NO. 1

MINISTRY OF MUNICIPAL AND RURAL AFFAIRS AND THE ENVIRONMENT
THE HASHEMITE KINGDOM OF JORDAN

BASIC DESIGN STUDY REPORT ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS IN THE HASHEMITE KINGDOM OF JORDAN

MARCH 1996

JAPAN INTERNATIONAL COOPERATION AGENCY
ENVIRONMENTAL TECHNOLOGIC CONSULTANT CO., LTD.
PACIFIC CONSULTANTS INTERNATIONAL

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PREFACE

In response to a request from the Government of the Hashemite Kingdom of Jordan, the Government of Japan decided to conduct a basic design study on the Project for Improvement of Solid Waste Management in Major Local Areas in the Hashemite Kingdom of Jordan and entrusted the study to the Japan International Cooperation Agency (JICA).

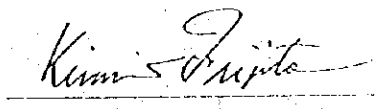
JICA sent to Jordan a study team from 21st November to 29th December, 1995.

The team held discussions with the officials concerned of the Government of Jordan, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Jordan in order to discuss a draft basic design, and as this result, the present report was finalized.

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

I wish to express my sincere appreciation to the officials concerned of the Government of the Hashemite Kingdom of Jordan for their close cooperation extended to the teams.

March, 1996



Kimio Fujita
President
Japan International Cooperation Agency

March, 1996

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Improvement of Solid Waste Management in Major Local Areas in the Hashemite Kingdom of Jordan.

This study was conducted by Environmental Technologic Consultant Co., Ltd. and Pacific Consultants International, under a contract to JICA, during the period from 17th November 1995 to 19th March 1996. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Jordan and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

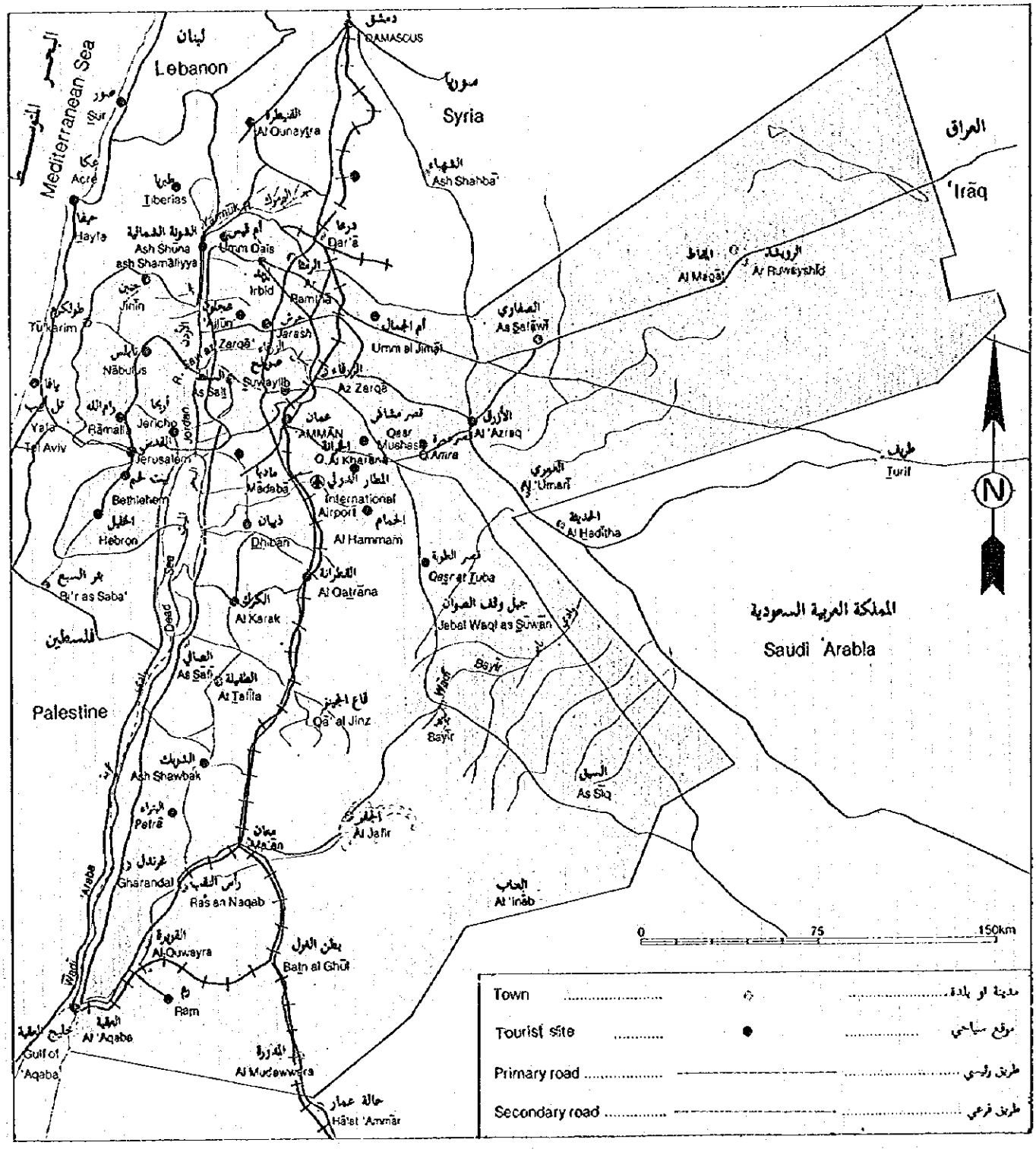
Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

中村健二郎

Kenjiro Nakamura
Project manager,
Basic design study team on the Project for Improvement of Solid Waste Management in Major Local Areas in the Hashemite Kingdom of Jordan.

THE HASHEMITE KINGDOM OF JORDAN



ABBREVIATION

BWC	Basic Work Capacity
CSC	Corporative Service Council
CSR	Collection Service Rate
DOE	Department Of Environment
DORC	Department Of Rural Council
FDS	Final Disposal Site
GQCMSW	Generation Quantity per Capita of the MSW
GOV.	Governorate
ISW	Industrial Solid Waste
JICA	Japan International Cooperation Agency
M/D	Minutes Of Discussion
MMRAE	Ministry Of Municipal and Rural Affairs and the Environment
MOP	Ministry Of Planning
MOT	Ministry Of Transportation
MSW	Municipal Solid Waste
RQMSW	Required Quantity of the MSW to be collected and transported
WA	Water Authority

CONTENTS

Appendices

CHAPTER 1 BACKGROUND OF THE PROJECT

Chapter 1 Background of the Project

On the basis of the National Environmental Strategy (1991), the solid waste management (SWM) has been undertaken in Jordan, principally by the Department of Environment (DOE) of the Ministry of Municipal and Rural Affairs and the Environment (MMRAE). In 1994 the DOE established a comprehensive plan for the SWM on a nationwide level with efforts being made to improve the 23 final disposal sites (FDSs) in the entire area of nation. This plan provides for an extension of the waste collection and disposal services, including nightsoil in the surrounding areas and the rural districts with endeavors being made to improve the living environment as a whole. In October 1995, the Environmental Protection Law was materialized in an attempt to create the legal framework for environmental measures in general and the treatment of wastes including nightsoil, in particular and further progress is being made in achieving greater improvements.

However, the local government authorities and agencies are unable to provide necessary equipment because of the lack or shortage of financial sources so that the current situation is marked by the suspension of waste disposal.

Thus, the Government of Jordan approached the Japanese government with a request for cooperation on the basis of a grant aid scheme for the procurement of the equipment needed for the regions so as to bring about district improvements in environmental and hygienic conditions, namely "the project for improvement of solid waste management in the major local areas in the Hashemite Kingdom of Jordan" (hereinafter referred to as "the project").

1-1 Outline of the Request

Date of the request : August 1995

Requested equipment :

for the collection of waste (including garbage and nightsoil) and for the operation of the FDSs at the following ten areas shown in Figure1-1 where the improvement of environment is most urgently required.

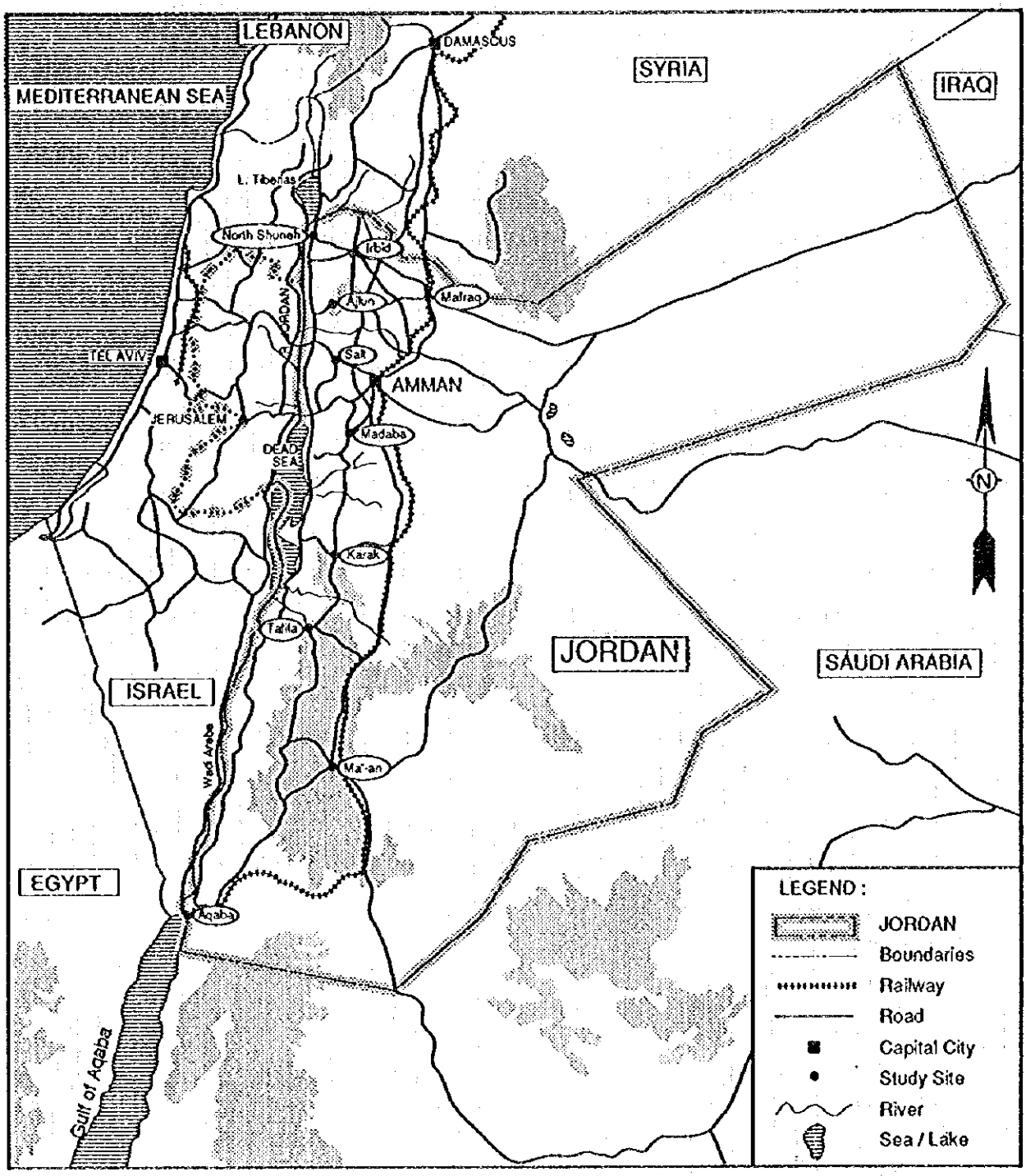


Fig.1-1 PROJECT LOCATION MAP

Areas :

1) Irbid, 2) Mafraq, 3) Ajlun, 4) North Shuneh, 5) Salt,
6) Madaba, 7) Karak, 8) Tafila 9) Ma'an, and 10) Aqaba.

1-2 Requested Equipment

The contents of requested equipment are shown in Table 1-2-1 and the requested equipment by the areas is shown in Table 1-2-2.

Table 1-2-1 Contents of Requested Equipment

Name of equipment	Specification	quantity
1) Equipment for the Collection and Transportation		
(1) Garbage Truck (cf.1)	16m3	8
(2) Dump Truck	10m3	2
(3) Dump Truck	8m3	14
(4) Dump Truck	6m3	16
(5) Vacuum Car	12m3	2
2) Equipment for the Operation of Final Disposal Sites		
(1) Buildozer	220 HP	6
(2) Dozer Shovel	200 HP	5
(3) Wheel Loader	140 HP	1
(4) Garbage Compactor	220 HP	2
(5) Hydraulic Excavator	128 HP	1
(6) Tractor head		5

cf.1: The name of "garbage truck" is changed to "compactor" in the Study.

