

- During the four months operation of collection experiment, the surplus of the experiment summed up to 540,520 kips. This proved that DCTC would be able to cover not only the O & M cost but also to replace the vehicle after 7 years.
- Proposed bell and curb collection system is feasible and shall result in effective collection works.

## 2) Strategy for expansion of collection area

Based on the collection experiment, the strategy for expansion of collection area is proposed as follows:

- a. The expansion of collection area shall be conducted in a stepwise manner and the experiences obtained in the experiment shall be fully utilized. According to the requests and needs which may arise, proposed collection system shall be revised based on past experiences.
- b. As shown in Fig. 11.1-2, the Study area is divided into the following areas and their collection service coverage ratios in 1995 are set up as follows;

- urbanized area                      90%
- semi-urbanized area                50%
- less-urbanized area                25%

The reason is described as follows;

- i. Since the greater part of the urbanized area is already covered by collection services and the area consists of rather high income households and shops, it is possible to increase the ratio up to 90% by 1995.

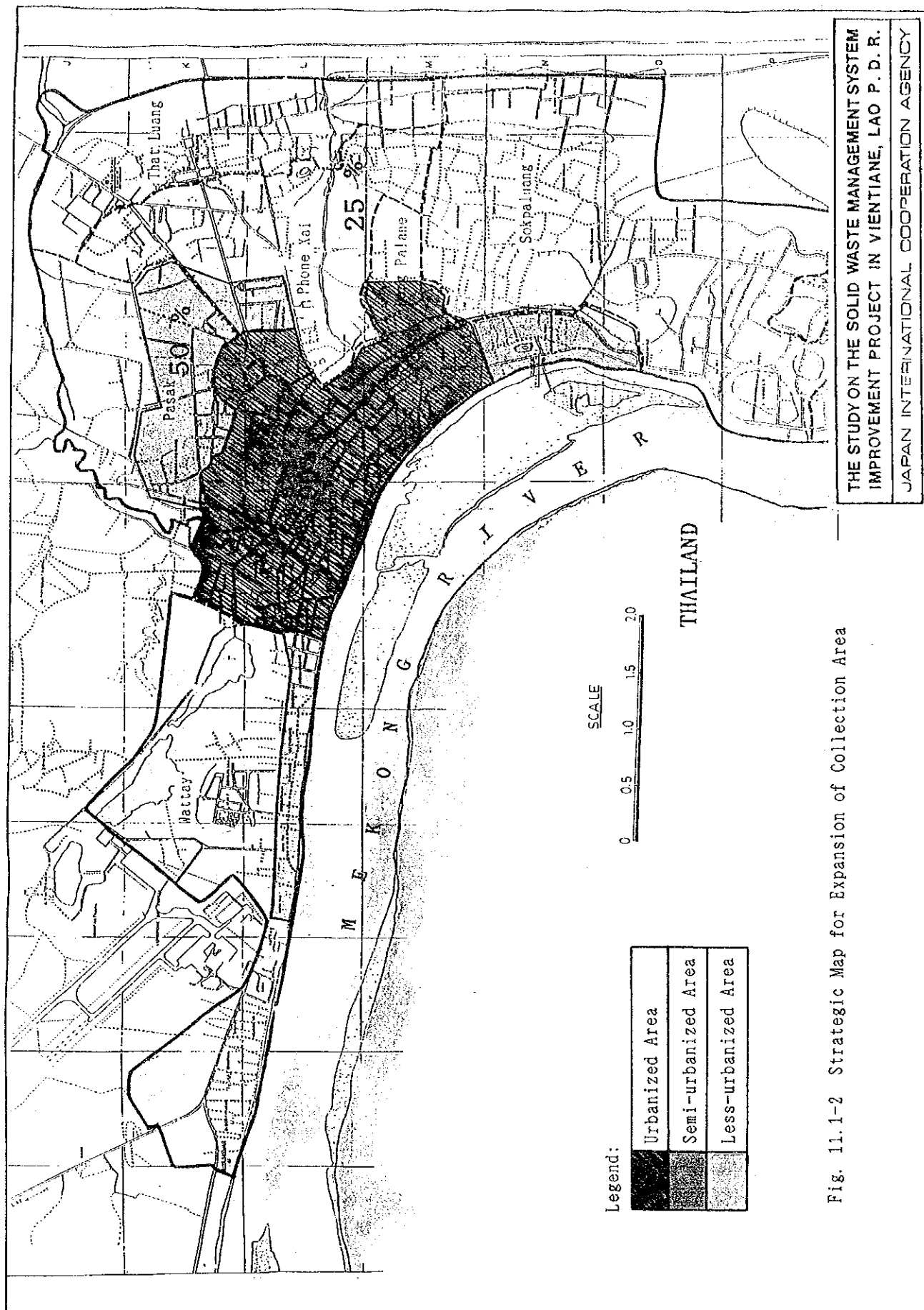


Fig. 11.1-2 Strategic Map for Expansion of Collection Area

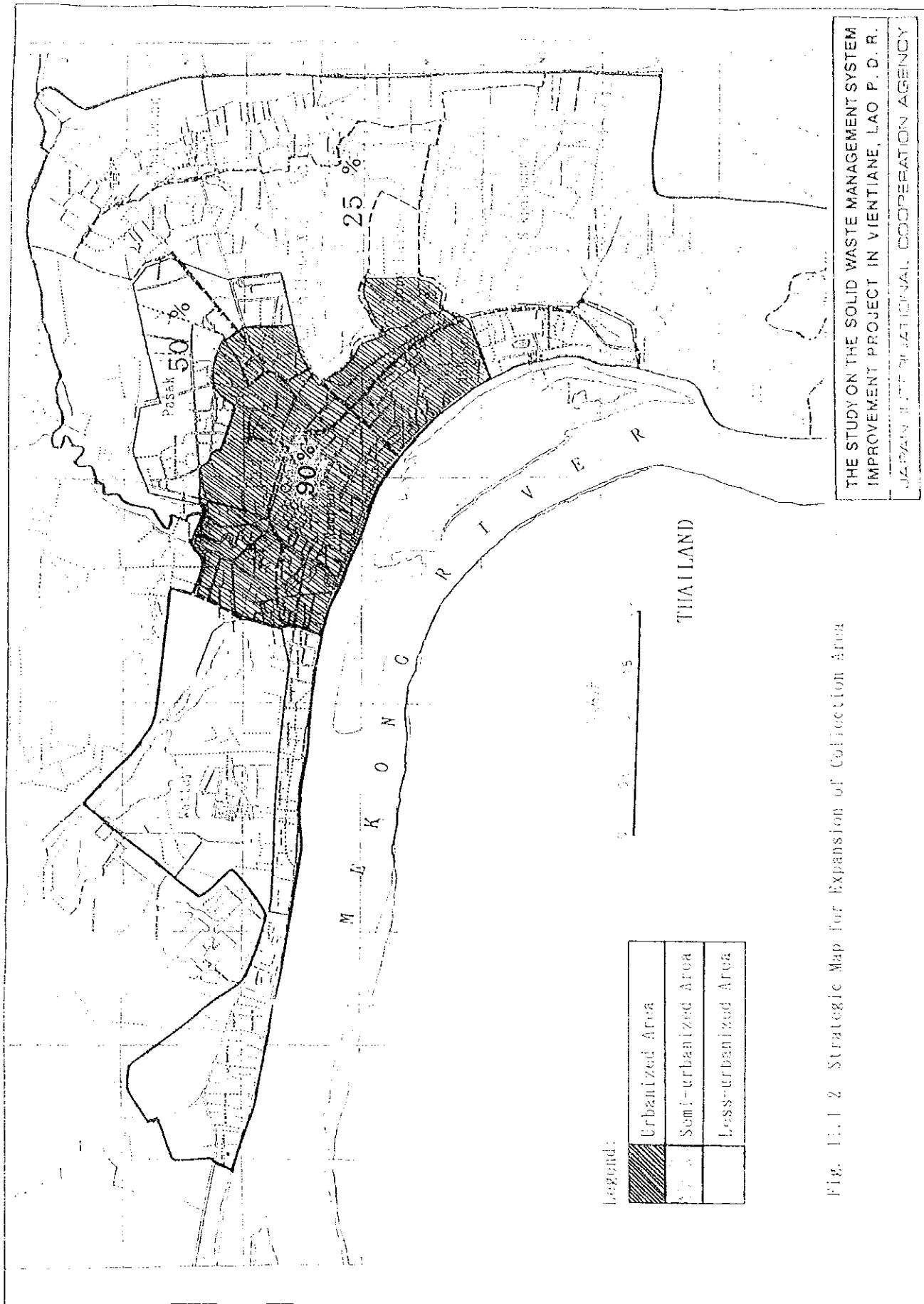


Fig. 11.1 2 Strategic Map for Expansion of Collection Area

- ii. The collection experimental areas are located in the semi-urbanized area. Although the present participation ratio in the experiment is 30%, it is possible to increase the ratio up to 50% by 1995 through the continuous efforts to be done of DCTC and the urbanization of the area.
- iii. By 1995, due to rapid urbanization, the less-urbanized area may become semi-urbanized. Collection services can be expanded then up to 25%.
- c. In case some difficulties concerning the application of the curb and bell collection system in an area arise due to limited passable roads, the introduction of handcarts for primary collection may be considered and the extra expenses from the introduction shall be shouldered by the beneficiaries.
- d. By the year 1995, the proposed collection fee system shall be maintained and collection service ratio will be increased from 4.8% upto 50%. This target could be achieved by the expansion method proposed above. It seems, however, very difficult to increase the ratio from 50% to 100% by 2000 due to the existence of poor households. It shall be, therefore, necessary to reduce the proposed collection fee making up the deficit by means of the cross-subsidy through the introduction of a new tax system for the Municipality or the increase in the present land tax.
- e. The introduction of a collection fee system in accordance with income level is not recommended by the Study Team according to the following reasons;
  - i. According to the UNDP M/P, the government employees share more than 60% in labour force in Vientiane Municipality and their income is less than 25,000 kips/month. The data of the World Bank on the income level in Vientiane shows the same figure.

ii. The actual income of average households including government employees, however, is more than 55,000 kips/month/household according to the results of the CCS. This is because the average household has several jobs in addition to an official one like livestock farming, retailing, etc..

iii. Consequently, if the collection fee is set in accordance with nominal income, the average collection fee should be much less than 1,000 kips/month/household.

iv. Furthermore, it seems to be very difficult to know the actual income level.

v. In addition, since the present fee collection system other than the one operated in the experiment has not functioned well, it is difficult to establish and operate a more complicated fee system than the present due to the lack of manpower both in terms of quantity and quality.

#### 11.1.3 Collection and Haulage

##### 1) Basic Policy for Design

The basic policy for the preliminary design of the collection and haulage system on the phase I project are as follows:

- a. To be acceptable to the residents.
- b. To be able to improve the environmental and sanitary conditions in the project area.
- c. To be secure and effective.
- d. To be harmonious with both the discharge and storage method and collection and haulage method.
- e. To select proper equipment according to system.
- f. To be able to extend a collection service with self-sustainable solid waste management.

2) Outline of the Discharge and Storage and Collection and Haulage System in 1995

Outline of amount of waste is shown as follows:

- Amount of Generated Wastes	: 160.8 ton/day
- Amount of Recycled Wastes	: 26.9 ton/day
- Amount of Self-disposed Wastes	: 61.7 ton/day
- Amount of Collected Wastes	: 68.3 ton/day
Domestic Wastes	: 49.5 ton/day(50% of all waste discharged from residences except self-disposed waste)
Commercial Wastes	: 9.2 ton/day(60% of all waste discharged from shops except self-disposed waste)
Institutional Wastes	: 7.1 ton/day(100%)
Road Sweeping Wastes	: 0.9 ton/day(100%)
- Amount of Disposed Wastes	: 72.3 ton/day

The discharge and storage system and collection and haulage system to be achieved by 1995 is shown in Table 11.1-2 and 11.1-3, respectively.

Table 11.1-2 Outline of Proposed Discharge and Storage System in 1995

Generation Source	Source Separation	Type of Refuse Bins	Storage & Discharge Points	Discharge Frequency
Residential Area	<p>Continuance of present system</p> <p>- Partly separate discharge (Food waste is separated as food for domestic animals.)</p>	<p>Continuance of present system</p> <p>- Bamboo basket</p>	<p>- Designated road sides or designated collection point</p>	<p>- Once a week</p>
Commercial Area	<p>Continuance of present system</p> <p>- Partly separate discharge (Food waste is separated as food for domestic animals.)</p>	<p>Continuance of present system</p> <p>- Bamboo basket</p>	<p>- Designated road sides or designated collection point</p>	<p>- Once a week (more than twice a week according to requests)</p>
Market	<p>Continuance of present system</p> <p>- Mixed discharge</p>	<p>- Communal container</p>	<p>- Placing a container in the premises</p>	<p>- Everyday</p>
Office	<p>Continuance of present system</p> <p>- Mixed discharge</p>	<p>- Communal container</p>	<p>- Placing a container in the premises</p>	<p>- Everyday</p>
Hospital	<p>- Separate discharge (Infectious waste should be segregated from other wastes.)</p>	<p>- Communal container</p>	<p>- Placing a container in the premises</p>	<p>- Everyday</p>

Table 11.1-3 Outline of Proposed Collection and Haulage System in 1995

Generation Source	Service Coverage(%)	Collection Frequency	Mixed or Separate Collection	Collection System	Collection Time	Collection Tools	Haulage Method	Transfer System
Residential Area	50 %	- Once a week	- Mixed collection	- Curb collection and bell collection	- Day time	-Not necessary	- Dump truck (10m3)	- Without transfer
Commercial Area	60 %	- Once a week (more than twice a week according to requests)	- Mixed collection	- Curb collection and bell collection	- Day time	-Not necessary	- Dump truck (10m3)	- Without transfer
Market	100 %	- According to the rotation	- Mixed collection	- Station collection	- Day time	-Not necessary	- Detachable container truck(5m3)	- Transfer from the station
Office	100 %	- According to the rotation	- Mixed collection	- Station collection	- Day time	-Not necessary	- Detachable container truck(5m3)	- Transfer from the station
Hospital	100 %	- According to the rotation	- Separate collection	- Station collection	- Day time	-Not necessary	- Detachable container truck(5m3)	- Transfer from the station



### 3) Required Number of Close Dump Trucks (CDT)

Required units of CDT in the target year for the feasibility study in 1995 are calculated according to the following items:

- strategy for expansion of collection area described;
- population covered by collection service;
- amount of collected waste; and
- specification and working condition of CDT.

#### a. Population and shops to be covered by the collection services in 1995

There are presently 44 Bans in the study area with a population density of more than 70 persons/ha. The population in these Bans totals 67,188, and is equivalent to 47% in Vientiane urban area. These figure is estimated to increase to 48 Bans, 89,033 persons and 55% in 1995. Moreover, the service coverage would be extended as shown below.

Table 11.1-4 Extension of Service Coverage

	1991	1995	2000
Domestic Waste			
Priority Area (more than 70persons/ha)	4.8%	70%	100%
Less Prioritized Area (not more than 70persons/ha)	4.8%	25%	100%
Commercial Waste			
Shop	22.3%	60%	100%

Note; Each service coverage ratio is supposed from the participant's ratio in the collection experiment.

Consequently, it is estimated that the population covered by the collection services will arrive to 81,500 persons and will be equivalent to 50% in 1995.

On the other hand, it is estimated that the number of shops to receive collection services will reach 1,720 according to the Basic Plan which stated that 60% of the shops in the study area will receive collection services in 1995.

b. Amount of collected waste

Total amount of domestic and commercial waste collected is estimated at 60.3 tons/day in 1995.

Amount of domestic and commercial wastes collected by private contractors is projected to be 10 tons/day in the future.

Average amount of waste collected daily is 13.9 ton in 1991. Of these wastes, those collected by private contractors and by the Municipality are 7.8 ton and 6.1 ton, respectively. Since a further increase in the amount of waste collected by private contractors is not considered, the amount will be set to 10 tons/day in 1995 in the Study.

Amount of domestic and commercial wastes collected by each sector is tabulated in Table 11.1-5.

Table 11.1-5 Amount of Domestic and Commercial Wastes to be  
Collected by Each Sector in 1995

(Unit: ton/day)

Items	Domestic Waste (Prioritized Area)	Commercial Waste	Domestic Waste (Less Prioritized Area)	Total
a. Total amount of domestic and commercial wastes collected	39.5	9.3	11.5	60.3
b. Amount of domestic and commercial wastes collected by Vientiane Municipality	38.8		11.5	50.3
c. Amount of domestic and commercial wastes collected by private contractors	10.0		0.0	10.0

c. Outline of dump truck specification and working condition

According to the regulation of Vientiane Municipality, wastes loaded in the collection vehicles should be covered in order to avoid scattering. Although the use of open dump trucks are popular in the Study area, a close dump truck is planned in accordance with the regulation. The specification for the close dump truck is summarized as follows:

- i. loading capacity :  $10\text{m}^3$
- ii. type of vehicle : closed type dump truck

Working condition of the vehicle are as follows:

- i. loading ratio : 85%
- ii. number of trips

Number of trips per day of the collection vehicles in prioritized and less prioritized areas are estimated to be 3 and 2 trips, respectively. Bases of calculation are tabulated in Table 11.1-6.

Table 11.1-6 Operation Plan for Collection Vehicle (CDT)

	Domestic Waste (Prioritized Area)	Domestic waste (Less Prioritized Area)
	Commercial Waste	
Working Time (hr.)	7	7
Round Trip Distance (km)	36	36
Speed (km/hr.)	40	40
Collection Time per Trip (hr.)	1	2
Unloading Time (hr.)	0.2	0.2
Opening Check Time for Vehicle(hr.)	0.3	0.3
Closing Check and Washing Time for Vehicle (hr.)	0.3	0.3

d. Calculation of required number of Close Dump Trucks (CDT)

Close dump trucks (CDT) will be used for the collection of domestic and commercial wastes. The number of vehicles required in 1995 is estimated to be 14 units.

Bases of calculation are shown in Table N.1-8 of Appendix N, the Supporting Report (3).

4) Required Number of Detachable Container Trucks (DCT)

DCT will be used as a collection vehicle for institutional, road sweeping and grass cutting wastes due to its improved loading efficiency.

