Lao People's Democratic Republic

THE STUDY
ON
THE SOLID WASTE MANAGEMENT
SYSTEM IMPROVEMENT PROJECT
IN VIENTIANE

FINAL REPORT

EXECUTIVE SUMMARY

AUGUST, 1982

Japan International Cooperation Agency (JICA)

Lao People's Democratic Republic

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LIST OF VOLUMES

This is EXECUTIVE SUMMARY

PREFACE

In response to a request from the Government of Lao People's Democratic Republic, the Government of Japan decided to conduct a study on the Solid Waste Management System Improvement Project in Vientiane and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Lao P.D.R. a study team headed by Mr.Takao Yoshida, Kokusai Kogyo Co., Ltd., 3 times between October 1991 and June 1992.

The team held discussions with the officials concerned of the Government of Lao P.D.R., and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

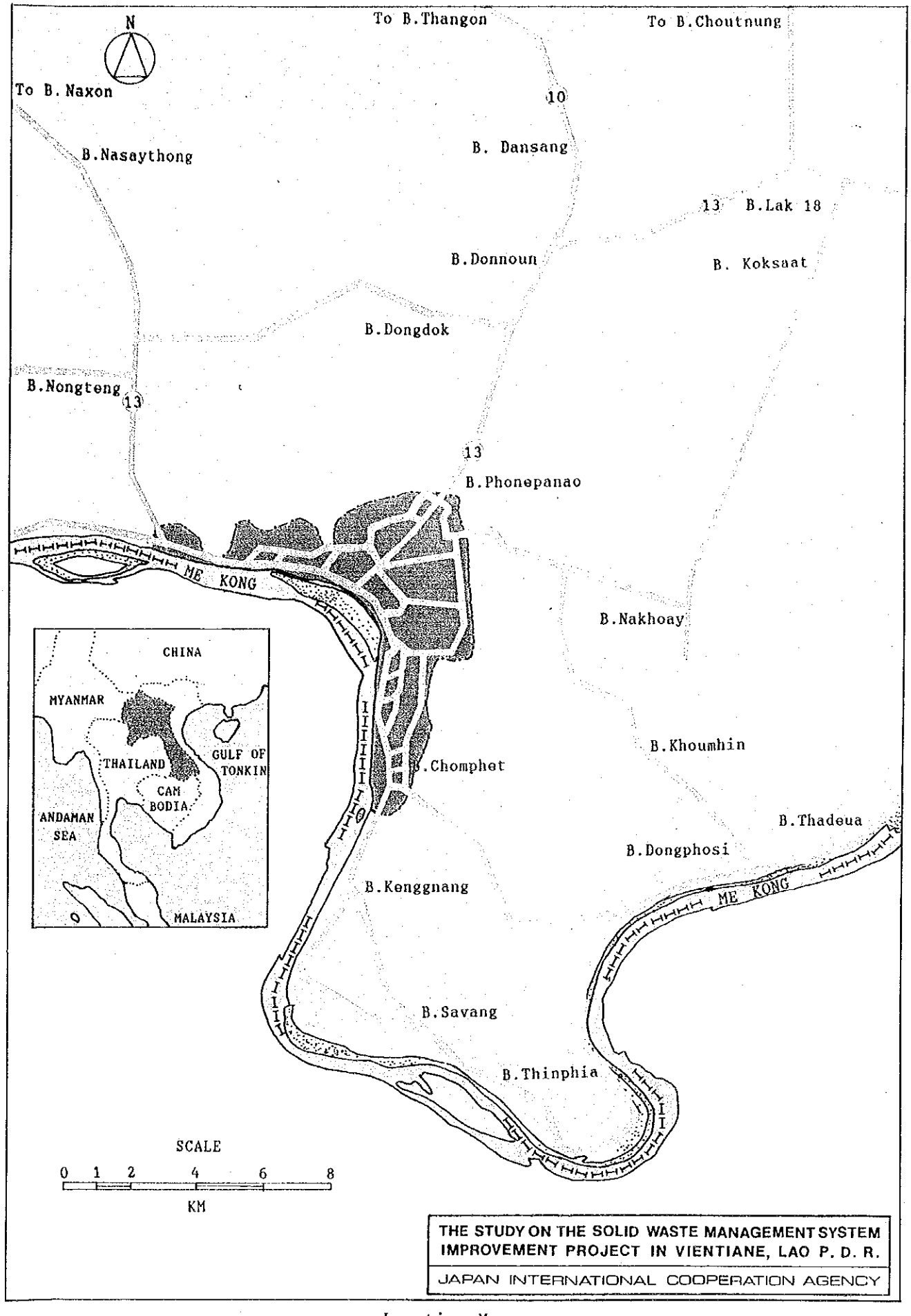
I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Lao People's Democratic Republic for their close cooperation extended to the team.

