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JAPAN INTERNATIONAL COOPERATION AGENCY
THE MINISTRY OF LAND RECLAMATION, REGIONAL AND WATER DEVELOPMENT
THE REPUBLIC OF KENYA

THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA

FINAL REPORT

VOLUME III
SUPPORTING REPORTS
APPENDIX J - Q

OCTOBER 1997

NIPPON KOEI CO., LTD.
NIHON SUIDO CONSULTANTS CO., LTD.

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Abbreviations

A.I.A	Appropriation in Aid
AC	Asbestos Cement (Pipe)
AFW	Accounted - for Water
AIC	Average Incremental Cost
AIDS	Acquired Immune Deficiency Syndrome
ASK	Agricultural Society of Kenya
BHN	Basic Human Needs
BPT	Break Pressure Tank
CH1	Survey Points in Chogoria
CK2	Survey Points in Chuka
CWS	Community Water Supplies
dia	diameters
DWE	District Water Engineer
DWO	District Water Office
EIA	Environmental Impact Assessment
GI	Galvanized Iron
GOK	Government of Kenya
GPS	Global Positioning System
ha	Hectares
I5	Survey Points in Isiolo
IEE	Initial Environmental Examination
ITCZ	Intertropical Convergence Zone
JICA	Japan International Cooperation Agency
km	Kilometer
Kshs	Kenya Shillings
KEWI	Kenya Water Institute
KNUT	Kenya National Union of Teachers
lcd	Litres per Capita per Day
l/sec	Litres per second
m3/day	Cubic Meters per Day
M6	Survey Points in Meru
MLRRWD	Ministry of Land Reclamation, Regional and Water Development
MOCSS	Ministry of Culture and Social Services
MOWD	Ministry of Water development

N1	Survey Points in Nkubu
NCCK	National Council of Churches of Kenya
NEAP	National Environmental Action Plan
NWCPC	National Water Conservation and Pipeline Corporation
NWMP	National Water Master Plan
O/M	Operation and Maintenance
ODA	Overseas Development Assistance
PE	Polyethylene Pipe
PH	Plan and Height Point
PIO	Project Implementation Office
PVC	Poly Vinyl Chloride
RDF	Rural Development Fund
RGS	River Gauging Station
S, T, ST, TT	Trigonometric Station Points
SIDA	Swedish International Development Agency
SOI	School of Infantry
SOK	Survey of Kenya
Sq. KM	Square Kilometers
TDS	Total Dissolved Solids
TW	Tigania Water Points
UFW	Unaccounted for Water
UNICEF	United Nations Children's Fund
US$	United States Dollar
USAID	United States Agency for International Development
UTM	Universal Transverse Mercator
VES	Vertical Electric Sounding
WAB	Water Apportionment Board
WC	Water Closet
WHO	World Health Organization
WID	Women In Development
WQPCL	Water Quality and Pollution Control Laboratory
WRAP	Water Resources Assessment Project
WTP	Water Treatment Plant

APPENDIX J

INITIAL ENVIRONMENTAL EXAMINATION

APPENDIX J INITIAL ENVIRONMENTAL EXAMINATION

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1. ENVIRONMENTAL ASSESSMENT SITUATION IN KENYA

1.1 Environmental Plan

The Kenyan government have well established national policies and strategies, covering economic development and population growth. However, aware of the need to protect the natural environment from unsustainable development, the Government, in 1994 formulated the National Environment Action Plan (NEAP).

The objectives of environment policy are stated in the NEAP as "Facilitating optimal use of the national land base and water resources in improving the quality of the human environment". Water resources are discussed in the NEAP as a sector issue with particular reference to the preservation of wetlands, and mountain forests.

District-specific Environmental Action Plan (EAP) was prepared by MLRRWD in 1993 in order to harmonize environmental management with sectoral planning at district level.

The plans for Meru, Isiolo, and Tharaka-Nithi district are prepared and consist of description of the natural and human environment, key environmental issues, and strategies for natural and human resources. They suggest environmental issues in every fields and the issues related to water are shown in below.

(1) Meru District

1) Water pollution by chemicals from coffee factory
2) Poor sanitary standards caused by the use of latrines
3) Droughts in ASAL areas

(2) Isiolo District

1) Unavailability of water resources
2) Excessive abstraction of water for irrigation
3) Conflicts in Water Resource

(3) Tharaka-nithi District

1) Water shortage in residential area
2) Water pollution in the perennial rivers

1.2 Laws and Regulations on Environmental Aspects

Enforcement of Environmental Impact Assessments (EIA) and the establishment of environmental legislation are recommended in the NEAP; however, it has not yet been legislated. The Environmental Management and Co-ordination Act is now being discussed in the parliament. There are 77 individual statutes related to environmental issues in Kenya and statutes concerning the water and environmental management are as follows.

The Water Act (Cap. 372)
The Local Government Act (Cap. 265)
The Public Health Act (Cap. 242)
The Forest Act (Cap. 385)
The Wildlife Conservation and Management Act (Cap. 376)
The Factories Act (Cap. 514)
The Pest Control Product Act (Cap. 346)
The Agricultural Act (Cap. 318)
The National Water Conservation and Pipeline Corporation (No. 270, 1988)

(1) The Water Act

The Water Act stipulates that it makes better provision for the conservation, control, apportionment and use of the water resources of Kenya.

It gives powers to the Minister in charge of water affairs to exercise control over everybody of water. Under this authority, the local authorities manage water affairs in their areas of jurisdiction.

(2) The Local Government Act

The Local Government Act provides for local authorities to establish and maintain management of water supplies, sewerage and drainage systems. It empowers local authorities aimed at maintaining health, well-being and safety of the local inhabitants.

(3) The Public Health Act

The Public Health Act empowers the Minister in charge to make rule for protection of water supplies through the local authorities.

(4) The Forest Act

The Forest Act provides for conservation, management and utilization of forests and forest products. It provides also the protection and conservation of flora and fauna in the area declared as nature reserves.

(5) The Wildlife Conservation and Management Act

The Wildlife Conservation and Management Act takes care of the preservation and control of wild animals life, vegetation and their natural habitats.

2 WATER QUALITY ON EXISTING WATER SOURCE

2.1 Water Quality Standards

Water quality standards for drinking water in Kenya follow those established by the World Health Organization (WHO). These are outlined by the MLRRWD. Design manual for water supplying in Kenya regulates of bacteriorological and chemical water quality aspects. The water quality standards are given in ***Table J-1 to J-6.***

Facilities for water quality analysis are limited in district offices, the water quality analysis tests were therefore performed to utilize the Water Quality and Pollution Control Laboratory's (WQPCL) equipment of MLRRWD. Chemical quality testing were performed approximately 27 constituents, and coliform is examined as bacteriological examination. The major rivers in Kenya are monitored by WQPCL, however, monitoring term is once a several years. Thus, establishment of the monitoring system is highly required.

2.2 Existing Water Quality of Water Source

(1) Surface Water

A water quality survey for the proposed water resources was conducted in dry season and wet season respectively. Water quality survey in dry season was carried out in September 1996. Samples were taken from upstream of intake, proposed intake site and from downstream of the respective towns. Downstream sampling was included to survey the influence of wastewater. Some projects which use spring water were sampled only at the intake and downstream only. In the case of Meru town, water of Mujini springs which is located in the center

town was also sampled to check the water quality.

Wet season sampling was done in March 1997. Samples were taken from intake sites. Intake sites in Meru water supply and Tigania water supply were changed. Former Meru site could not get enough elevation to flow water by gravity, hence, new intake site was shifted to upstream. Tigania intake site could not get enough supplying water volume for the area so that newly intake site was recommend to get enough water for the supplying area. It is therefore that wet season water quality data in Meru and Tigania were taken from new sites.

Water quality test of community water supply was also conducted in this survey. Samples were taken from Meru, Maua and Tigania community water supply projects respectively.

Twenty seven items of chemical quality and two items of bacteriological quality were examined.. The resulting water quality are attached in ***Table J-7***, and selected parameters are summarized in the following table. It should be noted however, that these results are shown the spot water quality testing in dry season and wet season.

Table J-8 Water Quality Summary at Intake Sites

Parameters	Unit	Meru			Nkubu		Isiolo		Chuka		Chogoria		Maua		Tigania		
		Wet	Dry2	Dry1	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry2	Dry1
Turbidity	F.T.U	0.8	0.3	0.4	1.7	1.4	1.2	1.3	1.3	1.2	1.0	0.5	2.0	0.6	0.8	0.2	0.2
BOD	m g/l	4	2	5	1	5	5	3	4	2	6	10	1	6	1	2	5
Coliform	No./m	35	5	0	25	30	10	50	15	20	45	10	15	25	0	20	10

Note : Dry1 shows old site and Dry2 shows new site.
Source : Study team

1) Meru

a) Old Site (dry season sampling)

Samples were taken from 3 sites, with an additional sample taken from Mujini spring, which is used for the communal water point. Sampling at intake site was at the confluence of the Kathita river and the Luguso river, and upstream sampling point was located 100m upstream. The downstream sampling point were at the wastewater effluent outfall on the

Kathita river. The water quality at the proposed intake site indicates suitability for drinking water. However a high value of coliform were found at the Mujini springs. Since this water is directly distributed among residents, hygiene education is necessary for residents to reduce the dangers of incurring water-related diseases.

b) New Site (wet season sampling)

The new site is located in the Kathita Munyi river and approximately 5 km upstream of the former proposed site. Though the number of feacal coliform has more than the former intake site, the raw water at the new intake site still has suitability as a drinking water and this water can apply for the source water.

2) Nkubu

The intake site sampling point was about 4 km upstream of the existing intake. The upstream sampling point was 100 m further upstream of the proposed intake. The downstream point was at wastewater effluent outfall on Thingithu river. The water quality at the intake location indicated a high value of coliform. This high coliform contamination is associated with upstream land-use. Farmers are living with cattle upstream of the intake site, which appears to have influenced the water quality. Other parameters generally satisfy the WHO guidelines. Treatment is required to remove at least the bacteriological count.

3) Isiolo

The intake sampling point at Isiolo river was about 2 km upstream of the existing intake, and the upstream sampling point was 100 m further upstream. Samples from Kithima spring were taken about 6 km upstram from the confluence of the resultant stream and the Isiolo river. The downstream point was at the outfall of the wastewater effluent on Isiolo river. The sample taken from proposed intake site indicated a rather high coliform count. This is due to livestock grazing and watering around the site. Other parameters met WHO guidelines. Treatment is required to remove bacteriological count.

4) Chuka

The intake point sample was taken about 9 km inside the Mt. Kenya forest. The upstream sampling point was taken a further around 100 m upstream. The downstream sampling point was at wastewater effluent outfall on Kurugucha river. The water quality at the proposed site was fairly good, and met WHO guidelines for drinking water.

5) Chogoria

The intake sampling point was on the Mara Manyi river, approximately 2 km inside Mt. Kenya forest. The upstream sampling point was a further 100 m upstream of the intake. The downstream was at the wastewater effluent outfall on the Kirurumwe river. All the parameters satisfied the WHO guidelines for drinking water.

6) Maua

The sampling point at the intake site was several hundred meters upstream of the existing intake. The intake site is located downstream of the Mboone river water fall, so that upstream sampling was not conducted. The downstream sampling point was at the wastewater effluent outfall on Mboone river. Intake site water indicated good quality for drinking water, and it satisfies all the WHO parameters.

7) Tigania

a) Old Site (dry season)

The intake sampling point was at the Thangatha spring. No upstream sampling was done, and downstream sample was taken at the wastewater effluent outfall on Thangatha river. The intake water sample satisfied all the WHO guidelines and indicates suitability for drinking water.

b) New Site (wet season)

The new intake site is also located in the Thangatha River and it is several hundreds meter downstream of former intake site. One tributary stream flows into the river just upstream of new proposed site. The raw water quality still satisfy the raw water guideline for coliform organisms. Other parameters are almost same as former site and the water has good quality.

(2) Groundwater

Water quality survey for boreholes were conducted in March 1997. Survey results are shown in ***Table J-9***. The Borehole 1635(2) result looks suspicious. It is assume that oil leaked from the equipment. Sodium quantity was less than existing data, but the result still contained high volume of those. Other factors were almost same as existing data.

2.3 Water Quality Monitoring Test on Existing Facilities

(1) Surface Water

Spot water quality monitoring were also conducted in Meru , Nkubu, Isiolo on existing works. The samples were recorded higher values of turbidity than the samples taken in September 1996, and indicate low-grade suitability for drinking water. The resultant data are attached in ***Table J-10.***

(2) Groundwater

Groundwater constitutes one of the water resources in Isiolo project. Some of existing boreholes were tested by spot water quality analysis. Resultant of chemical water qualities is shown in ***Table J-11*** . Four samples are assumed to use as Isiolo town water supply. Though most of them contain high ratio of total hardness, they still qualify WHO standard of water resource. C7924 borehole, which is closest one from proposed drilling points, exceeds Sodium (Na) and Total Dissolved Solid (TDS) standards extremely high. It is therefore water quality analysis is required to verify the existing data and if the water contains high volume of Na and TDS, full treatment is necessary for supplying water.

3. RESULTS OF INITIAL ENVIRONMENTAL EXAMINATION (IEE)

3.1 IEE Method for the Project

There are many guidelines existing such as those by the World Bank, African Development Bank and so on. JICA however, also has their own guidelines. As described in 1.2, the Kenyan EIA guideline regulation is currently being discussed by parliament. Both guidelines use the check list method for screening and scoping and those are not much different. Screening and scoping for the EIA for this Study has

been based on the JICA guideline, because it has already established in public, and modifies appropriately to adjust to the draft Kenyan guidelines.