In principle, institutional wastes will be collected by container system. It is, however, difficult to use the container system for all institutional wastes because of the following reasons:

- a. Collection fee payability;
- b. Space for containers; and
- c. Amount of waste discharged from each institution.

Therefore, 70% of all institutional wastes, will be collected by container system, and the remaining 30% will be collected by the close dump truck.

Required units of DCT and Container in the target year for the feasibility study in 1995 are calculated according to the following items:

- survey on large waste producers :
- amount of waste discharged by each producer; and
- specification and working condition of DCT and container.

a. Survey on large waste producers

Large waste producers who should set up containers are selected according to the following conditions:

- large waste producers who can pay the collection fee;
- large waste producers whose waste discharge manners should be improved rapidly; and
- large waste producers with enough spaces for containers.

The survey was executed by the Study Team and DCTC, according to the list shown by DCTC, and consequently, a total of 20 institutions were selected. The list of the candidate large waste producers who should have containers is in Table N.1-9 of Appendix N, and their location is shown in Fig. 11.1-3.

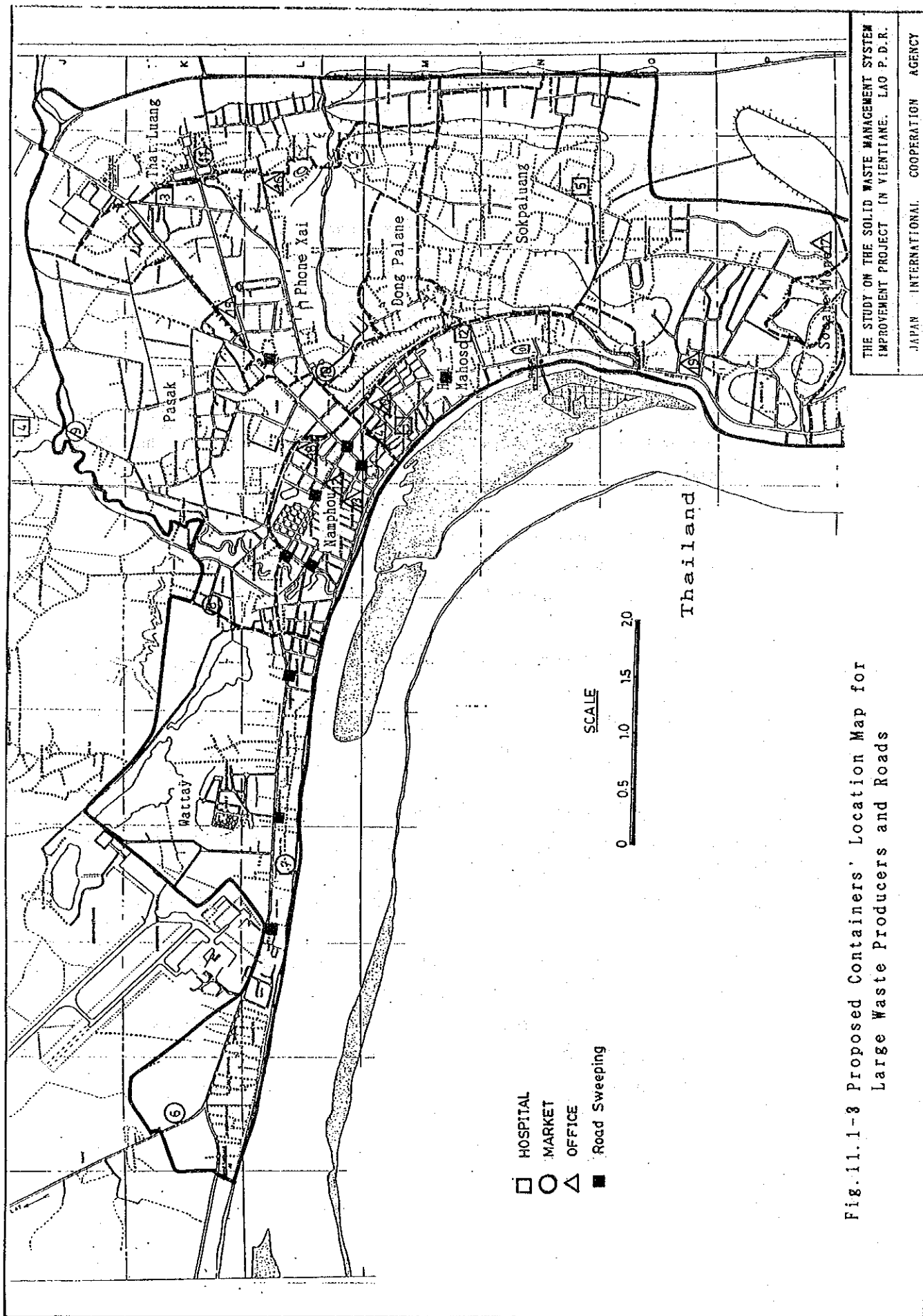


Fig.11.1-3 Proposed Containers' Location Map for Large Waste Producers and Roads

All of the general hospitals in the project area are selected as large waste producers whose method of discharging infectious waste and loading efficiency should be improved. In principle, two containers will be put in the hospital premises, one for infectious waste and another for non-infectious waste.

Six markets and nine offices were considered as large waste producers. The loading efficiency of these institutions in need of improvement.

b. Amount of waste discharged by each producer

Amount and volume of waste discharged from each institution and collected from road sweeping activities are calculated according to the amount of discharged waste discharge ratio and ASG (Apparent Specific Gravity) observed at the WACS.

c. Specification and working conditions of DCT and Container

The specification and working conditions of DCT and containers are shown as follows:

- capacity of container :  $5m^3$
- average collection frequency

Amount of waste discharged from markets, hospitals and those collected from road sweeping activities differ from each other. Although it takes a number of days to fill the container with waste, the average frequency of transportation is assumed as twice a week.

- number of trips

Number of trips per day of the detachable container truck is calculated based on Table 11.1-7. Consequently, the number of trips is 5.



Table 11.1-7 Operation Plan for Collection Vehicle (DCT)

Working Time (hr.)	7
Round-Trip Distance (km)	36
Speed(km/hr.)	40
Loading Time(hr.)	0.15
Unloading Time(hr.)	0.15
Opening Check Time for Vehicle(hr.)	0.3
Closing Check Time and Washing Time for Vehicle (hr.)	0.3

d. Required number of containers and DCT

i. required number of containers

The volume of waste discharged from each institution shall be less than  $5\text{m}^3$  per day in 1995. Since That Luang market exceeds  $5\text{m}^3$ , i.e.  $6.8\text{m}^3$ , 2 containers shall be set there. Because of the segregation of infectious and non-infectious wastes of hospitals, two containers shall be set there. Therefore, a total of 40 containers, including spares, are required. The number of containers required and the collection frequency are shown in Table 11.1-8.

ii. required number of DCT

Number of detachable container trucks(DCT) required is 3 units, including a spare vehicle.

5) Motorcycle

A motorcycle is required for fee collection. One collector will be able to cover around 3 bans, and 18 collectors will cover the areas covered by the collection services in 1995. Therefore, a total of 18 motorcycles are required.

Table 11.1-8 Number of Containers Required

Classification	Number of Containers	Remarks
1. Market		
Sikhai	1	
Wongdouang	1	
Kok Pho	1	
Phone Thong	1	
Nong Chanh	1	
That Luang	2	
Sub-Total	7	
2. Hospital		
Mahost	2	One for infectious waste and another for non-infectious waste
Police	2	
103 Hospital	2	
Setthathirat	2	
Lao-Soviet	2	
Sub-Total	10	
3. Office	9	
4. Road Sweeping, Grass Cutting	11	
5. Spare Containers	3	One for each vehicle
Total	40	

#### 11.1. 4 Road Sweeping, Drain cleaning and Grass Cutting

##### 1) Basic Policy

Road sweeping, drain cleaning and grass cutting systems are presently not well established in the project area because of poor equipment and weak organization of cleaning activities. Accordingly, the basic policy for the preliminary design of these system regarding the phase I project has been considered as follows:

- a. To be able to improve the environmental and sanitary conditions in the project area;
- b. To select proper equipment according to system;
- c. To be secure and effective;
- d. To establish an organization to manage the system; and
- e. To establish cleansing activity through public cooperation.

##### 2) Outline of the Road Sweeping, Drain Cleansing and Grass Cutting Systems in 1995

The outline of the road sweeping, drain cleansing and grass cutting systems to be achieved by 1995 is shown in Table 11.1-9.

Table 11.1-9 Outline of Proposed Road Sweeping, Drain Cleansing and Grass Cutting System in 1995

Type of Cleansing Service	Cleansing System	Cleansing Area and Length	Cleansing Equipment	Cleansing Frequency
Road Sweeping	<ul style="list-style-type: none"> <li>• Manual sweeping by labourers</li> <li>• Station collection system using containers(5m3)</li> <li>• Haulage method by detachable container trucks</li> </ul>	Present road covered by the sweeping services (15km*)	Detachable container truck and container	Everyday except on sundays and holidays
Sprinkling Road	<ul style="list-style-type: none"> <li>• Mechanical sprinkling roads with water</li> </ul>	150 km (65% of roads in VM)	Water trucks	Once a week
Drain Cleansing	<ul style="list-style-type: none"> <li>• Manual cleaning by labourers *</li> <li>• Loading method by wheel loader</li> <li>• Haulage method by small dump trucks</li> </ul>	Drains of roads covered by the sweeping services (15km*)	Small dump trucks & a wheel loader	Once every six months
Grass Cutting	<ul style="list-style-type: none"> <li>• Grass cutting by cutting machines</li> <li>• Station collection system using container(5m3)</li> <li>• Haulage method by detachable container trucks</li> </ul>	Side of road covered by the sweeping services (15km*)	Grass cutters	Every two months
Cleansing Activity through Public Cooperation	<ul style="list-style-type: none"> <li>• Cleaning by residents and collection and haulage by the Municipality</li> </ul>	50% of Vientiane urban area	Small dump truck & wheel loader	Once every two months

Note: \* The road length which receives sweeping services.

3) Required Number of Detachable Container Trucks (DCT)

DCT will be used as the collection vehicle for road sweeping and grass cutting wastes as well as the collection of institutional wastes. The number of DCTs and containers required for road sweeping and grass cutting wastes are 1 unit and 9 units, respectively.

4) Required Number of Small Dump Trucks (SDT)

SDT will be used as the collection vehicle for wastes cleaned up at the drains of roads covered by the sweeping services and cleaned through public cooperation. Required units of SDT in the target year for the feasibility study in 1995 are at 3 units as shown below.

a. For cleaning of the drains of roads covered by the sweeping services : 2 units

b. For cleansing activity through public cooperation : 1 unit

Number of Bans where cleansing activity will be established : 48  
Bans in 1995 as well as collection service.

Frequency of cleansing activity shall be once every two months.

5) Grass Cutter

Grass cutters instead of manual grass cutting will be used to improve cleansing efficiency. DCTC is responsible for collection of grass cutting wastes generated at the roads with the sweeping services (15 km). The length of the roads to be cleaned is around 1.5 km/worker, therefore, 10 grass cutters are required.

6) Water Truck

Water trucks will be used to prevent the generation of clouds of dusts. 2 water trucks are required according to the following conditions:

- Total length of road in the study area : 230 km
- The length of road to be sprinkled in 1995 : 150 km (65%)
- The length of road covered by one truck : 12 km/day
- Frequency of sprinkling activity : once a week

The water trucks will also be used at the KM 18-DS upon request.

#### 7) Others

A wheel loader will be required to clean up waste after cleansing of drain and cleansing activity through public cooperation. In principle, a wheel loader will be used along with small dump trucks.

A pick up will be required for the supervision of the workers and for emergencies.

The conceptual drawings for each equipment are prepared, as shown in Fig. N.2-3, N.2-4 and N.2-5, the Supporting Report (3).

#### 11.1.5 Final Disposal

##### 1) Planning Conditions

###### (1) Basic Principles

The basic principles for the execution of the preliminary designs regarding Phase I of the project have been conceived of and are arranged as follows :

- a. An adequate landfill volume should be secured within the area selected as the final disposal site.
- b. The design shall be compatible with the topography, geology and other environmental features of the surrounding area.
- c. The wastes disposed of at the site should be stabilized quickly.
- d. During and after completion of the filling, the area shall be sanitarily maintained so as not to become a pollution source.
- e. Safety should be guaranteed during and after completion of the filling.
- f. The completed site should be harmonious with the surrounding environment.
- g. The operation and maintenance expenses should be curtailed throughout and after completion of the filling.

## 2) Designed Landfill Volume

### a. Condition for estimation

- i. landfill periods : 1995-1997 (Phase I)  
1998-2000 (Phase II)
- ii. unit weight of wastes disposed :  $0.7 \text{ ton/m}^3$   
(after compaction)
- iii. Covering materials : 35% of the waste volume

### b. Designed landfill volume

The designed landfill volume for the KM 18 disposal site within Phase I and II is tabulated in Table 11.1-10.



Table 11.1-10 Designed Landfill Volume

Item	Unit	Phase I	Phase II	Remarks
Disposal Amount	t/day	101.7	152.9	Phase I in 1997 Phase II in 2000
Cumulative Disposal Amount	1000 t	95.1	148.0	
Cumulative Disposal Volume	1000 m <sup>3</sup>	135.9	211.4	0.7 ton/m <sup>3</sup>
Cumulative Cover Soil Volume	1000 m <sup>3</sup>	47.6	74.0	35% of the above volume
Designed Landfill Volume	1000 m <sup>3</sup>	183.5	285.4	

### (3) Topography and Geology

#### a. Topography

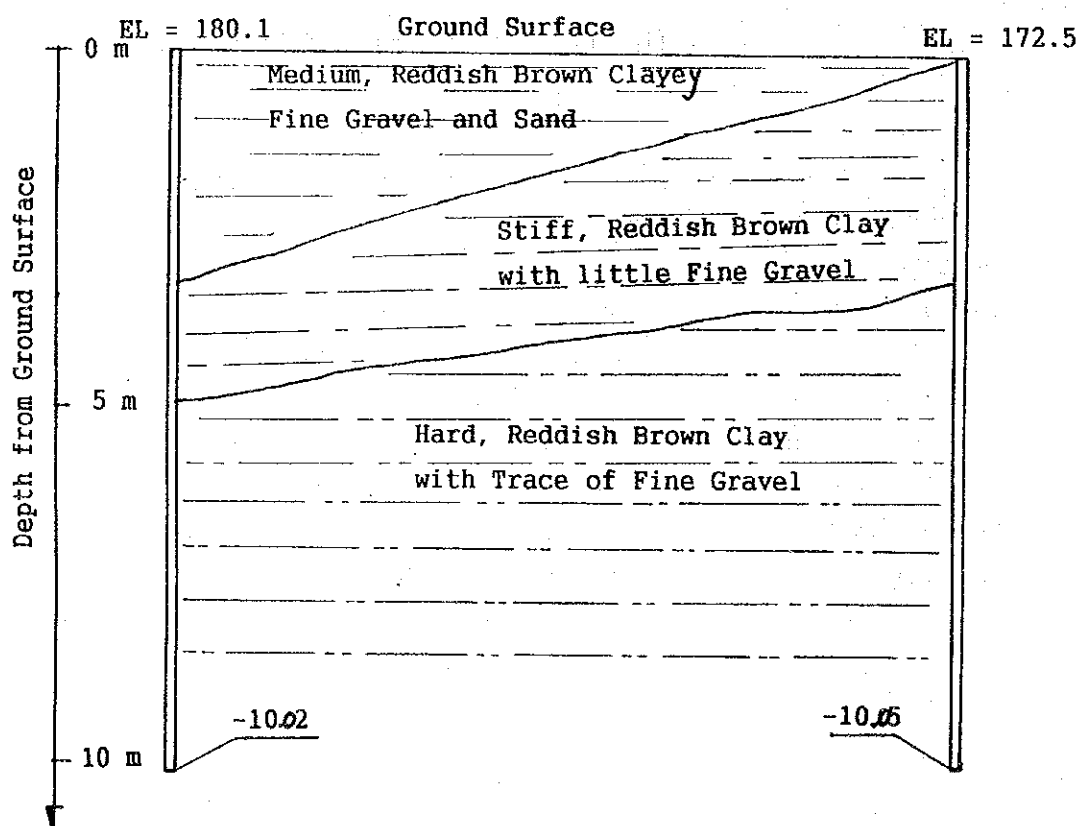
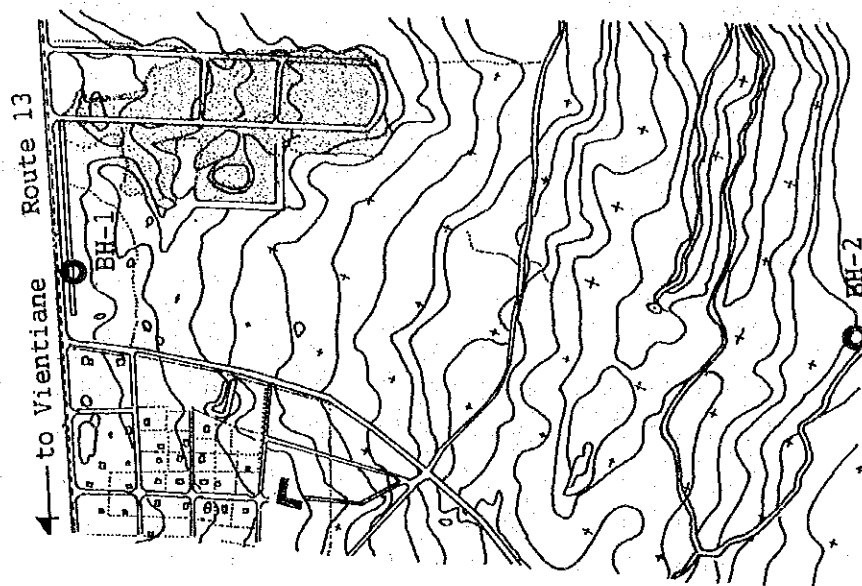
The elevation of the area is between 172 m and 180 m. Generally, the site is flat and covered with bushes and trees. Cultivated lands are partly distributed in the area.

#### b. Geology

The geology is accumulated layers of principally stiff to hard clayey soil where little fine gravel and sand are observed. The sub-soil investigation was done by boring and the following is the derived profile. A geological profile of the KM 18-DS is illustrated in Fig. 11.1-4.