August 1992

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency



Location Map

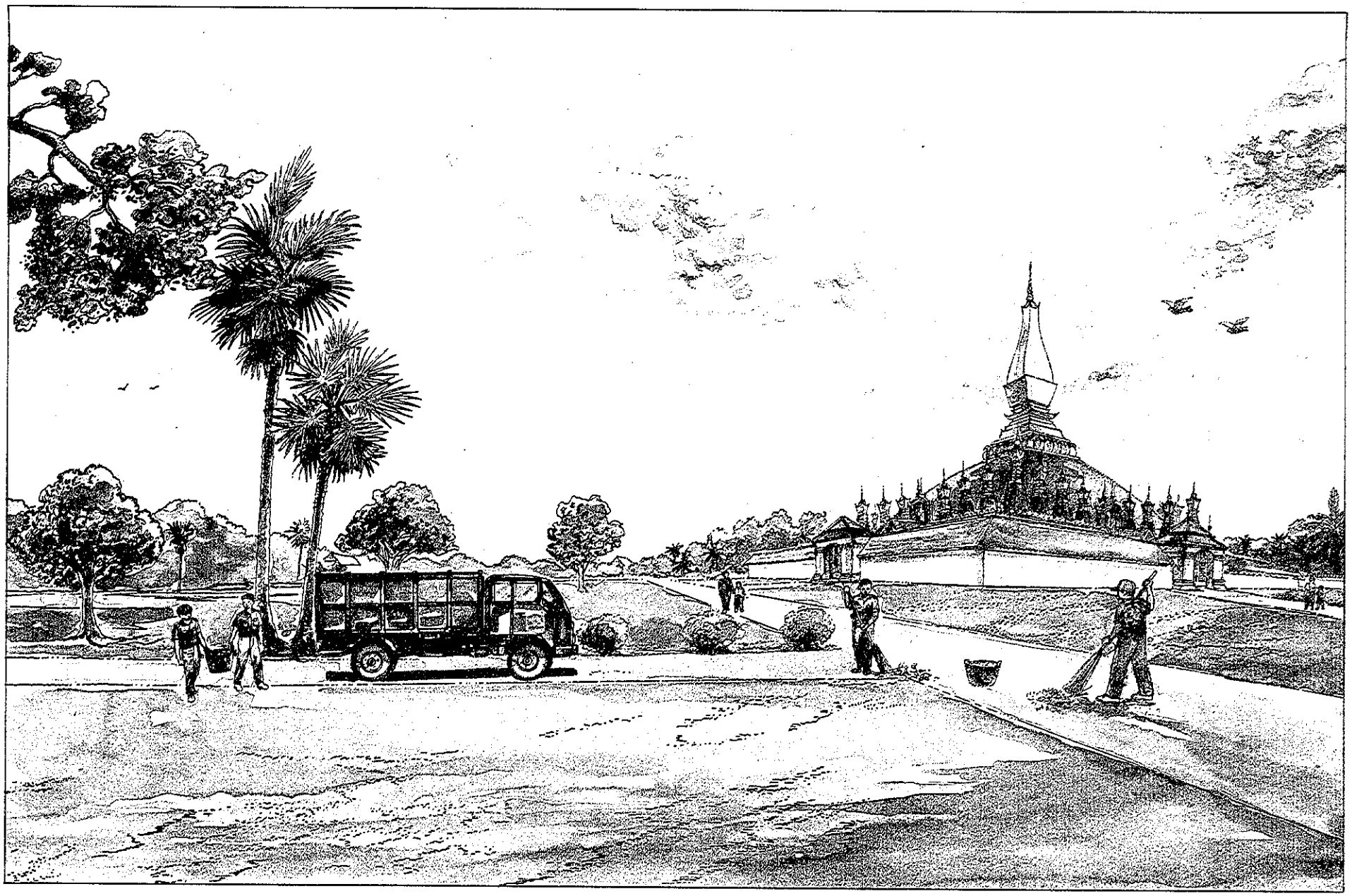
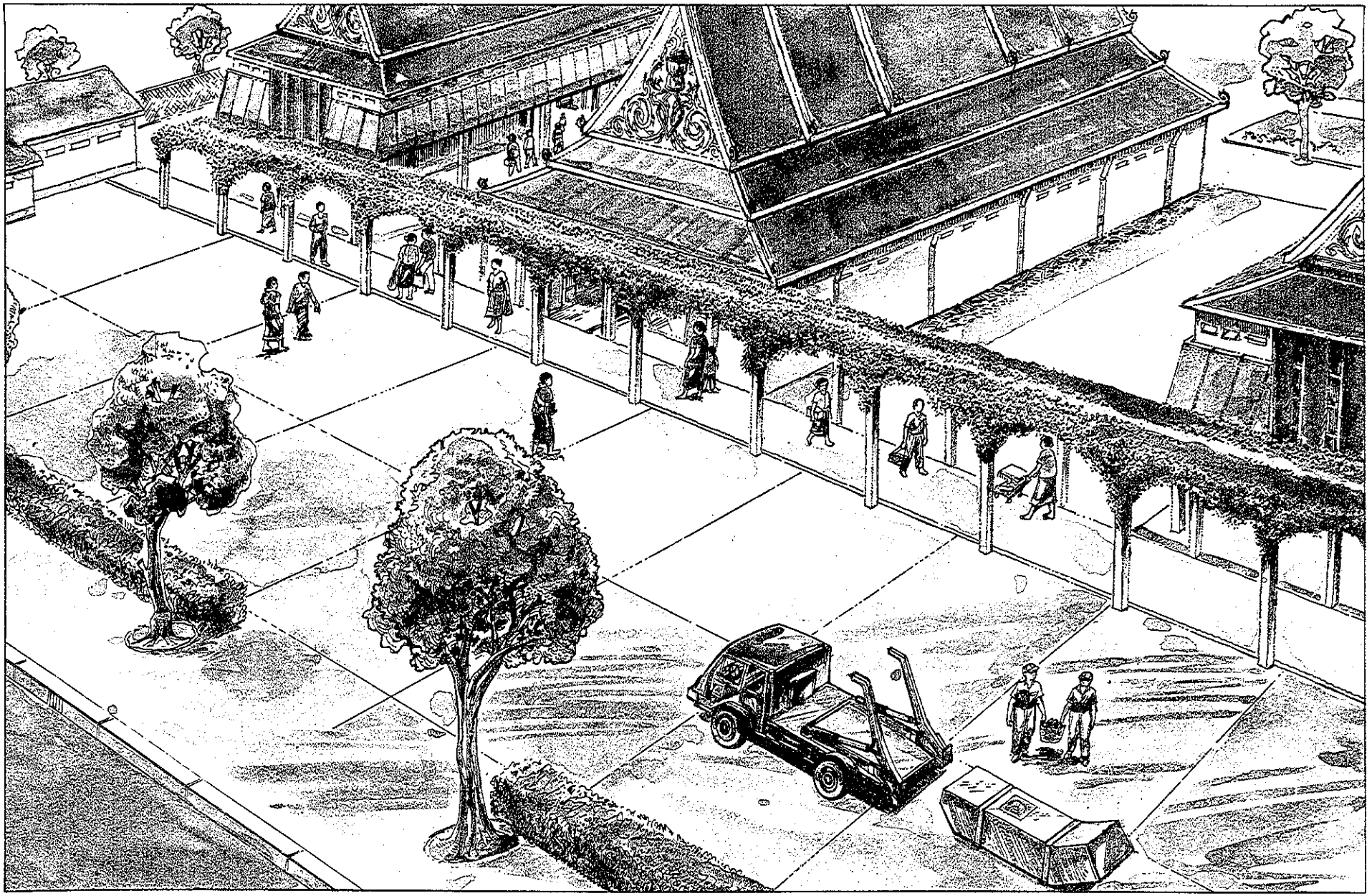


Plate 1. Image of Clean Vientiane



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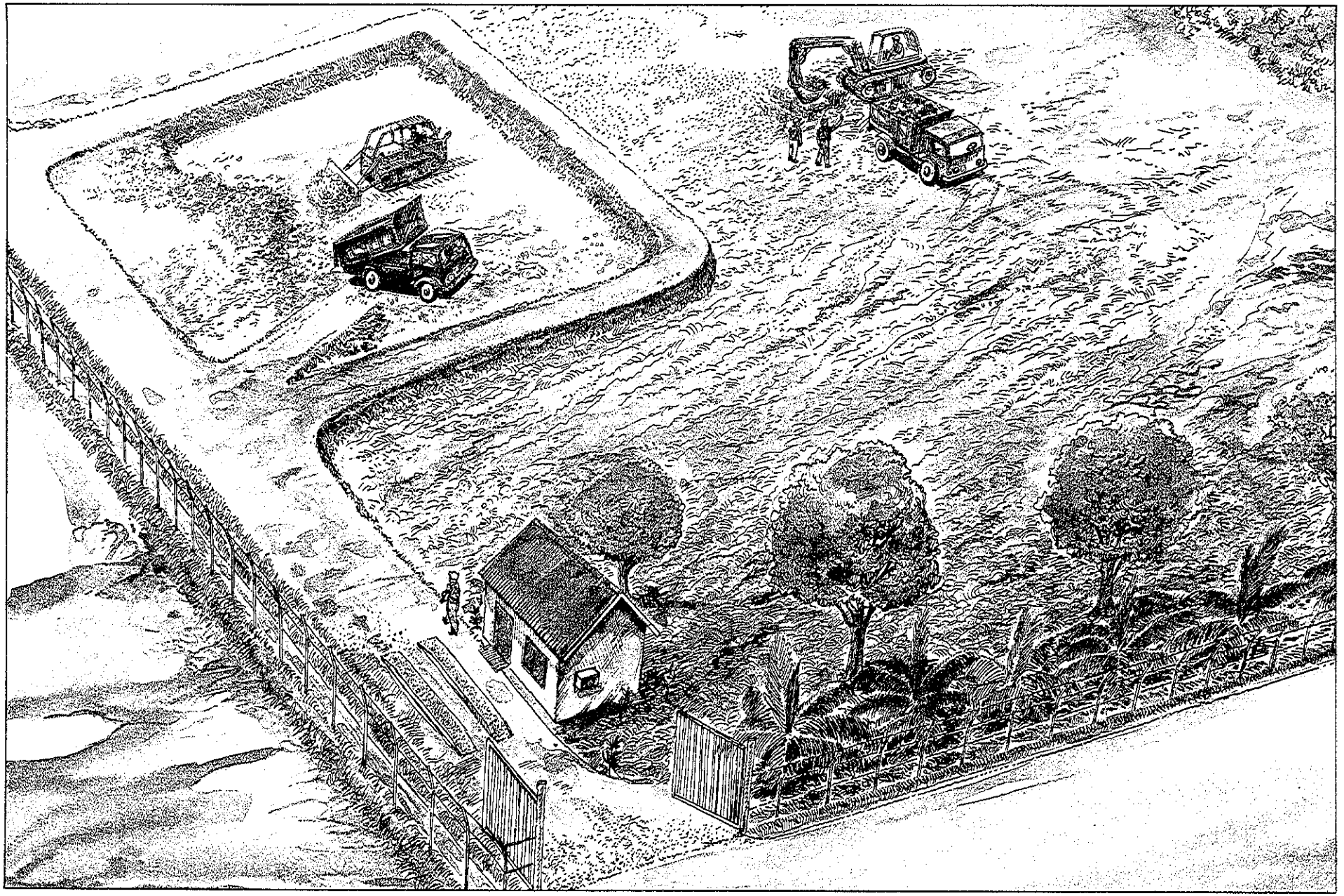

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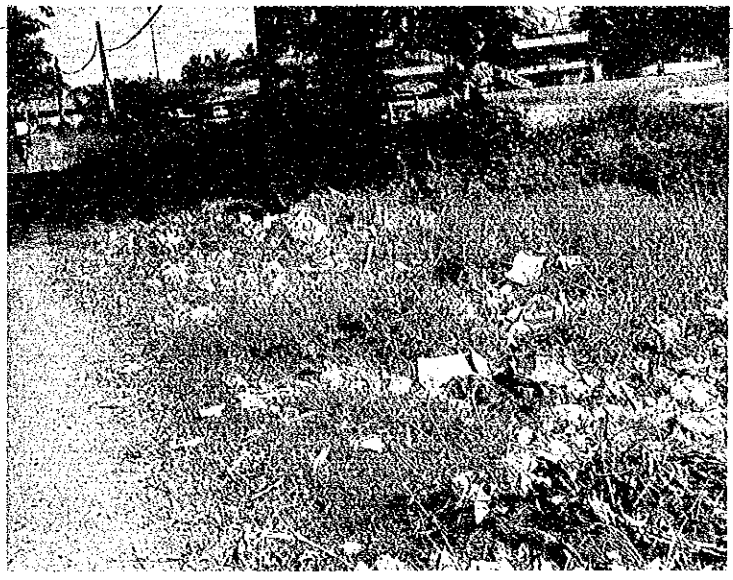

