Department of Communication,
Transport, Post and Construction
Vientiane Municipality
LAO PEOPLE'S DEMOCRATIC REPUBLIC

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR IMPROVEMENT
OF THE SOLID WASTE MANAGEMENT SYSTEM
IN VIENTIANE URBAN AREA
IN
LAO PEOPLE'S DEMOCRATIC REPUBLIC

MARCH 1996

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)
KOKUSAI KOGYO CO., LTD.

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PREFACE (draft)

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

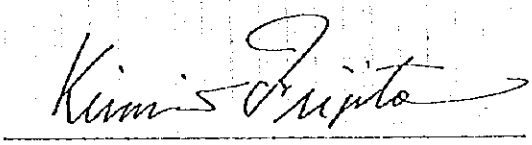
JICA sent to Laos a study team from September 10 to October 9, 1995.

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

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

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

March, 1996



Kimio FUJITA
President
Japan International Cooperation Agency

March, 1996

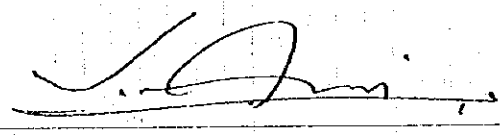
Letter of Transmittal (draft)

We are pleased to submit to you the basic design study report on the Project for Improvement of the Solid Waste Management System in Vientiane Urban Area in Lao People's Democratic Republic.

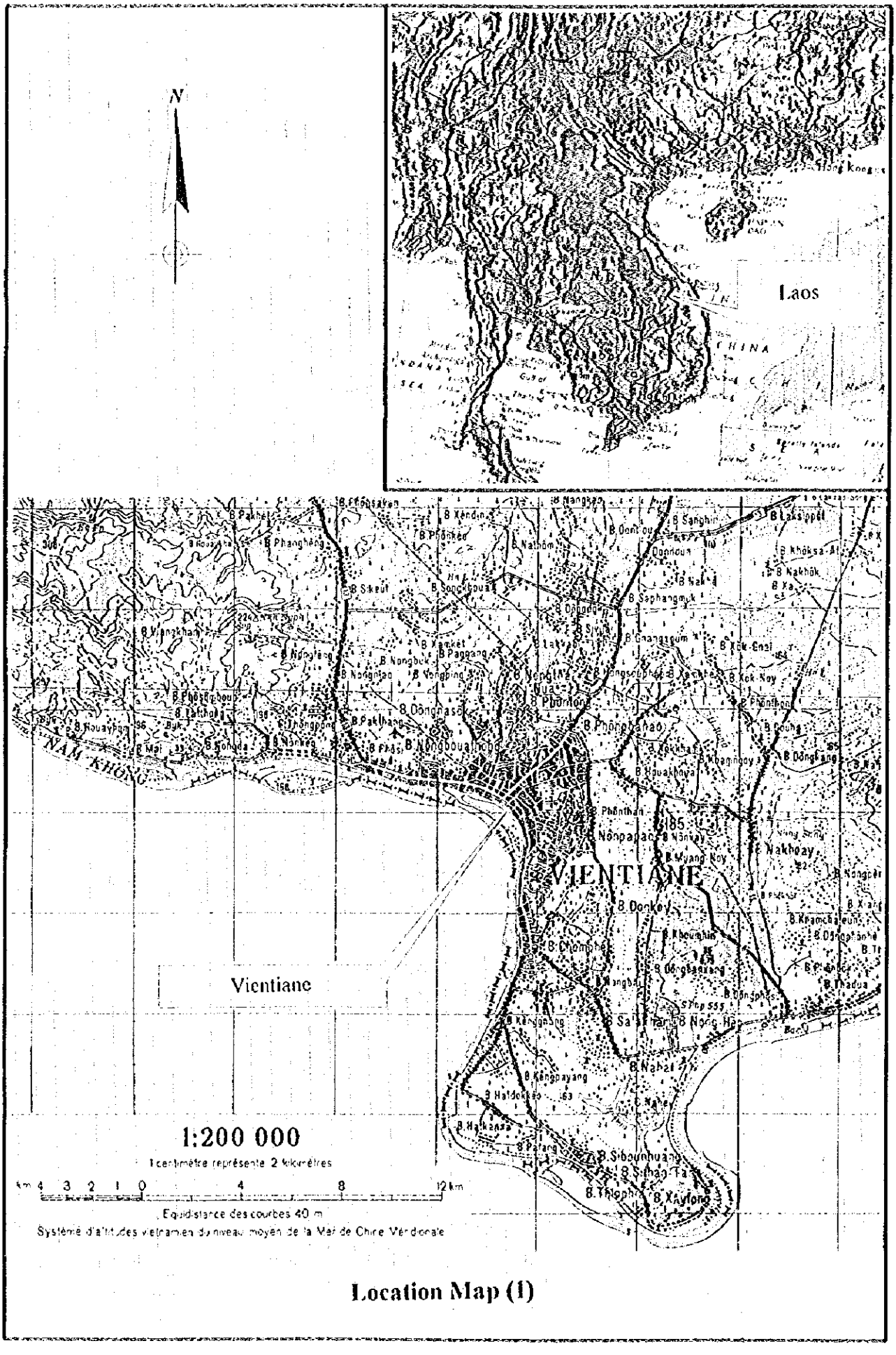
This study was conducted by KOKUSAI KOGYO CO., LTD., under a contract to JICA, during the period from September 5, 1995 to March 4, 1996. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Laos and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