Table 11.1-11 Characteristics of Clayey Soil

Items	Unit	PADS
Natural Moisture Content	%	20 - 28
Bulk Density	ton/m <sup>3</sup>	1.65 - 1.70
Specific gravity	g/cm <sup>3</sup>	2.69 - 2.74
Atterberg limit		
- Plastic limit	%	51 - 70
- Liquid limit	%	20 - 29
Permeability Coefficient	cm/sec	$2.52 \times 10^{-5}$ - $5.86 \times 10^{-6}$



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Fig. 11.1-4 Geological Profile of KM 18-DS

## 2) Facility Design

### (1) Facility Lay-out

#### a. Design principles

The design principles for the facility lay-out are as follows:

- i. The design is to consider the disposal and clean-up of the waste disposed by the end of 1994.
- ii. The design shall smoothen the execution and transitions of the work from Phase I through to Phase II.
- iii. Each facility is to cast no adverse impacts on surrounding land use conditions.
- iv. The on-site roads and/or landfill operation flow must be harmonious and uncomplicated.
- v. The administration facilities are to be erected near the entrance to the disposal site for full inspection of the waste collection vehicles.

#### b. Types of facilities

##### i. main facilities

- enclosing structure
- drainage system
- access

##### ii. environmental protection facilities

- buffer zone
- gas removal facilities
- monitoring facilities (use of existing wells)

### iii. building and accessories

- site office (use of the existing building)
- weighbridge (use of the existing one)
- safety facilities...gates/fences (use of the existings)
- fire prevention facilities...water truck; and
- others...parking lots/greeneries.

### c. Lay-out design

The lay-out of the main facilities is done and shown in Fig. 11.1-5.

## (2) Clearing and Site Preparation

As described in the design principles, Phase I site development shall consider the disposal and clean-up of the waste disposed at the site by the end of 1994. The following works, therefore, shall be done for clearing and site preparation.

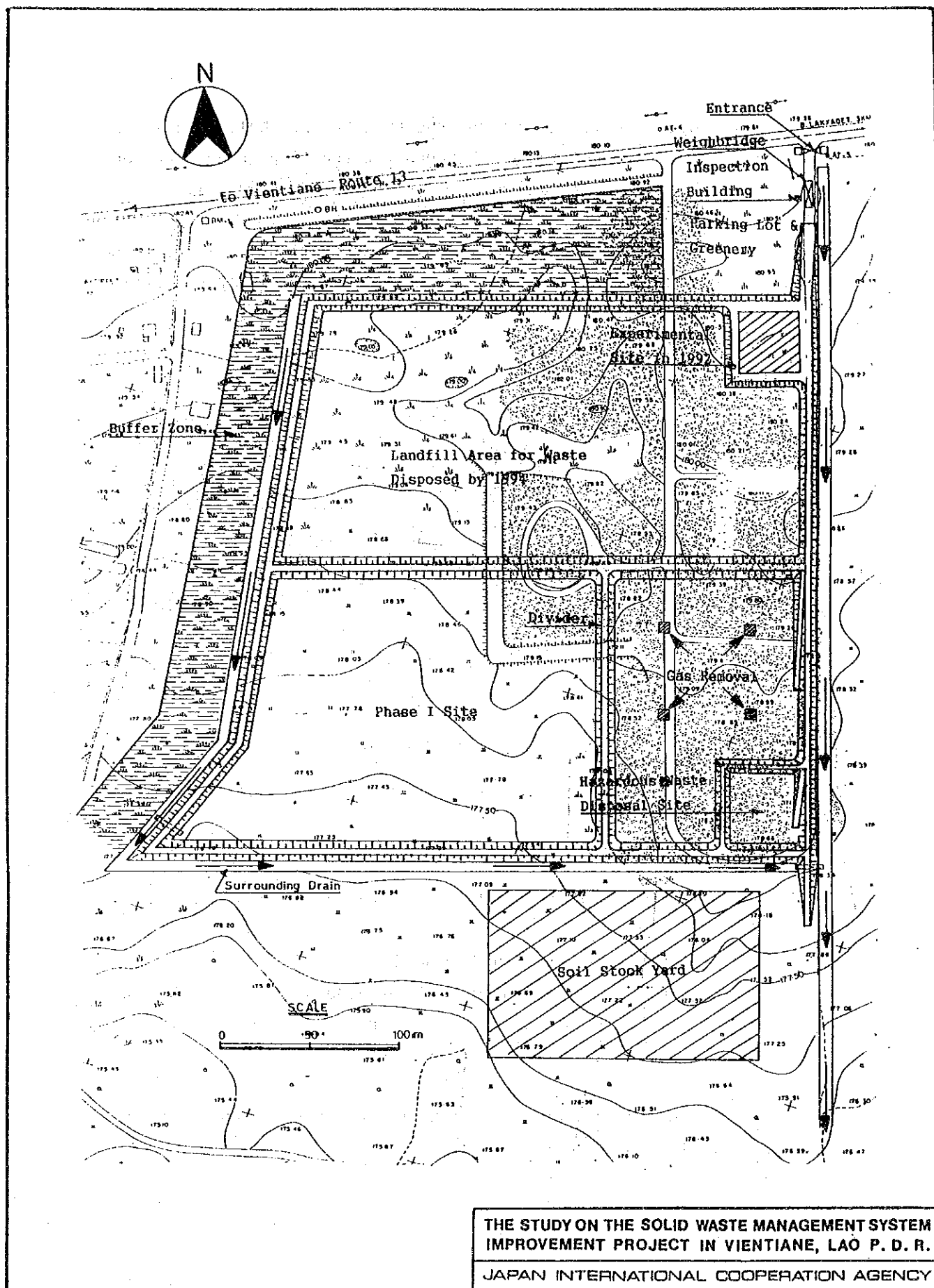
- clearing plants;
- cleaning-up waste disposed;
- soil excavation;
- soil cover for landfill area by 1994; and
- soil stock.

## (3) Main Facilities

### a. enclosing structures

#### i. enclosing bund

Because the disposal site is located on flat land in order to carry out sanitary landfill, a bund shall be constructed to enclose the landfill area to prevent rain water invasion and to guarantee the designed landfill volume.



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Fig. 11.1-5 Layout of Main Facilities

The landfill height and the bund height shall be 4 m and 2 m, respectively. The bund top functioning as the on-site roads is a 4 m in width and paved in gravel.

As for the bund, a typical cross section is planned and shown in Fig. 11.1-6, based on the soil investigation data.

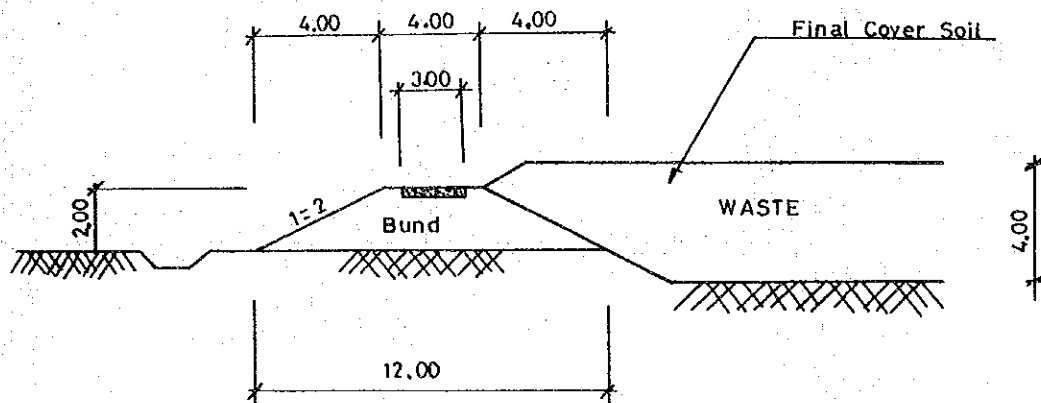


Fig. 11.1-6 Typical Cross Section of Enclosing Bund

## ii. divider

The divider inside the enclosing bund is established:

- for efficient landfill work
- for the separation of hazardous waste such as infectious hospital waste; and
- for leachate control measures.

The typical cross section of a divider is shown in Fig. 11.1-7.

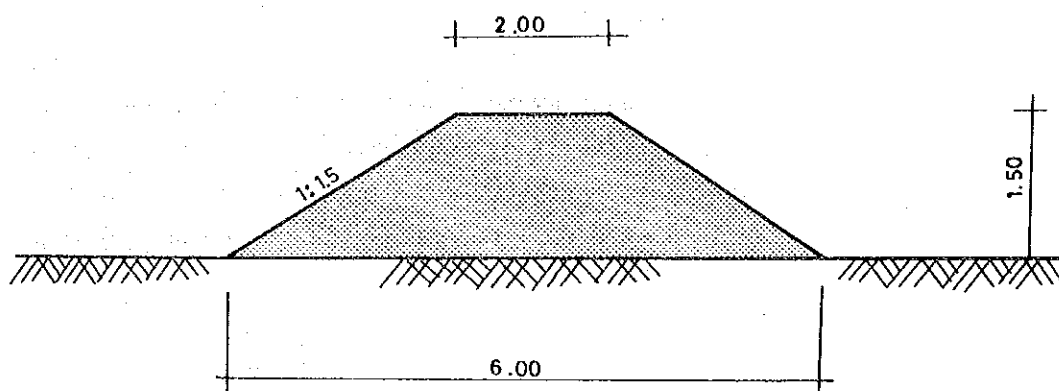


Fig. 11.1-7 Typical Cross Section of Divider Drainage System

b. Drainage systems

i. principal purposes

The principal purposes for the systems are as follows:

- surrounding drain : Elimination of rainwater inflow from outside of the landfill site.
- on-site drain : Elimination of rainwater from the non-landfill site partitioned-off by the divider within the enclosing bund.
- drain for reclaimed area : Elimination of rainwater inflow after the completion of the landfill operations.



## ii. design conditions

The drainage system is designed in accordance with the "Feasibility Study on Improvement of Drainage System in Vientiane, March 1990 by JICA". Design discharge of each drain system will be calculated by the unit discharge per ha, as shown in Table 11.1-12.

Table 11.1-12 Design Discharge

Drain Systems	Return Period (year)	Unit Discharge (m <sup>3</sup> /sec/ha)	Remarks
Surrounding Drain	2 to 5 years	0.063-0.098	Rainfall duration is one hour
On-site Drain	0.5	0.067	Rainfall duration is 30 min.
Drain for Reclaimed Area	2	0.100	- ditto -

## iii. design of drainage systems

The following drains are planned and a drainage system is illustrated in Fig. 11.1-8.

- surrounding drains

- on-site drains

- . unlined drains

- . pipe culvert (see Fig. N.1-12)

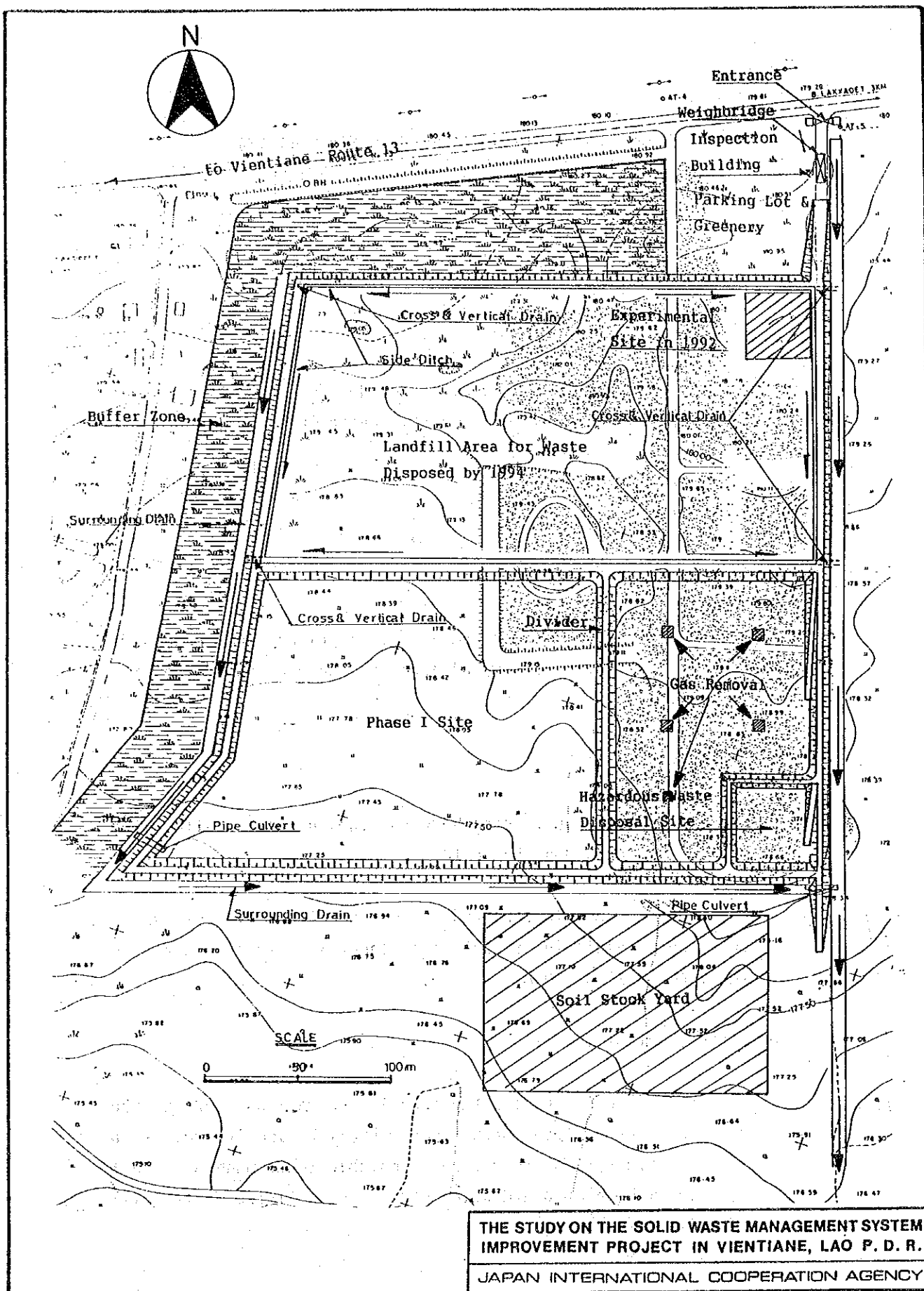


Fig. 11.1-8 Proposed Drainage System at KM 18-DS

- drains for reclaimed area (see Fig. N.1-13)

- . side ditches
- . cross drains
- . vertical drains

#### c. Access

For access, the following roads are designed and the typical cross-section of each road is illustrated in Fig. 11.1-9.

- approach road; and
- on-site road.

#### (4) Environmental Protection Facilities

These facilities are for the prevention of primary and secondary outbreak of pollution during and after the completion of landfill operations.

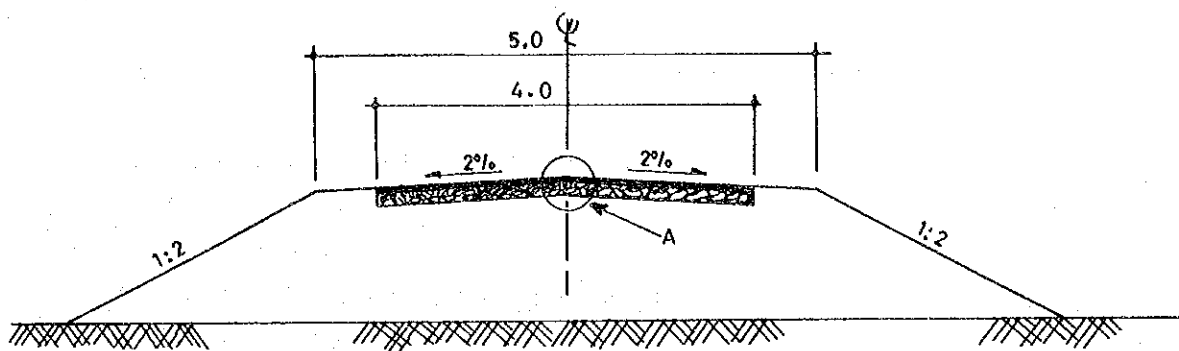
##### a. buffer zone

This will be constructed between the disposal site, the residential area, and Route 13.

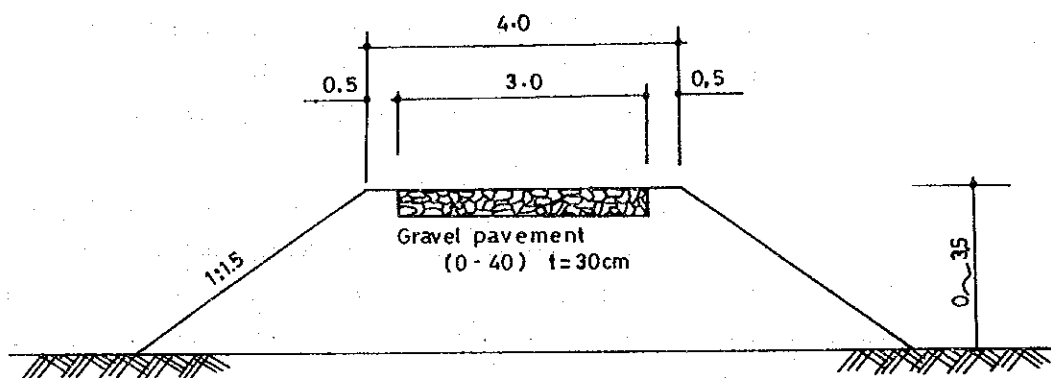
The buffer zone is expected to occupy quite a bit of space that would result in reduction of landfill volume. Therefore the zone shall be 50 m in width.

##### b. Litter control facilities

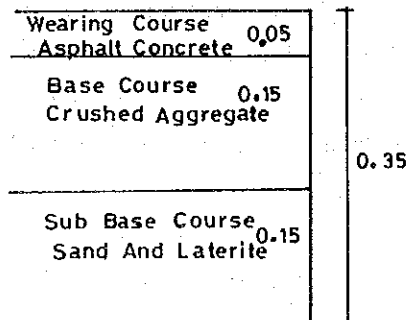
Litter scattering during the landfill operations, before the covering material has been placed, shall be inevitable. As a means of prevention, therefore, a movable fence made of local material like bamboo and with nets to catch flying litter will be constructed.



