

F15
61.8
G.R.F.

No. 4

BASIC DESIGN STUDY
ON
SOLID WASTE DISPOSAL IMPROVEMENT PROJECT
OF
METROPOLITAN AREA
IN
THE REPUBLIC OF THE SUDAN

January 1986

JAPAN INTERNATIONAL COOPERATION AGENCY

G R F
[REDACTED]
86-19

JICA LIBRARY



1029578[0]

**BASIC DESIGN STUDY
ON
SOLID WASTE DISPOSAL IMPROVEMENT PROJECT
OF
METROPOLITAN AREA
IN
THE REPUBLIC OF THE SUDAN**

January 1986

JAPAN INTERNATIONAL COOPERATION AGENCY

国際協力事業団	
受入 月日 '86. 5. 15	415
登録No. 12646	618
	GRF

PREFACE

In response to the request of the Government of the Republic of the Sudan, the Government of Japan decided to conduct a basic design study on the Solid Waste Disposal Improvement Project in Metropolitan Area and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Sudan a study team headed by Mr. Midio SAKAMOTO Technical Supervisor, Sanitation Bureau, Kyoto City Government from October 21 to November 5, 1985.

The team had discussions on the project with the officials concerned of the Sudanese Government and conducted a field survey in the metropolitan area in the Sudan. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Republic of the Sudan for their close cooperation extended to the team.

January, 1986.

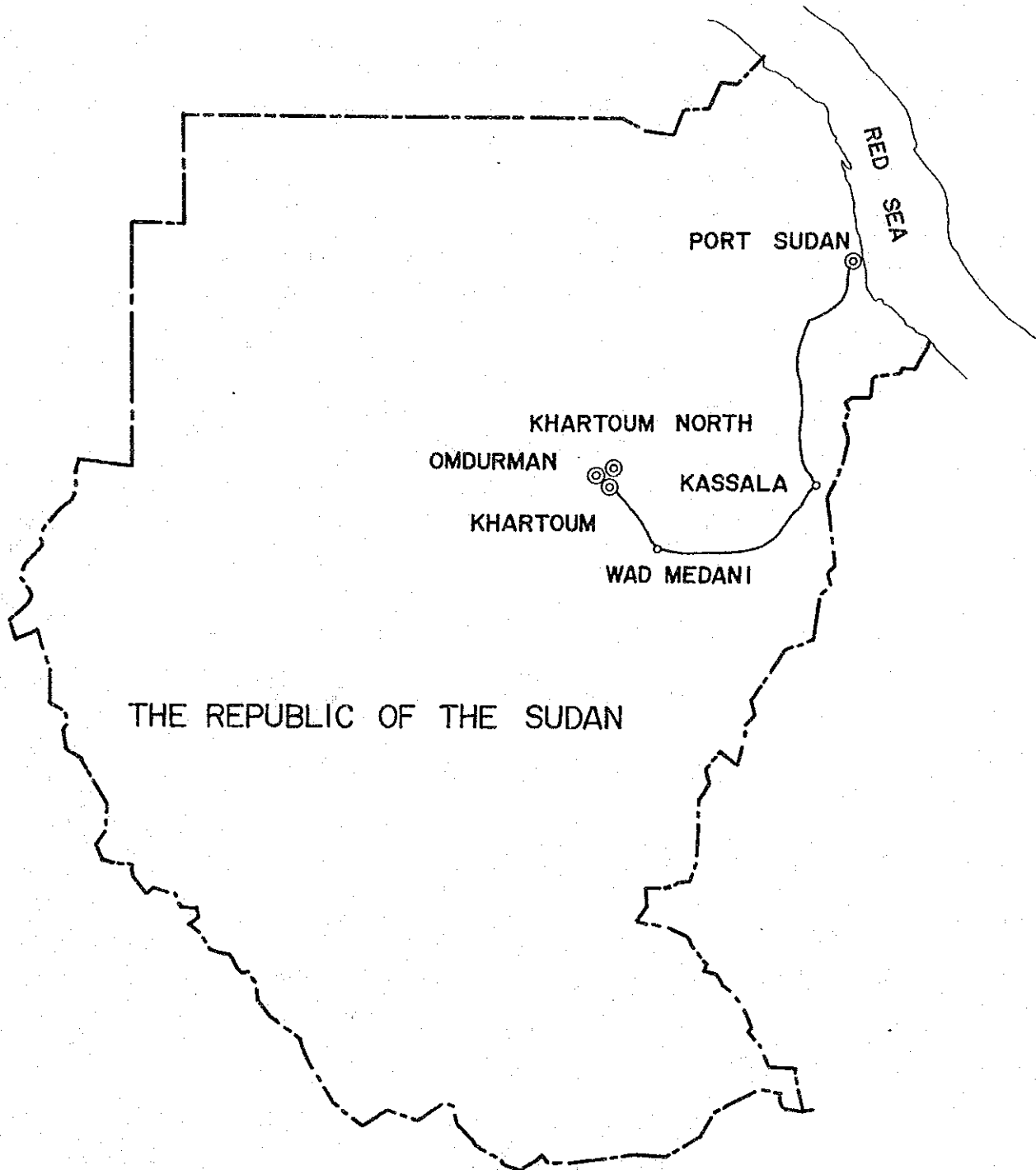
A handwritten signature in dark ink, appearing to read "Keisuke Arita", is written over a horizontal line.

Keisuke Arita

President

Japan International Cooperation Agency

Location Map



SUMMARY

Khartoum, the capital of the Republic of the Sudan, has a population of about 1.8 million. From the area, approximately 2,300 tons of solid waste are generated daily while only about 1,000 tons are collected and disposed of properly. As the amount of solid waste is presumed to further increase due to population increase and change in life style, it is anticipated that more and more wastes will be left on streets and will become a source of flies and mosquitos to cause an outbreak of malaria and other epidemics. Similarly, public sewerage system can serve only 1/3 of the entire population in the metropolitan area. As a result, sewages are discharged into open spaces or side ditches in alleys without proper treatment, creating insanitary conditions and potential hazards of epidemics.

To improve these situations, the Metropolitan Area the Government of Sudan made a request to the Government of Japan for a grant aid of equipment for collection and hanlage of solid waste and sewage.

In response, to the request, the Government of Japan decided to conduct a basic design study on the project, and the Japan International Cooperation Agency (JICA) dispatched a study team to Sudan from October 21 to November 5, 1985.

The study team carried out a field survey in Khartoum, Omduraman, Khartoum North and East Nile which are major cities in the metropolitan area, and held discussions with the Sudanese authorities concerned. On the basis of the field survey and analyses of data and information collected, a basic design of the project was carried out in Japan. As the result, it is decided that the following equipments are proper for this grant aid project.

List of Equipment to be Provided under the Grant Aid

Equipment name		Khartoum	Khartoum North	Omdurman	East Nile	Total	
1. Detachable container truck		12 vehicles	8 vehicles	14 vehicles	6 vehicles	40 vehicles	
2. Tipper	Roofed	9 vehicles	5 vehicles	11 vehicles	4 vehicles	29 vehicles	60 vehicles
	Non-roofed	10 vehicles	6 vehicles	11 vehicles	4 vehicles	31 vehicles	
3. Cesspit emptier		-	5 vehicles	9 vehicles	3 vehicles	17 vehicles	
4. Container		248 units	152 units	288 units	112 units	800 units	
5. Tractor with small trailer		5 vehicles	5 vehicles	6 vehicles	2 vehicles	18 vehicles	
6. Equipment for workshop		1 set	1 set	1 set	1 set	5 set	
7. Spare parts		1 set	1 set	1 set	1 set	-	

* Note ; A set of workshop equipment shall be provided for the head office.

After signing the Exchange of Notes (E/N), it requires approximately 13.5 months for the project implementation which consists of tender, contract of procurement, delivery, etc. The project executing bodies are the National Capital Khartoum and each city district council.

The operation and maintenance of all the equipment will be carried out by each city district council to which they will be assigned. The operation cost for each council is estimated approximately about 530,000 Sudanese pound (32 million yen) for Khartoum, about 410,000 Sudanese pound (25 million yen) for Khartoum North, about 740,000 Sudanese pound (45 million yen) for Omdurman, and about 270,000 Sudanese pound (16 million yen) for East Nile. Per ton collection costs are estimated as follows:

Unit: LS (yen)

City Unit Item		Khartoum DC	Khartoum North DC	Omdurman DC	East Nile DC
Container collection	LS/t	2.06 (126)	2.21 (135)	2.06 (126)	2.24 (137)
Tipper collection	LS/t	6.73 (412)	6.37 (390)	6.65 (407)	6.01 (368)
Sewage collection	LS/ 1000 ²	-	2.94 (180)	2.96 (181)	2.96 (181)
Tractor/ trailer collection	LS/t	11.65 (713)	8.67 (531)	5.70 (349)	11.66 (714)

Since both the city district councils and government are anxious to execute the Solid Waste Disposal Improvement Project, the study team believes that the equipment to be provided by Japan will be effectively utilized for effective implementation of the project, thereby contributing to the improvement of solid waste and sewage disposal services in the cities.

Therefore, it is very important to execute this project under the Japan's Grant Aid and is expected to have a great effect of the aid.