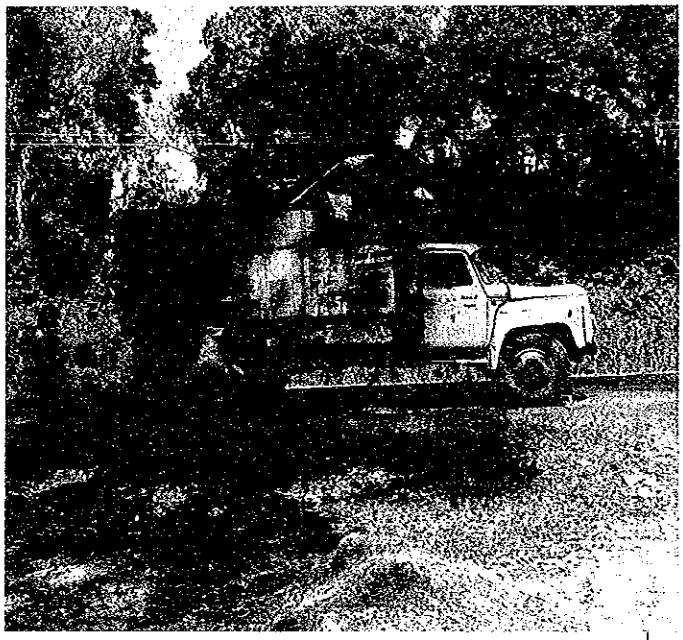

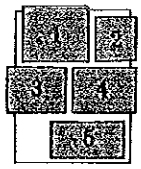

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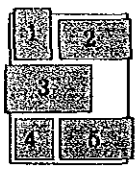

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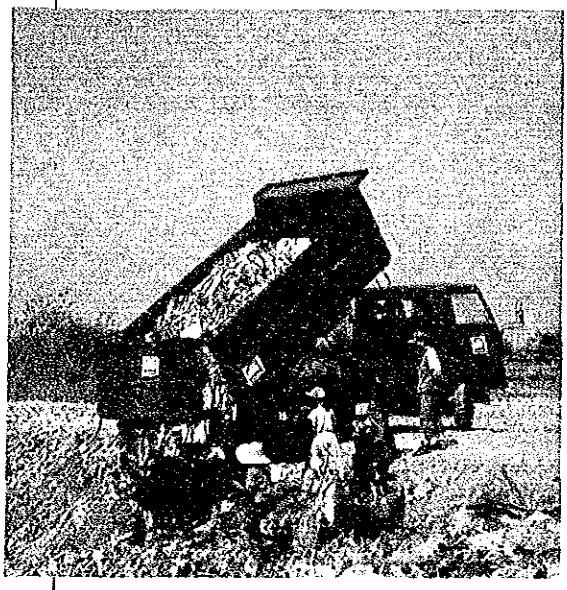

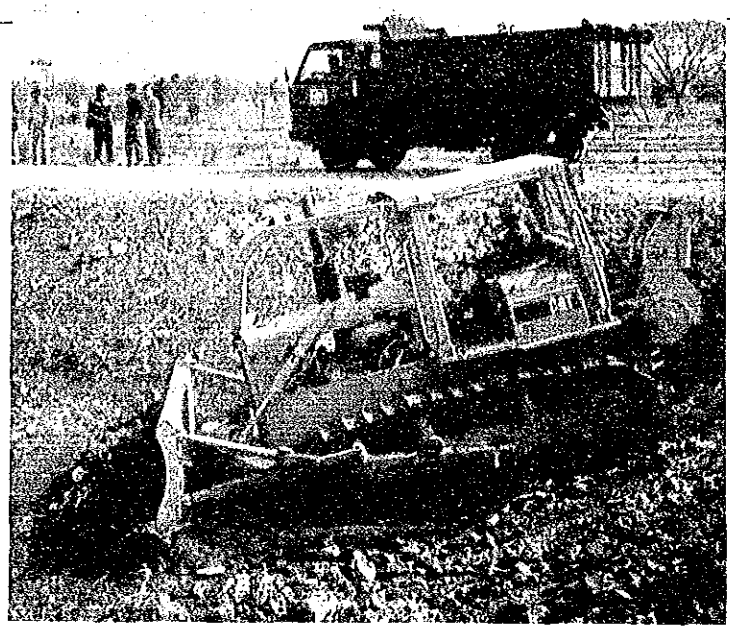

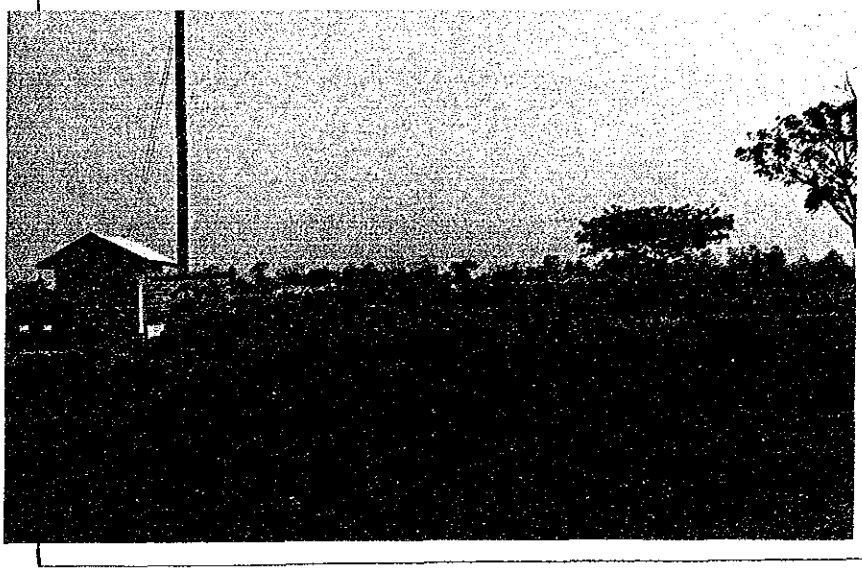

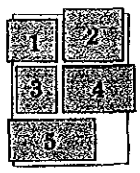

1 Disposal of waste collected in the bund at KM 18 disposal site
2 During Sanitary Landfill Operation
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5 Outside view of KM 18 after improvement

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2 Explanation conducted to members of Lao Women's Federation
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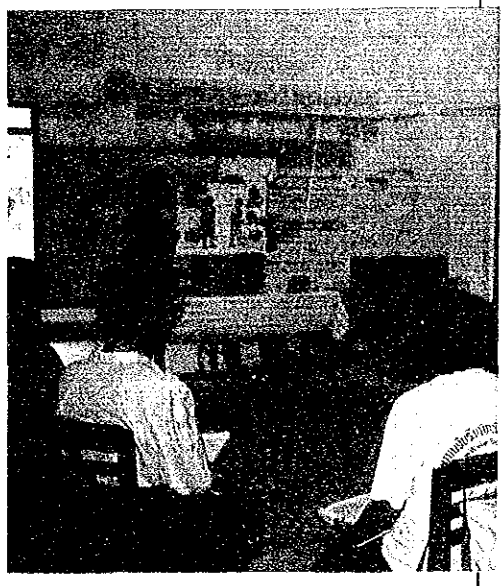
4 "Are there any questions?
5 People joining in the Cleansing Day