TYPICAL CROSS-SECTION OF AN APPROACH ROAD



TYPICAL CROSS-SECTION OF AN ON-SITE ROAD



A DETAIL OF APPROACH ROAD

THE STUDY ON THE SOLID WASTE MANAGEMENT SYSTEM  
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JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 11.1-9 Typical Cross Sections of Access

#### c. Gas removal facilities

Because of organic matters present in the landfilled waste, decomposition occurs by micro-organisms and results in the production of water, gas, and inorganic chlorines. If the landfill structure keeps aerobic conditions, this gives rise to aerobic bacterial activity. If the decomposition is fast, carbon dioxide, water, ammonia etc., are produced easily. On the other hand, if the structure is such that would develop anaerobic conditions, this gives rise to anaerobic bacteria, which slow decomposition and adversely affect the environment through the emission of odors and combustible gas, such as methane, carbon dioxide, hydrogen sulfide and ammonia.

As for the outbreak of gas in landfill sites, gush and exhaust are common at the weak points on the boundary surface between filled area and surrounding structures. Disaster prevention measures, which are represented by gas removal facilities, are necessary at points where gas is expected to gush producing fires, odors, etc.

During landfilling operations the individual gas evacuation method is followed and after the completion of landfill, for safety and control, the collective gas evacuation method is followed by connecting the individual vertical shafts with the horizontal shaft.

An outline of the gas removal facilities is shown in Fig. N.1-16.

#### d. Leachate collection facilities

Upon consideration of the very limited financial resources of the Municipality, the establishment of Level 2 of sanitary landfill in Phase I is proposed. It will then be improved to Level 3 in Phase II. Therefore, the design for the leachate collection facilities was not made in this report.

e. Monitoring facilities

The existing wells will be used in order to monitor groundwater quality.

(5) Building and Accessories

a. Site office

This will be established for the administration of the disposal site in addition to the existing building for the weighbridge.

Locally available materials will be used for the construction of this office, as shown in Fig. N.1-17.

b. Weighbridge

The existing weighbridge installed by JICA will be used continually.

c. Fire prevention facilities

A fire extinguisher and other fire prevention facilities are to be installed in the site office.

d. others

In order to prevent anyone from illegally entering the site, a gate and fence are to be constructed. Flashlights will also be provided for the guard. A parking lot will be constructed for visitors and the staff.

#### (6) Water Supply

Although the permeability of the subsoil of the KM 18 disposal site is less than  $10^{-5}$  cm/sec., impact on groundwater pollution will be fair. The use of groundwater for drinking is not recommended, therefore, it is necessary to provide potable water to the surrounding area.

In terms of the water supply in Vientiane, the Nampapa Lao, of the state companies under MCTPC, is responsible for the construction, operation and maintenance of the potable water supply. As such, the cost of construction for the supply of water to the surrounding residents of the KM 18 is excluded in the project cost and is not estimated. The details of the water supply construction work, however, are identified and preliminarily designed. The following are the details of the water supply construction work, as shown in Fig. N.1-18 and N.1-19.

##### i. booster house

- building
- pump

##### ii. pipe construction

- Ø 150 PVC Pipe
- communal water tap
- others

### 3) Operation and Maintenance Plan

#### (1) Landfill Plan

##### a. Basic policy

The following basic policy is sustained for the preparation of the landfill plan:

- i. to solid spread and compact solid waste sufficiently;
- ii. to minimize the scattering of solid wastes;
- iii. to minimize the diffusion of offensive odor; and
- iv. to stabilize of wastes as early as possible.

Compaction of solid wastes is necessary to prolong the the service life of the landfill site, which is also helpful in lessening the settlement after the completion of landfill. Furthermore, the prevention of scattering of solid wastes and diffusion of offensive odor is required in order to conserve the surrounding environment. For ultimate use of the completed landfill site, early stabilization is necessary for landfill purposes.

##### b. Landfill structure

Regarding landfill structure, the improved anaerobic sanitary landfill method is applied.

##### c. Landfill method

In order to protect the surrounding environment, the cell method should be applied.

##### d. Cover soil

The cover soil is to be placed in the manner shown in Fig. 11.1-10 and the thickness of each covering is as follows:



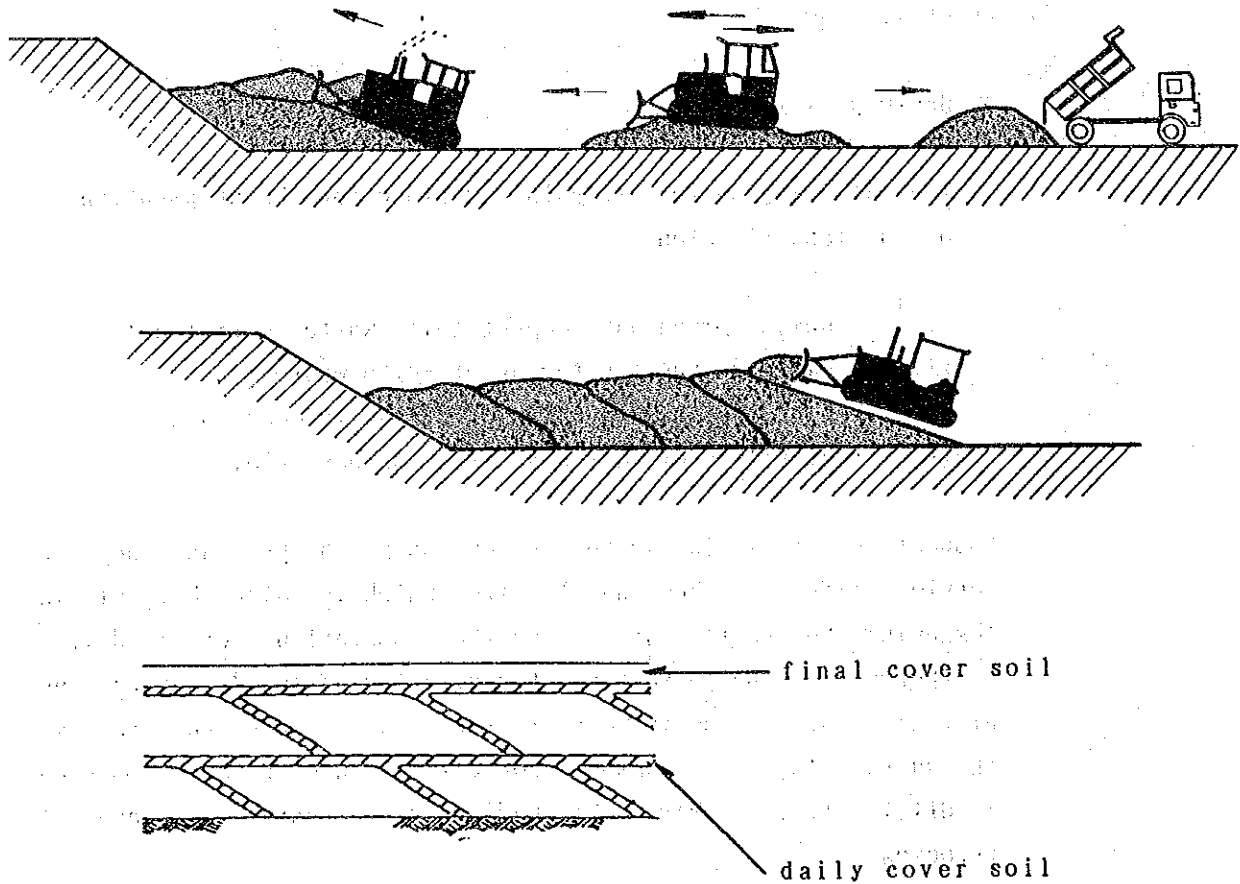


Fig. 11.1-10 Cover by Cell Method

- daily covering soil                      20 cm thick
- final cover soil                          60 cm thick

Accordingly, the ratio of cover soil to the disposal volume of waste will be 35%.

e. Landfill equipment plan

i. content of the work

The content of the work for the landfill equipment is summarized as follows.

Waste Handling	Cover Soil Handling	Others
pushing (moving)	excavation	leveling of site access road & unloading site
crushing	loading, hauling, spreading and leveling	site maintenance
compaction	compaction	

ii. equipment selection

The following equipment is selected for efficient operation and maintenance of landfill.

- bulldozer

The leveling and compaction of waste and cover soil can be satisfactorily achieved through the use of a bulldozer. A bulldozer of a 16 ton class weight should be selected.

- back hoe (hydraulic excavator)

Although the loading capacity of a back hoe is inferior to that of the crawler-loader, it is ideal for excavation, in which a bulldozer is inferior.

f. Landfill operations

The landfill operations are outlined below.

- i. The waste is unloaded in places directed to the driver by the staff.
- ii. The dumped waste is spread and crushed by a bulldozer into a flat horizontal layer for sufficient compaction.
- iii. After the completion of compaction of waste, the covering operations will be performed on a daily basis by the cell method.
- iv. A second layer of landfill will be laid on the first layer in the same manner, extending to the divider.
- v. Final covering material will be laid on top of the second layer of landfill.
- vi. A divider and gas removal facilities will be constructed in the adjacent area for the next landfill operations.

g. Landfill plan

i. divider

The divider should always be constructed directly adjacent to the soon-to-be completed landfill area.

ii. construction work

According to the landfill progress, the USD (present DCTC) will construct the following:

- dividers;
- gas removal facilities;
- on-site roads; and
- site ditches.

### iii. maintenance of completed landfill area

To insure the immediate drainage of rainwater on the completed area, the following will be completed by the USD.

- leveling
- temporary drain construction

### iv. acquisition of cover soil

The cover soil will be acquired within the KM 18-DS by the excavation of the next landfill area.

## (2) Facilities Maintenance

### a. On-site maintenance

#### i. on-site and approach roads

The on-site road is to be repaved with gravel and compacted and the approach road with asphalt, to avoid vehicular problems.

#### ii. fire prevention measures

Fire-fighting sand (cover soil will be applied for this purpose) will be used to cope with any unexpected fire in the disposal site. Furthermore, daily covering operations will be carried out concurrently so as to prevent fire incidents.

### iii. sanitation control

The most effective sanitation control is to carry out daily covering operations by the cell method, and it is also important to prohibit solid wastes from being exposed and standing water from being produced. Only when absolutely needed should insecticides be used and only in very little amounts.

### iv. waste scattering prevention

A fence will prevent waste from scattering outside the site. In addition, scattered waste within the site will be constantly checked and collected.

### v. on-site maintenance (equipment)

The following are the equipment necessary for effective on-site maintenance.

- disaster prevention.....water sprinkler truck
- on-site patrol.....inspection vehicle

### b. Main facilities maintenance

The main facilities must be kept in top condition, as one breakdown could affect all, resulting in mass damage.

- i. The bund must be checked for any breaks or holes.
- ii. The drainage system should be constantly checked and cleaned out as it can be blocked up by sand, leaves, weeds and other objects.

c. Equipment maintenance

In order to perform maintenance for effective operations, problems that may occur during periodic investigations should be analyzed and equipment should be repaired. Necessary spare parts should be kept in stock.

d. Hygiene and safety control

i. hygiene control

Periodic health check-ups are to be performed and medicine will be given for any possible accident. In addition, the staff will be informed fully of the hospital location and access in case of any emergency.

ii. safety control

In order to prevent fire caused by carelessly thrown cigarettes, no-smoking rule should be put into effect at the landfill site. The staff will be well educated on disaster prevention.

(3) Environmental Monitoring

In the process of carrying out landfill work, a monitoring (or supervision) plan which includes water quality inspection and scattering of solid wastes should be prepared, in order to preserve the environmental conditions of the final disposal site.

a. water quality monitoring

The following monitoring methods shall be effected for effective control.

- i. monitoring of groundwater by existing wells;
- ii. monitoring of surface water in surrounding drain; and
- iii. monitoring of leachate.

b. Waste monitoring

- i. monitoring of directly-hauled waste by the generators themselves, in particular, checking of unacceptable industrial wastes;
- ii. monitoring of scattered waste outside the site; and
- iii. monitoring of illegal dumping.

4) Ultimate Use

(1) Basic Conditions on Ultimate Use

These are the following basic considerations concerning the ultimate use of the completed landfill sites:

- problems related to settlement;
- problems related to gas generation; and
- maintenance of completed landfills.

(2) Ultimate Use Plan

Due to settling and gas problems, construction of buildings on completed landfill site is not recommended for at least up to over 15 years. Thus, the construction of a park for the surrounding inhabitants is recommended due to the following reasons:

- a great contribution to the surrounding residents;
- in harmony with the existing landscape;
- compatible with the surrounding land use; and
- one of the least expensive methods of land use.

#### 11.1.6 Operation and Maintenance of Equipment

The present operational capability is very limited, because the Maintenance Section of DCTC does not have any maintenance workshop, data on daily, weekly, monthly inspection sheets, and one year operational records for all equipment.

The establishment of the repair, maintenance and back-up services will help the effective use of the equipment and vehicles.

In order to achieve efficient operation and maintenance system for the equipment to be acquired, a maintenance shop at KM 7 and a field storage at KM 18-DS are planned. In addition, the present compound of DCTC headquarters will be used as vehicle depot. The following are the function and major contents of the equipment to be acquired;

##### 1) Maintenance Shop

###### a. Site development

In order to establish proper operation and maintenance system for vehicles and equipment, a maintenance shop is planned to be constructed in the compound of previous State Sanitary Company (SSC) of the Municipality located at the KM 7 on the way to the KM 18-DS. A layout of the maintenance shop is designed, as shown in Fig. 11.1-11. As shown in Figure, the previous compound shall be developed in order to establish the following maintenance shop:

- embankment of the site by imported soil; and
- improvement of the approach road by embankment and asphalt pavement.



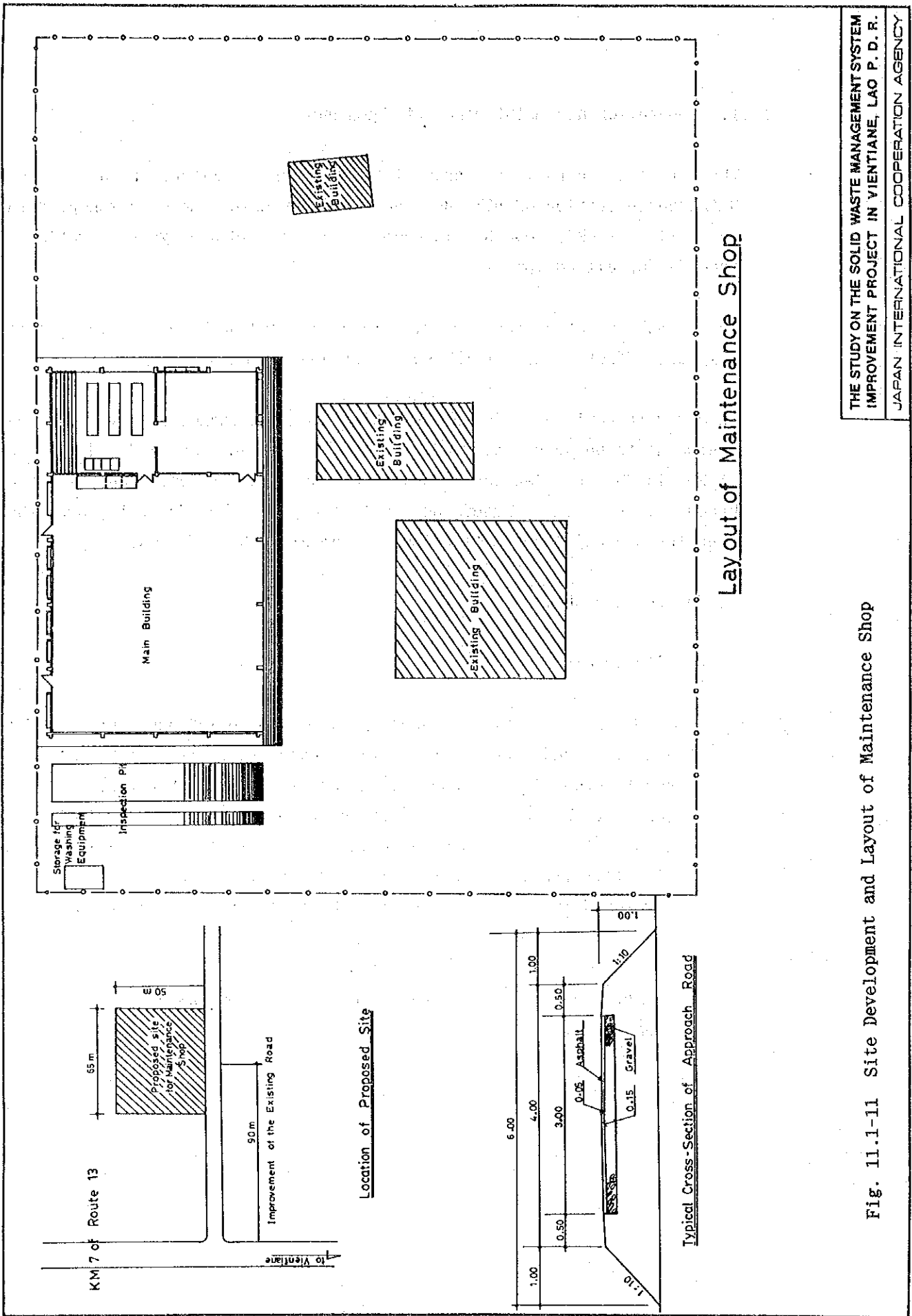


Fig. 11.1-11 Site Development and Layout of Maintenance Shop

**b. Buildings**

The maintenance shop shall consist of the following structures, as shown in Fig. 11.1-12.

- main building;
- inspection pit; and
- storage for washing equipment.

The functions of the above are described in Table 11.1-13.