3.2 General Description of the Projects

The projects consist of 7 individual ones and they are no relation with each other. Components of the each project basically contain the intake, transmission pipeline, water treatment facilities and distribution pipelines network. Water will be taken from the river, however, alternatives such as groundwater, springs water are also studied in case of Isiolo water supply. Hence IEE in Isiolo is carried out including not only the river water but also the groundwater, and the spring water.

Meru, Chuka, and Chogoria project components are relatively close and some structures of those projects will be located in the Mt. Kenya area. Surroundings of the Nkubu project expand the coffee and tea plantations and it is supposed that the project will be affected by these plantations. Maua and Tigania project components include a part of the Nyambene forest. Isiolo is the only area which is located in the semi-arid climate, and annual rainfall is only one third of the other areas. Hence hydrological consideration will be necessary more than the other projects. Meru and Tigania intake sites were shifted based on the suggestion of the Interim Report and Master Plan in Meru and Tigania were revised to apply for the new site. It is therefore that IEE study in both areas is described for new master plan.

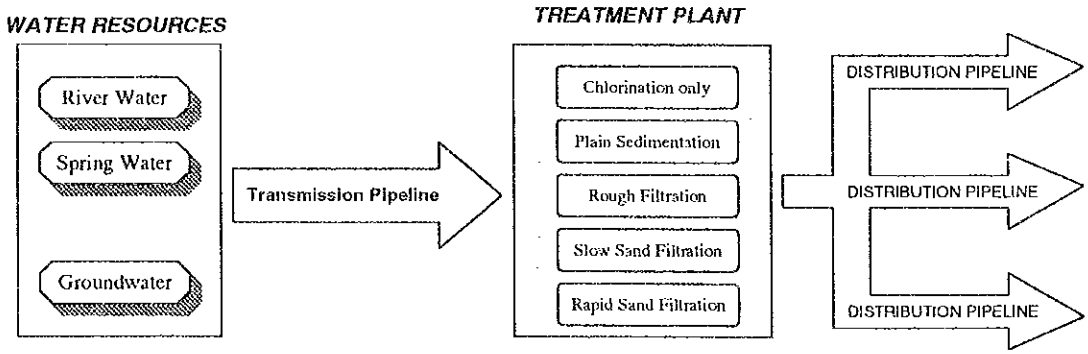


Figure J-8 Schematic Project Components of The Projects

3.3 Screening of the Projects

Screening is the first step to evaluate the impact on environment, if the development project proceeds. A screening check list for all the sites is provided in the following. This indicates the environmental concerns applicable to each site. Items which concerned all identifies as "yes", or as questionable "?" are discussed in more detail in

the following sections.

Table J-12 Screening Check List in Seven Towns

ITEMS	Meru			Nkubu			Isiolo			Chuka			Chogoria			Maua			Tigania		
	Yes	No	?	Yes	No	?	Yes	No	?	Yes	No	?	Yes	No	?	Yes	No	?	Yes	No	?
Human Environment																					
1 Resettlement			●	●					●			●	●					●			●
2 Economic Activity	●			●					●	●			●					●			●
3 Transport		●			●			●			●			●			●			●	
4 Separation of Community		●			●				●		●			●			●			●	
5 Cultural Heritage		●			●			●			●			●			●			●	
6 Water Right, Common Right			●			●	●					●			●			●			●
7 Sanitation	●			●			●			●					●	●			●		
8 Waste Disposal		●			●				●		●			●			●			●	
9 Dangers		●			●			●		●			●				●			●	
Natural Environment																					
10 Topography and Geology		●			●				●		●			●			●			●	
11 Soil Erosion			●	●			●				●			●				●		●	
12 Groundwater		●			●				●		●			●			●			●	
13 Lake, Marsh and River			●			●	●					●			●			●			●
14 Coastline and Sea		●			●			●			●			●			●			●	
15 Flora and Fauna			●			●			●			●			●		●				●
16 Weather		●			●			●			●			●			●			●	
17 Landscape		●			●				●		●			●			●			●	
Environmental Pollution																					
18 Air Pollution		●			●			●			●			●			●			●	
19 Water Pollution	●			●			●			●			●			●			●		
20 Soil Contamination		●			●			●			●			●			●			●	
21 Noise and Vibration		●			●			●			●			●			●			●	
22 Land Subsidence		●			●				●		●			●			●			●	
23 Offensive Odor		●			●			●			●			●			●			●	

3.4 Initial Environmental Examination

3.4.1 Human Environment

(1) Resettlement

The transmission and distribution pipeline routes of all the projects basically pass along the existing road, and serious resettlement may not be required for the area. The sites for the structures are located in different conditions and each project conditions are described as follows.

1) Meru

The general land use around the intake and treatment area is gazetted forest,

forest plantation and agricultural land. There are no villages in the vicinity of proposed intake site and proposed treatment plant site. The few structures in the vicinity of the treatment plant have been illegally built on government land. Resettlement may not therefore be necessary for the structure land.

2) Nkubu

The intake site is surrounded by plantation land. There is no access road to the river, so that a new road is necessary for the construction and access. Several houses and one coffee factory stand next to the site, and the route will pass through some private land. Land acquisition will be needed depending on the pipeline route or access road route.

3) Isiolo

The area around Isiolo river is utilized for farmland and grazing, and same cultivation takes place within the river banks. In the case of river water development, resettlement of farmland, especially inside the river banks, will be needed. The surrounds of Kithima spring consist of woods and the construction will affect those woods. Riverine woodland, and this land use continues to the confluence with the Isiolo river. If the private woods include among them, resettlement will be necessary for the owners. Boreholes area is located along the existing local road and land use of sites and surroundings are plain. Human activities like cultivating or fencing are not taken place. Hence, resettlement issue together with land acquisition will not arise at all in the sites.

4) Chuka

The intake is located inside Mt. Kenya forest well away from human habitation, and resettlement does not therefore arise. The treatment plant is also located within the forest reserve, close to its boundary, and it is not therefore necessary for resettlement.

5) Chogoria

The proposed intake is in Mt. Kenya forest, and surrounds consist of tropical forest. Land use at the proposed plant site is at the forest edge and

its surrounding consists of shrubs, and one house stands next to the site. Resettlement will not be required among those facilities.

6) Maua

The proposed intake site is located at the middle of Mboone river as it descends a steep escarpment. The proposed plant is located along the side of the river and surrounds have already been developed for agricultural land. Land acquisition may take place during the construction stage, but it should be possible to avoid the resettlement. The pipeline route may pass through some agricultural land. It is therefore that wayleaves will be required where pipelines cross agricultural land.

7) Tigania

The intake site is located at border of the Nyambene forest, and vegetation lands which are cultivated tea plantation, maize, etc., exist around the site. Resettlement problems does not arise along the transmission pipeline route.

(2) Economic activity

Total amount of the land to be acquired for the project is not much, but planning of the route should care to minimize the impact. Impacts on the each project sites are as follows.

1) Meru

The Muchichica forest plantation area lies to the east side of the intake site. Agriculture is widely practiced around the treatment plant site, and farmers cultivate mainly maize. Some land inside Muchichia plantation and the surrounding farmland will be acquired by the project. However, land required would be for wayleaves of the pipeline route, and any impact for the economic activity will therefore be slight.

2) Nkubu

Coffee and tea are the major industries around the site. Farming in the area is entirely small-scale, and extends to the foot of Mt. Kenya forest. One coffee factory is being operated next to proposed treatment plant site. Land acquisition may be necessary for farmers land to construct pipeline or

access road to the intake. Hence, due to the small-scale of the farms, the project may affect their income.

3) Isiolo

Agriculture is a major economic activity along the Isiolo river. Since the farming scale is relatively small, it is supposed that farming income is also not high. If a water intake structure is built on the Isiolo river, a significant area of farmland will be flooded and will need to be acquired for their life.

Habitants close to Kithima springs are generally livestock pasturalists. They own cows, sheep, goats, and others and utilize spring water. Unless their water requirements are compensated the development of this source will affect their livelihood.

Crops are cultivated along the proposed pipeline route, however, its scale is small so that no significant problem will happen. Pasturing is done frequently around each site so that consideration for livestock activity is necessary.

4) Chuka

Timber is the only economic activity at the intake and treatment plant sites. Though the total area of land affected is not much, land along the transmission pipeline route will be acquired by the construction. Since the pipeline routes will tend to be located in road reserves, where they pass through farmland, required wayleaves will not be much and the problem may not be so serious.

5) Chogoria

Logging is the major economic activity in this part of Mt. Kenya forest. Total amount of the area is not so high and impact for the economic activity is slight. Small-scale agricultural farming is practised below the treatment plant site, including tea/coffee and other cash as well as subsistence crops. In case that private land is acquired as pipeline route, wayleaves to be required will not affect the farmers economic activity much.

6) Maua

The land around the site is currently used for the agriculture. The existing raw water pipeline follows the route of a foot path and causes some obstruction to pedestrians. The proposed pipeline will follow a parallel route, but will pass underground. Land for the wayleaves is slight, and influence on the farmers activity may not be serious.

7) Tigania

A village settlement has already existed in the center of Nyambene forest. The major economic activity is timber logging, but tea plantations are also evident at the foot of the forest. Though the pipeline routes may pass through farmland, amount of wayleaves will not be many and impact on the economic activity is insignificant.

(3) Transport

Transmission pipeline routes for all the projects pass inside the forest or local roads with few traffic volume. Hence interruption of the local transport will be negligible even in the construction stage. On the other hand, distribution pipeline routes plan to pass along the road relatively close to the town. It is therefore necessary to pay attention not to interrupt the local traffic especially during the construction stage.

(4) Separation of Community

In case of spring development in Isiolo area, the transmission pipeline route will pass along side the A2 Route, the main North South trunk road on which the regional community relies for its communications with the rest of the country. Proper planning and construction of the pipeline method is therefore required so as not to interrupt regional communications.

(5) Cultural Heritage

There are no cultural heritages around the sites. A shrine stands close to the Maua intake site, however the project does not affect the shrine and it does not need any protection for it.

(6) Water Right

Water rights in each project are shown in ***Table J-13 to J-19.*** Schematic diagram are prepared in Meru, Nkubu and Isiolo project respectively, since those have the grid reference data. The Water Apportionment Board manages all the water right in the river. The Study surveyed the registered water right only and it does not reflect actual situation including illegal abstractions. However, the Water Act stipulates as " the right to the use of every body of water is hereby declared to bd vested in the Minister, and, except in accordance with any such right, no person shall divert, abstract, obstruct or use water from a body of water otherwise than under this Act.", and it does not hereby ponder about illegal abstractions.

1) Meru

Two intakes have already existed in the upstream of the new proposed site. One intake is prepared for the community water supply project. The other intake is under construction. This project is called CEFA project and the capacity of water supply is approximately 8,300 m3/day. Meru project plans to supply water 22,000 m3/day. Flow rate at intake site is over 100,000 m3 and these intake volume does not have any hydrological problems. Water rights for downstream is less than 1,000 m^3/day and the discharge volume of the flow measurement result at downstream has more than 100,000 m^3/day. It is therefore water right is insignificant at intake site and down stream.

Table J-20 Flow Measurement and Downstream Water Right in Kathita River

Location	m^3/day Discharge
Community Water Supply	
CEFA Project	8,300
Proposed Intake Site	78,278
Downstream Water Right	963
Effluent Outfall	100,244

2) Nkubu

Main water usage appears to be for upstream irrigation. The registered

water right exists only in upstream and no abstraction exists in downstream. River discharge at the intake site exceeds 18,000 m^3/day and this is more than 6 times of the intake volume. Therefore problem will not take place in Nkubu.

Table J-21 Flow Measurement and Downstream Water Right in Kiugandegwa River

m^3/day

Location	Discharge
Proposed Intake Site	18,662
Downstream Water Right	0
Effluent Outfall	78,710

3) Isiolo

Many registered water rights exist on the Isiolo river. In addition, some of the upstream water rights are within Meru district. The water abstraction rights already granted in the spring water flow are 100 m^3/day and it does not affect the Isiolo river flow. The total water rights in Isiolo river have already exceeded the discharge at intake site, so that the water can not taken without any limitation for the existing rights. The spring water is the better water resource to avoid water right problem.

Table J-22 Flow Measurement and Downstream Water Right in Isiolo River

m^3/day

Location	Discharge
Proposed Intake Site at Spring	5,098
Downstream Water Right	101
Proposed Intake Site at Isiolo river	5,270
Downstream Water Right	5,289
Effluent Outfall	432

4) Chuka

More than 90% of registered water rights are used for irrigation. Discharge at the intake site shows more than 8 times of the registered discharge. Since location of effluent outfall is different from the Ruguti

river, the effluent outfall quantity is very little to compare with the intake site discharge. Problems concerning as water rights will not be supposed to take place under this conditions.

Table J-23 Flow Measurement and Downstream Water Right in Ruguti River

Location	Discharge (m^3/day)
Proposed Intake Site	33,264
Downstream Water Right	3,842
Effluent Outfall (Kurugucha River)	1,123

5) Chogoria

The registered water abstraction for Chogoria is much more than for other projects. Moreover, the abstraction water rights exceed the river flow rate more than two times. Grid reference is not shown in the water rights list, so it is not clear whether all the water rights originate from the Mara Manyi river. It is therefore requested to confirm water undertakers' locations and actual undertaking rate.

