domestic market has been catered for at the expense of supply for the export under the stagnated production. Hence the export price can be taken as its economic price.

The economic price of cement at the project site was estimated at Kshs.1,311/ton by adding to the f.o.b. price(Kshs.698) the land transportation costs to the project site.

(3) Standard Conversion Factor (SCF)

The price distortions in nontraded items or the local cost portion have to be adjusted by employing SCF. SCF was estimated at 0.86, based on the recent macro data on international trade and the related duties and tax.

In accordance with the manner set forth in the above, the economic costs of the Project have been obtained as presented in Table 10.1.

10.2.3 Economic Benefit

The major economic benefits of the Project con be categorized as follows :

(a) Incremental consumer's surplus and water revenue,
(b) Health benefits resulting from improved sanitation,
(c) Benefits accrued from reduction in fire loss,
(d) Benefits resulting from the impacts on regional economic development, and
(e) Negative benefits.

Of the above benefits, the item (a) can be measured quantitatively and has actually been adopted in the economic evaluation of the Project. The items (b) through (d) are the precious project benefit but are intangible to quantify. Their effects are, however, evaluated as the socio-economic impacts as described in Section 10.3 of this report.

For the item (e), two major negative benefits accrued from the Project can be enumerated from the national economic point of view. One is economic loss due to the innundation of the reservoir area of Malewa dam, and another is the one due to the impacts of the Project on Lakes Naivasha and Nakuru. The former is taken as the production foregone as above-mentioned and was measured as a part of the economic cost. The possible negative benefits are a reduction in fish population in Lake Naivasha and ecological damage to Lake

Nakuru. Such negative benefits are impossible to measure quantitatively at this stage and need further assessment and appraisal.

In general, water supply projects are often evaluated only in terms of financial viability due to the difficulty of measuring their economic benefits. Even if evaluated economically, it is usual to measure a part of them: incremental project revenue valued at the current water tariff, or unit benefit. In measuring economic benefits of the Project, the consumer's willingness-to-pay was estimated on the basis of the results of the questionnaire survey as shown in detail in Annex E. The unit economic benefit by consumer categories are as follows:

Residential category (Urban)	Kshs. 5.70/m^3
Residential category (Rural)	Kshs. 4.55/m^3
Institutional category	Kshs. 6.91/m^3
Commercial/Industrial category	Kshs. 22.82/m^3

The economic benefit of the Project has been derived from the unit economic benefit an the quality of water supplied. As shown in Fig. 10.1, the water supply quantity increases gradually year of the year until it reaches its full production capacity of 35 million m^3/year in 2010. Thereafter it becomes constant. The said full capacity has been worked out in relation to the level of Lake Naivasha at El. 1,882.0 m.

10.2.4 Economic Internal Rate of Return

EIRR has been calculated for the following cases, including the sensitivity tests as noted in Section 10.1 of this report.

(a) Standard condition

Case (a. i)	:	No variation in cost and benefit
Case (a. ii)	:	Cost increase of 10%
Case (a. iii)	:	Benefit decrease of 10%
Case (a. iv)	:	Benefit increase of 20%
Case (a. v)	:	Combination of Cases (a. ii) and (a. iii)

(b) Increase of the Lake Naivasha level by 0.5 m, El. 1,882.5 m, under the condition of the Case (a. i).

(c) Decreased inflow into the Malewa reservoir under the condition of the Case (a. i)

Case (c. i) : Increase of 10%
Case (c. ii) : Increase of 30%

The resultant EIRRs are as summarized below.

Cases	EIRR (%)
Case (a. i)	4.52
Case (a. ii)	3.78
Case (a. iii)	3.70
Case (a. iv)	6.02
Case (a. v)	3.01
Case b	3.80
Case (c. i)	4.46
Case (c. ii)	4.39

EIRR is calculated at 4.52% for the standard case, lower than OCC in Kenya. It is not to be hastily concluded that the Project is economically infeasible. The Project will bring about various intangible benefits, among which the followings are deemed to be noted.

(a) Health benefits

About 38% of households in Nakuru municipality recognize negative influences of supply problem on health and hygiene. It is observed that there are some problems of water quality such as high concentration of fluoride in ground-water, and brown water. The Project will completely eliminate such a situation.

(b) Benefits resulting from the impacts on regional/economic development

28% of households in the municipality suffers from water supply problem due to its time-consuming to fetch water. About 10% of commercial and industrial entities is aware that the present water supply problem negatively affects their production. The Project will certainly ensure a safe and stable water supply and contribute to a sustained regional/economic development.

10.3 Financial Evaluation

10.3.1 Financial Internal Rate of Return

As assumed in the sub-section 7.3, price escalation is set three per cent a year for the foreign market and eight per cent for the domestic market. The foreign portion of the Project cost is assumed not to be subjected to import duties.

As noted in Chapter IV, the water supply by the Project will be divided into two categories; one is the bulk supply to the Nakuru municipality, Naivasha towns, and four bulk consumers in Gilgil town. The other is the direct distribution down to the consumers in Gilgil town and both Gilgil and Eburru rural areas. Basic unit rates have been set forth as follows:

Bulk supply	:	Kshs. 1.54/m^3
Direct supply	:	
Gilgil town	:	Kshs. 2.04/m^3
Rural areas	:	Kshs. 1.25/m^3

The rate of the bulk supply is assumed to be the same as MOWD does to Naivasha town which buys water in bulk and sell it to their consumers. The unit water rate was Kshs.1.54/m^3 in 1985/86. In the case of the direct supply, the average water tariff or unit water tariff is applied as a unit financial revenue.

Annual revenue of NWCPC is estimated as shown in Table 10.3.

As shown in Table 10.4, FIRR is calculated at 2.60%, which means that all the costs including capital cost would be recovered by the revenue of the Project, assuming the average water rate increased at eight per cent a year, the assumed rate of inflation in Kenya, through the project life.

Sensitivity analysis of FIRR should especially take into account the changes in increase in average water rate, because the increase might not be able to keep pace with the assumed inflation rate. The sensitivity is analysed under the following conditions:

Case 1	:	decrease in the benefit by 10%
Case 2	:	increase in the cost by 10%
Case 3	:	combination of the Cases 1 and 2
Case 4	:	decrease in the growth rate of average water rate by 0.5%

Cases	FIRR (%)
Base	2.60
1	1.67
2	1.74
3	0.51
4	1.32

The result of the sensitivity analysis indicates that it would be difficult to recover all the costs of the Project in the Case 3.

10.3.2 Repayability of Loan

In this study, the repayability of the foreign loan is examined, assuming the following conditions:

Interest rate	:	2.5% per annum
Grace period	:	construction period
Repayment period	:	30 years including the grace period

In addition, 85% of the total costs can be met from the foreign fund, including the interest during construction. The sum of principal repayment and interest a year is considered to be constant over the repayment period. A part of the local portions of the investment costs which would not be funded by the foreign loan is assumed to be provided by the Government of Kenya.

A simple financial statement is shown in Table 10.5. The annual balance would turn positive in 2018 and the accumulated balance become positive in 2028, if the increase in average water rate keeps pace with the assumed inflation rate of eight per cent.

10.3.3 Water Cost

For the reference of NWCPC, the cost of the water is calculated. All the costs at 1990 prices through the project life are annuitized by applying capital recovery factor for various

discount rates, whereas the water volume is the one at full supply with the level of Lake Naivasha El. 1,882 m. The result of calculation is presented below:

Discount Rate	Unit Cost (Kshs./m^3)
10 %	14.4
8 %	11.8
5 %	8.2
0 %	3.5

10.4 Socio-economic Impacts

EIRR estimated in the Sub-section 10.2.4 only represents the extent of the viability of the Project in terms of economic efficiency from the national point of view, although the economic benefits of the Project were partly measured. In this sub-section, socio-economic impacts of the Project will be qualitatively examined, taking into account income distribution and the regional point of view.

(1) Impacts on the Regional development

As mentioned in the Sub-section 3.2, urban centers in the beneficiary area is getting the importance in terms of the regional development . Taking into account the trend of development and geographical advantage with its good access to Nairobi, the population in these areas are expected to continue to grow at a higher rate. In addition, the long-term policy concerning rural-urban balance as described in the Sub-section 2.2.2 is considered to give a high priority to the regional development in those areas.

On the other hand, those areas, in particular Nakuru municipality and Naivasha town, suffer from insufficiency of water supply in terms of quantity as well as quality. The water supply problems hamper the regional development in terms of not only human basic needs but economic development. Therefore expansion and improvement of water supply catering for the growing demand are required for the regional development.

For rural areas, improvement or introduction of water supply system would partly contribute to restraint on outmigration into urban centers and relieve, to some extent, the burden of those who fetch water from remote areas, mainly women and children. Supply

of water to the livestock would enhance the livestock production. Also, other benefits such as health benefits wold be accrued from the Project.

(2) Impacts on the lower income households

The questionnaire survey revealed that there are a large number of the lower income households in the southern and western parts of Nakuru municipality (see Annex E). For those areas, there is a tendency that fewer households have individual connections probably due to their unaffordability of installation and are satisfied with the current situation of water supply, as compared with other areas.

Improvement of water supply including distribution measures is expected to relieve the burden of fetching water, especially for the lower income households, which emphasize time-consuming as a major problem of the present situation of water supply. As those who fetch water mainly consist of women and children, the Project could give them opportunities to spend the sacrificed time for other activities including economic ones.

Although health benefits do not seem recognized among the lower income households, to the extent that they deserve, the Project could contribute to improving their heath by providing sufficient clean piped water. The benefits are considered to give more substantial impacts to lower income households than upper because the former are more vulnerable to diseases.

TABLES

Table 1.1 Members of JICA Advisory Committee and Study Team

(1) Advisory Committee

Mr. K. Ichikawa	Chairman, Public Works Research Institute, Ministry of Construction
Mr. J. Kashiwagi	Member, Water Resources Development Public Corporation
Mr. H. Miyamoto	Member, Ministry of Construction
Mr. M. Takashima	Member, Ministry of Foreign Affair
Mr. M. Suemori	Coordinator, JICA
Mr. T. Ezuka	Coordinator, JICA

(2) Study Team

Mr. M. Yamaguchi	Team Leader, Nippon Koei Co., Ltd.
Mr. K. Endo	Dam Planner, Nippon Koei Co., Ltd.
Mr. M. Inoue	Hydrologist, Nippon Koei Co., Ltd.
Mr. T. Bitoh/Y. Minami	Dam Engineer, Nippon Koei Co., Ltd.
Mr. S. Yamakawa	Pipe Engineer, INA Civil Engineering Consultants Co., Ltd.
Mr. J. Ebihara	Construction Planner, INA Civil Engineering Consultants Co., Ltd.
Mr. Y. Kokufu	Topo-survey Expert, INA Civi Engineering Consultants Co., Ltd.
Mr. J. Inoue/M. Yasuda	Geologist, Nippon Koei Co., Ltd.
Mr. K. Sakai	Environmental Expert, INA Civi Engineering Consultants Co., Ltd.
Mr. M. Fujii	Water Quality Analyst, Nippon Koei Co., Ltd.
Mr. K. Yamada	Agronomist, Nippon Koei Co., Ltd.
Mr. R. Nagase	Project Economist, Nippon Koei Co., Ltd.
Mr. T. Kasahara	Biologist, Nippon Koei Co., Ltd.

Table 2.1 Gross Domestic Product in Kenya

Constant 1982 prices (KL Million)	1984	1985	1986	1987	1988*	Share (%)	Share (%)	Growth rate (% p.a.n)
A. Non-Monetary Economy								
Forestry	23.21	23.34	24.88	25.7	26.55			3.4
Fishing	1.29	1.66	1.45	1.5	1.54			4.5
Building and Construction	54.01	64.11	56.8	58.01	59.6			2.5
Water collection	20.34	21.14	21.95	22.8	23.69			3.9
Ownership of dwellings	79.55	82.65	86.07	89.33	92.89			4.0
Total	178.4	192.9	191.15	197.34	204.27	5.3		3.4
B. Monetary Economy								
1. Enterprises and Non-profit institutions								
Agriculture	941.05	975.59	1023.39	1062.57	1109.26	28.9	30.5	4.2
Forestry	24.84	23.69	24.04	26.18	29.37	0.8	0.8	4.3
Fishing	8.05	9.43	9.59	10.93	12.27	0.3	0.3	11.1
Mining and Quarrying	7.41	8.11	8.4	9.12	10.15	0.3	0.3	8.2
Manufacturing	405.84	424.07	448.67	474.34	502.8	13.1	13.8	5.5
Building and Construction	105.72	110.19	114.72	120.26	126.51	3.3	3.5	4.6
Electricity and Water	26.21	26.16	28.37	31.18	33.88	0.9	0.9	6.6
Trade, Restaurants and Hotels	332.6	355.22	389.98	412.53	436.27	11.4	12.0	7.0
Transport, Storage and Communications	202.29	206.54	215.42	224.9	234.02	6.1	6.4	3.7
Other services	504.68	536.81	564.32	591.89	623.19	16.2	17.1	5.4
Less: Imputed Bank Service Charges	-99.4	-102.97	-105.94	-113.43	-121.81			
Sub-total	2459.29	2572.84	2720.96	2850.47	2995.91	78.0	82.4	5.1
2. Private Households (Domestic Services)	37.16	39.74	43.32	47.82	52.11	1.4	1.4	8.8
3. Producers of Government Services	473.13	497.26	528.73	554.13	586.16	15.3	16.1	5.5
Total	2969.58	3109.84	3293.01	3452.42	3634.18	94.7	100.0	5.2
Grand total	3147.98	3302.74	3484.16	3649.76	3838.45	100.0		5.1

* Provisional

Source: Central Bureau of Statistics, Economic Survey 1989

Table 2.2 Balance of Payments in Kenya

(Unit:Kshs. Million)

	1983	1984	1985	1986	1987*	1988**	Growth rate(%)
A. Current Account							
1. Merchandise							
Imports	15946	19283	20912	23602	26699	31984	14.9
Exports	12234	14900	15499	18988	14951	18057	8.1
Net	-3712	-4383	-5413	-4614	-11748	-13927	-30.3
2. Travel							
Debit	165	204	248	364	400	408	19.8
Credit	2600	3033	4087	4930	5841	6986	21.9
Net	2435	2829	3839	4566	5441	6578	22.0
3. Others							
Debit	7677	9092	10260	11513	13929	15951	15.7
Credit	8345	9012	10246	10938	12047	15240	12.8
Net	668	-80	-14	-575	-1882	-711	-1.3
Net Balance	-609	-1634	-1588	-623	-8189	-8060	-67.6
B. Capital Account							
4. Government : Long-term							
Debit	1654	2042	2623	2876			
Credit	2992	3795	2217	2951	3245	5129	11.4
Net	1338	1753	-406	75	3245	5129	30.8
5. Government Corporations							
Debit	826	921	991				
Credit	1134	711	478	1126	1231	787	-7.0
Net	308	-210	-513	1126	1231	787	20.6
6. Others							
Debit	1132	769	739	1328	637	39	-49.0
Credit	1070	1671	1566	2172	2480	645	-9.6
Net	-62	902	827	844	1843	606	
Net Balance	1584	2445	-92	2045	6319	6522	32.7
C. Errors & Omissions	273	-173	204	38	-217	184	-7.6
D. Overall Balance	1248	638	-1476	1460	-2087	-1354	

* Provisional

** Central Bank of Kenya estimates

Source: Central Bank of Kenya, Quaterly Economic Review, June 1989

Table 2.3 Foreign Trade in Kenya

(Unit: Kshs. million)

	1984	1985	1986	1987	1988	Share(%)	Growth rate (% p.a.n.)
Exports							
Coffee	4073	4613	7769	3892	4895	26.9	3.7
Tea	3789	3828	3456	3267	3708	20.4	-0.4
Petroleum products	2852	2385	2050	2010	3202	17.6	2.3
Fruits and vegetables	1084	1058	1323	1543	1882	10.3	11.7
Hides and skins	142	200	252	338	522	2.9	29.7
Others	3156	3436	4206	4008	3975	21.9	4.7
Total	15096	15520	19056	15058	18184	100.0	3.8
Imports							
Machinary&transport equipments	5884	5866	1005	9841	13587	38.4	18.2
Chemicals	2662	3743	4426	5105	6352	17.9	19.0
Manufactured goods	2676	3015	3384	4044	5692	16.1	16.3
Mineral fuels,lubricants etc.	6716	7685	4781	5671	5176	14.6	-5.1
Food and live animals	1919	1301	1512	1142	821	2.3	-15.6
Others	2440	2413	11603	2833	3760	10.6	9.0
Total	22297	24023	26711	28636	35388	100.0	9.7

Source: Central Bank of Kenya, Quarterly Economic Review, June 1989

Table 3.1 Climatological Features in Study Area

Description	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
(1) Nakuru Climatological Station (El. 1872 m)													
Air temperature (°C)													
Mean max	27.3	27.3	27.2	25.0	23.6	22.8	22.4	23.0	24.5	25.5	24.5	25.7	24.9
Mean min.	7.9	8.1	9.4	11.0	10.6	9.2	8.6	8.6	7.9	8.9	9.1	8.3	9.0
Relative humidity (%)													
0600 GMT	65.0	65.0	70.0	78.0	80.0	81.0	79.0	77.0	74.0	71.0	74.0	70.0	74.0
1200 GMT	32.0	33.0	38.0	53.0	55.0	54.0	53.0	51.0	46.0	44.0	50.0	43.0	46.0
Rainfall (mm)	24	39	59	113	84	41	34	44	44	47	59	39	627
Evaporation (mm)	184	179	187	136	134	122	124	131	139	133	116	157	1,742
(2) South Kinangop Station (El. 2,591 m)													
Air temperature (°C)													
Mean max.	19.4	20.1	19.8	18.2	17.5	16.6	15.5	15.9	16.8	17.4	17.5	18.3	17.7
Mean min.	3.6	3.7	5.6	7.8	6.9	5.2	5.1	4.8	4.6	6.2	6.8	4.7	5.4
Relative humidity (%)													
0600 GMT	80.0	77.0	80.0	85.0	87.0	86.0	89.0	88.0	84.0	81.0	83.0	84.0	84.0
1200 GMT	67.0	59.0	68.0	75.0	77.0	78.0	81.0	81.0	76.0	70.0	76.0	76.0	74.0
Rainfall (mm)	70	85	153	274	220	92	71	64	61	130	154	769	1,453

Table 3.2 Monthly Mean Runoff of Malewa River at Malewa Dam Site

(Unit : cu.m/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1952	0.93	0.75	1.39	8.31	6.07	4.63	4.04	2.73	4.53	4.38	1.58	0.80	3.35
1953	0.45	0.72	0.36	0.74	1.78	0.96	0.54	0.66	0.52	1.00	1.03	0.62	0.78
1954	0.49	0.24	0.27	1.59	9.58	11.05	4.26	4.17	4.54	2.20	1.31	1.00	3.39
1955	0.47	0.65	0.58	1.03	1.23	0.61	1.01	3.56	5.49	7.27	3.02	3.22	2.35
1956	5.62	3.28	0.80	1.46	7.22	2.58	3.06	4.38	10.07	6.72	3.61	1.42	4.19
1957	0.69	0.84	0.72	1.86	7.97	6.30	3.41	3.33	2.74	1.73	1.34	1.05	2.67
1958	0.64	2.10	3.30	1.24	13.86	3.85	9.21	3.54	2.14	4.41	1.53	3.78	4.13
1959	1.09	0.58	0.60	0.90	2.65	2.19	1.15	2.00	1.68	1.71	1.24	0.79	1.38
1960	0.46	0.41	0.64	1.14	1.11	0.80	0.76	0.91	2.66	2.10	2.63	0.84	1.21
1961	0.43	0.41	0.39	0.75	1.50	1.03	0.53	2.09	2.58	4.63	29.75	18.16	5.19
1962	9.90	1.01	0.93	2.14	14.51	5.38	3.23	2.13	8.91	9.25	3.44	2.55	5.28
1963	2.82	1.25	1.23	9.15	22.26	10.75	1.40	1.87	1.38	1.01	1.09	11.64	5.49
1964	1.33	0.65	1.51	11.29	9.00	2.92	2.54	4.81	3.22	5.52	2.01	1.19	3.83
1965	1.21	0.58	0.57	1.41	4.88	1.14	1.21	0.58	0.57	1.41	4.88	1.14	1.63
1966	0.61	0.61	0.72	3.94	3.89	1.28	1.03	1.56	4.45	2.15	5.22	1.04	2.21
1967	0.50	0.37	0.43	0.93	9.62	4.48	4.52	2.37	1.40	2.58	2.29	2.08	2.63
1968	0.60	0.86	5.08	27.61	5.45	2.09	0.95	1.40	0.72	0.67	1.62	1.40	4.04
1969	0.51	1.40	0.88	0.68	3.50	0.70	0.68	0.66	1.70	1.28	0.78	0.53	1.11
1970	0.93	0.75	1.39	8.31	6.07	4.63	4.04	2.73	4.53	4.38	1.58	0.80	3.35
1971	0.61	0.41	0.34	0.95	4.98	4.65	3.58	7.70	4.06	2.11	1.38	1.09	2.66
1972	0.75	1.49	0.90	0.68	0.90	2.51	1.27	3.62	1.31	2.29	5.42	1.50	1.89
1973	1.13	0.93	0.46	0.69	0.77	2.11	0.93	2.21	1.85	1.53	1.73	0.62	1.25
1974	0.41	0.35	0.57	4.46	1.59	3.43	8.59	6.51	8.54	6.17	3.42	0.94	3.75
1975	0.49	0.37	0.39	0.86	1.48	2.39	2.50	5.98	7.68	10.70	2.13	0.88	2.99
1976	0.50	0.39	0.43	0.73	0.89	1.01	2.26	2.55	3.02	1.62	0.85	0.82	1.26
1977	0.79	0.53	0.63	8.14	20.48	2.76	6.87	3.46	3.21	1.35	7.54	6.85	5.22
1978	4.74	1.92	10.33	17.64	10.31	2.14	2.93	2.68	6.76	4.16	4.18	1.56	5.78
1979	1.01	17.89	1.47	6.83	10.19	5.86	6.87	5.06	3.62	2.23	1.66	0.83	5.29
1980	0.55	0.56	1.26	1.34	8.78	9.36	3.40	1.09	1.08	1.25	1.70	0.78	2.60
1981	0.41	0.57	0.86	10.66	14.83	3.50	5.41	5.95	8.17	5.35	2.75	1.26	4.98
1982	0.78	0.52	0.43	1.31	3.15	2.38	1.52	4.04	4.28	1.87	9.06	8.19	3.13
1983	0.90	0.77	0.67	4.13	5.59	1.39	2.58	2.21	3.85	9.42	5.43	3.32	3.36
1984	2.06	1.48	1.43	0.89	0.56	0.47	0.76	0.96	1.06	2.20	1.99	3.19	1.42
1985	0.76	0.71	0.85	7.51	8.08	4.56	2.49	1.43	1.23	1.53	10.32	6.65	3.84
1986	0.52	0.43	0.44	9.21	11.45	2.62	1.78	2.64	3.07	2.12	2.24	1.14	3.14
1987	0.54	0.50	0.96	0.83	1.68	4.08	0.88	0.67	1.04	0.77	3.32	0.88	1.35
1988	0.62	0.35	0.51	30.15	11.97	4.75	4.21	5.24	9.27	-	-	-	7.45
Mean	1.28	1.29	1.21	5.18	6.75	3.44	2.88	2.96	3.70	3.36	3.75	2.63	3.23

