CHAPTER 9

ENVIRONMENTAL IMPACT ASSESSMENT

9 ENVIRONMENTAL IMPACT ASSESSMENT

9.1 GENERAL

Environmental Impact Assessment (EIA) for Phase I Project is carried out as a part of the Study on Kisumu Water Supply and Sewerage System.

9.1.1 Objective

The items of potential environmental impacts of Phase I Project were identified in the Initial Environmental Examination in Master Planning Stage of the Study. The identified environmental items are assessed in Feasibility Study Stage in the Study. The objectives of EIA are as shown below.

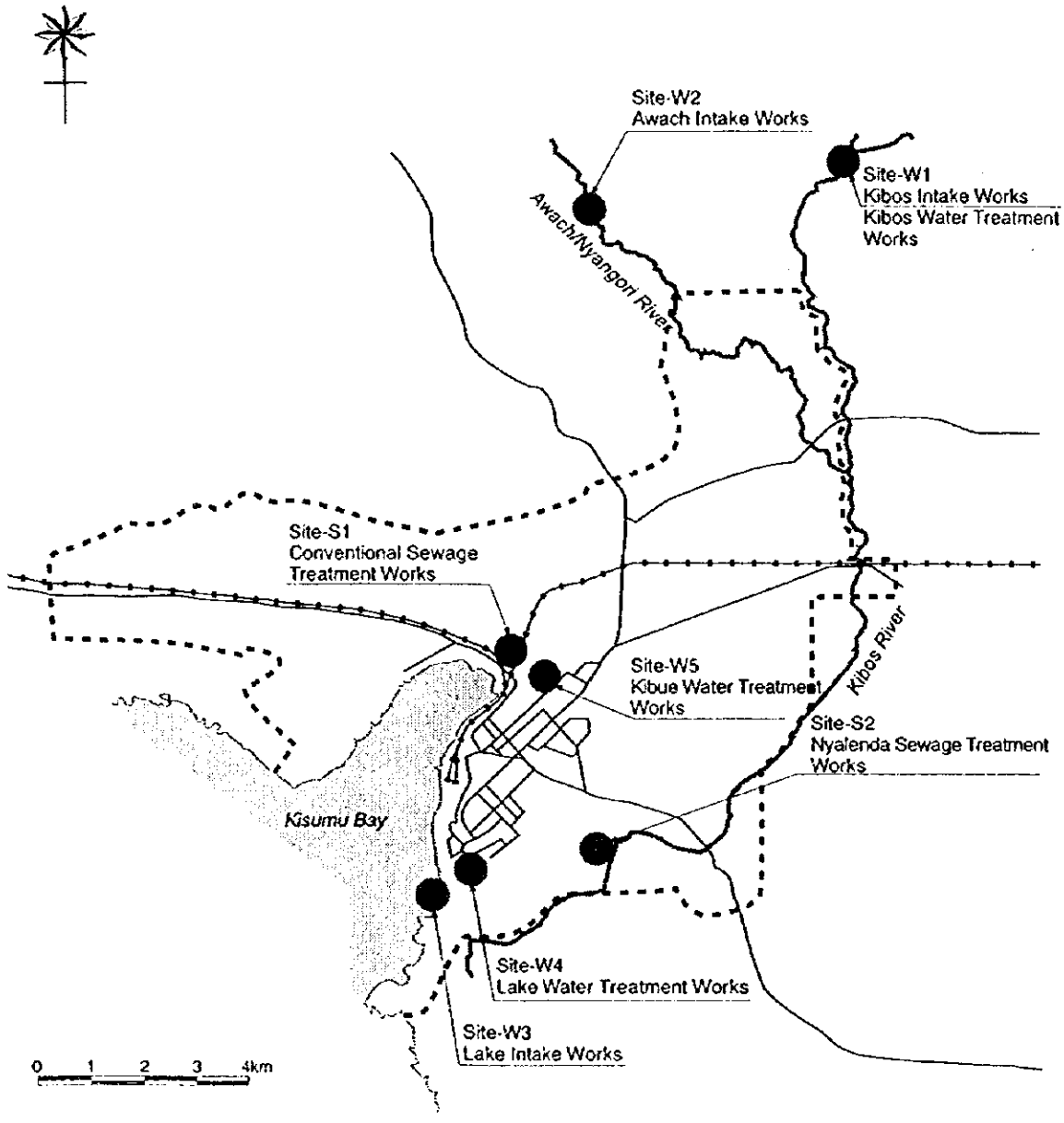
- To evaluate environmental impacts of Phase I Project
- To propose countermeasures for mitigating the impacts and recommendations for environmental conservation

The Study Area of EIA is shown in Figure 9-1.

9.1.2 Summary of the results of IEE

Details of Initial Environmental Examination of the Project are described in Appendix (O). Table 9-1 and 9-2 show the IEE Check Lists for Water Supply Component and Sewerage Component of Phase I Project.

Figure 9-1



THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE : EIA STUDY AREA

Table 9-1 IEE Check List: Water Supply Component

Item	Evaluation	Reason
1. Resettlement	C	Not clear
2. Economic Activities	D-2	Positive impacts are expected by increased water supply amount
3. Transport	D-1	Need attention during construction period
4. Separation of Community	D-2	This is not an issue in this component
5. Cultural Assets and Archaeology	D-2	No such sites
6. Water and Common Rights	C	This may be affected, because water discharge amount will be reduced in Rivers to be proposed as intake sites
7. Sanitation	D-2	Sanitation condition shall be improved by safe water supply
8. Waste	D-1	Need attention during construction
9. Dangers	D-1	Need attention during construction
10. Topography and Geology	D-2	Project include no big structure to give such impact
11. Soil Erosion	D-1	Need attention during construction period
12. Groundwater	D-2	Project would not be related to groundwater
13. Lake, Marsh and River	A	Kibos River shall be affected by the completion of the intakes
14. Coastline and Sea	D-2	No such area
15. Flora and Fauna	C	Changing the rivers discharge and sewage generation may affect Flora and Fauna in Lake Victoria and Kibos River
16. Weather	D-2	This Project does not include structures which might influence weather
17. View	D-2	This Project does not include structures which might influence view
18. Air Pollution	D-2	No adverse impact
19. Water Pollution	C	Sewage amount shall be increased due to the new water supply. Lake Victoria will be affected, if countermeasure are not taken
20. Soil Contamination	D-1	Nothing expected
21. Noise and Vibration	D-1	Need attention during construction
22. Ground Subsidence	D-2	Nothing expected
23. Noxious odors	D-2	Nothing expected

A : Serious Impact expected

B : Minor Impact expected

C : Uncertain (may become clear on investigation)

D-1 : Almost no Impact expected, if proper construction is carried out

D-2 : Almost no Impact expected, no need for EIA

Table 9-2 IEE Check List: Sewerage Component

Item	Evaluation	Reason
1. Resettlement	C	Not clear
2. Economic Activities	D-2	Any negative impacts are not expected
3. Transport	D-1	During construction period, needs attention
4. Separation of Community	D-2	Nothing expected
5. Cultural Assets and Archaeology	D-2	No such sites
6. Water and Common Rights	D-2	No impact expected
7. Sanitation	D-2	Sanitation condition shall be improved by proper sewage treatment
8. Waste	B	Sludge generated from Sewage Treatment Works should be managed properly
9. Dangers	D-1	Need attention during construction period
10. Topography and Geology	D-2	Project include no big structure to have such an impact
11. Soil Erosion	D-1	Need attention during construction period
12. Groundwater	C	Waste Stabilization Ponds may deteriorate ground water. Reduction of pit latrine user shall improve ground water deterioration
13. Lake, Marsh and River	D-2	Water quality in Lake Victoria shall be improved by strengthened sewage treatment capacity
14. Coastline and Sea	D-2	No such area
15. Flora and Fauna	C	Increase of effluent discharge from sewage treatment works may effect Flora and Fauna in Lake Victoria.
16. Weather	D-2	This Project does not include structures which might influence weather
17. View	D-2	This Project does not include structures which might influence view
18. Air Pollution	D-2	Nothing expected
19. Water Pollution	D-2	The main function of the Project is to treat sewage properly before discharge into Lake Victoria
20. Soil Contamination	C	Raw sewage may cause soil contamination during the treatment process
21. Noise and Vibration	D-1	Need attention during construction
22. Ground Subsidence	D-2	Nothing expected
23. Noxious odors	B	Any sewage generates odors.