Table J-24 Flow Measurement and Downstream Water Right in Mara Manyi River

Location	Discharge (m^3/day)
Proposed Intake Site	13,219
Downstream Water Right	33,052
Effluent Outfall (Kirurumwe River)	3,370

6) Maua

Water rights issued for the Mboone river amount to approximately 2,800 m^3/day. In addition to the registered water rights, it was noted that a self-help project also operates an upstream intake. The flow rate of the Mboone river was measured as approximately 1,900 m^3/day. It is supposed that actual operation for the intake flow differs from registered discharge, and it needs to clarify the operational conditions.

Table J-25 Flow Measurement and Downstream Water Right in Mboone River

m^3/day

Location	Discharge
Proposed Intake Site	1,901
Downstream Water Right	2,772
Effluent Outfall	3,197

7) Tigania

The registered water abstraction rights in Tigania are low compared to the other six projects. Flow measurements at intake new site indicated around 4,600 m^3/day. Effluent outfall discharge is about 50,000 ton/day. Though intake volume satisfies the water demand projection, amount of water demand projection and existing water right are over 4,600 m^3/day, it is necessary to consider coordination among them.

Table J-26 Flow Measurement and Downstream Water Right in Thangatha River

m^3/day

Location	Discharge
Proposed Intake Site	4,579
Downstream Water Right	666
Effluent Outfall	49,248

(7) Sanitation

As for the public awareness survey results, more than 85 % of the residents have had the water-related diseases in the areas. Meru and Isiolo are the only towns which have the sewage treatment plant and a monitoring survey was conducted by the Study. According to the monitoring survey, it is found that approximately 30% of the population in both towns can be sewered. Unsewered premises use septic tanks or pit latrines. Other towns do not have any wastewater treatment facilities, and sewage is infiltrated to the ground. In the case of increased water supplies, the sewage volume will also increase, and sanitary conditions are likely to deteriorate. Improved measures for sanitation combined with hygiene education are therefore necessary for the residents.

Table J-27 Family Numbers Affected by Water-Related Diseases in Each Area

Sample : 100 families each

Area	Malaria	Typhoid	Cholera	Dysentry	Others	None
Meru	76	13	0	3	44	14
Nkubu	78	4	0	1	46	18
Isiolo	62	25	5	0	40	23
Chuka	85	5	3	13	58	9
Chogoria	96	5	0	8	66	1
Maua	51	2	2	5	50	28
Tigania	81	3	4	6	66	5

Source : Public Awareness Survey

(8) Waste Disposal

In case of Isiolo river development, a dam is one of the choices of the development method. Heavy volume of waste dumps generation will be anticipated, detailed survey for the waste disposal such as wastes volume, damping site, is therefore required.

(9) Dangers

Both side slopes of the river at the intake site are steep at Meru, Nkubu, Chuka and Chogoria intakes. The existing track only follows the ridge above the site. Hence an access road is required down the steep valley sides for construction of the intake. As for Chuka, it will therefore be necessary to carefully design this access road to avoid induce environmental damage on to ensure safety for traffic.

3.4.2 Natural Environment

(1) Topography, Geology, and Landscape

These subjects are considered in Isiolo as a dam is planed as an intake structure. The dam height is between 10m and 20m so that surrounding topography is not much changed. Further, there is no significant structures around the site and the project does not affect the site landscape. In case of other development methods, they are not a serious problem, because the structures are small scaled. The other projects' structures are also small scaled ones, so that impacts are insignificant.

(2) Soil Erosion

Meru, Chuka, and Chogoria intake sites consist of the rock surface, and upstream of the river is covered by the forest. It is therefore that soil erosion does not occur during operation stage. Impact of the other towns having possibility for soil erosion are as follows.

1) Nkubu

The steeply sloping cultivated fields around the intake site have no slope protection. Tea and coffee plantations cover the catchment area upstream of the intake. The steep slopes, types of crop and methods of cultivation combined encourage a high soil erosion. A silt trap facility to store the sediment is therefore necessary at the intake.

2) Isiolo

Soil type at the proposed intake in Isiolo river is rocky red loam. Both sides of bank slope are gentle; however, they have little natural grass coverage. Since small scale farming activity is carried out inside the river bank, the hazard of soil erosion on the banks is high. It will be necessary to provide slope protection to minimize soil erosion.

3) Maua

There is no sedimentation at existing intake. The river bed mainly consists of rock material, and the discharge volume is less than 50 lit./sec. However, this survey and water sampling test was conducted during the dry season, indicates that the catchment area contains agricultural land where there is a high risk of soil erosion particularly in the rainy seasons. It is therefore recommended that soil protection planning is practised especially along the upstream river banks.

4) Tigania

The new proposed intake site is located at the border of the Nyambene forest and vegetation lands expand upstream of the intake site. Soil erosion may happen in rainy season, hence, slope protection at agricultural lands will be recommended.

(3) Groundwater

Existing chemical water quality in Isiolo is not so suitable as surface water, and relatively sophisticated water treatment process may be required. There appears to be no serious hydrological impact and environmental pollution of groundwater at present. Major environmental impacts related to the groundwater development are;

1) Impacts on surrounding boreholes' water potential
2) Land subsidence caused by over pumped
3) Inflow into the test borehole from surroundings

One borehole affects to groundwater of surroundings approximately within a diameter 500m. Proper pumping discharge should be set not to prevent the groundwater situation. Hence, the discharge does not affect any impact for groundwater potential.

(4) Hydrological Situation

The results of the flow measurement, the water demand projection in 2010 and the total water right in downstream are compared below. The flow measurements of Meru, Nkubu, Chuka, and Chogoria are over the total volume of the demand projection and the water right. Hence, those sites satisfy the hydrological condition. The flow measurement result of Isiolo taken from the river and Maua exceeds the total of the demand projection and the water right. In these areas, it can not take all the registered water discharge from the river in downstream. Adjustment of the water volumes will be necessary to satisfy the water supply. Though the flow measurement in Tigania is also over the demand projection, total amount of water demand and water right are nearly equal to the flow measurement. It is therefore that detailed hydrological survey will be required to avoid troubles.

Table J-28 Flow Measurement, Water Demand Projection in 2010 and Water Right

m^3/day

Project	Flow Measurement	Demand Projection	Water Right
Meru	78,278	22,000	963
Nkubu	18,662	2,000	0
Isiolo (Spring)	5,098	4,400	101
Isiolo (River)	5,270	ditto	5,289
Chuka	33,264	4,400	3,842
Chogoria	13,219	2,900	33,052
Maua	1,901	1,650	2,772
Tigania	4,579	4,000	666

(5) Coastline and Sea

All the sites are located inland area and there are far from the coast. Hence, they does not affect anything for the coastline and sea area.

(6) Flora and Fauna

Many species of wildlife such as elephant, buffalo, monkey, etc. and many tropical forest species exist in the Mt. Kenya forest. Elephant being the most notable as evident from their spore left along the logging tracks.

In case of Chuka and Chgoria project, a new road is necessary for construction and it may impact on the wildlife in the forest. Appropriate construction methods are therefore necessary to conserve wildlife.

Other major issues for the flora and fauna in each project are as follows.

1) Meru

Effluent from wastewater treatment plant flows into the Kathita river which passes through agricultural land and eventually reaches Meru National Park. Hence, it is required that wastewater planning should be designed to minimize impacts on animals.

2) Isiolo

Some wild animals such as monkeys live in the grove around Kithima springs; however, the total number is not many to judge from woodland

scale. Nevertheless, development methods should be designed to conserve them.

3) Tigania

The Nyambene forest has many types of animals however, their numbers are relatively few. Though all the structures are small scaled, planning should minimize the impact for the flora and fauna in the forest.

(7) Weather

All the structures in each site are not large scaled ones and impact for the local weather is negligible.

(8) Landscape

The dam planning in Isiolo project will change the surrounding landscape, however, there are no valuable landscape around the site and this issue is insignificant. Other projects have also no symbolic landscape, it is therefore negligible.

3.4.3 Environmental Pollution

(1) Air Pollution

There is no evidence for the air pollution and no harmful material will be applied for the project. It is therefore air pollution will not occur when the project is implemented.

(2) Water Pollution

Meru and Isiolo have the wastewater treatment facilities. Other towns do not have treatment facilities and wastewater is treated by the septic tanks and pit latrines. It is infiltrated to the ground eventually. Since the sewage volume will increase as the water supply increases, improved wastewater sanitation planning is necessary to conserve the environmental health conditions of the town and downstream water quality.

The results of the Meru and Isiolo towns are described in below.

1) Meru

Water quality of the effluent from the wastewater treatment pond indicates a high BOD value compared with normal wastewater standards. It is caused by over-loading and poor operation and maintenance of the pond. Treated water from the pond flows into the side ditch along the road leading to Kathita river. Hence, expansion of the waste stabilization pond system and renovation of side ditch are urgently required for the water pollution protection.

2) Isiolo

Water pollution caused by effluent from the wastewater treatment plant is a serious problem at present. Effluent water is used for downstream irrigation, and its water quality does not satisfy natural wastewater standards. The impact on humans and crops are major concerns, and hygiene education for the farmers is also necessary.

(3) Soil Contamination

As the results of the water quality test, harmful materials, which can affect the environment were not generated. Hence, it is supposed that no project will cause soil contamination problem.

(4) Noise and Vibration

Noise and vibration will take place during the construction period, however, there are not many heavy equipment operating and the areas for the major structures are not located in the town area. Hence, noise and vibration is negligible .

(5) Land Subsidence

On existing condition in Isiolo, land subsidence was not reported in the EAP in 1993. It appears that it does not occur under the present water abstraction regime.

One borehole affects to groundwater of surroundings approximately within a diameter 500m. There are no existing boreholes found in peripheral area, it is supposed that no impacts will take place around the sites, if proper volume will be taken.

(6) Offensive Odor

Offensive odor is not generated from any of the treatment plant at present. Treatment method to be applied for the project will not be much different from present method. This will not be supposed to take place during the operation phase.

3.5 Summary of Scoping for EIA for Each Project Site

Scoping for EIA aims to clarify the potential environmental impacts through the IEE exercise. Environmental impacts are evaluated as four levels from the most serious level (A) to almost no impact (D). The check list result for seven projects is attached below. There are some alternatives of the water resources in Isiolo and IEE scoping includes all alternatives. Planning will decide one water resource eventually so that it will be necessary to reconsider the impacts in the next stage.

Table J-29 IEE Check List in Seven Towns

No Items	Meru	Nkubu	Isiolo	Chuka	Chogoria	Maua	Tigania
1. Human Environment							
1 Resettlement	D	D	D	D	D	D	D
2 Economic Activity	C	C	C	C	C	C	C
3 Transport	C	C	C	C	C	C	C
4 Separation of Community	D	D	D	D	D	D	D
5 Cultural Heritage	D	D	D	D	D	D	D
6 Water Right and Common Right	C	D	C	D	C	C	D
7 Sanitation	C	C	C	C	C	C	C
8 Waste Disposal	D	D	C	D	D	D	D
9 Dangers	D	D	D	D	D	D	D
2. Natural Environment							
1 Topography and Geology	D	D	D	D	D	D	D
2 Soil Erosion	D	C	D	D	D	D	C
3 Groundwater	D	D	C	D	D	D	D
4 Lake, Marsh and River	C	D	D	D	D	D	D
5 Coastline and Sea	-	-	-	-	-	-	-
6 Flora and Fauna	C	C	C	C	C	C	C
7 Weather	D	D	D	D	D	D	D
8 Landscape	D	D	D	D	D	D	D
3. Environmental Pollution							
1 Air Pollution	D	D	D	D	D	D	D
2 Water Pollution	B	B	B	B	B	B	B
3 Soil Contamination	D	D	D	D	D	D	D
4 Noise and Vibration	D	D	D	D	D	D	D
5 Land Subsidence	D	D	C	D	D	D	D
6 Offensive Odor	D	D	D	D	D	D	D

Evaluation Key :
A Serious impact expected
B Minor impact expected
C Uncertain (may become clear on investigation)
D Almost no impact expected, no need for EIA

3.6 Results of IEE

Most of projects' components consist of small scaled structures and impacts on the projects are not so serious. A dam construction in Isiolo is an exceptional case. However dam construction was not suitable planning in Isiolo project, so this plan was resigned.

EIA items through the IEE study are as follows;

(1) Flora and Fauna in Mt. Kenya Forest Area in Meru, Chuka, and Chogoria.

Damages for plants, animals, and soil will also take place so that the construction method to conserve them will be requested.

(2) Land Acquisition Problem

Land acquisition problem causes resettlement of the residents, degradation of the regional economy. Estimation of the resettlement and economic activities damages will be necessary.

(3) Wastewater Problem

Quantitative estimation for the wastewater will be requested in EIA.

(4) Hydrological Problem

Several projects do not satisfy the hydrological conditions, and it will be necessary to clarify it in EIA stage.

TABLES

Table J - 1 Raw Water Guideline For Coliform Organisms

Number/100 ml	Required treatment
0 - 50	Bacterial quality requiring disinfection only
50 - 5000	Bacterial quality requiring full treatment - coagulation - sedimentation - filtration - disinfection
5000 - 50000	Heavey pollution requiring extensive treatment
greater than 50000	Very heavy pollution, unacceptable as source unless no alternative exists. Special treatment needed.