Table 3.3 Monthly Mean Runoff of Turasha River at Turasha Dam Site

(Unit : cu.m/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1952	1.04	0.84	1.56	9.30	6.80	5.19	4.53	3.06	5.07	4.90	1.77	0.89	3.75
1953	0.50	0.81	0.40	0.83	1.99	1.08	0.61	0.74	0.59	1.12	1.15	0.70	0.88
1954	0.54	0.27	0.30	1.79	10.72	12.37	4.78	4.67	5.08	2.46	1.46	1.12	3.80
1955	0.52	0.73	0.65	1.15	1.38	0.68	1.14	3.98	6.14	8.14	3.39	3.60	2.63
1956	6.29	3.68	0.89	1.63	8.09	2.89	3.43	4.90	11.28	7.52	4.04	1.59	4.69
1957	0.77	0.94	0.81	2.08	8.93	7.05	3.81	3.73	3.07	1.93	1.50	1.17	2.98
1958	0.72	2.35	3.70	1.39	15.52	4.31	10.32	3.97	2.39	4.94	1.72	4.23	4.63
1959	1.22	0.65	0.68	1.00	2.97	2.45	1.28	2.24	1.88	1.91	1.39	0.88	1.55
1960	0.51	0.45	0.72	1.08	1.24	0.90	0.85	1.02	2.97	2.35	2.94	0.94	1.33
1961	0.48	0.46	0.43	0.67	1.68	1.15	0.60	2.34	2.88	5.18	33.31	20.33	5.79
1962	11.09	1.13	1.04	2.09	16.25	6.03	3.62	2.39	9.98	10.36	3.85	2.85	5.89
1963	3.16	1.40	1.38	9.64	24.92	12.03	1.57	2.09	1.55	1.13	1.22	13.03	6.09
1964	1.49	0.73	1.69	11.83	10.08	3.27	2.85	5.38	3.60	6.18	2.25	1.34	4.22
1965	1.36	0.64	0.64	1.34	5.47	1.27	1.36	0.64	0.64	1.57	5.47	1.27	1.81
1966	0.69	0.68	0.80	3.77	4.35	1.43	1.15	1.74	4.98	2.41	5.85	1.17	2.42
1967	0.56	0.41	0.48	0.80	10.77	5.01	5.06	2.65	1.57	2.89	2.56	2.32	2.92
1968	0.67	0.97	5.69	30.56	6.11	2.34	1.07	1.56	0.80	0.75	1.82	1.56	4.49
1969	0.58	1.57	0.99	0.60	3.92	0.79	0.76	0.73	1.91	1.44	0.87	0.60	1.23
1970	1.04	0.84	1.56	9.30	6.80	5.19	4.53	3.06	5.07	4.90	1.77	0.89	3.75
1971	0.68	0.46	0.38	1.07	5.57	5.21	4.01	8.62	4.54	2.36	1.54	1.22	2.97
1972	0.84	1.67	1.01	0.76	1.01	2.81	1.42	4.05	1.46	2.56	6.07	1.68	2.11
1973	1.26	1.04	0.52	0.77	0.86	2.37	1.04	2.48	2.08	1.72	1.94	0.70	1.40
1974	0.46	0.39	0.64	5.00	1.78	3.84	9.62	7.29	9.56	6.91	3.82	1.06	4.20
1975	0.55	0.42	0.43	0.97	1.66	2.68	2.79	6.69	8.60	11.98	2.38	0.99	3.35
1976	0.56	0.43	0.48	0.82	1.00	1.13	2.53	2.86	3.38	1.82	0.95	0.91	1.41
1977	0.88	0.59	0.71	9.11	22.93	3.09	7.69	3.87	3.59	1.51	8.44	7.67	5.84
1978	5.31	2.15	11.56	19.75	11.55	2.40	3.28	3.00	7.57	4.65	4.68	1.74	6.47
1979	1.13	20.03	1.64	7.65	11.41	6.56	7.69	5.67	4.05	2.49	1.85	0.93	5.93
1980	0.61	0.63	1.41	1.50	9.84	10.48	3.80	1.22	1.21	1.40	1.90	0.87	2.91
1981	0.46	0.64	0.96	11.93	16.61	3.92	6.06	6.66	9.14	5.99	3.08	1.41	5.57
1982	0.87	0.59	0.48	1.48	3.53	2.67	1.70	4.52	4.79	2.09	10.14	9.18	3.50
1983	1.01	0.86	0.75	4.63	6.26	1.56	2.89	2.48	4.31	10.54	6.08	3.72	3.76
1984	2.30	1.66	1.60	0.99	0.63	0.53	0.85	1.08	1.19	2.47	2.23	3.57	1.59
1985	0.85	0.79	0.95	8.40	9.05	5.10	2.78	1.60	1.38	1.71	11.55	7.44	4.30
1986	0.58	0.48	0.50	10.31	12.82	2.94	1.99	2.95	3.44	2.37	2.51	1.28	3.51
1987	0.60	0.56	1.08	0.93	1.88	4.57	0.99	0.75	1.17	0.86	3.72	0.98	1.51
1988	0.70	0.39	0.57	33.76	13.40	5.31	4.72	5.87	10.39	-	-	-	8.35
Mean	1.43	1.44	1.35	5.69	7.56	3.85	3.22	3.31	4.14	3.76	4.20	2.94	3.61

Table 3.4 Summary of Water Quality Test

Items	Unit	Malewa River			Turasha River		
		Max.	Min.	Ave.	Max.	Min.	Ave.
pH		8.08	8.27	(8.12)	7.0	7.7	(7.4)
Conductivity	µs/cm	65	130	(89)	-	-	(71)
SS	mg/l	23	323	(94)	1	10	(6)
DO	mg/l	-	-	(7.4)	7.2	9.7	(8.3)
COD	mg/l	8	65	(24)	4	24	(11)
T-N	mg/l	-	-	(2.7)	-	-	-
N-NO3	mg/l	0.10	2.00	(0.84)	0.25	1.25	(0.97)
T-P	mg/l	0.45	1.54	(0.89)	-	-	-
P-PO4	mg/l	0.12	0.21	(0.16)	0.028	0.057	(0.041)

Table 3. 5 Population in the Proposed Water Service Area

	Current*	1979 census	1969 census	Growth rate Current-1979 (% p.a.n.)	Growth rate 1979-1969 (% p.a.n.)
Nakuru Municipality	240,000	92,851	47,151	12.6	7.0
Naivasha town	37,500	11,491	6,920	12.6	5.2
Gilgil town	15,100	9,103	4,178	6.5	8.1
Gilgil rural	13,600	12,891	6,930	0.9	6.4
Eburu rural	n.a.	n.a.	n.a.	n.a.	n.a.

* Figures of Nakuru and Gilgil town in 1987
Figure of Naivasha in 1989
Figure of Gilgil rural in 1985

Sources: (1) Nakuru District Development Plan, 1989-1993
(2) The 1985 Preliminary Report

Table 3. 6 Urban Centres with Population over 50,000 (1979)

	1979 (census)	1969* (census)	Area (km2)	Population growth rate (% p.a.n.)	1979 Population density (/km2)
Nairobi	827,775	509,286	684	5.0	1210
Mombasa	341,148	247,073	210	3.3	1625
Kisumu	152,643	111,700	270	3.2	565
Nakuru	92,851	50,700	78	6.2	1190
Machakos	84,320	-	324	-	260
Meru	70,439	52,900	128	2.9	550
Eldoret	50,503	24,900	58	7.3	871

* Adjusted for boundary changes

Source: World Bank, Kenya Economic Development and Urbanization Policy, 1985

Table 3. 7 Wage Employment in the Main Towns of Nakuru District

Municipality/ Township	1979	1980	1981	1982	1983	1984	1985	Growth rate (% p.a.n.)
Nakuru	17,861	19,701	19,682	20,080	22,251	20,969	21,914	3.5
Gilgil	2,101	1,226	1,354	1,570	1,851	3,343	3,435	8.5
Naivasha	3,203	3,165	3,351	3,181	2,609	3,824	3,976	3.7
Elburgon	944	837	928	1,015	1,108	1,040	1,049	1.8
Njoro	922	1,011	954	918	376	363	496	-9.8
Molo	829	901	953	870	733	1,039	1,049	4.0

Source: Nakuru District Development Plan, 1989-1993

Table 3.8 Occupational Composition in Nakuru Municipality and Nakuru Districts

	Nakuru Municipality				Nakuru District			
	1 969		1980/81		1 969		1980/81	
	Nos.	Share(%)	Nos.	Share(%)	Nos.	Share(%)	Nos.	Share(%)
Primary	368	2.5	62	0.3	31,885	55.0	33,830	44.8
Secondary								
Manufacturing	3,345	22.8	5,525	27.1	5,830	10.1	9,846	13.0
Construction	1,508	10.3	1,636	8.0	1,152	2.0	2,066	2.7
Tertiary								
Trade & commerce	2,633	17.9	5,253	25.8	3,404	5.9	7,485	9.9
Other services	6,606	45.0	7,437	36.5	15,392	26.6	21,641	28.6
Others (electricity & water)	235	1.6	470	2.3	263	0.5	671	0.9
Total	14,695	100.0	20,383	100.0	57,926	100.0	75,539	100.0

Source: G. Ndua & N. Ng'ethe, " The role of informal sector in the development of small and intermediate-size cities: Background information on Nakuru", IDS Working Paper No.416, University of Nairobi,1984

Table 3.9 Earnings of Modern Sector Wage Employment by Industry in Naivasha Town

(Unit: K£ 1000)

	1981	Share (%)	1982	1983	1984	Share (%)
Agriculture& Forestry	20.9	1.2	21.8	63.7	156.9	5.6
Mining & Quarrying	0.0	0.0	0.0	0.0	0.0	0.0
Manufacturing	547.1	30.6	462.5	629.2	617.4	22.1
Electricity and Water	73.8	4.1	47.8	46.7	63.3	2.3
Construction	3.3	0.2	10.5	17.4	5.3	0.2
Wholesale, Retail & Hotels	171.6	9.6	162.4	208.5	279.8	10.0
Transport & Communication	36.3	2.0	37.0	62.5	42.4	1.5
Finance, Insurance & Real estate business	70.9	4.0	106.3	120.5	173.0	6.2
Community/social /personal services	864.9	48.4	977.9	917.1	1,455.6	52.1
Total	1,788.8	100.0	1,826.2	2,065.6	2,793.7	100.0

Source: Nakuru District Development Plan,1989-1993

Table 3.10 Proposed Effluent Standards for Nakuru Municipal Sewage Works

A. Total Discharge into Lake Nakuru				
1)	Total BOD_5	not to exceed	800	kg/day
2)	Heavy metals (excl. Zn; Fe)	not to exceed	0.1	mg/l
B. Additional Standards for Discharge Directly into Lake Nakuru (Town Sewage Works)				
1)	BOD_5 at 20 °C (excl. algae)	not to exceed	50	mg/l
2)	COD	"	80	mg/l
3)	Suspended Solids	"	30	mg/l
4)	Free ammonia	"	10	mg/l
5)	Heavy metals total (excl. Zn; Fe)	"	0.1	mg/l
6)	Zinc	"	0.3	mg/l
7)	Cyanide	"	0.05	mg/l
8)	Total phenols	"	0.1	mg/l
9)	Organochlorines total	"	0.001	mg/l
10)	Oil			No trace
11)	Anionic detergents	not to exceed	0.5	mg/l
12)	Effluent at dilution 1:20 must not be toxic to Tilapia grahami in 48 hours.			
13)	Flow records must be maintained at the inlet and outlet of all sewage works.			
14)	The effluent must be aerated over a cascade before discharge into the lake.			
(Njoro River Sewage Works)				
1)	BOD5 at 20 °C (excl. algae)	not to exceed	30	mg/l
2)	COD	"	50	mg/l
3)	Suspended Solids	"	30	mg/l
4)	Free ammonia	"	5	mg/l
5)	Heavy metals total (excl. Zn; Fe)	"	0.1	mg/l
6)	Zinc	"	0.3	mg/l
7)	Cyanide	"	0.05	mg/l
8)	Total phenols	"	0.1	mg/l
9)	Organochlorines total	"	0.001	mg/l
10)	Oil			No trace
11)	Anionic detergents	not to exceed	0.5	mg/l
12)	Effluent at dilution 1:10 must not be toxic to Tilapia grahami in 48 hours. Toxicity = a water killing 50% or more of the test animals.			
13)	Flow records must be maintained at the inlet and outlet of all sewage works.			

Data source: MOWD

Table 4.1 Forecast Population and Growth Rate

	Nakuru Municipal.	Gilgil Town	Naivasha Town	Gilgil Rural	Eburu Rural	Total
(1)	Population growth rate (per cent per annum)					
	1991 - 95	6.9	6.0	8.1	3.8	4.0	5.76
	1996 - 00	6.9	5.0	5.3	2.9	3.5	4.72
	2001 - 05	5.6	5.0	4.2	2.9	3.5	4.24
	2006 - 10	5.0	5.0	4.2	2.9	3.5	4.12
	2011 - 15	5.0	5.0	4.2	2.9	3.5	4.12
(2)	Population (1,000)					
	1990	295.6	18.0	41.2	20.5	30.9	406.2
	1995	412.0	24.1	60.8	24.7	37.5	965.3
	2000	574.0	30.7	78.7	28.5	45.7	757.6
	2005	752.4	39.2	96.7	32.9	55.6	976.8
	2010	960.3	50.0	118.7	38.0	66.0	1,233.0
	2015	1,225.6	63.9	145.8	43.8	78.4	1,557.5

Data source :

(1) Greater Nakuru Water Supply Project, Eastern Division, Stage 1, Preliminary Design Report, July 1988

(2) Eburru Water Supply Project, Preliminary Design Report, 1982

(3) Greater Nakuru Supply Project, Preliminary Design Report, May 1985

Table 4.2 Unit Water Consumption

	Demand Category	Unit Water Consumption
(1)	Residential	
	High income group	250 lpcd
	Middle income group	150 lpcd
	Low income group (1)	75 lpcd
	Low income group	20 lpcd
(2)	Institutional	
	Day schools and technical institutes	25 lpcd
	Boarding schools	50 lpcd
	Hospitals, regional	400 l per bed
	district	200 l per day
	outpatient	20 l per day
	Police and prison	100 lpcd or as per demand
	Local government offices	25 lpcd
	Bulk water consumer	As per used or demand
(3)	Commercial	20 cu.m per day per ha or
	As per used or demand	
(4)	Industrial	As per used or demand
(5)	Livestock	50 l per livestock unit
(6)	Military	As per demand

Data Source : (1) Design Manual for Water Supply in Kenya
(2) Greater Nakuru Water supply Project, Eastern Division, Stage1, Preliminary Design Report, 1988

Table 4.3 Distribution of Population Group in Urban Areas

(per cent)

	Population Category	1990	1995	2000	2005	2010	2015
(1)	Nakuru municipality						
	High income	3.0	2.6	2.4	2.2	n.a.	n.a.
	Medium income	12.6	12.5	12.0	12.6	n.a.	n.a.
	Low income (1)	52.7	54.1	55.6	56.3	n.a.	n.a.
	Low income (2)	31.7	30.8	30.0	28.9	n.a.	n.a.
(2)	Gilgil town						
	High income	1.5	3.0	5.0	6.5	n.a.	n.a.
	Medium income	3.5	7.0	10.0	14.5	n.a.	n.a.
	Low income (1)	55.0	60.0	57.0	51.0	n.a.	n.a.
	Low income (2)	40.0	30.0	28.0	28.0	n.a.	n.a.
(3)	Naivasha Town						
	High income	0	0	0	0	0	0
	Medium income	20.0	20.0	20.0	20.0	20.0	20.0
	Low income (1)	80.0	80.0	80.0	80.0	80.0	80.0
	Low income (2)	0	0	0	0	0	0

Data source : (1) Greater Nakuru water Supply Project, Eastern Division, Stage 1, Preliminary Design Report, 1988

Table 4.4 Forecast Average Daily Water Demand

Demand Categories	1990	1995	2000	2005	2010	2015
(1) Nakuru Municipality						
Residential	21,390	29,670	41,160	54,440	72,200	95.700
Institutional	3,210	4,100	5,230	6,680	8,530	10,900
Industrial	8,000	8,000	10,210	13,030	16,600	21,200
Livestock	450	400	300	200	150	100
Military	1,200	1,400	1,720	2,200	2,810	3,580
Sub-total	35,520	45,190	60,690	79,200	103,670	135,800
(2) Gilgil Town						
Residential	1,050	1,650	2,320	3,200	4,400	6,060
Institutional, general public	180	250	320	400	510	650
NYTSTC	1,310	1,760	2,240	2,860	3,650	4,660
ATSU	760	860	1,100	1,410	1,800	2,300
Commercial	30	40	60	70	80	90
Industrial	140	180	230	290	370	470
Livestock	30	40	60	70	80	90
Military, KMB	870	940	1,160	1,480	1,890	2,410
GMB	1,200	1,300	1,510	1,930	2,460	3,140
Sub-total	5,570	7,020	9,000	11,710	15,240	19,870
(3) Naivasha Town						
Residential	3,710	5,470	7,080	8,700	10,690	13,130
Institutional, general public	1,040	1,540	2,000	2,450	3,010	3,690
WLFTI	990	1,460	1,890	2,320	2,840	3,500
Prison	160	240	310	380	470	580
Commercial	110	160	210	260	320	390
Industrial	110	160	210	260	320	390
Sub-total	6,120	9,030	11,700	14,370	17,650	21,680
(4) Gilgil Rural						
Residential	650	870	1,070	1,290	1,550	1,870
Institutional	120	210	240	280	320	380
Commercial	10	10	10	10	10	10
Industrial	130	150	170	190	210	230
Livestock	280	320	360	390	420	460
Sub-total	1,190	1,560	1,850	2,160	2,510	2,950
(5) Eburu Rural 1,800	2,200	2,700	3,300	4,030	4,930	
Total	50,200	65,000	85,940	110,740	143,100	185,230

Data source :

(1) Greater Nakuru Water Supply Project, Eastern Division, Stage 1, Preliminary Design Report, July 1988

(2) Greater Nakuru Supply Project, Supplementary Report to Preliminary Design Report, May 1985

(3) Greater Nakuru Supply Project, Preliminary Design Report, May 1985

Table 4.5 Water Deficit by Service Area

(Unit : m^3/day)

	Description	1990	1995	2000	2005	2010	2015
(1)	Nakuru Municipality						
	Water demand, average daily	35,520	45,190	60,690	79,200	103,670	135,800
	max. daily	42,620	54,230	72,830	95,040	124,400	162,960
	Available supply						
	Meroroni treatment works	5,200	5,200	5,200	5,200	5,200	5,200
	Borehole fields	15,710	15,710	0	0	0	0
	Lanet treatment works	950	950	950	950	950	950
	Lanet borehole	200	200	200	200	200	200
	Stage 1 Project	-	13,300	13,300	13,300	13,300	13,300
	Water deficit, average daily	13,460	9,830	41,040	59,550	84,020	116,150
	max.daily	23,560	18,870	53,180	75,390	104,750	143,310
(2)	Gilgil Town						
	Water demand, average daily	5,570	7,020	9,000	11,710	15,240	19,870
	max. daily	6,680	8,420	10,800	14,050	18,290	23,840
	Available supply						
	Murindati treatment works	1,680	1,680	1,680	1,680	1,680	1,680
	Gilgil Malewa treat. works	1,000	0	0	0	0	0
	Stage 1 Project	-	4,700	4,700	4,700	4,700	4,700
	Water deficit, average daily	2,890	640	2,620	5,330	8,860	13,490
	max. daily	4,000	2,040	4,420	7,670	11,910	17,460
(3)	Naivasha Town						
	Water demand, average daily	6,120	9,030	11,700	14,370	17,650	21,680
	max. daily	7,340	10,840	14,040	17,240	21,180	26,020
	Available supply						
	Borehole	1,430	1,430	0	0	0	0
	Kinangop Ring Main	40	40	0	0	0	0
	Water deficit, average daily	4,650	7,560	11,700	14,370	17,650	21,680
	max. daily	5,870	9,370	14,040	17,240	21,180	26,020
(4)	Gilgil Rural						
	Water demand, average daily	1,190	1,560	1,850	2,160	2,510	2,950
	max. daily	1,430	1,870	2,220	2,590	3,010	3,540
	Available supply						
	Gilgil Nakuru treat. works	950	950	950	950	950	950
	Water deficit, average daily	240	610	900	1,210	1,560	2,000
	max. daily	480	920	1,270	1,640	2,060	2,590
(5)	Eburu Rural						
	Water demand, average daily	1,800	2,200	2,700	3,300	4,030	4,930
	max. daily	2,160	2,640	3,240	3,960	4,840	5,920
	Available supply	0	0	0	0	0	0
	Water deficit, average daily	1,800	2,200	2,700	3,300	4,030	4,930
	max. daily	2,160	2,640	3,240	3,960	4,840	5,920
(6)	Whole Service Area						
	Water demand, average daily	50,200	65,000	85,940	110,740	143,100	185,230
	max. daily	60,240	78,000	103,130	132,880	171,720	222,280
	Available supply	27,160	44,160	26,980	26,980	26,980	26,980
	Water deficit, average daily	23,040	20,840	58,960	83,760	116,120	158,250
	max. daily	33,070	33,840	76,150	105,900	144,740	195,300

Table 4.6 Features of Malewa and Turasha Dam Schemes

	Description	Unit	Malewa Scheme	Turasha Scheme
(1)	Reservoir			
	Gross storage	10^6m^3	71.70	70.51
	Active storage	10^6m^3	55.82	52.55
	Dead storage	10^6m^3	15.88	17.96
	FSL	El.m	2,149.00	2,175.00
	MSL	El.m	2,123.50	2,144.00
(2)	Diversion tunnel			
	Design discharge	m^3/sec	240	270
	Diameter	m	3.65	6.0
	Length	m	342	682
(3)	Dam			
	Type		Rockfill with center core	Rockfill with center core
	Crest elevation	El.m	2,154.00	2,180.00
	Dam height above river	m	69	85
	Crest length	m	345	480
	Embankment volume	m^3	946,000	3,220,000
	Slope, upstream		1 : 2.5	1 : 2.5
	downstream		1 : 2.0	1 : 2.0
(4)	Spillway			
	Design flood	m^3/sec	960	1,100
	Type		Side-spillway with chuteway	Side-spillway with chuteway
	Crest length	m	80	90
	Chuteway, with	m	20.0	20.0
	length	m	280	310
(5)	Trans-basin Tunnel			
	Design discharge	m^3/sec	2.30	2.30
	Diameter	m	2.5	2.5
	Length	m	2,600	2,600
	Slope of invert		1 : 1,000	1 : 1,000
(6)	Raw water transmission system (for each row)			
	Design discharge	m^3/sec	1.22	1.22
	Diameter	mm	950	950
	Length	m	9,500	10,200
	Pipe material		Steel	Steel

Note : This was applicable only for the economic comparative study.

Table 4.7 Rough Cost Estimate of Malewa Scheme and Turash Scheme

(Unit : Kshs. million)

Items	Malewa Scheme	Turash Scheme
1. Direct Constuction Cost		
1.1 Preparatory work	173.2	337.8
1.2 Water facilities		
- Diversion tunnel	63.5	189.7
- Cofferdam	18.2	15.9
- Main dam	259.3	885.9
- Spillway	216.3	210.5
1.3 Trans-basin tunnel		
- Intake & Outlet	5.7	5.7
- Tunnel	82.8	82.8
1.4 Raw water transmission system		
- Intake	21.9	85.9
- Pipeline	198.2	212.8
Sub-total	1,039.1	2,027.0
2. Indirect Construction Cost		
2.1 Land acquisition	8.2	5.5
2.2 Government administration	31.2	60.8
2.3 Engineering services	83.1	162.2
Sub-total	122.5	228.5
3. Physical Contingency	232.3	451.1
4. Interest during Construction	184.0	357.3
Total	1,577.9	3,063.9

Government administrati : Assumed at 3% of the direct cost
Engineering services : Assumed at 8% of the direct cost

Table 4.8 Preliminary Cost Estimate for Varied Dam Height

(Unit: Kshs. million)

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Dam Crest	EL.2,135.00	EL.2,139.00	EL.2,144.00	EL.2,150.00	EL.2,154.00	EL.2,160.00
1. Direct Construction Cost						
a. Preparatory works	124.1	123.1	122.5	125.5	129.2	153.6
b. Diversion tunnel	63.5	63.5	63.5	63.5	63.5	59.7
c. Cofferdam	16.2	16.2	16.2	17.1	18.2	42.1
d. Main dam	121.7	141.3	170.2	220.3	259.3	334.5
e. Spillway	330.7	306.2	274.2	238.3	216.3	243.2
f. Trans-basin tunnel	88.5	88.5	88.5	88.5	88.5	88.5
Sub-total	744.7	738.8	735.1	753.2	775.0	921.6
2. Indirect Construction Cost						
Engineering services	59.6	59.1	58.8	60.3	62.0	73.7
Government administration	22.3	22.2	22.1	22.6	23.3	27.6
Land acquisition	4.4	5.3	6.3	7.3	8.2	9.5
sub-total	86.3	86.6	87.2	90.2	93.5	110.8
3. Physical Contingency	166.2	165.1	164.5	168.7	173.7	206.5
4. Interest during Construction	131.6	130.7	130.3	133.6	137.6	163.5
Total	1,128.8	1,121.2	1,117.1	1,145.7	1,179.8	1,402.4

Note : Engineering services : Assumed at 8 % of the direct cost
Government administration : Assumed at 3 % of the direct cost
Physical contingency : Assumed 20 % of the sum of the direct and indirect cost
Interest : Based on the following assumptions :
Interest rate per annum : 10 %
Construction period : 3 years

Table 4.9 (1/2) Water Supply by Project to Respective Area

(Unit: m^3/day)

	Description	1990	1995	2000	2005	2010	2015
(1)	Nakuru Treated Water Transmission						
	Water demand in Nakuru						
	Average daily	35,520	45,190	60,690	79,200	103,670	135,800
	Max. daily	45,620	54,230	72,830	95,040	124,400	162,960
	Available supply						
	Existing facility (max.)	22,060	22,060	6,350	6,350	6,350	6,350
	Stage 1 Project (max.)	0	13,300	13,300	13,300	13,300	13,300
	Supply by Project						
	Average daily	0	0	41,040	59,550	84,020	116,150
	Max.daily	0	0	53,180	75,390	104,750	143,310
(2)	KMB Bulk System						
	Water demand						
	Average daily	870	940	1,160	1,480	1,890	2,410
	Max. daily	1,040	1,130	1,390	1,780	2,270	2,890
	Available supply						
	Existing facility(ave. and max.)	870	0	0	0	0	0
	Stage 1 project (ave. and max.)	0	870	870	870	870	870
	Supply by Project						
	Average daily	0	0	290	610	1,020	1,540
	Max. daily	0	0	520	910	1,400	2,020
(3)	GMB Bulk System						
	Water demand						
	Average daily	1,200	1,300	1,510	1,930	2,460	3,140
	Max. daily	1,440	1,560	1,810	2,320	2,950	3,770
	Available supply						
	Existing facility (ave. and max)	700	0	0	0	0	0
	Stage 1 project (ave. and max)	0	1,200	1,200	1,200	1,200	1,200
	Supply by Project						
	Average daily	0	0	310	730	1,260	1,940
	Max. daily	0	0	610	1,120	1,750	2,570
(4)	NYSTC Bulk System						
	Water demand						
	Average daily	1,310	1,760	2,240	2,860	3,650	4,660
	Max. daily	1,570	2,110	2,690	3,430	4,380	5,590
	Available supply						
	Existing facility(ave. and max)	420	0	0	0	0	0
	Stage 1 project (ave. and max.)	0	1,300	1,300	1,300	1,300	1,300
	Supply by Project						
	Average daily	0	0	940	1,560	2,350	3,360
	Max. daily	0	0	1,390	2,130	3,080	4,290
(5)	ASTU Bulk System						
	Water demand						
	Average daily	760	860	1,100	1,410	1,800	2,300
	Max. daily	910	1,030	1,320	1,690	2,160	2,760
	Available supply						
	Existing facility average	50	860	1,100	1,410	1,680	1,680
	max.	50	1,030	1,320	1,680	1,680	1,680
	Stage 1 project	0	0	0	0	0	0
	Supply by Project						
	Average daily	0	0	0	0	120	620
	Max. daily	0	0	0	10	480	1,080