Table 1-2-2 Requested Equipment by the Areas

Priority	1	2	3	4	5	6	7	8	9	10	Total
FDS	Al-Akaider	Mafraq	Humra	Tafila	Ma'an	Lojoon	Aqaba	Kufrinja	Madaba	N. Shuneh	-
CSC	Irbid	Mafraq	Balqa	Tafila	Ma'an	Karaq	Aqaba	Ajlun	Madaba	N. Gohr	-
Number of staff	18	13	17	4	8	4	12	8	4	3	91
Space x 1.000[m²]	606	180	270	500	500	1.000	60	71	52	67	3.306
Population :*1 x 1.000	714	128	171	81	70	125	62	100	72	75	1.598
Population :*2 x 1.000	746	170	173	61	97	170	94	123	106	75	1.815
Population in 2015 x 1.000	1.500	340	540	120	180	300	180	250	220	150	3.780
Quantity of waste disposed :*1 [t/day]	571	100	136	56	56	100	60	80	57	60	1.276
Quantity of waste disposed :*2 [t/year]	171.300	30.000	40.800	16.800	16.800	32.400	18.000	24.000	18.000	18.000	386.100
Collected by Municipality	39	11	5	7	11	20	3	5	10	5	116
Collected by Country Council	26	8	12	11	33	40	5	8	8	9	160
Requested Equipment											
For collection and transport											
Garbage truck (16m³) :*3	3	1		1			1		1	1	8
Dump truck (10m³)	1			1						2	
Dump truck (8m³)	3	1	1	1	1	2	2	1	1	1	14
Dump truck (6m³)	3	1	2	1	1	2	2	1	2	1	16
Vacuum Tank(12m³)									1	1	2
For landfill site											
Bulldozer (220 Hp)	1	1	1			1	1			1	6
Dozer shovel (200 Hp)	1			1	1			1	1		5
Loader (140 Hp)	1										1
Trash compactor (220 Hp)	1	1									2
Excavator (128 Hp)	1										1
Tractor head	1	1			1	1				1	5

Remarks: *1: Information made in August 1995.

*2: Information made in October 1995.

*3: The name of the "Garbage truck" is changed to "Compactor" in the Study.

CHAPTER 2 CONTENTS OF THE PROJECT

Chapter 2 Contents of the Project

2-1 Objectives of the Project

Objectives of the Project are to conserve the environment conditions and the sanitary conditions of 10 areas where 10 Final Disposal Sites (FDSs) are managed by 9 Cooperative Service Councils (CSCs) and 1 Municipality (hereinafter referred to as "CSCs etc.") among 23 FDSs planned nationwide improving the equipment for Collection, Transportation, Landfill and Maintenance.

2-1-1 Objective Waste of the Project

Objective Waste of the Project is Municipal Solid Waste (MSW) except for Hospital Waste and Industrial Waste.

2-1-2 Objective Areas of the Project

Objective Areas of the Project are 10 collection service areas of the CSCs etc. which manage the 10 FDSs.
The CSCs etc. are comprised of the CSCs of Irbid, Mafraq, Balqa, Tafila, Ma'an Central, Karak, Ajlun and Madaba and the Municipality of Aqaba.

2-1-3 Objective Equipment of the Project

Objective Equipment of the Project means the equipment described in the Terms of Reference (TOR), those are consisted of the equipment for Collection, Transportation and Landfill and the equipment for Maintenance.

2-2 Basic Concept of the Project

2-2-1 Precondition

(1) Discharge, collection and transportation of the MSW

1) Outline

Jordan is consisting of some local governortes and each governorate has some autonomies. The governorate is analogous to a prefecture in Japan. Besides this, Cooperative Service Councils (CSCs) were established under the supervision of the Department of Rural Councils (DORC), a department of the Ministry of Municipal and Rural Affairs and the Environment (MMRAE), for carrying out various administrative services. The CSC takes a form that is substantially in line with the corresponding Governarate or is established in plural in a Governerate.

Although the CSC is similar to the Wide-Area Sanitation Management Cooperatives in Japan established for the administration of the MSW management, etc., the CSC differs from the Cooperatives in Japan in the range of activities and in the affiliation of all regional autonomies being with it.

Of the various activities for the MSW and the nightsoil, such as collection, transportation, treatment, disposal, etc., the collection and the transportation are carried out under the responsibility of the MMRAE at the central government level and under the responsibility of the autonomies at the local government level.

On the other hand, the treatment and disposal are all carried out by the CSC. However, there are autonomies which cannot carry out their collection and transportation activities on their own responsibilities due to the small scale of population, finance, etc., so that the CSC often carries out these activities instead of the autonomies in such cases.

The situation concerning discharge from households, collection, transportation and disposal of the MSW is shown in Table 2-2-1-1.

TABLE 2-2-1-1 Collection and Transportation of the MSW

No.	NAME OF FDS (*1)	NAME OF CSC (*1/*2)	COLLECTION AREA: NAME OF GOVERNORATE	COLLECTION AREA: DESCRIPTION OF COLLECTION AND TRANSPORTATION (*3)→	FREQUENCY: times/week: 1	2	3	4	FEE/METHOD: JD/year: 1	2	3	4	FDS: LOCATION ←(*4)	SEWAGE HAULING/ METHOD	REMARKS
1.	AL-AKAIDER	IRBID CSC	IRBID Gov., JERASH Gov. and a part of MAFRAQ Gov.	1.The most densely populated area except for Amman. 2.Large FDS. located in Mafra. the MSW from sorrounding autonomies are hauled.					C	C	H	-	MAFRAQ: 2 km from Syrian border. 3 km from the nearest village.	YES/ 4 ponds (*5)	The only one FDS located outside of the administrative
2.	MAFRAQ (AL-HUSAI-NEYAT)	MAFRAQ CSC	MAFRAQ Gov.	1.The area is comparably flat land. but roads are narrow. 2.It is specified as an agri-calture district.					C	C	H	-	MAFRAQ: 2 FDSs are in approx. 20 km away. The old one is small & will be closed soon.	NO	Average distance of collection trucks is approximately 35 km. 2 CSCs are in the Governarate.
3.	HUMRA	BALQA CSC	BALQA Gov. Capital city is Salt.	1.The area is in mountain area and the roads are narrow and sloped. especially in the cen-ral part of Salt city.					12	6	0.5 ↓ 2		BALQA: 10 km from Salt City	NO	
									C	CH	H	-			
4.	TAFILA	TAFILA CSC	TAFILA Gov.	1.The area is in mountain area and the roads are narrow and hard sloped. 2.Population of Tafila is high.					12	4	1 ↓ 2		TAFILA: 20 km from Tafila City	YES/ 4 ponds (*5)	
									C	CH	H	-			
5.	MA'AN	MA'AN CENTRAL CSC	Central part of Ma'an Gov.	1.The area is located at high level and has the least industry and agricalture.	6	3			12	4	Shops	12	MA'AN: 15 km from Ma'an City.	YES/ 4 ponds (*5)	3 CSCs are in the Ma'an Governarate.
									C	C	C	-			
6.	LOJOON	KARAK	KARAK Gov.	1.The area is in mountain area and the roads are narrow and hard sloped. but relatively cleaned by hand-carts collection. 2.New FDS is prepared already.	6	3	2	-	12	6 ↓ 8	shops	50	KARAK: 2 FDSs The old one will be closed soon.	NO	Famouse for its old stone castle walls of Karak city cen-ter located on the top of mountain.
									C	C	C	-			
7.	AQABA	AQABA MUNICIPALITY	AQABA City	1.The city is responsible for solid waste management and owns workshop for equipment. 2.Roads are narrow in city center	6 ↓ 3	3	3	-	12	4	4	-	AQABA: 10 km from Aqaba City	NO	The city is speci-fied for the only one city of port of the Red Sea.
									C	C	C	-			
8.	KUFRINJA	AJLUN CSC	AJLUN Gov.	1.The area is in mountain area and the roads are narrow and sloped. 2.New FDS near old one is under planning.									KUFRINJA, AJLUN: 10 km bad road from Kufrinja City	NO	The access road to the existing FDS is bad and the new one is worse.
									CH	CH	H	-			
9.	MADABA	MADABA CSC	MADABA Gov.	1.The area is comparably flat and has a high population. 2.MSW from International Air Port is included.	6	3	-	-	12	6	-	-	MADABA: 10 km from Madaba City	NO	The area is a part of Capital area.
									C	CH	H	-			
10.	NORTH SHUNEH	NORTH GHOR CSC	NORTH GHOR Gov.	1.The area is east side along the Jordan River. 2.The length of the area is 50-60 km & the width is 5-10 km.									NORTH GHOR: 0.5km from the nearest agricultural well. 2 km from the nearest villages & 5 km from North Shuneh City.	NO	Average distance of collection trucks is approximately 50 km.
									C	CH	H	-			

cf.: *1: FDS: Final Disposal Site / MSW: Municipal Solid Waste / ISW: Industrial Solid Waste / CSC: Cooperative Service Council
*2: AQABA is managed by the municipality itself.
*3: 1= Municipality (City area) / 2= Rural Council (area) / 3= Small Council (area) / 4= Others such as shops. factories etc.
*4: H= House To House Collection / C= Curb-side Collection
*5: 4 ponds of which water levels are lowered next to next are prepared for night-soil storage, fermentation and flowing down.

2) Collection area and collection service rate

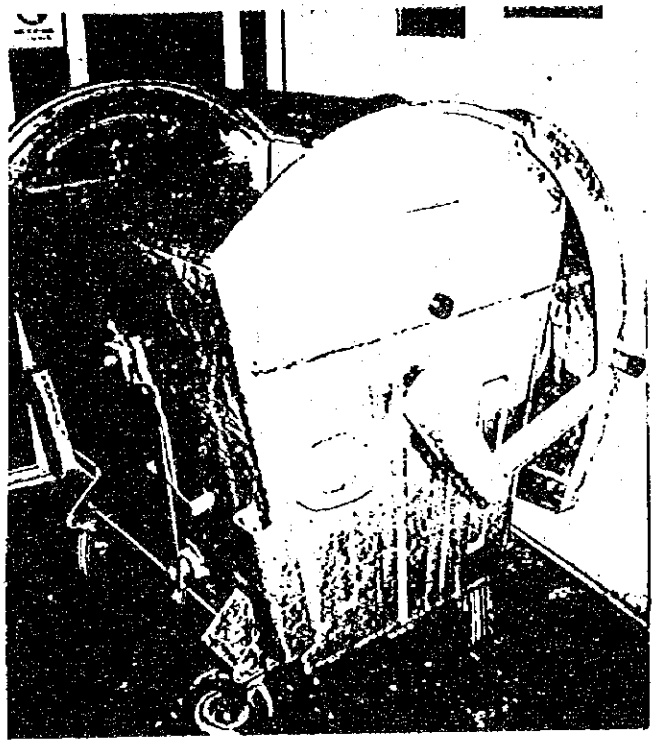
Each CSC is obliged to collect the MSW in a designated local area where autonomies are situated, however, some autonomies collect their own MSW by themselve and the others do not. Explained previously, for such autonomies, the CSC is obliged to take place.
Meanwhile, each CSC is also financially limitted to cover the entire area due to indirectly a lack of the collection and transportation vehicles. Thus there are unserved collection areas. The field survey indicates that the collection service rate of MSW (CSR) is approximately in the range of 80-70% as a nationwide average. In the case by the CSCs etc., the average CSR is estimated to be 75.4% as shown in the Table 2-2-1-7, "Quantity of the MSW hauled".

3) Collection frequency and collection method

Collection methods and frequencies differ somewhat from urban areas to rural areas. That is, the collection method carried out in the urban areas is so-called a curbside collection (C-S) method, in which households and stores discharge the MSW in a 1.1 m^3 steel container placed on the curbside. Collection vehicles make their collection rounds every day or once every 2 days. On the other hand, in the rural areas, though the collection frequency decreases to once every 3 or 6 days, so-called a house to house collection (HTH) method, in which collection is made from each house is carried out, because each house stands independently keeping some distance from each other. In some urban areas, the HTH is also carried out.

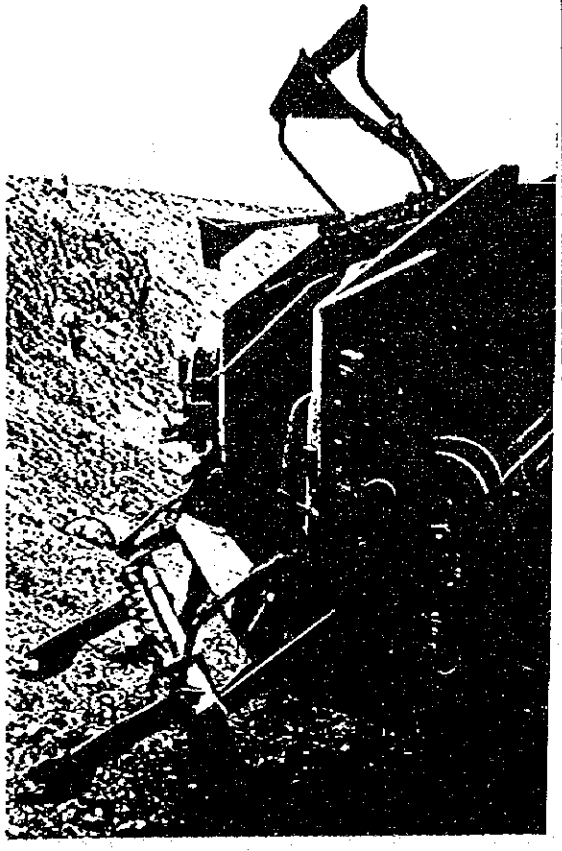
4) Collection containers

Plastic bags are basically used for discharging MSW from households and stores. The steel collection container shown in Figure 2-2-1-1, is a 1.1 m^3 of standard capacity that complies with German standards (DIN-30700).