Note : When more than 41% of the number of coliforms are found to be of the coliform group, the water source should be considered to fall into the ne category with respect to the treatment required

Table J - 2 Distributed Water Guideline

1 Piped Water Supplies		
1) Treated water entering the distribution system		
Faecal Coliforms	0	Turbidity 1 NTU; for disinfection with chlorine
Coliform Organisms	0	PH preferably <8.0 free chlorine residual 0.2-0.5 mg/l following 30 minutes (minimum) contact
2) Untreated water entering the distribution system		
Faecal coliform	0	
Coliform organisms	0	In 98% of samples examined throughout the year for large supplies with surficient sample examined
Coliform organisms	3	In occasional sample but not in consecutive samples
Water in the distribution system		
Faecal coliforms	0	
Coliform organisms	0	In 95% of samples examined throughout the year for large supplies with surficient sample examined
Coliform organisms	3	In occasional sample but not in consecutive samples
Unpiped water supplies		
Faecal coliform	0	
Coliform organisms	10	Not occuring repeatedly. Repeated occurance and failure to improve sanitary protection, alternate source to be found if possible

Table J - 3 Inorganic Constituents of Health Significance

Parameter	Unit	Guideline Value	Remarks
Arsenic	mg/l	0.05	
Asbestos	-	No guideline value set	
Barium	-	No guideline value set	
Beryllium	-	No guideline value set	
Cadmium	mg/l	0.005	
Chromium	mg/l	0.05	
Cyanide	mg/l	0.1	
Fluoride	mg/l	1.5	Natural or deliberately added. Local or climatic conditions may necessairate adaption.1
Hardness	-	No healthrelated guideline value set	
Lead	mg/l	0.05	
Mercury	mg/l	0.001	
Nickel	-	No guideline value set	
Nittate	mg/l(N)	10	
Nitrite	-	No guideline value set	
Selenium	mg/l		
Silver	-	No guideline value set	
Sodium	-	No guideline value set	

Note : In exceptional cases a Fluoride content of 3 mg/l may be accepted in Kenya.

Table J - 4 Organic Constituents of Health Significance

Parameter	Unit	Guideline Value	Remarks
Aldrin & Dieldrin	µg/l	0.03	
Benzene	µg/l	10	
Benzo-a-pyrene	µg/l	0.01	
Carbon retrachloride	µg/l	3	Tentative guideline value
Chlordane	µg/l	0.3	
Chlorobenzenes	µg/l	No health related guideline value set	Odour threshold concentration between 0.1 and 3 mg/l
Chlorophenols	µg/l	No health related guideline value set	Odour threshold concentration between 0.1 mg/l
Chloroform	µg/l	30	Disinfection efficiency must not be compromised when controlling this parameter
2,4,D	µg/l	100	
DDT	µg/l	1	
1,2 Dichloroethane	µg/l	10	
1,1 Dichloroethylene	µg/l	0.3	
Heptachlor and	µg/l	0.1	
Heptachlor epoxide	µg/l		
Hexachlorobenzene	µg/l	0.01	
Lindane	µg/l	3	
Methoxychlor	µg/l	30	
Pentachlorophenol	µg/l	10	
Tetrachloroethelene	µg/l	10	Tentative guideline value
Trichloroethylene	µg/l		Tantative guideline value
2,4,6 Trichlorophenol	µg/l		Odour threshold Concentration is 0.1 µg/l
Trihalomethanes	µg/l	No guideline value set	See chloroform

Table J - 5 Desirable Aesthetic Water Quality Guideline

Parameter	Unit	Guideline Value	Remarks
Aluminium	mg/l	0.2	
Chloride	mg/l	250	
Chlorobenzenes and	mg/l	No guideline value set	These compounds are capable
Chlorophenols	mg/l		of affecting taste and odour
Colour	TCU	15	
Copper	mg/l	1	
Hardness	mg/l	500	as $CaCO_3$
Hydrogen sulphide		Not detectable by consumers	
Iron	mg/l	0.3	
Manganese	mg/l	0.1	
Oxygen (dissolved)		No guideline value set	
Ph		6.5 to 8.5	
Sodium	mg/l	200	
Solids (total dissolved)	mg/l	1000	
Sulphate	mg/l	400	
Taste and odour		Inoffensive to most consumers	
Temperature		No guideline value set	
Turbidity	NTU	3	Preferably <1 for disinfection
			efficiency
Zinc	mg/l	5	

Note : TCU means True Colour Unit
NTU means Nephelometric Turbidity Units

Table J - 6 Permissible Aesthetic Water Quality Guideline

Parameter	Unit	Guideline Value	Remarks
Aluminium	mg/l	0.2	
Chloride	mg/l	***600***	
Chlorobenzenes and	mg/l	No guideline value set	These compounds are capable
Chlorophenols	mg/l		of affecting taste and odour
Colour	TCU	***50***	
Copper	mg/l	***1.5***	
Hardness	mg/l	500	as $CaCO_3$
Hydrogen sulphide		Not detectable by consumers	
Iron	mg/l	***1***	
Manganese	mg/l	***0.5***	
Oxygen (dissolved)		No guideline value set	
Ph		***6.5 to 9.2***	
Sodium	mg/l	200	
Solids (total dissolved)	mg/l	***1500***	
Sulphate	mg/l	400	
Taste and odour		Inoffensive to most consumers	
Temperature		No guideline value set	
Turbidity	NTU	***25***	Preferably <1 for disinfection efficiency
Zinc	mg/l	***15***	

Note : TCU means True Colour Unit

NTU means Nephelometric Turbidity Units

Table J - 7 Water Quality Survey Results (Wet Season)

PARAMETERS	UNIT	MERU			NKUBU		ISIOLO		CHUKA		CHOGORIA		MAUA		TIGANIA		
		Kathita Muriyi River 29th Mar	Kathita Muriyi River 29th Mar	Kathita Muriyi River 30th Mar	Kiguandogwa River 28th Mar	Kiguandogwa River 31st Mar	Kathima Springs 29th Mar	Kathima Springs 31st Mar	Maiyaga (Rujaini) River 29th Mar	Maiyaga (Rujaini) River 30th Mar	Mara Mamvi River 27th Mar	Mara Mamya River 30th Mar	Mitunguu River 28th Mar	Mitunguu River 31st Mar	Thangatha River 28th Mar	Thangatha River 29th Mar	Thangatha River 31st Mar
pH		7.89	8.28	8.30	8.08	8.09	8.14	8.18	7.78	7.87	8.04	8.05	7.91	7.8	7.52	8.05	8.06
Apparent Colour	o H	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
True Colour	o H	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Conductivity	µs/cm	104	98	95	98	76	207	206	75	71	65	59	60	83	92	60	60
Turbidity	F.T.U.	0.3	0.4	1.1	1.9	1.4	1.2	1.1	0.9	1.7	0.5	1.5	0.5	2.5	0.2	0.4	1.2
Calcium Hardness as CaCo3	mg/l	2	2	2	4	8	22	22	2	2	2	2	8	8	4	12	8
Total Hardness asCaCo3	mg/l	6	18	18	32	66	176	174	18	18	18	18	62	60	12	76	68
Total Alkalinity as CaCo3	mg/l	50	94	90	70	28	72	74	70	70	72	72	22	22	46	32	30
Carbonate Alkalinity	mg3/l	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron	mg/l	0.04	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.01	0.06	0.02	0.02
Fluorides	mg/l	0.45	0.31	0.32	0.38	0.38	0.28	0.26	0.32	0.32	0.30	0.30	0.40	0.41	0.43	0.43	0.44
Sulphates	mg/l	44	38	37	38	38	48	50	40	42	38	40	38	40	60	56	56
Phosphates	mg/l	0.05	0.01	0.01	0.02	0.02	0	0	0.03	0.03	0	0	0.03	0.02	0 06	0.02	0.01
Silica	mg/l	47	54	56	44	44	64	63	58	60	48	50	52	52	86	82	82
Dissolved Oxygen	p.p.m.	6.0	5.8	5.8	5.9	5.9	5.4	5.4	6.0	6	5.8	5.9	5.6	5.6	5.9	5.9	5.9
Nitrates	mg/l	0.06	0	0	0	0.01	0.01	0.01	0.01	0	0.01	0.01	0.02	0.01	0.04	0.03	0.02
Manganese	mg/l	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chlorides	mg/l	25	10	17	23	12	32	30	24	24	16	21	42	23	27	25	33
Chromium	mg/l	0.02	0	0	0.01	0.01	0	0	0.01	0.01	0	0	0.01	0.01	0 01	0.01	0
Copper	mg/l	0.02	0.01	0.01	0	0	0	0	0	0	0	0.01	0.01	0.01	0	0.01	0
Total Coliform	/ml	60	10	410	90	320	550	500	220	15	0	90	200	170	270	100	20
Total Feacal Coliform	/ml	5	0	70	0	50	100	100	30	0	0	0	30	0	20	0	0
Dissolved Solids	mg/l	182	150	130	160	140	280	260	65	65	150	135	160	130	181	150	155
Suspended Solids	mg/l	0	10	25	15	15	30	20	25	25	20	5	15	25	0	20	25
Total Solids	mg/l	2	160	155	175	155	310	280	90	90	170	140	175	155	191	170	180
Biochemical Oxygen Deman	mg/l	8	4	4	2	0	6	4	0	8	6	6	2	0	2	0	2
Chemical Oxygen Demand	mg/l	8	8	8	4	4	8	8	12	12	10	12	8	8	6	4	4

Table J - 7 Water Quality Survey Results (Dry Season)

PARAMETERS	UNIT	MERU				NKUBU			ISIOLO					CHUKA			CHOGORIA			MAUA			TIGANIA		
		UP STREAM	PROPOSED INTAKE	DOWN STREAM	DOWN STREAM	UP STREAM	PROPOSED INTAKE	DOWN STREAM	ISIOLO RIVER UPSTREAM	ISIOLO RIVER INTAKE	GITHIMA SPRING UPSTREAM	GITHIMA SPRING INTAKE	GITHIMA SPRING DOWN-STREAM	UP STREAM	PROPOSED INTAKE	DOWN-STREAM	UP STREAM	PROPOSED INTAKE	DOWN-STREAM	UP-STREAM	PROPOSED INTAKE	DOWN-STREAM	UP-STREAM	PROPOSED INTAKE	DOWN-STREAM
		15th Sep.	13th Sep.	22nd Sep.	16th Sep.	13th Sep.	13th Sep.	22nd Sep.	12th Sep.	22th Sep.	13th Sep.	12th Sep.	13th Sep.	12th Sep.	19th Sep.	20th Sep.	14th Sep.	17th Sep.	21st Sep.		16th Sep.	15th Sep.		14th Sep.	17th Sep.
pH		7.62	7.93	7.42	6.11	7.58	7.69	7.86	8.02	8.04	7.72	7.7	8.12	7.64	7.97	7.17	7.84	7.57	7.51	-	7.5	7.65	-	7.66	7.79
Apparent Colour	HU	10	10	15	5	10	10	15	10	10	10	15	100	10	10	150	5	5	30	-	5	10	-	5	20
True Colour	HU	< 5	< 5	< 5	< 5	< 5	< 5	10	< 5	< 5	< 5	< 5	80	< 5	< 5	100	< 5	< 5	20	-	< 5	< 5	-	< 5	10
Conductivity	µs/cm	67	90	121	169	79	93	92	554	558	215	219	1099	28	103	44	70	70	30	-	65	102	-	96	79
Turbidity	F.T.U.	1.4	0.4	1.6	0.3	1	1.4	2.5	1.7	1.3	1	1.2	46	1	1.2	75	0.6	0.5	6		0.6	1.3	-	0.2	3.1
Calcium Hardness as CaCo3	mg/l	4	8	26	12	12	4	18	16	20	20	40	18	12	10	9	18	12	12		12	10	-	18	22
Total Hardness asCaCo3	mg/l	24	36	76	46	36	12	58	52	70	72	114	62	36	38	26	44	36	34	-	42	30	-	52	90
Total Alkalinity as CaCo3	mg/l	38	45	53	58	33	47	42	260	262	92	96	555	14	46	21	36	32	24	-	32	43	-	47	40
Carbonate Alkalinity	mg/ml	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	-	0	0
Iron	mg/l	0.03	0.01	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.05	0.02	0.02	0.03	0.02	0.02	-	0.02	0.03	-	0.01	0.02
Fluorides	mg/l	0.28	0.5	0.38	0.24	0.31	0.3	3.3	0.48	0.48	0.34	0.34	0.62	0.28	0.42	0.25	0.26	0.26	0.23	-	0.27	0.28	-	0.23	0.23
Sulphates	mg/l	35	38	33	37	27	25	38	40	33	39	46	26	22	29	22	25	36	30		33	35	-	39	41
Phosphates	mg/l	0.03	0.01	0.02	0.03	0.02	0.03	0.04	0.02	0.01	0.02	0.01	0.04	0.02	0.03	0.03	0.01	0.02	0.04		0.01	0.02	-	0.01	0.04
Silica	mg/l	55	56	66	44	20	22	30	32	30	55	60	38	36	55	32	38	47	55	-	45	44	-	56	60
Dissolved Oxygen	p.p.m.	5.8	6	5.9	5.4	6.1	5.9	6	5.8	5.7	5.8	5.6	5.4	5.9	6	5.9	5.7	5.8	5.8	-	5.7	5.7	-	5.8	5.9
Nitrates	mg/l	0.03	0.02	0.01	0.03	0.02	0.02	0.03	0.01	0.04	0.01	0.01	0.02	0.05	0.02	0.02	0.04	0.01	0.01	-	0.04	0.04	-	0.03	0.02
Manganese	mg/l	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	-	0	0
Chlorides	mg/l	16	10	16	24	8	10	12	60	64	22	22	86	8	12	14	12	8	14	-	10	14	-	8	10
Chromium	mg/l	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	-	0	0
Copper	mg/l	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	-	0	0
Total Coliform	/ml	0	0	350	660	20	300	450	10	50	30	20	500	30	20	60	100	10	130	-	25	25	-	10	225
Total Feacal Coliform	/ml	0	0	9	140	4	55	80	3	11	6	0	150	10	10	18	20	0	28	-	4	0	-	0	65
Dissolved Solids	mg/l	50	50	65	80	35	45	50	305	325	100	90	660	25	40	20	45	35	40	-	45	45	-	55	45
Suspended Solids	mg/l	5	5	5	0	15	15	5	25	15	10	30	60	5	10	15	5	5	0	-	0	0	-	0	5
Total Solids	mg/l	55	55	70	80	50	60	55	330	340	110	120	720	25	50	35	50	40	40	-	45	45	-	55	50
Biochemical Oxygen Demand	mg/l	5	5	10	5	5	5	10	50	3	2	130	10	20	2	5	2	10	5	-	6	12	-	5	5
Chemical Oxygen Demand	mg/l	8	6	12	8	8	8	12	68	4	4	160	12	28	4	8	4	12	6	-	8	16	-	8	8