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

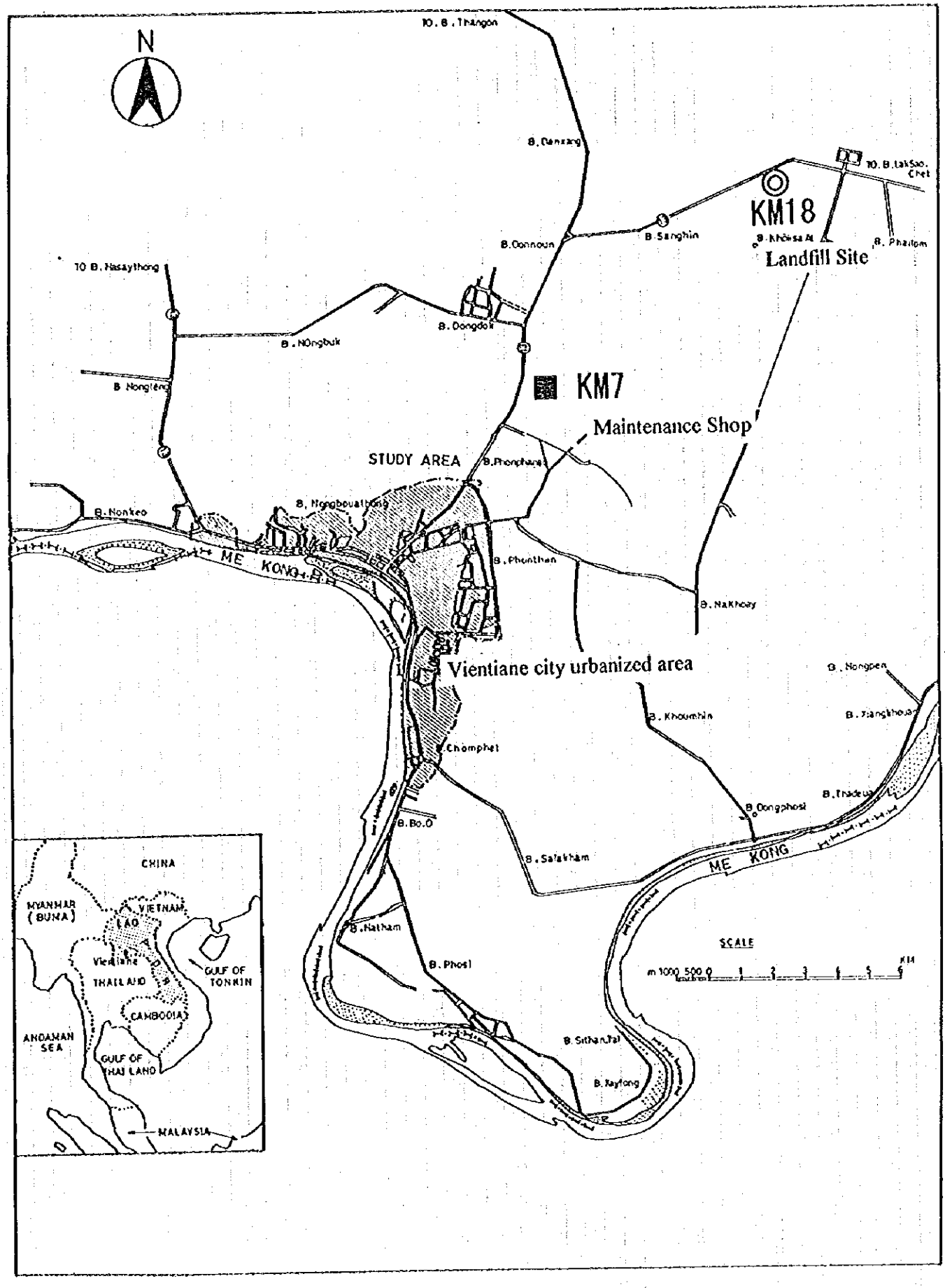
Very truly yours,



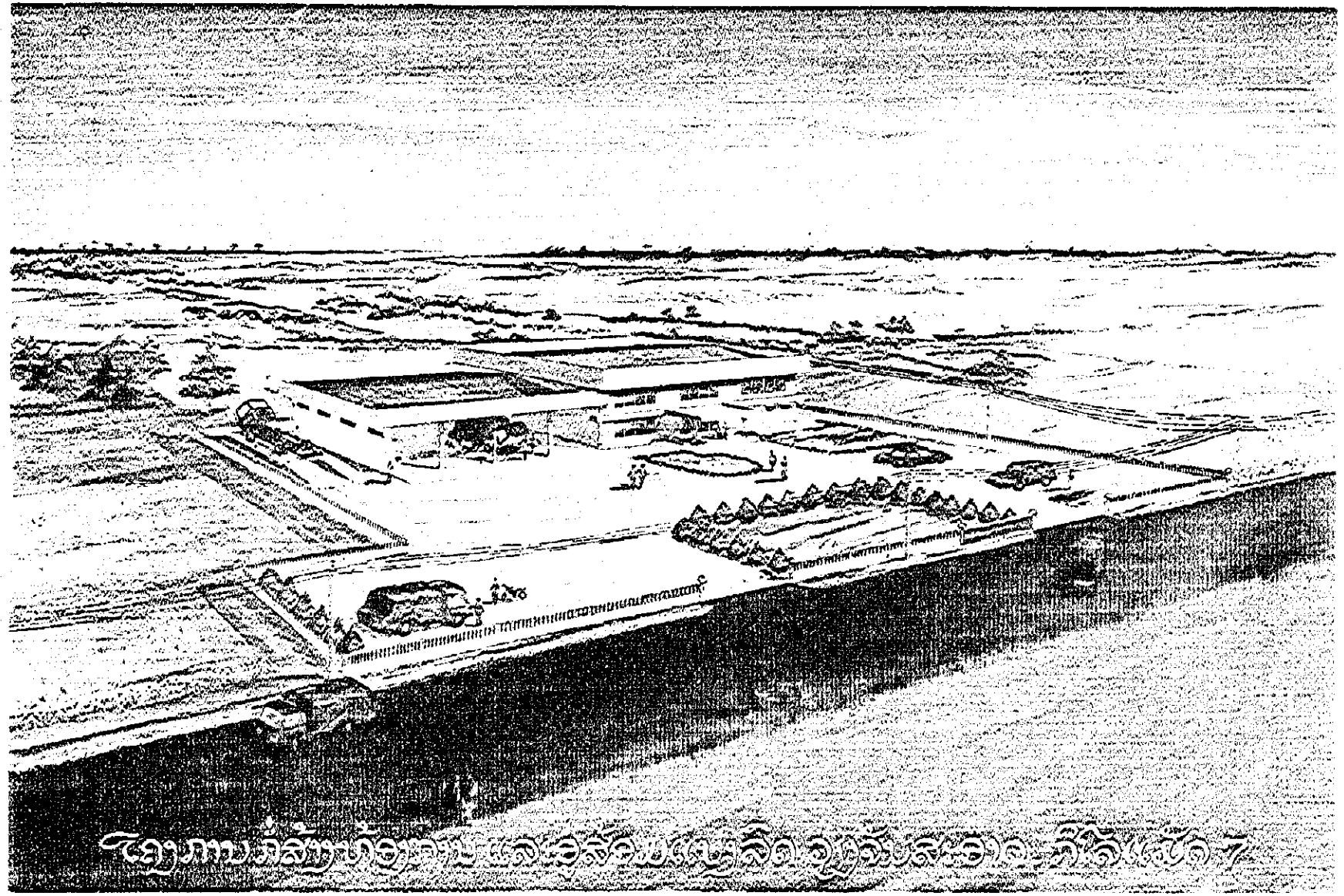
Junji ANAI
Project Manager,
Basic design study team on the Project for Improvement of the Solid Waste Management System in Vientiane Urban Area in Lao People's Democratic Republic
KOKUSAI KOGYO CO., LTD.