CONTENTS

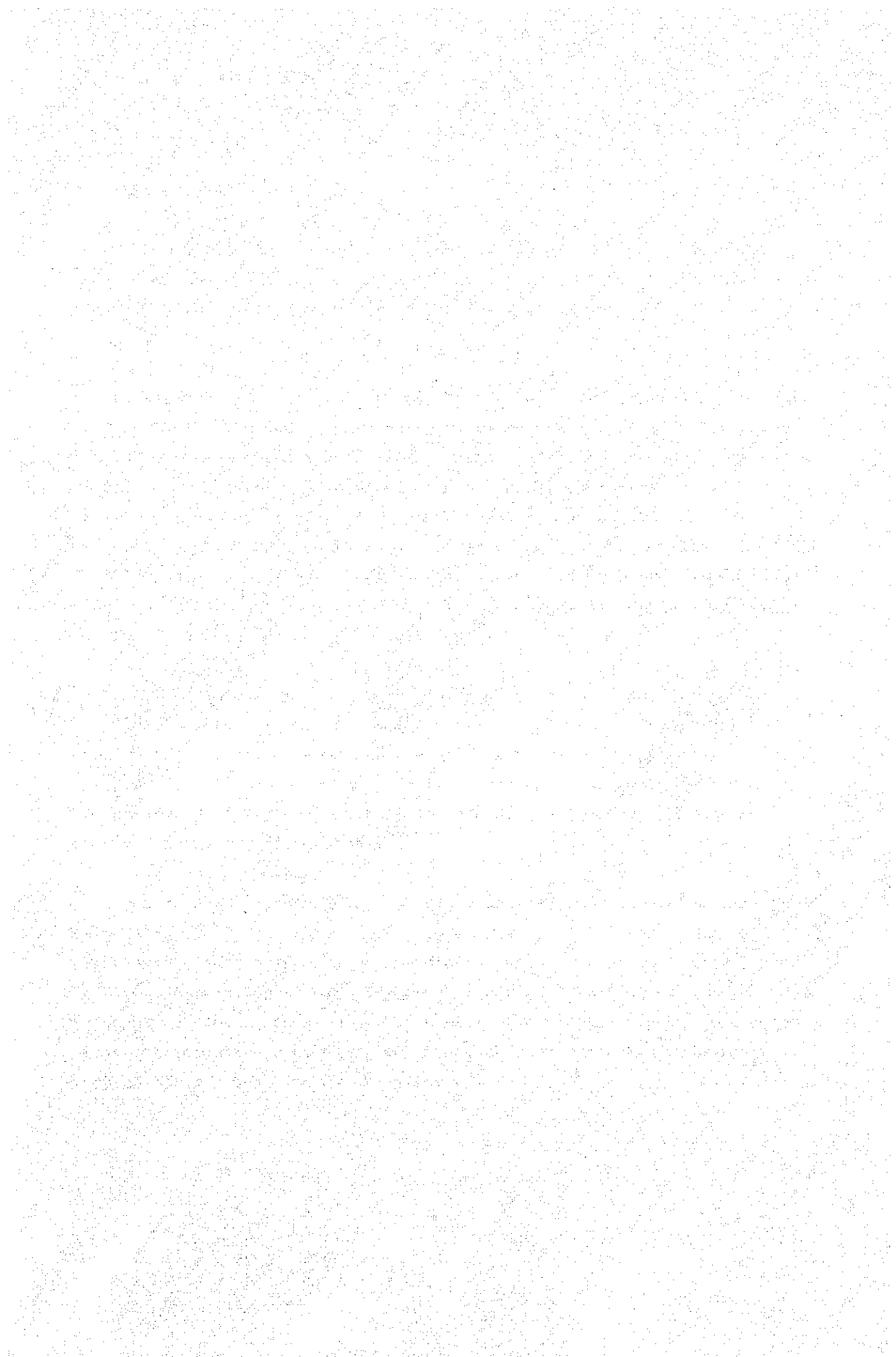
	Page
PREFACE	
LOCATION MAP	
SUMMARY	
CONTENTS	
CHAPTER 1 INTRODUCTION	1
CHAPTER 2 BACKGROUND OF THE PROJECT	
2-1 Socioeconomic conditions	3
2-1-1 Natural environment	3
2-1-2 Population	3
2-1-3 National socioeconomic development plans and environmental health conditions	6
2-1-4 Government budget	6
2-1-5 Present state of solid waste and sewage disposal and problems	7
2-1-6 Organization of local government	9
2-1-7 Background and content of the request by Sudanese government	12
2-2 Solid Waste and Sewage Collection in Khartoum Metropolitan Area	14
CHAPTER 3 CONTENTS OF THE PROJECT DESCRIPTION	
3-1 Objective	16
3-2 Study on Contents of Request	16
CHAPTER 4 BASIC DESIGN	
4-1 Design Policy	17

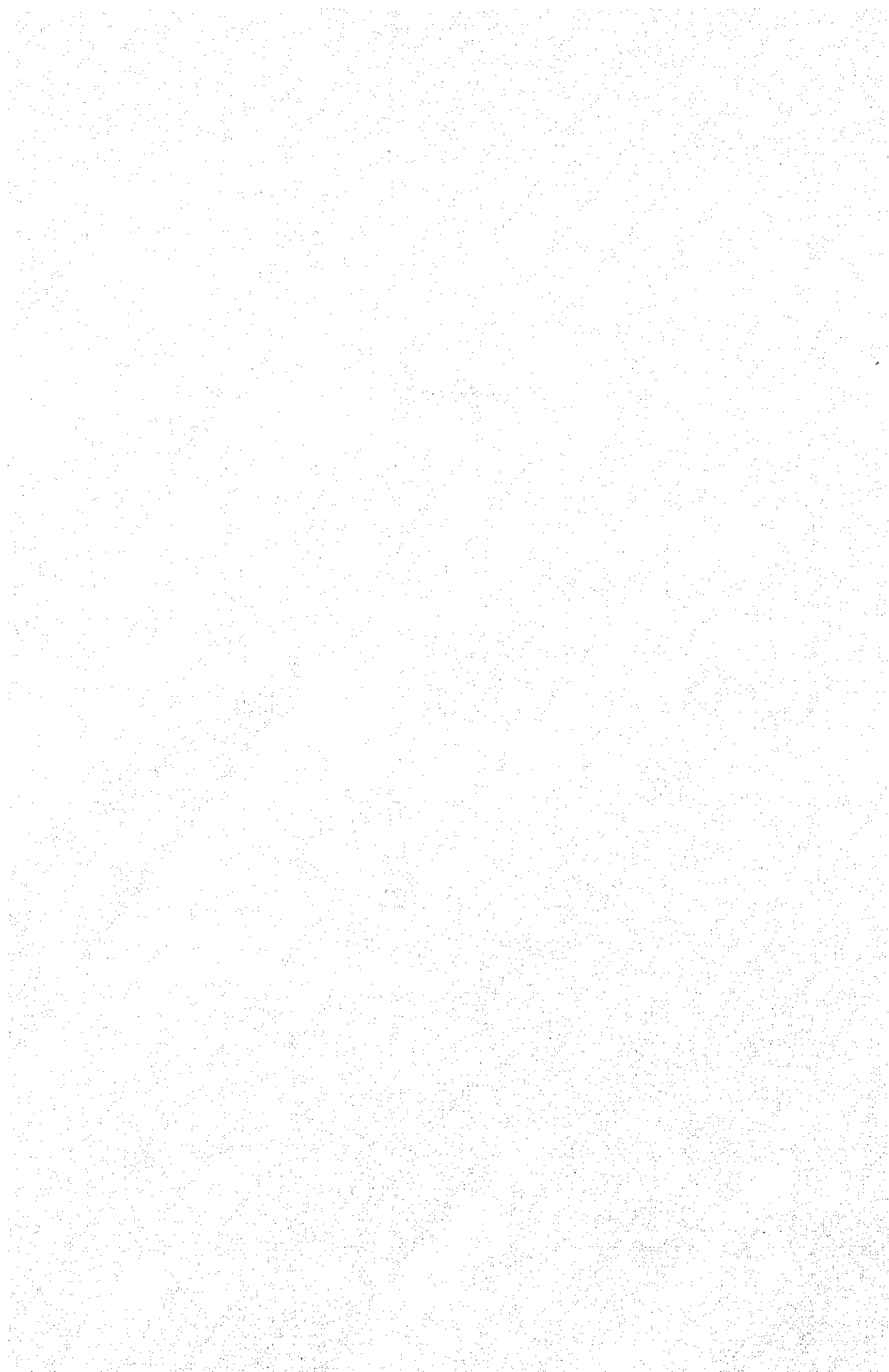
Contents (Cont'd)

	Page
4-2 Study on Design Conditions	17
4-2-1 Road	17
4-2-2 Bridge	17
4-3 Basic Design	18
4-3-1 Discharge rate	18
4-3-2 Amount of solid waste and sewage discharges	19
4-3-3 Composition of solid waste	21
4-3-4 Vehicle allocation plan	22
4-4 Outline of The Project	29
4-4-1 Equipment specification	29
4-4-2 Manpower requirements	31
4-4-3 Equipment specification	32
4-4-4 Other items to be furnished	33
CHAPTER 5 PROJECT IMPLEMENTATION PLAN	
5-1 Project Implementation Bodies	34
5-2 Project Implementation Schedule	34
5-3 Consulting Services	34
5-4 Operation and Maintenance	35
5-4-1 Direct operating cost	35
5-4-2 Labor cost	38
5-4-3 Per unit disposal cost	43
CHAPTER 6 PROJECT EVALUATION	
6-1 Manpower Plan	45
6-2 Operation and Maintenance	45

Contents (Cont'd)

	Page
6-3 Equipment Utilization	45
6-4 Project Evaluation	45
CHAPTER 7 CONCLUSION AND RECOMMENDATION	
7-1 Conclusion	47
7-2 Recommendations	47
ANNEX	
I Member List of The Study Team	
II Study Schedule	
III Minutes of Discussions	
IV List of Discussion Attendants	





CHAPTER 1 INTRODUCTION

Khartoum, the capital of Sudan, has a population of approximately 1.8 million and is divided into city district councils of Khartoum, Khartoum North, Omdurman and East Nile, forming the metropolitan area in the country.

With rapid increase in urban population recently, the ability of the councils to collect and dispose solid waste and sewage is left far below from actual generation ratio of solid waste. Although the government and the city councils are making an effort to improve equipment and facilities to maintain sanitary conditions in the area, it cannot keep pace with increasing solid waste and sewage. As a result, a large amount of solid waste and sewage are left or discharged to open spaces behind buildings and along streets to create insanitary conditions and potential hazards of cholera, dysentery, malaria and other epidemics.

Under these circumstances, the Government of Sudan does not have financial resources to procure the necessary equipment. Therefore, in order to improve the above-mentioned situation, the Government of Sudan made a request to the Government of Japan for providing vehicles to collect and transport solid wastes and sewages as well as their spare parts under the grant aid program.

In response, the Government of Japan decided to carry out a basic design study, and the Japan International Agency (JICA) sent a basic design study team, headed by Mr. Michio Sakamoto, Technical Supervisor of Sanitation Bureau, Kyoto City Government, for 14 days from October 21 to November 3, 1985. The study team investigated whether the project would be suitable for the grant aid program and carried out a basic design study on content and size of the project.

This report discusses the background of the project based on analyses of data and information obtained from discussions with the Sudanese authorities concerned and the field survey, and presents the content and size of the project, selection of equipment, allocation of equipment, cost estimate, and operation and maintenance plan, as determined by the study team.

In addition, related data and information collected during the field survey and Minutes of Discussion covering the contents of discussion between the Sudanese authority and the study team are attached to this report.

CHAPTER 2 BACKGROUND OF THE PROJECT

2-1 Socioeconomic Conditions

2-1-1 Natural environment

Khartoum is located in an approximate center of Sudan, at the confluence of Blue Nile River and White Nile River, and covers approximately 20,000 km².

Geographically, the area is situated on a plateau with elevation of 500 m and is a part of desert zone.

As a result, temperature is relatively high throughout the year. November to March is relatively cool with dry condition (mean temperature of 23°C) while April to June is a season with highest temperature which is further heated up by hot sand storm (Habub); sometimes, the temperature rises above 50 C in the city area. July to August is a rainy season with occasional torrential rain, with mean temperature in excess of 35°C.