Table 11.1-13 Function of Maintenance Shop

... 1

Items	Function	Major Equipment Required
<u>1. Main Building</u>		
I. Office	<ul style="list-style-type: none"> <li>- Administration</li> <li>- Management of workers</li> <li>- Control and filing of maintenance record, manual and catalogs</li> <li>- Accounting</li> <li>- Management of vehicles and equipment</li> <li>- Inventory control of fuel, spare parts, tools, oil and tire</li> <li>- Cost management on operation, maintenance and repair</li> <li>- Key control of vehicles and equipment</li> </ul>	<ul style="list-style-type: none"> <li>- Time Recorder</li> <li>- Cabinet for document</li> </ul>
II. Parts and Tools Storage	<ul style="list-style-type: none"> <li>- Control and storage of spare parts and tools</li> <li>- Storage of oil and Lubricant</li> </ul>	<ul style="list-style-type: none"> <li>- Oil stand</li> <li>- Heavy duty shelf</li> <li>- Tool shelf</li> </ul>

Items	Function	Major Equipment Required
III. Service Shop(4bays)	<ul style="list-style-type: none"> <li>- Regular inspection and maintenance</li> <li>• oil change</li> <li>• valve adjustment</li> <li>• change of fuel elements</li> <li>• minor repair</li> <li>- Final inspection after repair</li> <li>- Issue of the repair specification</li> </ul>	<ul style="list-style-type: none"> <li>- Nozzle tester</li> <li>- Electric welder</li> <li>- Gas cutting equipment</li> <li>- Working table with devices</li> <li>- Shelf for dismount parts</li> </ul>
IV. Tire Shop	<ul style="list-style-type: none"> <li>- Inspection and repair of tire</li> </ul>	<ul style="list-style-type: none"> <li>- Tire repair set</li> <li>- Air compressor</li> </ul>
V. Battery Shop	<ul style="list-style-type: none"> <li>- Inspection and charge of battery</li> </ul>	<ul style="list-style-type: none"> <li>- Battery quick charger</li> </ul>
2. <u>Inspection pit</u>	<ul style="list-style-type: none"> <li>- Inspection of vehicles and landfill equipment</li> <li>- Washing vehicles and equipment</li> <li>- Loading and unloading of landfill equipment</li> </ul>	
3. <u>Storage for Washing Equipment</u>	<ul style="list-style-type: none"> <li>- Storage of high pressure car washer and steam cleaner</li> </ul>	<ul style="list-style-type: none"> <li>- High pressure car Washer</li> <li>- Steam cleaner</li> </ul>

c. Maintenance equipment

The equipment and tools will be furnished for the maintenance and repairing of the vehicles and equipment, thereby ensuring their sufficient operating rate. It is desirable, therefore, that periodical maintenance and repair at an appropriate interval be carried out using these equipment and tools.

Basically, the maintenance and repair of motor vehicles can be largely done by ordinary tools including, open-end wrench, offset box wrench, and other types of wrench, pliers, screw driver, hammer, etc. In addition to supply of the ordinary tools, equipment and tools are to be furnished to allow the maintenance of landfill equipment, thereby ensuring a wide range of maintenance and repair services.

Particular emphasis is placed on those which can be used to disassemble, assemble and measure component parts of the engine and power train. In addition, portable types of equipment and tools are selected to assure the convenience of the works.

Consequently, the following equipment is planned for the maintenance of vehicles and landfill equipment. Details are shown in Appendix N.1.5, the Supporting Report (3).

i. for general maintenance and repair

- work bench
- machine vice
- tool stand
- hydraulic garage jack
- portable jack
- others

ii. for tire shop

- tire bead remover
- chuck gauge
- air impact wrench with impact socket and impact wrench holder
- tube tire repair set
- others

iii. for battery shop

- battery quick charger
- battery hydrometer set
- battery filler
- polyethylene funnel
- others

iv. for parts and tools storage

- tool and parts shelf
- heavy duty shelf
- pallet, plastic type
- oil measure
- others

v. for office work

- time recorder
- time card
- card rack
- cabinet for time recorder
- desk & chair

vi. for inspection pit

- high pressure car washer
- hot water car washer

## 2) Field Storage at KM 18-DS

For the efficient operation of vehicles and landfill equipment at KM 18-DS, a field storage at KM 18-DS is necessary. The functions of the storage are:

- to execute maintenance and minor repair of vehicles and equipment at the site; and
- to keep fuel, oil and lubricant.

Consequently, the following maintenance equipment is necessary.

- hand tool set
- heavy duty tool set
- grease gun with 3 kinds of micro hose
- oil measure

## 3) Vehicle Depot

In order to execute the first priority project (Phase I), the Municipality shall increase the number of vehicles and equipment. Thus a large area of land will be necessary for their depot in order to conduct proper operation and maintenance. It is proposed that the present compound of DCTC headquarters will be used as a depot. As shown in Fig. N.1-27, enough area (9,000 m<sup>2</sup>) is available for the depot and the location of the site is desirable.

## 4) Operation and Maintenance of Equipment

An operation manual for SWM is prepared and described in section N.5.1. The operation and maintenance of equipment is described in the manual.



## 11.2 Institutional Plan

### 11.2.1 Organization

#### 1) Organization Scheme

In order to realize the Basic Plan, establishment of the USD (Urban Service Department) is proposed. For the smooth implementation of the first priority project, the USD is to be set up by 1995. An organization scheme, as shown in the Fig. 11.2-1, is proposed for the new Urban Service Department of the Vientiane Municipality which would be established by employing additional personnel in addition to the existing cleansing personnel deployed.

#### Note:

- a. Cleansing Service Section I is responsible for collection and haulage of solid waste.
- b. Cleansing Service Section II is responsible for road sweeping, grass-cutting, drain cleansing and clean-up of illegal dumps.
- c. Details of the functions and role of each section is described in Appendix J.2-2, Supporting Report (2).

#### 2) Manpower Scheme

Personnel requirements projected for 1995 according to sections are shown in Table 11.2-1. In total, 197 persons, a size about three times larger than the present manpower size, will be required. 130 persons shall be recruited.

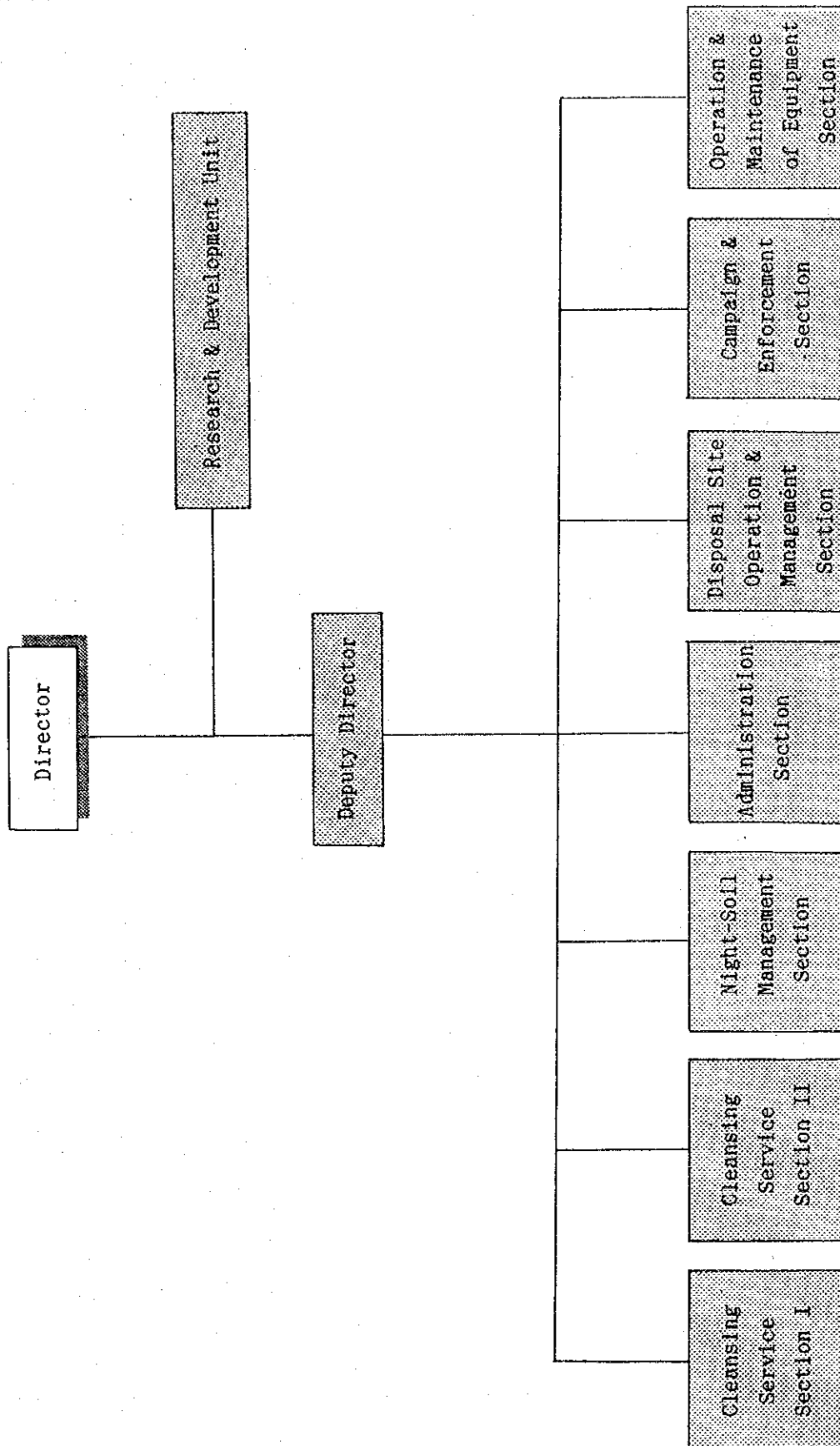


Fig. 11.2-1 Proposed Organization of the USD

Table 11.2-1 Proposed Number of Personnel According to Section (1995)

Position		Manager	Engineer	Supervisor	Technician (Mechanic) or Operator	Clerk or Fee Collector	Driver	Worker	Total
Name of Section									
1. Research & Development Unit		1	-	-	1	-	-	-	2
2. Administration Section		4	-	-	-	24	-	-	28
3. Cleansing Services Section I		1	1	3	-	-	17	59	81
4. Cleansing Services Section II		1	-	2	1	-	6	29	39
5. Night-Soil Management Section		1	-	1	1	2	7	15	27
6. Disposal Site Operation & Management Section		1	-	-	2	1	1	1	6
7. Campaign & Enforcement Section		1	-	1	-	2	-	-	4
8. Operation & Maintenance of Equipment Section		1	-	1	4	4	-	-	10
Total		11	1	8	9	33	31	104	197

### 3) Organization Scheme for the USD

The organizational scheme, as shown in Fig. 11.2-2, is proposed for the USD. It is proposed that both manager and supervisor would generate more managerial and planning inputs rather than occupying themselves with daily routine.

The managers are expected to concentrate on non routine matters such as:

- identification of fundamental problems;
- planning for system improvement and expansion of collection area;
- maintaining effective disciplinary control and strengthening employees work-morale;
- inter-sections communication to exchange experience and know-how;
- overall supervision;
- monitoring the service performance of the sections' workers;
- data gathering and analysis; and
- measurement of productivity and cost control.

### 4) Establishment of Appropriate Role of Each Organization

The roles of the organizations involved in solid waste management shall be reviewed and the needs for the modification and enhancement of their roles shall be identified. The functions, responsibilities and authorities of each organization on solid waste management shall be re-defined. Then, the appropriate role of each organization including the private sector shall be established. The establishment of an inter-ministerial or inter-departmental committee shall also be encouraged.

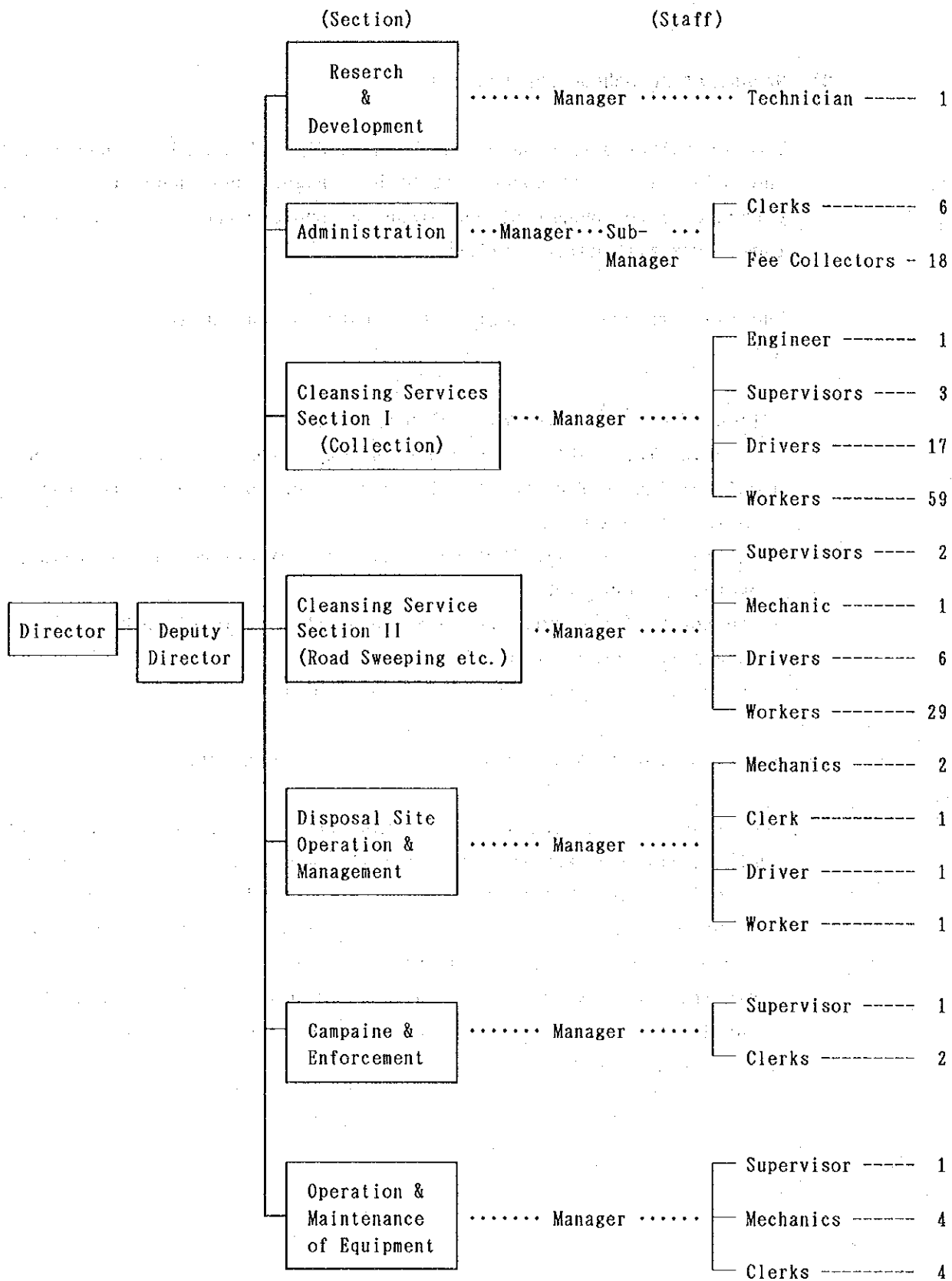


Fig.11.2-2 Organization Scheme of USD

#### 5) Improvement of Working Conditions

The Municipality's labour management is generally weak and loose in terms of its disciplinary control and work-morale support. Loose management, is in fact the important factor behind why the Municipality is more inefficient than private contractors in terms of waste collection.

In order to improve the labour management, it is necessary to improve the working conditions by means of the supply of lockers, shower rooms, uniforms, etc., to the workers.

In addition, good labour management requires fair and quick evaluation of employees' job performance and behavior. Results of such evaluation then should be expressed in terms of disciplinary actions and rewards.

#### 6) Establishment of Regulatory System of Private Companies

Even after the improvement of SWM by the Municipality, there will still be some works to be conducted by private companies. It is, therefore, necessary to establish a regulatory system of private companies in the USD Campaign and Enforcement Section. The system will include the following works:

- licensing; and
- supervision of collection services done by the private companies.

#### 7) Establishment of Training System

It is recommended that the National Government will establish education/training programs, as shown below:

- a formal post-diploma course on SWM for relevant personnels;
- sanitary engineering course in universities; and
- seminar/workshop on SWM.

It is recommended that Local Authorities should provide SWM training in the following forms:

- to promote discussion horizontally among the same level of positions and vertically among different level of positions in order to identify and solve problems.
- to give engineers and supervisors opportunities to visit other Local Authorities including abroad to observe their SWM systems and exchange opinions.
- on-the-job-training.

### 11.2.2 Finance

#### 1) Basic Concept

As mentioned in the Basic Plan, the establishment of 100% self-finance system through fee collection in 2000, i.e. the Beneficiary-Pay-Principle, is a main objective. Although the participant ratio in the collection experiment was about 30%, considering income level and fee set up (1,000 kips/household/month), the residents of Vientiane Municipality were found to be rather willing and cooperative in the payment of collection fees. It is, however, also necessary to examine a self-finance system by means of the cross-subsidy through the introduction of a new tax system for the Municipality or the increase of the present land tax. Further, in addition to maintain the Beneficiary-Pay-Principle, it is also important to make efforts which would make sure of the fixed collection time, the equal allocation of shares concerning the collection fees, and the use and flow of the fees collected.

The Phase I level aims to establish the foundation for a 100% self-finance system in 2000 by promoting the improvement of the fee collection and accounting systems.

For the establishment of the equal allocation of shares, there are following problems to be solved.

##### a. Weak financial foundation

The first problem is the weak financial foundation of Vientiane Municipality. Aside from an unimproved local tax system, its ability to manage its budget to cope with the annual increase in the volume of waste to be collected is also a big problem, as the budget for investment is almost dependent on foreign assistance. Nevertheless, nothing much can be done on this aspect except to leave it under the care of the capital city administration regarding waste disposal services.



As stated in the Basic Plan, the costs of road, drain and park cleansing services and the collection and disposal costs of waste discharged by the public institutions under the Municipality shall be shouldered by the Municipality.

b. Tipping fee

The expensive tipping fees will reduce the benefits which private enterprises gain by independently hauling waste to the disposal site and might increase dependency on the collection services of the administration. It is, therefore, desirable to gain the cooperation of private enterprises in Phase I where collection ratio is low, to aid the insufficient collection services. Further, the imposition of expensive tipping fees would only motivate illegal dumping. The cost of the container system proposed for institutional wastes is more expensive than the use of bamboo baskets. The use of containers, however, is tremendously labour saving when large volume of wastes have to be discharged, and is, therefore, much more desirable in the long run.