Table 4.9 (2/2) Water Supply by Project to Respective Area

(Unit: m^3/day)

	Description	1990	1995	2000	2005	2010	2015
(6)	Gilgil Town (to be added to Nakuru treated water transmission)						
	Water demand						
	Average daily	1,430	2,160	2,990	4,030	5,440	7,360
	Max. daily	1,720	2,590	3,590	4,830	6,530	8,830
	Available supply						
	Existing facility (ave. and max)	640	0	0	0	0	0
	Stage 1 project (ave. and max)	0	1,330	1,330	1,330	1,330	1,330
	Supply by Project						
	Average daily	0	0	1,660	2,700	4,110	6,030
	Max. daily	0	0	2,260	3,500	5,200	7,500
(7)	Naivasha Treated Water Transmission						
	Water demand,						
	Average daily	6,120	9,030	11,700	14,370	17,650	21,680
	Max. daily	7,340	10,840	14,040	17,240	21,180	26,020
	Available supply						
	Existing facility (ave. and max.)	1,770	1,770	0	0	0	0
	Supply by Project						
	Average daily	0	0	11,700	14,370	17,650	21,680
	Max. daily	0	0	14,040	17,240	21,180	26,020
(8)	Gilgil Rural						
	Water demand						
	Average daily	1,190	1,560	1,850	2,160	2,510	2,950
	Max. daily	1,430	1,870	2,220	2,590	3,010	3,540
	Available supply (ave. and max)	950	950	950	950	950	950
	Supply by Project						
	Average daily	0	0	900	1,210	1,560	2,000
	Max. daily	0	0	1,270	1,640	2,060	2,590
(9)	Eburu Rural						
	Water demand						
	average daily	1,800	2,200	2,700	3,300	4,030	4,930
	Max. daily	2,160	2,640	3,240	3,960	4,840	5,920
	Available supply	0	0	0	0	0	0
	Water deficit						
	Average daily	0	0	2,700	3,300	4,030	4,930
	Max. daily	0	0	3,240	3,960	4,840	5,920

Table 4.10 Features of Water Supply Schemes by Phased Developments

Case	Stage	Raw Water Transmission	Treatment Works	Nakuru Treated Water Transmission	Naivasha Treated Water Transmission
A	2-1	Intake Q = 2.37m^3/s Tunnel Q = 2.37 m^3, L = 190 m Sand basin Q = 2.37 m^3/s Pipeline Q = 1.19 m^3/s D 1,000 mm, L=6,800 m D 900 mm, L=2,600 m	Treatment facilities 50,000 m^3/day x 2 nos. High level tank Q = 1,100 m^3 Control buildings Staff houses	Pipeline Q = 0.955 ~ 0.830 m^3/s D 1,000 mm = 1,800 m, D 900 mm = 10,250 m D 800 mm = 24,210 m, D 750 mm = 8,300 m D 550 mm = 4,400 m, D 400 mm = 2,050 m Service reservoirs: Gilgil Central and Nakuru (R1~R7) Total storage = 38,080 m^3	Pipeline Q=0.193 m^3/s D 500 mm = 25,700 m D 450 mm = 3,000 m Service reservoirs Naivasha (R1, R2) Total storage = 10,000 m^3
	2-2	Pipeline Q = 1.19 m^3/s D 1,000 mm, L = 6,800 m D 900 mm, L = 2,600 m	Treatment facilities 50,000 m^3/day x 2 nos. High level tank Q = 1,100 m^3 Control buildings Staff houses	Pipeline Q = 1.036 ~ 0.884 m^3/s D 1,000 mm = 4,150 m, D 900 mm = 10,070 m D 800 mm = 30,340 m, D 550 mm = 4,400 m D 400 mm = 2,050 m Service reservoirs: Gilgil Central and Nakuru (R1~R7) Total storage = 53,410 m^3	Pipeline Q = 0.115 m^3/s D 450 mm = 4,000 m D 400 mm = 24,700 m Service reservoirs Naivasha (R1, R2) Total storage = 6,000 m^3
B	2-1	Intake Q = 2.37 m^3/s Tunnel Q = 2.37 m^3/s L = 190 m Sand basin Q = 2.37 m^3/s Pipeline Q = 1.19 m^3/s D 1,000 mm, L = 6,800 m D 900 mm, L = 2,600 m	Treatment facilities 50,000 m^3/day x 2 nos. High level tank Q = 1,100 m^3 Control buildings Staff houses	Pipeline Q = 0.955 ~ 0.830 m^3/s D 1,000 mm = 1,800 m, D 900 mm = 10,250 m D 800 mm = 24,210 m, D 750 mm = 8,300 m D 550 mm = 4,400 m, D 400 mm = 2,050 m Service reservoirs: Gilgil Central and Nakuru (R1 ~ R7) Total storage = 38,080 m^3	Pipeline Q = 0.193 m^3/s D 500 mm = 25,700 m D 450 mm = 3,000 m Service reservoirs Naivasha (R1, R2) Total storage = 10,800 m^3
	2-2	Pipeline Q = 0.593 m^3/s D 700 mm, L = 6,800 m D 650 mm, L = 2,600 m	Treatment facilities 50,000 m^3/day x 1 no High level tank Q = 1,100 m^3 Control buildings Staff houses	Pipeline Q = 0.518 ~ 0.442 m^3/s D 700 mm = 4,080 m, D 650 mm= 10,070 m D 600 mm = 30,330 m, D 400 mm = 4,400 m D 300 mm = 2,050 m Service reservoirs: Gilgil Central and Nakuru (R1 ~ R7) Total Storage = 26,705 m^3	Pipeline Q = 0.0573 m^3/s D 400 mm = 25,700 m D 350 mm = 3,000 m Service reservoirs: Naivasha (R1, R2) Total Storage = 3,000 m^3
	2-3	Pipeline Q = 0.593 m^3/s D 700 mm, L = 6,800 m D 650 mm, L = 2,600 m	Treatment facilities 50,000 m^3/day x 1 no Control buildings Staff houses	Pipeline Q = 0.518 ~ 0.442 m^3/s D 700 mm = 4,080 m, D 650 mm = 10,070 m D 600 mm = 30,330 m, D 400 mm = 4,400 m D 300 mm = 2,050 m Service Reservoirs: Gilgil Central and Nakuru (R1 ~ R7) Total Storage = 26,705 m^3	Pipeline Q = 0.0573 m^3/s D 400 mm = 25,700 m D 350 mm = 3,000 m Service reservoirs: Naivasha (R1, R2) Total Storage = 3,000 m^3

Table 4.11 Construction Cost Estimate for Comparative Study of Water Supply Scheme

(Unit: Kshs.10^6)

Components	Case A			Case B			
	Stage 2-1	Stage 2-2	Total	Stage 2-1	Stage 2-2	Stage 2-3	Total
Raw Water Transmission	139.5	120.2	259.7	139.5	84.2	84.2	307.9
Water Treatment Works	380.1	305.6	685.7	380.1	196.6	180.9	757.6
Nakuru Treated Water Transmission	586.4	568.7	1,155.1	586.4	421.0	406.5	1,413.9
Naivasha Treated Water Transmission	166.9	116.3	283.2	166.9	84.6	83.3	334.8
Total	1,272.9	1,110.8	2,383.7	1,272.9	786.4	754.9	2,814.2

Note: Price escalation is not included

Table 4.12 Capacity and Dimension of Service Reservoirs (1/2)

Reservoirs	Stage	Average Daily (cu.m/day)	Max. Daily (cu.m/day)	Required Capacity (cu.m)	Designed Capacity (cu.m)
Gilgil Central Reservoir	2-1	9,950	11,940	5,970	6,160
	2-2	5,950	7,140	3,570	3,850
	2-3	5,950	7,140	3,570	3,850
	Total			13,110	13,860
Nakuru R1	2-1	2,440	2,928	1,464	1,600
	2-2	1,300	1,560	780	800
	2-3	1,300	1,560	780	800
	Total			3,024	3,200
Nakuru R2	2-1	400	480	240	300
	2-2	215	258	129	150
	2-3	215	258	129	150
	Total			498	600
Nakuru R3	2-1	15,480	18,576	9,288	10,080
	2-2	8,275	9,930	4,965	5,040
	2-3	8,275	9,930	4,965	5,040
	Total			19,218	20,160
Nakuru R4	2-1	7,370	8,844	4,422	4,800
	2-2	3,940	4,728	2,364	2,400
	2-3	3,940	4,728	2,364	2,400
	Total			9,150	9,600
Nakuru R5	2-1	16,350	19,620	9,810	10,800
	2-2	8,740	10,488	5,244	5,400
	2-3	8,740	10,488	5,244	5,400
	Total			20,298	21,600
Nakuru R6	2-1	11,210	13,452	6,726	7,350
	2-2	6,010	7,212	3,606	4,200
	2-3	6	7,212	3,606	4,200
	Total			13,962	15,750
Nakuru R7	2-1	17,710	21,252	10,626	10,800
	2-2	9,470	11,364	5,682	6,300
	2-3	9,470	11,364	5,682	6,300
	Total			21,990	23,400
Naivasha R1	2-1	3,340	4,008	2,004	2,400
	2-2	990	1,188	594	600
	Total			3,192	3,600
Naivasha R2	2-1	13,360	16,032	8,016	8,400
	2-2	3,960	4,752	2,376	2,400
	2-3	3,960	4,752	2,376	2,400
	Total			12,768	13,200
KMB	1	870	1,044	522	1,000
	2-1	830	996	498	740
	2-2	600	720	360	-
	2-3	600	720	360	-
	Total			1,740	1,740
ASTU	1	1,680	2,016	1,008	1,000
	2-1	-	-	-	-
	2-2	1,140	1,368	684	720
	2-3	-	-	-	-
	Total			1,692	1,720

Table 4.12 Capacity and Dimension of Service Reservoirs (2/2)

Reservoirs	Stage	Average Daily (cu.m/day)	Max. Daily (cu.m/day)	Required Capacity (cu.m)	Designed Capacity (cu.m)
Gitgil East No.1	2-1	780	936	468	495
	2-2	550	660	330	330
	Total			798	825
Gilgil East No.2	2-1	490	588	294	330
	2-2	340	408	204	220
	Total			498	550
Gilgil East No.3	2-1	295	354	177	200
	2-2	205	246	123	200
	Total			300	400
Gilgil West No.1	2-1	-	-	40	50
	2-2	-	-	30	50
	Total			70	100
Gilgil West No.2	2-1	150	180	90	90
	2-2	100	120	60	90
	Total			150	180
Eburu No.1	2-1	-	-	90	90
	2-2	-	-	60	90
	Total			150	180
Eburu No.2	2-1	-	-	90	90
	2-2	-	-	60	90
	Total			150	180
Eburu No.3	2-1	1,900	2,280	1,140	1,200
	2-2	1,110	1,332	666	800
	Total			1,806	2,000
Eburu No.4	2-1	-	-	90	90
	2-2	-	-	60	90
	Total			150	180
Eburu No.5	2-1	-	-	90	90
	2-2	-	-	60	90
	Total			150	180
Eburu No.6	2-1	950	1,140	570	660
	2-2	555	666	333	330
	Total			903	990
Eburu No.7	2-1	-	-	90	90
	2-2	-	-	60	90
	Total			150	180
Eburu No.8	2-1	-	-	90	90
	2-2	-	-	60	90
	Total			150	180
Eburu No.9	2-1	950	1,140	570	660
	2-2	555	666	333	330
	Total			903	990

Table 6.1 Designs of Nakuru and Naivasha Treated Water Transmission Systems

(1) Reservoir Water Level and Deign Discharge of Pipeline

	Pipeline Section	Reservoir W.L (El.m)		Design Discharge (m^3/day)	
		HWL	LWL	Stage 2-1	Stage 2-2
(a)	Nakuru System				
	Clear water reservoir	2,072.0	2,069.0		
				82,520	89,550
	KMB take-off		2,056.2		
				81,690	88,350
	Central reservoir	2,051.7	2,047.0		
				71,740	76,450
	Gilgil West take-off		1,980.93		
				70,960	75,900
	R6 in Nakuru				
(b)	Naivasha System				
	Clear water reservoir	2,072.0	2,069.0		
				16,700	9,900
	R1 in Naivasha	1,994.0	1,990.0		

(2) Pipeline Configuration

	Pipeline Section	Stage 2-1			Stage 2-2		
		Dia. (mm)	Length (m)	Hydraulic gradinent (‰)	Dia. (mm)	Length (m)	Hydraulic grandient (‰)
(a)	Nakuru System						
	Clear W. Res. - KMB	D1000	1,800	1.50	D1000	4,150	1.76
		D900	3,850	2.62	D900	1,500	3.09
	KMB - Central Res.	D900	1,750	2.59	D900	1,750	3.02
	Central Res. - Gilgil West.	D800	17,900	3.69	D800	15,740	4.19
	Gilgil West - R6	D800	6,310	3.61	D800	14,600	4.13
		D750	8,300	5.09			
(b)	Naivasha System						
	Clear W. Res. - R1	D500	25,700	2.42	D450	4,000	1.49
		D450	3,000	4.25	D400	24,700	2.80

Table 6.2 Designs of Nakuru and Naivasha Distribution System (1/2)

(1) Reservoir Water Level, Pipeline Hydraulic Water Level and Design Discharge

Pipeline Section	Reservoir W.L (El.m)		Design Discharge (m^3/day)		
	H.W.L	L.W.L	Stage 2-1	Stage 2-2	Stage 2-3
Nakuru System					
R_6 reservoir take-off	1,915.90	1,911.70			
			59,750	31,940	31,940
R_5 Reservoir take-off		1,904.28			
(R_3, R_1 reservoir take-off)		(1,909.00)			
			25,480	13,625	13,625
R_4 reservoir take-off		1,889.31			
(R_2 reservoir take-off)		(1,896.99)			
			17,710	9,470	9,470
R_7 reservoir	1,871.01				
	(1,874.33)				
R_4 reservoir take-off		1,904.28			
		(1,909.00)			
			16,350	8,740	8,740
R_5 reservoir	1,850.96	1,846.96			
R_3, R_1 reservoir take-off		1,904.28			
		(1,909.00)			
			17,920	9,575	9,575
R_3 reservoir	1,903.00	1,898.80			
			2,440	1,300	1,300
R_1 reservoir	1,983.03	1,979.03			
R_4 reservoir take-off		1,889.31			
(R_2 reservoir take-off)		(1,896.99)			
			7,770	4,155	4,155
R_4 reservoir	1,888.46	1,884.46			
			400	215	215
R_2 reservoir	1,935.20	1,932.20			
Naivasha System					
R_1 reservoir	1,994.00				
R_2 reservoir	1,962.00	1,958.00	13,360	3,960	3,960

Note: The figures in parentheses denote the hydraulic water level in stage 2-2 and stage 2-3.

Table 6.2 Designs of Nakuru and Naivasha Distribution System (2/2)

(2) Pipeline Configuration

Pipeline Section	Stage 2-1			Stage 2-2			Stage 2-3		
	Dia. (mm)	Length (m)	Hydraulic gradient (‰)	Dia. (mm)	Length (m)	Hydraulic gradient (‰)	Dia. (mm)	Length (m)	Hydraulic gradient (‰)
Nakuru System									
R_6 reservoir									
- R_5 take-off	D900	4,650	2.51	D700	4,650	1.48	D700	4,650	1.48
R_5 take-off									
- R_4 take-off	D550	4,400	3.40	D450	4,400	2.73	D450	4,400	2.73
R4 take-off									
- R_7 reservoir	D400	2,050	8.77	D300	2,050	11.05	D300	2,050	11.05
R_5 take-off									
- R_5 reservoir	D200	100	212.00	D100	150	321.00	D100	150	321.00
R_3, R_1 take-off									
- R_3 reservoir	D600	500	1.83	D300	500	11.29	D300	500	11.29
R_3 reservoir*									
- R_1 reservoir	D250	1,100	2.70	D200	1,100	2.70	D200	1,100	2.70
R_4 take-off									
- R_4 reservoir	D450	550	0.94	D250	550	5.66	D250	550	5.66
R_4 reservoir*									
- R_2 reservoir	D150	1,200	1.20	D100	1,200	3.00	D100	1,200	3.00
Naivasha System									
R_1 reservoir	D300	650	16.98	D150	1,050	7.66	D150	1,050	7.66
- R_2 reservoir	D250	400	42.48						

Note: * Booster Station

Table 6.3 Designs of Rural Water Supply System (1/2)

(1) Reservoir Water Level and Design Discharge of Pipeline

Pipeline Section	Reservoir W.L (El.m)		Design Discharge (m^3/day)	
	HWL	LWL	Stage 2-1	Stage 2-2
Gilgil East System				
Clear Water Reservoir	2,072.00	2,069.00		
Reservoir No. 1	2,210.00	2,207.80	780	550
Reservoir No. 2	2,335.00	2,332.80	490	340
Reservoir No. 3	2,460.00	2,458.00	295	205
Gilgil West System				
Gilgil West take-off		1,980.93		
Reservoir No. 1	1,860.00	1,858.00	780 ~ 150	550 ~ 150
Reservoir No. 2	1,960.00	1,956.40	150	100
Eburu System				
Central Reservoir	2,051.70	2,047.00		
Reservoir No. 1	2,014.00	2,010.40	3,700	2,220
Reservoir No. 2	1,890.00	1,886.40	1,900	1,110
Reservoir No. 3	1,955.00	1,953.00	1,900	1,110
Reservoir No. 4	2,170.00	2,166.40	1,900	1,110
Reservoir No. 5	2,350.00	2,364.40	1,900	1,110
Reservoir No. 6	2,620.00	2,167.80	950	555
Reservoir No. 7	2,260.00	2,256.40	950	555
Reservoir No. 8	2,100.00	2,096.40	950	555
Reservoir No. 9	2,020.00	2,017.80	950	555

Table 6.3 Design of Rural Water Supply System (2/2)

(2) Pipeline Configuration

Pipeline Section	Stage 2-1			Stage 2-1		
	Dia. (mm)	Length (m)	Hydraulic gradient (‰)	Dia. (mm)	Length (m)	Hydraulic gradient (‰)
Gilgil East System						
Clear Water Reservoir*						
- Reservoir No. 1	150	7,100	4.2	150	7,100	4.2
Reservoir No. 1*						
- Reservoir No. 2	125	4,300	2.2	125	4,300	2.2
Reservoir No. 2*						
- Reservoir No. 3	100	4,600	1.5	100	4,600	1.5
Gilgil West System						
Gilgil West take-off	150	15,000	0.4	150	15,000	0.4
- Reservoir No. 1	100	11,700	0.4	100	11,700	0.4
Reservoir No. 1*	80	2,200	0.4	80	2,200	0.4
- Reservoir No. 2	100	2,100	1.5	100	2,100	1.5
Eburu System						
Central Reservoir						
- Reservoir No. 1	250	14,300	4.5	250	14,300	4.5
Reservoir No. 1						
- Reservoir No. 2	250	8,700	4.5	250	8,700	4.5
Reservoir No. 2*						
- Reservoir No. 3	200	8,700	5.3	200	8,700	5.3
Reservoir No. 1*						
- Reservoir No. 4	200	3,400	5.3	200	3,400	5.3
Reservoir No. 4*						
- Reservoir No. 5	200	3,700	5.3	200	3,700	5.3
Reservoir No. 5*						
- Reservoir No. 6	150	4,600	5.0	150	4,600	5.0
Reservoir No. 5						
- Reservoir No. 7	100	1,700	52.9	100	1,700	52.9
Reservoir No. 7						
- Reservoir No. 8	100	1,800	88.9	100	1,800	88.9
Reservoir No. 8						
- Reservoir No. 9	100	2,300	34.8	100	2,300	34.8

Note: * Booster Station

Table 7.1 Major Work Items & Quantities of Malewa Dam Scheme

	Work Item	Quantity	Unit
1	Diversion Tunnel		
1.1	Open Excavation of Inlet & Outlet		
1.1.1	Open Excavation, common	1,100	cu.m
1.1.2	Open Excavation, weathered rock	5,100	cu.m.
1.1.3	Open excavation, hard rock	12,500	cu.m.
1.2	Concrete of Inlet & Outlet	1,300	cu.m.
1.3	Tunnel Excavation	12,300	cu.m.
1.4	Tunnel Concrete	5,100	cu.m.
1.5	Reinforcement Bar	200	ton
1.6	Plug Concrete	820	cu.m.
2	Coffer Dam		
2.1	Temporary Coffer Dam Embankment	4,800	cu.m.
2.2	Excavation		
2.2.1	Open Excavation, common	11,300	cu.m.
2.2.2	Open Excavation, weathered rock	5,500	cu.m.
2.3	Embankment		
2.3.1	Embankment, filter	8,900	cu.m.
2.3.2	Embankment, filter	8,900	cu.m.
2.3.3	Embankment, outer shell-1	50,200	cu.m.
2.3.4	Embankment, outer shell-2	48,700	cu.m.
3	Main Dam		
3.1	Excavation		
3.1.1	Excavation, common	34,300	cu.m.
3.1.2	Excavation, weathered rock	53,200	cu.m.
3.1.3	Excavation, hard rock	47,100	cu.m.
3.1.4	Trench excavation for grout gallery	10,500	cu.m.
3.2	Embankment	166,900	cu.m.
3.2.2	Embankment, core	110,900	cu.m.
3.2.3	Embankment, inner shell	59,100	cu.m.
3.2.4	Embankment, outer shell-1	516,200	cu.m.
3.2.5	Embankment, outer shell-2	148,100	cu.m.
3.3	Concrete for grout gallery	8,700	cu.m.
3.4	Curtain Grouting	5,700	cu.m.
3.5	Consolidation Grouting	2,700	cu.m.
4	Spillway		
4.1	Excavation		
4.1.1	Excavation, common	35,600	cu.m.
4.1.2	Excavation, weathered rock	97,200	cu.m.
4.1.3	Excavation, hard rock	313,500	cu.m.
4.2	Concrete	41,000	cu.m.
4.3	Reinforcement Bars	1,230	ton
5	Transbasin Diversion Tunnel		
5.1	Open Excavation of Inlet & Outlet		
5.1.1	Open Excavation, common	1,200	cu.m.
5.1.2	Open Excavation, weathered rock	5,300	cu.m.
5.1.3	Open Excavation, hard rock	11,600	cu.m.
5.2	Concrete of Inlet & Outlet	1,100	cu.m.
5.3	Tunnel Excavation	15,500	cu.m.
5.4	Tunnel Concrete	6,000	cu.m.
5.5	Reinforcement Bars	100	ton
5.6	Plug Concrete	200	cu.m.