A : Serious Impact expected

B : Minor Impact expected

C : Uncertain (may become clear on investigation)

D-1 : Almost no Impact expected, if proper construction is carried out

D-2 : Almost no Impact expected, no need for EIA

9.1.3 Approach to EIA Study

As the results of IEE, the items of potential impacts of Phase I Project are identified as below;

- Impacts caused by Construction Works during Construction Period
- Impacts caused by Water Abstraction from Rivers during Operation Period
- Impacts caused by Increase of Wastewater Generation due to the new water supply
- Impacts caused by Operation of Sewage Treatment Works

The above impacts are assessed in EIA. EIA Study Area is defined as below,

- Area in/around the Proposed Construction Sites
- River Course between the Proposed Intake Sites and the River Mouth on Kibos and Awach/Nyangori River
- Kisumu Bay

The locations of the above areas are shown in Figure 9-1.

9.2 ENVIRONMENTAL ACT AND GUIDELINE IN KENYA

General information of Environmental Organizations and Laws in Kenya are described in Appendix (O). As written in it, there are various organizations and Laws relevant to Environmental Issues in Kenya, however, official EIA procedure has not been established. "Environmental Management and Co-ordination Bill" and "Environmental Assessment (Guidelines and Administrative Procedure)", which propose official EIA procedure and guideline, have not been approved by the Government of Kenya, though two of them have been expected to be effective in the near future.

(1) Environmental Management and Co-ordination Bill

Environmental Management and Co-ordination Bill was drafted in 1996, but has not been approved by Parliament of Government of Kenya. Once the bill is approved, it will become the Environmental Management and Co-ordination Act. The bill indicates the issues related to EIA Procedure as below;

- National Environmental Management Authority (NEMA) will be established. The

authority will be responsible for the administration of the Act.

- Before undertaking or financing any new project specified in the bill (This Project is to be specified), any proponent shall submit Environmental Impact Assessment Report to NEMA in order to get Environmental Impact Licence.
- After being satisfied with the adequacy of EIA report, NEMA may issue an environmental impact licence.
- Environmental Impact Assessment shall be conducted in accordance with the Environmental Impact Assessment Guidelines and Procedures provided for in the Fourth Schedule of the bill. The Fourth Schedule shows a form of EIA Report, which consists of "Introduction", "Title of the Project", "Project Initiator", "Statement of Need", "Project Description", "Project Options", "Description of Existing Environment", "Results of Preliminary Assessment", "Detailed Examination on Impacts", "Suggested Mitigation and Abatement Measures", "Residual Impacts", "Project Evaluation", "Summary of Conclusions".

(2) Environmental Impacts Assessment (Guidelines and Administrative Procedure)

Draft report of Environmental Impacts Assessment (Guidelines and Administrative Procedure) was prepared in 1996, under National Environmental Action Plan (NEAP) Secretariat, Ministry of Environment and Natural Resources. The report was prepared by taking into considerations the Environment Management and Co-ordination Act (Bill). The report consists of following two parts;

Part 1: It describes procedures for use in environmental planning and management in Kenya.
Part 2: It contains sector checklists, which would provide guidance to the public and private sector agencies responsible for development projects and programs.

The contents of the EIA of this Study are consistent with the above guideline.

9.3 EXISTING ENVIRONMENTAL CONDITION OF STUDY AREA

9.3.1 Proposed Construction Sites

The principal features of Water Supply Component and Sewerage Component of Phase I Project are described in Chapter 4 and 5, respectively. The locations of the proposed construction are shown in Figure 4-1, Figure 5-1, and Figure 9-1. Major construction site conditions and

construction work items are described in Table 9-3.

Table 9-3 Construction Site Condition and Construction Work Item

Site	Location and Condition	Construction Work Item
W1	Site is along Kibos River, and located in the vicinity of existing Kajulu Water Treatment Works, 23 km away from the river mouth. The landscape is hilly rugged and stony.	- Rehabilitation and expansion of the existing Kibos River Intake (3,000 m^3/day.) - Construction of new Kibos River Intake (71,000 m^3/day) - Rehabilitation and expansion of the existing Kajulu WTW (2,800 m^3/day)
W2	Site is in Awach/Nyangori River, 8km upstream from confluence of Kibos River. The landscape is hilly rugged and stony.	- Construction of Awach River intake (14,000 m^3/day)
W3	Existing site facing Kisumu Bay, away from residential area, no need expansion of the site	- Rehabilitation and expansion of existing Lake Intake Works (27,000 m^3/day)
W4	Existing site, 1.2 km away from Lake Intake Work, near residential area, no need expansion of the site	- Rehabilitation and expansion of the existing Lake WTW (25,000 m^3/day)
W5	Existing site in center of the town, need expansion of the land	- Construction of a Kibue WTW (40,000 m^3/day)
W6	Along the major road in the municipality and three small sites	- Installation of raw water transmission of 1.2 km and 18.8 km in length - Installation of treated water transmission of 3.6 km, 5.2 km, 4.2 km and 6.2 km in length - Installation of trunk distribution main of 23.9 km and 25.5 km in length - Installation of secondary distribution main of 330 km in total length - Construction of three units of distribution reservoirs
S1	Existing site in center of the town, no need expansion of the site	- Rehabilitation and expansion of existing Conventional STW (14,600 m^3/day)
S2	Existing site in center of the town, no need expansion of the site	- Rehabilitation and expansion of existing Nyalenda STW (18,000 m^3/day)
S3	Along the major road in the municipality and three of existing pumping station sites	- Rehabilitation and expansion of Trunk Sewers and Branch Sewers - Rehabilitation of three sewage pumping stations

9.3.2 Kibos River and Awach/Nyangori River

The EIA Study Area on Kibos river and Awach/Nyangori River is the river course between the two proposed intake sites and the river mouth (refer to Figure 9-1 and 9-2). The river course between Kibos River Intake site and the river mouth of Kibos River is 23 km in length, and the river course between Awach River Intake to the confluence of Kibos River and Awach/Nyangori Rivers is 8 km in length. About 30 villages are existing along the river course as shown in Figure 9-2.

Water Usage and River Condition Survey in the Study area on Kibos River System was carried out under the Study. As the results of the survey, it is estimated that Riparian communities with about 13,000 residents in about 230 households are existing along the river course. Those residents depend on Kibos River or Awach/Nyangori River in the field of water source for domestic water, water source for irrigation, source for sand harvesting, source for fishing. The residents obtain their domestic water from River, Roof Catchment (rainwater), Pipes, Wells/boreholes, Spring. Most of the residents obtain domestic use water from river and Roof Catchment, other resources are not popular in this area.

Fishing activity is popular along all of the river course. The fish caught along the river course include Adel (*Barbus*), Fulu (*Haplochromis*), Mumi (*Claias*), Ndhira (*Xenoclarias*), Ngege (*Tilapia*), Kamongo (*Protopterus*), and Omena (*Rastrineobola argentea*). Most fish species are used for household consumption to provide protein, and some of the fishes are marketed to supplement the family income.

Sand harvesting is also popular in the river course, especially downstream of the river course. The sand is used for material for building construction. Moreover, sand harvesting has become an important industry to provide job opportunity for riparian communities.

Some water rights had been registered as shown in Table 9-4. However, all of the water rights have already expired.

