometime with a GTZ project, and more recently, the involvement of the French government in the training component of their overall Human Resources Development Plan.

As the staffing situation in the Kisumu WSD stabilises, technicians and operatives may be identified for short course available at GTZ/KEWI. Courses can be tailor made to suit the needs, and these highly appropriate and practical courses should commence as soon as staffing condition allow.

In addition to the specialised course referred to above , other course are, or will become available, at KEWI and other establishments and examples of these are given in the following tables.

Short courses which exist at present are as follows:-

POST	COURSE TITLE	*INSTITUTION
General Manager	Effective Management and Public Relations	KIM KIA ESAMI
	Water and Wastewater Management	Unai MoiU JKUAT KEWI
	Environmental Management	Unai MoiU JKUAT KENU
Deputy General Manager (Commercial)	Financial Management	KEWI, MMI KIA
Sewerage and Water Superintendents	Effective Management and Public Relations	KIA KCCT KIM
Meter Readers	Meter Reading	KEWI

*KIM Kenya Institute of Management

KIA	Kenya Institute of Administration
ESAMI	East & Southern Africa Management Institute
UNai	University of Nairobi
MoiU	Moi University
JKUAT	Jomo Kenyatta University of Agric. & Tec.
KEWI	Kenya Water Institute
KenU.	Kenyatta University
MMI	Modern Management Institute
KCCT	Kenya College of Communication Tech.

The following Courses are being planned at KEWI

POST	COURSE TITLE
Sewerage Superintendent	Accounting
	Operating & Maintenance of Facilities
	Design
	Construction
	Safety Standards and Council By-Laws
Water Superintendent	Accounting
	Operation & Maintenance of Facilities
	Reduction of Unaccounted for water
	Design of Reticulation Systems
	Construction
Billing Clerk	Billing Procedures
Water Technician	Water Treatment
Water supply and sewerage	Operation and Maintenance of Facilities
Operators	Basic Plant Mechanics
Plant Mechanics	Repair and Maintenance of Pumps
Meter Repairer	Plumbing and Meter Repairs.

All of the above course are of one to three weeks duration and are suitable for the posts listed.

In addition, as and when a Public Relations officer is appointed KCCT will be offering a one week Public Relation course which should be attended.

Overseas training should consist of short study tours and be oriented to broadening the horizon of those in management positions.

It is important that management staff in Kisumu are exposed to the more global issues involved in water supply and sewerage systems operations and management, to ensure that the WSC does not operate in isolation.

Selection of candidates must be made at a later date when there is stability in the company and this training element may be financed by JICA.