Table J-9 Groundwater Quality Survey in Isiolo

Item	Unit	Test Results			
		1635(1) 3/1/93	1635(2) 3/1/93	11636 3/1/93	C11551 3/1/93
Colour	Hazen Unit	15	150	<5	<5
Turbidity	JTU5	Slight	Very Turbid	Clear	Clear
Odour	TON		Petroleum prod	None	None
Taste					
pH		6.6	6.5	7.4	6.9
Conductivity	m mho5/cm3	1050		1600	630
		mg/l	mg/l	mg/l	mg/l
Total Alkalinity	as CaCO3	630	1310	1060	630
Phenolphthalein	(CO3)	Nil	Nil	Nil	Nil
Mathyl Orange	(HCO3)	630	1310	1060	408
Chloride	(Cl)	12	20	35	17
Sulphate	(SO4)	6.8	14.6	32	2
Nitrate	(NO3)	Nil	Nil	Nil	Nil
Nitrite	(NO2)	Nil	Nil	Trace	Nil
Fluoride	(F)	0.1	-	0.1	0.4
Sodium	(Na)	103.4	196.4	210.9	62.6
Potassium	(K)	14.4	25.9	22.9	8.8
Calcium	(Ca)	68	-	96	49.6
Magnesium	(Mg)	64.8	-	91.2	43.2
Iron (total)	(Fe)	0.05	27.9	0.03	0.03
Mangnesium	(Mn)	0.04	1.5	0.03	Trace
Ammnorim Free & Saline	(NH4)	-	-	-	-
Ammonia albuminold	(NH4)	-	-	-	-
(Pb, Cu, Zn)		-	-	-	-
Carbonate Hardness		440	600	620	304
Non Carbonate Hardness		Nil	Nil	Nil	Nil
Total Hardness		440	600	620	304
Free Carbon Dioxide		19	18	7	16
Silica		80	-	100	50
Oxygen absorbed 4hr@ 27°c(PV)		2.45	11.7	0.4	Nil
Total Dissoved Solid		750	1400	1100	450
Oil & Grease			64		

Table J - 10 Existing Water Quality Monitoring Data

PARAMETERS	UNIT	MERU			NKUBU						ISIOLO				
		4/8/87	5/4/94	5/4/94	11/15/86	11/15/86	9/29/87	9/29/87	5/7/96	5/7/96	11/27/95	1/3/96	1/3/96	6/4/96	6/4/96
		Raw Water	Raw Water	Raw Water	Raw Water	Treated Water	Raw Water	Treated Water	Raw Water	Treated Water	Treated Water	Raw Water	Treated Water	Raw Water	Partly Treated
pH	pH Scale	6.8	7.3	7.2	7	6.5	6.4	6.5	7.9	6.7	8	8.2	7.7	8.2	7.9
Colour	mg pt/l	5	30	30	< 0.05	< 0.05	5	< 5	10	5	< 5	50	< 5	50	20
Turbidity	N.T.U.	1.9	40	80	18	20	33	25	12	11	-	63	5	49	19
Permanganate No. (20 min. boiling)	mgO_2/l	6	8	9.5	11	1.9	1	1	0.79	2.37	< 0.4	2.39	0.79	4.8	3.2
Conductivity (25°C)	µS/cm	90	62	62	100	120	104	130	105	106	500	485	445	533	542
Iron	mgFe/l	1.2	-	-	2.6	0.3	2.1	0.5	0.6	0.5	0.2	4.6	0.4	2.3	0.4
Manganese	mgMn/l	0.05	-	-	0.13	0.02	0.1	< 0.1	0.3	0.1	< 0.1	0.3	< 0.1	< 0.1	< 0.1
Calcium	mgCa/l	0.9	2.4	3.2	0.5	0.7	0.4	0.1	6.4	4.8	19	40	37.6	35	33
Magnesium	mgMg/l	0.8	1.9	0.9	0.6	0.7	0.3	0.5	2.42	1.46	21	31.6	27.6	24	26
Sodium	mg/Na/l	12	8.4	7.4	16	14	12	17	11	11	37	40	33	40	40
Potassium	mgK/l	3.9	2.8	2.7	3.3	2.8	-	-	3.2	3.1	5.3	5.6	5.4	7.5	7.5
Aluminium	mgAl/l	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Hardness	mgCaCO$_3$/l	18	14	12	22	20	18	16	26	18	134	230	208	182	184
Total Alkalinity	mgCl/l	40	24	28	44	24	30	36	46	26	174	228	192	260	240
Chloride mg Cl/l	mgF/l	5	1	3	5	6	7	6	4	6	23	23	21	26	25
Flouride	mgN/l	0.52	0.5	0.5	0.28	0.21	0.2	0.3	0.2	< 0.2	0.2	0.8	0.4	0.2	< 0.2
Nitrate	mgN/l	0.18	-		0.46	0.49	-	-	-	-	-	-	-	-	-
Nitrite	mgN/l	< 0.01	< 0.01	< 0.01	-	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ammonia	mgN/l	-	-		-		-	-		-	-	-	-	-	-
Total Nitrogen	mgN/l	-	-		-	-	-	-	-	-	-	-	-	-	-
Sulphate	mgSO_4/l	0.53	3.3	2.7	1.2	27	< 0.3	11.4	< 0.3	13	28	< 0.3	25	< 0.3	26
Orthophosphate	mgP/l	0.04	< 0.01	< 0.01	0.03	0.01	0.03	< 0.01	< 0.01	< 0.01	0.1	0.06	0.01	0.06	0.01
Total Suspended Solids	mg/l	-	-	-		-	-	-	-	-	-	-	-	-	-
Free Carbon Dioxide	mg/l	2	4	8	4	8	4	6	2	16	8	-	6	Nil	8
Dissolved Oxygen	mg/l	-	-	-	-	-	-	-	-	-	-	-		-	-
TDS	mg/l	54	37	37	60	72	62	78	83	71	346	419	384	430	450

Table J-11 Chemical Data for Boreholes around Isiolo Town

Borehole No.	Date	pH	EC	Fe	Mn	Ca	Mg	Na	K	Total Hardness	Total Alkatinity	Cl	F	HCO3	NO2	SO4	Free CO2	TDS
			(microS/cm)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
WHO Water Source			2500	5	5										10	40		1500
WHO Drinking Water		6.5-8.5	1600	0.3	0.1			200		500		250	1.5		3	400		1000
Japan Water Source		6.5-8.6		0.3	0.05								0.8		10			
Japan Drinking Water		5.8-8.6	800	0.3	0.05			200		300	>5	200	0.8		10	200	20	500
C7631	05/01/88	8.6	1100	0.8	0.15	86	53	137	11.5	440	-	26	-	652	-	6	-	800
C7924	28/07/89	7.4	7278	0.2	< 0.1	-	-	1323	82	468	442	176	0.1	538.8	< 0.01	288	460	4367
C7927	07/11/89	7.1	1696	0.7	< 0.1	90	81	168	13	558	860	22	0.4	1048	< 0.01	17	398	1017
C90		6.9	-	0.3	-	-	-	-	-	100	-	1.2	0.3	453	-	-	-	585

Source : WRAP, NWMP, Isiolo District Water Office

Table J - 13 Registered Water Rights in Meru

No.	Source	Grid. Ref.	Quantity	Purpose
1	Kazita	497052	40.0	Domestic
2	Kathutamunyi	320002	4.3	Domestic
3	Ruuji Rwa Ngombe	340020	5.5	Domestic
4	Kathita		1.3	Domestic
5	Kirimaiga	465051	600.0	Domestic
6	Ntura	393029	300.0	Domestic
7	Kathita	341035	20.0	Domestic
8	Gankeria	347019	14.5	Domestic
9	Karimaiga	461042	15.8	Domestic
10	Luguso		27.0	Domestic
11	Kazita	322022	472.0	Domestic
12	Matuntukene		5.2	Domestic

Table J - 14 Registered Water Rights in Nkubu

No.	Source	Grid. Ref.	Quantity	Purpose
1	Kiugandegwa	469922	1.2	Domestic
2	Kiugandegwa	347267	3.2	Domestic
3	Kiugandegwa	438929	2,702.0	Domestic
4	Kiugandegwa	423922	11.7	Domestic
5	Kiugandegwa	344250	12.4	Domestic
6	Kiugandegwa	344935	5.4	Domestic
7	Kiugandegwa	418932	15.9	Domestic

Table J - 15 Registered Water Rights in Isiolo

No.	Source	Grid. Ref.	Quantity	Purpose
1	East Marania	267358	37.4	Domestic
2	East Marania	267358	2,072.6	Irrigation
3	Isiolo		32.5	Domestic
4	Isiolo		54.5	Irrigation
5	Isiolo	540060	1,345.5	Irrigation
6	Isiolo	336385	25.0	Domestic
7	Isiolo	336385	27.3	Irrigation
8	Isiolo	53331	363.4	Irrigation
9	Isiolo	401389	233.2	Irrigation
10	Isiolo	54006	5.8	Domestic
11	Isiolo	398379	1.3	Domestic
12	Isiolo		1,998.0	Irrigation
13	Isiolo	385910	77.5	Domestic
14	Isiolo	385910	918.7	Irrigation
15	Isiolo	6370	5,000.0	Domestic
16	Isiolo		36.3	Irrigation
17	Isiolo	254327	2.5	Domestic
18	Isiolo	61362	2.4	Domestic
19	Isiolo	454439	4.9	Domestic
20	Isiolo	454439	99.0	Irrigation
21	Isiolo		243.0	Irrigation
22	Isiolo	87883	22.5	Irrigation
23	Ruguthu	296061	8.7	Domestic
24	Ruguthu	32115	9.4	Domestic
25	Ruguthu	32115	27.0	Irrigation
26	Kithtima Spring	383294	13.4	Domestic
27	Kithtima Spring	840010	77.5	Domestic
28	Kithtima Spring	840010	908.7	Irrigation
29	Kithtima	383296	87.4	Domestic

Table J - 16 Registered Water Rights in Chuka

No.	Source	Grid. Ref.	Quantity	Purpose
1	Tungu	Down Stream	18.2	Domestic & Irrigation
2	Tungu	Down Stream	20.1	Domestic & Irrigation
3	Tungu	Down Stream	18.2	Domestic & Irrigation
4	Tungu	Down Stream	45.5	Industrial
5	Tungu	Down Stream	19.3	Domestic & Irrigation
6	Tungu	Down Stream	68.3	Industrial
7	Tungu	Down Stream	20.5	Domestic & Irrigation
8	Tungu	Down Stream	1.8	Industrial
9	Isiolo	Down Stream	438.0	Domestic & Irrigation
10	Isiolo	Down Stream	295.8	Domestic & Irrigation
11	Isiolo	Down Stream	22.3	Domestic & Irrigation
12	Isiolo	Down Stream	18.2	Domestic & Irrigation
13	Isiolo	Down Stream	20.5	Domestic & Irrigation
14	Isiolo	Down Stream	20.0	Domestic & Irrigation
15	Isiolo	Down Stream	23.0	Domestic & Irrigation
16	Isiolo	Down Stream	75.5	Domestic & Irrigation
17	Isiolo	Down Stream	23.7	Domestic & Irrigation
18	Isiolo	Down Stream	136.5	Industrial
19	Isiolo	Down Stream	2,000.0	Domestic & Irrigation
20	Isiolo	Down Stream	22.2	Domestic & Irrigation
21	Isiolo	Down Stream	54.5	Domestic & Irrigation
22	Isiolo	Down Stream	272.8	Industrial
23	Ruguthu	Down Stream	273.0	Industrial
24	Ruguthu	Down Stream	1,620.0	Domestic & Irrigation
25	Ruguthu	Down Stream	22.7	Industrial
26	Kithtima Spring	Down Stream	120.0	Industrial
27	Kithtima Spring	Down Stream	34.2	Domestic & Irrigation
28	Kithtima Spring	Down Stream	22.7	Industrial
29	Kithtima	Down Stream	18.2	Domestic & Irrigation
30	Kithtima Spring	Down Stream	22.8	Industrial
31	Kithtima	Down Stream	22.7	Industrial
32	Kithtima Spring	Down Stream	1,230.0	Domestic & Irrigation
33	Kithtima	Down Stream	195.7	Domestic & Irrigation
34	Kithtima Spring	Down Stream	66.0	Industrial
35	Kithtima	Down Stream	287.0	Domestic & Irrigation
36	Kithtima	Down Stream	1,800.0	Domestic & Irrigation