Figure 9-2

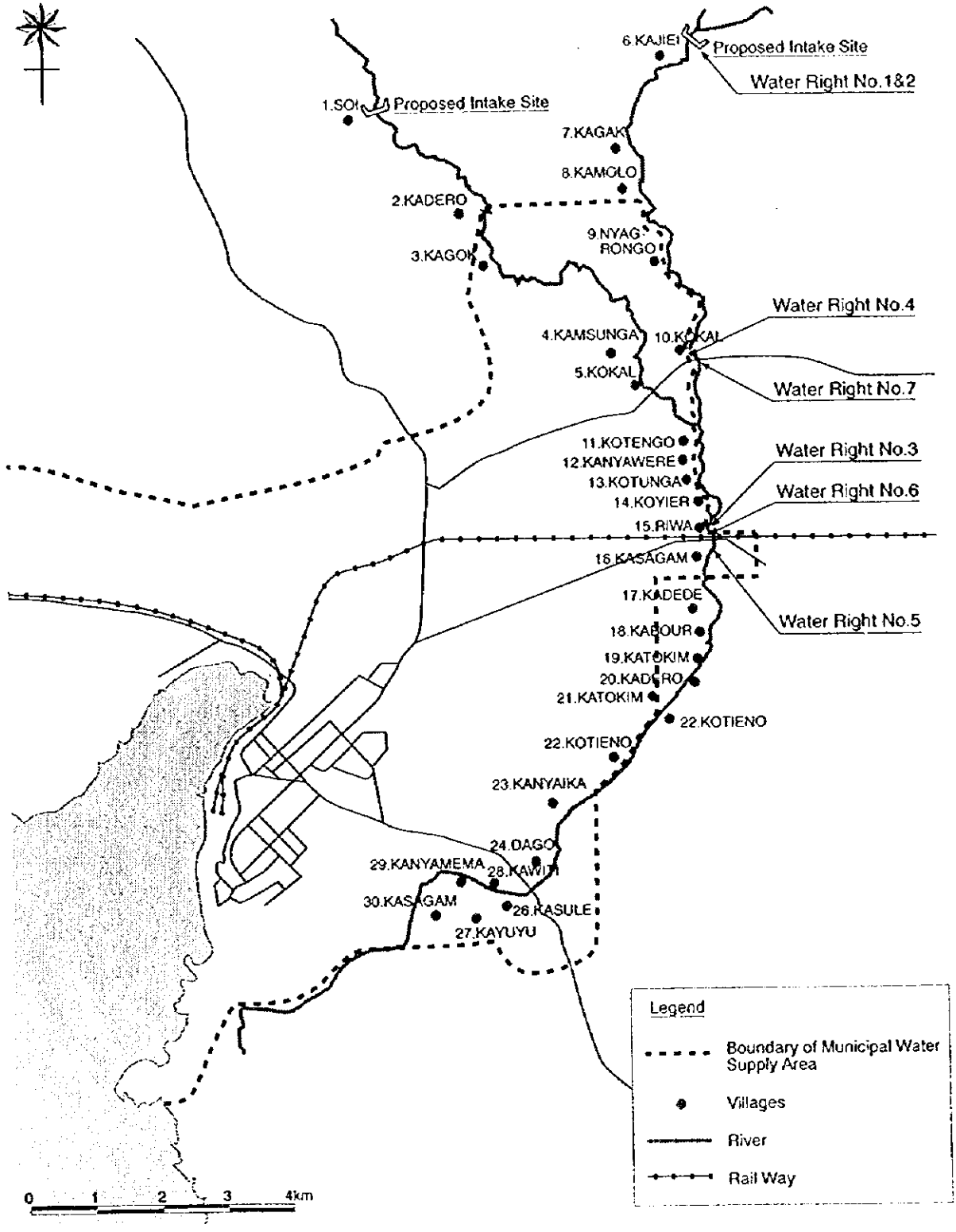


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Table 9-4 List of Water Abstraction Permissions

No.	Applicant	Allocation	Purpose	Issue Date	Expiry Date	Remarks
1.	Municipality of Kisumu	136.08 m^3/d	Public Use (Water Supply)	2-9-70	5-6-95	Under Renewal
2.	Municipality of Kisumu	1360.8 m^3/d	Public Use (Water Supply)	18-2-70	5-9-94	Under Renewal
3.	Director of Agriculture	29.8 m^3/d	Irrigation	8-2-61	31-12-85	Expired
4.	Director of Agriculture 66	7723.95 m^3/d	Irrigation	30-11-75	30-11-79	Under Renewal
5.	Kibos Industries	64.28 m^3/d	Domestic Steam Raising	19-3-75	31-12-83	Under Renewal
6.	Commissioner of Prisons (Kibos Prison)	908.7 m^3/d	Irrigation	23-6-76	23-6-78	Under Extension
7.	Rehmatk Kerdin	no-record	Domestic & Irrigation	18-9-84	13-9-86	Under propose

9.3.3 Kisumu Bay (Lake Victoria)

Kisumu Bay is a part of Winam Gulf (Lake Victoria). The bay is adjacent to Kisumu Municipality, and it is an important source of water supply for a large population in Kisumu Municipality. 18,000 m^3/day of raw water have been taken from the bay for the municipal water supply. The bay is acting not only as water source, but recipient of effluent from the Kisumu Municipality. The bay is therefore considered the most polluted part of Winam Gulf. The pollution load generated in the catchment area is discharged to the bay through Kisat River and the drainage system in the municipality.

Currently, Kisumu Bay suffers a heavy infestation of water hyacinth (Eichhornia crassipes). During the field investigations, it was completely covered by water hyacinth. Kisumu Port, which is an important transport facility for the region, is located in the bay. The infestation of the above weed interferes greatly with the transportation activities. Due to the coverage by water hyacinth, there are no fishing activities in the bay.

9.4 ENVIRONMENTAL IMPACT ASSESSMENT

As written in section 9.1.3, EIA are carried out on following Impacts,

- Impacts caused by Construction Works during Construction
- Impacts caused by Water Abstraction from Rivers
- Impacts caused by Increase of Wastewater Generation
- Impacts of Operation of Sewage Treatment Works

9.4.1 Impacts during Construction

As mentioned in section 9.3.1, the Study Area can be divided into 9 sub-area. Five items of potential impacts are assessed on each 9 sub-area, and the results are summarized as shown in Table 9-5.

Table 9-5 Evaluation of Impacts in/around Construction Sites

Site No.	Resettlement	Transportation	Dangers	Soil Erosion	Noise and Vibration
W1	○	○	○	○	○
W2	○	○	○	○	○
W3	○	○	○	○	○
W4	△	○	○	○	○
W5	○	○	○	○	○
W6	○	△	○	○	○
S1	○	○	○	○	○
S2	○	○	○	○	○
S3	○	△	○	○	○

○: nothing or no-possibility

△: minor

a. Resettlement Due to the construction of Kibue WTW in the existing Kibue reservoir site, the site shall be expanded into residential area. Accordingly, several households shall be resettled. The land ownership belongs to the Government. The Government shall arrange reasonable resettlement plan with the residents. Other construction works will not require any resettlement for land acquisition. In the case of Sites-W3, W4, S1 and S2, the construction works will be carried out within the existing sites.

b. Transportation It is considered that there are no large scale construction works to disturb

traffic condition around the construction sites. Pipe installation works for water supply and sewerage system are to be carried out along the road in the municipal. It may affect traffic condition, but it is a temporary phenomenon.

c. Dangers There are no construction works which can be dangerous or cause damage or risk around the sites.

d. Soil Erosion The Phase 1 Project does not include large scale earth works (embankment and excavation) in the construction sites. Serious soil erosion is not expected.

e. Noise and Vibration All construction works generate noise and vibration more or less. It is considered that there are no large-scale construction works to disturb neighbor's daily life by noise and vibration.

9.4.2 Impacts caused by Water Abstraction from River

Operation of Kibos Intake Works and Awach Intake Works shall be controlled to keep the river discharge to ensure water right. Water Act stipulates that " the right to the use of every body of water is hereby declared to be vested in the Ministry, and except in accordance with such right, no person shall divert, abstract or use water from a body of water otherwise than under this act". According to District Water Engineer of Kisumu District, all of the registered water rights (water abstraction permits) along Kibos River downstream of the proposed intakes have expired, and no other water right have been registered, as shown in Table 9-4.

However, in actual situation, many persons use river water without any registration and permission. As described in section 9.3.2, riparian communities along the river course depend on the river water. These communities may be affected by the water abstraction of the Phase 1 Project. However, 20 villages among the 30 will be covered by water supply area after completion of the Phase 1 Project. Another seven villages are located within 1 km from the boundary of the water supply area, therefore it is possible for the residents to get water from public taps in the supply area. There will be no serious impact on domestic users of the river water.

Many kinds of fishes are found out in the river course. These fishes will survive even if the river is dried up, because the fishes can move to Kisumu Bay (Lake Victoria).

Even after completion of Phase I Project, the water abstraction amount shall be controlled to keep

the maintenance flow in the rivers. As described in 4.2, the river maintenance flow is assumed equivalent to the recorded minimum daily flow tentatively as below,

Kibos River (at proposed intake site): 6,100 m^3/day
Awach/Nyangori River (at proposed intake site): 2,600 m^3/day

Because there no any water right downstream of the proposed intakes, the above maintenance flow is considered as reasonable.