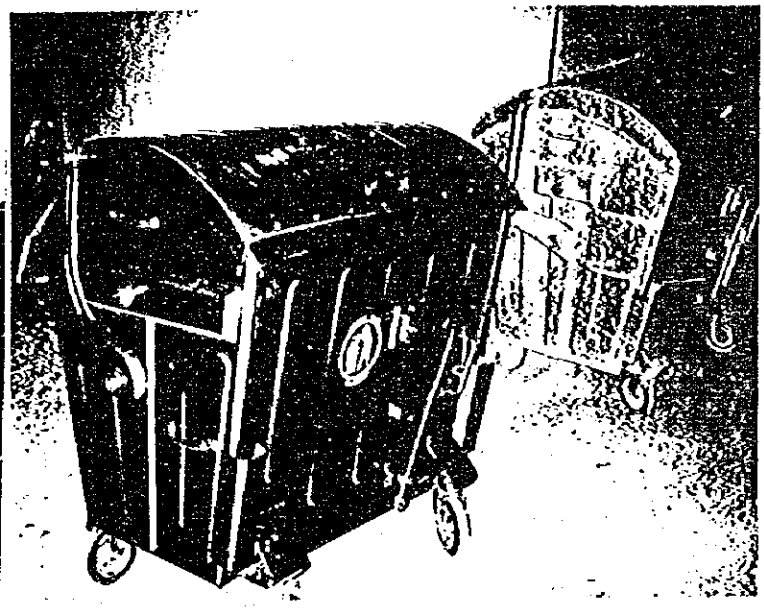


(1) Existing standard type container

(2) Broken and left container



(3) 1.1m³ container lifting device



(4) Improved type container for export

FIGURE 2-2-1-1

1.1 m³ CONTAINER

This steel container is made convenient to use and equipped at its lower part with lockable casters (wheels) that facilitate movement to the side and can be lifted mechanically by a collection vehicle by means of an mechanical lifting device fitted as standard on the compaction type collection vehicle (hereinafter referred to as "compactor") of 16 m^3.

It should be noted that the number of 16 m^3 compactor in use is few. Also because the mechanical lifting device tends to fail easily, in many cases the MSW is taken out and fed manually with a shovel from the steel container or is left uncollected. The casters or caster mounting base of the container is broken due to the container being lifted forcibly and then dropped. Furthermore, several points which could be improved have been noted. For example, the steel lid does not close properly and tends to injure a person who tries to close the lid forcibly.

Besides this, 0.1 or 0.2 m^3 plastic containers and steel containers are also used in the areas where the HTH is carried out. However, since plastic containers tend to cause fires due to cigarettes, etc. and are damaged easily, the Department of Environment (DOE) is intending to abolish such containers and to replace them with steel containers.

Collection containers are basically procured and installed by the autonomies. The 1.1 m^3 steel containers are made domestically or in Europe while most of the plastic containers are made in Saudi Arabia.
There is only one domestic manufacturer in Jordan and although there is room for improvement as indicated above, this manufacturer has a production capacity of 1,000 steel containers of 1.1 m^3 per year (actual amount for 1995).

The factory was visited and it was found that there are no problems in the production facilities for container manufacturing and the management was thorough. Upon asking the possibility of ordering 500 improved 1.1 m^3 steel containers at a delivery date of approximately 4 to 5 months, it was replied that they could be manufactured without any problems and that an order with similar specifications and scale from a neighboring nation has been received and fulfilled recently.

5) Collection and transportation vehicle

By all CSCs, the vehicles transport the MSW without reloading after collection even though the travel distances to the FDSs may be as far as 35 km per trip on average as the case of Mafraq. The number of trips per day is thus limited to 2 or 3. However, no problems were seen with the road conditions up to the entrance of the FDSs except for difficulties in collection imposed by illegal parking in urban areas.

The equipment of the CSC etc. for collection and transportation is shown in Table 2-2-1-2 and the equipment purchased by period is shown in Table 2-2-1-3.

TABLE 2-2-1-2 Equipment of the CSCs etc. for Collection and Transportation

No.	CSC etc.	Compaction				Dump Truck						Sub-total	
		16m³		4m³		8m³		6m³		4m³			
		OP	RP	OP	RP	OP	RP	OP	RP	OP	RP	OP	RP
1	IRBID	1	-	-	-	-	-	-	-	1	-	2	-
2	MAFRAQ	-	-	2	-	-	-	1	-	-	-	3	-
3	BALQA	-	-	-	-	1	-	-	-	-	-	1	-
4	TAFILA	-	-	-	-	-	-	-	-	2	-	2	-
5	MA'AN	-	-	-	-	-	-	-	-	3	-	3	-
6	KARAK	-	-	-	-	1	-	2	-	2	-	5	-
7	AQABA	3	-	-	-	-	-	1	-	-	-	4	-
8	AJLUN	-	-	-	-	-	-	1	-	-	-	1	-
9	MADABA	-	-	-	-	-	-	4	-	-	-	4	-
10	N. SHUNEH	-	-	-	-	-	-	-	-	2	-	2	-
Total		4	-	2	-	2	-	9	-	10	-	27	-

No.	CSC etc.	Other purpose		Total			Op.*1 Rate	Exsist. Auto.*2		Grand total		
		OP	RP	OP	RP	Tot	[%]	OP	RP	OP	RP	Total
1	IRBID	1	2	3	2	5	60	54	-	57	2	59
2	MAFRAQ	-	-	3	-	3	100	22	-	25	-	25
3	BALQA	-	2	1	2	3	33	19	2	20	4	24
4	TAFILA	-	3	2	3	5	40	18	-	20	3	23
5	MA'AN	-	-	3	-	3	100	3	-	6	-	6
6	KARAK	2	3	7	3	10	70	53	2	60	5	65
7	AQABA	-	2	4	2	6	67	5	2	9	4	13
8	AJLUN	-	1	1	1	2	50	16	-	17	1	18
9	MADABA	1	1	5	1	6	83	6	-	11	1	12
10	N. SHUNEH	-	-	2	-	2	100	14	-	16	-	16
Total		4	14	31	14	45	69	210	6	241	20	261

REMARKS: OP = in operation RP = under repair
*1 = Rate of equipment in operation
*2 = Existing equipment owned by autonomies

As shown in Table 2-2-1-3, more than half of the equipment for collection are outdated and having been used for 10 to 20 years. Some were used for 30 years or more. The types of vehicles have increased during this time span and the CSCs have voiced their desire for unifying the types of vehicle as much as possible since it is extremely difficult to procure so different types of vehicles and maintenance parts.

Table 2-2-1-3 Equipment Purchased

Period	Years Used	for collection & transport				for landfill	
		CSC	Autono-mies	Total [unit]	Ratio [%]	Total [unit]	Ratio [%]
1960	25 or over	0	5	5	2	0	0
1970-74	25-21	3	6	9	3	0	0
1975-79	20-16	3	18	21	8	0	0
1980-84	15-11	15	82	97	37	10	17.5
1985-89	10- 6	13	64	77	30	17	30
1990-94	6- 1	3	36	39	15	22	38.5
1995	1- 0	8	5	13	5	8	14
Total		45	216	261	100	57	100

(2) Landfill of the MSW

The landfill is operated by the CSC and the equipment for landfill is owned by the CSC as shown in Table 2-2-1-4. The detail of the preconditions of the landfill is described in item 2-3-2.

(3) Classification of the MSW

1) Outline of the classification of the MSW

The classification of MSW was studied for each CSC from the three regions, ie. Mafraq of the northern region, Madaba of the central region, and Ma'an of the southern region. As a rule, each CSC collected the total 8 samples; ie. 2 samples of the MSW from each of 3 residential areas classified according to income or the total 6 samples from residential areas and 1 sample each from markets and office areas. Each sample was collected 10 kg upon quartering from about 100 kg initialy collected at the time of discharge and was sent along with the sampling records to Jordan University. The Environmental Technology Section of the Technical Engineering Department of Jordan University analyzed the waste composition of the total 26 samples. The results are shown in Table 2-2-1-5.

TABLE 2-2-1-4 Equipment of CSC etc. for Landfill

No.	C S C etc.	Bulldozer				Loader				Compac-tor		Excava-tor		Tractor	
		A		B		A		B							
		OP	RP	OP	RP	OP	RP	OP	RP	OP	RP	OP	RP	OP	RP
1	IRBID	-	1	-	-	1	-	1	-	1	-	-	-	1	-
2	MAFRAQ	-	-	1	-	-	-	-	1	-	-	-	-	1	-
3	BALQA	-	-	-	1	-	1	1	-	1	-	-	-	-	-
4	TAFILA	-	-	1	-	-	-	1	-	-	-	-	-	1	1
5	MA'AN	-	-	1	-	1	-	-	-	-	-	-	-	2	1
6	KARAK	-	-	1	-	1	1	1	1	-	-	-	-	-	-
7	AQABA	-	-	-	1	-	-	-	1	-	-	-	-	-	-
8	AJLUN	-	-	-	-	1	-	1	1	1	-	-	-	2	-
9	MADABA	-	-	1	-	-	-	1	-	-	-	-	-	1	-
10	N. Gohr	-	-	-	-	-	-	1	-	-	-	-	-	1	1
Total		0	1	5	2	4	2	7	4	3	0	0	0	9	3

No.	C S C etc.	Pick-up		Others		Total		Grand total	Op. *1 Rate [%]	SAO [YES /NO]	RS [YES /NO]	Remarks
		OP	RP	OP	RP	OP	RP					
1	IRBID	2	-	-	-	6	1	7	86	Y	N	
2	MAFRAQ	1	-	-	-	3	1	4	75	N	N	
3	BALQA	1	1	-	-	3	3	6	50	Y	Y	
4	TAFILA	1	-	1	-	5	1	6	83	Y	N	
5	MA'AN	-	1	1	-	5	2	7	71	Y	N	
6	KARAK	2	-	2	-	7	2	9	78	Y	N	
7	AQABA	-	-	-	-	0	2	2	0	N	Y	No Equipment operated
8	AJLUN	-	-	-	-	5	1	6	83	N	N	
9	MADABA	1	-	1	-	5	0	5	100	Y	Y	
10	N. Gohr	1	-	1	-	4	1	5	80	N	N	
Total		9	2	6	0	43	14	57	75	-	-	

REMARKS: OP = in operation RP = under repair

SAO = Site Administration Office RS = Repair Shop

*1 = Rate of equipment in operation

TABLE 2-2-1-5 Classification of Solid Waste

No. of SAMPLE	SAMPLE WEIGHT	1 PAPER CARDBOARD		2 FIBER TEXTILES		3 PLASTIC		4 GLASS		5 GRASSES & GARDEN WASTE		6 LEATHER		7 RUBBER		8 METALS		9 KITCHEN GARBAGE		10 STONE CERAMICS		11 OTHERS		WATER CONTENT	INCOMBU-STIBLES	REMARKS
*1	kg	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%	%	%	
MAFRAQ																										
AVE.of MSW		12.33		0.85		15.45		1.73		-		-		-		2.17		66.87		0.53		0.07		63.62	21.5	
1-M-1	7.262	2.688	37.0	-	-	0.626	8.6	-	-	-	-	-	-	-	-	0.083	1.1	3.408	46.9	0.457	6.3	-	-	38.8	28	
1-O-1	10.426	1.990	19.1	-	-	0.298	2.9	0.229	2.2	-	-	-	-	-	-	-	-	7.833	75.1	0.076	0.7	-	-	74.3	28	
MADABA																										
AVE. of MSW		7.33		6.02		12.62		1.65		0.82		-		-		0.87		70.35		0.27		0.08		64.97	25.7	
2-M-1	10.040	0.388	3.9	-	-	0.439	4.4	-	-	0.146	1.4	-	-	-	-	0.088	0.9	8.979	89.4	-	-	-	-	66.8	18	
2-O-1	9.536	1.689	17.7	0.136	1.4	1.936	20.3	-	-	-	-	-	-	-	-	0.179	1.9	5.169	54.2	0.427	4.5	-	-	52.4	26	
2-I-1	8.996	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.996	100	-	-	-	-	-	-	1.4	98.4	:ALUMINUM CANS
2-I-2	10.317	2.309	22.4	0.163	1.6	7.845	76.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.1	29	:SMALL INNER CARTON BOXES FOR PHARMACY
MA'AN																										
AVE. of MSW		13.78		6.08		21.28		2.82		0.42		0.55		0.77		3.13		50.7		0.05		0.42		51.72	34.2	
3-M-1	8.992	0.339	3.8	-	-	1.079	12.0	-	-	-	-	-	-	-	-	0.089	1.0	7.485	83.2	-	-	-	-	58.1	47	
3-O-1	10.194	0.911	8.9	0.222	2.2	3.943	38.7	0.215	2.1	-	-	0.144	1.4	-	-	1.407	13.8	2.393	23.5	-	-	0.959	9.4	18.1	26	
OVERALL AVE:*2		11.15		4.23		16.45		2.06		0.41		0.18		0.26		2.06		62.64		0.28		0.19		60.10	27.1	

REMARKS: *1: The letters in the number of sample mean area of: M: Market/ O: Office/ I: Industrial waste

*2: The overall average shows the MSW

SOURCE: JORDAN UNIVERSITY (DEC. 1995)

2) Composition of the MSW

The contents of the household waste among the MSW sampled by the 3 CSCs are listed in the order of simply averaged value in Table 2-2-1-6.

Table 2-2-1-6 Composition of the MSW : Household Waste

No	Content	%	7	GRASSES / GARDEN WASTE	0.41
1	KITCHEN GARBAGE	62.64	8	STONE / CERAMICS	0.28
2	PLASTIC	16.45	9	RUBBER	0.26
3	PAPER / CARDBOARD	11.15	10	OTHERS	0.19
4	FIBER / TEXTILE	4.32	11	LEATHER	0.18
5	GLASS	2.06	-	TOTAL	100.00
6	METALS	2.06			

From the Table, it can be seen that kitchen garbage is extremely abundant, indicating approximately 63 % of the entire waste, much of plastic waste is approximately 16 % of the entire waste, and the combustible matter consisting of plastic, paper and kitchen garbage is approximately 90 % of the total waste. The abundance of kitchen garbage can be seen in the market system in Jordan. That is, meat is sold with bones and vegetables are sold unprocessed with roots and leaves attached and such bones, etc. are discharged. A high water content of approximately 60 % can also be understood in relation to the above results.
Ignition tests have indicated a high incombustible content of 27.1 %.
Presently it is difficult to provide a consistent explanation for this and the high content of combustibles indicated above. Results of further study are expected on this matter.