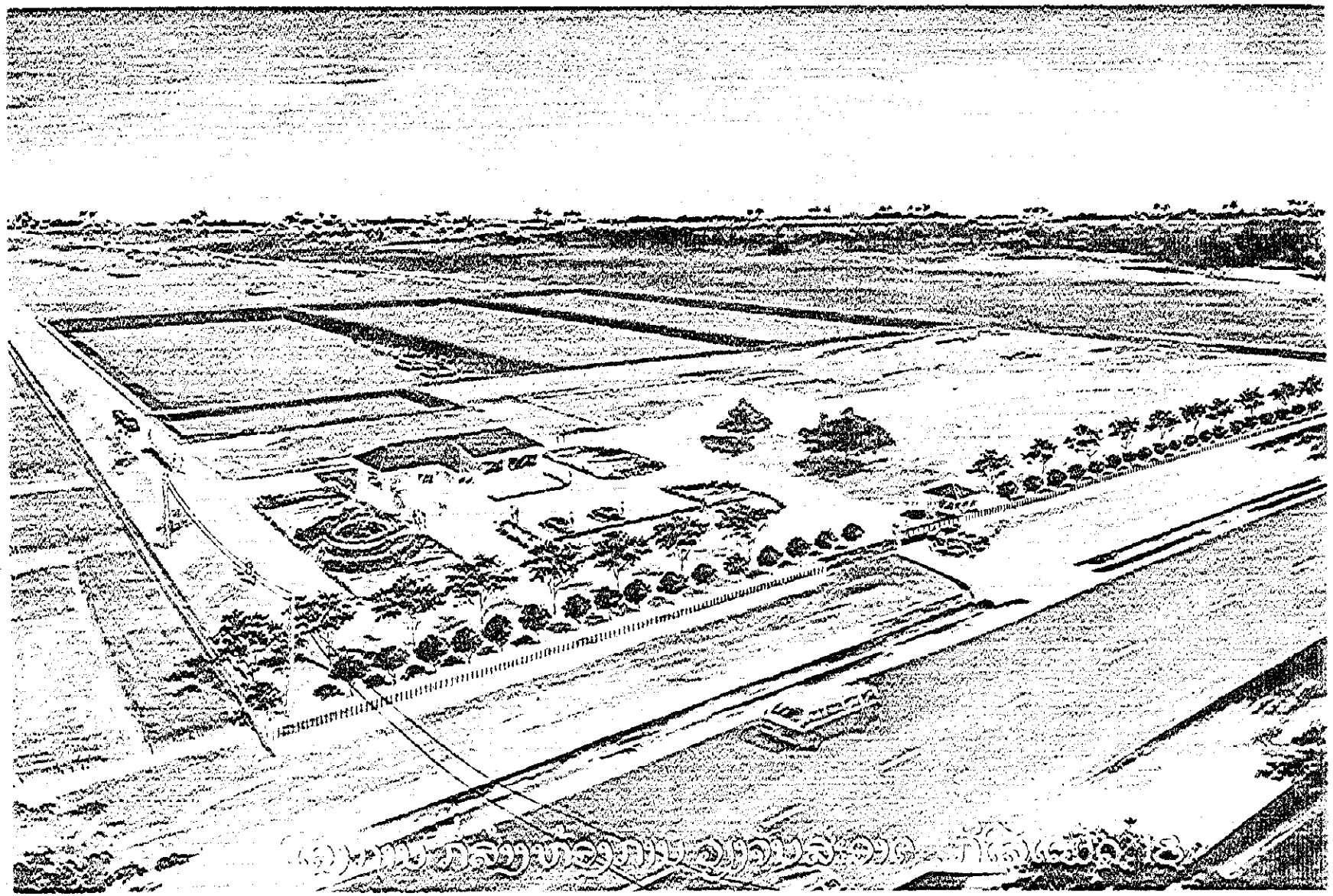
Location Map (1)