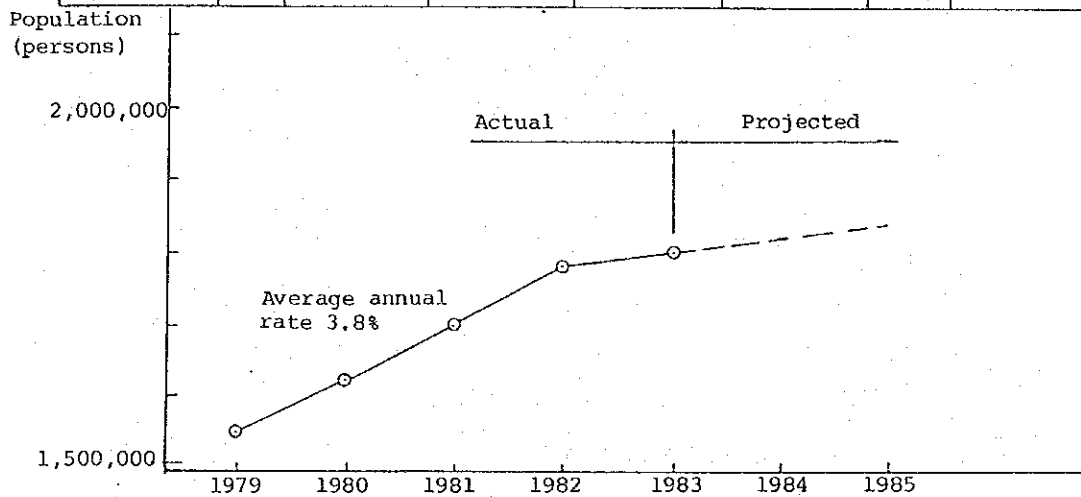
In contrast, humidity is relatively low throughout the year to result in slow decomposition of solid wastes and sewages.

2-1-2 Population

According to 1983 census, Khartoum had a population of approximately 1.8 million. Population trends between 1979 and 1983 based on census data are presented in Table 2-1. 1985 population is not known since no census was taken, and it was estimated from annual average growth rate between 1979 and 1983.

Table 2-1 Population of Khartoum

Year Item	1979	1980	1981	1982	1983	1985*
Popula- tion (persons)	1,552,000	1,626,000	1,703,000	1,784,000	1,802,298	1,839,000
Increase rate (%)		4.8	4.7	4.8	1.0	



Population in each city district council consisting of the metropolitan area in 1983 census, and 1985 population estimated on the basis of distribution in 1983 are presented in the following tables.

In addition, the population in 1990 as a target year of the project was estimated. The target year was established as a mid-point between 1987, when the equipment will be inservice, and 1994, when the equipment will be out of service (service life of 7 years applied to other LDCs was assumed).

Population and No. of Households in 1983

	Population (persons)	No. of households	No. of persons per household
Khartoum	557,350 (30.9)	88,556	6.3
Omdurman	648,700 (36.0)	107,512	6.0
Khartoum North	341,146 (18.9)	54,078	6.3
East Nile	255,102 (14.2)	47,837	5.3
Total	1,802,298 (100)	297,983	6.0

() - share in total population of the four cities (%)

Population in 1985

Item Calculation basis City	Population in administrative district (persons)	Population requiring solid waste collec- tion (persons)	Population requiring sewage collection (persons)
	①	② = Same as ①	③ = Same as ①
Khartoum	568,000	568,000	0 ^{*1}
Omdurman	662,000	662,000	662,000
Khartoum North	348,000	348,000	348,000
East Nile	261,000	261,000	261,000
Total	1,839,000	1,839,000	1,271,000

*1 The entire population of Khartoum is served by a public sewage system

Estimated Population in the Target Year (1990)

Item Calculation basis City	Average annual increase rate	Population in administra- tive district (persons) [*]	Population re- quiring solid waste collec- tion	Population re- quiring sewage connection
	④	⑤ = ① × ④ ⁴	⑥ = Same as ⑤	⑦ = Same as ⑤
Khartoum		659,000	659,000	0 ^{*2}
Omdurman	3.8	769,000	769,000	769,000
Khartoum North		404,000	404,000	404,000
East Nile		303,000	303,000	303,000
Total	-	2,135,000	2,135,000	1,476,000

*2 The entire population of Khartoum is served by a public sewage system

2-1-3 National socioeconomic development plans and environmental health conditions

Recently, Sudanese economy is in difficult situation caused by various adverse conditions, including external borrowing amounting to 9 billion dollars, influx of 1.15 million refugee from neighbouring countries, sluggish nation economy including agricultural production damaged by draught in the past three years and 8.4 million farmers seriously affected, and rapid population increase at annual average rate of over 3%. Also, insufficient infrastructure, chronic shortage of raw materials, fuels and electric power, and outflow of human resources are significant obstacles to economic development in the country.

Despite of a major political change in April 1985, the government continues to adopt economic development policies which are based on "Prospects, programmes and Policies for Economic Development - III" prepared in October 1984. The programme contains action programmes to effectively initiate required policies, the Fifth Public Investment 3 Year Plan (TYPIP - V) which aims to allocate limited financial resources to the recovery of production capacity and the improvement of infrastructure as a stimulus to economic growth, and "Outlook for Private Investment and Production" which serves as a guideline to private economic activities which are playing an important role in national economy.

Among various infrastructures, the improvement of equipment and facilities to maintain environmental sanitation is considered critical, particularly the prevention of epidemics and the improvement of living environment being adopted as major objectives of government policies.

2-1-4 Government budget

The preceding fiscal year (1405 Islamic year) ended on September 15, and the government budget for the current fiscal year is still under consideration by the cabinet (as of November 1985) since the procedure was delayed due to the prime minister's inspection tours in the country and other reasons.

Thus, it is expected to take some more time until the new budget is approved by a joint session of the provisional military council and the cabinet. An outline and related items of 1985/86 government budget as reported by a national news agency SUNA and a local newspaper ALAYAM are as follows.

Budget period: September 16, 1985 - June 30, 1986

An abnormal budget period was adopted to abandon a fiscal period based on Islamic calendar introduced last year and return to an old fiscal period between July 1 - June 30.

Budget outline : Revenue : 1,347,000,000 Sudanese pound

Expenditure: 6,095,000,000 Sudanese pound

Supplemental revenue by foreign aid 3,633, 000,000
Sudanese pound

Budget deficit: 1,115,000,000 Sudanese pound

In total, 22% of the expenditure will be financed by domestic funds and 60% by external funds.

2-1-5 Present state of solid waste and sewage disposal and problems

In Khartoum Metropolitan Area, approximately 2,300 tons of solid waste are produced daily, of which only 980 tons are collected and disposed by the city councils, with remaining 1,300 tons not properly disposed. This situation is largely due to a shortage of equipment and vehicles for collection and transportation.

As to sewage treatment, Khartoum district council is operating a sewerage facility with design capacity of 180,000 population which was constructed in 1957. The facility is operated under overload conditions because of deterioration of various equipment due to aging as well as rapid increase in sewage discharge due to change in life style and population increase. No sewerage facility is available in other district councils.

Consequently, a large amount of solid waste and sewage are left on streets without proper treatment, creating insanitary living environment.

Each city council has vehicles for collecting and transporting solid wastes and sewages as shown in Table 2-2. (Figure in () denotes serviceable vehicles)

Table 2-2

City \ Equip- ment type	Pu Compactor (6.5m ³) (Nos)	Load Lugger (5t) (Nos)	Container (5t) (Nos)	Open Tipper(6.5t) (Nos)	Tractor with Tailer	Cesspit emptier
Khartoum	9 (5)	4 (3)		6 (3)	15 (10)	3 (2)
Omdurman	8 (4)	2 (1)		10 (6)	4 (3)	6 (3)
Khartoum North	7 (5)	2 (1)		-	8 (6)	6 (2)
East Nile	-	-		2 (1)	1 (1)	-
Total	27 (14)	8 (5)	110	18 (10)	29 (20)	15 (7)

As shown in the table, the number of vehicle operated the city councils are not sufficient to handle a large amount of solid waste and sewage produced at present.

In considering requirements in the project, the existing vehicles will not be included because of their ages and small number.

Workshop for maintenance and repair of the vehicles is operated by each district council, under similar organization and operation system. Generally, each workshop has a material warehouse, a repair shop and a vehicle garage, and employs 8 mechanics, 3 welders, 3 blacksmiths, 4 electrical technicians, 20 operators, and 20 workers.

Although many parts and components are stored in the warehouses, the most of them are not usable: parts and components removed from out-of-service vehicles, rather than bearings, oil hoses and electrical parts which are needed frequently. On the other hand, there is obviously a shortage of repairing the vehicles, technical level of operating hydraulic equipment is low and should be improved in the future.