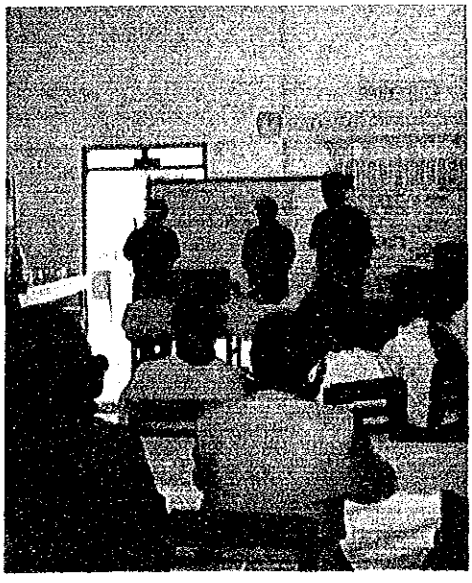


Plate 7. Public Education

THE STUDY ON THE SOLID WASTE MANAGEMENT SYSTEM IMPROVEMENT PROJECT IN VIENTIANE

CONTENTS OF EXECUTIVE SUMMARY

ABBREVIATION

ORGANIZATIONS

DCTC, VM	: Department of Communication, Transport and Construction, Vientiane Municipality
DPH, VM	: Department of Public Health, Vientiane Municipality
DPF, VM	: Department of Planning and Finance, Vientiane Municipality
ITSTP, MCTPC	: Institute of Technical Studies and Town Planning, Ministry of Communication, Transport, Post and Construction
JICA	: Japan International Cooperation Agency
JIS	: Japan Industrial Standard
JSCE	: Japan Society of Civil Engineers
Lao P.D.R.	: Lao People's Democratic Republic
MCTPC	: Ministry of Communication, Transport, Post and Construction
MOH	: Ministry of Health
NGD	: National Geographic Department
PRIVATE-CRC	: Construction and Renovation Company No.1
PRIVATE-ISC	: Inter-Construction and Sanitation Company
PRIVATE-SWM	: Solid Waste Management Company
SSC,MEPE	: State Statistical Center, Ministry of Economy,Planning and Finance
SSC,VM	: State Sanitary Company, Vientiane Municipality
UNDP	: United Nations Development Program
US	: United States
USAID	: United States Agency for International Development
USSR	: Union of Soviet Socialist Republics
VM	: Vientiane Municipality
WHO	: World Health Organization

REPORT & STUDY

ASG	: Apparent Specific Gravity
CCS	: Community Consciousness Survey
CV	: Calorific Value
DCDS	: Dongphosi Candidate Disposal Site
DF/R	: Draft Final Report
DRAINAGE F/S	: Feasibility Study on Improvement of Drainage System in Vientiane, March 1990
DS	: Disposal Site
F/R	: Final Report
IC/R	: Inception Report
IT/R	: Interim Report
KM 18-DS	: Kilometer 18 of Route 13 Disposal Site
M/M	: Minutes of Meetings
N.A.	: Not Available
NCDS	: Noensaard Candidate Disposal Site
PR/R	: Progress Report
S/W	: Scope or Work for the Study
SWM	: Solid Waste Management
UNDP M/P	: Master Plan for Urban Development in Vientiane conducted by UNDP (Vientiane, Schema Directeur ETD Amenagement Urbain Rapport Final Mai 1989)
WACS	: Waste Amount and Composition Survey

SOCIO-ECONOMY

EIRR	: Economic Internal Rate of Return
GDP	: Gross Domestic Product
GRDP	: Gross Regional Domestic Product
GVA	: Gross Value Added
NRMP	: Net Regional Material Products
O&M	: Operation and Maintenance

TECHNICAL

EL (el)	: Elevation
Dai.	: Diameter
GL	: Ground Level
RC	: Reinforced Concrete
BOD	: Biochemical Oxygen Demand
Cl^-	: Chlorine Ion
COD	: Chemical Oxygen Demand
DO	: Dissolved Oxygen
Hg	: Mercury
Pb	: Lead
T-N	: Total Nitrogen

UNIT

m m	: milimeter	cm	: centimeter
m	: meter	km	: kilometer
m^2	: square meter	ha	: hectare
m^3	: cubic meter	mg	: milligram
lit.	: litre	km^2	: square kilometer
sq	: square	cu.	: cubic
kg	: kilogram	t	: ton
s(sec)	: second	min.	: minutes
hr	: hour	d	: day
%	: percent	p.a	: per annum
o/oo	: per mille (1/1.000)	no.	: number
nos.	: numbers	k w	: kilowaltt
res.	: residence	per.	: person
hou.	: household	emp.	: employees

1. INTRODUCTION

1.1 Background

The solid waste management in the Vientiane urban area (the Study area) has become a critical problem due to the following factors:

- Large portion of the waste is not routinely collected;
- A considerable amount of waste is illegally dumped into Mekong River and the existing drainage channels;
- Collection vehicle fleet is old and subject to frequent breakdowns;
- Crude open dumping is adopted at the present disposal site, causing environmental problems.
- The institutional and administrative structure is not well established and not suitable for the required cleansing services;
- Finance and auditing procedures are in need of revision;
- Public education system and participation programs are not established.

To overcome the above-mentioned problems and to improve the situation in a systematic manner, the preparation and implementation of a Basic Plan on the Solid Waste Management System Improvement Project in Vientiane is a very effective approach technically as well as financially. However, so far this approach has not been practiced in the area leaving the existing solid waste management at a very low level.

It is with the above mentioned objective and consideration that the Government of Lao has requested the Japanese Government to carry out "The Study on the Solid Waste Management System Improvement Project in Vientiane".

1.2 Objectives of the Study

The objectives of the Study defined by the Scope of Works are:

1) to generally contribute to the development of solid waste management system in Vientiane with aim to improve and safeguard public health and protect environmental quality;

2) to formulate a basic plan on the solid waste management system improvement project, identify the first priority project, and conduct a feasibility study on the first priority project; and

3) to pursue technology transfer to the Laotian counterparts during the Study, especially through the collection experiment and experiment on sanitary landfill operation.

1.3 Policy of the Study

1) Joint Study

Upon consideration of the characteristics of a SWM (Solid Waste Management) study, the rapid change in the socio-economic and political situation in Lao P.D.R., it would be very important to identify the present situation of the institutional system on SWM and to make an appropriate institutional development plan. This task, however, shall not be easy for foreign professionals without the appropriate support of the Laotian side.

With these reasons, the Study Team proposed the joint implementation of the Study and asked the cooperation and active participation of the Laotian side, specially on the following works;

a. Community consciousness survey;

b. Study on waste amount and composition;

c. Execution of pilot project; i.e. collection experiment and experiment on sanitary landfill operation;

d. Intensive education campaign for the people in conjunction with the pilot project; and

e. Organization and institution planning.

2) Stepwise Approach

Considering the financial limitation and difficulty of obtaining public cooperation, a stepwise approach is necessary to achieve the targets of the Basic Plan.

Phased development plan was proposed as follows.

- Immediate Improvement Phase 1992-1994

- Phase I 1995-1997

- Phase II 1998-2000

Based on the immediate improvement needs identified, the immediate improvement plans were prepared and most of the plans were implemented in the Study period.

With regard to collection and disposal, the phased improvement will be conducted in accordance with the following steps.

a. Curb collection and bell collection system which were examined in the collection experiment shall be established by 1995.

b. Collection service ratios of residential and commercial areas shall be expanded up to 50% and 60% by 1995, respectively, and up to 100% by 2000.

c. Public cooperation for cleaning up roads and drains shall be established by 1995, and the cleaned-up wastes shall be collected and disposed by the USD (Urban Service Department) which will be newly established in Vientiane Municipality and be fully responsible for SWM.

d. Level 2 sanitary landfill site should be constructed at the KM 18-DS in 1994. It is proposed that level 3 sanitary landfill system should be realized in Phase II.

1.4 Scope of the Study

1) Study Area

The Study area for the Basic Plan covers the Vientiane urban area in the year 2000 (approximately 30 km^2). The future landfill site (KM 18-DS) is included in the Study area together with its environs even though it is located outside the area.

2) Study Wastes

The Study wastes for the Basic Plan cover domestic wastes, commercial wastes, street sweeping wastes and institutional wastes (schools, hospitals and markets).

1.5 Key Assumptions

Key assumptions used in this Study are as follows:

1) Socio-economic Conditions

	1995	2000
- projected population (persons)	163,000	193,000

		1995	2000
- annual growth rate of population		3.4%	
- annual increase rate of GRDP in real term	1991-1995	7%	
	1996-2000	5%	
- future budget scale of the Municipality	to increase in proportion to GRDP based on the budget of 1992		
- currency exchange rate	US$ 1.00 = ¥ 129 = 729 Kips		
- inflation rate	17.7% in 1990 10.4% in 1991 3% from 1992 to 2000		

2) Waste Amount and Composition

- generation ratio of domestic waste per capita per day in 1991	0.75 Kg
- annual increase of waste generation rate	3.4%
- waste composition	It will not change much by the year 2000.