Location Map (2)



Bird's eye view of KM7 Maintenance Shop



Bird's eye view of KM18 Landfill Site

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CHAPTER 1 BACKGROUND

The People's Democratic Republic of Lao (Laos) is a landlocked country situated in the central area of the Indochina Peninsula. It covers a territory of 236,800km² and has an estimated population of 4,400,000 (1992). Vientiane, the capital city, is 3,920km² and is administratively divided into 8 districts. In 1991, the population of Vientiane was estimated at 424,717, 10% of the national population.

The cleansing unit under the Department of Communications, Transport Post & Construction (DCTPC) of Vientiane conducts road sweeping services, and collects the wastes of public institutions (e.g., government offices, hospitals) and general offices. It also collects general household wastes and market wastes in cooperation with private waste collection companies. The inefficiency in the collection system has resulted in poor collection rates: 13% in housing areas, 22% in commercial and business areas. Uncollected waste is illegally disposed of in the Mekong River, city drains, or the vacant lots found in various parts of the city, consequently clogging the drains, breeding harmful insects, and producing annoying odor problems. Open burning of wastes in backyards on the other hand pollutes the air, bringing about environmental problems that could jeopardize the health of the citizens of Vientiane.

Acknowledging the considerable urgency and importance of the long term improvement of the waste management system in respect to urban planning, the government of Laos aims to improve the aforementioned conditions and requested the conduct of a development study from the government of Japan. In response, the Japan International Cooperation Agency (JICA) conducted the master plan study and feasibility study, targeting the year 2000, for the improvement of the waste management system in the urban areas of Vientiane, and compiled the final report in 1992.

In accordance with the results of the development study, the government of Laos requested grant aid from the Japanese government for the implementation of the short - term improvement plan which consists of the procurement of waste collection & haulage equipment, improvement of the final disposal site, and the construction of a maintenance workshop.

CHAPTER 2 CONTENTS OF THE PROJECT

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2-1 Objectives of the Project

In 1992, the Japan International Cooperation Agency (JICA) conducted a development study on solid waste management in the urban areas of Vientiane. And the waste plan for the solid waste management system in Vientiane urban area, targeting the year 2000 was established in this study.

Proposed in this plan were: extension of the collection service area, carrying out of sanitary landfill operations, establishment of a new solid waste management system, and the creation of a new financing system. These projects which were given the highest priority were enlisted in the *short - term improvement plan* in the Master Plan.

- Extension of the collection service area
- Establishment of an appropriate transfer system for institutional wastes
- Establishment of public cooperation for cleaning up roads and drains
- Improvement of the operation and maintenance system
- Construction and running of a sanitary landfill (level 2) on the existing KM-18 landfill site.

Note: Sanitary landfill level 2 involves the immediate covering of hauled waste to prevent the scattering of waste and the production of obnoxious odor; it does not include leachate treatment measures.

During the development study a community awareness survey, waste collection experiment, sanitary landfill experiment, and public education campaign were also carried out to assess the feasibility of the short term improvement plan (hereafter referred to as the F/S). According to the results of the F/S the following recommendations were made: procurement of collection and haulage equipment, construction of a final disposal site, and construction of a maintenance workshop. These recommendations have been given priority and are hence the objectives of this grant aid project (hereinafter referred to as "the Project").

2-2 Basic Concept of the Project

2-2-1 Review of the Request

(1) Contents of the request

The contents of the original request to the Japanese government by the Laotian government was submitted based on the results of the F/S. Through discussion with the Laotian side the contents of the request were modified as follows;

- to include infectious medical waste in the waste to be collected in the Project.
- to include the installation of water supply facilities for residents in the vicinity of the KM-18 disposal site
- to add following equipment :
  - one collection and haulage vehicle for infectious waste
  - one dump truck for soil
  - one crawler type loader
  - one truck scale

The contents of the request including the above modifications were examined according to the results of a review of the F/S and a site investigation.