9.4.3 Impacts caused by Increase of Wastewater generation

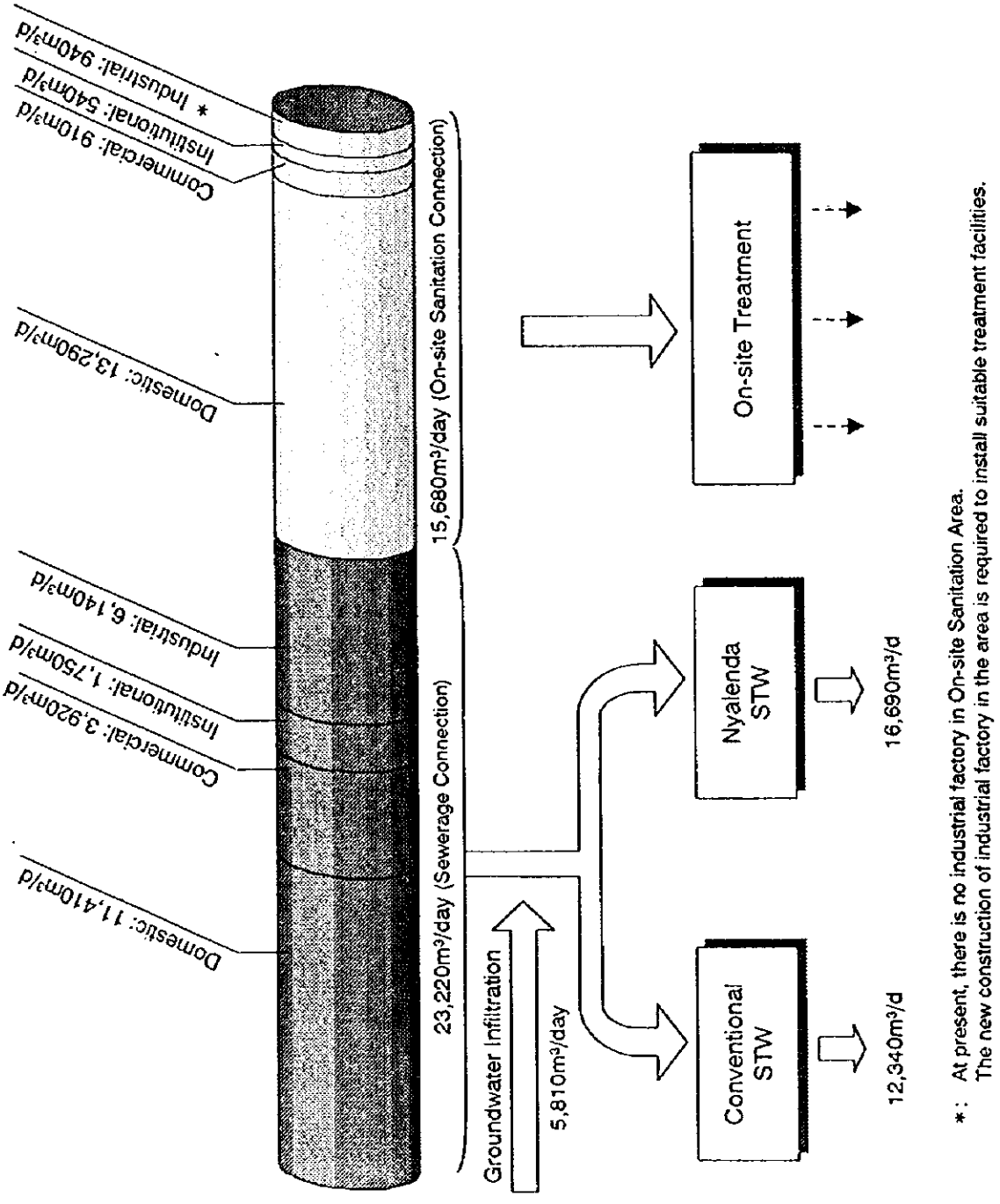
Due to the increase of water supply amount to Kisumu Municipality by the Phase 1 Project, wastewater generation in Kisumu Municipality is expected to increase. The Phase 1 Project aims not only to increase water supply amount in Kisumu Municipality, but also to increase wastewater collection and treatment capacity.

Table 9-6 and Figure 9-3 show prediction of wastewater generation in 2005 after completion of the Phase 1 Project, which are summarized from the results of the prediction in section 3.3. According to the prediction, 60 % of total wastewater in Kisumu Municipality will be collected through sewer system and treated in Sewage Treatment Works, and another 40 % of the wastewater should be treated individually by on-site treatment facilities.

Table 9-6 Wastewater Generation Prediction (2005) Unit: mg/L

	Treatment Method		Total
	Sewerage	Individual Treatment	
Domestic	11,410	13,290	24,700
Commercial	3,920	910	4,830
Institutional	1,750	540	2,290
Industrial	6,140	940	7,080
Total	23,220	15,680	38,900

Figure 9-3



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(1) Wastewater in Sewerage Area

In order to assess impacts of wastewater in Sewerage Area, the Study Team calculates BOD Load of effluent from the Sewage Treatment Works in three cases as follows;

- Present Condition in 1998
- Condition in 2005, after Completion of Phase 1 Project (with Water Supply and Sewerage Components)
- Condition in 2005, after Completion of Phase 1 Project (only Water Supply Component without Sewerage Component)

The results of the calculation are shown in Table 9-7.

Table 9-7 Prediction of Effluent from Sewage Treatment Works

	1998	2005 (after completion of Phase 1)	
		with Sewerage Component	without Sewerage Component
Flow Rate (m^3/day)*1			
Conventional STW	6,800	12,340	12,340
Nyalenda STW	2,000	16,690	16,690
Total	8,800	29,030	29,030
BOD Value (mg/L)			
Conventional STW	220*2	20*3	220*2
Nyalenda STW	80*2	20*3	80*2
BOD Load (kg/day)			
Conventional STW	1,496	247	2,715
Nyalenda STW	160	334	1,335
Total	1,656	581	4,050

*1: Flow Rate includes groundwater infiltration from sewer pipes

*2: The results of Water and Sludge Survey

*3: Design Criteria for the Sewage Treatment Works

Even now, the effluent of Conventional and Nyalenda STW are considered as great pollution sources of Kisumu Bay. After completion of Phase I Project, influent of the STWs is expected to increase from 8,800 m^3/d to 29,030 m^3/d due to the increase of the water supply as shown in Figure 9-4. In the case of no rehabilitation and expansion of the sewerage in the Phase 1 Project, total BOD pollution load from two STWs is expected to increase to 4,050 kg/d, which is more than double of the present value, 1,656 kg/d.

As the countermeasure for mitigating the above impacts, the Phase 1 Project includes

rehabilitation and expansion program for the existing sewage treatment works as follows;

- Rehabilitation of the existing Conventional STW (trickling Filter Process) which includes an expansion of the treatment capacity on daily maximum from the existing 6,800 m^3/day to 13,400 m^3/day with design BOD effluent of 20 mg/L
- Rehabilitation of the existing Nyalenda STW (Waste Stabilization Pond Process) which includes an expansion of the treatment capacity on daily average from the existing 11,000 m^3/day to 12,900 m^3/day with design BOD effluent of 20 mg/L

Due to the above rehabilitation and expansion works, the BOD pollution load reduction is guaranteed, even comparing with the present condition, as shown in Figure 9-4.

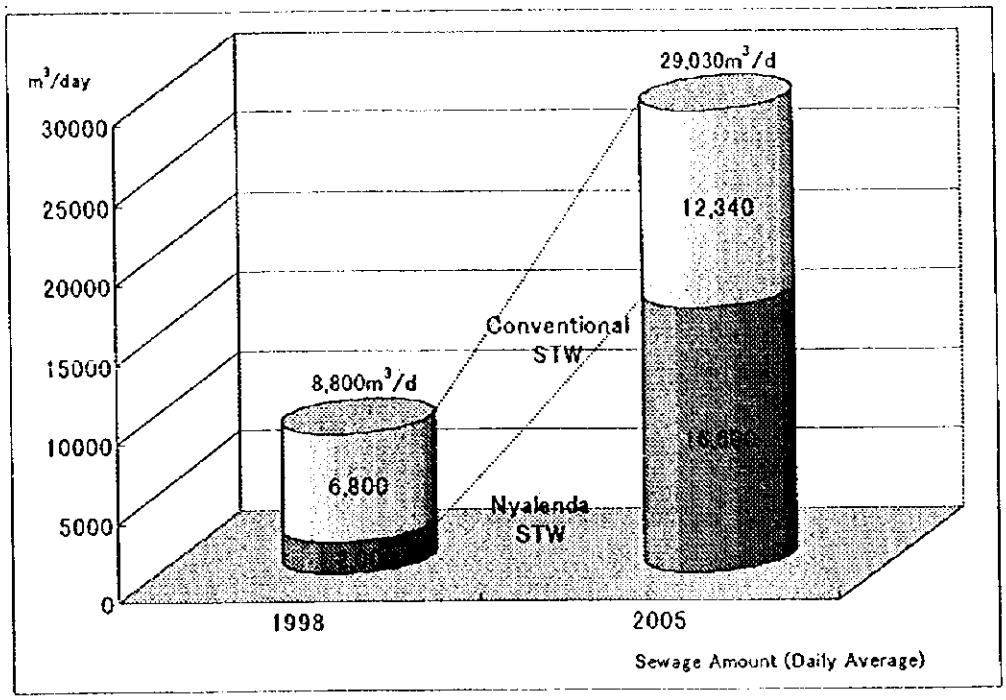
(2) Wastewater in On-site Sanitation Area

Even if sewerage system is expanded by the Phase 1 Project, sewerage system will cover about 60 % of total wastewater generated in Kisumu Municipality. Remaining 40 %, which is wastewater in on-site sanitation area, shall be treated at the source individually.