	1991	1995	2000
- Collection Amount (ton/day)	13.9	68.3	148.2
Vientiane Municipality	(6.1)	(58.3)	(138.2)
Private Contractors	(7.8)	(10)	(10)

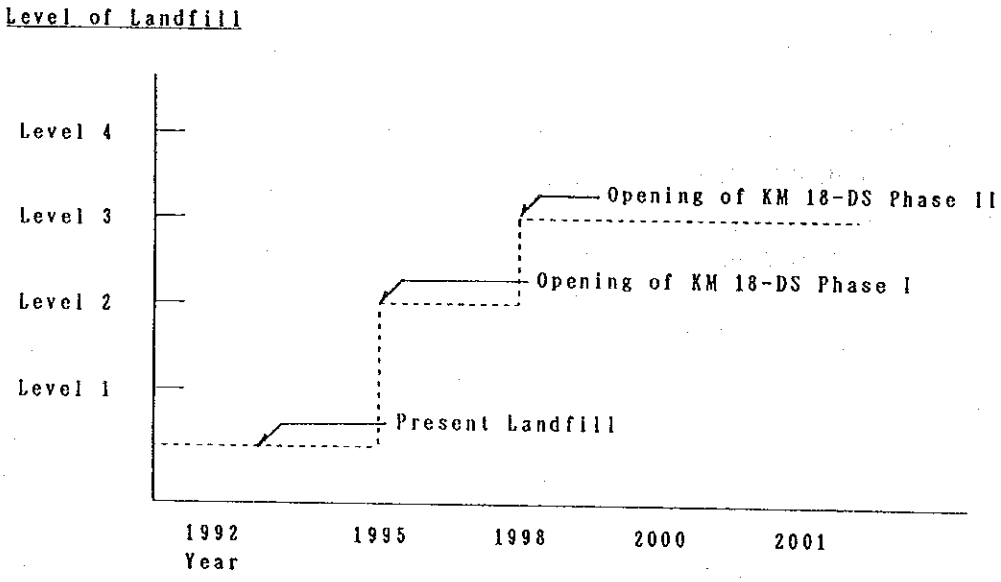
3) Life Span of Equipment and Facilities

	Life Span (years)	Salvage value (%)
- container, grass cutter and maintenance equipment	5	0
- vehicle and heavy equipment	7	10
- machinery	18	0
- building and civil works	30	0

Note: The Life span of other facilities for the disposal site depends on the period of its operation.

4) Sanitary Landfill Development by Stage

Sanitary landfill will be developed in step by step manner as shown below.



Landfill Level and Target Year

Note : Level of landfill development and operation is described in the Main Report Chapter 7, 7.1.6.

5) Estimation of Fee Collection

- type of fee
  basic fee
  extra fee
  special fee
  tipping fee

- fee collection rate
  100% of collected waste
  (No services are provided without contract and pay by 1995. Afterwards, a cross-subsidy system shall be introduced.)

- amount of solid waste according to type of fee (ton/day)

	1995	2000
basic	40.3	103.1
extra	10.1	25.8
special (for container)	7.1	8.4
tipping	14.0	14.7

- number of households, shops and containers

basic fee (No. of households and shops)	13,400	32,700
special fee (No. of containers)	29	29

- number of vehicles for tipping fee collection (vehicle/day)

small	1.2	1.3
medium	1.5	1.5
large	3.9	4.0

- fee tariff

	1995-	1998-
. basic fee	1,000 kips/basket/month	1,200
. extra fee	250 kips/basket	
. special fee	30,000 kips/container/month	50,000

. tipping fee (kips/vehicle)	small	600	900
	medium	800	1,200
	large	1,000	1,500

6) Loan Conditions

repayment schedule and interest rate in real term (nominal interest rate)

- long term loans repayment over 20 years with a 3 years grace period 3.0% (6.0%)

- short term loans repayment in the following years 8.5% (11.5%)

1.6 Work Processes of the Study

The Study commenced in October of 1991 and ended in August of 1992. The Study consists of the following two phases;

Phase 1 : Formulation of a Basic Plan (from October 1991 to January 1992)

- collection and review of existing data and information;
- preparation of the basic plan of the solid waste management system improvement project; and
- identification of the first priority project.

Phase 2 : Execution of the Feasibility Study on the First Priority Project (from February 1992 to August 1992)

- execution of Pilot Project (collection experiment and experiment on sanitary landfill operation)
- execution of the feasibility study on the first priority project.

2. Present Solid Waste Management

2.1 Profile of the Study Area

1) Area and Population

Vientiane Municipality is the capital and primary city of Lao P.D.R. and is politically, economically and commercially the key center of the nation.

Vientiane Municipality covers 3,920 km^2 and comprises 8 administrative districts. As of 1991, the population of the Municipality has reached 425,000, that is, 10% of the national population.

The urban area of Vientiane (the Study Area) covers 2,935 ha comprising the 4 districts; Chanthabouly, Sikhottabong, Sisattanak and Saisettha. The total population in this urban area in 1991 was estimated to be 142,723.

2) Climate

The annual Asian monsoon cycles that affect mainland South-East Asia produce two general seasons in Lao P.D.R.: the wet season from May to October and the dry season from November to April.

Temperature in Vientiane ranges from about 12°C during the coolest months of December and January to 38°C during the hottest months of March through May. The average annual rainfall is around 1,600 mm in Vientiane, of which about 86 percent occurs during May through September.

3) Land Use

The present land use in the Study Area (2,935 ha) is summarized as follows:

Residential area	1,240 ha	43.3 %
Public and commercial area	820 ha	27.9 %
Industrial area	25 ha	0.9 %
Water area	65 ha	2.2 %
Green area	697 ha	23.7 %
Others	88 ha	3.0 %

Source; ITSTP, MCTPC

4) Public Health

Public health has been one of the areas of primary concern in Lao P.D.R.. The life expectancy at birth in Laos was estimated at 50 years, one of the lowest in Asia. In 1990, the infant mortality rate still stood at a high figure of 118 per 1,000. Laotian death rate, which is still 16.1 per thousand, was also one of the highest in Asia.

5) National Economy

Lao economy is in a reforming process by the policy of NEM (New Economic Mechanism).

The principles of NEM were first announced in 1985. The NEM was approved by the 4th Congress of the LPRP (Lao People's Revolutionary Party). The NEM aims at the reformation of Lao economy from a control economy to a market oriented economy and has been developed as a strategy for improving the productivity and efficiency of the Lao economy.

6) Regional Economy

GRDP (gross regional domestic product) of Vientiane Municipality was estimated at about 30 billion kips in 1990, about 10% of the GDP.

GRDP per capita was estimated at US$ 87 in 1990, which is lower than the national average.

According to the Master Plan for Urban Development in Vientiane, the middle class gets 25,445 kips per month and spends 71% for food.

The unemployment ratios is 15%. There are many government workers in Vientiane Municipality due to the stagnancy of the market economy. According to the UNDP M/P, 61% of the labour force in Vientiane is made up of government workers.

7) Local Finance

The budget of Vientiane Municipality was 3,553 million kips in 1990, and its revenue was 9.7% of GRDP in 1989.

In Lao P.D.R., a tax reform policy was introduced in 1988 and is being promoted now.

The major taxes imposed in the Municipality is land tax and agriculture tax.

2.2 Field Survey

Basic information such as the quantity of solid waste generated in the Study area, the population covered by the collection services, maps showing the collection area, etc., is the principal and the key factor for a successful and workable solid waste management plan.

In order to clearly know the present SWM, the following field surveys have been conducted in cooperation with the DCTC:

- time and motion study for waste collection and cleansing works;
- survey on three private contractors of waste collection;
- survey on scavengers;
- survey on the recycling system and the market for reusable materials;
- community consciousness survey (totally 180 households were interviewed);
- investigation of present and future disposal sites (three sites were investigated);
- study on waste amount and composition both in rainy and dry season (43 samples were selected and analyzed in each season);
- collection experiment (three bans were selected);
- experiment on sanitary landfill operation; and
- intensive public education campaign.

2.3 Present Solid Waste Management in Vientiane

A study which was made on the current SWM included the following items;

- review of existing plans and studies on the SWM in Vientiane;
- amount and composition of solid waste and waste stream;
- methods of waste discharge and storage;
- collection and haulage systems;
- road sweeping, drain cleansing and grass cutting systems;
- disposal system including illegal dumping;
- recycling of reusable materials;
- equipment operation and maintenance system;
- organization;
- financial situation;
- personnel administration;
- legislation and enforcement;
- the existing capability and degree of utilization of the private sector in solid waste management;
- other related studies carried out in Vientiane; and
- existing standards, codes of practice and guidelines.