(2) Target

The target of the Project is to implement the short term improvement project defined in the Master Plan, which includes the procurement of equipment and construction of the facilities for the proposed solid waste management system. However the waste to be treated in the Project does not include an industrial waste. The target year of the Project is 1998, though it was originally set in 1995 in the Master Plan. Therefore the basic study for the procurement of equipment and construction of the facilities will be done according to the amount of waste forecasted for 1998.

Table 2- 1 Comparison Table of Basic Condition

Item	Original Request based on F/S		Basic Design	
1. Target Year	At time of F/S (1991)	1995	Present (1995)	1998
2. Project Area	urban area	urban area	urban area	urban area
3. Collection ratio				
Residential	4.8%	50%	12.4%	48%
Commercial	22.3%	60%	22.1%	60%
4. Whole population	142,723	163,100	163,100	180,400
Service population	6,850	81,500	8,644	86,592
5. Generation amount (ton/day)	140.8	160.8	162.0	179.0
6. Collection amount (ton/day)	13.9	68.3	26.5	75.6
Municipality (ton/day)	6.1	58.3	9.2	65.6
Private B (ton/day)	-	-	7.4	-
Private A (ton/day)	7.8	10.0	9.9	10.0
7. Road sweeping (km)	15.0	15.0	28.6	30.0
8. Public cooperation (*van*)	0	48	0	48
9. sprinkling road (km)	0	150.0	0	150.0
10. Recycle amount (ton/day)	23.5	26.9	26.9	29.7
11. Self disposal amount (ton/day)	99.8	61.7	105.9	70.4
12. Disposal amount (ton/day)	17.1	72.3	28.9	78.6
13. Level of sanitary landfill	Open dumping	Level-2	Open dumping	Level-2
14. Infectious medical waste (ton/day)	included in collection amount	-	included in collection amount	0.25

(3) Procurement of collection and haulage equipment

a. Planned collection ratio

The planned collection ratio in the Master Plan has been calculated by weighted average.

- Priority area where the population density is more than 70 persons per hectare 75 %
- Other areas 25 %
- Planned collection ratio = 50 %

In this Basic Design, the collection ratio was reexamined considering the factors having an effect on the collection works such as the distribution of residences and road conditions.

The following collection ratios were given to the domestic, commercial, market and office, hospital, and road sweeping waste, because the collection system for each type of waste are different.

• Domestic waste	The project area was divided into high density area, medium density area, and low density areas according to present conditions such as distribution of residences and road conditions. And the target collection ratios for each urban area are set as follows; - High density: 90 % - Medium density: 50 % - Low density: 25 % The weighted average of the collection ratio of project area is therefore calculated to be 48%.
• Commercial waste	The present collection ratio is 22.1% according to the basic design study. The collection ratio for the commercial waste could be more than that of domestic waste, because most of shops are located in the higher density area. Therefore the planned collection ratio of commercial waste is 60%.
• Market & office waste	The collection ratio of market and office waste is 100%. Presently, private companies collect waste from certain parts of the markets. It is assumed that the amount of waste collected by the private companies will remain the same. Consequently the municipality will collect the remaining market and office waste.
• Hospital waste	100% of hospital waste should be collected. Hospital waste consists of the general waste and infectious waste. Infectious waste will be collected by a collection system completely independent from the collection of general waste, to prevent secondary infection,.

- Road sweeping — The length of the road the municipality undertakes sweeping is 28.6km (say 30 km). It is assumed that the length of road sweeping will not change because there are no concrete plans for road development at present.

b. Utilization of private collection companies

Collection of the wastes are undertaken by the municipality itself and in addition by two big companies contracted, Lao Garbage(LG) and Vientiane Phatana(VP) and 6 small companies contracted. LG and VP are operating under official contract with the Department of Communication, Transport, Post and Construction (DCTPC), and the other 6 companies are operating under temporary contracts with the cleansing unit of the municipality. DCTPC has a policy of utilizing private companies for partial waste collection in certain areas.