As shown in Figure 9-3, about 85 % of wastewater in on-site sanitation area, 13,290 m^3/day will be generated from domestic users. Most of the users are living in peri-urban area, and the unit water supply amount in this area is assumed low level from 15 Lpcd to 60 Lpcd. Therefore, even simple on-site treatment facilities, such as pit latrine can work well, so the 85 % of wastewater will not be a serious pollution sources. Commercial and Institutional wastewater will also not be a serious pollution source.

Industrial Wastewater in on-site sanitation area are predicted 940 m^3/d, only 6 % of the total wastewater in the area. However, the effluent may be high-density contamination. If on-site treatment works can not work well, the effluent become serious pollution load. At present, there is no industrial factory in the area. When new factories are constructed in the area, they shall be equipped with wastewater treatment facilities to meet the effluent standard as that of the Sewage Treatment Works.

Figure 9-4



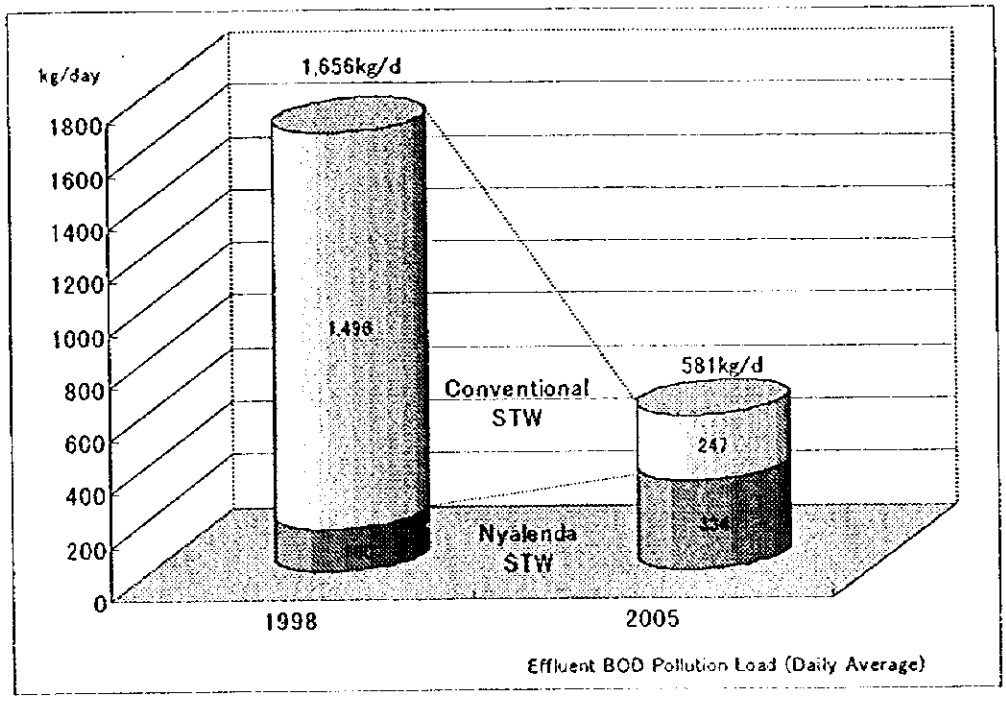


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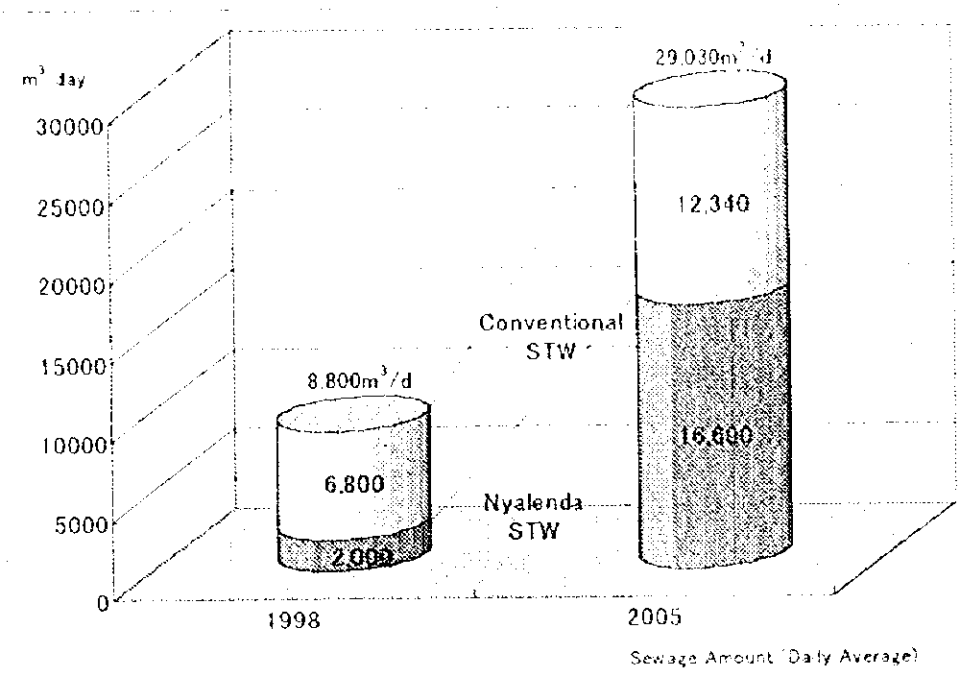
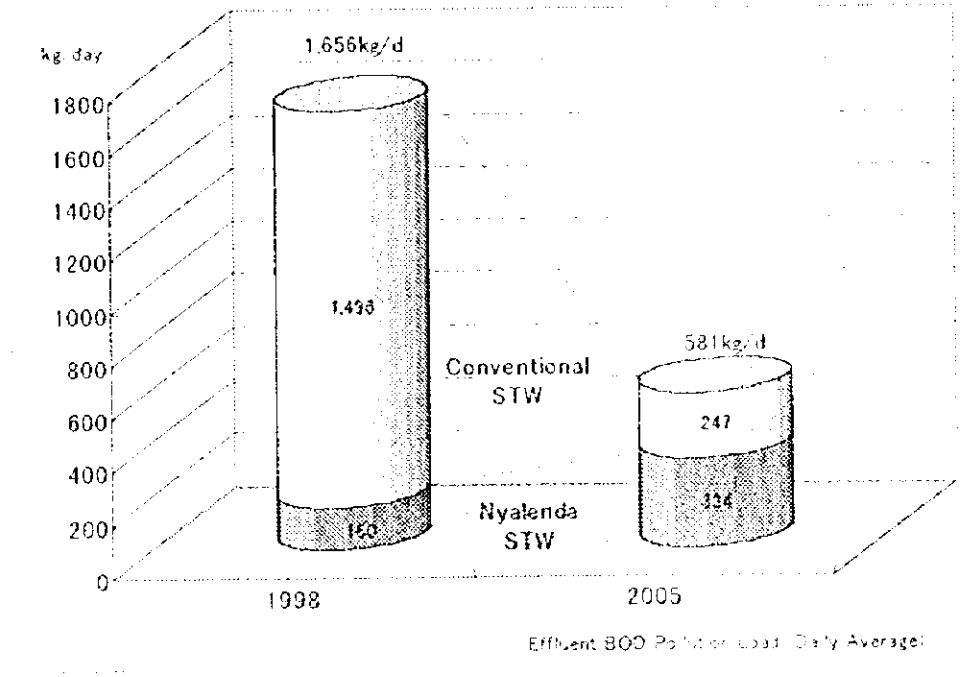
Figure 9-4



Sewage Amount (Daily Average)



Effluent BOD Pollution Load (Daily Average)

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9.4.4 Impacts of Operation of Sewage Treatment Works

Operation of Conventional and Nyalenda Sewage Treatment Works are expected to affect positive impacts rather than negative impacts, as described in section 9.4.3. This section describes about impacts caused by operation themselves of the two sewage treatment works, but does not describe about impacts by effluent of the STWs because they were already assessed in 9.4.3.