3) Bulk density of the MSW

Bulk Densities of the MSW were measured in the free condition at the curbside at the time of discharge and in the collection vehicles. The former measurements were made using a 100 l plastic bag and a 20 kg scale, while the latter measurements were determined from the loading weight and loading volume of each vehicle using a truck scale. The results are shown in Table 2-2-1-7.

Table 2-2-1-7 Bulk Density of the MSW (t/m³)

CONDITION \ CSC		MAFRAQ	MA'AN	AVERAGE
FREE CONDITION	HOUSEHOLD	0.432	0.202	0.317
	MARKET/OFFICE	0.802	0.150	0.476
ON TRUCK	No. 1	0.654	0.537	-
	No. 2	0.668	0.483	-
	No. 3	0.770	0.475	-
	No. 4	0.612	-	-
	AVERAGE	0.676	0.498	0.600

(3) Quantity of the MSW hauled

Quantities (t/d) of the MSW hauled to the FDSs were determined by taking the numbers of hauling trucks for 7 days at the entrance of 10 FDSs and by calculating the loading weight of each vehicle, multiplying the hauled volume and the on-truck bulk density measured with a truck scale as indicated in the previous section. The results are shown in Table 2-2-1-8, and the amount generated per capita was calculated 0.607 kg/d.

(4) Nightsoil

1) Current conditions of the collection and treatment system

Among the nightsoil treatment activities, the operation of a sewerage network with a treatment plant for sewage including nightsoil is carried out in Amman City. Among the areas of the Project, only the central part of Aqaba City has a treatment plant. Although a sewerage network is not furnished, a treatment plant is being operated in Mafraq. In most of the other cities, the nightsoil and general household wastewater are storaged in a combined manner in a septic tank and sacked by a vacuum vehicle, and then disposed at the FDS. All of the nightsoil collection work are contracted by private firms, but not in the less populated areas where payability is low.

TABLE 2-2-1-8 Quantity of the MSW Hauled to FDSs

No.	FDS:*1	CSC:*1	SAT	SUN	MON	TUE	WED	THU	FRI	TOTAL (DAYS)	DAYLY AVERAGE		POPULATION (1): *3	POPULATION (2): *4	C.S. RATE : *5	HAULED MSW PER CAPITA	REMARKS
			DATE OF HAULING: *2														
			m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3/d	t/d	person	person	%	kg/d-cap.	
1.	AL-	IRBID	12/2	12/3	12/4	12/5	12/6	11/30	12/1	(7)							
	AKAIDER		631	681	586	592	674	523	0	3.687	526.7	316.0	745,774	570.333	76.5	0.554	
2.	MAFRAQ	MAFRAQ	12/2	12/3	12/4	12/5	11/29	11/30	12/1	(7)							
			213	176	186	0	194	194	0	963	137.6	82.5	170.903	158.775	92.9	0.520	
3.	HUMRA	BALQA	12/9	12/10	12/11	12/5	12/6	12/7	12/8	(7)							
			280	272	162	256	240	214	36	1.460	208.7	125.2	273.489	150.000	54.8	0.835	
4.	TAFILA	TAFILA	12/2	12/3	12/4	12/5	12/6	12/7	12/8	(7)	61.2	36.7	61.156	61.156	100	0.600	MSW: *1
			178	177	171	197	197	188	36	1.144	(102.2)	-	-	-		-	ISW: *1
											(163.4)	-	-	-		-	TOTAL
5.	MA'AN	MA'AN	12/9	12/10	12/11	12/12	12/13	12/14	12/15	(7)							
		CENTRAL	68	66	74	64	64	62	0	398	56.8	34.1	84.870	59.933	70.6	0.569	
6.	LOJOON	KARAK	12/2	12/3	12/4	12/5	12/6	12/7	12/8	(7)							
			212	214	176	160	206	156	0	1.124	160.7	96.4	169.552	141.740	83.6	0.680	
7.	AQABA	AQABA	12/2	12/3	12/4	11/28	11/29	11/30	12/1	(7)							
		MUNIC.	114	114	0	142	114	114	128	726	103.7	62.2	79.745	63.735	79.9	0.976	
8.	KUFRINJA	AJLUN	12/16	12/10	12/11	12/12	12/13	12/14	12/15	(8)							
			92	76	64	70	64	64	0	500	62.5	37.5	125.000	110.000	88.0	0.341	
				12/17													
				70													
9.	MADABA	MADABA	12/9	-	12/4	12/5	12/6	12/7	12/8	(7)							
			65	-	109.5	114.3	116	219	106	729.8	104.3	62.6	157,308	76.609	48.7	0.817	
10.	NORTH	NORTH	12/2	12/3	12/4	11/28	11/29	11/30	12/1	(8)							
	SHUNEH	GHOR	77	63	57	88	84	56	0	485	60.7	36.4	75.612	72.461	95.8	0.502	
						12/5							*6				
						60											
TOTAL										-	1.482.8	889.6	1.943.409	1.464.742			
AVERAGE											m^3/d	t/d			75.4	0.607 t/m^3	

cf.: *1: FDS: Final Disposal Site / MSW: Municipal Solid Waste / ISW: Industrial Solid Waste / CSC: Cooperative Service Council
*2: November & December, 1995
*3: Population by governorate: Result of the population & housing census on Dec. 10, 1994 except for North Shuneh.
*4: Calculated population of collected area.
*5: C.S. RATE: Collection Service Rate
*6: Population by governorate: Reply to the questionnaire.

Of the CSCs etc. of the project, the 3 FDSs of Irbid, Tafila, and Ma'an operate the disposal sites with nightsoil. In particular, the Al-Akaider FDS of a large scale, receives nightsoil from Mafraq, Kufrinja, etc. as well. However, operation cost of transportation is basing a lot due to long transport distances and the necessary number of vacuum vehicles is lacking in Mafraq, Kufrinja, etc.

The treatment methods are similar among the FDSs. That is, 4 ponds, of which water-heads are different, are directly dug in a gradually sloping foundation. A channel with a dam made of cobble stones of about 10cm in size is installed between each pond.

The nightsoil is disposed of in the pond at the upstream side and only the top water flows down by gravity to the next pond at the downstream side. Although it may be possible to treat a considerable amount of nightsoil during the summer when an evaporation rate is high, on the other hand during the winter when the Study was carried out, nearly no evaporation progressed and the nightsoil remained stagnant over a long period. In all 3 FDSs, the person in charge was troubled by this method which lacked a definite treatment capacity and sought other improvement methods, the one is able to utilize the water for irrigation at times when the water does not evaporate, the other is able to take out the settled sludge easier than using a bulldozer.

2) Improvement of the collection and treatment systems

The vacuum vehicles requested in the TOR are for improving the conditions described above. Enough vehicles must be supplied to accomodate for the nightsoil collection and transportation in the areas which nearly coincide with the areas where MSW is uncollected.

The absolute number of vacuum vehicles is lacking and the frequency of collection is inadequate. The situation is observed in Tafila, this is because the city is situated in a mountainous region which has many places where collection is difficult and is 20km away from the FDS.

In Madaba, the above holds same because additionally there are no nightsoil treatment plant in its jurisdictional area, and the nightsoil must be transported over long distances to other Governorates.
Thus the addition of vacuum vehicles is required urgently for both cities targeted by the project.

Also, in view of the present conditions where nightsoil collection services are carried out by private firms, considerations must be made to avoid straining their operations.

The following opinions were presented by Jordan University concerning with the improvement of the treatment methods.

(A) Although there is some percolation, there should be no affects on the groundwater veins that are presumably located at 500-600m or deeper.
(B) Since most of the current FDSs are located in a desert, etc. and are 5-10km or more away from residences, the disposal of nightsoil does not affect with much of pollution problems to residents such as odor, etc.
(C) Rather, the disposal of organic matter in the desert is favorable, because it provides soil improvement and greening effects.
(D) Thus there are no problems in the treatment method. However, the design of the capacity should be reconsidered carefully.
(E) The installation of a pump-feeding unit is effective for taking out the settled sludge, instead of using a bulldozer. Figure 2-3-2-42 shows the general drawing of nightsoil pit including a pump-feeding unit for reference.

From the above, it is considered that other considerations should be made concerning the improvement of the treatment methods in Jordan of which environment differs greatly from that of Japan.

2-2-2 Basic Concept of the project

(1) Boundary conditions

1) Considerations of natural condition, safety, durability and operating condition

(A) With respect to the collection and transportation equipment, the specifications shall be determined by considering the road conditions, including steep inclines and narrow widths.

(B) In general, equipment for landfill shall have driver's safety measures against fall, turnover and slip allowing for the operating environment. Exact geographical conditions of the FDSs should be considered on case by case basis.

(C) For wheel type equipment, the protection of tires such as the use of steel chains will be usefull in order to prevent tire wear and damage.

(D) Environment at landfill is to be thought of bad working condition such as offensive odor, dust, flies and mosquitoes.

2) Consideration of conditions such as the features of areas, systems and potentialities of the executing Agency.

(A) Standard specification for equipment and unification of parts and consumables

Standard specification for equipment is important to be maintained and purchased easily.

Unification of parts and consumables is also important for maintenance and easy purchase of equipment.

(B) Technology instruction and transfer

The skills of driving vehicles and heavy duty machines are kept high, however the skills of equipment maintenance and landfill site planning are not sufficient.

Therefore technology instruction and transfer of those skills by training will be necessary for long term maintenance and environmental conservation.

(C) Selection view points of equipment

Selection of equipment are to be prudently implemented with consideration of the conditions of the existing equipment, repairing capabilities the scale of planned equipment and the repair shops of dealers or private company.

In addition, manufacturers are to be selected in consideration of dealers who prepare locally a full scale after-service system such as repair shops with enough spare parts anytime, training facilities and service engineers.

3) Other considerations

(A) Study on procurement possibility from a third country

The study on procurement possibility from a third country will be usefull in order to seek for suitable equipment.

(B) Strict scheduling

Delivery period of the procurement to a recipient country is very much important for the project. Therefore contractors and manufacturers should be strictly bound by its delivery schedule.

(2) Basic concept of the project

1) Collection and transportation equipment

To prepare the equipment for collection and transportation so that the collection service rate may be 100 % at the target year of 2000 from 75.4 % at present.

2) Landfill equipment

To prepare the equipment for landfill so that the adequate final disposal called " sanitary landfill " may be executed in 10 FDSs.

3) Maintenance equipment

To prepare the equipment for maintenance so that prompt repair services may be possible.

2-2-3 Design Policy

In view of the current conditions described above, the basic policy and the design policy for the design of the Project were formulated as follows.

(1) Collection and transportation

1) Targets to be improved

(A) The MSW collection service rate should be raised up to 100%.
The MSW collection service rate, which is presently said to be 75.4%, should be raised up to 100%.
For this purpose, equipment for the collection and transportation should be substantiated with the CSCs.

A) Addition and renewal of collection vehicles
   a. Collection vehicles should be added and outdated vehicles should be renewed.
   b. In adding vehicles, the compactness of vehicles is to be emphasized so that the collection may be enabled particularly in cities of mountainous areas with narrow roads which do not allow the entry of previously used large vehicles.

B) Addition and renewal of solid waste containers
   a. Solid waste containers to be used for the C-S are to be added and broken solid waste containers are to be renewed.
   b. In adding containers, considerations should be made so that containers may be installed at locations where they could not be installed previously.

(B) Workability should be improved.

A) Mechanization

New vehicles should be mechanized as much as possible in order to improve the workability of the collection and the working environment.

B) Promotion of lightweightness

The abovementioned vehicles and the MSW containers should be made as lightweight as possible in order to improve workability.

(C) The effective use of equipment should be promoted.

A) As each FDS has its characteristic, the specified equipment would be selected in the project. However the characteristic will be changed by proceeding the landfill, then the equipment will be followed to meet. For instance, a FDS might need a bulldozer at the first stage and then an excavator at the second stage because of the change of topographic condition. At that time the exchange of equipment among CSCs is expected effective, the DOE is requested to consider such system.

B) Dump trucks should also be used as the MSW collection vehicles so that the dump trucks may take a roll for both collection and transportation of cover material for the FDS and the MSW in a way of multi-usage.

2) Design policy

(A) Collection vehicles

A) For most of cities in plain areas, since the transportation distance per trip is long, the equipment is to be selected with the priority placed on the large compaction truck (hereinafter refered to as "compactor") of a 16 m^3 class, which is presently used most popularly in Jordan. The large compactor is to be equipped with a mechanical lifting device for 1.1 m^3 MSW containers.

B) For cities in mountain areas, the equipment is to be selected with the priority placed on a small compactor of a 4 m^3 class.
Since the hopper volume is small in the case of a 4 m^3 class compactor, it cannot be equipped with a mechanical lifting device for 1.1 m^3 MSW containers. Therefore, a mechanical lifting device for 0.4 m^3 MSW containers is to be equipped. This device can be used for 0.1 - 0.4 m^3 MSW containers.

C) For cities in plain areas with wide roads but without setting any of 1.1 m^3 MSW container, the equipment is to be selected with the priority placed on a large dump truck of 8 and/ or 10 m^3 class.

D) For cities in mountain areas with narrow and sloped roads and without setting any of 1.1 m^3 MSW container, the equipment is to be selected with the priority placed on a large dump truck of 4 and/ or 6 m^3 class.

(B) Municipal solid waste (MSW) containers

1.1 m^3 containers are to be installed with the priority in the areas where the operation of a 16 m^3 class compactor is possible, while 0.2 or 0.4 m^3 containers are to be installed with the priority in the areas where 4 m^3 class compactors are operated.
In either case, the containers are to be made of steel for strength, and be provided with casters for easy workability and with a cover for appearance.