Table 7.2 Major Work Items & Quantities of Water Supply Scheme (1/5)

Stage: 2-1 (1/2)

	Work Item	Unit	Quantity
1.	Raw Water Transmission System		
1.1	Intake		
	Open Excavation	cu.m	1680
	Concrete	cu.m	650
	Reinforcement Bar	ton	39
1.2	Tunnel		
	Tunnel Excavation	cu.m	900
	Tunnel Concrete	cu.m	300
	Steel Support	ton	10.5
1.3	Sand Basin		
	Open Excavvation	cu.m	1290
	Backfill	cu.m	330
	Concrete	cu.m	970
	Reinforcement Bar	ton	59
	Screen	ton	2.5
1.4	Raw Water Mains		
	Pipe Trench Section		
	Trench Excavation	cu.m	28920
	Backfill	cu.m	21660
	Steel Pipe		
	1000 mm	m	6800
	900 mm	m	2600
2.	Water Treatment Works		
2.1	Treatment Works		
	Sedimentation Basins	nos.	2
	Cler Water Reservoirs	nos.	2
	Sludge Lagoons	nos.	4
	Wash Water Pond	nos.	2
	High Level Tank	no.	1
	Valve		
	Flow Control 900 mm	no.	1
	Flow measurement	no.	1
2.2	Building Works		
	Stuff House		
	Double Grade	nos.	8
	Single Grade	nos.	2
	Operation Building		
	Office & Operator Room	sq.m	120
	Chemical Storage	sq.m	1650
	Workshop	sq.m	250
3.	Nakuru Treated Water Transmission System		
3.1	Pipe Trench Section		
	Trench Excavation	cu.m	92840
	Backfill	cu.m	69850
	Steel Pipe		
	1000 mm	m	1800
	900 mm	m	5600
	800 mm	m	24210
	750 mm	m	8300
3.2	Service Reservoirs		
3.2.1	Gilgil Central		
	Excavation	cu.m	1656
	Concrete	cu.m	1722
	Reinforcement Bar	t	103
3.2.2	Nakuru R1		
	Excavation	cu.m	492
	Concrete	cu.m	558
	Reinforcement Bar	t	34
	Distribution		
	Excavation	cu.m	759
	Backfill	cu.m	705
	UPVC 250 mm	m	1100
	Pump	nos.	2
3.2.3	Nakuru R2		
	Excavation	cu.m	1335
	Concrete	cu.m	160
	Reinforcement Bar	t	10
	Distribution		
	Excavation	cu.m	629
	Backfill	cu.m	607
	UPVC 150 mm	m	1200
	Pump	nos.	2
3.2.4	Nakuru R3		
	Excavation	cu.m	2465
	Concrete	cu.m	2563
	Reinforcement Bar	t	154
	Distribution		
	Excavation	cu.m	722
	Backfill	cu.m	581
	UPVC 600mm	m	500
3.2.5	Nakuru R4		
	Excavation	cu.m	1298
	Concrete	cu.m	1292
	Reinforcement Bar	ton	78
	Distribution		
	Excavation	cu.m	598
	Backfill	cu.m	511
	UPVC 450mm	m	550
3.2.6	Nakuru R5		
	Excavation	cu.m	2570
	Concrete	cu.m	2579
	Reinforcement Bar	ton	154
	Distribution		
	Excavation	cu.m	91
	Backfill	cu.m	86
	UPVC 200mm	m	100
3.2.7	Nakuru R6		
	Excavation	cu.m	1785
	Concrete	cu.m	1915
	Reinforcement Bar	ton	114

Table 7.2 Major Work Items & Quantities of Water Supply Scheme (2/5)

Stage: 2-1 (2/2)

	Work Item	Unit	Quantity
3.2.8	Nakuru R7		
	Excavation	cu.m	2726
	Concrete	cu.m	2852
	Reinforcement Bar	ton	171
	Distributin		
	Excavation	cu.m	20040
	Backfill	cu.m	15780
	Steel pipe		
	900 mm	m	4650
	550 mm	m	4400
	400 mm	m	2050
3.2.9	Flow Control Valve		
	Gilgil Central 900 mm	no.	1
	R6 750 mm	no.	1
	R7 400 mm	no.	1
4.	Naivasha Treated Water Transmission System		
4.1	Pipe Trench Section		
	Trench Excavation	cu.m	37330
	Backfill	cu.m	31290
	Steel Pipe		
	500 mm	m	25941
	450 mm	m	3031
4.2	Service Reservoirs		
4.2.1	Naivasha R1		
	Excavation	cu.m	634
	Concrete	cu.m	695
	Reinforcement Bar	t	42
4.2.2	Naivasha R2		
	Excavation	cu.m	2294
	Concrete	cu.m	2206
	Reinforcement Bar	t	132
	Distribution		
	Excavation	cu.m	784
	Backfill	cu.m	719
	UPVC 300 mm	m	650
	UPVC 250 mm	m	400
4.2.3	Flow Control Valve		
	Naivasha Reservoir		
	450 mm	no.	1
5.	Gilgil Rural Supply System		
5.1	Gilgil East		
	Excavation	cu.m	8880
	Backfill	cu.m	7660
	Steel Pipe		
	150 mm	m	7100
	125 mm	m	4300
	100 mm	m	4600
	Pump	nos.	6
5.2	Gilgil West		
	Excavation	cu.m	14980
	Backfill	cu.m	14640
	UPVC		
	150 mm	m	15000
	100 mm	m	11700
	80 mm	m	2200
	Steel Pipe 100 mm	m	2100
	Pump	nos.	2
6.	Eburu Rural Supply System		
	Excavation	cu.m	30430
	Backfill	cu.m	28680
	Steel Pipe		
	200 mm	m	15800
	150 mm	m	4600
	UPVC		
	250 mm	m	23000
	100 mm	m	5800
	Pump	nos.	8
7.	Bulk Supply System in Gilgil		
7.1	Kenyatta Barrack		
	Excavation	cu.m	179
	Concrete	cu.m	238
	Reinforcement Bar	m	14
	Distribution		
	Excavation	cu.m	67
	Backfill	cu.m	65
	UPVC 150 mm	m	129
7.2	Distribution of NYSTC - GMB		
	Excavation cu.m		200
	Backfill	cu.m	182
	UPVC 300 mm	m	259

Table 7.2 Major Work Items & Quantities of Water Supply Scheme (3/5)

Stage: 2-2 (1/2)

	Work Item	Unit	Quantity
1.	Raw Water Transmission System		
1.1	Raw Water Mains		
	Pipe Trench Section	cu.m	29820
	Trench Excavation	cu.m	21660
	Backfill		
	Steel Pipe		
	1000 mm	m	6800
	900 mm	m	2600
2.	Water Treatment Works		
2.1	Treatment Works		
	Sedimentation Basins	no.	1
	Clear Water Reservoirs	no.	1
	Sludge Lagoons	nos.	2
	Wash Water Pond	no.	1
	High Level Tank	no.	1
	Valve	no.	
	Flow Control 900 mm	no.	1
	Flow Measurement		1
2.2	Building Works		
	Stuff House		
	Double Grade	nos.	5
	Single Grade	no.	1
	Operation Building		
	Chemical Storage	sq.m	532.5
	Workshop	sq.m	250
3.	Nakuru Treated Water Transmission System		
3.1	Pipe Trench Section		
	Excavation Trench	cu.m	116575
	Backfill	cu.m	88096
	Steel Pipe		
	1000 mm	m	4150
	900 mm	m	5420
	800 mm	m	30340
3.2	Service Reservoirs		
3.2.1	Gilgil Central		
	Excavation	cu.m	1060
	Concrete	cu.m	1163
	Reinforcement Bar	t	70
3.2.2	Nakuru R1		
	Excavation	cu.m	269
	Concrete	cu.m	329
	Reinforcement Bar	t	20
	Distribution		
	Excavation	cu.m	660
	Backfill	cu.m	630
	UPVC 200 mm	m	1100
	Pump	no.	1
3.2.3	Nakuru R2		
	Excavation	cu.m	73
	Concrete	cu.m	85
	Reinforcement Bar	t	5
	Distribution		
	Excavation	cu.m	540
	Backfill	cu.m	530
	UPVC 200 mm	m	1200
	Pump	no.	1
3.2.4	Nakuru R3		
	Excavation	cu.m	1495
	Concrete	cu.m	1552
	Reinforcement Bar	t	93
	Distribution		
	Excavation	cu.m	390
	Backfill	cu.m	360
	UPVC 300 mm	m	500
3.2.5	Nakuru R4		
	Excavation	cu.m	710
	Concrete	cu.m	765
	Reinforcement Bar	t	45
	Distribution		
	Excavation	cu.m	540
	Backfill	cu.m	530
	UPVC 250 mm	m	550
3.2.6	Nakuru R5		
	Excavation	cu.m	1513
	Concrete	cu.m	1502
	Reinforcement Bar	t	90
	Distribution		
	Excavation	cu.m	70
	Backfill	cu.m	60
	UPVC 100 mm	m	150
3.2.7	Nakuru R6		
	Excavation	cu.m	1097
	Concrete	cu.m	1183
	Reinforcement Bar	t	71
3.2.8	Nakuru R7		
	Excavation	cu.m	1495
	Concrete	cu.m	1578
	Reinforcement Bar	t	94
	Distribution		
	Excavation	cu.m	14340
	Backfill	cu.m	11700
	Steel Pipe		
	700 mm	m	4650
	450 mm	m	4400
	300 mm	m	2050
3.2.9	Flow Control Valve		
	Gilgil Central 900 mm	no.	1
	R6 800 mm	no.	1
	R7 400 mm	no.	1
4.	Naivasha Treated Water Transmission System		
4.1	Pipe Trench Section		
	Excavation Trench	cu.m	27365
	Backfill		
	Steel Pipe		
	450 mm	m	4052
	400 mm	m	24920
4.2	Service Reservoirs		
4.2.1	Naivasha R1		
	Excavation	cu.m	209
	Concrete	cu.m	266
	Reinforcement Bar	t	16

Table 7.2 Major Work Items & Quantities of Water Supply Scheme (4/5)

Stage: 2-2 (2/2)

	Work Item	Unit	Quantity
4.2.2	Naivasha R2		
	Excavation	cu.m	711
	Concrete	cu.m	765
	Reinforcement Bar	t	45
	Distribution		
	Excavation	cu.m	550
	Backfill	cu.m	530
	UPVC 150 mm	m	1050
4.2.3	Flow Control Valve		
	Naivasha Reservoir		
	400 mm	no.	1
5.	Gilgil Rural Supply System		
5.1	Gilgil East		
	Excavation	cu.m	8880
	Backfill	cu.m	7660
	Steel Pipe		
	150 mm	m	7100
	125 mm	m	4300
	100 mm	m	4600
5.2	Gilgil West		
	Excavation	cu.m	14980
	Backfill	cu.m	14640
	UPVC		
	150 mm	m	15000
	100 mm	m	11700
	80 mm	m	2200
	Steel Pipe		
	100 mm	m	2100
6	Eburu Rural Supply System		
	Excavation	cu.m	30430
	Backfill	cu.m	28680
	Steel Pipe		
	200 mm	m	15800
	150 mm	m	4600
	UPVC		
	250 mm	m	23000
	100 mm	m	5800

Table 7.2 Major Work Items & Quantities of Water Supply Scheme (5/5)

Stage: 2-3

	Work Item	Unit	Quantity
1.	Water Treatment Works		
1.1	Treatment Works		
	Sedimentation Basins	no.	1
	Clear Water Reservoirs	no.	1
	Sludge Lagoons	nos.	2
	Wash Water Pond	no.	1
	Valve		
	Flow Measurement	no.	1
1.2	Building Works		
	Stuff House		
	Double Grade	nos.	5
	Single Grade	no.	1
	Operation Building		
	Chemical Storage	sq.m	532.5
	Workshop	sq.m	250
2.	Nakuru Treated Water Transmission System		
2.1	Service Reservoirs		
2.1.1	Gilgil Central		
	Excavation	cu.m	1068
	Concrete	cu.m	1163
	Reinforcement Bar	t	70
2.1.5	Nakuru R4		
	Excavation	cu.m	710
	Concrete	cu.m	765
	Reinforcement Bar	t	45
	Distribution		
	Excavation	cu.m	540
	Backfill	cu.m	530
	UPVC 250 mm	m	550
2.1.6	Nakuru R5		
	Excavation	cu.m	1513
	Concrete	cu.m	1502
	Reinforcement Bar	t	90
	Distribution		
	Excavation	cu.m	70
	Backfill	cu.m	60
	UPVC 100 mm	m	150
2.1.7	Nakuru R6		
	Excavation	cu.m	1097
	Concrete	cu.m	1183
	Reinforcement Bar	t	71
2.1.8	Nakuru 7		
	Excavation	cu.m	1495
	Concrete	cu.m	1578
	Reinforcement Bar	t	94
	Distribution		
	Excavation	cu.m	14340
	Backfill	cu.m	11700
	Steel Pipe		
	700 mm	m	4650
	450 mm	m	4400
	300 mm	m	2050
2.1.2	Nakuru R1		
	Excavation	cu.m	269
	Concrete	cu.m	329
	Reinforcement Bar	t	20
	Distribution		
	Excavation	cu.m	660
	Backfill	cu.m	630
	UPVC 200 mm	m	1100
	Pump	no.	1
2.1.3	Nakuru R2		
	Excavation	cu.m	73
	Concrete	cu.m	85
	Reinforcement Bar	t	5
	Distribution		
	Excavation	cu.m	540
	Backfill	cu.m	530
	UPVC 100 mm	m	1200
	Pump	no.	1
2.1.4	Nakuru R3		
	Excavation	cu.m	1495
	Concrete	cu.m	1552
	Reinforcement Bar	t	93
	Distribution		
	Excavation	cu.m	390
	Backfill	cu.m	360
	UPVC 300 mm	m	500
3.	Naivasha Treated Waster Transmission System		
3.1	Service Reservoirs		
3.1.1	Naivasha R1		
	Excavation	cu.m	199
	Concrete	cu.m	277
	Reinforcement Bar	t	166
3.1.2	Naivasha R1		
	Excavation	cu.m	675
	Concrete	cu.m	765
	Reinforcement Bar	t	45
	Distribution		
	Excavation	cu.m	550
	Backfill	cu.m	530
	UPVC 150 mm	m	1050

Table 7.3 Major Construction Equipment, Plant and Machinery

Equipment/Plant/Machinery	Specification	Quantity
I. Melewa Dam Scheme		
Bulldozer	D8, 32 ton	3
Bulldozer	D7, 21 ton	9
Bulldozer	11 ton	1
Backhoe	PC300, 1.2 cu.m	3
Backhoe	0.9 cu.m	1
Dozer Shovel	963, 1.9 cu.m	10
Wheel Loader	950E, 2.7 cu.m	2
Wheel Loader	916, 1.4 cu.m	1
Train Loader	L = 20 m W = 0.7 m	2
Battery Locomotive	6 ton	2
Rocker Shovel	0.23 cu.m	2
Dump Truck	11 ton	83
Grambee Toro	3.0 cu.m	6
Load Haul Dump	6.6 cu.m	2
Truck Crane	15 ton	1
Crawler Crane	40 ton	1
Tower Crane	1.7 ton, 45 m	2
Tower Crane	H = 40 m	2
Winch	15 ton	1
Truck with Crane	4 ton	2
Grout Mixer	200 lit.	1
Grout Pump	400 lit.	1
Leg Drill	40 kg	18
Prescrete	3 cu.m	2
Leg Drill Stoper	31.5 kg	11
Hand Breaker	29 kg	2
Rock Drill Sinker	26.9 kg	2
Pick Hammer	8 kg	14
Breaker (Hydro)	1,300 kg	2
Crawler Drill	102 ps	7
Motor Grader	3.7 m	1
Tamping Roller	10 ton	1
Vibratory Roller	8 ton	2
Aggregate Plant	100 ton/h	1
Crushing Plant		
Concrete Plant	50 cu.m/h	1
Truck Mixer	4.4 cu.m	11
Concrete Pump	50 cu.m/h	2
Concrete Vibrator	D60 m/m	16
Cement Silo	100 ton	2
Sedimentation Plant		
Water Sprinkle Truck	10 ton	2
Air Compressor	21 - 27 cu.m/min	1
Air Compressor	16.8 cu.m/min	2
Air Compressor	10 - 12 cu.m/min	7
Water Pump	6 inch, 7.5 kw	8
Water Pump	4 inch, 5.5 kw	9
Water Pump	3 inch, 5.5 kw	17
Cooling Pump	2 inch, 5.5 kw	4
II. Water Supply Scheme		
Buildozer	21 ton	1
Buildozer	15 ton	2
Backhoe	0.7 cu.m	5
Backhoe	0.4 cu.m	7
Crawler Drill	5 ton	2
Wheel Loader	1.8 cu.m	6
Crawler Crane	40 ton	3
Truck Crane	15 ton	4
Concrete Plant	50 cu.m/h	1
Concrete Mixer	0.5 cu.m	2
Concrete Pump	50 cu.m/h	1
Agitator Car	4.5 cu.m	8
Dump Truck	11 ton	18
Truck with Crane	8 ton	6
Truck with Crane	4 ton	2
Compactor	90 kg	12
Tamper	80 kg	12
Train Loader	L = 20 m, W = 0.7 m	1
Rocker Shovel	0.13 cu.m	1
Grambee Toro	3.0 cu.m	6
Battery Locomotive	6 ton	2
Toro Dumper	3 cu.m	1
Prescrete	3 cu.m	2
Conc. Spray Machine	10 cu.m/h	1
Air Compressor	17 cu.m/min	1

Table 7.4 Labour Wages

Category	Unit	Unit Price (Kshs)
Foreman	day	390
Assistant foreman	"	260
Carpenter	"	155
Bar Bender	"	155
Operator	"	155
Driver	"	145
Welder	"	180
Concreter	"	145
Mason	"	145
Form Worker	"	145
Plaster Worker	"	145
Painter	"	145
Common Labour	"	120
Assistant Engineer	month	21,000
Surveyer	"	15,500
Driver	"	4,000
Typist	"	4,000
Clark	"	5,000
Watch man	"	3,500
House boy	"	3,500
Maid	"	2,000
Cook	"	2,500

Table 7.5 Material Cost

Description	Unit	Unit cost (Kshs)	Remarks
Cement, ordinary portland	ton	1,969.00	Ex-factory
Reinforcement, square twisted	ton	10,750.00	Ex-factory, Excluding sales tax
Reinforcement, round	ton	10,250.00	Ex-factory, excluding sales tax
Fuel, diesel	lit	7.65	From Feb. 22, 1990
Gasoline, Premium	lit	11.00	From Feb. 22, 1990
Diesel engine oil	lit	14.18	
Gear oil	lit	16.46	
Grease	kg	20.52	
Compressor oil	lit	17.81	
Bitumen	ton	5,500.00	
Explosive	kg	135.00	
Detonator	p.c.	30.00	
Detonator, delay	p.c	46.68	
Timber, square	m^3	4,600.00	
Timber, plane	m^3	5,500.00	
Timber, log	m^3	2,900.00	
Playwood	m^3	20,000.00	Including sales tax
Structural steel, channel	ton	18,750.00	
Structural steel, angle	ton	17,500.00	
Wire	kg	27.00	
Nail	kg	14.00	
Sand	ton	20.60	Ex-quarry
Aggregate	ton	200 ~ 230	Ex-quarry
Crusher-run	ton	200.00	Ex-quarry
Asphalt mixture	ton	2,200.00	

Remarks: Above cost is based on the Supplier's price at Nairobi.
Transportation cost shall be added to the above cost.

Table 7.6 Construction Cost Estimate, Malewa Dam Scheme

Description	Foreign Currency Portion (US$10^3)	Local Currency Portion (Kshs.10^3)	Total (Kshs. 10^3)
(1) Direct Construction Cost			
1.1 Preparatory works	2,564	30,098	87,792
1.2 Diversion tunnel	2,155	11,615	60,094
1.3 Coffer dam	1,688	5,389	43,362
1.4 Main dam	14,037	47,986	363,824
1.5 Spillway	7,233	60,575	223,325
1.6 Trans-basin diversion tunnel	2,270	12,489	63,557
Sub-total for (1)	29,947	168,152	841,954
(2) Indirect Construction Cost			
2.1 Land compensation & acquisition	0	8,155	8,155
2.2 Government administration	0	25,259	25,259
2.3. Engineering services	2,395	13,469	67,356
Sub-total for (2)	2,395	46,883	100,770
(3) Contingency			
3.1 Physical contingency	3,234	21,504	94,272
3.2 Price escalation	5,912	112,549	245,580
Sub-total for (3)	9,146	134,053	339,852
Total	41,488	349,088	1,282,568

Table 7.7 Construction Cost Estimate, Water Supply Scheme, Stage 2-1 (1/3)

Description	Foreign Currency Portion (US$10^3)	Local Currency Portion (Kshs.10^3)	Total (Kshs. 10^3)
(1) Direct Construction Cost			
1.1 Preparatory works	2,854	17,227	81,442
1.2 Raw water transmission system	4,520	19,242	120,942
1.3 Water treatment works	10,148	86,784	315,114
1.4 Nakuru treated water transmission system	17,985	83,836	488,499
1.5 Naivasha treated water transmission system	5,117	23,189	138,322
1.6 Gilgil East rural supply system	709	6,566	22,518
1.7 Gilgil West rural supply system	577	7,305	20,287
1.8 Eburru rural supply system	1,666	18,792	56,277
1.9 KMB bulk supply system	43	359	1,326
1.10 GMB-NYSTC bulk supply system	6	28	163
1.11 ASTU bulk supply system	0	0	0
Sub-total for (1)	43,625	263,328	1,244,890
(2) Indirect Construction Cost			
2.1 Land acquisition and compensation	0	1,190	1,190
2.2 Government administration	0	37,384	37,384
2.3 Engineering services	3,490	21,066	99,591
Sub-total for (2)	3,490	59,640	138,165
(3) Contingency			
3.1 Physical contingency	4,363	26,333	124,501
3.2 Price escalation	8,215	162,215	347,053
Sub-total for (3)	12,578	188,548	471,554
Total	59,693	511,516	1,854,609

Table 7.7 Construction Cost Estimate, Water Supply Scheme, Stage 2-2 (2/3)

Description	Foreign Currency Portion (US$10^3)	Local Currency Portion (Kshs.10^3)	Total (Kshs. 10^3)
(1) Direct Construction Cost			
1.1 Preparatory works	2,312	13,065	65,085
1.2 Raw water transmission system	3,716	15,468	99,078
1.3 Water treatment works	5,229	44,795	162,448
1.4 Nakuru treated water transmission system	17,416	77,545	469,405
1.5 Naivasha treated water transmission system	3,613	15,697	96,989
1.6 Gilgil East rural supply system	709	6,566	22,518
1.7 Gilgil West rural supply system	577	7,305	20,287
1.8 Eburu rural supply system	1,666	18,792	56,277
1.9 KMB bulk supply system	0	0	0
1.10 GMB-NYSTC bulk supply system	0	0	0
1.11 ASTU bulk supply system	97	472	2,655
Sub-total for (1)	35,335	199,705	994,742
(2) Indirect Construction Cost			
2.1 Land acquisition and compensation	0	810	810
2.2 Government administration	0	29,867	29,867
2.3 Engineering services	2,827	15,976	79,584
Sub-total for (2)	2,827	46,653	110,261
(3) Contingency			
3.1 Physical contingency	3,534	19,970	99,485
3.2 Price escalation	16,622	278,271	652,266
Sub-total for (3)	20,156	298,241	751,751
Total	58,318	544,599	1,856,754

Table 7.7 Construction Cost Estimate, Water Supply Scheme, Stage 2-3 (3/3)

Description	Foreign Currency Portion (US$10^3)	Local Currency Portion (Kshs.10^3)	Total (Kshs. 10^3)
(1) Direct Construction Cost			
1.1 Preparatory works	456	3,936	14,196
1.2 Raw water transmission system	0	0	0
1.3 Water treatment works	4,912	42,709	153,229
1.4 Nakuru treated water transmission system	1,420	12,009	43,959
1.5 Naivasha treated water transmission system	179	1,513	5,541
1.6 Gilgil East rural supply system	0	0	0
1.7 Gilgil West rural supply system	0	0	0
1.8 Eburu rural supply system	0	0	0
1.9 KMB bulk supply system	0	0	0
1.10 GMB-NYSTC bulk supply system	0	0	0
1.11 ASTU bulk supply system	0	0	0
Sub-total for (1)	6,967	60,167	216,925
(2) Indirect Construction Cost			
2.1 Land acquisition and compensation	0	380	380
2.2 Government administration	0	6,519	6,519
2.3 Engineering services	557	4,813	17,346
Sub-total for (2)	557	11,712	24,245
(3) Contingency			
3.1 Physical contingency	697	6,017	21,700
3.2 Price escalation	4,925	123,688	234,500
Sub-total for (3)	5,622	129,705	256,200
Total	13,146	201,584	497,370

Table 7.8 Disbursement Schedule of Initial Cost

(Unit:1000Kshs.)

Description	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
(A) Initial Cost																					
1) Foreign Currency																					
Malewa Dam and Diversion Tunnel	6404	14408	6404	180903	217725	338595	36021														
Raw Water Transmission System	1058	2273	1058	8483	29700	85208	698		855	1868	855	7178	29025	65768							
Water Treatment Works	2340	5063	2363	69300	104378	103388	1463		1193	2610	1193	42458	53798	47250		1148	2453	1148	39893	50535	44415
Nakuru Treated Water Transmission System	4140	9000	4140	167310	274005	49703	2610		4028	8730	4028	33705	222233	222075		338	720	315	2723	28665	7538
Naivasha Treated Water Transmission System	1170	2565	1170	9608	52628	77445	743		833	1823	833	6975	10328	81833		45	90	45	338	68	4500
KMB Bulk Water Supply System	0	23	0	90	23	1080	0														
NYSTC & GMB Bulk Water Supply System	2	3	1	12	2	159	1														
ASTU Bulk Water Supply System									23	45	23	203	1958	495							
Gilgil East Rural Water Supply System	158	360	158	1328	7290	10733	113		158	360	180	1373	7313	10800							
Gilgil West Rural Water Supply System	135	293	113	1080	5918	8753	90		135	293	135	1103	5940	8798							
Eburu Rural Water Supply System	383	833	383	3128	17145	25223	248		383	833	383	3218	17145	25380							
Price Contingency	474	2121	1464	55380	112896	135892	9652	0	2070	4950	2520	34650	135608	194220	0	720	1665	810	24503	47543	35573
Total	16264	36942	17254	496622	821710	836179	51639		9675	21510	10148	130860	483345	656618	0	2250	4928	2318	67455	126810	92025
2) Local Currency																					
Malewa Dam and Diversion Tonnel	3075	6387	3075	70962	57479	81369	14192														
Raw Water Transmission System	664	1205	664	2099	6218	16899	501		541	1000	573	2022	6179	12487							
Water Treatment Works	2106	3956	2106	27727	41228	41324	1447		1086	2041	1138	17296	21801	18516		1029	1935	1079	16482	20773	17648
Nakuru Treated Water Transmission System	2745	5005	2745	36917	59240	13438	2049		2606	4742	2758	9996	47826	45452		293	551	308	1508	11176	2985
Naivasha Treated Water Transmission System	771	1405	772	2591	11305	16491	578		536	973	567	2077	2800	16113		37	70	39	198	78	1707
KMB Bulk Water Supply System	9	16	9	50	16	408	7														
NYSTC & GMB Bulk Water Supply System	1	2	1	11	3	33	1														
ASTU Bulk Water Supply System									15	28	16	66	447	120							
Gilgil East Rural Water Supply System	155	290	154	661	3116	4563	105		154	291	162	733	3188	4516							
Gilgil West Rural Water Supply System	154	293	153	702	3439	5045	100		154	293	159	766	3504	5008							
Eburu Rural Water Supply System	410	780	410	1853	8876	13005	271		410	780	428	2025	9055	12897							
Price Contingency	807	3218	2620	51756	89604	113017	13742		3961	8102	5104	33589	98593	128922		1741	3475	2052	27646	51245	37530
Total	10897	22557	12709	195329	280524	305592	32993		9463	18250	10905	68570	193393	244031	0	3100	6031	3478	45834	83272	59870
3) Total Cost																					
Malewa Dam and Diversion Tonnel	9479	20795	9479	251865	275204	419964	50213	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Raw Water Transmission System	1722	3478	1722	10582	35918	102107	1199	0	1396	2868	1428	9200	35204	78255	0	0	0	0	0	0	0
Water Treatment Works	4446	9019	4469	97027	145606	144712	2910	0	2279	4651	2331	59754	75599	65766	0	2177	4388	2227	56375	71308	62063
Nakuru Treated Water Transmission System	6885	14005	6885	204227	333245	63141	4659	0	6634	13472	6786	43701	270059	267527	0	631	1271	623	4231	39841	10523
Naivasha Treated Water Transmission System	1941	3970	1942	12199	63933	93936	1321	0	1369	2796	1400	9052	13128	97946	0	82	160	84	536	146	6207
KMB Bulk Water Supply System	9	39	9	140	39	1488	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYSTC & GMB Bulk Water Supply System	3	5	2	23	6	191	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ASTU Bulk Water Supply System	0	0	0	0	0	0	0	0	38	73	39	269	2405	615	0	0	0	0	0	0	0
Gilgil East Rural Water Supply System	313	650	312	1989	10406	15296	218	0	312	651	342	2106	10501	15316	0	0	0	0	0	0	0
Gilgil West Rural Water Supply System	289	586	266	1782	9357	13798	190	0	289	586	294	1869	9444	13806	0	0	0	0	0	0	0
Eburu Rural Water Supply System	793	1613	793	4981	26021	38228	519	0	793	1613	811	5243	26200	38277	0	0	0	0	0	0	0
Price Contingency	1281	5339	4084	107136	202500	248909	23394	0	6031	13052	7624	68239	234201	323142	0	2461	5140	2862	52149	98788	73103
Total	27161	59499	29963	691951	1102234	1141771	84632	0	19138	39760	21053	199430	676738	900649	0	5350	10959	5796	113289	210082	151895

Table 7.9 O & M and Replacement Cost (1/2)

(Unit:1000Kshs.)