Although a financial study is basically done in accordance with the Beneficiary-Pay-Principle, a study will be made on the partial allocation of the share of the costs; i.e. Although landfill cost shall be about 4,200 kips/ton, it is set at 400 kips/ton in order to avoid illegal dumping and the balance is allocated to the collection fee.

2) Fee Collection System

The fee collection for collection and disposal services was proposed under 3 systems, however, partial modifications were deemed necessary after the collection experiment.

The fee collection system according to the services is as shown below:

- Basic collection services : Basic Fee
- Extra discharge : Extra Fee
- Large discharge (by mean of container) : Special Fee
- Disposal service (no collection service) : Tipping Fee

a. Basic and extra fee

Before the collection experiment, the need for door to door services was supposedly strong. As observed during the collection experiment, proper instruction to the residents could realize their cooperation in the discharge of waste. The collection fee of wastes in households and shops will consists of both the basic fee and extra fee system to meet with the smooth acceptance of temporarily large discharge.

The monthly contract for basic fees will be calculated according to the number of bamboo baskets, and only marked bamboo baskets will be collected. Extra fee coupons shall be sold during contract negotiations. These coupons shall be handed over to the waste collectors when the collection of waste excluded from the contract is required.

b. Special fee

The special fee for containers shall be based on the collection frequency, that is, the number of times collection, which would depend on the volume and kind of waste, is conducted. As a rule, collection will be conducted 4 times a month, once every week.

c. Tipping fee

As a truck scale is provided in the disposal site, a tipping fee system according to the amount of waste is possible. In consideration of the former fee collection system, however, the tipping fee will depend on the type of vehicle used for collection.

The basic fee, extra fee and special fee does not only cover the collection and transportation costs but also the final disposal cost.

### 3) Expenses and Fee Table

The cost of the Feasibility Study project is shown in section 11.3. Based on the 313 working days of a year, the amount of waste, service cost and necessary share according to the services' recipient are calculated and tabulated in Table 11.2-2.

Table 11.2-2 Amount of Waste, Service Cost and Necessary Burden in 1995  
(Unit: ton/day and million Kips/year)

Services Items	to be collected	to be disposed	to be cleaned	Ton per Year
1.Amount of Waste				
Household & shop	50.3	50.3		15744
Institution	7.1	7.1		2222
Public	0.9	0.9	0.9	282
Collected by PC*		10.0		3130
Direct haul		4.0		1252
Total	58.3	72.3	0.9	22630
	collection	disposal	cleansing	Total
2.Service Cost				
Cost required by the work	230.2	122.3	126.3	478.8
Management cost	13.2	0.8	4.4	18.3
Maintenance shop	21.0	5.2	5.4	31.7
Total	264.4	128.4	136.0	528.8
3.Necessary Burden				
Household & shop	228.1	89.3	0.0	317.4
Institution	32.2	12.6	0.0	44.8
Public	4.1	1.6	136.0	141.7
Collected by PC*	0.0	17.8	0.0	17.8
Direct haul	0.0	7.1	0.0	7.1
Total	264.4	128.4	136.0	528.8

Note: PC\*means private contractors

Based on the Table 11.2-2, necessary cost share according to the services' recipient is calculated in Table 11.2-3.

Table 11.2-3 Necessary Cost Share according to Services' Recipient

	Cost Share (million Kips per year)	Collected Volume (ton per year)	Cost Share (kips per ton)
a. Share of Household and Shop	413.2	25,584	16,148
b. Share of Institution	38.5	2,385	16,148
c. Public Share	142.4	282	504,964
d. Direct Haulage*	18.7	4,470	4,176

Note: \* Direct haulage includes waste collected by 3 private companies.

From the above-mentioned cost share and willingness of the residents to pay, the tariff will be increased in step by step up to the necessary cost share as shown below:

Table 11.2-4 Tariff for SWM (Unit : Kips)

Fees \ year	1995	1998
Basic Fee(per basket/month)	1,000	1,200
Extra Fee(per extra basket)	250	250
Special Fee(per container/month)*	30,000	50,000
Tipping Fee		
per small vehicle	600	900
per middle vehicle	800	1,200
per large vehicle	1,000	1,500

Note : \* The Fee is determined based on once a week collection.  
In case of twice a week or once a month collection, it is  
twice or one fourth of the settled fee, respectively.

It is necessary to check monthly the change in the cost by keeping the cost analysis sub-program in the accounting system installed in the collection experiment. By accumulating these data and analyzing them, it is possible to revise the proposed tariff in the future.

It is also necessary to yearly allocate VM budget to cover public share.

#### 4) Fee Collection System

Fee collection system in Vientiane is conducted through bank remittance and direct payment to fee collectors. Generally, fee collection by fee collectors causes trouble, though little trouble is observed in Vientiane mainly due to the nature of the people of Lao. To avoid problems, however, it is necessary to keep customers' records and conduct daily book keeping as in the collection experiment.

The collection of tipping fee at the disposal site should be continued also. But it may be more advantageous to issue pre-paid coupons for private cleaning companies.

#### 5) Related Measures

##### a. Examination of the reduction of the proposed collection fee (1000 kips/household/month)

By the year 1995, the proposed collection fee system shall be maintained and collection service ratio will be increased from 4.8% to 50%. This target could be achieved by the expansion method proposed by the Study. It seems, however, to be very difficult to increase the ratio from 50% to 100% by 2000 due to the existence of the poor households. It shall be, therefore, necessary to reduce the proposed collection fee making up the deficit by means of the cross-subsidy through the introduction of a new tax system for the Municipality or the increase of the present land tax.

b. Clear record keeping and computerized data processing

The issuance of receipts and the keeping of customers' records should be continued, as in the collection experiment, for fee collection. Accordingly, the effective use of the personal computer supplied for the execution of a Seminar and the continuance and improvement of the training program for the staff is necessary.

When collection services are extended all throughout the Vientiane area, back-up equipment like computer and its accessories will be necessary, and is subjects of future studies in Lao.

Further, the establishment of a new department would necessitate the clarification of collection responsibilities and the investigation of an independent accounting system.

c. Monitoring of illegal dumping and imposition of fines

To continue the collection of tipping fees, the establishment of a monitoring system for illegal dumping of wastes and the imposition of fines are most important. Although managing sections will be established in the new department, satisfactory results can not be expected from the efforts of the employees alone. Therefore, a study on how to gain the active participation/cooperation of the residents should be made.

d. Improvement of work conditions and securing qualified staff

To make the work appealing to the workers, the terms of employment should be improved by raising wages, working time, and social welfare benefits. It is particularly important to establish an incentive system to counteract the workers acceptance of tips. Acceptance of tips, therefore, should be prohibited.

Moreover, as bribing of those in charge of the enforcement of the laws against illegal dumping is very much possible, it is doubly important to employ people of integrity for this position. In addition, the employment of retired individuals for this post could prove to be beneficial.

#### 11.2.3 Laws and Enforcement

##### 1) Establishment of Proper Legislation and Regulations

The existing legislation and regulations shall be reviewed and those in need of modification shall be identified. Then, the proper legislation and regulations on solid waste management shall be established.

##### 2) SWM Aspects Requiring Legal Control

Some legal control is necessary in the following aspects of solid waste management.

- waste storage and discharge method to be applied to households and business establishments;
- waste collection fee and tipping fee;
- control of toxic waste;
- control of illegal dumping; and
- control of littering.

##### 3) Establishment of Enforcement System

Vientiane Municipality is weak and poor in law enforcement. Whether or not the Municipality can effectively enforce the law depends entirely on the intention of the Municipality's Administrators. Their firm determination is much desired, therefore, as it is necessary to establish the law enforcement system.

Campaign and Enforcement Section will be set up in the USD to expand the collection services, to stop illegal dumping and littering of waste, and to improve its SWM.

This Section will have one manager, one supervisor and four overseers who will be mobilized for campaign and enforcement. Both manager and supervisor are expected to prepare a plan to strengthen the law enforcement system.

#### 11.2.4 Public Education

##### 1) Objective of Public Education

Both National and Municipal Governments should be responsible for educating the public concerning the following aspects:

- proper storage and discharge manner;
- reducing litter in public places;
- eliminating illegal dumping of waste; and
- resource recycling

##### 2) Public Education by the National Government

The National Government can conduct public education on SWM through the following channels : one through schools, and the other through mass-media.

Basic education with respect to cleanliness and health is given in primary schools in Lao P.D.R.. Some education on waste is also recommended for primary or secondary school levels. A solid waste education program for the primary school is prepared and used in the collection experiment campaign. The program is written both in English and Lao and shown in N.2.4, the Supporting Report (3).



### 3) Public Instructions and Education by Municipal Government

The following public instructions and education to be given by the municipal government should enable the municipal government to achieve its specific improvement targets with respect to waste collection and disposal.

- days of waste discharge (to keep waste inside the house until the collection day);
- discharge time;
- discharge method and place;
- use of standard bins if required; and
- separation of waste if required.

Public instruction and education can be most effective if they are given in the form of an organized campaign.

### 11.3 Estimation of Project Cost

#### 11.3.1 Investment Cost

The investment cost was estimated based on the 1992 prices by adding the cost of each items. The project cost was basically estimated as follows:

- Foreign portion was estimated on the basis of CIF cost, taking into consideration the import tax (5%) and turnover tax (3%).
- Exchange rate used was:  
1 US\$ = 129 yen = 729 kips
- The import tax, turnover tax and a part of the labour cost of unskilled workers were excluded from the economic cost estimates.
- Land cost was excluded from the financial cost estimate, as the land is owned by Vientiane Municipality.

#### 1) Collection and Haulage

Investment cost for collection and haulage covers the purchasing of the collection vehicles and containers required for the Municipality's service in 1995. Financial and economic costs for collection and haulage are shown in Table 11.3-1.

Table. 11.3-1 Investment Cost for Collection and Haulage  
(million Kips)

	Financial Cost			Economic Cost
	Foreign	Local	Total	
Collection Equipment				
Dump Truck (DT)	479.3	0.0	479.3	443.8
Detachable Container Truck (DCT)	140.9	0.0	140.9	130.5
Container	177.0	0.0	177.0	163.9
Spare Parts				
for DT	48.0	0.0	48.0	44.4
for DCT	14.1	0.0	14.1	13.1
Total	859.3	0.0	859.3	795.7

## 2) Cleansing

Investment cost for cleansing services such as road sweeping, grass cutting and drain cleansing, covers the purchasing of containers, water trucks, small dump trucks, wheel loaders, grass cutters, etc.. Financial and economic cost for cleansing services are shown in Table 11.3-2.

Table 11.3-2 Investment Cost for Cleansing  
(million Kips)

	Financial Cost			Economic Cost
	Foreign	Local	Total	
Cleansing Equipment				
Water Truck	87.3	0.0	87.3	80.8
Small Dump Truck	52.4	0.0	52.4	48.5
Wheel Loader	60.4	0.0	60.4	55.9
Pick-up	15.2	0.0	15.2	14.1
Grass Cutter	6.7	0.0	6.7	6.2
Container	67.2	0.0	67.2	62.2
Spare Parts				
for Water Truck	8.7	0.0	8.7	8.1
for Dump Truck	5.3	0.0	5.3	4.9
for Wheel Loader	6.0	0.0	6.0	5.6
for Pick-up	1.5	0.0	1.5	1.4
for Grass Cutter	0.6	0.0	0.6	0.6
Total	311.3	0.0	311.3	288.3

### 3) Disposal (Level 2)

Investment cost for the disposal site consists of the construction and equipment purchasing costs. Financial and economic costs are shown in Table 11.3-3.

Table 11.3-3 Investment for Disposal Site

(million Kips)

	Financial Cost			Economic Cost
	Foreign	Local	Total	
Site Development				
Clearing & Site Preparation	117.7	117.6	235.3	210.1
Main Facility				
Enclosing Structure	29.4	29.4	58.8	52.5
Drainage System	18.4	18.4	36.8	32.9
Access	4.4	4.3	8.7	7.8
Building & Accessories	8.3	5.5	13.8	12.8
Environmental Protection Facilities	1.0	1.0	2.0	1.8
Equipment				
Landfill Equipment				
Bulldozer	137.4	0.0	137.4	127.2
Hydraulic Excavator	92.8	0.0	92.8	85.9
Dump Truck	44.0	0.0	44.0	40.7
Spare Parts	27.4	0.0	27.4	25.4
Total	480.8	176.2	657.0	597.1

#### 4) Maintenance Shop

Investment cost for the maintenance shop covers the purchasing of maintenance equipment, site development and construction of buildings. Financial and economic costs are shown in Table 11.3-4.

Table 11.3-4 Investment Cost for Maintenance Shop

(million Kips)

	Financial Cost			Economic Cost
	Foreign	Local	Total	
Construction				
Site Development	5.1	5.0	10.1	9.2
Buildings				
Main Building	63.9	42.6	106.5	98.6
Inspection Pit	7.5	5.0	12.5	11.6
Storage for Washing Equipment	0.6	0.4	1.0	0.9
Maintenance Equipment	122.0	0.0	122.0	113.0
Total	199.1	53.0	252.1	233.3

## 5) Fee Collection

Investment cost for fee collection covers the purchasing of motorcycles. The fee collection activities shall greatly influence the success of SWM. Therefore, the usage of motorcycles are expected to extend the service.

Table 11.3-5 Investment Cost for Fee Collection

(million Kips)

	Financial Cost			Economic Cost
	Foreign	Local	Total	
Equipment Motorcycle	32.9	0.0	32.9	30.5
Spare Parts for Motorcycle	3.3	0.0	3.3	3.1
Total	36.2	0.0	36.2	33.6

# 6) Total Investment Cost

Total investment cost amounts to 2,450.9 million kips including engineering fees, physical contingency and price contingency as shown in Table 11.3-6.

Table 11.3-6 Total Investment Cost

(million Kips)

	Financial Cost			Economic Cost
	Foreign	Local	Total	
Collection Improvement	859.3	0.0	859.3	795.7
Cleansing	311.3	0.0	311.3	288.3
Final Disposal	480.8	176.2	657.0	597.1
Maintenance shop	199.1	53.0	252.1	233.3
Fee Collection	36.2	0.0	36.2	33.6
Sub-Total	1,886.7	229.2	2,115.9	1,948.5
Engineering Fee <sup>1)</sup>	188.7	22.9	211.6	
Physical Contingency <sup>2)</sup>	25.6	22.9	48.5	
Price Contingency <sup>3)</sup>	56.6	18.3	74.9	
Total	2,157.6	293.3	2,450.9	1,948.5

## Note:

- 1) Engineering fee is equivalent to 10% of investment cost.
- 2) Physical contingency is equivalent to 10% of construction cost.
- 3) Price contingency for foreign and local costs is equivalent to 3% and 8% of investment cost respectively.
- 4) The construction period of the disposal site and maintenance shop is assumed to take one year (1994) and the supply of vehicles and equipment is also assumed to take the same period of time.

Above mentioned investment costs are necessary to set up the Phase I project. As mentioned in the Basic Plan, it is important to gradually increase the supply of collection vehicles to achieve the 100% target collection rate for 2000. As for the disposal site, extension works will be required after 1998.

The financial analysis of the above is shown in Section 11.4.4 and the financial plan is in Section 12.3.

#### 11.3.2 Operation Cost

Operation cost consists of the depreciation cost and the operation/maintenance cost which covers costs for fuel, personnel, construction and management, etc.

The depreciation cost was calculated by dividing facility and equipment costs by their life spans, taking the residual value into consideration. The maintenance cost was calculated by multiplying the construction/procurement costs by specific rates. The fuel cost was calculated on the basis of a standard unit of consumption.

Personnel cost was calculated based on Table 11.3-7. Economic cost was estimated to consider the import tax for fuel and spare parts, the turnover tax and personnel cost of unskilled labourers.



Table 11.3-7 Number of Personnel for the USD

Sub-pro 10	Number of person					
	1995	1996	1997	1998	1999	2000
Director	1	1	1	1	1	1
Deputy Director	1	1	1	2	2	2
Reserch & Development						
Manager	1	1	1	1	1	1
Engineer				1	1	1
Technician	1	1	1	2	2	2
Administration						
Manager	1	1	1	1	1	1
Sub Manager	1	1	1	2	2	2
Clerk	6	6	6	8	8	8
Fee Collector	18	21	24	28	31	34
Collection						
Manager	1	1	1	1	1	1
Engineer	1	1	1	1	1	1
Supervisor	3	3	3	4	4	4
Driver	17	21	25	30	34	38
Worker	59	75	91	111	127	143
Cleansing						
Manager	1	1	1	1	1	1
Supervisor	2	2	2	3	3	3
Mechanic	1	1	1	1	1	1
Driver	6	6	6	8	8	8
Worker	29	29	29	32	32	32
Disposal						
Manager	1	1	1	1	1	1
Engineer				1	1	1
Supervisor				1	1	1
Mechanic	2	2	2	2	2	2
Clerk	1	1	1	1	1	1
Driver	1	1	1	2	2	2
Worker	1	1	1	2	2	2
Campaign & Other						
Manager	1	1	1	1	1	1
Supervisor	1	1	1	1	1	1
Clerk	2	2	2	4	4	4
Workshop						
Manager	1	1	1	1	1	1
Engineer				1	1	1
Supervisor	1	1	1	2	2	2
Mechanic	4	4	4	8	8	8
Clerk	4	4	4	4	4	4
Sub Total *	170	193	216	270	293	316
Night Soil	27	31	35	40	45	50
Total *	197	224	251	310	338	366

## 1) Collection and Haulage

The annual operation cost of collection and haulage will increase according to collection amount of waste.

Table 11.3-8 Annual Operation Cost of Collection and Haulage  
(million Kips)

	Financial Cost			Economic Price 1995
	1995	1996	1997	
Depreciation				
Vehicle	87.7	107.1	126.5	
Container	35.4	35.4	35.4	
Sub-Total	123.1	142.5	161.9	
Maintenance Cost	22.5	26.6	30.7	21.4
Fuel & Others	66.1	73.6	81.0	56.2
Personnel Expenses	18.5	22.9	27.3	14.6
Total*	230.2	265.5	300.9	

## 2) Cleansing

The annual operation cost of road sweeping, grass cutting and drain cleansing services was considered to remain the same.