(C) Number of the equipment for collection and transportation

The number of the equipment for collection and transportation (NECT) is to be calculated with a "required quantity of the MSW to be collected and transported" (RQMSW) with a "base work capacity" (BWC) in a formula below;

NECT = RQMSW / BWC

Details are described in the item 2-3-1 and the item 2-3-3.

(2) Landfill in FDS

1) Targets to be improved

(A) Sanitary landfill is thoroughly implemented

(B) Preparation of equipment with consideration of environment

(C) Preparation of basic facilities for maintenance

2) Design policy

The design policy of landfill in FDS is described in the item 2-3-2.

2-3 Basic Design

2-3-1 Planning of Collection and Transportation

(1) Kind of equipment and number of equipment

The target of the project is to raise up the collection service rate (CSR) from 75.4 % to 100 % in 2000.
Firstly, the kind of the equipment corresponded to the project purpose are to be selected as the "necessary equipment", then the number of the necessary equipment are to be decided. Both will be decided in item 2-3-3. The number of the equipment should be calculated with the " required quantity of MSW to be collected and transported (RQMSW) ", and the "base work capacity (BWC)".

(2) Required quantity of the MSW to be collected and transported (RQMSW)

The RQMSW is fluctuated by 3 factors, those are;

1) Fluctuation of population

The annual increasing ratio of population from 1985 to 1992 was a little bit large, 3.3 %, which was influenced mainly by the returners caused by the gulf-war. Thus it is too difficult to predict in the future, because it or otherwise will be influenced by such big social affairs like the piece talk in the area. Therefore in the project this factor will be ignored.

2) Fluctuation of MSW generation quantity per capita of MSW (GQCMSW)

The MSW generation quantity will be increased because of people's life style becoming better. Generally speaking, the increasing ratio of "generation quantity per capita of the MSW" (GQCMSW) is in proportion to the GNP per capita, in other words people's income. The "increasing ratio of the GQCMSW" (IR) is supposed to be 0.4 % annually in the rural area in Jordan. Therefore in 5 years from 1995 to 2000, the total increasing ratio is calculated 102 %.

$$GQCMSW2000 = GQCMSW1995 \times (1 + IR) \wedge (Years) \cdots\cdots\cdots ①$$
$$= GQCMSW1995 \times 1.004^5$$
$$= GQCMSW1995 \times 1.02$$

The calculation results of 10 areas are shown in the column [B] of Table 2-3-1-1. The average GQCMSW of 10 areas is 0.607 kg/day·capita in 1995 and it will be 0.638 in 2000.

3) Quantity of the MWS in 2000

The quantity of the MWS of each CSC etc. in 2000 [C] is the multiplication result of the population [A] and the GQCMSW [B];

$$[C] = [A] \times [B] \cdots\cdots\cdots ②$$

4) Balance quantity of the MSW

The balance quantity of the MSW of each CSC etc. in 2000 is the subtraction result of the quantity of the MSW in 2000 [C] minus the quantity of the MSW in 1995 [E];

$$[F] = [C] - [E] \cdots\cdots\cdots ③$$

5) Required quantity of MSW to be collected and transported (RQMSW)

The population [A] is comprised of the population in the CSC etc. concerned and the population of the other CSCs etc. whose MSW are hauled to the FDS concerned. Therefore the balance quantity of the MSW of each CSC etc. in 2000 [F] is to be rectified by the coefficient of [G] / [A]. The RQMSW [H] is the rectification result from the [F] with the coefficient of [G] / [A];

$$[H] = [F] \times [G] / [A] \cdots\cdots ④$$

The RQMSWs of 10 areas in 2000 are calculated and shown in the column [H] of Table 2-3-1-1.

Table 2-3-1-1 Required Quantity of the MSW to be collected and transported [RQMSW] (2000)

No.	Final Disposal Site	CSC etc.	[A]	[B]	[C]	[D]	[E]	[F] :C-E	[G]	[H] :F×G/A
			2000				1995	2000		
			POPULATION from Tab. 2-2-1-3	QUANTITY OF MSW/ CAPITA [GQCMSW]	QUANTITY OF MSW		QUANTITY OF MSW from Tab. 2-2-1-3	BALANCE QUANTITY OF MSW	POPULATION IN THE CSC	REQUIRED QUANTITY OF MSW [RQMSW]
			person	kg/d·cap	t/d	m³/d	t/d	t/d	person	t/d
1.	AL-AKAIDER	IRBID	745,774	0.565	421.7	702.8	316.0	105.7	645,945	91.5
2.	MAFRAQ	MAFRAQ	170,903	0.530	90.6	151.0	82.5	8.1	158,775	7.5
3.	FUHRA	SALT(BALQA)	273,489	0.852	233.0	388.3	125.2	107.8	109,019	43.0
4.	TAFILA	TAFILA	61,156	0.612	37.4	62.4	36.7	0.8	61,156	0.8
5.	MA'AN	MA'AN	84,870	0.581	49.3	82.1	34.1	15.2	41,469	7.4
6.	LOJOON	KARAQ	169,552	0.694	117.7	196.1	96.4	21.3	76,128	9.6
7.	AQABA	AQABA MUNIC.	79,745	0.996	79.4	132.4	62.2	17.2	63,735	13.8
8.	KUFRINJA	AJLUN	125,000	0.348	43.5	72.5	37.5	6.0	125,000	6.0
9.	MADABA	MADABA	157,308	0.834	131.2	218.6	62.6	68.6	120,827	52.7
10.	NORTH GHOR	NORTH GHOR	75,612	0.513	38.8	64.6	36.4	2.4	75,612	2.4
TOTAL			1,943,409	-	1,242.5	2,070.9	889.6	352.9	1,477,666	268.4
AVERAGE			-	0.638	-	-	-	-	-	-

REMARKS: 1) The generation quantities of MSW (GQCMSWs) shown in column [B] are calculated by the annual incresing rate of 0.4%.

2) The required quantities of MSW to be collected and transported (RQMSWs) shown in column [H] mean the MSW to be collected and transported additionally by the CSCs.

(3) Planning of each CSC etc.

1) Irbid CSC

The population using the Al-Akaider FDS is approximately 740 thousand. The additional aiming quantity of the MSW of the Irbid CSC is approximately 92 t/d. The nightsoil is transported to the FDS. The operating equipment for the collection and transportation of the MSW among 5 existing equipment owned by the CSC are 2, the one is 16 m^3 compactor and the other is 4 m^3 dump truck. The compactors of 16 m^3 able to transport a mass of the MSW effectively are to be procured for the collection and transportation, because the population density of the collection area is high and the distances between areas and the FDS are far.

2) Mafraq CSC

The population using the Mafraq FDS is approximately 170 thousand. The additional aiming quantity of the MSW of the Mafraq CSC is approximately 8 t/d. There are 2 FDSs in the area, the main is Al-Husaineyat and the sub is Balma. The operating equipment for the collection and the transportation of the MSW owned by the CSC are 3, the 2 are 4 m^3 compactors and the other is 6 m^3 dump truck procured in the second half of 1980'. In the near future, the Balma FDS will be closed because the room of the FDS will be saturated, and the transportation distance will be extended further, so the capacity of operating equipment will be in short, therefore the collection service rate might be dropped down. To prevent such and to raise the rate up to 100%, the procurement of equipment should be necessary. The compactors of 4 m^3 able to drive on narrow roads are to be procured for the collection and transportation.

3) Balqa CSC

The population using the Humra FDS is approximately 270 thousand. The additional aiming quantity of the MSW of the Balqa CSC is approximately 43 t/d.

The operating equipment for the collection and transportation of the MSW among 3 existing equipment owned by the CSC is only one, 8 m^3 dump truck, which is not enough to cover the objective area, now. The compactors of 16 m^3 able to transport a mass of the MSW for the city area and the small dump truck of 3.5 t able to drive on narrow roads with the population of high density and hard slope area are to be procured for the collection and transportation.

4) Tafila CSC

The population using the Tafila FDS is approximately 60 thousand. The nightsoil is transported to the FDS. The operating equipment for the collection and transportation of the MSW among 5 existing equipment owned by the CSC are 2 and they are 4 m^3 dump trucks but too old. Though the collection service rate of the MSW is now 100% , it depends on the cooperation of private companies, that is; the Industrial Solid Waste from these companies are disposed of at the FDS by themselves and the MSW disposed from the surrounding residents are collected and transported by trucks owned by these companies. The compactors of 16 m^3 able to transport a mass of the MSW effectively and of 4 m^3 able to drive on narrow roads are to be procured for the collection and transportation, because the distance between Tafila city area and the FDS is long and more than 20 km.

5) Ma'an Central CSC

The population using the Ma'an FDS is approximately 84 thousand. The additional aiming quantity of the MSW of the Ma'an Central CSC is approximately 8 t/d. The nightsoil is transported to the FDS. The operating equipment for the collection and transportation of the MSW owned by the CSC are 3 and they are 4 m^3 dump trucks procured in the first half of 1980'. The dump trucks of 10 m^3 able to transport a mass of the MSW effectively and able to drive on bad roads are to be procured for the collection and transportation, because the distances between areas and the FDS are far.

6) Karaq CSC

The population using the Lojoon FDS is approximately 170 thousand. The additional aiming quantity of the MSW of the Karaq CSC is approximately 10 t/d. The operating equipment for the collection and transportation of the MSW owned by the CSC are 5, they are 8 m^3 x 1, 6 m^3 x 2 and 4 m^3 x 2 of dump trucks and in addition there are 10-20 of handcarts. The compactor of 16 m^3 able to load the MSW from these handcarts and able to transport a mass of the MSW effectively is to be procured for the collection and transportation, because the distances between areas and the FDS are far.

7) Aqaba Municipality

The population using the Aqaba FDS is approximately 80 thousand. The additional aiming quantity of the MSW of the Aqaba Munucipality is approximately 14 t/d. The management of the MSW is executed by the Aqaba Municipality itself. The operating equipment for the collection and transportation of the MSW among 6 existing equipment owned by the CSC are 4 and they are 3 of 6 m^3 compactors and one of 6 m^3 dump truck procured in the 1980' and overaged. The dump trucks 4.5 t and 3.5 t able to drive easily through narrow roads with population of high density area are to be procured for the collection and transportation.

8) Ajlun CSC

The population using the Kufrinja FDS is approximately 125 thousand. The additional aiming quantity of the MSW of the Ajlun CSC is approximately 6 t/d. The operating equipment for the collection and transportation of the MSW among 2 existing equipment owned by the CSC is a 6 m^3 dump truck. The dump trucks of 5 t able to drive through narrow and bad roads to not only the old FDS but also the new FDS expected to be constructed in the greater distance and the harder location are to be procured for the collection and transportation, because the collection area is also located in the mountain area, and the distances between areas and the FDS are far.

9) Madaba CSC

The population using the Madaba FDS is approximately 157 thousand. The additional aiming quantity of the MSW of the Madaba CSC is approximately 53 t/d. The operating equipment for the collection and transportation of the MSW among 6 existing equipment owned by the CSC are 4 and they are 6 m^3 dump trucks. The compactors of 16 m^3 able to transport a mass of the MSW effectively are to be procured for the collection and transportation, because the population density of the collection area is high, the distances between areas and the FDS are far and the collection area is to be a modernized city as a part of capital area near the Greater Amman and the International Air Port.

10) North Gohr CSC

The population using the North Shuneh FDS is approximately 75 thousand. The collection service rate of the MSW is approximately 96%. The collection area of the CSC is located in the most western part of Jordan along the Jordan Valley, the width of it is 5 to 10 km in longitude and the length of it is 50 to 60 km in latitude. The FDS is located in the North Shuneh, the northern end of the collection area. The operating equipment for the collection and transportation of the MSW owned by the CSC are 2 and they are 4 m^3 dump trucks. The dump truck of 8 m^3 able to transport a mass of the MSW effectively is to be procured for the collection and transportation, because the roads are narrow and bad and the average distances between areas and the FDS are approximately 50 km.

2-3-2 Final Disposal Plan

(1) Selection of objective Final Disposal Sites for survey (Final Disposal Site hereinafter referred to as FDS)

A total of twenty-three (23) FDS's, sites of final waste disposal, is now in service in Jordan. Those have been selected after comprehensive discussions and evaluations of influences on such things as public health, ground-water and life of guard inhabitants by a committee composed of members from DOE of MMRAE and other institutions such as ministries of public health, agriculture and water resource. Table 2-3-2-1 shows the process flow for FDS selection.

Among those 23 FDS's selected after discussions and evaluations, 10 have been selected for the survey in our project.

The 10 FDS's;

① have serious environmental problems,

② are large in scale, and

③ are scattered in the southern, middle and northern areas of the country,

and cover the wastes generated by 1,870,000 residents out of the population of 4 million of Jordan (See Fig. 2-3-2-1.).

It would be worthy of consideration to establish a plan necessary for sanitary landfill together with required equipment with regard to those 10 FDS's.