Table J - 17 Registered Water Rights in Chogoria

No.	Source	Grid. Ref.	Quantity	Purpose
1	North Mara	Down Stream	48.1	Domestic & Irrigation
2	North Mara	Down Stream	90.9	Industrial
3	North Mara	Down Stream	29.5	Domestic & Irrigation
4	North Mara	Down Stream	1,250.0	Domestic & Irrigation
5	North Mara	Down Stream	22.7	Industrial
6	North Mara	Down Stream	136.3	Industrial
7	North Mara	Down Stream	70.9	Domestic & Irrigation
8	North Mara	Down Stream	113.6	Industrial
9	North Mara	Down Stream	20.2	Domestic & Irrigation
10	North Mara	Down Stream	5,878.0	Domestic & Irrigation
11	North Mara	Down Stream	68.3	Industrial
12	North Mara	Down Stream	1,273.0	Domestic & Irrigation
13	North Mara	Down Stream	4,337.6	Domestic & Irrigation
14	North Mara	Down Stream	113.6	Industrial
15	North Mara	Down Stream	19,599.1	Industrial

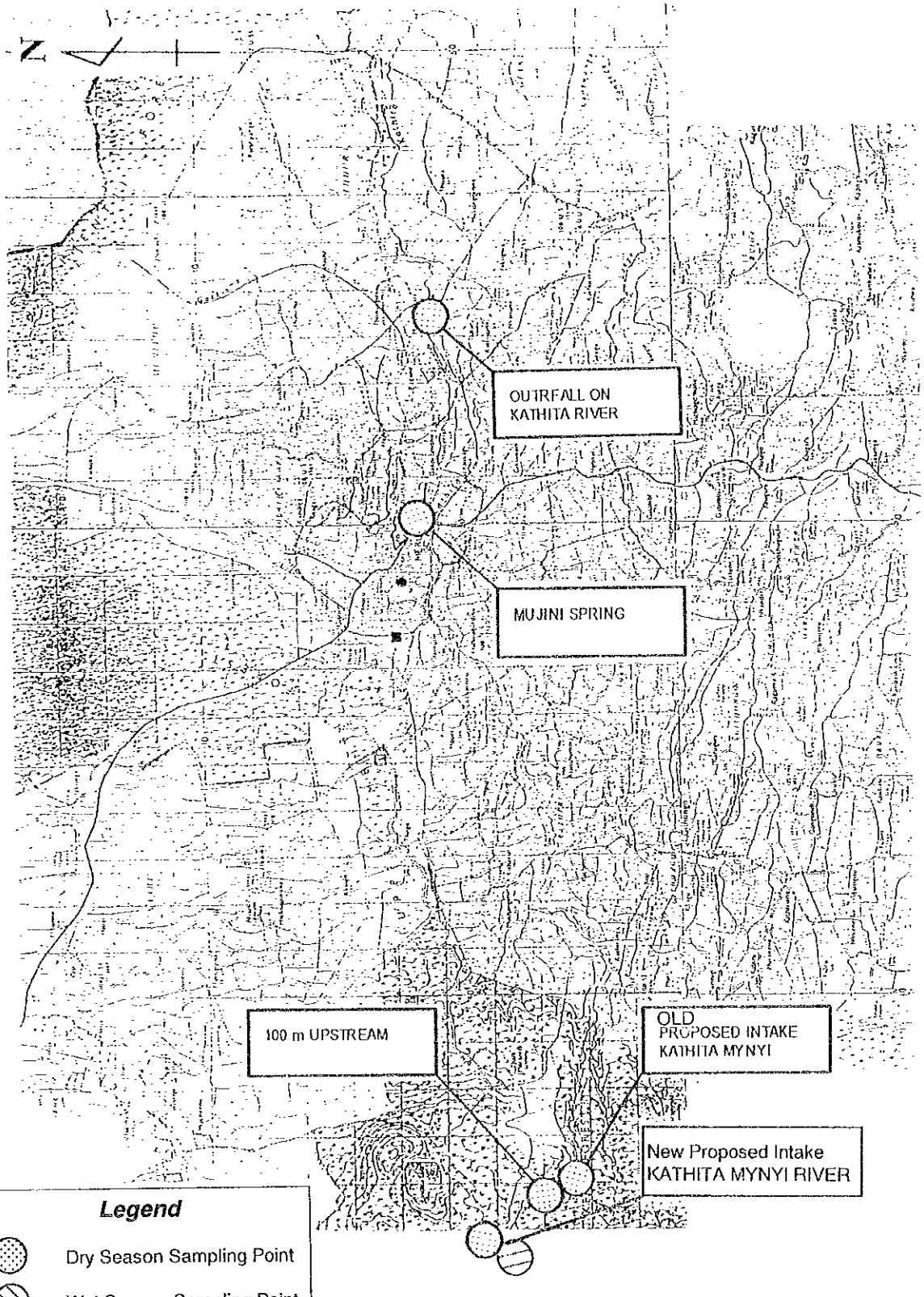
Table J - 18 Registered Water Rights in Maua

No.	Source	Grid. Ref.	Quantity	Purpose
1	Mboone	Down Stream	2,381.8	Domestic & Irrigation
2	Mboone	Down Stream	152.8	Domestic & Irrigation
3	Mboone	Down Stream	58.8	Domestic & Irrigation
4	Mboone	Down Stream	103.5	Domestic & Irrigation
5	Mboone	Down Stream	4.3	Domestic & Irrigation
6	Mboone	Down Stream	12.5	Domestic & Irrigation
7	Mboone	Down Stream	54.0	Domestic
8	Mboone	Down Stream	4.3	Domestic & Irrigation

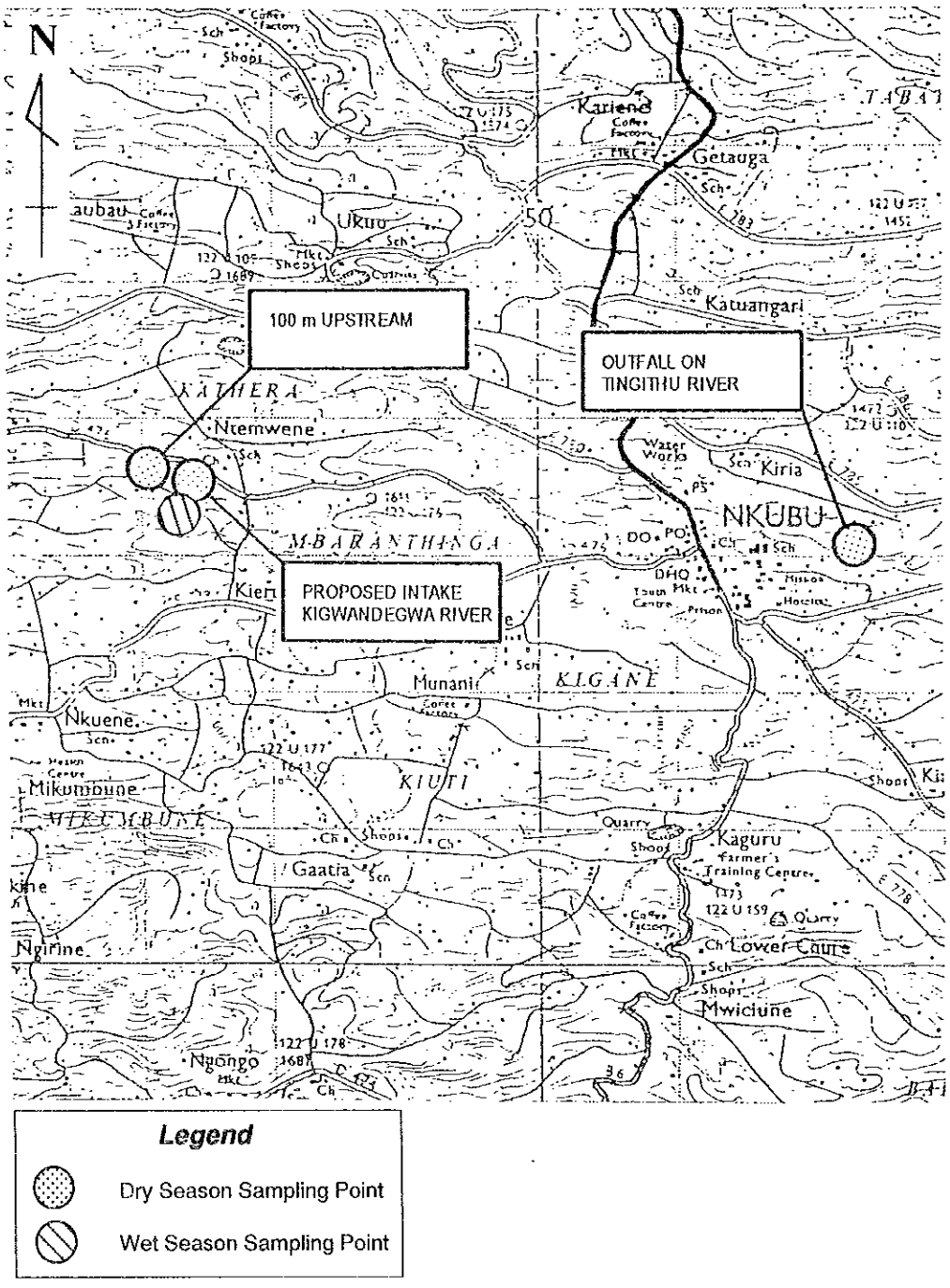
Table J - 19 Registered Water Rights in Tigania

No.	Source	Grid. Ref.	Quantity	Purpose
1	Thangatha	Down Stream	530.0	Domestic & Irrigation
2	Thangatha	Down Stream	66.8	Domestic & Irrigation
3	Thangatha	Down Stream	69.7	Domestic & Irrigation