Table 11.3-9 Annual Operation Cost of Clearing  
(million Kips)

	Financial Cost			Economic Price 1995
	1995	1996	1997	
Depreciation				
Vehicle	31.9	31.9	31.9	
Container	13.4	13.4	13.4	
Sub-Total	45.4	45.4	45.4	
Maintenance Cost	7.1	7.5	7.9	6.7
Fuel & Others	64.8	64.8	64.8	55.1
Personnel Expenses	9.0	9.0	9.0	7.1
Total	126.3	126.7	127.1	69.0

### 3) Disposal Site

The annual operation cost of the disposal site before 1998 was calculated based on the disposal amount of waste in that year. Fuel and other costs were included in the calculation. On the other hand, the annual operation cost of the disposal site after 1999 was calculated based on the disposal amount of waste estimated for 2005.

Table 11.3-10 Operation Cost of Disposal Site  
(million Kips)

	Financial Cost			Economic Price
	1995	1996	1997	1995
Depreciation				
Civil work & Building	99.7	99.7	99.7	
Equipment(Vehicle)	38.8	38.8	38.8	
Sub-Total	102.6	102.6	102.6	
Maintenance Cost	5.3	6.5	7.7	5.0
Fuel & Others	12.7	15.5	18.4	10.8
Personnel Expenses	1.7	1.7	1.7	1.6
Total	122.3	126.4	130.4	17.5

#### 4) Maintenance Shop

The slight increase in utility expenses resulting from the increase in the number of required vehicles might be disregarded in the calculation of the annual costs of the maintenance shop.

Table 11.3-11 Operation Cost of Maintenance Shop  
(million Kips)

	Financial Cost			Economic Price 1995
	1995	1996	1997	
Depreciation				
Civil work & Building	4.3	4.3	4.3	
Machinery	24.4	24.4	24.4	
Sub-Total	28.7	28.7	28.7	
Personnel Expenses	3.0	3.0	3.0	2.9
Total	31.7	31.7	31.7	2.9

5) Others

This section covers the administrative overall cost which includes fee collection services (see Table 11.3-12).

Table 11.3-12 Administrative Cost

(million Kips)

	Financial Cost			Economic Price
	1995	1996	1997	1995
Depreciation				
Motorcycle	4.7	5.4	6.2	
Maintenance Cost	1.0	1.2	1.4	1.0
Fuel & Others	3.5	4.1	4.7	3.0
Personnel Expenses	9.2	9.8	10.5	8.0
Total	18.3	20.6	22.8	11.9

6) Total Operation Cost

The total operation cost in 1995 is shown below in Table 11.3-13, based on the above estimation.

Table 11.3-13 Total Operation Cost in 1995

(unit : million Kips)

	Depreciation Cost	Maintenance Cost	Fuel & Others	Personnel Expenses	Total
Collection	123.1	22.5	66.1	18.5	230.2
Cleansing	45.4	7.1	64.8	9.0	126.3
Final Disposal	102.6	5.3	12.7	1.7	122.3
Maintenance Shop	28.7			3.0	31.7
Management	4.7	1.0	3.5	9.2	18.3
Total	304.5	35.9	147.1	41.3	528.8

## 11.4 Project Evaluation

### 11.4.1 Technical Evaluation

#### 1) Improvement of Collection and Cleansing Works

Technically the extension of collection services, establishment of an efficient and reliable service by curb and bell collection system, and establishment of public cooperation for cleaning-up roads, drains and public areas pose no problems. These systems have been implemented smoothly as pilot project in the collection experimental area and have been acknowledged by the residents, although residents complain about these systems, especially on the use of standard bamboo baskets in the initial stage.

As described in section 10.2, it is feasible to extend collection services to half population of Vientiane urban area by 1995 as proposed.

The collection experiment in the 3 Bans in Pasak shows that these systems have the following benefits:

- a. Bell and curb collection systems were applied in the experiment. Due to regular and designated collection services to residences and shops in the area, the residents conceded in bringing their waste to collection points. Consequently, an effective collection work was achieved as proven by the T & M study. It is also proven that the proposed collection system in the Basic Plan should be implemented in order to extend the collection services to the whole Vientiane urban area.

b. As for the cleaning-up of roads, drains and public areas through public cooperation, a cleansing day was proposed and implemented in each Ban. Although the result of the cleansing work by the residents was not satisfactory, it proves that the sanitary environment of the experimental areas can be improved on a step by step basis through further efforts such as the implementation of public campaigns and education, in order to achieve public cooperation in its cleansing services.

2) Use of Dump Truck

The use of dump trucks measuring 10 cu.m for the future collection of domestic and commercial wastes was proposed. This proposal will not cause DCTC any problem because it has been using vehicles of this type and size for quite some time.

According to the law of Vientiane Municipality, waste loaded in the collection vehicles should be covered in order to avoid scattering. Although the use of open dump trucks is popular in the Study area, a close dump truck is planned. The use of close dump trucks is considered to improve the collection work because loaded wastes will no longer require covers.

3) Construction of Level 2 Sanitary Disposal Site at KM 18-DS

From technical view point, the construction and operation of level 2 sanitary disposal site which has daily soil cover to improve the landfill operation will not be difficult.

#### 11.4.2 Environmental Evaluation

##### 1) Introduction

As part of the Basic Plan for the solid waste management in Vientiane urban area, the sanitary landfill site where the solid waste of Vientiane urban area shall be disposed, was identified.

The site was selected from a list of 3 potential sites based on a set of criteria that included environmental, economic, transactional and technical considerations.

The KM 18 site is located 18 km from Vientiane of Route 13. The area proposed is presently used as the open dump site of Vientiane Municipality, and the population density in the surrounding area is low.

The sanitary landfill operations will be constructed in two phases. Because of financial considerations, the level of landfill development and operation will be designed at level 2 in the first phase.

The level of landfill development and operation proposed for the second phase will be at level 3, where leachate from sanitary landfill will be collected.

##### 2) Existing Environment

###### a. Physico-chemical environment

The air quality in the area does not seem to be good due to the burning of wastes in the open.

The area is relatively quiet, except for the noise of the collection vehicles, and only little noise is generated by human activities as the population density is low.



b. Biological environment

The KM 18 site is sparsely wooded, and consists of paddy fields and dumping areas. The sparsely wooded area seems to be inhabited by few animal species.

c. Socio-economic environment

The two villages nearby are Ban Lak Sippet and Ban Phokham with a total population of about 1,000 persons. The population is predominantly Laotian and the main occupations are related to farming. The household income in Phokham is estimated at 40,000 kips per month or a mean income of 6,800 kips per capita.

The surrounding land use is mainly agricultural in nature with paddy cultivation in the alluvial plains.

3) Environmental Impacts

a. Construction phase

i. noise

The noise level may sometimes exceed WHO's standard of 55 db (A), but this shall not adversely affect daily life conditions because the construction period for one place is short and works shift.

ii. dust

Adverse impact from dust would not be significant in comparison with the present crude open dumping.

iii. traffic volume

Increase of traffic volume in relation to the construction will not be expected.

b. Operational phase

i. leachate

In comparison with the present crude open dumping, the landfill operation will be carried out in the limited area by the construction of enclosing bunds and dividers. This will reduce the generation of leachate. Accordingly, the adverse effect of leachates will be reduced in comparison with the present operation.

Although the permeabilities of the subsoils of the three candidate disposal sites are less than  $10^{-5}$  cm/sec., impact on groundwater pollution will be fair. Groundwater is not, therefore, recommended for drinking if the site would be used as a disposal site. Consequently, the Municipality or Nampapa Lao shall provide potable water to the surrounding area.

ii. noise

Of the sanitary landfill equipment, the major noise producers are bulldozers. However, more than 55 db (A) of noise is expected to be attenuated because of a two-meter high bund around the disposal area, and areas around the site would not be exposed to the same noise level for a long time because the landfill area will shift.

iii. dust and odor

The generation of dust can be controlled through the provision of water sprinkler truck proposed in the project. The truck will always be ready to sprinkle water whenever necessary.

The proposed sanitary landfill in which soil covering will be conducted every day can minimize the generation of odor.

#### iv. air pollution

Though the most serious pollutant derived from vehicle exhaust gas in Vientiane is carbon monoxide (CO). The estimated concentrations of CO are very low.

#### c. Plant and animal communities

There seems to be no adverse effects observed on the plant and animal communities, because the site has been used as the only open dumping site in Vientiane for more than 20 years.

#### d. Human settlements

There will be no additional adverse effects on the surrounding human settlements other than the present effects, because a sanitary landfill operation will mitigate the various adverse effects occurring at present. However, the Municipality or Nampapa Lao shall provide potable water to the surrounding settlements in order to avoid the use of groundwater for drinking as it may be contaminated by the landfill operation.

### 4) Mitigation and Abatement Measures

To reduce the impact of the leachate, an enclosing bund and divider will be constructed.

To avoid water related problems due to the contamination of groundwater, potable water will be supplied by the Municipality or Nampapa Lao to the surrounding residences.

There should be regular monitoring on the area surrounding the discharge point as well as seepage into the groundwater around the disposal site.

To reduce the noise levels during the operation of the site, there should be an earth bund to attenuate the noise levels as well as a buffer zone between the site and residences.

To minimize odor problems, sanitary landfill must be properly maintained.

There should also be green belt of trees and other plants between the disposal site and public areas for aesthetic reasons.

#### 5) Residual Impacts

Despite the above measures, some residual impact on the surrounding area would nevertheless remain.

In order to examine impacts on surrounding environment by landfill operation, monitoring systems should be introduced.

It would also be crucial to warn drivers to be careful along rural roads. Courteous behavior in these areas can go a long way to mitigate prejudice by the local residents on solid waste disposal.

Another important feature of the overall effort is to ensure that potable water should be supplied to the surrounding residents in order to avoid problems resulting from groundwater contamination.

### 11.4.3 Social Evaluation

#### 1) Impact on Public Health

##### a. Present situation

The urban and surrounding area of Vientiane Municipality has faced serious environmental degradation due to the generation of solid waste with increasing complexity. Solid waste collection and disposal has become the causal factors of social and public health problems of great magnitude, and this is evident in the infant mortality rate (IMR) and mortality rate of children from zero to four years old (U5MR) in the country. The IMR and U5MR in the country is estimated at 118 and 193 per 1,000 live births respectively.

Comparing the above figures with neighboring countries as shown in Table 11.4-1, the IMR and U5MR of Lao is placed poorly.

Table 11.4-1 Mortality of Lao P.D.R. Compare to Neighboring Countries

Country	IMR	U5MR	Life expectancy (Year)
Lao P.D.R.	118	193	50
Thailand	45	60	62
Vietnam	75	100	57
Myanmar	70	95	56
Indonesia	80	130	52

Source: Statistics on Children in assisted countries by UNICEF, 1986

Due to the very poor public health conditions stated earlier, it is very important to implement the project within a short period.

b. Impact

If the project is implemented, the public health of residents in Vientiane Municipality would be upgraded by the following improvement measures concerning solid waste management.

i. collection service

The purpose of solid waste management is the prompt collection/removal of solid waste resulting from urban activities, to maintain or improve the living environment and public hygiene.

Removal of waste can result to the reduction of mosquitoes, flies and rats etc., which cause two kinds of communicable diseases; one is due to poor sanitation (i.e. diarrhea, dysenteric parasitosis) and another is due to vector-borne diseases (i.e. dengue fever).

In non-collection areas, wastes are self-disposed at the premises or surrounding area such as road-sides, mainly by means of open burning and partly by landfilling. Open burning activities produce the air pollution which causes respiratory problems, (i.e. asthma, pneumonia) and conjunctivitis. These diseases are very popular in Vientiane, as shown in Fig. 11.4-1.

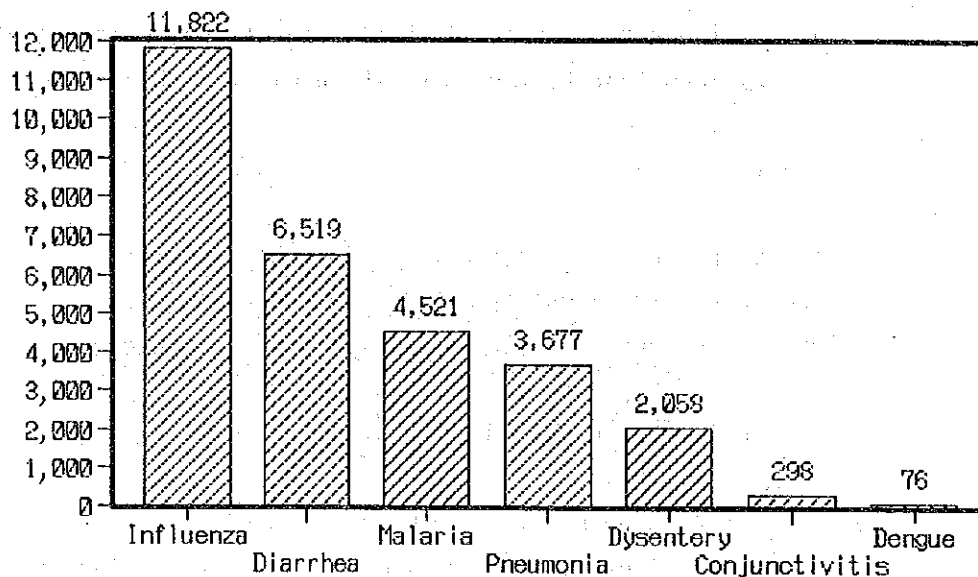


Fig.11.4-1 Number of patients by Kind of Diseases

Source ; Department of Health 1990, VM

## ii. cleansing work

Garbage dumping by the residents along roads and in drains causes the clogging of drains which leads to flood and the widespread of some diseases, especially skin diseases. In the rainy season water in bottles, tins and clogging drains breed mosquitoes that seriously results in the outbreak of dengue fever.

It can be concluded, therefore, that the environment and public hygiene can be improved and maintained through cleansing works and solid waste collection services.

## 2) Disposal Improvement

The level 2 sanitary landfill proposed will upgrade the standard of living and public hygiene as compared to the present situation of the disposal site at KM 18.

The following positive effects on public health can be achieved by adopting the sanitary landfill method.

- Prevention of fire which can cause eye and respiratory diseases.
- Reduction of scattered waste, odors and the propagation of harmful insects and rats, etc.
- Hazardous wastes such as infectious waste from hospitals will be disposed at the designated disposal site to eliminate the possible outbreak of communicable diseases.
- Avoidance of adverse environmental effects on the surrounding areas by the erection of fences to prevent the scattering of waste and to prevent scavengers and animals from entering the site.



#### 11.4.4 Economic and Financial Evaluation

##### 1) Framework of Evaluation

The project proposed consists of collection improvement, cleansing improvement and sanitary landfill at the final disposal site. The construction of a maintenance shop is also included for the smooth implementation of the works. The evaluation of the project was conducted on its economic and financial aspects.

The peculiarity of the SWM project, however, made the adaptation of the cost benefit analysis extremely difficult, particularly in Vientiane City where vehicles are limited and mostly dilapidated, and where the continuance of the collection services is met with danger. The calculation of the health damages effected by such practices like open burning in and around the Study area in moneterial terms, however, would prove worthless, as labour wages are relatively cheap in this country. Moreover, the calculations made by EIRR to conduct comparative analysis of projects can only be considered as arbitrary.

According to the above characteristics, the following basic policies were adopted to evaluate the project.

- a. The economic evaluation will be basically based upon the minimization of expenses, that is, "the examination of the use of minimum cost to achieve the targeted standard service". Accordingly, the willingness of the residents and private enterprises to pay and their relationships shall be studied. It will be considered feasible, however, if the costs can be covered by the amount residents are willing to pay.
- b. As for additional facilities, a study will be made on whether they will contribute to the curtailment of the cost or not.

- c. The financial evaluation will confirm the possibilities of materializing the project under VM's available financial resources for SWM.

## 2) Economic Evaluation

### a. Economic evaluation concept

Although economic evaluation is considered indispensable in judging the feasibility of a project from the national economic viewpoint, it is difficult to immediately measure the benefits of SWM.

In view of the above, economic evaluation was conducted according to the following steps:

- The effects of improvement in waste collection service and implementation of sanitary landfill will be qualitatively examined and evaluated.
- The effect of maintenance shop will be evaluated to prove that it can increase the efficiency of collection vehicles and reduce the total cost of SWM.
- A comparative study shall be made on the costs of large discharges of wastes in the container system, to confirm if the costs can be covered by the amount private enterprises are willing to pay.
- Finally, it will be verified if the total cost of SWM is less than the amount the inhabitants are willing to pay.

### b. Economic evaluation of collection improvement project

It is apparent that SWM in a city concerns the immediate collection and removal of wastes generated from urban activities, to improve public health and preserve the environment.

Generally, the improvement of the collection services will have the following effects:

Regular collection	--- will limit the propagation of flies, mosquitoes, rats, etc., will prevent piling and littering of waste	--- will prevent spreading of diseases caused by blight and harmful insects.
		--- will prevent obstruction of traffic flow; will recover canal functions
	--- will prevent generation of offensive odor	--- will form a comfortable environment; will favorably impress tourists
Improvement of working conditions	--- will reduce diseases and injuries	--- will improve collection efficiency

The degree of the propagation of infectious diseases caused by blight and harmful insects in Vientiane is minimal, as most garbage are used as animal feed. On the other hand, irregular collection services cause air pollution and some diseases such as pneumonia because of uncontrolled open burning of wastes. The piling and littering of waste sometimes disturbs the function of urban canals and pollute groundwater. In view of the above, it is concluded that regular collection services are essential to the urban life of Vientiane, and therefore, improvement of collection services is needed urgently.

On the other hand, the establishment of the collection service project would open job opportunities in Vientiane where potential unemployment ratio is high.

It is, however, difficult to expect production induced effects such as infrastructural improvements. Although a comfortable environment would indirectly enhance working behavior and contribute to the improvement of production, these effects cannot be considered as benefits.