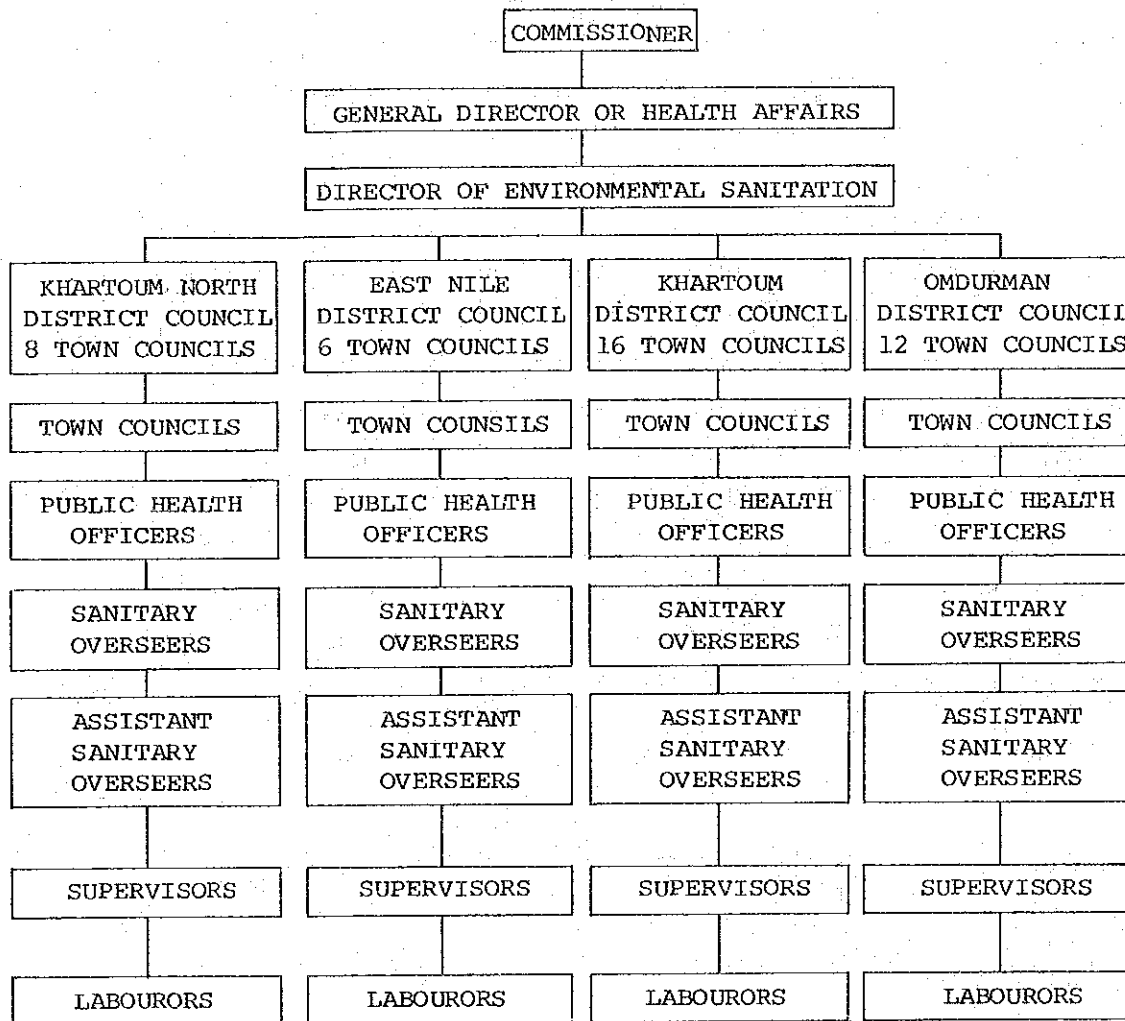
As to sewage disposal, households in the area not served by public sewerage have septic tanks by digging into the ground to store sewages for collection. However, a large amount of sewage appears to evaporate in hot weather and sewage is collected at a very low interval.

2-1-6 Organization of local government

Khartoum Metropolitan Area is comprised of four district councils of Khartoum, Khartoum North, Omdurman and East Nile which are controlled by the national capital.

An organization dealing with waste disposal is headed by a commissioner, who is a head of the national capital, and is managed by a director of environmental sanitation under direct supervision of a general director of health affairs. An outline of its organization is presented below.

Table 2-3



The waste disposal project is managed by each district council, under direction operation of public health division.

On the other hand, vehicle operation and maintenance are controlled by the technical bureau, and the workshops are directly operated by the district councils.

Personnels engaged in waste disposal project of each district council are classified as follows.

Table 2-4

Posts District	Senior Public Health Inspector	Public Health Inspector	P.H Officer	Sanitary Overseer	Assistant Sanitary Overseer	Super- visor	Driver	Labour	Mosquito Men
Khartoum	1	2	13	19	93	185	72	1784	305
Omdurman	1	2	11	26	130	91	36	550	164
Khartoum North	1	4	5	16	53	70	31	464	159
East Nile	1	1	1	8	28	17	5	213	150
Head office	3	-	-	-	-	-	3	-	-
Total	7	9	29	59	304	363	147	3011	778

At present, each district council charges the following fees for collection of solid waste and sewage from each house:

Table 2-5

	Charge (Sudan pound)
Khartoum DC	5
Khartoum North DC	3
Omdurman DC	3
East Nile DC	3

In total, approximately 12.8 million Sudanese pounds are collected while the annual cost of waste collection and disposal project is 13.3 million Sudanese pounds, an annual deficit of 500,000 Sudanese pounds being subsidized by the government.

2-1-7 Background and content of the request by Sudanese government

As a means to improve insanitary conditions in the capital, Sudanese government has requested to Japanese government for a grant aid of vehicles for collection and transpotration of solid waste and sewage as well as spare parts because of poor financial condition.

The request made by Sudanese government is roughly devided into 1. vehicles for waste collection and transportation, 2. maintenance vehicles, and 3. disinfectants and related equipment/materials (Table 2-6), covering a wide range of equipment suitable for the improvement of sanitary environment.

Table 2-6

Equipment Type	Quantity	Description
1. LOAD LUGGER	40	Container carrying vehicle
2. CLOSED TIPPER	60	Solid waste collecting/carrying vehicle (roofed)
3. EXHAUSTER CAR	17	Sewage carrying vehicle
4. GRADER	1	Solid waste accumulation/landfilling levelling
5. TRACTOR WITH TRAILER	18	Hauling vehicle
6. LOADER	4	Loading machine
7. DYNA CAR	25	Medium-sized truck
8. (TOYOTA) LAND CRUISER	2	Maintenance vehicle (patrol)
9. LOAD LUGGER CONTAINER	1200	Solid waste storing container
10. (TOYOTA) BOX	12	Maintenance vehicle (maintenance work)
11. (TOYOTA) SALOON	10	Maintenance vehicle (passenger car)
12. MOTOR CYCLE	50	
13. BYCICLE	120	
14. GENERATOR (20KVA)	5	Generator
15. (HUDSON) SPRAYER	140	Sprayer
16. FUMIGATION SPRAYER	50	
17. DURSBAN	430	
18. ABATE	250	
19. FENTHION	420	Organo-phosphorus insecticide
20. RESLIN	200	Compound insecticide (Resmetlin)
21. DIAZINON	500	Sulphadiazine
22. SPRAYER	10	Sprayer

2-2 Solid Waste and Sewage Collection in Khartoum Metropolitan Area

Solid wastes produced in the metropolitan area are collected by either of the following two methods:

1. Wastes are collected in trash boxes outside houses, from which collection vehicles of each district council (DC) collect them daily.

2. DC's containers are placed on street sides, to which each household dumps wastes, the most of solid waste is collected by the latter using the containers. The containers are carried to the disposal area twice a week, and solid wastes from the market once or twice a week. If solid wastes are piled up due to a shortage of DC's vehicles, they are collected by (1) residents, (2) leased vehicles, or (3) vehicles operated by other DCs. The disposal area has been originally selected near the city boundary to be used as a building site after the completion of landfilling, it is surrounded by built-up areas as a result of urban development, creating insanitary environment. For this reason, a new disposal area is situated a few kilometers from the city boundary.

On the other hand, sewages are collected by exhaust cars in Khartoum North, Omdurman and East Nile, and are carried to a desert a few kilometer away for dumping. The regulation requires the dumping to be done at least 500 m from nearby houses.

CHAPTER 3 CONTENTS OF THE PROJECT

3-1 objectives

The project is to furnish equipment and materials needed for the improvement of solid waste/sewage collection and transportation works in district councils of Khartoum, Khartoum North, Omdurman and East Nile.

3-2 Selection of Grant Aid Items

Since consumable items are not included in the grant aid programme, chemicals listed in Table 2-6 are excluded from the project. Also, only vehicles for solid waste collection and transportation will be furnished in consideration of the above objective.

The equipment and materials to be furnished under the project are listed in Table 3-1.

Table 3-1

Description
Detachable Container truck
Container
Tipper
Cesspit emptier
Tracter with trailer
Workshop (portable tools and machine)
Spare parts

Although containers are often considered as a consumable item, they have relatively long service life of 7 - 10 years. Several containers currently owned by Khartoum DC were imported and are difficult to manufacture locally as they are made of steel plate with 4 mm thick.

Thus, it appears to be reasonable that the containers are treated as equipment rather than consumable item.

CHAPTER 4 BASIC DESIGN

4-1 Design Principle

To select equipment and materials which can be easily maintained and repaired.

4-2 Study on Design Conditions

4-2-1 Road

Roads between collection points and a final disposal area have sufficient width and are in good condition generally.

4-2-2 Bridge

According to the field survey, all the bridges on the transportation route satisfy T-20 load in Japanese standard for first class bridges, and thus no weight limit will be required.

4-3 Basic Design

4-3-1 Discharge rate

Discharge rate was determined from figures given in a survey report on solid waste in Khartoum*1.

Table 4-1 Daily Average Weight and Volume of Domestic Disposable Waste per Capita in Khartoum Urban Area

*1

Measure \ Season	Season				Average
	Summer	Autumn	Winter		
Weight (Kg.)	0.673	0.682	0.535		0.630
Volume (lit.)	1.76	1.968	1.605		1.778

From the above table, 0.630 kg/person/day was selected as discharge rate. For comparison, discharge rates for major cities in Japan and other countries are listed in Appendix.

On the other hand, daily sewage discharge rate per person varies with age, sex, diet and season. Since no accurate data is available in Khartoum, an average sewage discharge rate published in Japan, or 1.2 litters, was adopted for the purpose.

*1 "Basic Study on Domestic Solid Waste in Khartoum Urban Area", prepared by the Ministry of Health, Department of Sanitation and National Committee for Environment

*2 "Sewage Disposal Guidebook" by Environmental Technology Research Institute

4-3-2 Amount of solid waste and sewage discharges

Using the discharge rate determined in 4-3-1 total amount of solid waste and sewage discharged in each of the four cities was estimated as follows.

Domestic Disposable Waste Discharged in 1985

Item Calculation basis	Unit (kg/person/day)	Population requiring collection (persons)	Total weight collected (t/day)
City	①	②	① × ② × 10 ⁻³
Khartoum	0.63	568,000	358
Omdurman		662,000	417
Khartoum North		348,000	219
East Nile		261,000	164
Total	-	1,839,000	1,158

Estimated Domestic Disposable Waste to be Discharged in
the target year (1990)

Item Calculation basis	Unit (kg/person/day)	Population requiring collection (persons)	Total weight collected (t/day)
City	①	②	① × ② × 10 ⁻³
Khartoum	0.63	659,000	415
Omdurman		769,000	484
Khartoum North		404,000	255
East Nile		303,000	191
Total	-	2,135,000	1,345

Sewage Discharged in 1985

Item Calculation basis	Unit (ℓ/person/day)	Population requiring collection (persons)	Total volume collected (ℓ/day)
City	①	②	① × ②
Khartoum	1.2	0	0
Omdurman		662,000	794,400
Khartoum North		348,000	417,600
East Nile		261,000	313,200
Total	-	1,271,000	1,525,200

Estimated Sewage to be Discharged in the Target Year (1990)

Item Calculation basis	Unit (ℓ/person/day)	Population requiring collection (persons)	Total volume collected (ℓ/day)
City	①	②	① × ②
Khartoum	1.2	0	0
Omdurman		769,000	922,800
Khartoum North		404,000	484,800
East Nile		303,000	363,600
Total	-	1,476,000	1,771,200

4-3-3 Composition of solid waste

According to the survey report prepared by the Ministry of health, solid wastes generated in Khartoum Metropolitan Area are composed of the following:

	Percent in weight (%)
(1) Dust ash and cinder	50.75
(2) Organic materials (liable fermentation)	33.64
(3) Paper and cardboard	4.53
(4) Plastics	2.47
(5) Metal and tins	2.22
(6) Rags	1.90
(7) Wood	1.49
(8) Glass and Crockery	1.12
(9) Bones	0.72
(10) Natural and artificial leather	0.25
(11) Rubber	0.19
(12) Miscellaneous	0.72

Dust ash and cinder constitute around 50% of the total because sand is carried by wind from the surround desert and is mixed with dust in large amount.