DCTPC plans to entrust the two big companies with collection works and dissolve the temporary contracts. Therefore the municipal collection equipment planning was based on the waste amount excluding the waste hauled by these two companies.

The collection area covered by LG and VP includes the Wattay, Sokpaluang, and Souane Monne areas. The collection areas of these companies are assumed not to change in the future, and the collection amount will be maintained at the present level ; 10 ton/day.

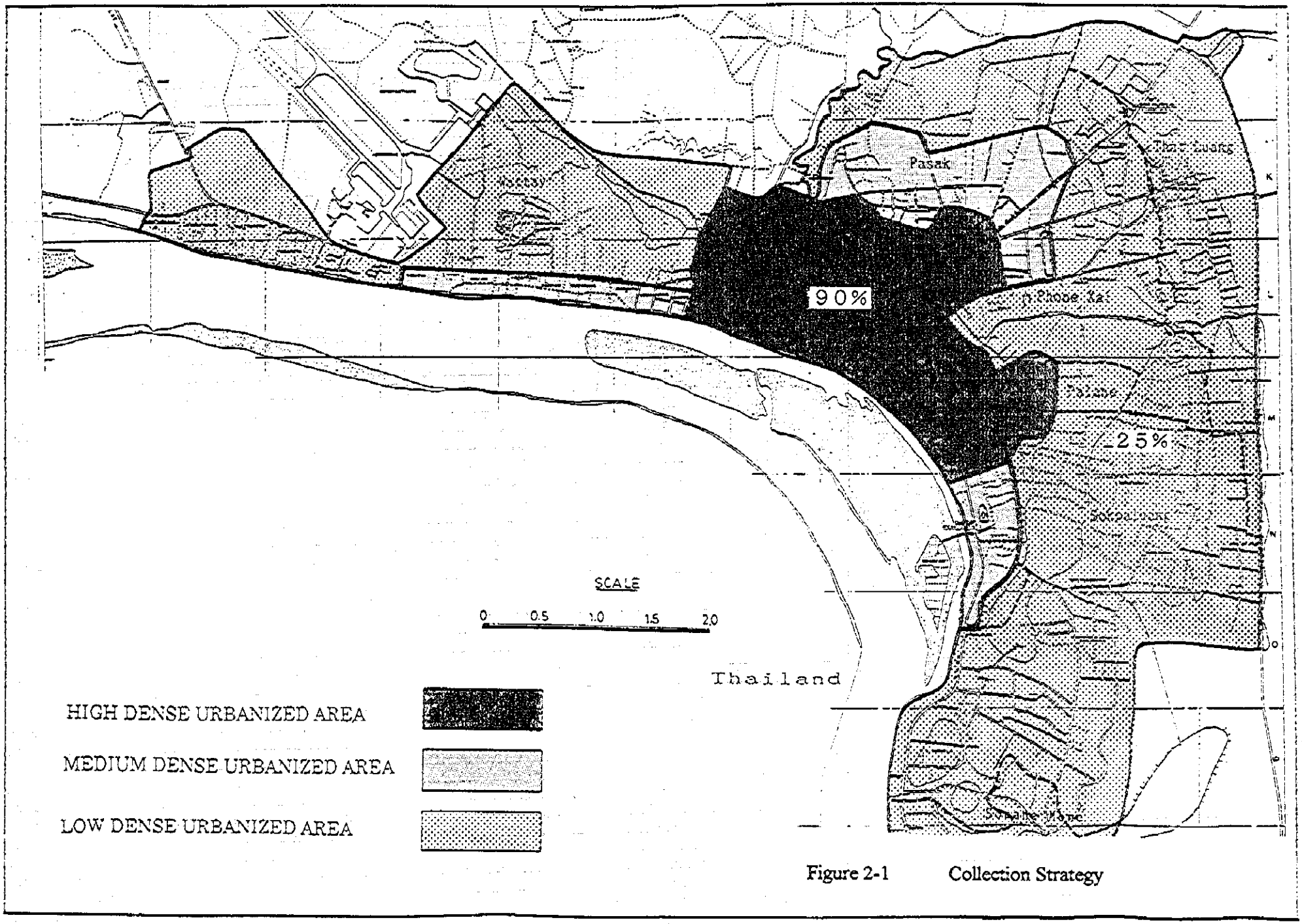


Figure 2-1 Collection Strategy

(4) Construction of final disposal site

a. Basic concept for improvement

The capacity of the landfill equipment is planned to correspond with the disposal amount in 1998.