As for the collection system by containers, it is necessary to investigate quantitatively the effect of the reduction of the collection cost for discharges of large amount of waste, though it is clear that the system is beneficial to the waste collectors. Generally, the loading of large amount of waste takes quite some time. If the collection system that combines waste from households and shops and those from discharge of large amounts is adopted, a considerable amount of time will be wasted resulting in inefficient collection services. The separate collection system for large amounts gives only one trip per day. It is, however, possible to give 5 trips a day with the proposed system as the loading and unloading works are very efficient. The number of crews needed is also reduced. From these assumption, a 14% curtailment (see Table 11.4-2) can be expected from the collection cost. On top of this, better impressions on market and hospitals will be expected as safety and cleanliness are maintained and the spreading of infectious diseases can be prevented. These are the indirect effects important for the beautification and sanitation of Vientiane.

Table 11.4-2 Comparison of transportation cost of Institutional waste

Type of Vehicle	DCT *1	DT *2
1) Average amount of collection waste(ton/day)	8.0	as same as DCT
2) Average volume of collection waste(m3/day)	46.2	ditto.
3) Volume to be transferred per trip	5m3	10m3
4) Number of Trip per day	5	1
5) Number of Crew		
Driver	1	1
Worker	1	4
5) Number of Vehicle	2	5
6) Round-trip distance per trip(km)	36	46
7) Running cost per trip(Kips)	3,017	3,855
8) Purchase cost of Vehicles (1,000 Kips)	87,026	158,515
9) Purchase cost of containers (1,000 Kips)	38,974	
10) Depreciation (1,000 Kips)	18,984	20,381
11) Personnel cost (1,000 Kips)	900	5,490
12) Maintenance cost (1,000 Kips)	3,481	6,341
13) Running cost (1,000 Kips)	9,443	6,033
Total cost per year	32,808	38,245
Unit cost(Kips/ton)	13,102	15,274

Note: \*1 DCT --- Detachable Container Truck

\*2 DT --- Dump Truck

The cost share calculated is less than the limits the market owners and the hospitals are willing to pay.

c. Economic evaluation of cleansing improvement project

It is apparent that solid waste collection concerns the immediate collection and removal of waste generated from urban activities, in order to improve public sanitation and environment. In contrast with solid waste collection, however, it is difficult to specifically identify the waste dischargers in the case of cleansing services. Nevertheless, the residents of Vientiane are highly cooperative and are always seen cleaning the shop in ordinary days, participating together with other residents in cleansing day activities. The problem in this matter is the absence of a waste removal system which results in the scattering of waste as it is blown by the wind polluting the area once again. Furthermore, uncollected waste and those not removed obstruct passages which leads to accidents. It is difficult to quantify the damages, but benefits can be expected from the systematization of the cleansing services.

d. Economic effect of disposal by sanitary landfill

Generally, the shift from open dumping to sanitary landfill can improve public health and preserve the environment around the final disposal site.

Along with the prevention of waste scattering activities, generation of odor and propagation of rats and flies, the cell method in which soil covering is implemented, will be adopted to make the proper storage, stabilization, and sterilization of wastes possible.

The waste can be used as soil covering, too, after stabilization for a given period of time, and its ultimate use can be considered in future, thus ensuring a comfortable urban environment. Furthermore, the management of hazardous wastes, like infectious hospital wastes, will be done by the disposal of it at the designated place of the site in order to guarantee the safeties of workers and scavengers.

This will contribute to the formulation of proper sanitary landfill techniques, which is the basis of final disposal activities, and the implementation of technology transfer to other cities.

The direct effects of road improvement works and soil covering at the disposal site will lessen the possibilities of vehicular tire punctures by glass or nails, ensuring the working ratio of the collection vehicles. The O&M costs of the disposal site can be covered, therefore, with every 10% increase in the working ratio of vehicles.

There are no water treatment techniques, however, in the proposed level 2, therefore, requiring a supplementary improvement plan at least upto level 3 in the future. The present conditions of the location does not require water treatment as natural purification can be achieved. The future expansion of the disposal site, however, would require a water treatment technique, regardless of the increase in expenses to prevent adverse effects on agricultural production.

e. Economic evaluation of maintenance shop improvement project

The major effects of the improvement of the maintenance shop are the prolongation of the life of the vehicles and the augmentation of the working ratio. The maintenance shop proposed at present does not include a large-scale overhaul, instead the efficiency of the collection and disposal works will be increased through the daily execution of check-ups and repairs.

The former maintenance system in Vientiane was not satisfactory as observed from the questionable operational capability of the vehicles, where the execution of one trip per day of collection work was uncertain. Based on these, the proposed maintenance system will be improved to enable 3 collection trips/day to main streets of town and 2 collection trips/day to the surrounding area. Concurrently, a fixed collection time will be established and the collection services will be improved.

Above everything else, a fixed collection time would heighten the willingness of the residents to pay, as observed from their response in the collection experiment.

If 3 trips/day to the main streets of town can be guaranteed through the provision of a maintenance shop, a slight reduction in the costs can be expected as shown in Table 11.4-3.

A considerable curtailment of costs can be expected, however, if the collection trips in the surrounding area and the working efficiency of the disposal site equipment are improved.

### 3) Financial Evaluation

#### a. Financial evaluation concept

Financial evaluation may be broadly divided into the following two fields:

- Financial evaluation of each project proposed
- Analysis of the project's impact on SWM in Vientiane as a result of its implementation.



Table 11.4-3 Comparison of the collection services with a maintenance-shop  
and without a maintenance-shop

	with maintenance-shop	without maintenance-shop
• Average amount of collection waste*	30.2	as same as with project
• Average volume of collection waste	174.5	ditto.
• Volume of waste per trip	10m3	ditto.
• Number of Trips per day	3	1
• Number of Crews		
Driver	1	as same as with project
Workers	4	ditto.
• Number of Vehicles	6	18
• Round-trip distances per trip(km)	56	as same as with project
• Running cost per trip(Kips)	4,693	ditto.
• Purchase cost of Vehicles	190,218	570,654
• Cost of collection		
Depreciation	24,457	73,370
Personnel cost	6,588	19,764
Maintenance cost	7,609	22,826
• Total running cost	26,440	26,440
Sub-total	<u>65,094</u>	<u>142,400</u>
• Cost of maintenance-shop		
Depreciation	28,737	-
Personnel cost	2,970	-
Sub-total	<u>31,707</u>	-
Total cost per year	96,801	142,400
Unit cost(Kips/ton)	10,241	15,065

Note; \* The average amount of collected waste is calculated by assuming that the volume to be collected from the center of the town is 60% of the 1995 collection.

The former is to compare the revenue and expenses in 1995 and to determine the feasibility of this project. The latter is to examine the financial capability of VM to continue the project and to achieve the goal of the Basic Plan based on the project proposed in the feasibility study. The latter includes the study of a 15 year cash flow and a sensitivity analysis on financial resources, initial investment cost, loan condition and inflation.

The revenue by fee collection is assumed to be the same as in the level proposed in 11.2.2 based on the consciousness survey and the collection experiment.

b. Financial evaluation of collection services

It is possible to collect waste from 80 households within an hour as the residents are found to be highly cooperative. The major items involved in this financial evaluation are as follows:

- working days per week : 5 days
- number of trips per day : 3 trips per day from the central urban area by DT (dump truck)
- discharged waste : 1.5 bamboo basket for every contractor, including wastes from shop.
- frequency of collection : once a week for households and shops  
1.3 times or 1.4 times per week for container system
- volume of extra service : 20% of waste discharged from households and shops

From the tariff and the above assumption, the revenue for collection service is as follows:

Unit : million kips

Revenue	Basic Fee	241.2	13,400 households x 1.5 basket x 1,000 kips x 12 month
	Extra Fee	64.9	830 baskets x 250 kips x 313 days
	Special Fee	13.6	29 containers x 1.3 times x 30,000 kips x 12 month
	Sub-total	319.7	

The cost is estimated in Section 11.3. The comparison of revenue and cost indicates that the balance of the collection service is in the black even with the inclusion of the depreciation for vehicles, etc.

Table 11.4-4 Balance of Collection Service in 1995

Unit : million Kips

Revenue		<u>319.7</u>
Expense	Personnel	18.5
	Utility	66.1
	Maintenance	22.5
	Sub-total	<u>107.1</u>
Balance		<u>212.6</u>
	Depreciation	<u>123.1</u>
Balance including depreciation		<u>89.5</u>

The balance, including the depreciation, however, would be in red if the share for the final disposal, maintenance shop and managerial costs are taken into consideration especially due to the share of the final disposal cost. But if half of the depreciation value can be covered by mean of financial assistances from the Central Government or other agencies, the collection services can be highly beneficial.

Table 11.4-5 Balance of Collection Service Considering  
Other Operational Shares in 1995

Unit : million kips

a. Revenue	<u>319.7</u>
b. Expense	
Personnel	18.5
Utility	66.1
Maintenance	22.5
Sub-total	<u>107.1</u>
c. Balance by work (a-b)	<u>212.6</u>
d. Other operation share	
Final disposal	126.7 (52.1)
Maintenance shop	21.0
Managerial cost	16.4
Sub-total	<u>164.1 (89.5)</u>
e. Balance (c-d)	<u>48.5 (123.1)</u>
f. Depreciation for collection service equipment	<u>123.1</u>
g. Balance including depreciation (e-f)	<u>-74.6 (0)</u>

Note: The figure in parentheses indicates it of which revenue and expenditure keep the balance.

c. Financial evaluation of the final disposal site

Tipping fees are the only direct source of revenue for the final disposal site.

By estimating the number of incoming vehicles at present, the mean number of incoming vehicles in the disposal site for 1995 is as shown below.

Table 11.4-6 Number of Vehicle by Size in 1995

Type	Nos./day
Small Vehicle	1.2
Medium Vehicle	1.5
Large Vehicle	3.9

Accounting, the revenues are as shown in the Table below.

Table 11.4-7 Revenues from Tipping Fees in 1995

Unit : million kips

	Revenue	Calculation
Small Vehicle	0.2	1.2 nos. x 600 kips x 313 days
Medium Vehicle	0.4	1.5 nos. x 800 kips x 313 days
Large Vehicle	1.2	3.9 nos. x 1,000 kips x 313 days
Sub Total	1.8 million kips	

The annual landfill expenses is 19.7 million kips, and only the labor cost can be covered by the tipping fees. If the revenue and expenditure of collection service keep the balance, the share by collection fee is 52.1 million kips. Consequently it results a deficit of 74.6 million kips, as shown in Table 11.4-8.

Table 11.4-8 Balance of Final Disposal Service

Unit: million kips

a. Revenue	Tipping Fee	1.8
	Collection	52.1
	Sub-total	<u>53.9</u>
b. Expense	Personnel	1.7
	Utility	12.7
	Maintenance	5.3
	Sub-total	<u>19.7</u>
c. Balance by work (a-b)		<u>34.2</u>
d. Other operational share		
	Maintenance shop	5.2
	Management	1.0
	Sub-total	<u>6.2</u>
e. Balance (c-d)		<u>28.0</u>
f. Depreciation for final disposal		
	facility and equipment	<u>102.6</u>
g. Balance including depreciation (e-f)		<u>-74.6</u>

As shown above, the management of the disposal site is largely dependent on the collection fees of the collection services.

d. The Cost Share of VM and the Financial Analysis of its SWM

As described above, the project balance without the road sweeping works results a deficit of 74.6 million kips due to the final disposal cost, especially depreciation of the facility and equipment. The deficit will, however, be covered by the increase of the collection fee. Nevertheless, the impact of the implementation of the project on the financial status of VM is looked into below.

Similar to the Basic Plan, a 15 year cash flow is formulated. The required investment for the vehicles, replacement of machineries, and the securement of the disposal site shall be estimated based on the nature of the project (see Table 11.4-9). Annual cost is estimated and tabulated in Table 11.4-10.

In the calculation, the annual expenses shall not be changed after 2000, and the same concept shall be applied to the fee collection. As for the financial resources, the first and the 1997 investment for the construction of the disposal site was derived from a long-term foreign loan, and the money for the annual purchase of machineries shall be appropriated from the internal funds like depreciation. If the internal funds are lacking, a short term domestic loan shall be made. Meanwhile, the annual expenses for road sweeping works will be covered by public taxes and, therefore, appropriated from the VM budget.

Consequently, the balance shall be in black by the year 2000. However, since an overall debt will become 3,825 million kips, an outflow of 391 million kips for repayment of long-term loan including interest, which is equivalent to 74% of the depreciation, will be made, as shown in Table 11.4-11.

Table 11.4-9 Investment Plan for SWM of VM

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
(Unit : million Kips)																	
Collection																	
Vehicle	682.4	150.6	150.6	202.3	150.6	150.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Renewal)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Container etc.	177.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Renewal)	0.0	0.0	0.0	0.0	0.0	177.0	0.0	0.0	0.0	0.0	177.0	0.0	0.0	0.0	0.0	177.0	0.0
Final Disposal																	
Construction	355.3	0.0	0.0	2345.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Renewal)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Heavy Equip.	301.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Renewal)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	301.4	0.0	0.0	0.0	0.0	0.0	0.0	301.4	0.0	0.0
Cleansing Work																	
Vehicle&Equipment	236.9	0.0	0.0	0.0	67.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Renewal)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	67.2	0.0	0.0	236.9	0.0	0.0
Container	67.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Renewal)	0.0	0.0	0.0	0.0	0.0	67.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Grass cutter	7.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Renewal)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Management & Other																	
Motorcycle	36.2	6.1	6.1	8.1	6.1	6.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Renewal)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shop	130.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Equipment etc.	122.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Renewal)	0.0	0.0	0.0	0.0	0.0	122.0	0.0	0.0	0.0	0.0	122.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	2115.9	156.7	156.7	2555.5	223.9	530.3	0.0	1256.9	156.7	156.7	584.0	223.9	156.7	0.0	1256.9	530.3	156.7

Note : \*1 Construction cost of final disposal site upto 2012 is included.



Table 11.4-10 Annual Cost Estimates

(Unit : million Kips)

	1995	1996	1997	1998	1999	2000
Disposal Site						
Personnel	1.7	1.7	1.7	2.8	2.8	2.8
Utility	12.7	15.5	18.4	21.2	24.1	26.9
Maintenance	5.3	6.5	7.7	8.8	10.0	11.2
Depreciation	102.6	102.6	102.6	201.2	201.2	201.2
Sub-total	122.3	126.4	130.4	234.1	238.1	242.1
Collection etc						
Personnel	18.5	22.9	27.3	33.1	37.5	41.9
Utility	66.1	73.6	81.0	88.5	95.9	103.4
Maintenance	22.5	26.6	30.7	34.9	39.0	43.1
Depreciation	123.1	142.5	161.9	187.9	207.3	226.6
Sub-total	230.2	265.5	300.9	344.3	379.6	415.0
Cleansing						
Personnel	9.0	9.0	9.0	10.5	10.5	10.5
Utility	64.8	64.8	64.8	64.8	64.8	64.8
Maintenance	7.1	7.5	7.9	8.3	8.7	9.1
Depreciation	45.4	45.4	45.4	45.4	54.0	54.0
Sub-total	126.3	126.7	127.1	128.9	138.0	138.4
Maintenance						
Personnel	3.0	3.0	3.0	4.8	4.8	4.8
Utility						
Maintenance						
Depreciation	28.7	28.7	28.7	28.7	28.7	28.7
Sub-total	31.7	31.7	31.7	33.5	33.5	33.5
Management etc						
Personnel	9.2	9.8	10.5	13.8	14.5	15.1
Utility	3.5	4.1	4.7	5.4	6.0	6.6
Maintenance	1.0	1.2	1.4	1.5	1.7	1.9
Depreciation	4.7	5.4	6.2	7.3	8.0	8.8
Sub-total	18.3	20.6	22.8	28.0	30.2	32.5
Total	528.8	570.8	612.8	768.8	819.4	861.4

Table 11.4-11 Calculation of Balance, Debt and Depreciation  
(Unit : million Kips)

	1995	1996	1997	1998	1999	2000
Case 1						
Balance	-144	-95	-42	-74	-4	51
Total Debt	2,116	2,116	4,337	4,212	4,155	3,825
Depreciation (A)	304	325	345	470	499	519
Repayment of						
Long Term Loan (B)	0	0	124	124	124	262
Interest of						
Long Term Loan (C)	63	63	63	130	126	123
B+C	63	63	188	255	251	385
(B+C)/A*100 (%)	20.8	19.6	54.5	54.1	50.3	74.1
Case 2						
Balance	-81	-28	30	7	86	153
Total Debt	0	0	2,345	2,345	2,345	2,207
Depreciation (A)	304	325	345	470	499	519
Repayment of						
Long Term Loan (B)	0	0	0	0	0	138
Interest of						
Long Term Loan (C)	0	0	0	70	70	70
B+C	0	0	0	70	70	208
(B+C)/A*100 (%)	0.0	0.0	0.0	15.0	14.1	40.1

Note:

Case 1 is the case in which the initial investment is made by a loan.

Case 2 is the case in which the initial investment is made by a grant.

A budget allocation to SWM in VM budget is assumed and tabulated in Table 11.4-12 based on the calculation of the cash flow. Although the SWM public share for 1995 and 2000, 120 million kips and 132 million kips, respectively, does not show much discrepancy, these budgets are more than 10 times of the present. If the increase ratio of VM budget will be in proportion to that of GRDP, the SWM budget will share 3.5% in 1995 and 7.7% in 2000 while the present ratio is only 0.3% in 1990.

Table 11.4-12 The Budget Allocation to SWM in VM Budget (Foreign Loan)

(Unit : million Kips)

	1995	1996	1997	1998	1999	2000	Total
SWM							
for investment*	(157)	(157)	(210)	(224)	(530)	(0)	(1,278)
for public share	126	127	127	129	138	138	785
for loan repayment	0	0	124	124	124	262	634
for interest	63	63	63	130	126	128	573
(short term loan)	(0)	(0)	(0)	(0)	(0)	(5)	
Total (A)	189	190	314	383	388	528	1,983
VM budget (B)	5,388	5,658	5,941	6,238	6,549	6,877	
A/B x 100 (%)	3.5	3.4	5.3	6.1	5.9	7.7	

Note: VM budget (B) means budget, excluding foreign aids, in local currency.

- \* The investment required for the purchase of collection vehicles will be released from the internal reserve and VM budget will be used for public share, and repayment of loan and interest.