Description	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
(1) O & M Cost																					
Malewa Dam and Diversion Tunnel							1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
Raw Water Transmission System							90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
Water Treatment Works							8627	9281	9957	10634	11451	12292	13131	14343	15282	16286	17290	18457	19460	20791	20791
Nakuru Ttreated Water Transmission System							304	316	328	341	356	371	387	630	637	646	654	664	673	684	684
Naivasha Ttreated Water Transmission System							34	34	34	34	34	34	34	58	58	58	58	58	58	58	81
KMB Bulk Water Supply System							43	43	43	43	43	43	43	43	43	43	43	43	43	43	43
NYSTC GMB Bulk Water Supply System							7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
ASTU Bulk Water Supply System														92	92	93	93	94	95	95	95
Gilgil East Rural Water Supply System							328	345	362	380	401	423	445	601	611	623	635	649	661	677	677
Gilgil West Rural Water Supply System							46	47	49	50	52	54	56	70	70	71	72	74	75	76	76
Eburu Rural Water Supply System							1324	1406	1488	1570	1673	1776	1879	2624	2671	2729	2786	2853	2910	2987	2987
Sub-total	0	0	0	0	0	0	11901	12668	13458	14248	15207	16189	17171	19657	20662	21745	22828	24088	25171	26608	26631
Price contingency							8495	10780	13445	16513	20251	24578	29527	38079	44881	52752	61637	72169	83461	97410	107423
Total	0	0	0	0	0	0	20396	23448	26903	30761	35458	40767	46698	57735	65543	74498	84465	96257	108632	124018	134054
(2) Replacement Cost																					
Malewa Dam and Diversion Tunnel																					
Raw Water Transmission System																					
Water Treatment Works																					
Nakuru Ttreated Water Transmission System																					
Naivasha Ttreated Water Transmission System																					
KMB Bulk Water Supply System																					
NYSTC GMB Bulk Water Supply System																					
ASTU Bulk Water Supply System																					
Gilgil East Rural Water Supply System																					
Gilgil West Rural Water Supply System																					
Eburu Rural Water Supply System																					
Price contingency																					
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 7.9 O & M and Replacement Cost (2/2)

(Unit:1000Kshs.)

Description	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
(1) O & M Cost																				
Malewa Dam and Diversion Tunnel	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
Raw Water Transmission System	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
Water Treatment Works	20791	20791	20791	20791	20791	20791	20791	20791	20791	20791	20791	20791	20791	20791	20791	20791	20791	20791	20791	20791
Nakuru Ttreated Water Transmission System	684	684	684	684	684	684	684	684	684	684	684	684	684	684	684	684	684	684	684	684
Naivasha Ttreated Water Transmission System	81	81	81	81	81	81	81	81	81	81	81	81	81	81	81	81	81	81	81	81
KMB Bulk Water Supply System	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43
NYSTC GMB Bulk Water Supply System	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
ASTU Bulk Water Supply System	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95
Gilgil East Rural Water Supply System	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677
Gilgil West Rural Water Supply System	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76
Eburu Rural Water Supply System	2987	2987	2987	2987	2987	2987	2987	2987	2987	2987	2987	2987	2987	2987	2987	2987	2987	2987	2987	2987
Sub-total	26631	26631	26631	26631	26631	26631	26631	26631	26631	26631	26631	26631	26631	26631	26631	26631	26631	26631	26631	26631
Price contingency	118148	129730	142239	155748	170338	186096	203114	221494	241344	262781	285934	310940	337945	367111	398611	432630	469371	509051	551905	598188
Total	144778	156360	168869	182379	196969	212726	229745	248124	267974	289412	312565	337570	364576	393742	425241	459260	496001	535681	578536	624819
(2) Replacement Cost																				
Malewa Dam and Diversion Tunnel																				
Raw Water Transmission System																				
Water Treatment Works						31500							16200							765
Nakuru Ttreated Water Transmission System						10350							7268							225
Naivasha Ttreated Water Transmission System						1710							698							28
KMB Bulk Water Supply System						135														
NYSTC GMB Bulk Water Supply System						23														
ASTU Bulk Water Supply System													765							
Gilgil East Rural Water Supply System						4343														
Gilgil West Rural Water Supply System						945														
Eburu Rural Water Supply System						12623														
Price contingency						75265							43176							2403
Total	0	0	0	0	0	136892	0	0	0	0	0	0	68106	0	0	0	0	0	0	3421

Table 8.1 General Characteristics of Lakes Naivasha and Nakuru

Descriptions	Unit	Lake Naivasha	Lake Nakuru
(a) Water level fluctuation			
Recording period		(1961-84)	(1959-82)
- Maximum	El. m	1,886.9	1,760.6
- Minimum	El. m	1,883.2	1,756.3
- Average	El. m	1,885.3	1,758.6
- Existing in July, 1990	El. m	1,884.6	1,758.5
(b) Maximum water depth at average level			
- Crescent Island Bay	m	13	2.3
- Main lake	m	8	43
(c) Lake surface area at average level	sq.km	190	72
(d) Water volume at average level	10^6 cu.m	760	
(e) Average inflow by river	cu.m/s	7.6 (Malewa)	0.8 (Enjoro)
	cu.m/s	0.3 (Gilgil)	0.4 (Others)
(f) Average annual rainfall on the lake	mm	670	
(g) Average evaporation	mm	1,900	900
(h) Average temperature	℃	??	17

Table 8.2 Summary of Water Quality Analysis

Items	Unit	Malewa River		Lake Naivasha				Small Lake	Lake Nakuru				Town Works		Njoro Works	
				Upper Layer		Lower Layer			Upper Layer		Lower Layer					
		Observed Range	Average	Observed Range	Average	Observed Range	Average		Observed Range	Average	Observed Range	Average	Before Treatmen	After Treatmen	Before Treatmen	After Treatmen
(a) Color		Color No.16-18		Color No. 15 - 17					Color No.18-21							
(b) Transparency				0.7 - 1.0					0.2 - 0.5							
(c) Temparature	deg. cent	14.3 - 18.5	16.8	20.1 - 21.2	20.7	19.8 - 20.7	20.3		24.2- 26.8	25.7	20.5- 25.1	21.7				
(d) pH		7.78 - 8.24	8.04	8.31 - 9.03	8.68	8.41 - 9.04	8.67	9.64	10.34- 10.62	10.42	10.36- 10.72	10.45	7.5	7.6	7.4	8.7
(e) Conductivity	s/cm	110- 240	157	250 - 300	275	270 - 300	278	1310	16960- 17760	17564	16900- 17760	17516	990	960	1060	1250
(f) SS				10 - 15	13	10 -1 5	13	43	13-69	24	11 - 47	19	580	136	483	36
(g) Turbidity	mg/l	14- 70	34										165	51	230	19
(h) DO	mg/l	6.8-8.4	7.2	7.4-11.1	8.3	6.6 - 8.8	7.8		6.3-13.2	9.7	1.8-13.7	5.5	0.8	0.8	1.2	6.9
(i) COD	mg/l	4 - 15	9	29 - 61	39	32 - 55	39	123	179-197	191	185-197	191	364	201	128	196
(j) NO3-N	mg/l	0.10- 1.2	0.89	0.50 - 0.9	0.89	0.50 - 1.1	0.8		15.5- 25	18.5	14.6- 18.9	17	33	20	40	4
No2-N	mg/l	0.001 - 0.04	0.021	0.009 - 0.015	0.011	0.010 - 0.015	0.11		0.019- 0.044	0.026	0.07- 0.04	0.024	0.3	0.1	0.3	0.002
T-N	mg/l	2.260 - 3.577	3.088			0.001 - 0.08	0.05		33.2 - 34.2	33.8	27.8 -29.3	28.6	107	79	117	24
PO4-P	mg/l	0.04- 0.13	0.1	0.02 - 0.1	0.05	0.01 - 0.08	0.05	0.78	1.28- 1.82	1.55	1.00- 2.1	1.68	36	23	51	36

Table 8.3 Aquatic Animals in Study Area

	Malewa River		Lake Naivasha		Lake Nakuru	
	Scientific Name	Common Name	Scientific Name	Common Name	Scientific Name	Common Name
Fish	Salmo gairdneri	Rainbow trout	Tilapia zillii	Tilapia	Alcalicus grahami	Tilapia
	Barbus amphigramma	Barbus	Oreochromis leucosticus	Tilapia		
			Micropterus salmoides	Black bass		
			Lebistes reticulata	Unknown		
			Barbus amphigramma	Barbus		
Invertebrate	Turbellaria	Planarian	Branchiura sowerbyi	Aquatic earthworm	———	———
	Oligochaeta	Earthworm	Limnodrilus hoffmeristeri	Aquatic earthworm		
	Decapoda	Crab	Chironomus	Midge		
	Procambarus clakii	Crayfish	Foraosipiennis	Midge		
	Ephemeroptera	Mayfly	Chironomidae			
	Anisoptera	Dragonfly	Procambarus clakii	Crayfish		
	Zygoptera	Dameselfly	Cladocera			
	Plecoptera	Stonefly	Ostracoda			
	Tricoptera	Caddisfly	Hemiptera			
	Coleoptera	Beetle	Chironomidae	Midge		
	Chironomidae	Midge	Culicidae	Mosquito		
			Ephemeroptera	Mayfly		
			Odonata	Dragonfly		
			Coleoptera	Beetle		
			Mollusca	Shellfish		
			Tridadida	Planarian		
			Micronecta spp.			
			Alma emini			

Source: Fisheries Department Naivasha 1989
Harper 1984, Mavuti 1981

Note: For Lake Nakuru, no detailed data and information are so far made available.

Table 8.4 Terrestrial Animals in Study Area

	Malewa River Basin		Lake Naivasha		Lake Nakuru	
	Scientific Name	Common Name	Scientific Name	Common Name	Scientific Name	Common Name
Mammals	Equus burchelli	Burchell's zebra	Syncerus caffer	African buffalo	Kobus ellipsiprymnus	Waterbuck
	Tragelaphus oryx	Eland	Hippopotamus amphibius	Hippopotamus	Aepyceros melampus	Impala
	Aepyceros melampus	Impala	Giraffa camelopardalis	Giraffe	Phacochoerus	Warthog
	Gazella thomsoni	Thomson's gazelle	Equus burchelli	Burchell's zebra	Syncerus	Buffalo
	Panthera pardus	Leopard	Alcelaphus buselaphus cokii	Coke's hartebeest	G. thomsoni	Gazella (Thomsons)
	Acinonyx jubatus	Cheetah	Connochaetes taurinus	Brindled gnu	G. granti	Gazelle (Grant)
	Lepus capensis	Cape hare	Tragelaphus oryx	Eland	Redunca fulvorufula	Reedbuck Mountain
	Herpestinae	Mongooses	Kobus ellipsiprymnus	Defassa waterback	Hippopotamus amphibius	Hippopotamus
			Aepyceros melampus	Impala	Aonyx capensis	Cape Clawless Otters
			Gazella thomsoni	Thomson's gazelle		
			Gazella granti	Grant's gazelle		
			Hyena hyaena	Striped hyaena		
			Cercop ithecus aethiops	Black-faced vervet		
			Hystrix cristata	North African crested porcupine		
			Heterohyrax brucei	Rock hyrax		
			Lepus capensis	Cape hare		
			Myocastor coypus	Coypu		
			Chiroptera	Bats		
Birds	Threskiornithidae	Ibises	Palecanus rufescens	White pelican	Pelecanus onocrotalus	White Pelican
	Turnicidae	Button quails	Phalacrocorax africanus	Long-tailed cormorant	Phoenicopterus minor	Lesser Flamingo
	Columbidae	Pigeons	Phalacrocorax carbo	White-necked cormorant	Chlidonias leucoptera	White Winged Black Tern
	Bucerotidae	Hombills	Podiceps ruficollis	Little grebe	Larus cirrocephalus	Grey-Headed Gull
	Apodidae	Swifts	Egretta garzetta	Little egret	Phoenicopterus ruber	Greater Flamingo
	Hirundinidae	Swallows	Egretta intermedia	Yellow-billed egret	Ibis ibis	Yellow-Billed Stork
	Lanidae	Shrikes	Ardea goliath	Goliath heron	Himantopus himantopus	Black-Winged Stilt
	Nectariniidae	Sunbirds	Threskiornis aethiopicus	Sacred ibis	Pelecanus rutescens	Pink-Backed Pelican
	Sturnidae	Starligs	Hagedashia hagedash	Hadada ibis	Gelochelidon nilotica	Gull-Billed Tern
	Garvus albus	Pied crow	Plegadis falcinellus	Glossy ibis	Podiceps ruticollis	Little Grebe
			Ibis ibis	Yellow-billed stock	Platalea alba	African Spoon Bill
			Platalea alba	African spoonbill	Alopochen aegyptiaca	Egyptian Goose
			Leptoptilos crumeniferus	Marabou stork	Vanellus armatus	Blacksmith Plover
			Oxyura maccoa	Maccoa duck		
			Athya erythrophthalma	African pochard		
			Anas hottentota	Hottentot teal		
			Anas undulata	Yellow-billed duck		
			Plectopterus gambensis	Spurwing goose		
			Alopochen aegyptiaca	Egyptian goose		
			Dendrocygna viduata	Fulvous tree duck		
			Haliaeetus vocifer	African fish eagle		
			Buteo rufofuscus	Augur buzzard		
			Porphyrio porphyrio	Purple gallinule		
			Fulica cristata	Red-knobbed coot		
			Balearica regulorum	Crowned crane		
			Vanellus armatus	Blacksmith plover		
			Gallinago nigripennis	African snipe		
			Actophilornis africanus	African jacana		
			Larus cirrocephalus	Grey-headed gull		
			Ceryle rudis	Pied kingfisher		
			Motacilla aguimp	Africana pied wagtail		
Reptiles	Bitis arletans	Puff adder	Bitis arletans	Puff adder		
	Dendroaspis polylepis	Black mamba	Dendroaspis polylepis	Black mamba		
	Python sabae	African python	Phthon sabae	African Python		
			Lacertilia	A kind of lizard		
Amphibians	Pipidae	Clawed toads	Anura	Tree frog		
	Ranidae	True frogs				
Source:	Ase 1987	Wildlife Training School, Naivasha	Nakuru National Park Warden 1990			

Table 8.5 Total Survey Area around Lake Naivasha (Acres)

Compass direction	Farm Land				Fodder Crops			Horticultural Crops								
	Holding area	Cultivated area	Irrigated area	Non Irrigated	Lucern	Pasture	Maize	Aspara carrots	French beans	Cabbegs	Grapes	Oranges	Straw-berries	Apples	Flower Bulbs	Cut-flowers
Eastern	3,123	1,303	1,018	285	66	185	111	142	212	121	65	32	43	16	12	13
Western	22,074	1,265	1,257	8	120	230	475	110	39	3		10	50			220
Southern	11,258	1,289	1,289			87		20							4	1,178
Northern	8,764	3,574	3,344	230	685	863	721	339	282	215	1	19		15	1	203
	45,219	7,431	6,908	523	871	1,365	1,307	611	533	339	66	61	93	31	17	1,614

Table 10.1 Economic Cost Stream (1/3)

(Unit:1000Kshs.)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
(A) Initial Cost																					
1) Foreign Currency (Economic Cost)																					
Malewa Dam and Diversion Tunnel	6404	14408	6404	180903	217725	338595	36021														
Raw Water Transmission System	1058	2273	1058	8483	29700	85208	698		855	1868	855	7178	29025	65768							
Water Treatment Works	2340	5063	2363	69300	104378	103388	1463		1193	2610	1193	42458	53798	47250		1148	2453	1148	39893	50535	44415
Nakuru Ttreated Water Transmission System	4140	9000	4140	167310	274005	49703	2610		4028	8730	4028	33705	222233	222075		338	720	315	2723	28665	7538
Naivasha Ttreated Water Transmission System	1170	2565	1170	9608	52628	77445	743		833	1823	833	6975	10328	81833		45	90	45	338	68	4500
KMB Bulk Water Supply System	0	23	0	90	23	1080	0														
NYSTC & GMB Bulk Water Supply System	2	3	1	12	2	159	1														
ASTU Bulk Water Supply System									23	45	23	203	1958	495							
Gilgil East Rural Water Supply System	158	360	158	1328	7290	10733	113		158	360	180	1373	7313	10800							
Gilgil West Rural Water Supply System	135	293	113	1080	5918	8753	90		135	293	135	1103	5940	8798							
Eburru Rural Water Supply System	383	833	383	3128	17145	25223	248		383	833	383	3218	17145	25380							
Sub-total	15788	34819	15788	441240	708812	700284	41984	0	7605	16560	7628	96210	347738	462398	0	1530	3263	1508	42953	79268	56453
2) Local Currency (Financial Cost)																					
Malewa Dam and Diversion Tunnel	3075	6387	3075	70962	57479	81369	14192														
Raw Water Transmission System	664	1205	664	2099	6218	16899	501		541	1000	573	2022	6179	12487							
Water Treatment Works	2106	3956	2106	27727	41228	41324	1447		1086	2041	1138	17296	21801	18516		1029	1935	1079	16482	20773	17648
Nakuru Ttreated Water Transmission System	2745	5005	2745	36917	59240	13438	2049		2606	4742	2758	9996	47826	45452		293	551	308	1508	11176	2985
Naivasha Ttreated Water Transmission System	771	1405	772	2591	11305	16491	578		536	973	567	2077	2800	16113		37	70	39	198	78	1707
KMB Bulk Water Supply System	9	16	9	50	16	408	7														
NYSTC & GMB Bulk Water Supply System	1	2	1	11	3	33	1														
ASTU Bulk Water Supply System									15	28	16	66	447	120							
Gilgil East Rural Water Supply System	155	290	154	661	3116	4563	105		154	291	162	733	3188	4516							
Gilgil West Rural Water Supply System	154	293	153	702	3439	5045	100		154	293	159	766	3504	5008							
Eburru Rural Water Supply System	410	780	410	1853	8876	13005	271		410	780	428	2025	9055	12897							
Sub-total	10090	19339	10089	143573	190920	192575	19251	0	5502	10148	5801	34981	94800	115109	0	1359	2556	1426	18188	32027	22340
Financial Cost to be subtracted																					
Land compensation & aquisition in the reservoir area				6524	1631																
Unskilled labour				32169	44219	46747	1806					6040	29220	41720					3000	5790	4230
Cement				106	353	577	408					35	93	104					46	88	66
3) Local Currency (Economic Cost)																					
Economic Cost except the land, unskilled labour & cement	8035	15399	8034	83431	115238	115663	13566	0	4381	8081	4619	23018	52147	58357	0	1082	2035	1136	12058	20822	14368
Economic Cost to be added																					
Land in the reservoir area (production foregone)				969																	
Unskilled labour				22518	30953	32723	1264					4228	20454	29204					2100	4053	2961
Cement				71	237	387	273					23	62	70					31	59	44
Sub-total after adjustment	8035	15399	8034	106989	146428	148772	15104	0	4381	8081	4619	27269	72663	87630	0	1082	2035	1136	14188	24934	17374
4) Economic Cost of Initial Cost (1) + 3))	23823	50218	23822	548230	855240	849056	57088	0	11986	24641	12247	123479	420401	550028	0	2612	5298	2643	57141	104202	73826

Note: Figure of total or sub-total does not necessarily coincide with the sum of figures of each item.

Table 10.1 Economic Cost Stream (2/3)

(Unit:1000Ksh.)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
(B) O & M Cost																					
Financial Cost																					
Malewa Dam and Diversion Tunnel							1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
Raw Water Transmission System							90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
Water Treatment Works							8627	9281	9957	10634	11451	12292	13131	14343	15282	16286	17290	18457	19460	20791	20791
Nakuru Ttreated Water Transmission System							304	316	328	341	356	371	387	630	637	646	654	664	673	684	684
Naivasha Ttreated Water Transmission System							34	34	34	34	34	34	34	58	58	58	58	58	58	58	81
KMB Bulk Water Supply System							43	43	43	43	43	43	43	43	43	43	43	43	43	43	43
NYSTC & GMB Bulk Water Supply System							7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
ASTU Bulk Water Supply System														92	92	93	93	94	95	95	95
Gilgil East Rural Water Supply System							328	345	362	380	401	423	445	601	611	623	635	649	661	677	677
Gilgil West Rural Water Supply System							46	47	49	50	52	54	56	70	70	71	72	74	75	76	76
Eburru Rural Water Supply System							1324	1406	1488	1570	1673	1776	1879	2624	2671	2729	2786	2853	2910	2987	2987
Sub-total	0	0	0	0	0	0	11901	12668	13458	14248	15207	16189	17171	19657	20662	21745	22828	24088	25171	26608	26631
Economic Cost	0	0	0	0	0	0	9477	10088	10717	11346	12110	12891	13673	15653	16453	17316	18178	19181	20044	21188	21206
(C) Replacement Cost																					
Malewa Dam and Diversion Tunnel																					
Raw Water Transmission System																					
Water Treatment Works																					
Nakuru Treated Water Transmission System																					
Naivasha Ttreated Water Transmission System																					
KMB Bulk Water Supply System																					
NYSTC & GMB Bulk Water Supply System																					
ASTU Bulk Water Supply System																					
Gilgil East Rural Water Supply System																					
Gilgil West Rural Water Supply System																					
Eburru Rural Water Supply System																					
Sub-total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(E) Total of Project Cost	**23823**	**50218**	**23822**	**548230**	**855240**	**849056**	**66565**	**10088**	**22703**	**35987**	**24356**	**136371**	**434074**	**565680**	**16453**	**19928**	**23476**	**21824**	**77185**	**125390**	**95032**
(F) Associated Cost																					
Reticulation System																					
1) Initial Cost																					
a. Foreign Currency																					
Nakuru				12105	7268	4860						17010	10215	6795							
Naivasha				2115	1260	833						1238	743	495							
Gilgil						3544						7155	4298	3236							
Indirect cost	68	158	68	135	293	338	90		113	270	113	248	518	608	158						
Physical Contingency				720	428	293						1260	765	518							
Sub-total	68	158	68	15075	9248	9866	90	0	113	270	113	26910	16538	11651	158						
b. Local Currency (Financial Cost)																					
Nakuru				36127	21676	14451						38619	23171	15448							
Naivasha				7995	4797	3198						4740	2844	1896							
Gilgil					130	802						2628	1592	1156							
Indirect cost	405	740	528	687	1372	1374	175		444	809	582	762	1520	1489	214						
Physical Contingency				2205	1324	882						2299	1380	920							
Sub-total	405	740	528	47014	29299	20707	175	0	444	809	582	49048	30507	20909	214						
c. Local Currency (Economic Cost)																					
Financial Cost to be subtracted																					
Unskilled labour				20740	12440	8290						21620	12970	8640							
Economic Cost except Unskilled Labour	323	589	420	20922	13425	9887	139	0	354	644	463	21841	13964	9769	170						
Economic Cost to be added																					
Unskilled labour				14518	8708	5803						15134	9079	6048							
Sub-total	323	589	420	35440	22133	15690	139	0	354	644	463	36975	23043	15817	170						
d. Sub-total (a. + c.)	390	747	488	50515	31380	25557	229	0	466	914	576	63885	39581	27468	328						
2) O & M Cost																					
Financial Cost							140	146	153	160	167	176	182	293	297	304	308	315	320	329	329
Economic Cost	0	0	0	0	0	0	111	116	122	127	133	140	145	233	237	242	245	251	254	262	262
3) Sub-total	390	747	488	50515	31380	25557	340	116	588	1041	709	64025	39726	27701	564	242	245	251	254	262	262
(G) Total Economic Cost	**24213**	**50965**	**24310**	**598745**	**886620**	**874612**	**66906**	**10204**	**23291**	**37028**	**25065**	**200395**	**473800**	**593381**	**17017**	**20170**	**23721**	**22075**	**77439**	**125651**	**95293**

Note: Figure of total or sub-total does not necessarily coincide with the sum of figures of each item.