(1) Outline of Sewage Treatment Works

The treatment capacity of Conventional STW will be doubled from 6,800 m^3/d to 14,600 m^3/d on daily maximum by the rehabilitation and expansion works. Though the increase of the treatment capacity, Conventional Sewage Treatment Works will adopt same treatment method, and the difference is only adopting Super Rate Plastic Media for Biofilter. The treatment capacity of Nyalenda STW will be increased from 11,000 m^3/d to 18,000 m^3/d on daily average by installation of three anaerobic ponds. Table 9-8 shows the comparison of major components of sewage treatment works between present and after Phase 1 completion.

Table 9-8 Major Component of Sewage Treatment works at Present and after Completion of Phase 1 Project

	Present	After Completion of Phase 1
1. Conventional STW		
Primary Sedimentation	6 units	7 units
Biofilter	6units (using stone media)	8 units (using SR plastic media)
Secondary Sedimentation	6 units	6 units
Design Capacity (Daily Maximum)	6,800 m^3/day	14,600 m^3/day
Management Capacity (Daily Average)	6,800 m^3/day	—
2. Nyalenda STW		
Anaerobic Pond	0	3 units
Facultative Pond	3 units	3 units
Maturation Pond	6 units	6 units
Design Capacity (Daily Maximum)	11,000 m^3/day	18,000 m^3/day
Management Capacity (Daily Average)	2,000 m^3/day	—

(2) Assessment

The potential impacts, which were identified in IEE are assessed on the two STWs and the results are summarized as below;

Table 9-9 Evaluation of Impacts by Operation of Sewage Treatment Works

	Waste Disposal	Groundwater	Flora and Fauna	Soil Contamination	Offensive Odor
Conventional STW	△	○	○	○	○
Nyalenda STW	△	△	○	○	△

○: nothing or no-possibility

△: not serious or minor

a. Waste Disposal Certain amount of sludge is continuously generated in the process of waste water treatment. Dry sludge, which is treated through the sludge treatment process in existing Conventional STW, is utilized for agriculture activities by farmers. As long as sludge is managed properly, the dry sludge is in great demand for agriculture use.

b. Groundwater The ponds of Nyalenda STW are constructed by earth works. The wastewater in Nyalenda STW, therefore may infiltrate to groundwater through the bottom of ponds during treatment process. It may be dangerous for health if ground water is used for drinking. Fortunately, near the site, no wells for drinking water exist. The infiltration of the wastewater is not expected serious impacts.

c. Flora and Fauna Any impacts on Flora and Fauna can hardly be expected as long as sewage treatment works are operating properly.

d. Soil Contamination Heavy metal and toxic material shall contaminate surface soil around the site. However, as long as industrial factories do not discharge such materials, soil contamination is not expected.

e. Offensive Odor Anaerobic ponds in Nyalenda STW may generate offensive odour. However, the site of Nyalenda STW is far from residential area, and located in open area. No serious odour problem is expected.

Because of function of sewage treatment works, large amount of raw wastewater should be collected to the site of sewage treatment works and treated. In case of mismanagement and/or brokendown of sewage treatment Works, collected raw wastewater may cause great impacts

around the site. Suitable operation and maintenance of sewage treatment works are minimum requirement for environmental conservation.

9.5 COUNTERMEASURE FOR MITIGATING IMPACTS

Countermeasures for each potential impact are recommended to mitigate magnitude of the impacts as below.

(1) Impacts caused by Construction Works during Construction Period

Impact Item	Countermeasure
a. Resettlement	The resettlement plan for expansion of Kibue WTW site shall be prepared as soon as possible. The plan shall be established in cooperation with the residents to be resettled.
b. Transportation	During installation of pipes along the road, the Contractor shall submit installation plan to the Municipality. The Contractor shall take necessary action such as traffic control to mitigate impacts on traffic condition in cooperation with the Municipality.
d. Dangers	The site condition and progress of construction works shall be checked periodically. The Contractor shall prepare safety-working condition.
e. Soil Erosion	After completion of earth works (embankment and excavation works) in the sites, soil condition shall be checked by the Consultant.
f. Noise and Vibration	Basically, any construction in midnight will not be allowed

(2) Impacts caused by Water Abstraction from Rivers during Operation Period

Impact Item	Countermeasure
a. Water and Common Rights	Intake Works shall be designed and operated to keep maintenance flow in the rivers. The maintenance flow is assumed equivalent to the recorded minimum daily flow in the rivers.
b. Lake, Mash and River	
c. Flora and Fauna	

(3) Impacts caused by Increase of Wastewater Generation

Impact Item	Countermeasure
a. Water Pollution	Rehabilitation and expansion of the sewerage system, which is one of components of the Project, are expected to act as the countermeasure. On-site treatment facilities will cover about 40 % of total wastewater generated in the Project Area. The Municipality is recommended to promote installation of proper on-site treatment facilities in the area.

(4) Impacts of Operation of Sewage Treatment Works

	Countermeasure
a. Waste Disposal	After expansion of treatment capacity of the STWs, sludge management system will be strengthened to meet new generation of the sludge. Sludge management shall be considered from the view point of demand and supply condition
b. Groundwater	It will be forbidden to drink raw groundwater near Nyalenda STW.
c. Flora and Fauna	Safety and proper operation of STWs shall be kept under the suitable O & M system.
d. Soil Contamination	It is not allowed to discharge with any toxic material by law. It is recommendable Effluent monitoring system will be organized especially for industrial effluent.
e. Offensive Odor	At detail design stage for anaerobic ponds in Nyalenda STW, tree planting shall be considered to protect the neighborhood from offensive odor. At present there is no residential area around site.

9.6 CONCLUSION AND RECOMMENDATION

(1) Conclusion

a. Impacts by Construction Works

- No serious impacts are expected during construction period, if the countermeasures are carried out as shown in Section 9.5.

b. Impacts by Water Abstraction from River during Operation

- There is no water right on the river course downstream from the proposed Kibos and Awach intake sites. However, many residents of riparian communities use river water for domestic use, irrigation or water for live stocks without any permission from the government. Many kinds of fishes are found out in the river course, and fishing is very popular in the riparian communities. Therefore, the maintenance flow, which is assumed equivalent to the recorded minimum daily flow, shall be kept in the rivers, in order to avoid great impacts on the river condition and riparian community life. After completion of Phase 1 Project, it will be possible for most of riparian communities get water through the public taps.

c. Impacts by Increase of Wastewater during Operation

- Due to increase of water supply amount under Phase 1 Project, total influent amount of Conventional and Nyalenda STWs is supposed to increase to 23,400 m^3/day from 8,500 m^3/day. However, total BOD pollution load from the both STWs is expected to decrease to 464 kg/day from 1,590 kg/day, due to rehabilitation and expansion of the STWs under Phase 1 Project. Phase 1 Project is therefore expected to work for environmental conservation in Kisumu Bay (Lake Victoria).
- Wastewater generated in On-site Sanitation Area shall be treated individually. Most of the wastewater in the area is generated from domestic water users, whose unit water consumption rate is low. This kind of wastewater is not expected to be a serious pollution source, even if only simple on-site treatment facilities are installed.
- According to the prediction, 940 m2/d of industrial wastewater will be generated in On-site Sanitation Area. It may become serious pollution sources, because Industrial effluent may discharge highly polluted material directly without proper treatment. At present, there is no industrial factory in the area. The government shall take note of any new construction of industrial factory in the area.

d. Impacts of Operation of Sewage Treatment Works

- If the sewage treatment works can not operate properly, large amount of collected wastewater at the sites will change to a serious pollution source. Proper operation and maintenance of the treatment works are required.

(2) Recommendation

a. Maintenance Flow

The operation of Kibos Intake Works and Awach Intake Works shall be controlled to keep the maintenance flow in Kibos and Awach/Nyangori Rivers. At further detail design of the intake works of Phase 1 Project, structural and institutional measures shall be considered in order to keep the maintenance flow.

The river maintenance flow is tentatively assumed to be equivalent to the recorded minimum daily flow. This is considered quite reasonable. However, the amount of maintenance flow has not been justified and approved officially. At the detail design stage, it shall be reconsidered by the relevant organizations in Kenya.

b. On-site Treatment Facilities

Even after completion of Sewerage Component of Phase 1 Project, about 40 % of wastewater generated in the Study Area shall be treated individually. Individual treatment facilities have not been overseen and controlled systematically in Kisumu Municipality. Installation of proper on-site treatment facilities shall be promoted for environmental conservation. It is recommended that Municipal Council of Kisumu establish a control and promotion program for on-site treatment facility.

c. Strengthening of O & M system of STW

Lack of proper operation and maintenance of STW may cause serious pollution problem. If the sewage treatment works can not work properly, large amount of collected wastewater will become serious pollution load immediately. Strengthening of O & M system for STWs is required for environmental conservation.