2.4 Major Findings and Problems Identified

a. Waste generation

Based on the result of the WACS (Waste Amount and Composition Survey), the generation ratio of each generation source is considered as follows:

- residence : 753 g/d/person (from this figure, 100 g is recycled)
- shop : 12,165 g/d/shop (from this figure, 3,207 g is recycled)
- market : 1,300 g/d/shop
- office : 30 g/d/emp.
- hospital : 960 g/d/bed
- road sweeping : 58,000 g/d/km

b. Waste stream

Based on the WACS, CCS and the actual disposal amount observed by the weighbridge, the present waste stream in Vientiane urban area is identified as shown in Table 1.

Table 1 Waste Stream in Vientiane Urban Area in January 1992

unit : ton/day

	Domestic Wastes	Commercial Wastes	Others*1	Directly Hauled Wastes	Total
Generation	107.5	21.5	9.4	2.4	140.8
Recycling	14.3	8.0	1.2	-	23.8*2
Self-disposal	88.9	10.5	0.4	-	99.8
Collection	4.3	3.0	6.6	3.5*3	17.4
Disposal	-	-	-	-	17.1*4

Note :

*1 : Others include market wastes, office wastes, hospital wastes and road sweeping wastes.

*2 : The figure includes the amount recycled by scavengers at KM 18-DS.

*3 : Thong Khan Kham market collects and transports their own waste to KM 18-DS (1.1 ton/day).

*4 : The figure excludes the amount recycled by scavengers at KM 18-DS.

c. Source separation

The recycling of domestic and commercial waste at the generation sources is well-established and wastes are segregated into waste for discharge, food waste to be used as domestic animal mainly livestock feed, reusable materials for recycling, and self-disposable waste.

d. Open burning

Self-disposal is the main disposal method in Vientiane. However, necesary measures to stop open burning of wastes should be taken in order to improve air quality in Vientiane.

e. Discharge system of institutional wastes

Discharge system of institutional wastes - markets, hospitals and governmental offices wastes - is not established.

f. Collection service coverage

Present ratio of collection service coverage in the residential area and commercial area is very limited, at only 4.8% and 22.3%, respectively.

g. Collection capability

According to the observation done by the weighbridge at KM 18-DS, the present collection capability of each sector, totalling only 17.4 ton/day, is as follows:

. DCTC	;	6.1 ton/day (35%)
. Private Contractors	;	7.8 ton/day (45%)
. Direct Haul	;	3.5 ton/day (20%)

h. Poor condition of equipment

In addition to the lack of collection capability, the present equipment used is old and dilapidated, and some seems to be out of order.

i. Processing

There is no processing facility in the Study area. In view of the very limited financial resources, present KM18-DS (it can be used for more than 20 years) and well organized recycling system, there seems to be less necessity for the introduction of a processing facility including a composting plant.

j. Recycling

At present, the total amount of waste recycled is estimated at 23.8 tons/day. Since a self-sustaining system in the society or community still exists and is well organized, the existing recycling system is considered to be much more efficient than that of the other countries.

k. Final disposal

Every aspect of the present KM 18-DS should be improved.

l. Illegal dumping and littering

Small scale illegal dumping and littering of waste are commonly seen in many places.

m. Equipment operation and maintenance

All aspects of the present operation and maintenance system of equipment should be improved.

n. Unclear responsibility of concerned agencies

There are various organizations concerned in solid waste management. However, the responsibilities and roles of these agencies are not clearly defined.

o. Lack of qualified personnel

The lack of sufficient and capable staff engaged in the solid waste management is also a serious problem.

p. Poor data management

Poor data management causes poor operation and maintenance. Data management is not properly done.

The data management and monitoring system of various aspects including number of personnel, job description, budget and financial situation, is indispensable for proper planning, study, implementation, operation and maintenance of the solid waste management.

q. Lack of enforcement system

Although the regulation of Vientiane Municipality can be legally enforced on violators, in practice it is very weak because of a poor enforcement system.

r. Lack of a basic law

There is no basic law regarding solid waste management in Lao P.D.R.. Although the Ministry of Health has drafted a law on solid waste management, it is somehow only used as a guideline and is not legally enforced.

A basic law is indispensable for setting up a standard guideline, code of practice, etc., regarding solid waste management.

s. Limited budget

As compared in Table 2, the budget for solid waste management in Vientiane Municipality is insufficient, especially the budget for maintenance which is not secured. Although fee collection is executed, money flow is not clear.

Table 2 Comparison of SWM Budget Share in Local Government Budget

Country or Municipality	SWM Budget Share	Unit SWM Cost (1000kips/ton)
Vientiane	0.3 %	10
Japan	About 5.0 % in Average	113
Pinang(Malaysia)	25 %	20
Seberang Perai(Malaysia)	25 %	21
Manila(Pilippines)	40 %	N.A.

t. Poor accounting system

The accounting system for solid waste management is not fully well established. Only personnel expenditure is reported to DPF, VM, in accordance with the budget. The collected fees and their uses are not being checked. Customs and system of settlement of accounts and an auditing system are not established.

u. Collection service requirement

According to the CCS conducted in 120 residences and 60 shops, more than 90% of the residences and shops not receiving collection services wish for services. (As for the breakdown, 50% is willing to pay 100 to 500 kips/month/household and 40% is less than 100 kips/month/household).

v. Collection fee

There is no clear tariff on the collection fee of DCTC and the private companies. The collection fee is decided basically by negotiation in consideration of the amount of discharge and collection frequency.

Although the results of the CCS indicated that an average residence pays about 500 kips/month for collection services, the results of the interview to DCTC and three private contractors indicated a collection fee of about 1,000 kips/month for once a week collection services. This is due to the differences of collection frequencies, i.e. 500 kips for twice a month and 1000 kips for once a week collection services. In addition, as discribed in section 4.5, the nominal income quite differs from the actual income in Vientiane.

The Study Team, therefore, concluded that although it differs from the results of the CCS, the average collection fee for the average family in terms of family members would be about 1,000 kips/month for once a week collection and this collection fee was applied to both the Basic Plan and the collection experiment in order to maintain the present collection fee tariff of DCTC and private contractors. Further the collection fee of waste for irregular collection services is 250 kips per bamboo basket.

In the collection experiment which was conducted at the non-collection area, even in the condition of the collection fee of 1000 kips/month, 30% of families in the area entered into contracts for collection services. According to the CCS conducted one month after the commencement of the experiment, all of the families still wished to receive the colletion serivices even in the condition of 1000 kips. It is, therefore, concluded that with the collection fee of 1000 kips the collection ratio can be expanded from 30% to 50% by 1995.

w. Public cooperation

Public cooperation is inadequate in Vientiane urban area and the major reasons behind this are as follows :

. Vientiane Municipality has not clearly and strongly specified the role of the public to the public.

. The Municipality does not strongly exercise the laws and regulations.

. Inadequate public education for children at home and in schools.

3. Basic Plan

3.1 Goal

The goal of the Basic Plan is as follows:

"Development and Realization of a Beautiful and Clean Living Environment in Vientiane urban area towards the 21st Century through Citizen's Participation and Establishment of Self-Sustainable Solid Waste Management"

The following should be implemented to attain the above goal.

a. Establishment of a self-sustainable solid waste management system.

b. Provision of a collection service in the whole Vientiane urban area and establishment of a reliable collection system under which regular services can be provided.

c. Construction of a sanitary landfill (Level 3) which employs sufficient measures for environmental protection.

d. Establishment of efficient road sweeping, drain cleansing and grass cutting system through public cooperation.

e. Establishment of Beneficiary-Pay-Principle under which service recipients pay waste collection fees and tipping fees.

f. Establishment of proper legislation and regulations through the modification and revision of the existing ones.

g. Establishment of proper roles of the organizations involved in solid waste management.

h. Strengthening of the management and administration system.

i. Development of public participation and education programs.

j. Development of human resources involved in solid waste management.

k. Securing funds for the capital investment for the equipment and facility necessary for the realization of the goal, specially during the time of take off.

3.2 Projection of Future Population and Waste Amount and Composition

The future population by the year 2000 is projected based on the annual growth rate (3.4%) given by the DPF, VM (Department of Planning and Finance, Vientiane Municipality).

Future solid waste amount by the year 2000 is estimated and tabulated in Table 3.

Only negligible changes can be predicted in the waste composition by the year 2000.