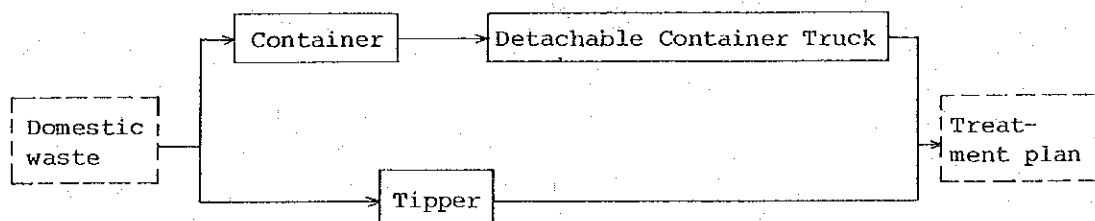
Composition of solid waste in selected cities in other countries is presented in Appendix.

4-3-4 Vehicle allocation plan

Based on analyses of present solid waste/sewage disposal, allocation of vehicles was planned for solid waste and sewage.

(1) Solid waste

solid wastes will be collected in containers which will be installed for every few households. Then the containers will be carried by detachable container trucks. Solid wastes not collected in the containers will be collected by tippers.



(1) Establishing design criteria

Design criteria were established as follows.

Item	Basis	Criteria established
Population increase rate	Average of increase rates during 1979 - 1983	3.8
Target year	Year mid-way between start of service (1967) and time amortization will be completed (1994)	1990
Existing vehicle	Excluded due to significant aging and wear	Not included in the project

Collection/transportation flows at present and in the target year are shown in the following pages.

No of trips: Average number of trips in each district council was assumed in range of 1 - 1.5 times. For calculation purpose, 1.5 times were used.

Load: 80% of tipper capacity

85% of container capacity

(2) No. of vehicles required

The number of vehicles for each type was determined to handle all the solid wastes produced at present, as follows:

Detachable container truck	40 vehicles
Container	800 units
Tipper	60 vehicles

(3) Collection and transportation flow at present

Domestic Waste

Item	Unit	Calculation basis	Q'ty
Weight	t/day	From the discharge in J-2-2	= 1,158
	t/2 days	1158×2	= 2,316
Daily quantity	m ³ /day	$1,158 \div 0.354$	= 3,271
	m ³ /2 days	3271×2	= 6,542

Container

Container				Tipper			
Item	Unit	Calculation basis	Q'ty	Item	Unit	Calculation basis	Q'ty
Container capacity	m ³ /vehicle	6.0×0.85	= 5.1	Loading weight	t	6.0×0.8	= 4.8
No. of collection	—	—	Once/2 days				
Required volume of domestic waste collected	m ³ /2 days	—	6,542				
Required No. of containers		$6,542 \div 5.1$	= 1,283				
No. of containers in service		—	800				
Actual volume of domestic waste collected	m ³ /day	5.1×400	= 2,040	No. of trips	No./day/vehicle	Average of 4 cities	1.5
"	t/day	$2,040 \times 0.354$	= 722	No. of tippers		$394 \div (4.8 \times 1.5)$	= 5.5
				No. of tippers in service		—	60
				Weight of domestic waste collected/carried	t/day	$4.8 \times 1.5 \times 60$	= 432

Detachable Container Truck

Item	Unit	Calculation basis	Q'ty
Loading weight	t	—	4.0
Hauling distance	km	Average of 4 cities	10
Running speed when loaded	km/hr.	—	40
Working hours	hrs./day	8:00AM - 2:00PM	6
No. of trips	No./day/vehicle	$6 \text{ hours} \div 36 \text{ min.}$	= 10
No. of DCT in service		—	40
No. of containers collected		10×40	= 400

Final Treatment Plant

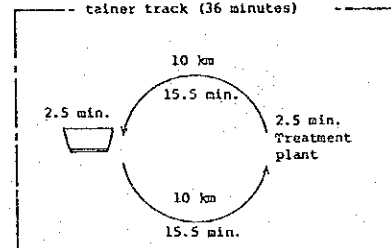
Item	Unit	Calculation basis	Q'ty
Transportable weight	t/day	$722 + 432$	= 1,154

1158 t/day & 1154 t/day

Collection ratio

Approximately 100%

One trip of detachable container truck (36 minutes)



(4) Estimated collection and transportation flow into the target year (1990)

Domestic Waste

Item	Unit	Calculation basis	Q'ty
Weight	t/day	From the discharge in 3-2-2 =	1,345
	t/2 days	$1,345 \times 2$	= 2,690
Daily quantity	m ³ /day	$1,345 \div 0.354$	= 3,799
	m ³ /2 days	$3,799 \times 2$	= 7,598

Container

Container				Tipper			
Item	Unit	Calculation basis	Q'ty	Item	Unit	Calculation basis	Q'ty
Container capacity	m ³ /vehicle	6.0×0.9	= 5.4	Loading weight	t	6.0×0.8	= 4.8
No. of collection	—	—	Once/2 days				
Required volume of domestic waste collected	m ³ /2 days	—	7,598				
Required No. of containers		$7,598 \div 5.4$	= 1,407				
No. of containers in service		—	800				
Actual volume of domestic waste collected	m ³ /day	5.4×400	= 2,160	No. of trips	No./day/vehicle	Average of 4 cities	1.5
"	t/day	$2,160 \times 0.354$	= 764	No. of tippers		$581 \div (4.8 \times 1.5)$	= 81
				No. of tippers in service		—	60
				Weight of domestic waste collected/carried	t/day	$4.8 \times 1.5 \times 60$	= 432

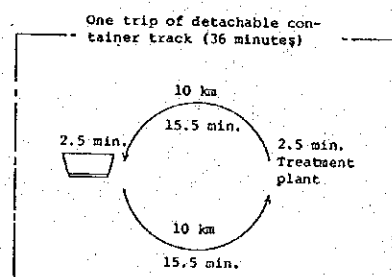
Detachable Container Truck

Item	Unit	Calculation basis	Q'ty
Loading weight	t	—	4.0
Hauling distance	km	Average of 4 cities	10
Running speed when loaded	km/hr.	—	40
Working hours	hrs./day	8:00 AM - 2:00 PM	6
No. of trips	No./day/vehicle	$6 \text{ hours} \div 36 \text{ min.}$	= 10
No. of DCT in service		—	40
No. of containers collected		10×40	= 400
Hauling volume	m ³ /day	5.4×400	= 2,160

Final Treatment Plant

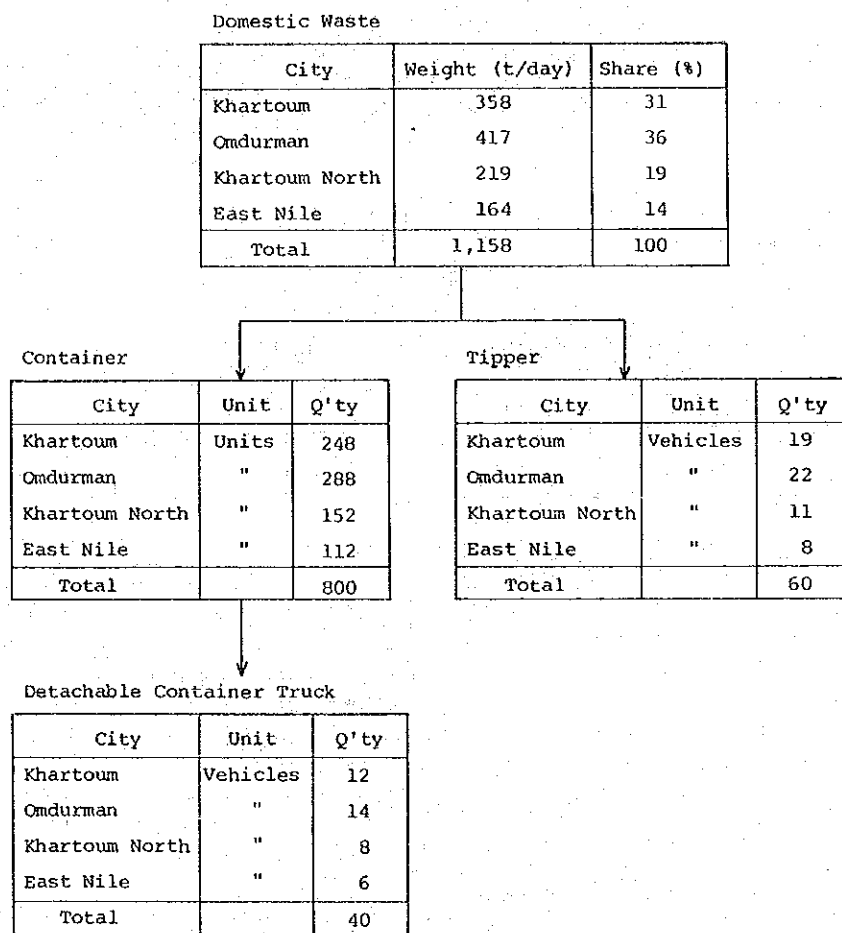
Item	Unit	Calculation basis	Q'ty
Waste produced	t/day	—	1,345
Transportable weight	t/day	$764 + 432$	= 1,196

Collection ratio 85%



(5) Vehicle allocation plan

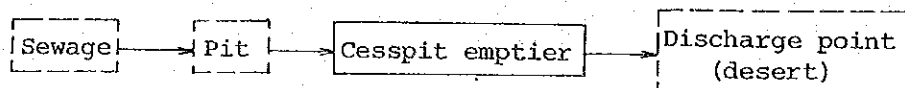
The number of vehicles determined on the basis of the collection and transportation flow at present was allocated to the four cities according to their share of solid waste produced.



Vehicle allocation in the target year (1990) is same as that for the present, since it is based on an amount of solid waste in each city which is closely associated with population growth rate.

(2) Sewage

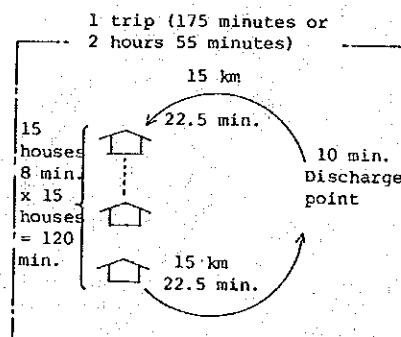
Sewages will be collected in pits of houses, from which cesspit emptiers will pump out and transport them to a discharge point (in the desert).