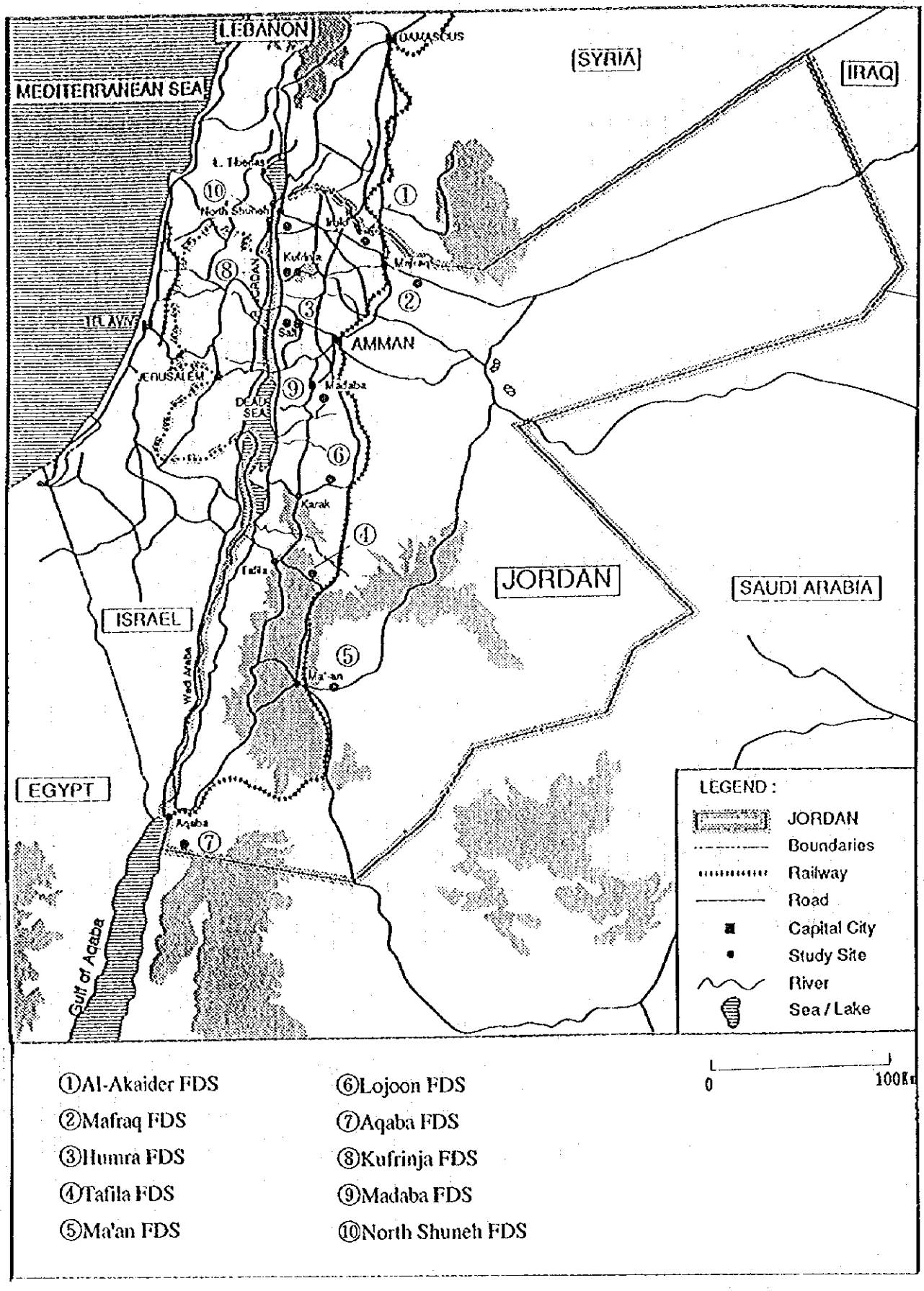


Fig. 2-3-2-1 Map of researched FDSs

Table 2-3-2-1 Process flow for FDS selection

Flow	Contents
START	
↓	
1. Application for New FDS by CSC	1. For DOE, CSC shows the necessity and the some proposed locations for the new FDS
↓	
2. Deliberations by DOE	2. Deliberations on the necessity of the new FDS's by DOE.
if no ↓ Yes	
↓	
3. Calling of related institutes	3. DOE calls related institutes as follows (1) Ministry of Water & Irrigation (2) Ministry of Health (3) Ministry of Agriculture (4) Natural Resource Authority (5) Ministry of Tourism (6) The CSC, applying for a new FDS cf.(4)and(5)institutions showed above are called by DOE as the need arised
↓	
4. Deliberations of a proposed FDS	4. The representatives of each institutes showed above have meetings to deliberate the most appropriate area for the FDS.
↓	
5. Observation on the proposed FDS	5. Each representative observes the proposed areas for the FDS and deliberate the properness of the areas individually.
↓	
6. Final decision of FDS	6. The decision is reported to the MMRAE.
if no ↓ Yes	
7. Land acquisition for the FDS's	7. After the final decision, DOE applies Land & Survey Dep't for the land acquisition through MMRAE.
if no ↓ Yes	
↓	
8. Setting of maintenance etc. of the FDS's	8. After acquisition, DOE sets up the system of maintenance, the efficiency of equipment, and the boundary of the FDS.
↓	
9. Appointment of FDS staff	9. CSC appoints FDS staff.
↓	
10. Ready for accepting wastes	10.FDS is ready for receiving wastes.
↓	
END	

2. Present state of objective FDS's

1) Al-Akaider FDS

Table 2-3-2-2 summarizes the present state of Al-Akaider FDS. The following sections describe the general, the state of landfill and the influences on environment.

(1) General

Al-Akaider FDS in Mafraq, managed by Irbid CSC, is located at a distance of 27 km west of Irbid City and at 1 km from the border to Syria (See Fig. 2-3-2-2). The geographical configuration there around is hilly with mild slopes, and there are no adjacent houses nor public facilities. The soil is sandy, and includes solidified limestones in some parts.

With an area of 606,000 m^2, this FDS has a scale so large as to requires about 15 years (1995-2010) to be completely landfilled. The facilities include control office, roads for carrying in and in-site traffics, guard fences together, and four sedimentation ponds for night-soil treatment. The top of pond water is used for plants.

The received wastes, amounting to a daily quantity of 600 t by 1995 record, include a small quantity of industrial wastes and hazardous wastes such as insect killers, oils and batteries besides general wastes. By this time survey, however, the amount of received wastes was 316 t/day, largely different from the amount in 1995. As for components of the wastes, food wastes occupy about 70%, papers 17%, and plastics and rubbers 5%. Al-Akaider FDS receives municipal solid wastes from other three cities in Mafraq.

Night-soil collected and transported by private companies is carried into this FDS, and amounts to 2,500-3,000 m^3/day.

(2) State of landfill

The sandwich method is adopted for landfill, and daily cover is being executed everyday by using landfilled and decomposed wastes as the cover soil. Moreover, leveling and compacting wastes are being carried out in order to use the FDS efficiently.

Wastes carried in by dump trucks are dumped at the dumping stages, spread and compacted with dumping rollers and/or other equipment. The compacted wastes

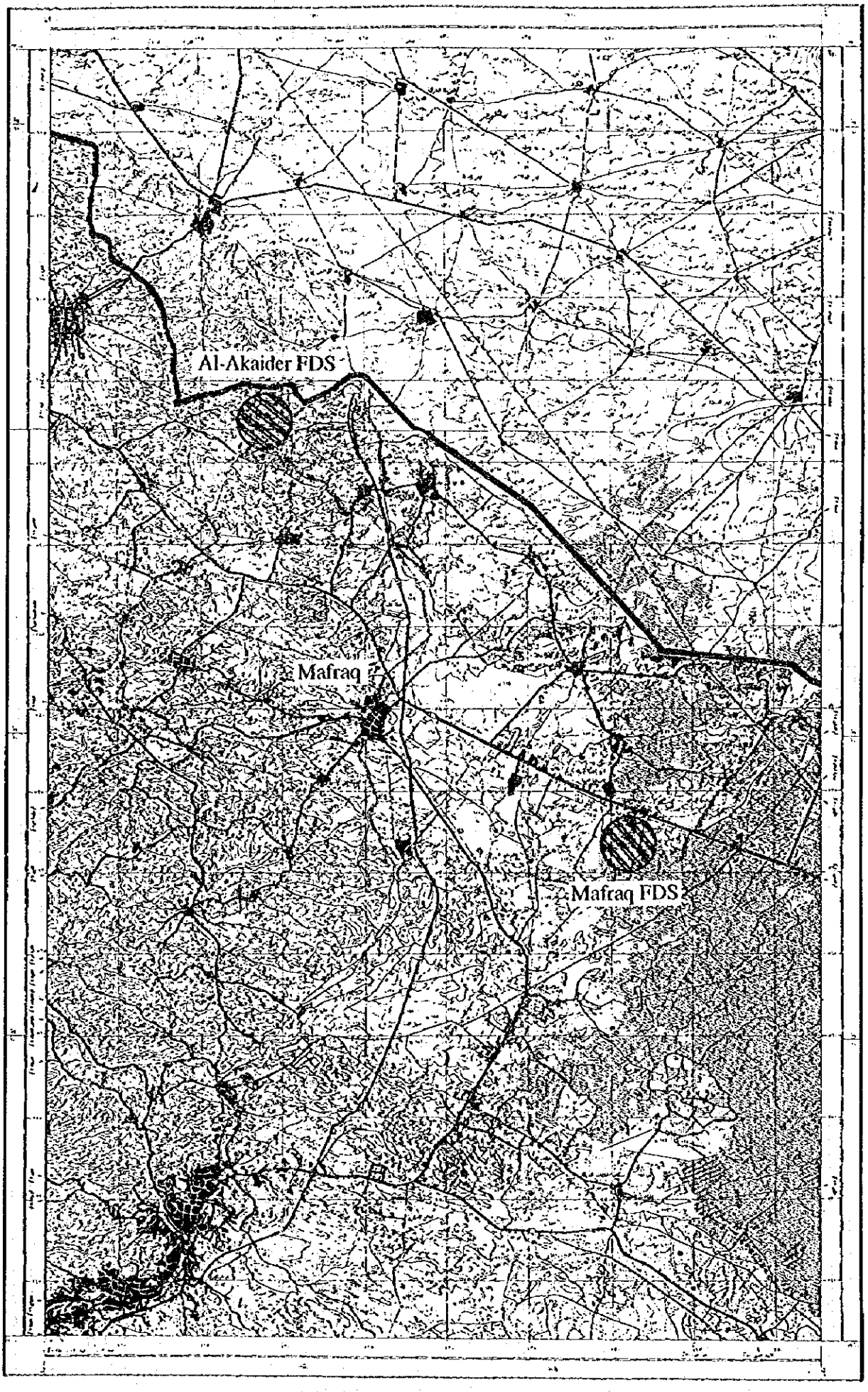


Fig. 2-3-2-2 Location of Al-Akaider FDS

are piled up by 1.0m. Landfilled and decomposed wastes are used as cover soil of a thickness of 20-30cm. Meanwhile, the soil used for top cover soil (t=70～100cm) would be collected from outside of Al-Akaider FDS.

(3) State of influences on environment

There are no houses nor public facilities in the vicinity of this FDS, and access roads are kept in repair.

Therefore, Al-Akaider FDS does not cause environmental problems, such as traffic jam, air pollution, and noise/vibration.

Al-Akaider FDS is estimated not to cause water pollution, because leachate is hardly generated under the environment, such as the small precipitation (479mm/yr) and active evaporation effect. Moreover, even if leachate was generated impermeable layer of 300m down from the surface of Al-Akaider FDS would prevent the leachate from spreading.

The present problem is that flies and harmful insects generated in this FDS influence nearby villages, and wastes fly out from this FDS.

Table 2-3-2-2 Present State of Al-Akaider FDS (1/4)

Item / Contents
1. Outlines of the final disposal site (1) Location: 27km west of Irbid City; 1km from the border to Syria; average distance from collection areas: 50km
(2) Geographical configuration: hilly or flat; no adjacent houses and public facilities
(3) Soil quality: sandy soil, including limestones partially
(4) Ground-water: impermeable layer down through to 300m from the surface
(5) Area: 606,000m²
(6) Volume capacity: ———
(7) Term of landfill: 1995-2010 (15 years)

Table 2-3-2-2 Present State of Al-Akaider FDS (2/4)

Item	Contents
(8) Types of received wastes:	
Municipal solid wastes, night-soil, industrial wastes, hazardous wastes (insect killers, waste oils, batteries)	
(9) Amount of wastes:	
600 t/day (1995), 316 t/day (result of this time survey)	
(10) Component of wastes (as of 1994):	
① papers	: 17.0%
② plastics and rubbers	: 5.0%
③ food wastes	: 70.0%
④ glasses and porcelains	: 2.35%
⑤ metals	: 2.0%
⑥ woods	: -%
⑦ fibers	: -%
⑧ others	: 3.65%
(11) Equipped facilities:	
* control office	
* access roads, in-site roads	
* guard fences	
2. State of landfill	
(1) Method of landfill:	
sanitary landfill by sandwich method	
(2) Plan of landfill sequence:	
Fundamental landfill plan is mostly carried out	
(3) Method of leveling and compacting:	
by dumping rollers or other equipment	
(4) Plan and actual state of soil cover	
Plan; ① thickness of waste layer	: 100cm
② thickness of daily cover soil	: 20-30cm
③ thickness of intermediate cover soil	: 30cm
④ thickness of final cover soil	: 70-100cm
⑤ procurement of cover soil	: from inside and occasionally from outside (1 - 2 km)

Table 2-3-2-2 Present State of Al-Akaider FDS (3/4)

Item / Judgment / Contents
Actual state: * Old wastes are used as cover soil * Daily cover is being done generally in accordance with the plan * Whereas being done on the day of our survey, daily cover seems not to be completely executed from the fact that light wastes such as garbage bags were seen scattered.
3. State of influences on the environment (1) Traffics and public facilities(school and :D hospital) * No increase of traffic jams and accidents nor adverse effect on adjacent facilities(2km apart from villages) because vehicles to this FDS restricted waste and night-soil trucks, are few
(2) State of sanitation and health :A * Flies and harmful insects are generated and damaging environment of nearby villages. In order to prevent the damage, chemicals are sprayed. (once every week in summer and once every month in winter) * Wastes are scattered.
(3) Ground-water :D * No contamination due to leachate or night-soil is detected in ground-water quality as a result of periodical tests held at a farm on upstream side of this FDS. * The ground-water level is at 300m down from the surface with an impermeable layer in between.
(4) State of lakes and rivers :D * No lakes and rivers around.
(5) Air pollution :D * No smoke pollution by occasional open-burn on the site. * No traffic jams nor exhaust gas pollution because vehicles, restricted to waste and night-soil trucks, are few.
(6) Water pollution :D * Leachate is hardly generated because of the small rain(479mm/yr) and active evaporation effect, therefore, water pollution caused by leachate has not been reported.