Table 3 Future Solid Waste Amount

Items	Unit	1991	1995	2000
Population	person	142,723	163,146	192,832
Collection Service Ratio in Residential Area	%	4.8	50	*1 100
Collection Service Ratio in Commercial Area	%	22.3	60	*1 100
Generation Waste Amount	ton/day	140.8	160.8	190.1
Total Recycling Amount	ton/day	23.8	26.9	31.7
- Food Waste	ton/day	(21.8)	(24.9)	(29.4)
- Reusable Materials	ton/day	(2.0)	(2.0)	(2.3)
Self-disposal Waste Amount	ton/day	99.8	61.7	5.2
Collection Waste Amount	ton/day	13.9	68.3	148.2
Disposal Waste Amount	ton/day	17.1	72.3	152.9

注) *1 : Although the collection ratio of 100 % is considerably high in comparison of the present ratios, it may be possible because the Study area (the Vientiane urban area) is small and only about 30 km^2 (the total area of the Municipality is 3,920 km^2.) and there is no area where collection service could be not provided physically. Moreover, the population ratio of the Study area to whole Municipality is 34 %.

3.3 Selection Method of an Optimum Alternative

1) System Components in SWM

The SWM (Solid Waste Management) system consists of technical and institutional systems. The technical system consists of the following sub-systems:

- discharge and storage
- collection and haulage (transportation)
- roads sweeping, drain cleansing and grass cutting
- processing and recycling
- final disposal
- equipment maintenance

In addition to the above-mentioned technical sub-systems, SWM system contains the following institutional sub-systems:

- organization and management
- legislation and enforcement
- finance (revenue source)
- public cooperation

2) Selection Method of an Optimum Alternative

An alternative to the SWM system is a combination of various technical sub-systems such as discharge and storage system, collection and haulage system, road sweeping, drain cleansing and grass cutting system, processing system and final disposal system. Many alternatives can be made by the combination of possible sub-systems.

Consequently, the following method was applied in the Study for the selection of an optimum alternative for the Basic Plan.

a. Selection of an optimum technical system

i. examination of technical sub-systems

Possible sub-system alternatives for each technical sub-system were examined and optimum sub-systems were selected.

ii. examination of combinations of technical sub-systems

A comparative study on the technical systems of the 3 sites below was carried out by combining each technical sub-system.

Case 1: Final disposal site is at Km 18-DS

Case 2: Final disposal site is at DCDS
(Dongphosi Candidate Disposal site)

Case 3: Final disposal site is at NCDS
(Noensaard Candidate Disposal Site)

iii. selection of an optimum technical system

Upon consideration of the results of the above-mentioned three alternative studies, an optimum technical system was selected by evaluating the following aspects:

a; technical points of view;
b; economic and financial points of view;
c; transactional facilitation points of view; and
d; environmental points of view.

b. Selection of the optimum institutional system

After the selection of the optimum technical system, a study was also made to generate alternatives for the organizationsal, institutional and financial aspects which would be suitable to the selected technical system. After the comparative study on the above-mentioned alternatives, an optimum SWM system was finally selected.

3.4 Selection of an Optimum Alternative

1) Alternative Plans

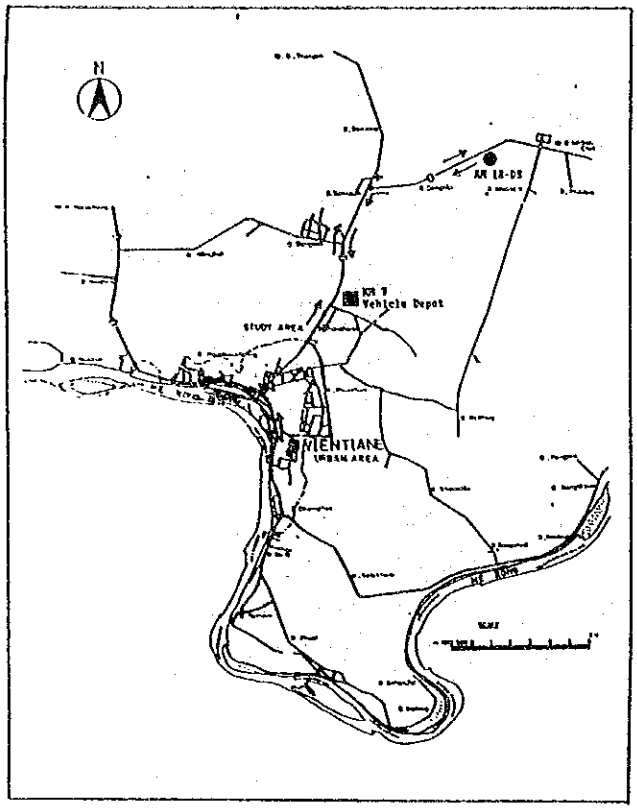
As clearly concluded in 2.4, it is not necessary to introduce a processing facility including a recycling system by the year 2000. Then, proper systems for discharge and storage, collection and haulage, road sweeping, drain cleansing and grass cutting, and final disposal were selected.

In view of the above, it was decided that the present Study should evaluate the 3 alternative plans to examine the possibility of implementing solid waste management in Vientiane Municipality, by considering the geographical and socio-economic conditions of the Municipality.

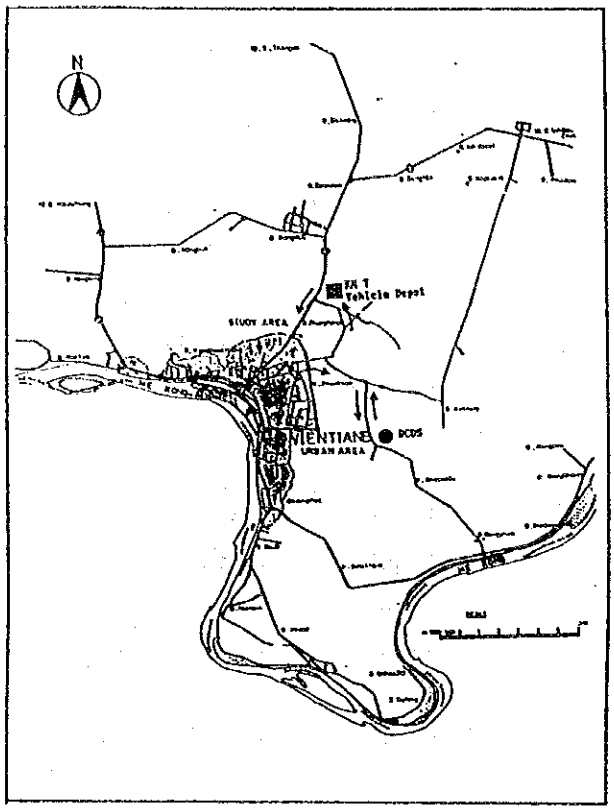
In this Study, three alternative plans, as shown in Fig.1, were studied for the formulation of the Basic Plan for Vientiane urban area. The concept of each alternative is as follows:

a. Alternative 1; Final Disposal Site at KM 18-DS

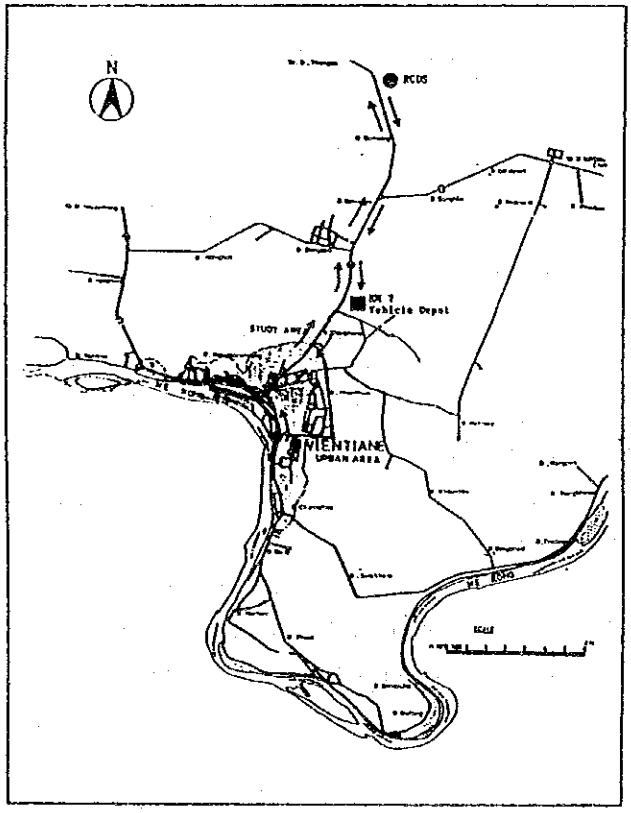
Alternative 1 is presented as a disposal system providing sanitary landfill operation at the existing KM 18 disposal site (KM 18-DS). All wastes would be hauled directly to the disposal site without using transfer stations nor processing facilities.