(2) Establishing design criteria

Design criteria were established as follows.

Item	Basis	Criteria established
Population increase rate	Average between 1979 - 1983	3.8%
No. of persons per household	(persons) (houses) $1,802,298 \div 297,983 = 6.0$	6
Unsatisfied demand for public sewage	As given by the city government	3 cities other than Khartoum
Frequency of collection		Once/2 months
Working hours	8:00 AM ~ 2:00 PM	6 hours
Basic unit of sewage		1.2 l/person/day
Distance to discharge		15 km
Monthly sewage discharge per household	$1.2 \text{ l/person/day} \times 6 \text{ persons} \times 30 \text{ days}$	216 l/month/house
Two-month sewage discharge per household	$216 \text{ l/month/house} \times 2$	432 l/2 months/house
Time available for collection per trip	Working time - Carrying time $\times 2$ - Sewage discharge time = (6 hours $\div 2$) - 22.5 min. $\times 2$ - 10 min. = 125 min.	2 hours 5 minutes
No. of houses collectable per trip	Time available for collection per trip \div Time required for collection per house = 2 hours 5 min. \div 8 min. = 15.6	15
Capacity of cesspit emptier		6000 l
No. of trips per day per vehicle		2
Running speed when loaded		40 km/hour
Time required for collection per house	Suction time + Preparation time + Carrying time = 3 min. + 3 min. + 2 min. = 8 min.	8 minutes



(2) Required number of vehicles

Item	Unit	Khartoum	Omdurman	Khartoum North	East Nile	Total
① Population in administrative district	Persons	568,000	662,000	348,000	261,000	1,839,000
② Population requiring collection	"	(0.0) 0	(52.1) 662,000	(27.4) 348,000	(20.5) 261,000	(100.0) 1,271,000
③ No. of households to be collected		0	110,334	58,000	43,500	211,834
④ No. of houses collected daily	Houses/day	0	2,207	1,160	870	4,237
⑤ Required No. of vehicles		0	74	39	29	142

Required number of Vehicles in the Target Year (1990)

Item	Unit	Khartoum	Omdurman	Khartoum North	East Nile	Total
⑥ Population in administrative district	Persons	659,000	769,000	404,000	303,000	2,135,000
⑦ Population requiring collection	"	(0.0) 0	(52.1) 769,000	(27.4) 404,000	(20.5) 303,000	(100.0) 1,476,000
⑧ No. of households to be collected		0	128,166	64,126	57,169	249,461
⑨ No. of houses collected daily	Houses/day	0	2,563	1,282	1,143	4,988
⑩ Required No. of vehicles		0	86	43	39	168

1 : 1985 population estimated in Chapter 2 was assigned to each city according to its share of 1983 population

2 = Same as 1 . None for Khartoum, because the entire population is served by a public sewage system

3 = 2 ' No. of person per household

4 = (3 ÷ 2) ÷ 25 days

5 = 4 ÷ (No. of houses collectable per trip x No. of trips)

6 = 1 x (1.038)⁷

7 = 6 x 2/3

8 = 7 ÷ No. of persons per household

9 = (8 ÷ 2) ÷ 25 days

10 = 9 ÷ (No. of houses collectable per trip x No. of trips)

() - Share in the total population requiring collection in the four cities

(3) Vehicle allocation plan

Compared to the number of vehicles required, the number of vehicles requested by the Sudanese side is much less (17 vehicles). This is probably because a basic unit of sewage discharge was determined from the Japanese standard established by the Ministry of Health and Welfare to result in vehicle requirements which are much higher than actually required. Thus, judging from weather conditions and life style in Khartoum, the number of vehicles requested by the Sudanese side appears to be reasonable. As a result, 17 vehicles were allocated to the four cities according to their share in population to be served.

Item		Unit	Khartoum	Omdurman	Khartoum North	East Nile	Total
Present	Required number of vehicles	Vehicles	0	74	39	29	142
	No. of vehicles in service *1	"	0	9	5	3	17
Target year (1990)	Required number of vehicles	Vehicles	0	86	43	39	168
	No. of vehicles in service *1	"	0	9	5	3	17

*1 17 vehicles were assigned according to the corresponding shares of the population requiring collection.

4-4 Project Outline

4-4-1 Equipment to be furnished

The equipment to be furnished for each city is summarized as follows.

Table 4-2 Number of Equipment to be Furnished and Allocation Japan

	Detachable container truck	Container	Tipper	Cesspit emptier	Tractor with trailer	Spare parts
Khartoum DC	12	248	19 $\begin{bmatrix} O, 10 \\ C, 9 \end{bmatrix}$	0	5	1 set
Khartoum North DC	8	152	11 $\begin{bmatrix} O, 5 \\ C, 6 \end{bmatrix}$	5	5	"
Omdurman DC	14	288	22 $\begin{bmatrix} O, 11 \\ C, 11 \end{bmatrix}$	9	6	"
East Nile DC	6	112	8 $\begin{bmatrix} O, 4 \\ C, 4 \end{bmatrix}$	3	2	"
Total	40	800	60 $\begin{bmatrix} O, 30 \\ C, 30 \end{bmatrix}$	17	18	

* $\begin{bmatrix} O, 10 \\ C, 9 \end{bmatrix}$ O: Open type, C: Closed type

To maintain and repair the furnished equipment at the workshops, portable repairing equipment and devices will be provided to each DC and headquarter.

Since it is difficult to determine the required number of tractors with trailers because of their duty to collect scattered wastes, the number of tractors with trailers as requested by the Sudanese side was allocated to each city according to their share in population.

(1) Purpose of equipment

1) Detachable container trunk

Trunk dedicated to carry containers

2) Container

Used as a public trash box placed on street

3) Tipper

Truck to carry solid wastes from a collection point to a disposal area

4) Cesspit emptier

Car to pump up sewage and carry to a disposal area

5) Tractor/trailer

Used to collect solid wastes scattered on streets and carry to a collection point

4-4-2 Manpower requirements

Manpower requirements for operating the vehicles properly are shown in Table 4-3.

Table 4-3

	Driver	Assistant	Labour	Total
Detachable container truck	1	1	1	3
Tipper	1	1	2	4
Cesspit emptier	1	-	2	3
Tractor with trailer	1	-	2	3

In addition, the following personnels will be required at the workshops:

1. Full time personnel for controlling spare parts
2. Full time personnels for controlling repairing equipment
3. Full time personnels for controlling repairing tools

4-4-3 Equipment specification

The capacity and performances of the equipment were established on the basis of principle and condition of use, as follows.

(1) Detachable container trunk

Type: Container loading truck
Maximum load: 4,000 kg or over
Driving system: 4 x 2
Engine: Diesel with maximum output of 160 ps or over

(2) Roofed tipper

Type: Roofed tipper
Maximum load: 6,000 kg or over
Driving system: 4 x 2
Engine: Diesel with maximum output of 160 ps or over

(3) Tipper

Type: Tiper
Maximum load: 6,000 kg or over
Driving system: 4 x 2
Engine: Diesel with maximum output of 160 ps or over

(4) Cesspit emptier

Type: Cesspit emptier
Maximum load: 6,000 kg or over
Tank capacity: 6,000 liters or more
Driving system: 4 x 2
Engine: Diesel with maximum output of 160 ps or over

(5) Container

Type: Container
Capacity: 6.0 m³ or over

(6) Tractor

Type: Agricultural motor tractor
Driving system: 4 x 4
Engine: Diesel with maximum output of 75 ps or over

(7) Small trailer

Type: Stationery type trailer
Maximum load: 3,000 kg or over
No. of axles: 2

4-4-4 Other items to be furnished

(1) Equipment and materials for workshops

Portable equipment and materials needed at the workshops

(2) Spare parts

1 set

CHAPTER 5 PROJECT IMPLEMENTATION SYSTEM

5-1 Project Implementation Bodies

An organization to implement the project in Sudan is the National Capital Khartoum which supervises Khartoum, Khartoum North, Omdurman and East Niles District Councils.

5-2 Project Implementation Schedule

The project will be implemented for 12 months after signing the official agreement (E/N), including 5 months for procurement of the equipment and materials.

Table 5-1 Implementation Schedule

month Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14
E / N														
Preparation of specifications														
Tender														
Tender evaluation														
Equipment material procurement														
Equipment material transport														
Acceptance														

Tender notice Closing

Contract

Shipping

Delivery

Inspection

5-3 Consulting Services

While the project will be implemented in accordance with the schedule shown in Table 5-1, consulting services will be provided in accordance with the grant aid programme operated by the Japanese government, as follows:

- (-) Signing the consultant contract with the Sudanese government
 - Verification of the contract by the Japanese government
 - Issuing of A/P (Authorization to pay) by the Sudanese government to Japanese banks dealing with foreign exchange
- (-) Preparation of special specifications and tender documents by the consultant
 - Verification by the Sudanese government
- (-) Tender preparation by the consultant on behalf of the Sudanese government
 - Procurement contract between the Sudanese government and Japanese suppliers
- (-) Attendance on inspection and delivery after procurement, loading and unloading by Japanese suppliers
- (-) - Services to be provided by the consultant

5-4 Operation and maintenance

5-4-1 Direct operating cost

In this section, depreciation and operating costs for equipment, as a major part of related cost, were estimated. (Labor cost is discussed in the next section)

(1) Basis of estimate

(1) Fuels and oils

diesel fuel cost is based on unit price per litter in October 1985 (Sudanese pound), and 10% of the fuel cost is allowed for oils.

(2) Maintenance and repair cost

5% of the fuel/oil cost is allowed for. (spare parts will be furnished and labor cost will be allocated in the separate item)

(3) Administration cost

Mainly insurance cost. 5% of the base value (Undepreciated value) is allowed for.

(2) Results

The direct operating cost was estimated as shown in Table 5-2.