CHAPTER 10

PROJECT EVALUATION

10. PROJECT EVALUATION

10.1 ENGINEERING ASPECTS

It was observed throughout the tenure of the JICA Study that most of the problems which currently undermine the operation and maintenance of the municipal water supply and sewerage system are either directly or indirectly associated with the breakdown of mechanical and electrical equipment, such as valves, meters, pumps, motors, agitators and so on.

The JICA Study Team therefore adopted the following as the basic engineering strategies for the planning of water supply infrastructure for the Phase I Project:

- Use of gravity flow to the maximum extent possible.
- Use of hydraulic energy for chemical mixing and flocculation instead of adopting mechanical agitators and flocculators at water treatment works
- Provision of an adequate capacity for distribution reservoirs instead of providing an emergency power supply equipment at water treatment works

Apart from the above, the Study Team also adopted the following measures with a view to expediting construction works as well as the operation and maintenance of facilities once they have been installed.

- Use of pipe materials which are locally available. Steel and polyvinyl chloride pipes proposed or use for water supply are locally fabricated or manufactured and readily available in a relatively short time. Concrete and polyvinyl chloride pipes proposed for sewerage improvement are also locally manufactured. The use of these pipe materials will therefore expedite pipeline construction works and maintenance of the pipelines once they have been installed.
- Adoption of horizontal flow sedimentation basins at the new Kibuye WTW, which will be much easier in operation and maintenance compared with the existing sludge-blanket type sedimentation basins at the Lake WTW.
- Separation of the treated water transmission mains function from that of distribution mains. At present, the existing two treated water transmission mains, one from the Lake WTW to the Kibuye reservoir and the other from the Kajulu WTW to the Kibuye reservoir, are

playing dual functions. These pipelines were originally assumed to be treated water transmission mains but have been tapped en-route or connected to the distribution system before they reach the Kibuye reservoir. For this reason, the Kibuye reservoir has never been filled up to its full capacity, i.e. 6,300 m3 in many years and is currently operated with almost half the capacity. The separation of the functions will therefore lead to the effective use of reservoir capacity, which in turn will also increase the reliability of water supply under emergency situations.

In view of economy and urgency, the JICA Study Team adopted the following as the basic policies for planning of sewerage system in Kisumu.

- To maximise the use of existing sewerage facilities

This is necessary for the urgent improvement of the current poor sewerage conditions in Kisumu. Experience indicates that rehabilitation of existing facilities will require less time and cost to complete than in the case new facilities are constructed.

- To develop sewerage system following the development of water supply system.

In many countries, it is planned that the provision of water supply always advances several years ahead of sewerage improvement. This approach will allow a sewerage planner to plan sewerage facilities according to actual necessities and will assure him that he will be able to obtain designed benefits and effects once his plan has been implemented.

A similar approach was adopted for Kisumu in that the Phase I Project is planned to concentrate on the rehabilitation of existing sewerage facilities (which are located in the center of current wastewater generation) and a major expansion of service area is planned under the Phase II Project. As a result, the proposed Phase I and Phase II Projects will be able to collect 60 % and 83 % of the total water supply volumes respectively.

With the integration of all the strategies and measures mentioned above, the proposed Phase I Project can be assessed, from an engineering point of view, that it is appropriate with respect to the level of skills required for construction, operation and maintenance of the Project, and that it will enhance the sustainability of the municipal water supply and sewerage system as a whole.

10.2 FINANCIAL ASPECTS

Analyses presented in Chapter 8 demonstrate that this project is financially viable. The financial rate of return is relatively high for a socially motivated project like this project. The sensitivity analyses indicate that the project remains financially viable under all likely adverse changes. This is partly a reflection of the strong demand and partly of people's willingness to pay for the service. Another important factor is the use of existing assets. This minimizes the capital investment relative to the output.

The project concentrates on increasing the supply of water. This is largely distributed through the existing distribution system. This system is presently underutilized due to limited capacity to supply water. The unit costs of the expansion based on the existing facilities is much lower than the average costs of the overall project.

An effort has also been made to develop a low cost water and sewerage service. Technologies proposed are simple and appropriate to the conditions of Kisumu. The implementation schedule is designed to avoid unused capacity. The spatial aspects of development have been fully considered and priority has been given to high-density areas. This minimizes the fixed capital investment requirements.

10.3 SOCIO-ECONOMIC ASPECTS

The basic strategy of the project is attainment of equity. The project is based on the principle of "some for all rather than more for some". A practical implication of this is to target the highest possible coverage of service. Special attention has been paid to the needs of people who have very low incomes and consume little water.

The estimates adopted for population projections and the service coverage for water and sewerage aim to provide the highest possible coverage. The base year population of the Kisumu Municipal Council area has been revised upward and established at 280,845 in 1997. Fairly high population growth rates are adopted with the population estimated to reach 414,531 in 2005 and 690,628 in the year 2015. Nearly 300,000 will be served by house connections while an additional 125,000 will benefit from the water kiosks in 2005.

Services are designed for the central service area both in conventional terms as well as to supply water and sewerage services in poor outlying areas in Kisumu. An important tool used for this purpose is the reliance on common water taps. This provides access to water at the lowest

possible cost. The relatively low levels of consumption under this kind of service spreads the available water among all residents.

The practical arrangements for managing these kiosks are designed to insure financial viability of this service. At the same time, people will receive clean water at prices, which are considerably below those presently paid by the low income people. The proximity of the proposed facilities to residences will substantially reduce the burden of fetching water which almost exclusively falls on women and children. The availability and reduced price of water will improve the health status of all population, particularly the poor and the children.

The supply of water is expected to provide a major boost to industry and commerce in the area. Kisumu is expected to play a major role in trade with other countries in East Africa. Lack of water is believed to have been a major factor constraining this growth. These requirements have been incorporated into the service demand estimates.

There are frequent outbreaks of water-borne diseases in Kisumu. A major cause of these outbreaks is the lack of water and the extremely poor quality of some water that is used by inhabitants. The study will provide clean water to all residents. The Project contains a carefully balanced package of investment not only to provide water but also to safely discharge the waste water generated. This is not only critical for the health of people of Kisumu but also to protect Lake Victoria.

While increasing the supply of water to acceptable levels, the project proposes a tariff structure to conserve the available resources. This will strongly discourage consumption beyond levels which are required healthy living. Those who consume beyond these levels will pay prohibitive tariffs. This will encourage conservation and will subsidize the consumption of low income households. Similarly, consumption of industry and commercial enterprises will be priced to generate revenue and to encourage rational use of water.

The project has made appropriate recommendations for development of the local capability for efficient implementation of the new project and its continued operation on a sustainable basis. This includes training of staff and development of appropriate institutional and administrative procedures and practices.

The management and administrative steps to be taken have been agreed with the local and central government representatives. It is expected that the project implementation schedule will be accompanied by the measures to insure that the project activities are sustained with the local resources.

CHAPTER 11

CONCLUSIONS AND RECOMMENDATIONS

11. CONCLUSIONS AND RECOMMENDATIONS

11.1 CONCLUSIONS OF FEASIBILITY STUDY

For a variety of reasons mentioned below, the proposed Phase I Project can be assessed feasible.

Throughout the planning process of water supply and sewerage system improvement works for the Phase I Project, a continuous attention was paid by the JICA Study Team to ensure that any improvement works to be proposed can be implemented, operated and maintained within the level of technical skills and engineering capacity currently available in Kenya and Kisumu. It is therefore expected that the proposed Phase I Project can be implemented within the time frame envisaged, and that the Project, once it has been implemented, can be managed on a sustainable basis.

The water resources study conducted by the JICA Study Team confirmed that adequate water will be available from the Kibos and Awach rivers to meet the raw water requirement of the proposed Kibuye WTW (42,500 m3/day) as well as the increased raw water requirement of the Kajulu WTW (3,000 m3/day) under the Phase I Project. Water is abundant in the Lake Victoria, and hence the lake will be able to meet the increased raw water requirement of 27,000 m3/day for the Lake WTW under the Phase I Project.

The Phase I Project will increase the supply capacity of the municipal water supply system from the present 18,000 m3/day to 67,000 m3/day. This drastic increase in supply capacity is expected to generate a significant impact on the management, in particular, on the financial management of water supply and sewerage. For this reason, the proposed Phase I Project has included a financial training programme which will be implemented prior to the completion of the Phase I Project. In addition, the Phase I Project has also included consultancy services for strengthening of management capacity, which will include, among others, water meter replacement, reduction of unaccounted-for water and improvement of accounting system.