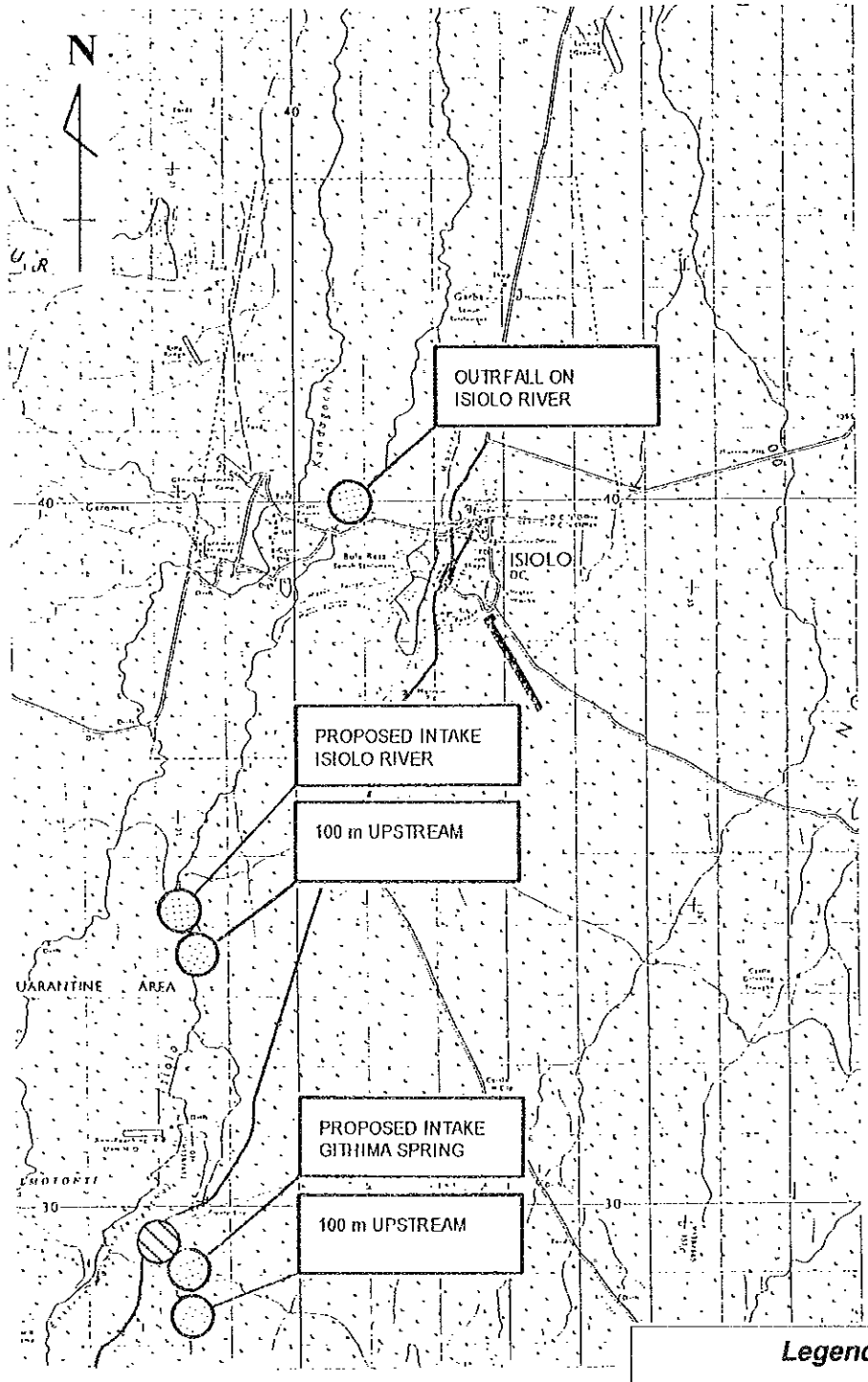
FIGURES



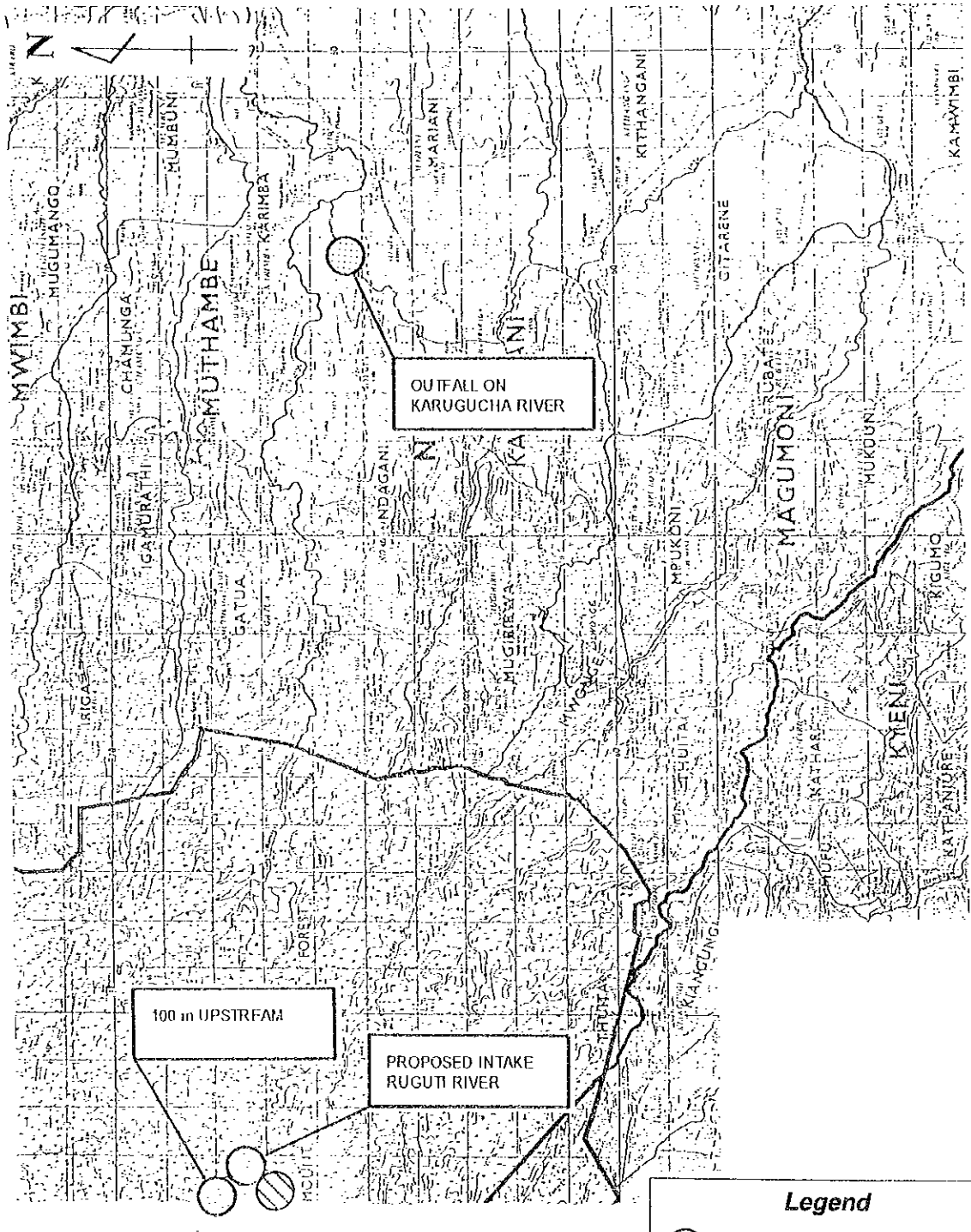
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA JAPAN INTERNATIONAL COOPERATION AGENCY	Figure J -1 Sampling Locations in Meru Town



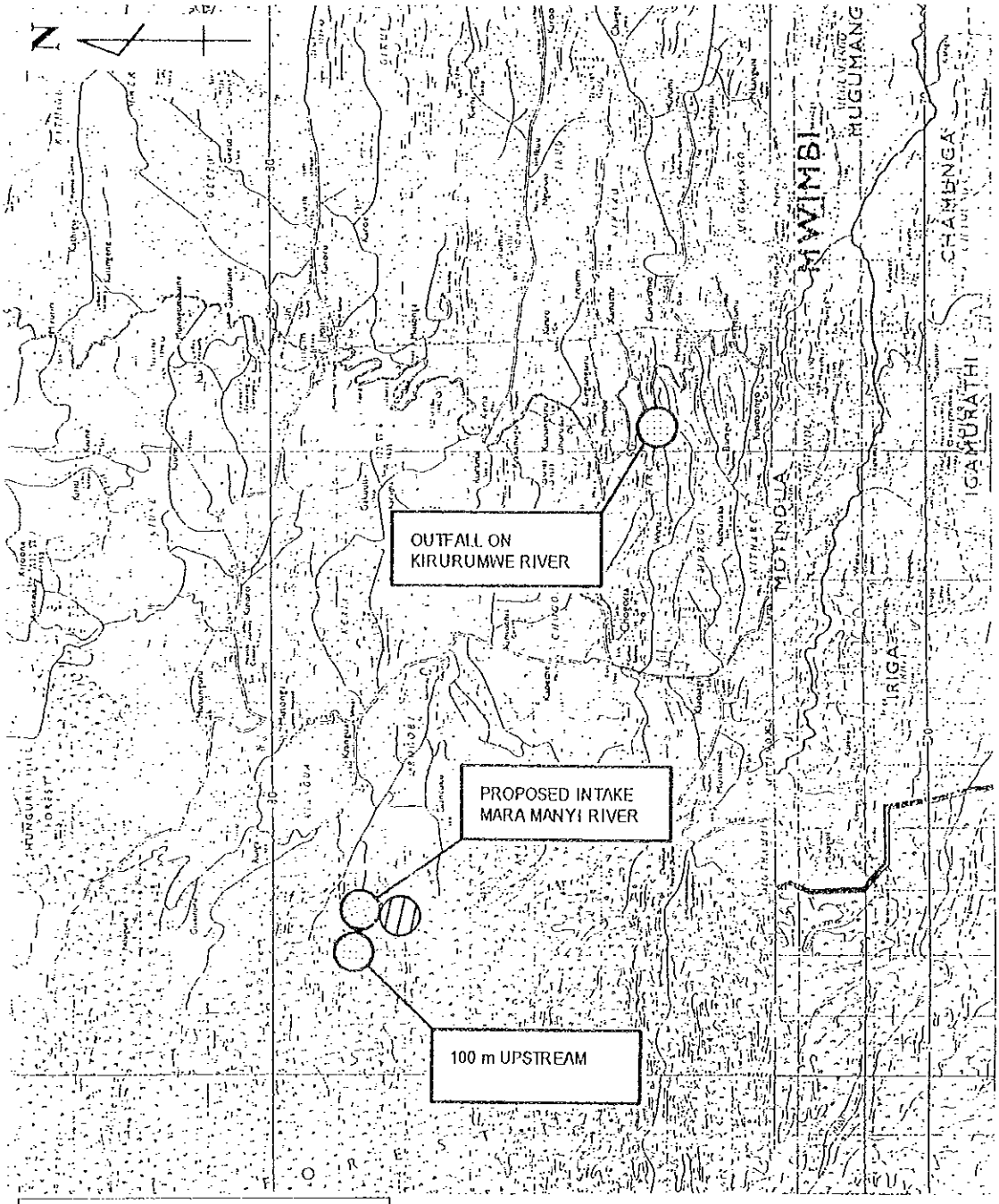
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA JAPAN INTERNATIONAL COOPERATION AGENCY	Figure J -2 Sampling Locations in Nkubu Town



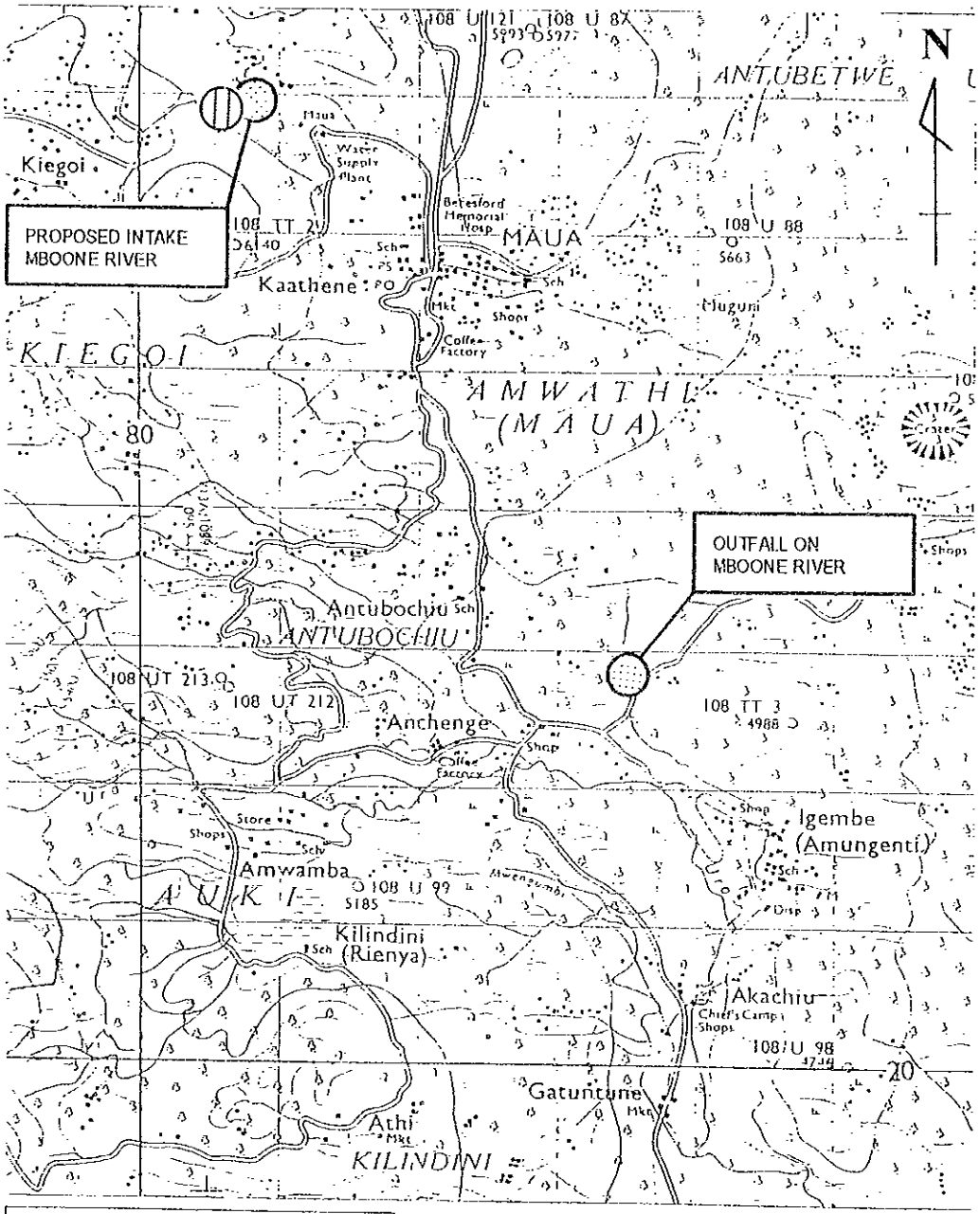
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA JAPAN INTERNATIONAL COOPERATION AGENCY	Figure J -3 Sampling Locations in Isiolo Town



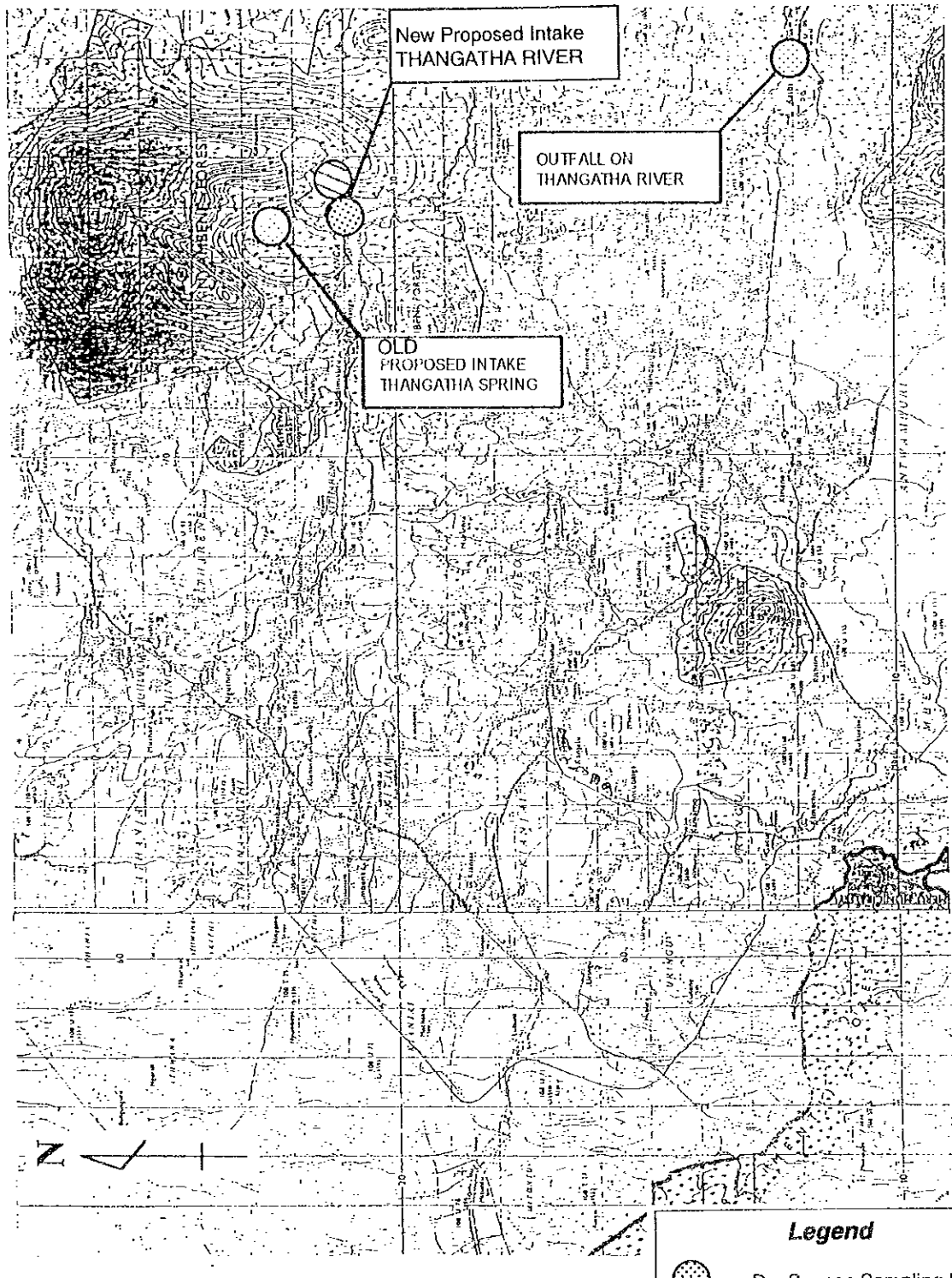
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA JAPAN INTERNATIONAL COOPERATION AGENCY	Figure J -4 Sampling Locations in Chuka Town