Alternative 1: Final Disposal Site at KM 10-DS



Alternative 2: Final Disposal Site at DCDS



Alternative 3: Final Disposal Site at PCDS

LEGEND

● : Disposal Site

■ : Vehicle Depot

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Fig. 1 Summary of Alternative Plan

b. Alternative 2; Final Disposal Site at DCDS

Alternative 2 is presented as a disposal system providing sanitary landfill operation at the Dongphosi candidate disposal site (DCDS). All wastes would be hauled directly to the disposal site without using transfer stations nor processing facilities.

c. Alternative 3; Final Disposal Site at NCDS

Alternative 3 is presented as a disposal system providing sanitary landfill operation at the Noensaard candidate disposal site (NCDS). All wastes would be hauled directly to the disposal site without using transfer stations nor processing facilities.

2) Selection of an Optimum Alternative

a. Evaluation criteria

The four evaluation criteria used for highlighting the distinguished features of the alternatives are:

- technical desirability;
- economic/financial viability;
- transactional facilitation requirements; and
- environmental acceptability.

The alternatives identified were ranked quantitatively and qualitatively based on the above-mentioned evaluation criteria. The methodology used for environmental evaluation, individual rankings (for the four criteria above) and obtaining the overall ranking is a simplified version of the multiple criteria evaluation method called "Electre". Without assigning any subjective weight, the predominant characteristics of certain alternatives over others became apparent.

b. Selection of an optimum alternative

The summary of the evaluation results based on each of the four evaluation criteria are presented in a matrix form in Table 4.

Table 4 Overall Evaluation

	Alternative 1	Alternative 2	Alternative 3
Technical Aspect	A	B	A
Economic Aspect	A	C	B
Transactional Aspect	A	C	B
Environmental Aspect	A	C	B
Overall Ranking	1	3	2

The matrix implies the following overall ranking of alternatives.

i. Alternative 2 is dominated by Alternative 1 and 3 regardless of any set of weights to be associated with the evaluation criteria.

ii. Alternative 3 is dominated by Alternative 1, regardless of any set of weights to be associated with the evaluation criteria except for the technical aspect.

iii. Alternative 1 is not dominated by any other alternative. Therefore, it may be considered to be the best alternative.

In view of the foregoing evaluation results, the solid waste management system to be established in the Vientiane urban area by 2000 should be Alternative Plan 1.

3.5 Outline of the Basic Plan

The main frames of the technical and institutional system proposed in the Basic Plan are described as follows:

a. Technical system

- Extension of collection service to the whole population of the Vientiane urban area; and
- Execution of sanitary landfill for disposal of solid waste collected.

b. Institutional system

- Establishment of a definite organization responsible for SWM, which may be set up as a new Urban Service Department; and
- Establishment of a stable financial system.

In view of the present defective SWM, especially with regard to its very limited financial resources, in order to achieve the goals and target of the Basic Plan, a stepwise improvement plan until 2000 is proposed in the following manner:

Category of Plan	Target Year
- Basic Plan	1992 ~ 2000
- Immediate Improvement Plan	Present to 1994
- Short Term Improvement Plan for Feasibility Study	1995 ~ 1997
- Medium Term Improvement Plan	1998 ~ 2000

The targets and contents of the Basic Plan are described in Table 5 below.

Table 5 Outline of Basic Plan (1)

	1991	1995	2000
1. Collection			
① Population (person)	142,700	163,100	192,800
② Service Population (person)	6,800	81,500	192,800
③ Non-Service Population (person)	135,900	81,500	0
④ Collection Service Ratio (%)	4.8	50.0	100.0
⑤ Collection Amount (ton/day)	13.9	68.3 (58.3)*1	148.2 (138.2)*1
⑥ Collection System	Curb collection and bell collection for the residential and commercial area by close dumptrucks and station collection for the institutions by detachable container trucks and containers (5 m³).		
⑦ Main Equipment			
- Close Dump Truck (Unit)	7 *2	14	36
- Detachable Container Truck (Unit)	-	3	3
- 5 m³ Container (Unit)	-	31	31
2. Road Sweeping, Drain Cleansing and Grass Cutting			
① Service Area by VM (km)	15	15	15
② Cleansing Activity through Public Cooperation (No. of Ban)	0 (0%)	48 (50%)	96 (100%)
③ Length of Road for Sprinkling Water (km)	0 (0%)	150 (65%)	230 (100%)
④ Main Equipment			
- 5 m³ Container (Unit)	-	9	9
- Small Dump Truck (Unit)	-	3	5
- Wheel Loader (Unit)	-	1	1
- Water Truck (Unit)	1	2	3
- Grass Cutter (Unit)	-	10	10
3. Final Disposal			
① Disposal Amount (ton/day)	17.1	72.3	152.9
② Disposal Site	KM 18-DS	KM 18-DS	KM 18-DS
③ Sanitary Landfill (ton/day)	0	72.3	152.3 *3
④ Ratio (%)	0	100	100
⑤ Level of Sanitary Landfill	Crude Open Dumping	Level 2	Level 3
⑥ Main Equipment			
. Bulldozer (Unit)	-	1	1
. Hydraulic Excavator (Unit)	-	1	1
. Dump Truck (Unit)	-	1	1
. Water Truck (Unit)	-	- *4	1

Table 5 Outline of Basic Plan (2)

	1991	1995	2000
4. Operation & Maintenance of Equipment			
① Vehicle Depot	Headquaters of DCTC (Site Area 9,000 m²)		
② Maintenance Shop	Headquaters of DCTC	KM 7 Maintenance Shop	
③ Main Equipment	Only Simple Hand Tools	Car Washer, Repairing Tools, etc.	
5. Operation			
① Organization	Cleansing Section of DCTC	Urban Service Department	
② Number of Personnel (person)	67	197	336
6. Financial Sources (million kips)			
① Fee Collection			
Basic Fee	11.5	241	706 *5
Extra Fee	-	65	167 *5
Special Fee	-	14	27 *5
Tipping Fee	0.4	2	3 *5
② VM Budget for SWM	10.5(0.3%) *6	210(3.8%) *6	469(5.7%) *6
③ Total of SWM Budget	22.4	532	1,372
④ Municipal Budget	3,553	5,550 *7 (estimated)	8,211 *7 (estimated)

Note:

*1 : The figures in parentheses are the collection amounts by Vientiane Municipality.

*2 : All are open dump trucks or open trucks. Among them 3 units are completely out of order.

*3 : The difference of waste amount (4.7 ton/day) between collection amount and disposal amount is derived from direct hauled amount.

*4 : A water truck for road sprinkling work will be used for sprinkling water at the KM 18-DS when necessary.

*5 : Each fee will increase in 1998 as described in the section 1.5, Key Assumptions.

*6 : ② VM Budget/④ Municipal Budget

*7 : The budget of VM is assumed to increase in accordance with the increase ratio of the GRDP plus inflation ratio of 3%.

4. Feasibility Study

4.1 Implementation of Immediate Improvement Plans

1) Immediate Improvement Needs

Immediate improvement needs have been identified based on the following criteria, and based on these needs, the immediate improvement plans were prepared and most of the plans prepared were implemented in the Study period.

a. Possibility of immediate improvement;

b. Efficient use of existing resources without requiring large investments;

c. Achievement of tangible improvement effects in a short time;

d. Possibility of becoming a model for future improvement.

There are two types of immediate improvement needs as shown below:

a. Improvement needs in crucial areas with specific problems.

b. Improvement needs to demonstrate the feasibility of introducing a future system (e.g. Pilot project for collection experiment and experiment on sanitary landfill operation).

2) Implementation of Immediate Improvement Plans

Based on the immediate improvement needs, immediate improvement plans were prepared and most of the plans were successfully implemented in the Study period. Among these, the following major aspects were implemented during the Study period.:

- preparation of weekly and monthly working schedule;

- collection of data on amount of waste collected;

- stimulation of community cooperation for cleaning-up activities;

- securing land and authorization for the use of the KM 18-DS;

- improvement of basic knowledge of the DCTC operators and mechanics;

- execution of regular maintenance;

- assignment of the person in charge of planning and management;

- improvement of accounting system;

- improvement of fee collection system;

- collection of data for operational expenditure; and

- preparation of an education program for the primary school.

4.2 Execution of Pilot Project

1) Purpose of the Pilot Project

There are many improvement measures stated in the Basic Plan. In terms of the technical system for the Basic Plan, the following two are the main objectives:

a. Extension of collection service to the whole population of the Vientiane urban area; and

b. Execution of sanitary landfill for disposal of solid waste collected.