Table 2-3-2-2 Present State of Al-Akaider FDS (4/4)

Item / Judgment / Contents
(7) Soil pollution :C * There may be some possibility of soil pollution, because this FDS receives not only municipal solid wastes but also industrial solid wastes. However, the details of soil pollution is not known yet.
(8) Noise and vibration :D * There is no house around this FDS, therefore operating construction machine does not cause noise and vibration problem;
(9) Offensive odor :D * Little offensive odor from the landfill wastes, but some from the sedimentation ponds of the night-soil treating facilities. But, no offensive odor on the site border.
Other remarks * No access problems with the access roads paved, branching from the Main Roads. * Seven scavengers are working on a contract with CSC. (annual compensation: approx. 1,000 JD/head) * Four sedimentation ponds are installed for night-soil treatment (approx. 3,000 m^3/day). The top water used for plants. * Night-soil is collected and transported by private companies. * Sludge from the sedimentation ponds is dredged with dozer shovels (once every three years) and offered to nearby farms. * This FDS is located near the border to Syria, and complained by Syrian about environmental problems. * This FDS is located in Mafraq. * This FDS receives wastes from the three cities in Mafraq.
< Judgment classification > A: serious influence presumed B: some influence presumed C: unknown D: no influence

View of sprinkling cover soil with supernatant of treated night soil.

View of dumping, heading for Syria.

Sediment control pond for night soil.

Fig. 2-3-2-3 Views of Al-Akaider FDS

2) Mafraq FDS

Table 2-3-2-3 summarizes present state of this FDS.
The following sections describe the general, the state of landfill and the influences on environment.

(A) General

Mafraq FDS, managed by CSC of Mafraq, is in a flat desert terrain about 18 km southeast of Mafraq City and at a distance of about 1.5 km from Main Road No.10 (See Fig. 2-3-2-4). There are no houses nor public facilities (schools and hospitals) in the adjacent areas. The soil on the site is composed of sand down to 0.5-7 m from the surface and rock (basalt) thereunder.
This FDS has an area of 180,000 m^2 and a volume capacity of 400,000 m^3, and a landfill capacity of 60 years (1986-2046). Control office and access and in-site roads are provided.
This FDS receives only municipal solid wastes. The quantity of the wastes amounts to 70-80 t/day as per 1995 record. This time survey resulted in a hauling quantity of 82 t/day, approximately same as given in the hearing. Food waste occupy more than half, papers (24%) and plastics and rubbers (14%) following. Some illegal dumping by private companies and invasions of scavengers can be seen.

(B) State of landfill

Mafraq FDS executes open dumping method with implementing open burn and final cover soil executes. Meanwhile, the daily cover and the intermediate cover, both cited in the plan, are not executed. Therefore, this FDS is estimated to execute neither sanitary landfill nor efficient landfill.
Wastes are dumped into large hollows irregularly excavated, and burnt on the field. When a hollow is filled with burnt wastes, the final cover soil (t=1.0m) heaped near by is applied.

(C) State of influences on environment

There are no problems such as traffic jams due to dump trucks, degradation of public facilities (school and hospital), air pollution, noise and vibration, since there are no houses nor public facilities near this FDS.
Mafrag FDS is estimated not to cause water pollution, because leachate is

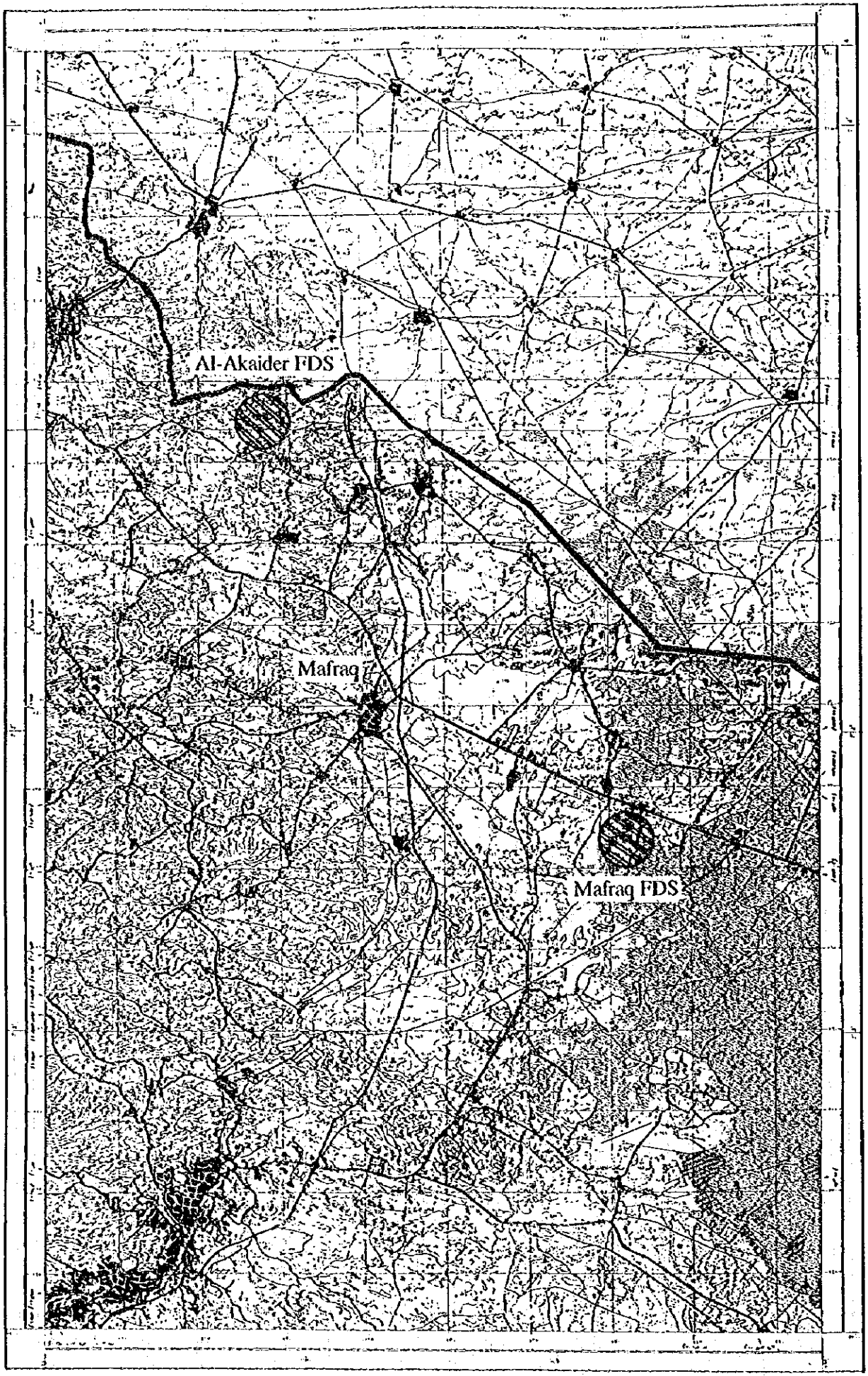


Fig. 2-3-2-4 Location of Mafraq FDS

hardly generated under the environment, such as the small precipitation (169mm/yr) and active evaporation effect. Moreover, impermeable base rock is lying under this FDS.

In order to take care of the sanitation issue, chemicals are periodically sprayed to control the generation of harmful insects. Therefore, harmful insects have never caused any problem. Meanwhile, open burn is considered a main factor causing air pollution.

Table 2-3-2-3 Present State of Mafraq FDS (1/4)

Item / Contents
1. Outlines of final disposal site (1) Location: approx. 18 km southeast of Mafraq City; av. distance from collection areas: 35 km
(2) Geographical configuration: flat desert with no houses nor public facilities nearby
(3) Soil quality: sandy soil of a thickness of 0.5-7 m on the surface, and basalt thereunder
(4) Ground-water: at a level 300-400 m down from the surface
(5) Area: 180,000 m^2
(6) Volume capacity: planned: 400,000 m^3, with a remaining capacity of 350,000 m^3
(7) Term of landfill: 1986-2046 (60 years)
(8) Types of received wastes: Municipal solid wastes, industrial wastes
(9) Amount of received wastes: 70-80 t/day (1995); 82 t/day (result of this time survey)

Table 2-3-2-3 Present State of Mafraq FDS (2/4)

Item / Contents
(10) Component of wastes (as of 1994): ① papers: 24% ② plastics and rubbers : 14% ③ kitchen garbage : 52% ④ glasses and porcelains : 3% ⑤ metals : 4% ⑥ woods : 2% ⑦ fibers : 1% ⑧ others : --%
(11) Equipped facilities: * control office * access roads, in-site roads
2. State of landfill (1) Method of landfill: Open dumping into large hollows excavated on the site and final soil cover are applied.
(2) Plan of landfill sequence: Dumping site is divided into Stage1 and Stage2 by a road.
(3) Method of leveling and compacting: Bulldozers or other equipment are used.
(4) Plan and actual state of soil cover Plan: ① thickness of waste layer : 30-50 cm ② thickness of daily cover soil : 20-30 cm ③ thickness of intermediate cover soil : 50 cm ④ thickness of final cover soil : 100 cm ⑤ procurement of cover soil : excavated soil of ditch
Actual state: * Ditches of a depth of 2-3 m and a width of 15 m are excavated, and excavation soil is heaped on the edge. When a ditch becomes full, the heaped soil is used as cover soil. * Shape of the ditch is irregular, and thickness of cover soil is insufficient at some areas.

Table 2-3-2-3 Present State of Mafraq FDS (3/4)

Item / Contents
Actual state: * Soil cover is not being executed in accordance with the plan. * Cover soil thickness is irregular relative to waste layer thickness.
Item / Judgment / Contents
3. State of influences on environment
(1) Traffics and public facilities :D * No increase of traffic jams and accidents nor impacts to nearby facilities, since there are only a few dump trucks.
(2) State of sanitation and health :D * Though flies and insects are generated, there is no environmental problem because of no nearby houses. * Wastes are flying.
(3) Ground-water :D * No problem because ground-water is located 300-400 m down from the surface and no contamination is detected by water quality analyses done near the site.
(4) State of lakes and rivers :D * No lakes nor rivers nearby.
(5) Air pollution :B * Smoke pollution could pose some problems due to open burns executed regularly. * Exhaust gas from a few number of dump trucks is estimated not to cause air pollution.
(6) Water pollution :D * Almost no impacts to the periphery because leachate is hardly generated under the environment at such as small precipitation (169mm/yr) and active evaporation effect.
(7) Soil pollution :D * No problems because no industrial wastes are received.
(8) Noise and vibration :D * No problems of noise and vibration because of no houses near by.

Table 2-3-2-3 Present State of Mafraq FDS (4/4)

Item / Judgment / Contents
(9) Offensive odor :D * Offensive odor is prevented from generating by open-burn and final cover soil. * No offensive odor issued from the landfill finished areas, since the final cover is applied.
Other remarks * Access to this FDS is effective, because the access roads and in-site roads are paved. * More than 10 scavengers, living on the site, recover resources. CSC burns wastes to prevent scavengers from picking valuables up. * Some wastes are illegally dumped by private companies and military. * The staff on this FDS desire to install guard fences to prevent scavengers' invasion and illegal dumping. * The staff are unwilling to bank wastes higher than the present level for the purpose of using this area as a park after closing this FDS. * Mafraq City has another FDS (a site of old quarry has been used for about ten years). However, the city is looking for a new FDS. Because the city plans to close this FDS in consideration of the volume of this FDS, environmental issue and the difficulty of procurement of cover soil.
< Judgment classification > A: serious influence presume B: some influence presume C: influence unknown D: no influence

View of open burning.

Black smoke caused by open burning.

Residual of burned wastes. Soil piled aside is used as cover soil.

Fig. 2-3-2-5 Views of Mafraq FDS

3) Humra FDS

Table 2-3-2-4 summarizes present state of this FDS.
The following sections describe the general, the state of landfill and the influences on environment.

(A) General

Managed by Balqa governorate CSC, Humra FDS is located about nine kilometers northwest of the city (see Fig. 2-3-2-6) on a steep slope of mountain sides. There are no houses nor public facilities near this FDS. Soil on the site is composed of clayey sandstones and the equivalents to sandy limestones.
This FDS is provided with an area of 275,000 m^2 for a landfill capacity of 30 years (1990-2019) together with facilities including control office, roads for carrying-in and in-site transportation, guard fences, and gates for vehicles. Slopes of the roads are so steep as to pose safety problems for dump trucks to pass.
The plan restricts wastes to accept only to municipal solid wastes, but some medical wastes were also seen when we visited. Quantity of receiving wastes in this FDS was 200 t/day as per 1995 report. This time, however, survey led to the result of 125 t/day, somewhat different from the amount in 1995. Visual inspection gave the result: food wastes of approx. 60%, papers of 20%, and plastics and rubbers of 10%. Leachate is generated and is stored in a simple pond(of 5 m width, 10 m length and 3 m depth approximately).

(B) State of landfill

Landfill adopts the open dumping method with irregular soil cover. This is hard to say sanitary landfill. Waste is dumped without any treatment such as leveling and compacting, therefore, landfill efficiency is low. After carrying in, wastes are dumped from the dumping stages and pushed in along the slope with wheel loaders or other equipment. Whereas occasional cover soil is applied for flat portions of the dumping stage, wastes dumped on the slope are not covered. For cover soil, soil made by excavation of rocky ground on the site is used. Landfill areas are divided into that for rainy season works and that for dry season works, since damping stages become muddy in the rainy season (from November to March).