The annual operating cost for the equipment is:

Kahrtoum	approx. 140,000 LS
Khartoum North	100,000 LS
Omdurman	210,000 LS
East Nile	70,000 LS

Table 5-2 Summary of annual Operating Cost

(Unit: LS/thousand yen)

Khartoum DC

	Amortiza- tion cost	Fuel/oil cost	Maintenance/ repair cost	Administra- tion cost	Subtotal
Container col- lection		29,400 (1,800)	1,500 (90)	32,600 (1,998)	63,500 (3,880)
Tipper collec- tion		46,600 (2,850)	2,300 (142)	11,400 (699)	60,300 (3,691)
Sewage collec- tion		0	0	0	0
Tractor/ trailer col- lection		12,300 (750)	600 (37)	3,400 (209)	16,300 (996)
Total		88,300 (5,400)	4,400 (269)	47,400 (2,906)	140,100 (8,575)

Khartoum North DC

	Amortiza- tion cost	Fuel/oil cost	Maintenance/ repair cost	Administra- tion cost	Subtotal
Container col- lection		19,600 (1,200)	980 (60)	20,500 (1,254)	41,080 (2,514)
Tipper collec- tion		27,000 (1,650)	1,400 (82)	6,700 (410)	35,100 (2,142)
Sewage collec- tion		12,000 (750)	600 (37)	4,300 (264)	16,900 (1,051)
Tractor/ trailer col- lection		12,000 (750)	600 (37)	3,400 (209)	16,000 (996)
Total		70,600 (4,350)	3,580 (216)	34,900 (2,137)	109,080 (6,703)

Omdurman DC

	Amortiza- tion cost	Fuel/oil cost	Maintenance/ repair cost	Administra- tion cost	Subtotal
Container col- lection		34,300 (2,100)	1,700 (105)	38,000 (2,323)	74,000 (4,528)
Tipper collec- tion		53,900 (3,300)	27,000 (165)	13,300 (814)	94,200 (4,279)
Sewage collec- tion		22,000 (1,350)	1,100 (67)	7,700 (474)	30,800 (1,891)
Tractor/ trailer col- lection		14,700 (900)	700 (45)	4,100 (251)	19,500 (1,196)
Total		124,900 (7,650)	30,500 (382)	63,100 (3,862)	218,500 (11,882)

East Nile DC

	Amortiza- tion cost	Fuel/oil cost	Maintenance/ repair cost	Administra- tion cost	Subtotal
Container col- lection		14,700 (900)	700 (45)	15,200 (930)	30,600 (1,875)
Tipper collec- tion		19,600 (1,200)	980 (60)	4,800 (296)	25,380 (1,556)
Sewage collec- tion		7,400 (450)	360 (22)	950 (158)	8,710 (630)
Tractor/ trailer col- lection		4,900 (300)	250 (15)	1,400 (84)	6,550 (399)
Total		46,600 (2,850)	2,290 (142)	22,350 (1,468)	71,240 (4,460)

5-4-2 Labor cost

(1) Basis of estimate

(1) Unit price

Labor cost consists of the following:

(Basic salary) + (Living wage) + (Overtime allowance) +
(Sanitation allowance)

Those other than the basic salary are expressed in percent of the basic daily salary: 100% for living wage, 20 % for overtime allowance, and 10% for sanitation allowance. In other words, unit price of labor per day is 2.3 times of basic salary.

Unit price of labor for the project is established as follows.

Table 5-3 Labour Cost

	Basic salary (LS)	Unit labour cost (LS)	Labour cost in yen
Driver	5	12	728
Assistant	4	10	606
Labour	4	10	606

Currency exchange rate: 1US\$ = 202 yen
1US\$ = 3.30 LS

(2) Manpower plan

Manpower plan for each type of work is shown below.

Table 5-4 Manpower Plan

Khartoum DC

	Driver	Assistant	Labour	Subtotal
Container collection	12	12	12	36
Tipper collection	19	19	38	76
Sewage collection	-	-	-	-
Tractor/trailer collection	5	-	10	15
Total	36	31	60	127

Khartoum North DC

	Driver	Assistant	Labour	Subtotal
Container collection	8	8	8	24
Tipper collection	11	11	22	44
Sewage collection	5	-	10	15
Tractor/trailer collection	5	-	10	15
Total	29	19	50	98

Omdurman DC

	Driver	Assistant	Labour	Subtotal
Container collection	14	14	14	42
Tipper collection	22	22	44	88
Sewage collection	9	-	18	27
Tractor/trailer collection	6	-	12	18
Total	43	36	88	167

East Nile DC

	Driver	Assistant	Labour	Subtotal
Container collection	6	6	6	18
Tipper collection	8	8	16	32
Sewage collection	3	-	6	9
Tractor/trailer collection	2	-	4	6
Total	19	14	32	65

(3) Manpower requirements

Manpower requirements in each district council are shown in Table 5-5.

Table 5-5

	Driver	Assistant	Labour	Subtotal
Khartoum DC	36	31	60	127
Khartoum North DC	29	19	50	98
Omdurman DC	43	36	88	167
East Nile DC	19	14	32	65
Total	127	100	230	357

(2) Results

Based on the aboves, labor cost for the project was estimated as shown in Table 5-6.

The annual labor cost required for equipment operation is:

khartoum	approx. 390,000 LS
Kahrtoum North	300,000 LS
Omdurman	540,000 LS
East Nile	200,000 LS

Table 5-6

Khartoum DC

	Annual labour cost LS (Yen)
Container collection	114,000 (6,982,000)
Tipper collection	237,000 (237,000)
Sewage collection	0 (0)
Tractor/trailer collection	47,500 (47,500)
Total	398,500 (398,500)

Khartoum North DC

	Annual labour cost LS (Yen)
Container collection	76,000 (4,655,000)
Tipper collection	137,000 (8,400,000)
Sewage collection	47,500 (2,909,000)
Tractor/trailer collection	47,500 (47,500)
Total	308,000 (308,000)

Omdurman DC

	Annual labour cost	LS (Yen)
Container collection	133,000	(8,145,000)
Tipper collection	274,400	(16,800,000)
Sewage collection	85,500	(5,236,000)
Tractor/trailer collection	57,000	(3,491,000)
Total	549,900	(33,672,000)

East Nile DC

	Annual labour cost	LS (Yen)
Container collection	57,000	(3,491,000)
Tipper collection	99,800	(6,109,000)
Sewage collection	28,500	(1,745,000)
Tractor/trailer collection	19,000	(1,164,000)
Total	204,300	(12,509,000)

5-4-3 Per unit disposal cost

The total operating cost is shown in Table 5-7.

Table 5-7

	Amount	LS (yen)
Khartoum DC	539,000	(32,976)
Khartoum North DC	418,000	(25,576)
Omdurman DC	744,000	(45,554)
East Nile DC	277,000	(16,969)
Total	1,978,000	(121,075)

From the total operating cost, disposal cost per ton of solid waste for each work type was estimated.

Amount of solid waste and sewage collected by each work type was estimated in Chapter 3 and summarized in Table 5-8.

As to sewage, the annual amount carried by cesspit emptiers was used.

Table 5-8

	Khartoum DC	Khartoum North DC	Omdurman DC	East Nile DC
Container collection t/day	237	145	275	107
Tipper collection t/day	121	74	142	57
Sewage collection l/day	0	60,000	108,000	36,000
Tractor/trailer collection t/day	15	15	18	6

From the table, the per unit collection cost was estimated as follows.

Table 5-9

Unit: LS (yen)

City Unit Item		Khartoum DC	Khartoum North DC	Omdurman DC	East Nile DC
Container collection	LS/t	2.06 (126)	2.21 (135)	2.06 (126)	2.24 (137)
Tipper collection	LS/t	6.73 (412)	6.37 (390)	6.65 (407)	6.01 (368)
Sewage collection	LS/ 1000ℓ	-	2.94 (180)	2.96 (181)	2.96 (181)
Tractor/ trailer collection	LS/t	11.65 (713)	8.67 (531)	5.70 (349)	11.66 (714)

CHAPTER 6 PROJECT EVALUATION

6-1 Manpower Plan

357 workers will be required for the project, including 127 drivers. Since 147 drivers are employed by the district councils, the requirement can be easily met.

Remaining 230 workers - assistants and laborers - can be obtained from 3,011 workers employed by the district councils.

6-2 Operation and maintenance

After the project is implemented, direct operating cost will increase to make it difficult to operate the project by the present government subsidy.

However, since the project serves a purpose of improving the infrastructure promoted by the government, increase in subsidy can be expected. Also, collection fees may be raised by the district councils.

6-3 Equipment Utilization

The equipment to be furnished under the project has same performances as those currently used in Khartoum, so that no training will be required for operation and maintenance. In addition, as portable repairing tools will be provided with spare parts, it is expected that the equipment can be properly maintained.

6-4 Project Evaluation

The project is considered essential in improving sanitary conditions in Khartoum by providing necessary equipment to the district councils.

CHAPTER 7 CONCLUSION AND RECOMMENDATION

7-1 Conclusion

Organizations to operate the waste disposal project in Khartoum are established to an acceptable level, and they have long time experiences in organizational management.

On the other hand, concerns of residents over waste and sanitation are not particularly high. Nevertheless, environmental sanitation courses have been introduced in school education recently, and it is expected that public concerns will be increased.

Since manpower requirements for the project can be obtained from the present employees in the district councils, revenue sources to meet the direct operating cost should be considered.

Given these situations, the grant aid by the Japanese government will contribute greatly to the improvement of environmental health in the area, and the equipment will be fully utilized for effective waste collection and disposal.

7-2 Recommendations

Finally, the following recommendations are made to ensure effective utilization of the equipment to be furnished.

(1) Collection fees

At present, waste collection fees in many countries, including Japan, are based on the principle of beneficiary's burden, with rate adjustment according to general price index. This system may be contemplated for the project.

(2) Spare part control

Since a large amount of spare parts will be delivered at the same time, proper control of these spare parts is very important in operating the equipment in effective and continuous manners. For this purpose, each district should establish its own maintenance system which includes spare parts control.

(3) Other measures to be taken by the Sudanese side

- a) Improvement of spare parts warehouses
- b) Public education on environmental health

ANNEX

I. Member List of The Study Team

Mr. Michio Sakamoto: Team Leader
Technical Supervisor, Sanitation Bureau
Kyoto City Government

Mr. Takashi Sasaki: Planning/Supervision
Senior Advisor
Mechanical & Industrial Engineer
JICA

Mr. Hirokazu Itoh: Waste Collection and Transportation Plan
Kokusai Kogyo Co., Ltd.

Mr. Yukiomi Nakagawa; Waste Disposal Plan
Kokusai Kogyo Co., Ltd.

Mr. Junichi Aoki: Equipment Supply Plan
Kokusai Kogyo Co., Ltd.