Table 10.1 Economic Cost Stream (3/3)

(Unit:1000Kshs.)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
(B) O & M Cost																				
Financial Cost																				
Malewa Dam and Diversion Tunnel	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
Raw Water Transmission System	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
Water Treatment Works	20791	20791	20791	20791	20791	20791	20791	20791	20791	20791	20791	20791	20791	20791	20791	20791	20791	20791	20791	20791
Nakuru Ttreated Water Transmission System	684	684	684	684	684	684	684	684	684	684	684	684	684	684	684	684	684	684	684	684
Naivasha Ttreated Water Transmission System	81	81	81	81	81	81	81	81	81	81	81	81	81	81	81	81	81	81	81	81
KMB Bulk Water Supply System	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43
NYSTC & GMB Bulk Water Supply System	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
ASTU Bulk Water Supply System	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95
Gilgil East Rural Water Supply System	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677
Gilgil West Rural Water Supply System	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76
Eburru Rural Water Supply System	2987	2987	2987	2987	2987	2987	2987	2987	2987	2987	2987	2987	2987	2987	2987	2987	2987	2987	2987	2987
Sub-total	26631	26631	26631	26631	26631	26631	26631	26631	26631	26631	26631	26631	26631	26631	26631	26631	26631	26631	26631	26631
Economic Cost	21206	21206	21206	21206	21206	21206	21206	21206	21206	21206	21206	21206	21206	21206	21206	21206	21206	21206	21206	21206
(C) Replacement Cost																				
Malewa Dam and Diversion Tunnel																				
Raw Water Transmission System																				
Water Treatment Works						31500							16200							765
Nakuru Ttreated Water Transmission System						10350							7268							225
Naivasha Ttreated Water Transmission System						1710							698							28
KMB Bulk Water Supply System						135														
NYSTC & GMB Bulk Water Supply System						23														
ASTU Bulk Water Supply System													765							
Gilgil East Rural Water Supply System						4343														
Gilgil West Rural Water Supply System						945														
Eburru Rural Water Supply System						12623														
Sub-total	0	0	0	0	0	61628	0	0	0	0	0	0	24930	0	0	0	0	0	0	1018
(E) Total of Project Cost	**21206**	**21206**	**21206**	**21206**	**21206**	**82833**	**21206**	**21206**	**21206**	**21206**	**21206**	**21206**	**46136**	**21206**	**21206**	**21206**	**21206**	**21206**	**21206**	**22224**
(F) Associated Cost																				

Table 10.2 Economic Benefit Stream (up to Year 2015)*

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1. Nakuru Municipality																			
1)Water Demand (1000m3/year)	15468	16408	17406	18460	19470	20535	21658	22843	24090	25422	26828	28312	29877	31533	33283	35130	37080	39138	41306
2)Total Sales Volume (1000m3/year)	15468	16408	17406	18460	19470	20535	21658	22843	24090	25422	26828	28312	29877	31533	33283	35130	37080	39138	41306
3)Sales Volume from Other Sources(1000m3/year)	5977	5977	5977	5977	5977	5977	5977	5977	5977	5977	5977	5977	5977	5977	5977	5977	5977	5977	5977
4)Incremental Sales Volume (1000m3/year)	9491	10431	11429	12483	13493	14558	15681	16866	18113	19445	20851	22335	23900	25556	27306	29153	31103	33161	35329
5)Adjustment by Regulation** (1000m3/year)	25266	25266	25266	25266	25266	25266	25266	25266	25266	25266	25266	25266	25266	25266	25266	25266	25266	25266	25266
6)Adjusted Incremental Volume (1000m3/year)	9491	10431	11429	12483	13493	14558	15681	16866	18113	19445	20851	22335	23900	25266	25266	25266	25266	25266	25266
Institutional	845	919	997	1076	1158	1244	1334	1429	1528	1632	1741	1856	1976	2079	2079	2079	2079	2079	2079
Commercial and Industrial	1981	2155	2337	2526	2721	2925	3140	3365	3586	3830	4086	4354	4636	4869	4869	4869	4869	4869	4869
Residential and Others	6665	7357	8095	8881	9614	10389	11207	12072	12999	13983	15024	16125	17288	18318	18318	18318	18318	18318	18318
2. Naivasha Town																			
1) Water Demand(1000m3/year)	3047	3209	3379	3559	3708	3864	4026	4195	4371	4554	4745	4944	5151	5366	5590	5825	6069	6323	6594
2)Total Sales Volume (1000m3/year)	3047	3209	3379	3559	3708	3864	4026	4195	4371	4554	4745	4944	5151	5366	5590	5825	6069	6323	6594
3)Sales Volume from Other Sources(1000m3/year)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4)Incremental Sales Volume (1000m3/year)	3047	3209	3379	3559	3708	3864	4026	4195	4371	4554	4745	4944	5151	5366	5590	5825	6069	6323	6594
5)Adjustment by Regulation** (1000m3/year)	5305	5305	5305	5305	5305	5305	5305	5305	5305	5305	5305	5305	5305	5305	5305	5305	5305	5305	5305
6)Incremental Adjusted Volume (1000m3/year)	3047	3209	3379	3559	3708	3864	4026	4195	4371	4554	4745	4944	5151	5305	5305	5305	5305	5305	5305
Institutional	1093	1152	1213	1278	1331	1386	1444	1504	1566	1632	1700	1771	1845	1901	1901	1901	1901	1901	1901
Commercial and Industrial	109	115	121	128	133	139	145	151	157	164	170	178	185	191	191	191	191	191	191
Residential and Others	1844	1943	2045	2154	2244	2340	2438	2541	2647	2759	2875	2995	3121	3214	3214	3214	3214	3214	3214
3. Gilgil Town																			
1) Water Demand(1000m3/year)	2358	2478	2604	2738	2886	3042	3206	3380	3562	3754	3958	4172	4397	4636	4888	5155	5435	5732	6044
2)Total Sales Volume (1000m3/year)	2358	2478	2604	2738	2886	3042	3206	3380	3562	3754	3958	4172	4397	4636	4888	5155	5435	5732	6044
3)Sales Volume from Other Sources(1000m3/year)	1718	1733	1748	1764	1781	1799	1818	1838	1858	1874	1890	1906	1923	1941	1941	1941	1941	1941	1941
4)Incremental Sales Volume (1000m3/year)	640	745	856	973	1104	1243	1388	1542	1703	1881	2068	2266	2474	2695	2948	3214	3495	3791	4103
5)Adjustment by Regulation** (1000m3/year)	2664	2664	2664	2664	2664	2664	2664	2664	2664	2664	2664	2664	2664	2664	2664	2664	2664	2664	2664
6)Incremental Adjusted Volume (1000m3/year)	640	745	856	973	1104	1243	1388	1542	1703	1881	2068	2266	2474	2664	2664	2664	2664	2664	2664
Institutional	261	304	349	396	447	501	558	617	679	747	818	893	972	1042	1042	1042	1042	1042	1042
Commercial and Industrial	20	24	27	31	35	39	43	48	52	57	63	68	74	79	79	79	79	79	79
Residential and Others	359	418	480	546	622	702	788	876	972	1076	1187	1305	1429	1544	1544	1544	1544	1544	1544
4. Gilgil Rural* **																			
1) Water Demand(1000m3/year)	506	524	543	563	580	599	618	637	657	677	698	719	741	763	788	814	841	869	897
2)Total Sales Volume (1000m3/year)	506	524	543	563	580	599	618	637	657	677	698	719	741	763	788	814	841	869	897
3)Sales Volume from Other Sources(1000m3/year)	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289
4)Incremental Sales Volume (1000m3/year)	217	235	254	274	291	310	329	348	368	388	409	430	452	475	500	525	552	580	608
5)Adjustment by Regulation** (1000m3/year)	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469
6)Incremental Adjusted Volume (1000m3/year)	217	235	254	274	291	310	329	348	368	388	409	430	452	469	469	469	469	469	469
5. Eburu Rural* **																			
1) Water Demand(1000m3/year)	726	757	788	821	855	890	926	964	1004	1045	1087	1132	1178	1226	1276	1329	1383	1440	1500
2)Total Sales Volume (1000m3/year)	726	757	788	821	855	890	926	964	1004	1045	1087	1132	1178	1226	1276	1329	1383	1440	1500
3)Sales Volume from Other Sources(1000m3/year)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4)Incremental Sales Volume (1000m3/year)	726	757	788	821	855	890	926	964	1004	1045	1087	1132	1178	1226	1276	1329	1383	1440	1500
5)Adjustment by Regulation** (1000m3/year)	1212	1212	1212	1212	1212	1212	1212	1212	1212	1212	1212	1212	1212	1212	1212	1212	1212	1212	1212
6)Incremental Adjusted Volume (1000m3/year)	726	757	788	821	855	890	926	964	1004	1045	1087	1132	1178	1212	1212	1212	1212	1212	1212
Total Incremental Volume (1000m3/year)	14121	15377	16707	18110	19452	20864	22351	23916	25559	27313	29160	31106	33155	35317	37620	40046	42602	45295	48134
Upper Limit of Supply(1000m3/year)	34916	34916	34916	34916	34916	34916	34916	34916	34916	34916	34916	34916	34916	34916	34916	34916	34916	34916	34916
Total Incremental Adjusted Volume (1000m3/year)																			
Institutional	2199	2374	2559	2749	2936	3131	3336	3550	3773	4011	4260	4520	4793	5021	5021	5021	5021	5021	5021
Commercial and Industrial	2111	2294	2486	2685	2889	3103	3328	3563	3795	4051	4319	4600	4894	5139	5139	5139	5139	5139	5139
Residential and Others (1)****	8868	9717	10620	11581	12480	13430	14433	15489	16618	17817	19086	20424	21838	23075	23075	23075	23075	23075	23075
Residential and Others (2)*****	943	992	1042	1095	1146	1200	1255	1313	1372	1433	1496	1562	1630	1681	1681	1681	1681	1681	1681
Unit Economic Benefit (Kshs./m3)																			
Institutional	6.91	6.91	6.91	6.91	6.91	6.91	6.91	6.91	6.91	6.91	6.91	6.91	6.91	6.91	6.91	6.91	6.91	6.91	6.91
Commercial and Industrial	22.82	22.82	22.82	22.82	22.82	22.82	22.82	22.82	22.82	22.82	22.82	22.82	22.82	22.82	22.82	22.82	22.82	22.82	22.82
Residential and Others (1)****	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70
Residential and Others (2)*****	4.55	4.55	4.55	4.55	4.55	4.55	4.55	4.55	4.55	4.55	4.55	4.55	4.55	4.55	4.55	4.55	4.55	4.55	4.55
Annual Benefits																			
Institutional	15195	16406	17682	18996	20286	21636	23049	24528	26075	27716	29435	31236	33121	34698	34698	34698	34698	34698	34698
Commercial and Industrial	48174	52357	56733	61270	65925	70810	75937	81317	86610	92443	98558	104968	111689	117267	117267	117267	117267	117267	117267
Residential and Others (1)****	50547	55389	60531	66012	71137	76553	82266	88287	94724	101559	108788	116416	124478	131528	131528	131528	131528	131528	131528
Residential and Others (2)*****	4292	4513	4743	4982	5216	5459	5711	5972	6242	6519	6807	7106	7416	7649	7649	7649	7649	7649	7649
Total Benefits (Kshs. 1000)	118208	128665	139689	151260	162564	174458	186963	200104	213650	228238	243589	259726	276704	291141	291141	291141	291141	291141	291141

* Exclusive of unaccounted-for water estimated at 20%.
** Adjustement of Incremental sales volume to 73% of full capacity due to the regulation of water level at E.L.1,882.0m in Lake Naivasha.
*** Unit economic benefit for residential category in rural areas are applied to all the consumers' categories.
**** For urban areas (Nakuru, Naivasha and Gilgil town)
***** For rural areas (Gilgil rural and Eburru rural)

Table 10.3 Financial Benefit Stream

(1000 Kshs.)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
1. Nakuru Municipality																																			
1)Water Demand at Delivery Point (1000m3/year)	17677	18752	19892	21097	22251	23468	24752	26106	27531	29054	30661	32356	34145	36038	38038	40149	42377	44729	47207	47207	47207	47207	47207	47207	47207	47207	47207	47207	47207	47207	47207	47207	47207	47207	47207
2)Total Sales Volume (1000m3/year)	17677	18752	19892	21097	22251	23468	24752	26106	27531	29054	30661	32356	34145	36038	38038	40149	42377	44729	47207	47207	47207	47207	47207	47207	47207	47207	47207	47207	47207	47207	47207	47207	47207	47207	47207
3)Sales Volume from Other Sources(1000m3/year)	6831	6831	6831	6831	6831	6831	6831	6831	6831	6831	6831	6831	6831	6831	6831	6831	6831	6831	6831	6831	6831	6831	6831	6831	6831	6831	6831	6831	6831	6831	6831	6831	6831	6831	6831
4)Incremental Sales Volume (1000m3/year)	10846	11921	13061	14266	15420	16637	17921	19275	20701	22223	23830	25525	27315	29207	31207	33318	35546	37898	40376	40376	40376	40376	40376	40376	40376	40376	40376	40376	40376	40376	40376	40376	40376	40376	40376
5)Adjustment by Regulation** (1000m3/year)	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180
6)Adjusted Incremental Volume (1000m3/year)	10846	11921	13061	14266	15420	16637	17921	19275	20701	22223	23830	25525	27315	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180	29180
7)Unit Water Rate (Kshs. /m3)	2.64	2.85	3.08	3.32	3.59	3.88	4.19	4.52	4.89	5.28	5.70	6.15	6.65	7.18	7.75	8.37	9.04	9.77	10.55	11.39	12.30	13.29	14.35	15.50	16.74	18.08	19.52	21.08	22.77	24.59	26.56	28.68	30.98	33.46	36.13
8)Annual Revenue (Kshs.1000)	28627	33981	40209	47432	55370	64520	75058	87186	101126	117249	135783	157080	181538	209452	226208	244305	263849	284957	307754	332374	358964	387681	418696	452192	488367	527436	569631	615202	664418	717571	774977	836975	903933	976248	1054348
2. Naivasha Town																																			
1)Water Demand at Delivery Point (1000m3/year)	3482	3667	3862	4067	4238	4416	4601	4795	4995	5205	5423	5650	5887	6132	6389	6657	6936	7226	7536	7536	7536	7536	7536	7536	7536	7536	7536	7536	7536	7536	7536	7536	7536	7536	7536
2)Total Sales Volume (1000m3/year)	3482	3667	3862	4067	4238	4416	4601	4795	4995	5205	5423	5650	5887	6132	6389	6657	6936	7226	7536	7536	7536	7536	7536	7536	7536	7536	7536	7536	7536	7536	7536	7536	7536	7536	7536
3)Sales Volume from Other Sources(1000m3/year)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4)Incremental Sales Volume (1000m3/year)	3482	3667	3862	4067	4238	4416	4601	4795	4995	5205	5423	5650	5887	6132	6389	6657	6936	7226	7536	7536	7536	7536	7536	7536	7536	7536	7536	7536	7536	7536	7536	7536	7536	7536	7536
5)Adjustment by Regulation** (1000m3/year)	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126
6)Incremental Adjusted Volume (1000m3/year)	3482	3667	3862	4067	4238	4416	4601	4795	4995	5205	5423	5650	5887	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126	6126
7)Unit Water Rate (Kshs. /m3)	2.64	2.85	3.08	3.32	3.59	3.88	4.19	4.52	4.89	5.28	5.70	6.15	6.65	7.18	7.75	8.37	9.04	9.77	10.55	11.39	12.30	13.29	14.35	15.50	16.74	18.08	19.52	21.08	22.77	24.59	26.56	28.68	30.98	33.46	36.13
8)Annual Revenue (Kshs.1000)	9190	10453	11890	13522	15217	17125	19272	21688	24403	27459	30898	34769	39123	43975	47492	51292	55395	59827	64613	69782	75365	81394	87905	94938	102533	110735	119594	129162	139495	150654	162706	175723	189781	204963	221360
3. Gilgil Town (Bulk Water Supply)																																			
1)Water Demand (1000m3/year)	1839	1919	2002	2089	2194	2305	2421	2542	2670	2803	2943	3091	3245	3407	3577	3756	3944	4141	4349	4349	4349	4349	4349	4349	4349	4349	4349	4349	4349	4349	4349	4349	4349	4349	4349
2)Total Sales Volume (1000m3/year)	1839	1919	2002	2089	2194	2305	2421	2542	2670	2803	2943	3091	3245	3407	3577	3756	3944	4141	4349	4349	4349	4349	4349	4349	4349	4349	4349	4349	4349	4349	4349	4349	4349	4349	4349
3)Sales Volume from Other Sources(1000m3/year)	1503	1503	1503	1554	1575	1596	1618	1639	1662	1680	1699	1718	1737	1755	1755	1755	1755	1755	1755	1755	1755	1755	1755	1755	1755	1755	1755	1755	1755	1755	1755	1755	1755	1755	1755
4)Incremental Sales Volume (1000m3/year)	336	416	499	535	619	709	803	903	1008	1123	1245	1373	1508	1651	1822	2000	2188	2385	2593	2593	2593	2593	2593	2593	2593	2593	2593	2593	2593	2593	2593	2593	2593	2593	2593
5)Adjustment by Regulation** (1000m3/year)	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650
6)Incremental Adjusted Volume (1000m3/year)	336	416	499	535	619	709	803	903	1008	1123	1245	1373	1508	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650
7)Unit Water Rate (Kshs./m3)	2.64	2.85	3.08	3.32	3.59	3.88	4.19	4.52	4.89	5.28	5.70	6.15	6.65	7.18	7.75	8.37	9.04	9.77	10.55	11.39	12.30	13.29	14.35	15.50	16.74	18.08	19.52	21.08	22.77	24.59	26.56	28.68	30.98	33.46	36.13
8)Annual Revenue (Kshs.1000)	887	1185	1536	1780	2224	2748	3363	4084	4925	5926	7092	8449	10025	11841	12789	13812	14917	16110	17399	18791	20294	21917	23671	25564	27609	29818	32204	34780	37562	40567	43813	47318	51103	55191	59607
4. Gilgil Town (Others)																																			
1)Water Demand (1000m3/year)	748	799	852	909	965	1025	1088	1155	1226	1302	1382	1467	1558	1655	1758	1867	1984	2107	2239	2239	2239	2239	2239	2239	2239	2239	2239	2239	2239	2239	2239	2239	2239	2239	2239
2)Total Sales Volume (1000m3/year)	748	799	852	909	965	1025	1088	1155	1226	1302	1382	1467	1558	1655	1758	1867	1984	2107	2239	2239	2239	2239	2239	2239	2239	2239	2239	2239	2239	2239	2239	2239	2239	2239	2239
3)Sales Volume from Other Sources(1000m3/year)	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405	405
4)Incremental Sales Volume (1000m3/year)	344	394	448	505	561	620	683	750	821	897	977	1063	1154	1250	1353	1463	1579	1703	1834	1834	1834	1834	1834	1834	1834	1834	1834	1834	1834	1834	1834	1834	1834	1834	1834
5)Adjustment by Regulation** (1000m3/year)	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249
6)Incremental Adjusted Volume (1000m3/year)	344	394	448	505	561	620	683	750	821	897	977	1063	1154	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249	1249
7)Unit Water Rate (Kshs./m3)	3.30	3.78	4.08	4.40	4.76	5.14	5.55	5.99	6.47	6.99	7.55	8.15	8.80	9.51	10.27	11.09	11.98	12.94	13.97	15.09	16.30	17.60	19.01	20.53	22.17	23.94	25.86	27.93	30.16	32.58	35.18	38.00	41.04	44.32	47.86
8)Annual Revenue (Kshs.1000)	1202	1488	1826	2224	2668	3186	3791	4495	5314	6269	7378	8664	10156	11876	12826	13852	14960	16157	17449	18845	20353	21981	23740	25639	27690	29905	32298	34881	37672	40686	43941	47456	51252	55352	59781
5. Gilgil Rural																																			
1)Water Demand (1000m3/year)	506	524	543	563	580	599	618	637	657	677	698	719	741	763	788	814	841	869	897	897	897	897	897	897	897	897	897	897	897	897	897	897	897	897	897
2)Total Sales Volume (1000m3/year)	506	524	543	563	580	599	618	637	657	677	698	719	741	763	788	814	841	869	897	897	897	897	897	897	897	897	897	897	897	897	897	897	897	897	897
3)Sales Volume from Other Sources(1000m3/year)	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289
4)Incremental Sales Volume (1000m3/year)	217	235	254	274	291	310	329	348	368	388	409	430	452	475	500	525	552	580	608	608	608	608	608	608	608	608	608	608	608	608	608	608	608	608	608
5)Adjustment by Regulation** (1000m3/year)	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474
6)Incremental Adjusted Volume (1000m3/year)	217	235	254	274	291	310	329	348	368	388	409	430	452	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474
7)Unit Water Rate (Kshs. /m3)	2.14	2.31	2.50	2.70	2.91	3.15	3.40	3.67	3.97	4.28	4.63	5.00	5.39	5.83	6.29	6.80	7.34	7.93	8.56	9.25	9.99	10.78	11.65	12.58	13.58	14.67	15.85	17.11	18.48	19.96	21.56	23.28	25.14	27.16	29.33
8)Annual Revenue (Kshs.1000)	465	544	635	739	850	975	1117	1278	1459	1662	1890	2148	2438	2762	2983	3222	3479	3758	4058	4383	4734	5112	5521	5963	6440	6955	7512	8113	8762	9462	10219	11037	11920	12874	13903
6. Elburu Rural																																			
1)Water Demand (1000m3/year)	726	757	788	821	855	890	926	964	1004	1045	1087	1132	1178	1226	1276	1329	1383	1440	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
2)Total Sales Volume (1000m3/year)	726	757	788	821	855	890	926	964	1004	1045	1087	1132	1178	1226	1276	1329	1383	1440	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
3)Sales Volume from Other Sources(1000m3/year)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4)Incremental Sales Volume (1000m3/year)	726	757	788	821	855	890	926	964	1004	1045	1087	1132	1178	1226	1276	1329	1383	1440	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
5)Adjustment by Regulation** (1000m3/year)	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225
6)Incremental Adjusted Volume (1000m3/year)	726	757	788	821	855	890	926	964	1004	1045	1087	1132	1178	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225
7)Unit Water Rate (Kshs./m3)	2.14	2.31	2.50	2.70	2.91	3.15	3.40	3.67	3.97	4.28	4.63	5.00	5.39	5.83	6.29	6.80	7.34	7.93	8.56	9.25	9.99	10.78	11.65	12.58	13.58	14.67	15.85	17.11	18.48	19.96	21.56	23.28	25.14	27.16	29.33
8)Annual Revenue (Kshs.1000)	1556	1751	1970	2216	2492	2801	3150	3541	3980	4474	5029	5653	6354	7135	7706	8322	8988	9707	10484	11323	12228	13207	14263	15404	16637	17968	19405	20957	22634	24445	26400	28512	30793	33257	35917
Total Incremental Volume (1000m3/year)	15951	17390	18913	20469	21985	23582	25264	27035	28897	30881	32971	35173	37493	39941	42546	45292	48184	51232	54448	54448	54448	54448	54448	54448	54448	54448	54448	54448	54448	54448	54448	54448	54448	54448	54448
Upper Limit of Supply Volume (1000m3/year)	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904
Total Incremental Adjusted Volume (1000m3/year)	15951	17390	18913	20469	21985	23582	25264	27035	28897	30881	32971	35173	37493	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904	39904
Total Benefits (Kshs. 1000)	41926	49401	58065	67913	78821	91355	105750	122272	141207	163038	188071	216763	249635	287041	310094	334804	361582	390516	421757	455498	491938	531293	573796	619709	669276	722818	780643	843095	910542	983316	1062056	1147021	1238383	1337385	1444916

* Exclusive of unaccounted-for water estimated at 5% for bulk water and 20% for distributed water.

** Adjustment of incremental sales volume to 73% of full capacity due to the regulation of water level at R.L. 1,882.0m in Lake Naivasha.

Table 10.4 Financial Cash Flow

(1000 Kshs.)

	Cost					Revenue	Balance	
Year	1) Capital	2) O & M	3) Replacement	4) 2) + 3)	5) Total	6)	7) 6) - 4)	8) 6) - 5)
1991	27161	0	0	0	27161	0	0	-27161
1992	59499	0	0	0	59499	0	0	-59499
1993	29963	0	0	0	29963	0	0	-29963
1994	691951	0	0	0	691951	0	0	-691951
1995	1102234	0	0	0	1102234	0	0	-1102234
1996	1141771	0	0	0	1141771	0	0	-1141771
1997	84632	20396	0	20396	105028	41926	21530	-63102
1998	0	23448	0	23448	23448	49401	25953	25953
1999	19138	26903	0	26903	46041	58065	31162	12024
2000	39760	30761	0	30761	70521	67913	37152	-2608
2001	21053	35458	0	35458	56510	78821	43363	22311
2002	199430	40767	0	40767	240197	91355	50588	-148842
2003	676738	46698	0	46698	723436	105750	59052	-617686
2004	900649	57735	0	57735	958384	122272	64537	-836112
2005	0	65543	0	65543	65543	141207	75664	75664
2006	5350	74498	0	74498	79848	163038	88540	83190
2007	10959	84465	0	84465	95424	188071	103606	92647
2008	5796	96357	0	96357	102053	216763	120406	114710
2009	113289	108632	0	108632	221921	249635	141003	27714
2010	210082	124018	0	124018	334100	287041	163023	-47059
2011	151895	134054	0	134054	285949	310004	175950	24055
2012	0	144778	0	144778	144778	334804	190026	190026
2013	0	156360	0	156360	156360	361589	205229	205229
2014	0	168869	0	168869	168869	390516	221647	221647
2015	0	182379	0	182379	182379	421757	239378	239378
2016	0	196969	0	196969	196969	455498	258529	258529
2017	0	212726	136892	349618	349619	491938	142320	142319
2018	0	229745	0	229745	229745	531293	301548	301548
2019	0	248124	0	248124	248124	573796	325672	325672
2020	0	267974	0	267974	267974	619700	351726	351726
2021	0	289412	0	289412	289412	669276	379864	379864
2022	0	312565	0	312565	312565	722818	410253	410253
2023	0	337570	0	337570	337570	780643	443073	443073
2024	0	364576	68106	432682	432682	843095	410413	410413
2025	0	393742	0	393742	393742	910542	516800	516800
2026	0	425241	0	425241	425241	983386	558145	558145
2027	0	459260	0	459260	459260	1062056	602796	602796
2028	0	496001	0	496001	496001	1147021	651020	651020
2029	0	535681	0	535681	535681	1238783	703102	703102
2030	0	578536	0	578536	578536	1337885	759349	759349
2031	0	624819	3421	628240	628240	1444916	816676	816676

FIRR(%)=
2.60

Table 10. 5 Loan Repayment Schedule (Current Price)

(Unit: 1000Kshs.)