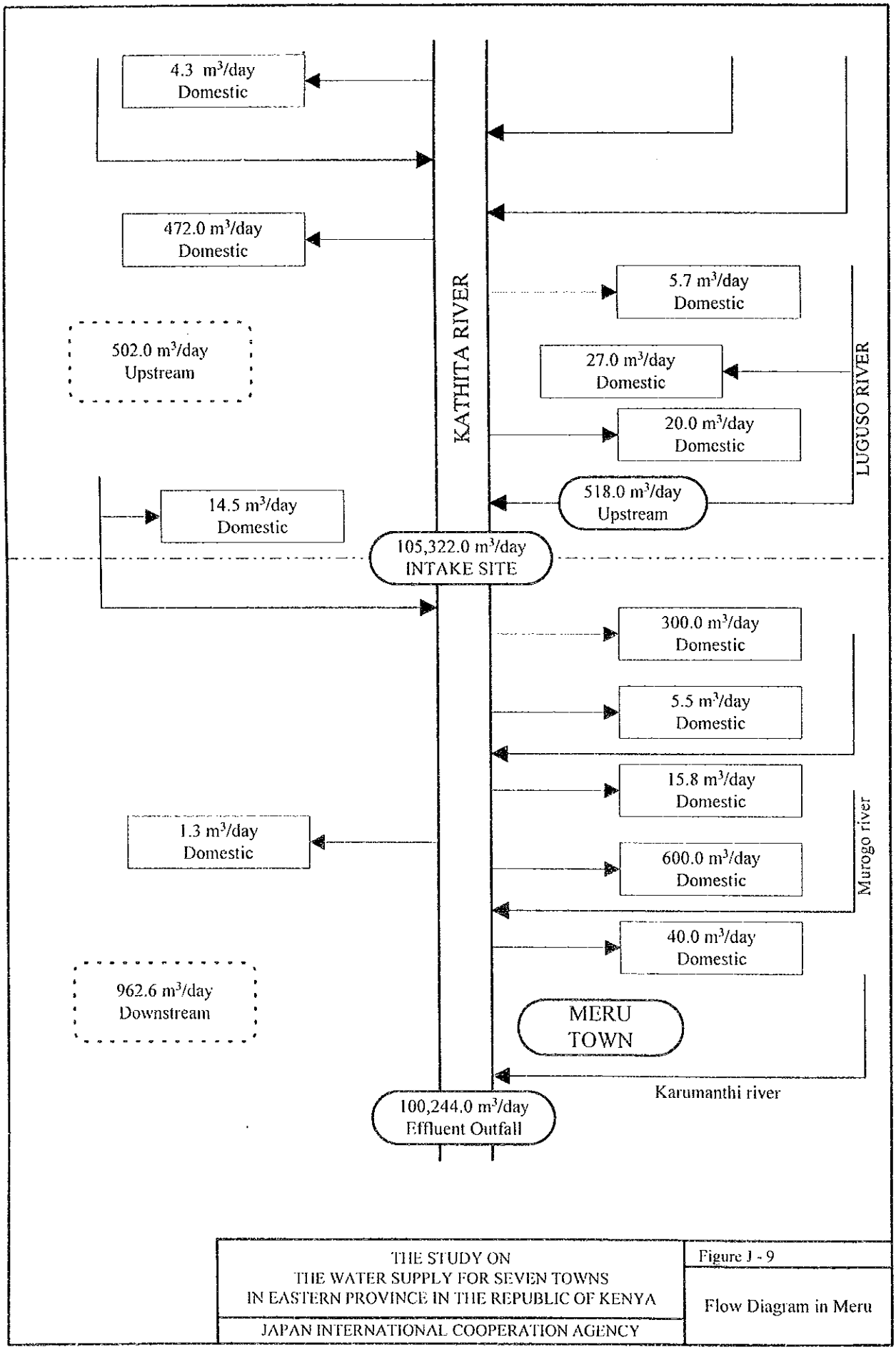
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA JAPAN INTERNATIONAL COOPERATION AGENCY	Figure J -5 Sampling Locations in Chogoria Town



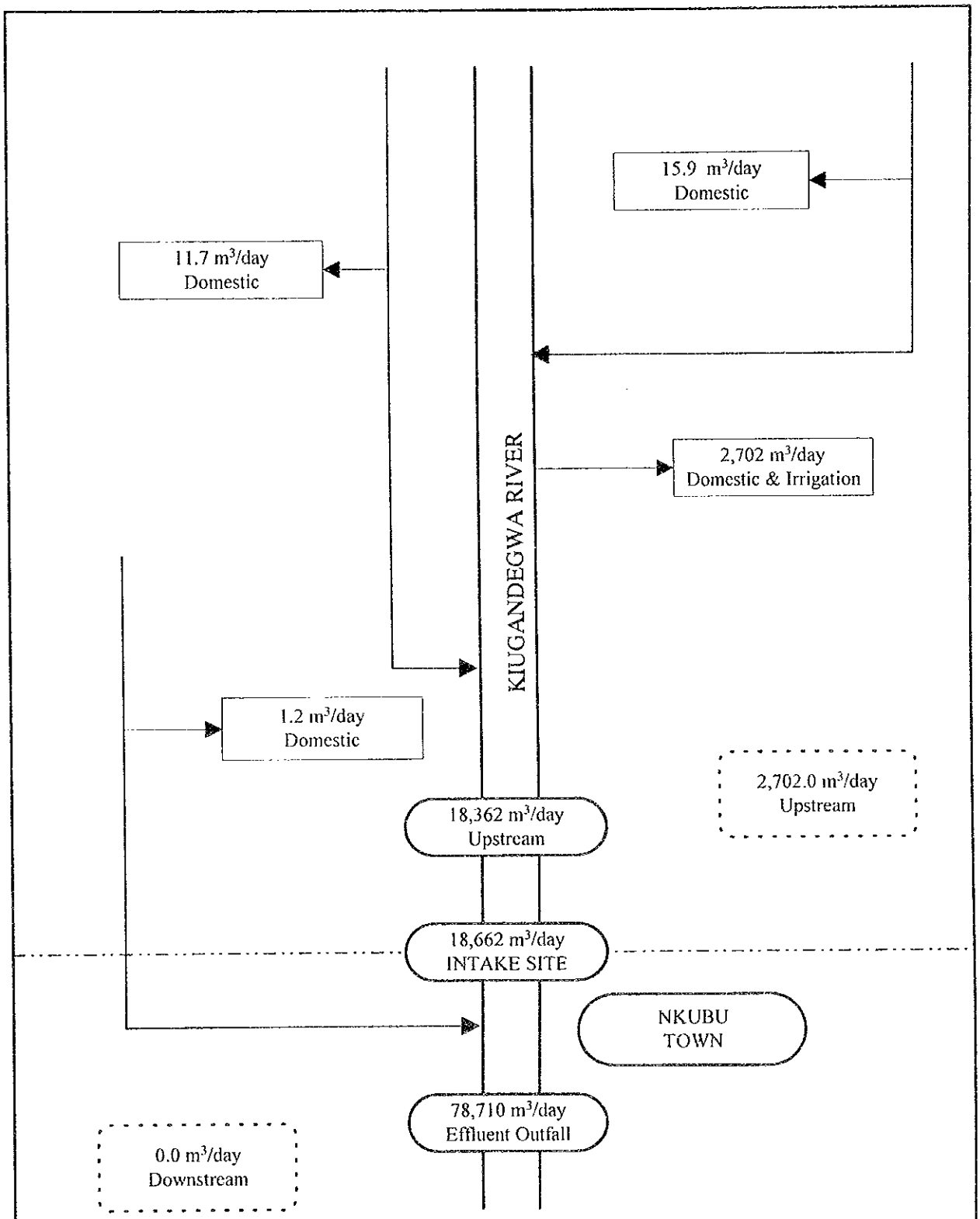
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA JAPAN INTERNATIONAL COOPERATION AGENCY	Figure J -6 Sampling Locations in Maua Town



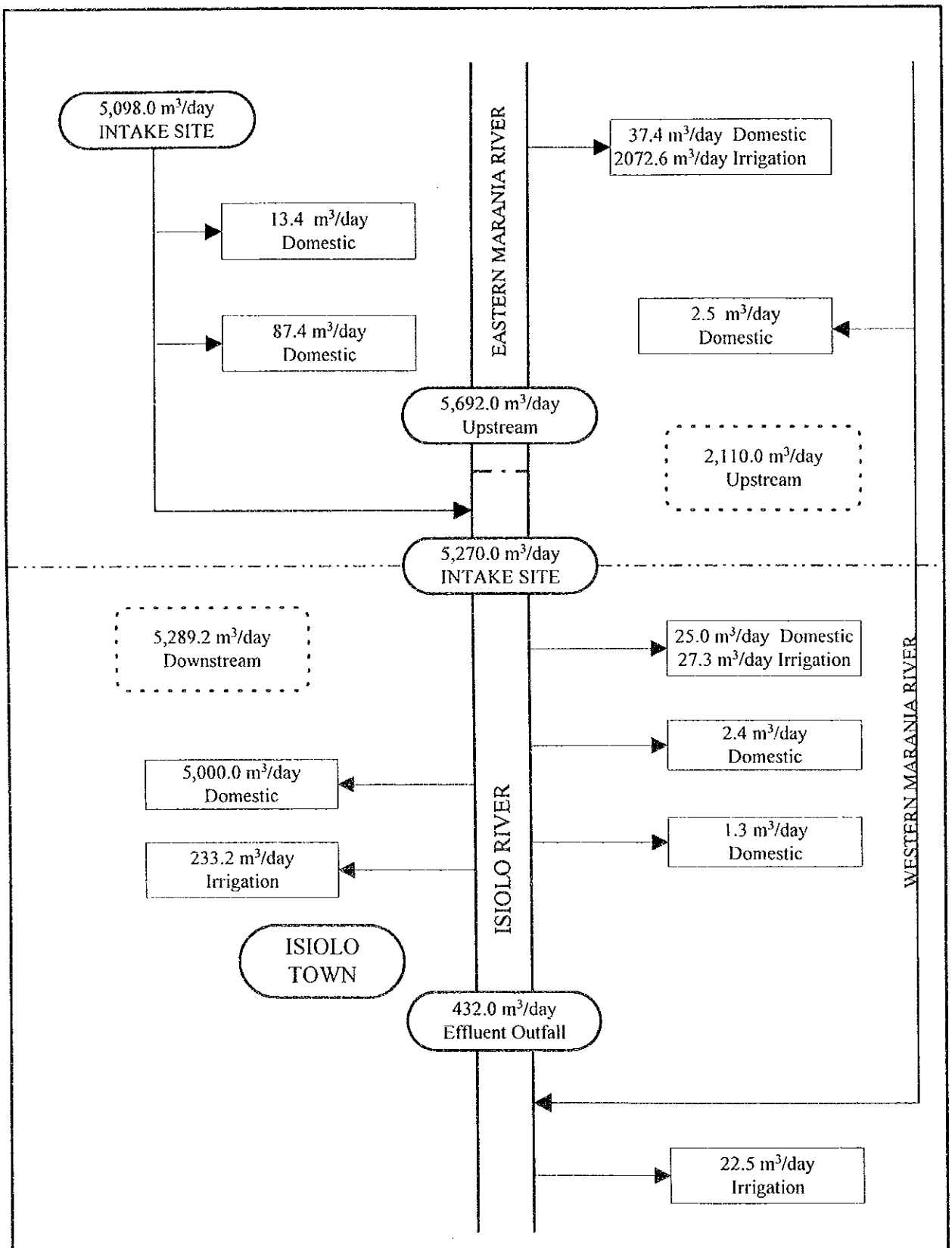
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA JAPAN INTERNATIONAL COOPERATION AGENCY	Figure J -7 Sampling Locations in Tigania Area



THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure J - 9
JAPAN INTERNATIONAL COOPERATION AGENCY	Flow Diagram in Meru



THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure J - 10
JAPAN INTERNATIONAL COOPERATION AGENCY	Flow Diagram in Nkubu



THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure J - 11
JAPAN INTERNATIONAL COOPERATION AGENCY	Flow Diagram in Isiolo