II. Study Schedule

Schedule No.	Date	Day	Description
1	Oct. 21	Mon.	Arrival at KHARTOUM
2	22	Tue.	Courtesy visit at the Japan Embassy Courtesy visit at the Commission of Health Affairs
3	23	Wed.	Courtesy visit at the Commission of Enginnering Affairs Visit to Work Shop Visit to Sewage plant
4	24	Thu.	Discussion with the officials of the National Capital
5	25	Fri.	Study team inside discussion
6	26	Sat.	Visit to the KHARTOUM DISTRICT Visit to the School of Hygiene Visit to the Health Education Department

Schedule No.	Date	Day	Description
7	Oct. 27	Sun.	Visit to the OMDURMAN District Council Visit to the KHARTOUM North Council Visit to the Environmental health oversees school
8	28	Mon.	Visit to the Commission of Health Affairs
9	29	Tue.	Signing the "Minutes"
10	30	Wed.	Visit to the Japan Embassy to report on
11	Nov. 1	Thu.	Data collection
12	2	Fri.	Data collection
13	3	Sat.	Departure from KHARTOUM
14	4	Sun.	Departure from London
15	5	Mon.	Arrival at Narita

MINUTES OF DISCUSSIONS
ON
SOLID WASTE DISPOSAL IMPROVEMENT PROJECT OF METROPOLITAN AREA
IN
THE DEMOCRATIC REPUBLIC OF THE SUDAN

In response to the request made by the Government of the Democratic Republic of the Sudan for a grant aid of the Solid Waste Disposal Improvement Project of Metropolitan Area (hereinafter referred to as "the Project"), the Government of Japan has dispatched, through the Japan International Cooperation Agency (JICA), a survey team headed by Mr. Michio Sakamoto, Technical Supervisor of Sanitation Bureau, Kyoto City Government (hereinafter referred to as "The Team") to conduct the basic design study on the Project for 13 days from October 21 to November 1985.

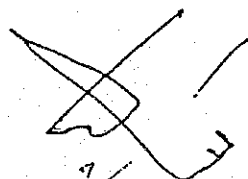
The Team has carried out a field survey, had a series of discussions and exchanged views with the Sudanese authorities concerned with the Project.

As a result of the survey and discussions, the Team and the Sudanese authorities have agreed to recommend to their respective Governments that the results of the discussions attached herewith should be examined toward the realization of the Project.

Khartoum, October 29, 1985

M. Sakamoto

Mr. Michio Sakamoto
Team Leader
Japanese Survey Team



General P.S.C.
Kamal Abashar Yassin
Governor National Capital
KHARTOUM - SUDAN.

ATTACHMENT

The objective of the Project is to provide equipment for implementation of solid waste disposal service so as to improve the living environmental conditions in the Metropolitan Area in Sudan.

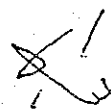
Sudanese authorities concerned will have total responsibility to implement the Project in the Sudanese side.

The team will convey the desire of the Government of Sudan to the Government of Japan that the Government of Japan will take necessary measures to cooperate in implementing the Project within the scope of Japan's Economic Cooperation Program in grant form.

The Sudanese authorities concerned have confirmed the Government of Sudan will take necessary measures as listed in Annex II on condition that the grant aid by the Government of Japan is extended to the Project

The Sudanese authorities concerned have understood and confirmed Japan's Grant Aid System explained by the Team.

Equipment to be provided will be finalized by the Team based on the request of the Sudanese side and the result of the study.



M.S.

III Minutes of Discussions

MINUTES OF DISCUSSIONS
ON
SOLID WASTE DISPOSAL IMPROVEMENT PROJECT OF METROPOLITAN AREA
IN
THE DEMOCRATIC REPUBLIC OF THE SUDAN

In response to the request made by the Government of the Democratic Republic of the Sudan for a grant aid of the Solid Waste Disposal Improvement Project of Metropolitan Area (hereinafter referred to as "The Project"), the Government of Japan has dispatched, through the Japan International Cooperation Agency (JICA), a survey team headed by Mr. Michio Sakamoto, Technical Supervisor of Sanitation Bureau, Kyoto City Government (hereinafter referred to as "The Team") to conduct the basic design study on the Project for 13 days from October 21 to November 4, 1985.

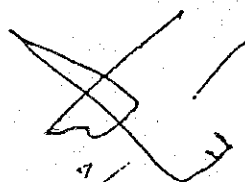
The Team has carried out a field survey, had a series of discussions and exchanged views with the Sudanese authorities concerned with the Project.

As a result of the survey and discussions, the Team and the Sudanese authorities have agreed to recommend to their respective Governments that the results of the discussions attached herewith should be examined toward the realization of the Project.

Khartoum, October 29, 1985



Mr. Michio Sakamoto
Team Leader
Japanese Survey Team



General P.S.C.
Kamal Abashar Yassin
Governor National Capital
KHARTOUM - SUDAN.

ATTACHMENT

The objective of the Project is to provide equipment for implementation of solid waste disposal service so as to improve the living environmental conditions in the Metropolitan Area in Sudan.

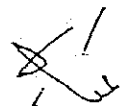
Sudanese authorities concerned will have total responsibility to implement the Project in the Sudanese side.

The team will convey the desire of the Government of Sudan to the Government of Japan that the Government of Japan will take necessary measures to cooperate in implementing the Project within the scope of Japan's Economic Cooperation Program in grant form.

The Sudanese authorities concerned have confirmed the Government of Sudan will take necessary measures as listed in Annex II on condition that the grant aid by the Government of Japan is extended to the Project

The Sudanese authorities concerned have understood and confirmed Japan's Grant Aid System explained by the Team.

Equipment to be provided will be finalized by the Team based on the request of the Sudanese side and the result of the study.



M.S.

ANNEX 1

Equipment, chemicals, and other items requested by the Government of Sudan whose cost will be borne by the Government of Japan are:-

1. EQUIPMENT with sufficient quantity of the spare parts;
 - 40 Loads Luggers, of which
 - 15 are to be distributed to Khartoum, 12 to Omdurman, 8 to Khartoum North and 5 to East Nile.
 - 60 Tippers, of which
 - 25 to Khartoum, 18 to Omdurman, 12 to Khartoum North and 5 to East Nile.
 - 17 Exhaust cars (cesspit emptiers), of which
 - 4 to Khartoum, 7 to Omdurman, 5 to Khartoum North and 1 to East Nile.
 - 1 Grader to the Head Quarters
 - 800 Containers (20 each containers to be attached to a load lugger)
 - 18 Tractors with one each trailer, of which
 - 5 to Khartoum, 6 to Omdurman, 5 to Khartoum North and 2 to East Nile.
 - 4 Loaders, of which
 - One each to Khartoum, Omdurman, Khartoum North and East Nile
 - 25 Medium size flat deck trucks with diesel engine (2-4 tonners), of which
 - 8 to Khartoum, 7 to Omdurman, 4 to Khartoum North, 4 to East Nile and 2 to the Head Quarters.
 - 12 Pickups (6 single cabs and 6 double cabs), of which
 - 5 to Khartoum, 4 to Omdurman, 2 to Khartoum North and 1 to East Nile
 - 2 four-wheel drive double cab pickups to East Nile
 - 10 Station wagons (van type), of which
 - 3 to Khartoum, 2 to Omdurman, 2 to Khartoum North, 1 to East Nile and 2 to the Head Quarters.
 - 50 125cc Motorcycles, of which
 - 15 to Khartoum, 15 to Omdurman, 10 to Khartoum North and 10 to East Nile

M.5

- 120 bicycles with wide tyres, of which
 - 40 to Khartoum, 45 to Omdurman, 30 to Khartoum North and 5 to East Nile
- 5 Generators, of which
 - one each to Khartoum, Omdurman, Khartoum North, East Nile and the Head Quarters.
- 140 Mannual sprayers, of which
 - 20 to Khartoum, 40 to Omdurman, 40 to Khartoum North and 40 to East Nile
- 50 Fumigation sprayers, of which
 - 20 to Khartoum, 10 to Omdurman, 15 to Khartoum North and 5 to East Nile

2. CHEMICALS

- 1250 Gallons of Temephos for fresh water cleansing
- 40 tons of Fentrithion (powder) for mosquitoes control
- 500 litres of Pyrethroids for domestic use for mosquito and fly control
- 2500 gallons of Diazinon for mosquito & fly control

3. WORKSHOP TOOLS AND MACHINES

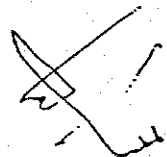
- 5 sets (assortments) of workshop tools and portable machines to be distributed to the Central Workshops and four District Workshops in Khartoum, Omdurman, Khartoum North and East Nile

M.S

ANNEX II

Following measures are to be undertaken by the Government of Sudan

1. To provide data and information necessary for basic design
2. To ensure prompt unloading, tax exemption, and customs clearance at the port of disembarkation in Sudan and prompt internal transportation of the imported equipment for the Project.
3. To exempt Japanese nationals concerned from customs duties, internal taxes and other fiscal levies which may be imposed in Sudan with respect to the supply of the products and services under the verified contracts.
4. To provide and accord necessary permission, licences and other authorization required for the Project.
5. To bear all the expenses other than those to be borne by the grant necessary for the supply of the equipment.
6. To maintain and use properly and effectively the equipment for the Project.



M.S

IV List of Discussion Attendants

List of Discussion Attendants

(1) Health Commission H. Q.

Dr. Al Tahir Ismail Salim	Director General of Health, Khartoum
Hassan Mohammed Mustafa	Director of Environmental Sanitation
El Nur Abdella El Nur	Deputy Director of Environmental Sanitation
Abdel Latif Satti	Senior Public Health Inspector
Muwia El Tigani	Senior Public Health Inspector

(2) Khartoum District Council

Ahmed Mohammed El Amin	Senior Public Health Inspector
A/Azim El Tayab	Senior Public Health Inspector
Ali El Tayib	Director
Yahya Mohammed	Director

(3) Omdurman District Council

Hassan Mahgoub	Senior Public Health Inspector
Abdalla Hassan El Gadal	Director
Mohgoub El Naim	Public Health Inspector
Adil Abraham	Public Health Officer
Abdo Egadir Mustaf	Public Health Officer
Osman El-Yas	Public Health Officer

(4) Khartoum North District Council

El Hadi Abdel Razig	Senior Public Health Inspector
Ahmed Idris Ahmed	Public Health Inspector
El Hadi Abdu Elsayiy	Senior Public Health Inspector

(5) East Nile District Council

Ali Mahgoub El Hussein	Senior Public Health Inspector
Hashimr M. Ahned	Public Health Inspector

(6) National Capital

Osman M. Abdalla	Inspector Planning
Elsheikh Hag Elsleikh	Director for Decentralization Affairs
Dafalla Mohd Nasir	Sec. General
Kamel Abrasher	Commissioner
Mohammed Aldel Ghafen	Director Planning

(7) Ministry of Finance & Economic

El Sheikh El Knidir Ahmed	Planning
---------------------------	----------

(8) Engineering Affairs Commissionali

Brahim Ali Khalifa	Director General
Yousif Mohamed Elsayed	Assistant Engineer

(9) Works Department

Abdel Tawab Muscafa

Works Manager

(10) School of Hygiene

Mahmoud Abdorahman

Deputy Dean

(11) Health Education Department

Abo Obieda Magzoub

Director

(12) Environmental Sanitary Oversere School

Mohammed El Hassan Salih

Principal

JICA

GRF

CR(2)

86-19