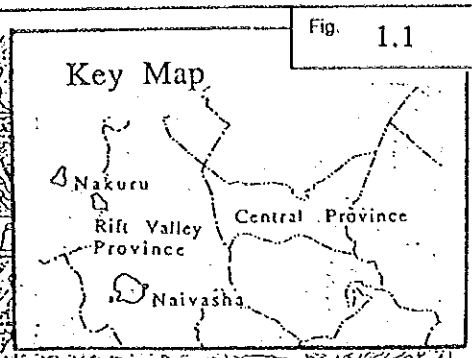
		Dam & Water Facilities(Stage 2-1)						Water Facilities (Stage 2-2)						Water Facilities (Stage 2-3)						Capital funded by Gov.of Kenya	OMR**	Annual Expenditure	Annual Revenue	Balance	Accumlated Balance
		Loan Disbursement		Accumlated	Repayment			Loan Disbursement		Accumlated	Repayment			Loan Disbursement		Accumlated	Repayment								
		Capital	IDC*	Loan	Interest	Principal	Total	Capital	IDC*	Loan	Interest	Principal	Total	Capital	IDC*	Loan	Interest	Principal	Total						
0	1990																								
1	1991	21358	539	21897	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5803	0	5803	0	-5803	-5803
2	1992	47487	1751	71135	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12012	0	12012	0	-12012	-17815
3	1993	23195	1828	96158	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6768	0	6768	0	-6768	-24583
4	1994	587937	15427	699522	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	104014	0	104014	0	-104014	-128597
5	1995	952853	39142	1691517	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	149381	0	149381	0	-149381	-277978
6	1996	979041	49567	2720125	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	162730	0	162730	0	-162730	-440708
7	1997	67063	27560	2814748	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17569	20396	37965	41926	3961	-436747
8	1998	0	0	2722716	70369	92032	162401	0	0	0	0	0	0	0	0	0	0	0	0	0	23448	185849	49401	-136448	-573195
9	1999	0	0	2628383	68068	94333	162401	13929	353	14282	0	0	0	0	0	0	0	0	0	5209	26903	194513	58065	-136448	-709643
10	2000	0	0	2531692	65710	96691	162401	29715	1114	45111	0	0	0	0	0	0	0	0	0	10045	30761	203207	67913	-135294	-844937
11	2001	0	0	2432583	63292	99109	162401	15051	1162	61324	0	0	0	0	0	0	0	0	0	6002	35458	203861	78821	-125040	-969977
12	2002	0	0	2330997	60815	101586	162401	161689	4489	227502	0	0	0	0	0	0	0	0	0	37741	40767	240909	91355	-149554	-1119531
13	2003	0	0	2226871	58275	104126	162401	570293	18547	816342	0	0	0	0	0	0	0	0	0	106445	46698	315544	105750	-209794	-1329325
14	2004	0	0	2120142	55672	106729	162401	766333	34105	1616780	0	0	0	0	0	0	0	0	0	134316	57735	354452	122272	-232180	-1561505
15	2005	0	0	2010745	53004	109397	162401	0	0	1566801	40420	49979	90399	0	0	0	0	0	0	0	65543	318343	141207	-177136	-1738641
16	2006	0	0	1898613	50269	112132	162401	0	0	1515572	39170	51229	90399	3644	93	3737	0	0	0	1706	74498	329004	163038	-165966	-1904607
17	2007	0	0	1783677	47465	114936	162401	0	0	1463062	37889	52510	90399	7639	289	11665	0	0	0	3320	84465	340585	188071	-152514	-2057121
18	2008	0	0	1665868	44592	117809	162401	0	0	1409240	36577	53822	90399	3882	300	15847	0	0	0	1914	96257	350971	216763	-134208	-2191329
19	2009	0	0	1545114	41647	120754	162401	0	0	1354072	35231	55168	90399	88062	2332	106241	0	0	0	25227	108632	386659	249635	-137024	-2328353
20	2010	0	0	1421341	38628	123773	162401	0	0	1297525	33852	56547	90399	164249	6433	276923	0	0	0	45833	124018	422651	287041	-135610	-2463963
21	2011	0	0	1294474	35534	126867	162401	0	0	1239564	32438	57961	90399	118942	7314	403179	0	0	0	32953	134054	419807	310004	-109803	-2573766
22	2012	0	0	1164435	32362	130039	162401	0	0	1180154	30989	59410	90399	0	0	390715	10079	12464	22543	0	144778	420121	334804	-85317	-2659083
23	2013	0	0	1031145	29111	133290	162401	0	0	1119259	29504	60895	90399	0	0	377940	9768	12775	22543	0	156360	431703	361589	-70114	-2729197
24	2014	0	0	894523	25779	136622	162401	0	0	1056841	27981	62418	90399	0	0	364846	9449	13094	22543	0	168869	444212	390516	-53696	-2782893
25	2015	0	0	754485	22363	140038	162401	0	0	992863	26421	63978	90399	0	0	351424	9121	13422	22543	0	182379	457722	421757	-35965	-2818858
26	2016	0	0	610946	18862	143539	162401	0	0	927286	24822	65577	90399	0	0	337667	8786	13757	22543	0	196969	472312	455498	-16814	-2835672
27	2017	0	0	463819	15274	147127	162401	0	0	860069	23182	67217	90399	0	0	323566	8442	14101	22543	0	349618	624961	491938	-133023	-2968695
28	2018	0	0	313013	11595	150806	162401	0	0	791172	21502	68897	90399	0	0	309112	8089	14454	22543	0	229745	505088	531293	26205	-2942490
29	2019	0	0	158437	7825	154576	162401	0	0	720552	19779	70620	90399	0	0	294297	7728	14815	22543	0	248124	523467	573796	50329	-2892161
30	2020	0	0	0	3961	158437	162398	0	0	648167	18014	72385	90399	0	0	279111	7357	15186	22543	0	267974	543314	619700	76386	-2815775
31	2021	0	0	0	0	0	0	0	0	573972	16204	74195	90399	0	0	263546	6978	15565	22543	0	289412	402354	669276	266922	-2548853
32	2022	0	0	0	0	0	0	0	0	497922	14349	76050	90399	0	0	247592	6589	15954	22543	0	312565	425507	722818	297311	-2251542
33	2023	0	0	0	0	0	0	0	0	419971	12448	77951	90399	0	0	231239	6190	16353	22543	0	337570	450512	780643	330131	-1921411
34	2024	0	0	0	0	0	0	0	0	340071	10499	79900	90399	0	0	214477	5781	16762	22543	0	432682	545624	843095	297471	-1623940
35	2025	0	0	0	0	0	0	0	0	258174	8502	81897	90399	0	0	197296	5362	17181	22543	0	393742	506684	910542	403858	-1220082
36	2026	0	0	0	0	0	0	0	0	174229	6454	83945	90399	0	0	179685	4932	17611	22543	0	425241	538183	983386	445203	-774879
37	2027	0	0	0	0	0	0	0	0	88186	4356	86043	90399	0	0	161634	4492	18051	22543	0	459260	572202	1062056	489854	-285025
38	2028	0	0	0	0	0	0	0	0	0	2205	88186	90391	0	0	143132	4041	18502	22543	0	496001	608935	1147021	538086	253061
39	2029	0	0	0	0	0	0	0	0	0	0	0	0	0	0	124167	3578	18965	22543	0	535681	558224	1238783	680559	933620
40	2030	0	0	0	0	0	0	0	0	0	0	0	0	0	0	104728	3104	19439	22543	0	578536	601079	1337885	736806	1670426
41	2031	0	0	0	0	0	0	0	0	0	0	0	0	0	0	84803	2618	19925	22543	0	628240	650783	1444916	794133	2464559
42	2032	0	0	0	0	0	0	0	0	0	0	0	0	0	0	64380	2120	20423	22543	0	0	22543	0	-22543	2442016
43	2033	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43447	1610	20933	22543	0	0	22543	0	-22543	2419473
44	2034	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21990	1086	21457	22543	0	0	22543	0	-22543	2396930
45	2035	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	550	21990	22540	0	0	22540	0	-22540	2374390
Total		2678934	135814		920472	2814748	3735220	1557010	59770		552788	1616780	2169568	386418	16761		137850	403179	541029	868988	7803379	15118184	17492574	2374390	

* Interest during construction

** O&M and Replacement costs

FIGURES

Fig. 1.1



Subukia Rural

Bahati Rural

Nakuru Municipality

Gilgil Rural

Gilgil Town

Eburru Rural

Naivasha Town

LAKE NAIVASHA

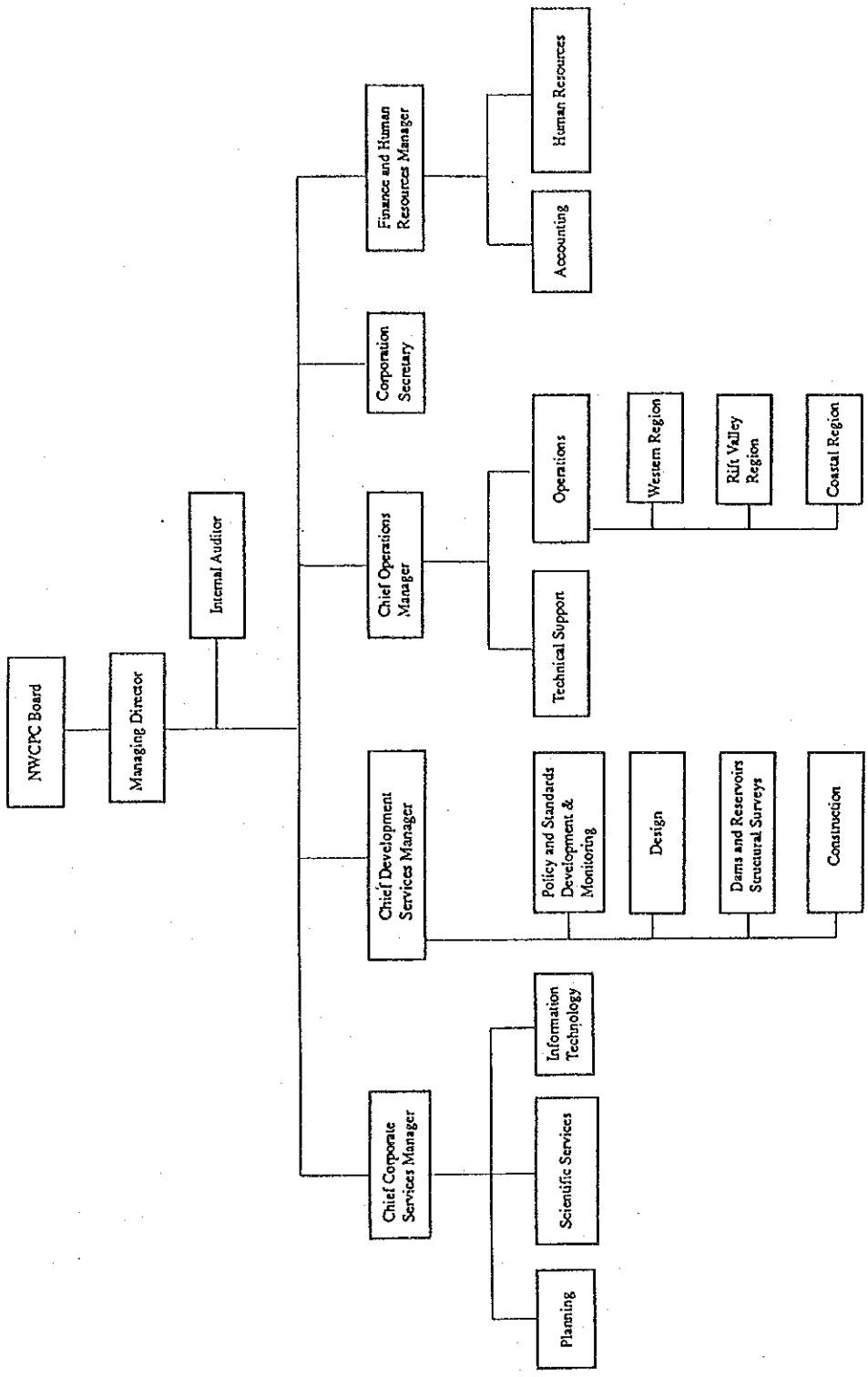
LEGEND

Boundary of Eastern Division

Boundary of Sub-division Area

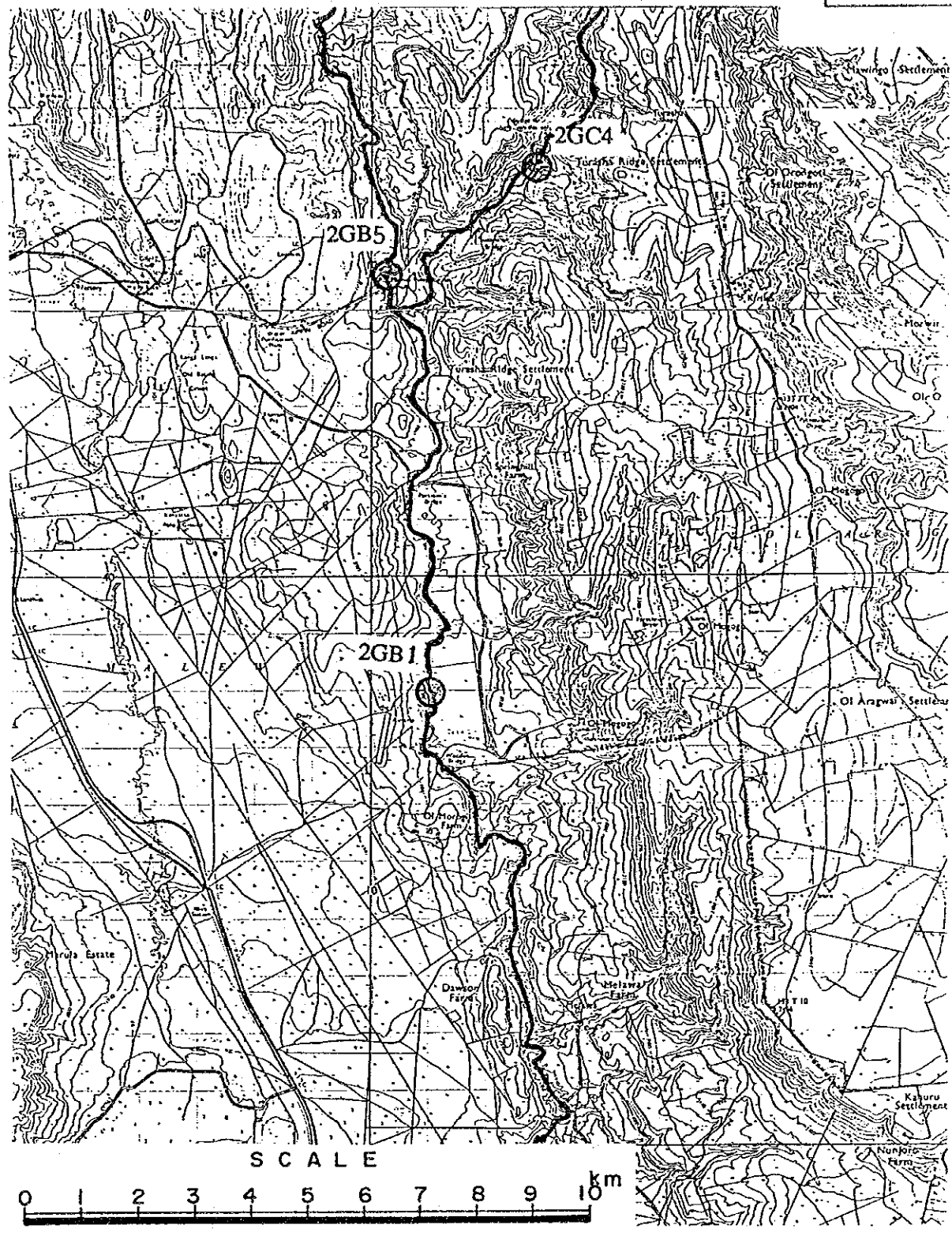
THE REPUBLIC OF KENYA MINISTRY OF WATER DEVELOPMENT NATIONAL WATER CONSERVATION AND PIPELINE CORPORATION	THE STUDY FOR CONSTRUCTION OF DAM IN MALEWA RIVER SYSTEM GREATER NAKURU WATER SUPPLY PROJECT EASTERN DIVISION JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE Location Map of Eastern Division

Fig. 2.1



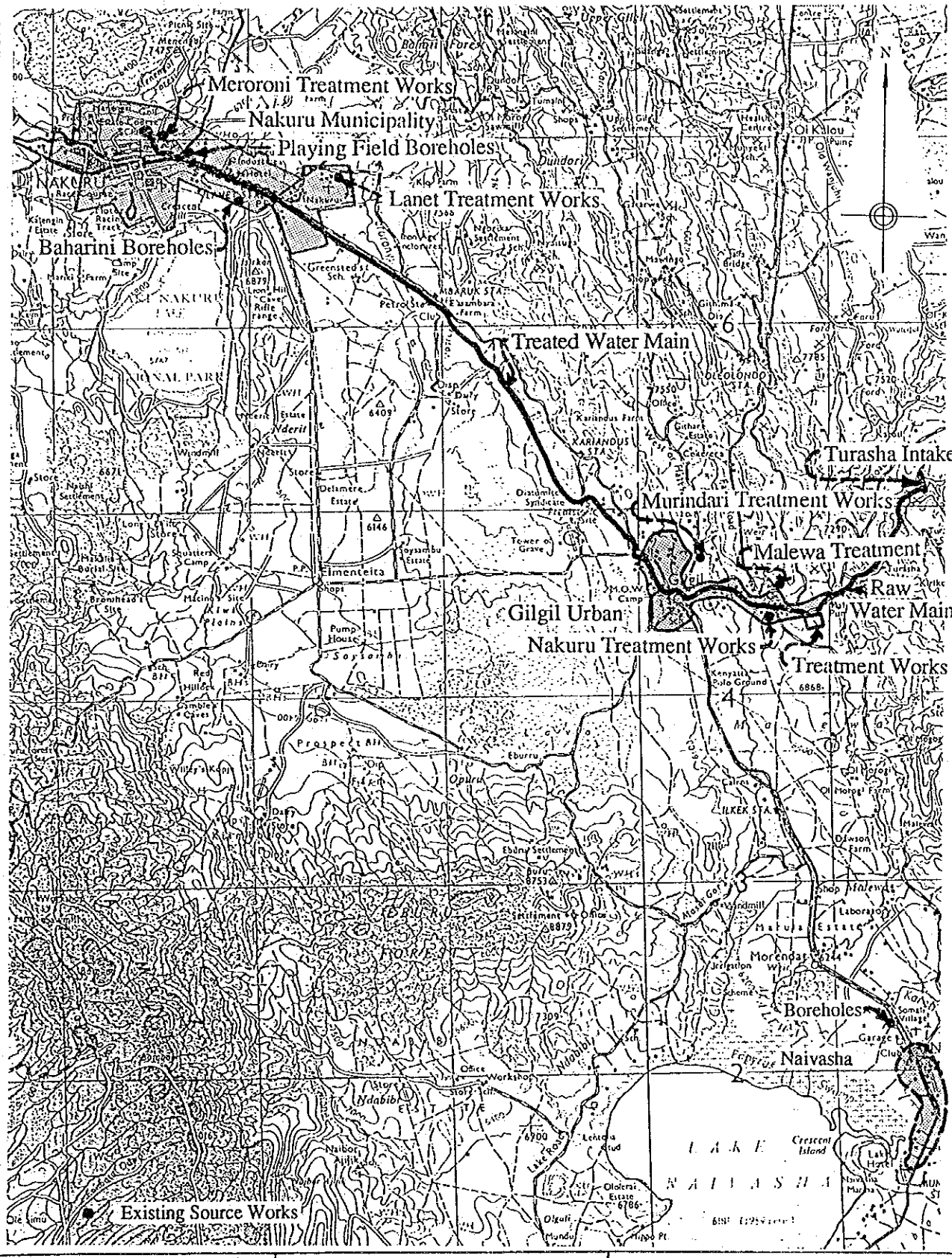
THE REPUBLIC OF KENYA MINISTRY OF WATER DEVELOPMENT NATIONAL WATER CONSERVATION AND PIPELINE CORPORATION	THE STUDY FOR CONSTRUCTION OF DAM IN MALEWA RIVER SYSTEM GREATER NAKURU WATER SUPPLY PROJECT EASTERN DIVISION JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE Organization Chart of NWCPC

Fig. 3.1

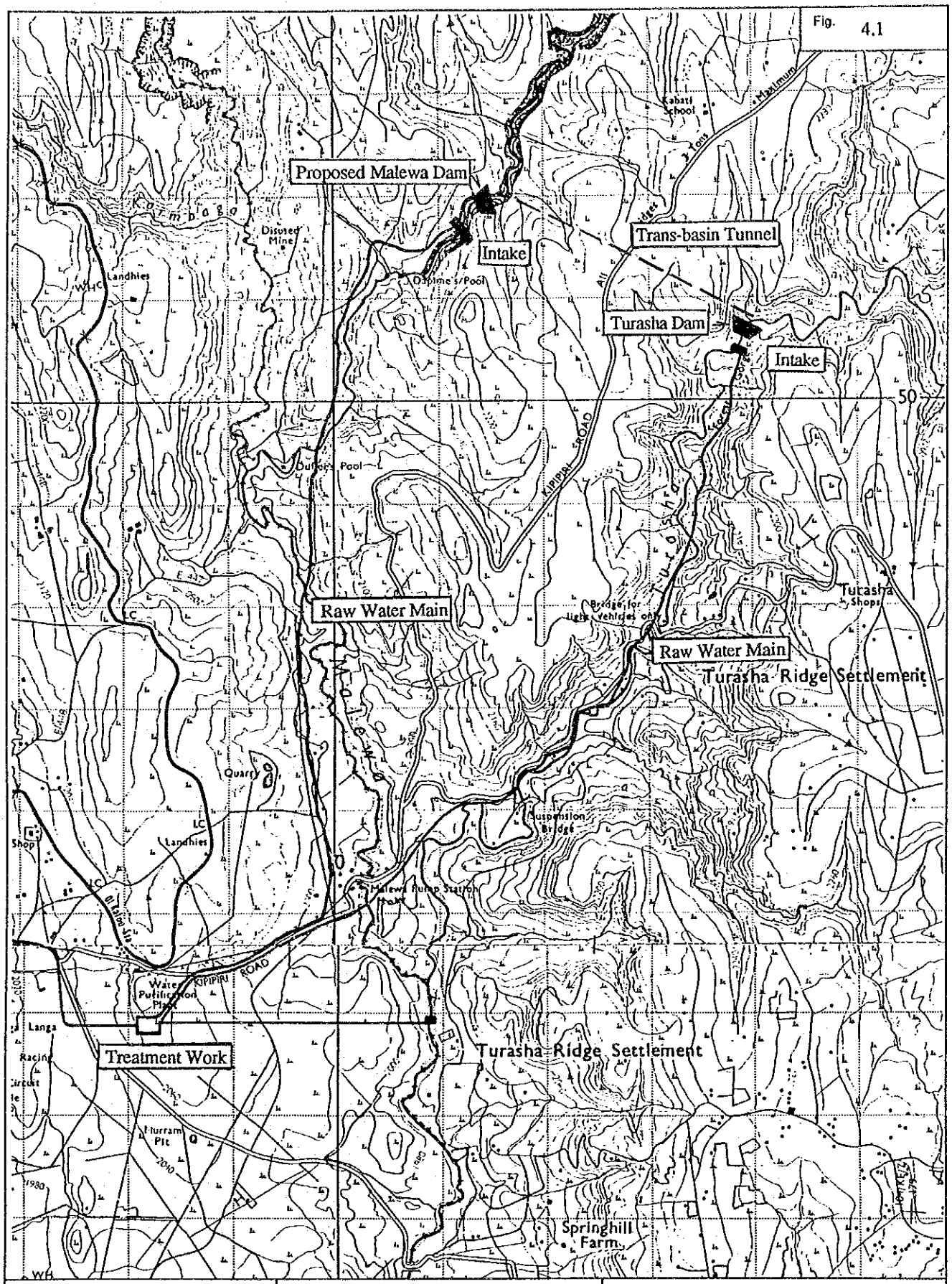


THE REPUBLIC OF KENYA MINISTRY OF WATER DEVELOPMENT NATIONAL WATER CONSERVATION AND PIPELINE CORPORATION	THE STUDY FOR CONSTRUCTION OF DAM IN MALEWA RIVER SYSTEM GREATER NAKURU WATER SUPPLY PROJECT EASTERN DIVISION JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE Locations of Stream Gauge Stations