With respect to the water tariff, it is proposed under the Phase I Project that the domestic minimum charge (up to 10 m3/month) be reduced from the present 180 Ksh to 100 Ksh, and that a progressive water tariff structure be adopted for non-domestic users and domestic customers who use more than 10 m3 of water per month. This water tariff structure will enhance the equity of water service in terms of water distribution by increasing, for low income customers, a chance of having access to municipal water supply while it is indirectly urging large users to minimize over-usage and wastage.

11.2 RECOMMENDATIONS ON FURTHER STEPS

11.2.1 Water Supply

(1) Water Abstraction Permit

With respect to the abstraction of water from the Kibos and Awach Rivers for Phases I and II Projects, the Kisumu Municipal Council is recommended to make an application to MOWR for water abstraction permit. Given that the two projects will be likely to be implemented in succession one after another, it is recommended that the application be made both for Phase I and Phase II Projects at one time. The application form, "Application for a Water Permit (Surface Water)" is available at the headquarters of MOWR. The amounts of water planned to be abstracted from the two rivers are shown below.

Water Abstraction Amounts from Kibos and Awach Rivers

unit: m3/d

River	Phase I Year 2005 and after	Phase II Year 2015 and after
Kibos	38,600	73,000
Awach	6,900	15,000
Total	45,500	88,000

(2) Land Appropriation

Under the Phase I Project, a new water treatment works with a treatment capacity of 40,000 m3/d will be constructed in Kibuye immediately adjacent to the existing Kibuye reservoir. The capacity of the works is planned to be doubled under the Phase II Project. A proposed layout plan of the works is shown in Figure 4-3 together with the extent of land to be required for construction of the works.

Three distribution reservoirs are also planned to be constructed in Kanyakwar (5,000 m3), Kogony (3,500 m3) and Kajulu (700 m3) under the Phase I Project. These reservoirs are planned to be increased in capacity to 8,000, 7,500 and 1,400 m3 respectively under the Phase II Project. Assuming an effective depth of the reservoirs at 5 m, the extent of land to be required for construction of each reservoir is estimated as shown below. The proposed locations and elevations of these reservoirs are shown in Figures 4-1 and 4-2. Another new reservoir (Phase I:

27,000 m3, Phase II: 19,000 m3) planned to be located in Kibuye will be constructed within the existing Kibuye reservoir compound.

Extent of Land Required for Distribution Reservoirs

Distribution Reservoir	Capacity (m3)			Extent of Land Required (m2)		
	Phase I	Phase II	Total	Phase I	Phase II	Total
Kanyakwar	5,000	3,000	8,000	1,400	900	2,300
Kogony	3,500	4,000	7,500	1,000	1,200	2,200
Kajulu	700	700	1,400	200	200	400

Apart from these distribution reservoirs, the project will also need a plot of land in the Nyalenda area for construction of wastewater disposal facilities. These facilities will comprise lagoons which receive wastewater from the Kibuye WTW and sludge drying beds as shown in Appendix G. The extent of the land required for construction of these facilities is estimated at about 34,000 m2.

It is recommended that the Kisumu Municipal Council take necessary actions to complete the appropriation of land in time before construction of these infrastructure starts on the ground. In doing so, it is also recommended that the land be appropriated for both Phase I and Phase II at one time.

11.2.2 Sewerage

(1) Inclusion or Exclusion of Rehabilitation Works Component

The proposed Phase I Project includes the rehabilitation works of the existing conventional STW and three wastewater pump stations. All of these rehabilitation works, however, have also been included in the Lake Victoria Environmental Management Programme (LVEMP). Prior to the implementation of the proposed rehabilitation works, the Kenyan Government therefore needs to make a decision as to whether the proposed rehabilitation works should be implemented under the Phase I Project or they should be implemented under the LVEMP.

(2) Establishment of Regulatory Framework for Controlling Industrial Effluents

The proposed sewerage treatment works has been planned on the basis that the industrial effluent standards proposed in the Master Plan will be accepted and complied with by industries. If this

is not the case, it will be difficult for the sewerage treatment works to maintain the proposed effluent standards (BOD: 20 mg/l, SS: 30 mg/l). To avoid this actually happening, early establishment of a regulatory framework for controlling industrial effluents, including monitoring and punitory measures against violations is strongly recommended.

(3) Community Participation in Shallow Sewer Schemes

The proposed Phase I Project includes the installation of shallow sewer networks in urban and peri-urban areas. This is to collect domestic wastewaters from low income households whose water consumption rate is projected to be in a range between 50 to 60 lcd, which is too low to be connected directly to the municipal sewerage system. The installation of shallow sewer networks will require a high degree of community participation and there will a need for public relations to explain the costs and benefits to community groups.

(4) Establishment of Central Library System

With respect to the existing sewerage facilities except for the Conventional STW, most of the design/construction drawings and design calculations have been missing. The information contained in these documents is valuable for operation and maintenance of the facilities as well as for extension of the facilities in future. It is therefore recommended that a central library system which systematically maintains all original drawings and calculations be urgently established within the Water and Sewerage Department.

11.2.3 Financial Aspects

The study team and the Kenyan counterpart staff have agreed on a number of practical steps to increase the transparency in the Council accounts and to formalize the financial relationship between the w/s account and the General Account.

The contribution of the w/s revenue to the General Account should be carefully specified beginning with the 1998/99 budget. In the past, the actual transfers have always exceeded the amount budgeted by a large margin. In the future, transfers from the water department should be strictly limited to the amount budgeted. This amount, however, should be set in a realistic way. In the last three budgets, this was always set at K.700,000 pounds but the actual transfers were

more than three times the amount budgeted.

The Council staff and the Study Team have agreed that the transfers to be included in the general budget will be related to the existing capacity of the w/s department. It should be based on projected performance targets on non-revenue water, billing and actual revenue collection. All other explicit and hidden subsidies should be discontinued.

The w/s department should enjoy financial autonomy within the limits set by the budget. The administrative steps for expenditure should be streamlined and expenditure authority of the w/s department strengthened. This should be accompanied by enhanced audits by the office of the town treasurer and MOLA for strict enforcement. The Council staff should be committed to adoption of a set of by-laws for that purpose by the end of July 1998.

The Council staff should prepare a set of performance targets to be met by the w/s department. This should include parameters on service coverage, costs, billing, and revenue collection. The investment and administrative requirements of the expected targets should be established by the w/s department and submitted to the Council for approval. The investment requirements of this program should be included in the 1998/99 budget and financed from the water revenue.

The w/s department should rationalize its meter reading and billing services immediately. The number of meters read and billing should be improved. The Council should enact the necessary bylaws for strict enforcement of controls to reduce non-revenue water and to improve revenue collection.

11.2.4 Institutional Aspects

It may be concluded that the project will only be viable if a reasonably efficient and fully autonomous WSD is in place by mid 1999. Further strengthening will then be required by way of consultancy services and training to be provided in Phase 1. Strengthening will concentrate on management and financial control with a strong commercial bias to provide for the conversion to a fully commercialised Water and Sewerage Company by the end of 2001.

It is therefore recommended that council officials establish, and strictly adhere to, a set of rules on the financial relationship between the WSD and the council. These may be formalised on the basis of monthly contributions from the WSD to the council's General Fund. Under no circumstances will additional funds be made available to council. Council may consider a sum equal to approximately 40% of the gross income of the WSD revenue generated from the

operation of the existing water supply system as its contribution. This is equivalent to the estimated amount currently being transferred. The WSD will have its own account separate from the council, and there shall be no hidden subsidies and interdepartmental transfers.

As regards operating autonomy, decision making for all routine matters should be vested in the WSD. Whilst this will delegate all routine powers to WSD, the council will continue with its functions to exercise controls and audit, and it is recommended that this be achieved by having the Town Clerk and Town Treasurer on the Water and Sewerage Committee which exercises council control of the WSD. This will eliminate the need for WSD matters to be referred to the Finance, Staff and General Purpose Committee.

The resulting autonomous WSD, strengthened through the M/I improvement consultancy, will then be able to progress to company status.

11.2.5 Environmental Aspects

Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) were conducted as part of this Study and both carefully evaluated possible impacts on the environment which might be derived from the implementation of the Phase I Project. These evaluations indicated that the project can be implemented and maintained without adversely affecting the environment throughout the stages of construction and operation.

11.2.6 Project Implementation

The loan for the Phase I Project will be on a government to government basis, with the ultimate borrower being KMC. KMC should therefore be the Executing Agency for the project and as such, responsible for the implementation of the project.

Neither KMC nor the WSD have the capacity to provide for the proper implementation and control of a project of this magnitude, therefore a Project Implementation Unit (PIU) should be established. This PIU may be established in a similar manner to the secretariat set up within MOLA to manage the KLGRP in association with a number of consultants as detailed in Section 6.1.