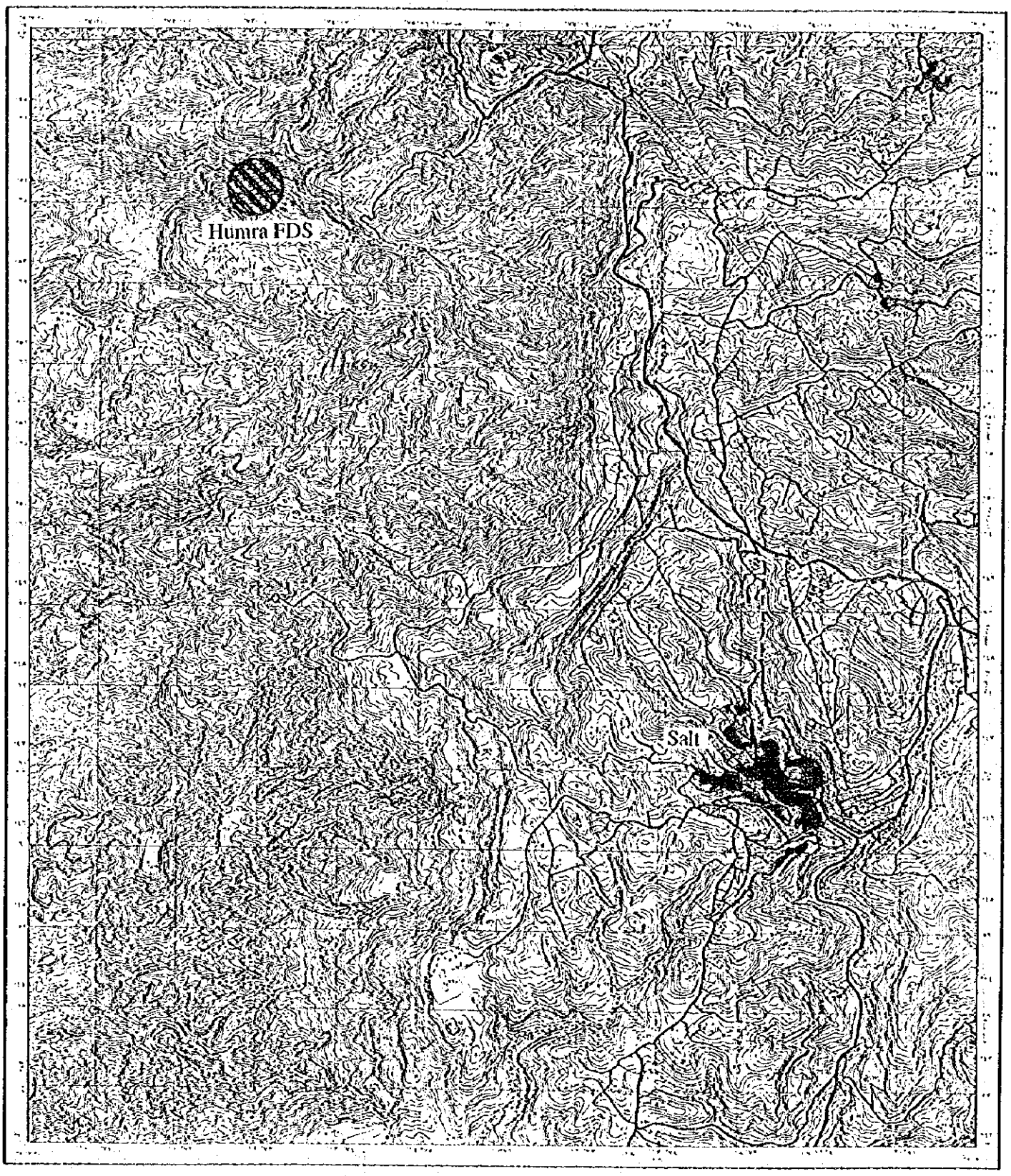


Fig. 2-3-2-6 Location of Humra FDS

(C) State of influences on environment.

There are no problems such as traffic jams due to the dump trucks, degradation of public facilities (school and hospital), air pollution, noise and vibration, since there are no houses nor public facilities near this FDS. Water pollution is considered no problem from the facts that annual precipitation is as small as 553 mm so that evaporation can well be expected, that almost no leachate is produced whereas small amount is currently stored in the pond, and the ground is rocky constituting an impermeable layer.

In the aspect of sanitation and health, no special problem exists because there are no houses nor public facilities whereas flies and harmful insects are generated.

Thus, the current environmental problems are treatment of the leachate stored in the simple pond and prevention of flying wastes and bad odor.

Table 2-3-2-4 Present State of Humra FDS (1/4)

Item / Contents
1. Outlines of the final disposal site (1) Location: approx. 9 km northwest of Salt City ave. distance from collection areas: 30 km
(2) Geographical configuration: on mountain slopes with no houses nor public facilities nearby
(3) Soil quality: clayey sandstones and sandy limestone-equivalents
(4) Ground-water: 200-300 m down from the surface
(5) Area: 275,000 m^2
(6) Volume capacity: -
(7) Term of landfill: 1990-2020(30 years)
(8) Types of received wastes: municipal solid wastes:
(9) Quantity of received wastes 200 t/day; or 125 t/day by our survey

Table 2-3-2-4 Present State of Humra FDS (2/4)

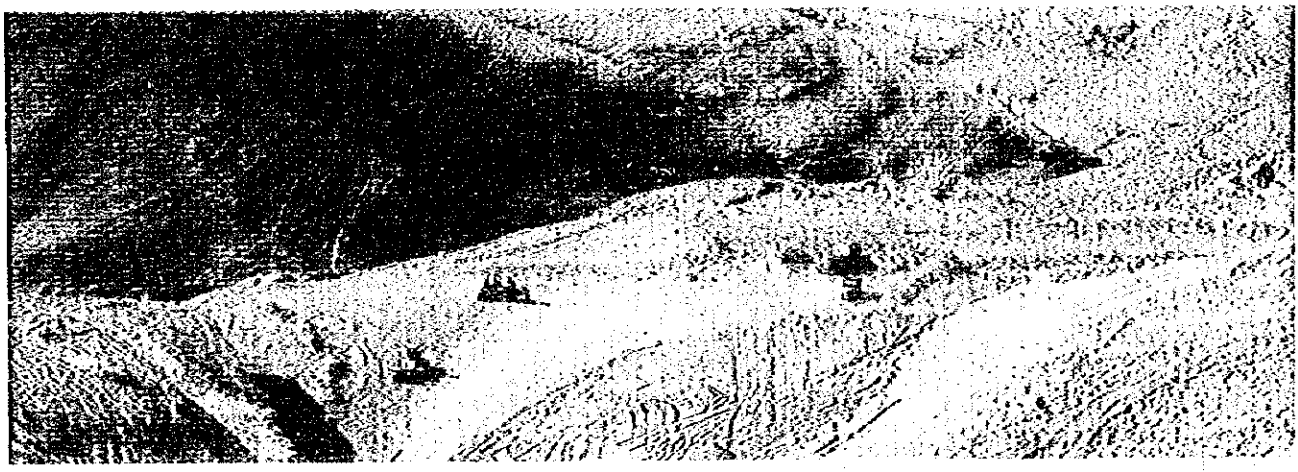
Item / Contents
(10) Component of wastes (by visual inspection): ① papers: 20% ② plastics and rubbers: 10% ③ kitchen garbage: 60% ④ glasses and porcelains: --% ⑤ metals: --% ⑥ woods: --% ⑦ fibers: --% ⑧ others: 10%
(11) Equiped facilities * control office: * access roads, in-site roads * guard fences * gates
2. State of landfill (1) Method of landfill: Open dumping method with irregular soil cover
(2) Plant of landfill sequence: From the bottom on the slope upwards to the top
(3) Method of leveling and compacting: Falling in with wheel loaders or other equipment
(4) Plan and actual state of soil cover Plan: ① thickness of waste layer: 100 cm ② thickness of daily cover: 30 cm ③ thickness of intermediate cover soil: 50 cm ④ thickness of final cover soil: 50 cm ⑤ procurement of cover soil: excavation soil in the site
Actual state: * Daily cover, though cited in the plan, is not executed. * Waste layer is thick. * Cover soil, obtained by cutting mountain ground, is short in quantity because the ground is solidified. * Leveling and compacting in flat portions of dumping stages is properly executed in general.

Table 2-3-2-4 Present State of Hmura FDS (3/4)

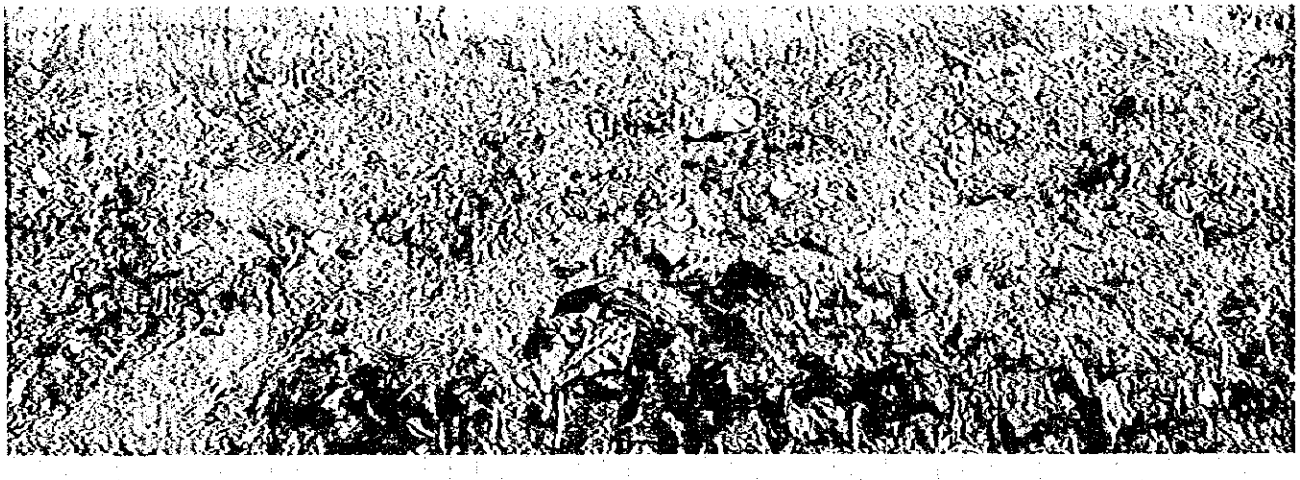
Item / Judgment / Contents
3 State of influences on environment
(1) Traffics and life facilities :D * No problem because of no houses in the periphery.
(2) State of sanitation and health :B * No problem because of no houses in the periphery whereas flies and harmful insects are generated. * Wastes are scattered.
(3) Ground-water :D * No problem because water level is at 200-300 m depth from the surface and the FDS ground is composed of clayey sandstones and sandy limestone-equivalents.
(4) State of lakes and rivers :C * Details are unknown, although little problem is suspected since almost no leachate comes out even in the adjacent valleys.
(5) Air pollution :D * No air contamination because no open burning is executed. * No effects from exhaust gas because of few dump trucks and no houses nearby.
(6) Water pollution :C * Details are unknown, although no problem is suspected considering evaporation effect and the FDS ground whereas small amount of leachate is stored in the FDS.
(7) Soil pollution :D * No problem judging from cover soil and the FDS ground whereas a few medical wastes were seen when we visited.
(8) Noise and vibration :D * No problem because of few dump trucks and no houses nearby. * No problem from dump trucks and other equipment operation.
(9) Offensive odor :B * Some offensive odor in the site since open dumping is executed and no daily cover is applied.

Table 2-3-2-4 Present State of Humra FDS (4/4)

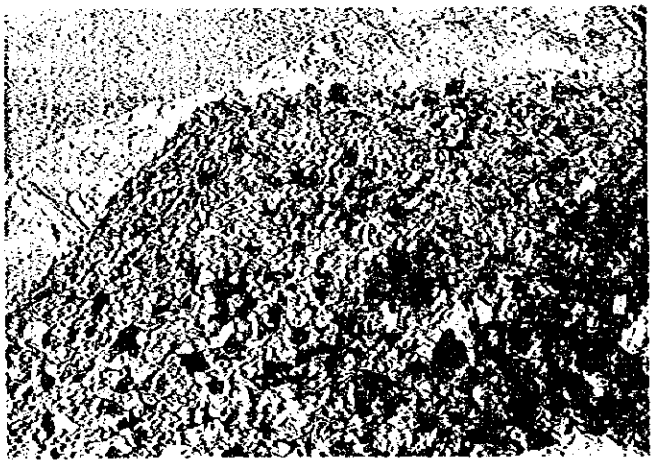
Item / Judgment / Contents
Other remarks * Good access with paved roads for carrying-in and transport in the site. * There are no scavengers. * Leachate generated and stored in a simple pond. (odor of ammonia; pH: more than 9.5; COD: more than 100 mg/lit.) * No water coming out in the valleys, and no farm water pumped in downstream. * Some vehicle accidents in the rainy season on in-site paved roads, frozen in that season. * Special dumping stages are necessary for rainy season (from November to March) because they become muddy. * Although there are basic design drawings for this FDS, current landfill works are not done in accordance with them.
< Judgment classification > A: serious influence presumed B: some influence presumed C: influence unknown D: no influence



Landfill utilizing slopes of mountains.



Wastes are exposed, because the thick of cover soil is not sufficient.



View of dropping waste.

View of leachate generated at a landfill.

Fig. 2-3-2-7 Views of Humra FDS