Fig. 3.2

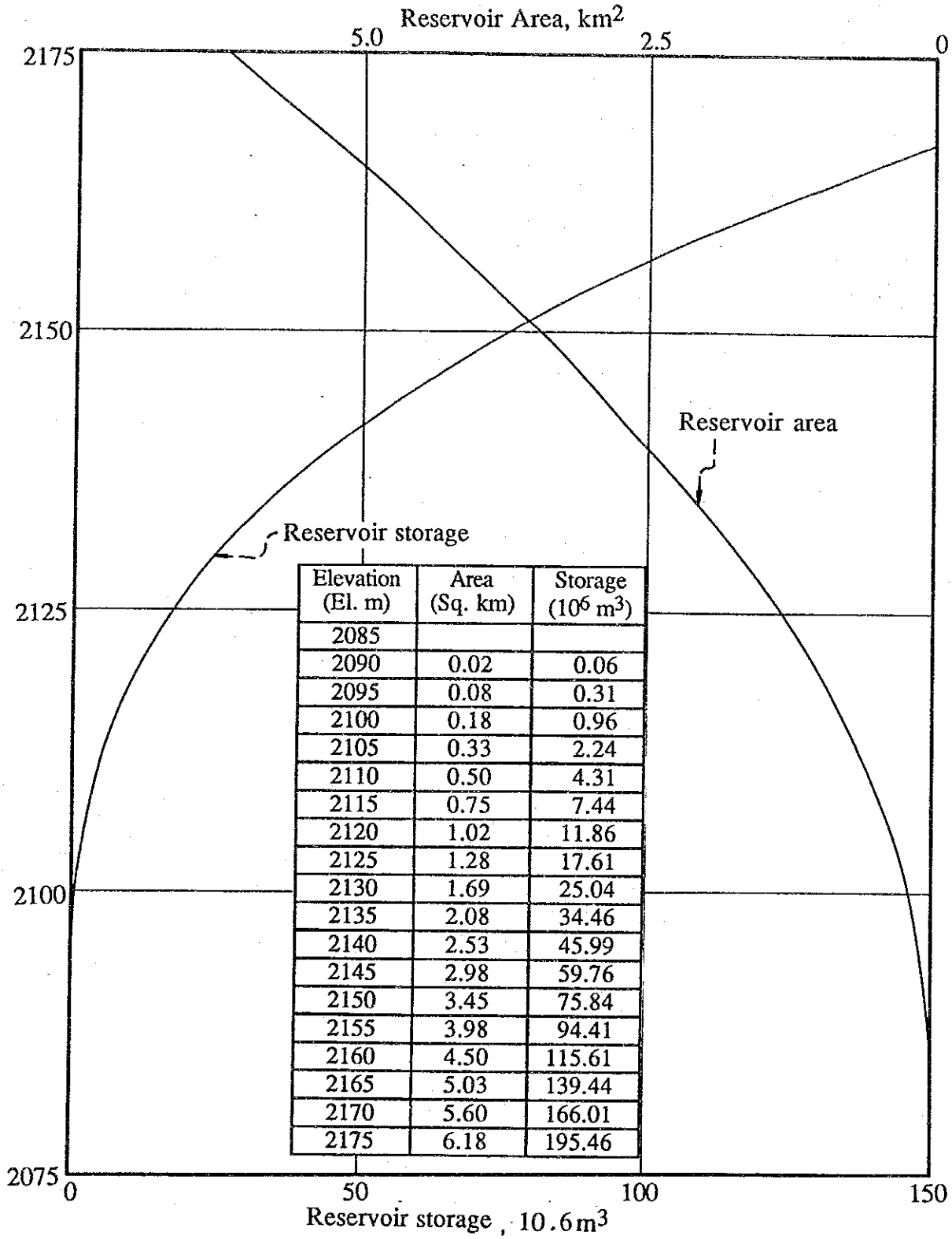


THE REPUBLIC OF KENYA MINISTRY OF WATER DEVELOPMENT NATIONAL WATER CONSERVATION AND PIPELINE CORPORATION	THE STUDY FOR CONSTRUCTION OF DAM IN MALEWA RIVER SYSTEM GREATER NAKURU WATER SUPPLY PROJECT EASTERN DIVISION JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE General Layout of Stage 1 Project



THE REPUBLIC OF KENYA MINISTRY OF WATER DEVELOPMENT NATIONAL WATER CONSERVATION AND PIPELINE CORPORATION	THE STUDY FOR CONSTRUCTION OF DAM IN MALEWA RIVER SYSTEM GREATER NAKURU WATER SUPPLY PROJECT EASTERN DIVISION JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE Location Map of Damsites

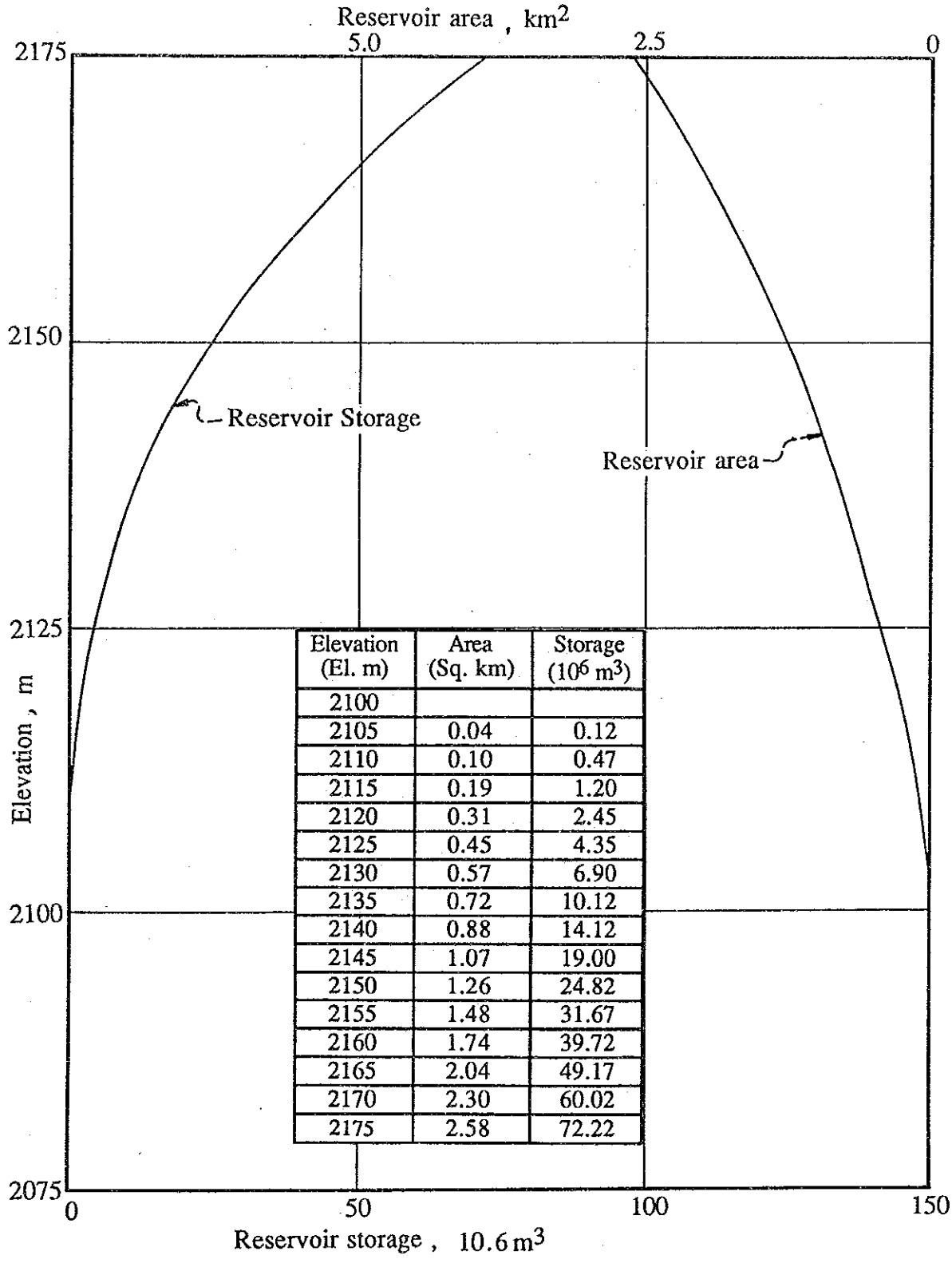
Fig. 4.2



Elevation (El. m)	Area (Sq. km)	Storage (10^6 m^3)
2085		
2090	0.02	0.06
2095	0.08	0.31
2100	0.18	0.96
2105	0.33	2.24
2110	0.50	4.31
2115	0.75	7.44
2120	1.02	11.86
2125	1.28	17.61
2130	1.69	25.04
2135	2.08	34.46
2140	2.53	45.99
2145	2.98	59.76
2150	3.45	75.84
2155	3.98	94.41
2160	4.50	115.61
2165	5.03	139.44
2170	5.60	166.01
2175	6.18	195.46

THE REPUBLIC OF KENYA MINISTRY OF WATER DEVELOPMENT NATIONAL WATER CONSERVATION AND PIPELINE CORPORATION	THE STUDY FOR CONSTRUCTION OF DAM IN MALEWA RIVER SYSTEM GREATER NAKURU WATER SUPPLY PROJECT EASTERN DIVISION JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE Area-Storage Curve, Malewa Reservoir

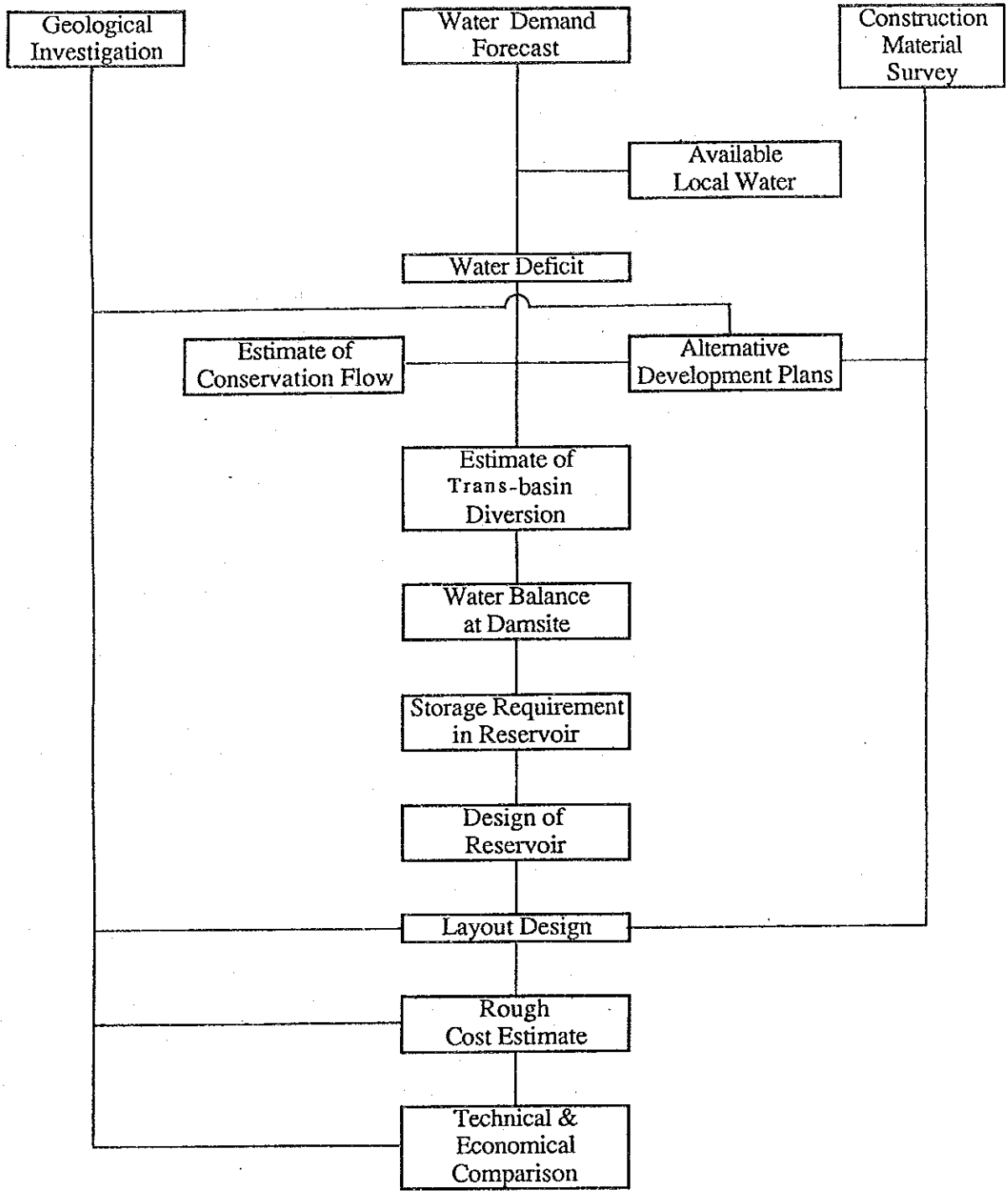
Fig. 4.3



Elevation (El. m)	Area (Sq. km)	Storage (10^6 m^3)
2100		
2105	0.04	0.12
2110	0.10	0.47
2115	0.19	1.20
2120	0.31	2.45
2125	0.45	4.35
2130	0.57	6.90
2135	0.72	10.12
2140	0.88	14.12
2145	1.07	19.00
2150	1.26	24.82
2155	1.48	31.67
2160	1.74	39.72
2165	2.04	49.17
2170	2.30	60.02
2175	2.58	72.22

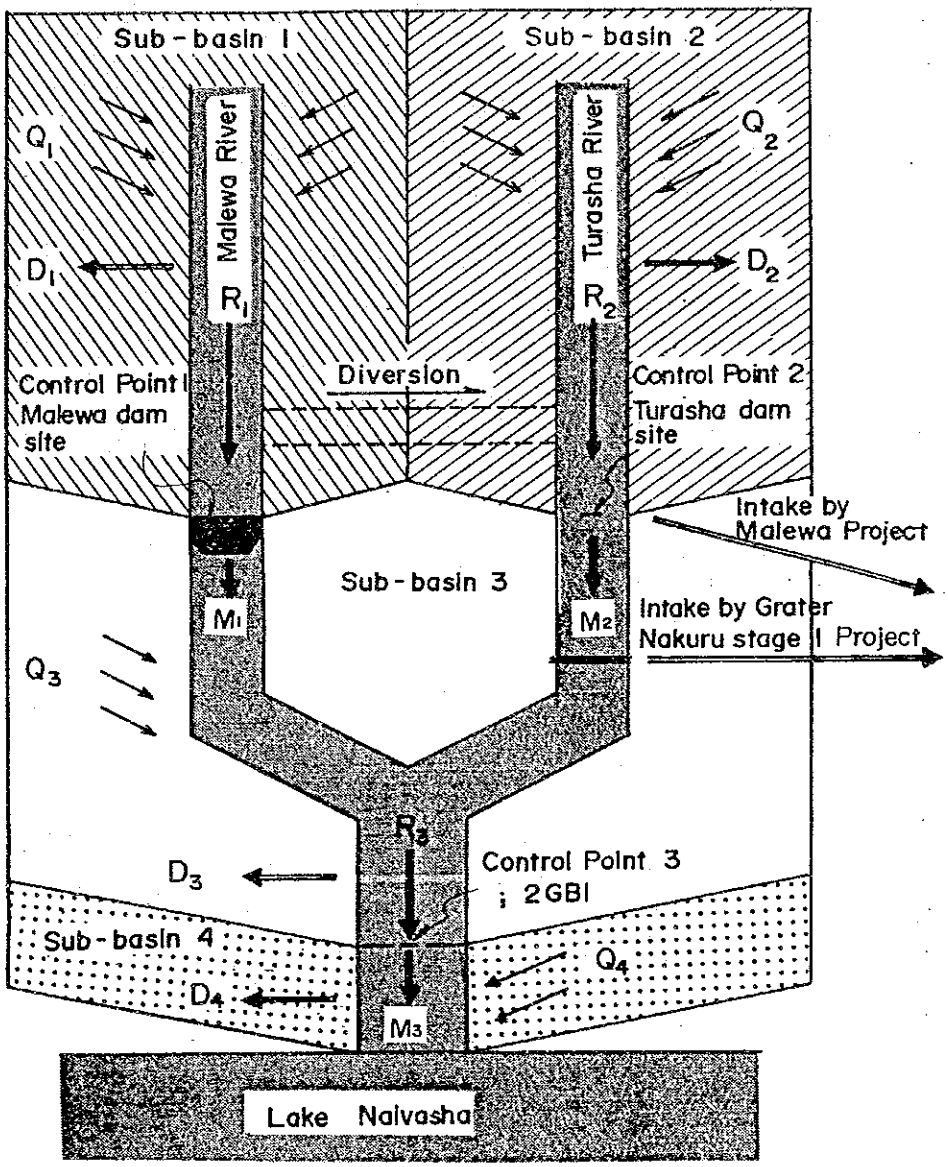
THE REPUBLIC OF KENYA MINISTRY OF WATER DEVELOPMENT NATIONAL WATER CONSERVATION AND PIPELINE CORPORATION	THE STUDY FOR CONSTRUCTION OF DAM IN MALEWA RIVER SYSTEM GREATER NAKURU WATER SUPPLY PROJECT EASTERN DIVISION JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE Area-Storage Curve, Turasha Reservoir

Fig. 4.4



THE REPUBLIC OF KENYA MINISTRY OF WATER DEVELOPMENT NATIONAL WATER CONSERVATION AND PIPELINE CORPORATION	THE STUDY FOR CONSTRUCTION OF DAM IN MALEWA RIVER SYSTEM GREATER NAKURU WATER SUPPLY PROJECT EASTERN DIVISION JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE Flow Chart for Selection Promising Damsite

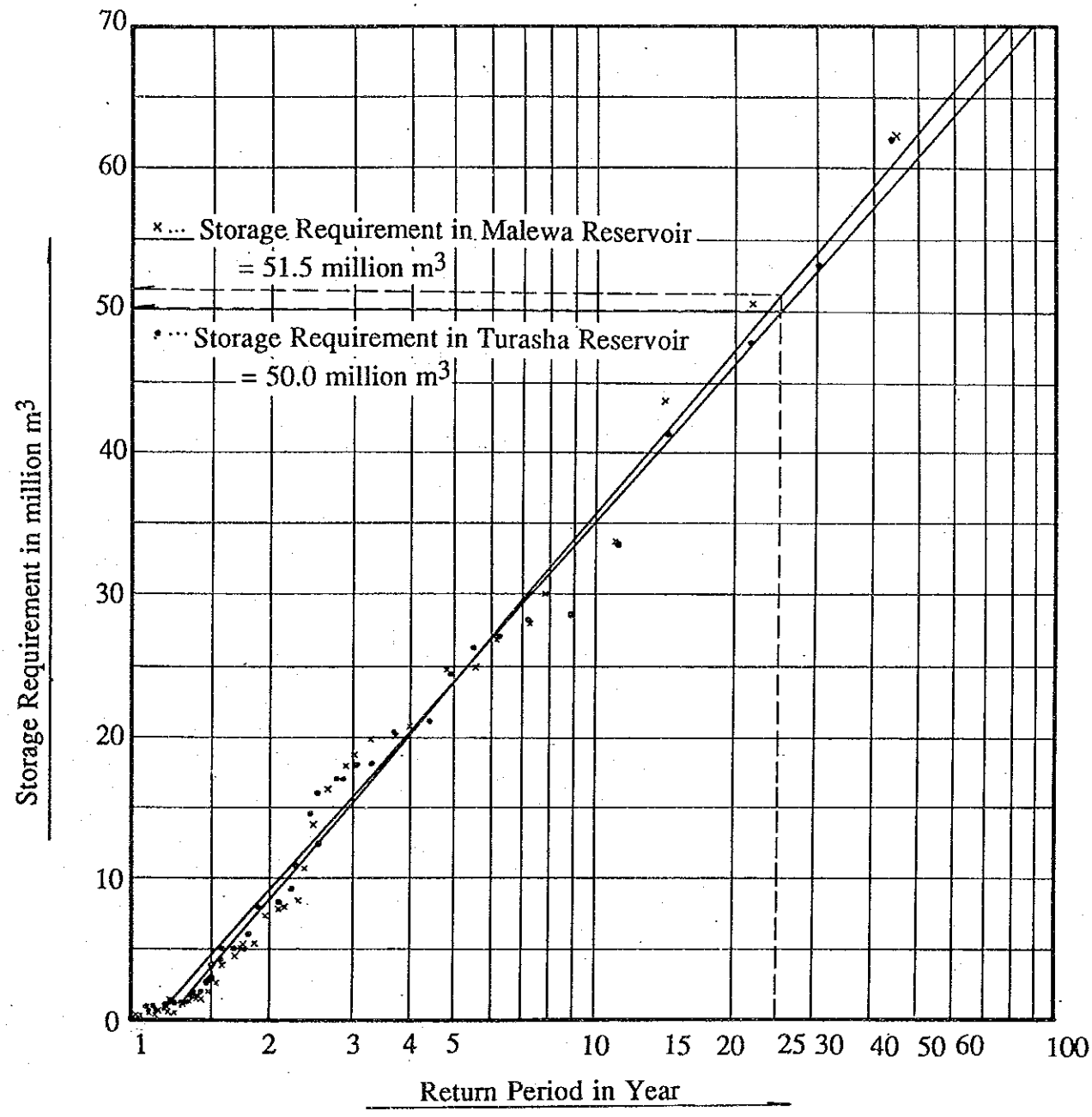
Fig. 4.5



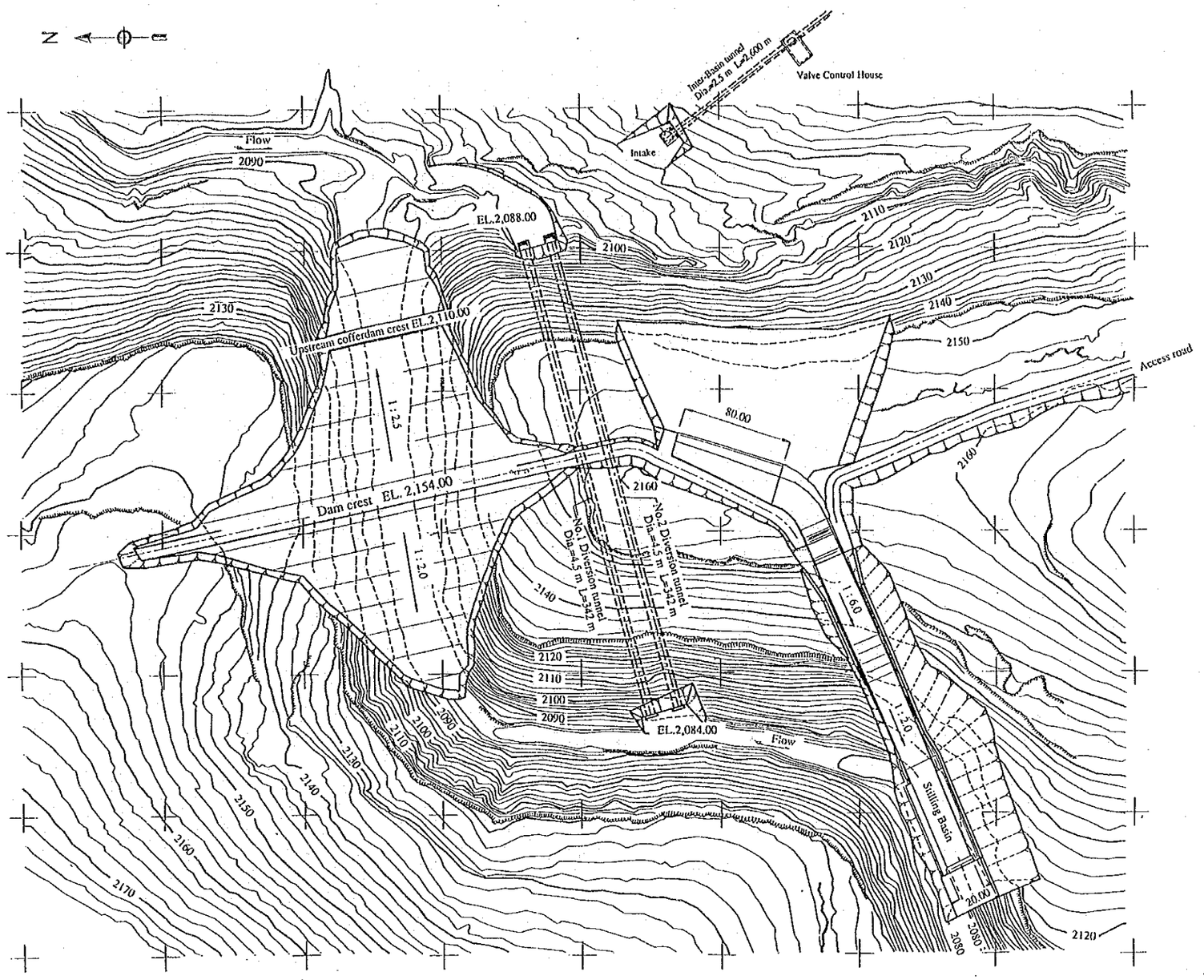
Ri : Available runoff at control point i
Di : Water requirement for registered water right in sub - basin i
Qi : Natural runoff drained in sub-basin i
Mi : Conservation flow at control point i

THE REPUBLIC OF KENYA MINISTRY OF WATER DEVELOPMENT NATIONAL WATER CONSERVATION AND PIPELINE CORPORATION	THE STUDY FOR CONSTRUCTION OF DAM IN MALEWA RIVER SYSTEM GREATER NAKURU WATER SUPPLY PROJECT EASTERN DIVISION JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE Schematic Model of Malewa Dam Scheme

Fig. 4.6



THE REPUBLIC OF KENYA MINISTRY OF WATER DEVELOPMENT NATIONAL WATER CONSERVATION AND PIPELINE CORPORATION	THE STUDY FOR CONSTRUCTION OF DAM IN MALEWA RIVER SYSTEM GREATER NAKURU WATER SUPPLY PROJECT EASTERN DIVISION JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE Frequency Analysis of Storage Requirement



GENERAL PLAN

SCALE 0 100 m

THE REPUBLIC OF KENYA MINISTRY OF WATER DEVELOPMENT NATIONAL WATER CONSERVATION AND PIPELINE CORPORATION	THE STUDY FOR CONSTRUCTION OF DAM IN MALEWA RIVER SYSTEM GREATER NAKURU WATER SUPPLY PROJECT EASTERN DIVISION JAPAN INTERNATIONAL COOPERATION AGENCY	General Layout of Malewa Dam Scheme