Meanwhile, the medium term improvement project commencing after 2000 is planned to establish a level-3 sanitary landfill including leachate treatment. For achieving of this target, the facilities required for operating a level-2 sanitary landfill are planned to be constructed in this Project as the first step of improvement.

b. Basic concept of leachate treatment

Phased improvement of the leachate treatment from an environmental point of view

· present	Rainwater passes through the disposed waste entering the ground and spreads out into the surroundings, mainly because the disposed waste is not covered with soil.
· short term	The amount of leachate will be reduced considerably by carrying out sanitary landfill as the permeation of rain water will be prevented by the covering soil. The surface rain water will drain separately from the leachate. However the leachate will still permeate into the ground.
· medium term	The leachate will be collected and returned back to the disposed waste (leachate circulation system) preventing outflow.

c. Installation of fixed truck scale

Measuring and recording the waste hauled into the final disposal site is vital for proper solid waste management. Usually, truck scales are used for measuring the weight of vehicles plus the waste. The truck scale

shall be fixed as it will be used for a long period and various kinds of vehicles will be weighed. A portable type truck scale was used in the F/S and donated by JICA after the study, operating for almost two years. This truck scale was designed to be used anywhere, but its capability was limited. After 2 years of use, the portable truck scale was worn out. Municipal staff are presently measuring the hauled waste by eye.

Therefore installation of the fixed type truck scale is proposed to establish a measurement system. Also a personal computer shall be included in this system for smooth measurement and analysis.

(5) Construction of maintenance facilities

a. Outline of facilities

Construction of the maintenance facilities consists of a maintenance workshop and a cleansing head office at KM-7. Maintenance equipment for periodical and minor repairs of the collection and haulage equipment will be installed in the workshop. Office for the cleansing headquarters will be in charge of entire municipal solid waste management (MSWM).

b. Application of maintenance

Periodical maintenance and minor repairs will be able to be done in the maintenance shop.

Heavy repairs and overhauls shall be done in a commercial workshop.

(6) Treatment of infectious medical solid waste

The municipal cleansing unit is collecting all the medical waste at present and this operation cannot be ceased.

If the infectious waste can not be disposed of at KM-18, this waste must be disposed of sporadically within the municipal area. Refusing the infectious waste, will cause serious menace to the urban sanitary environment.

Consequently, the basic design study team decided that infectious waste should be included in the Project according to the following:

Examination

a. Improvement of the present condition

The infectious waste treatment consists of segregation at the generation source, intermediate treatment, haulage and final disposal. Education of the operators is also important to prevent secondary infection.

According to WHO, US-EPA and the manual Japan, incineration and sterilization by autoclave are the preferred methods for infectious waste treatment. Therefore incineration is recommended for the future treatment of infectious waste.

b. Final disposal methods considered

i) incineration :

For the construction of an incinerator at KM-18 the following matters should be considered;

- High running costs of the incinerator will affect the limited operation costs of MSWM.

  ex. Comparison of disposal costs

  incineration: 234kip/kg= 4,200,000 kip/month

  landfill: 90kip/kg = 1,645,000 kip/month

- There are national, municipal, and military hospitals, etc. in Vientiane. If the municipality will incinerate all the infectious waste generated from these hospitals, a lot of matters such as role assignment for operation should be discussed with concerned institutions. It will take so long time that the commencement of the Project shall be postponed.
- Operation of individual incinerator is uneconomical considering the small amount of the infectious waste generated from the small hospitals in Vientiane. It seems that the operation cost will exceed the financial capability of these hospitals.

ii) landfill:

Infectious waste collected shall be landfilled in a special area separated from the disposal area for general waste at KM-18, with daily covering.

The landfill method cannot sterilize the infections waste completely, so hazardous infectious waste containing diseases such as hepatitis, or rabies, etc. should be sterilized by autoclave or chemical treatment before collection at the hospital.

c. Practical measures

It seems difficult to install incinerators at the hospitals by the target year. Therefore the phased improvement shown below is practical with the final target being the installation of incinerators.

1st phase

• establishment of laws and regulations	M, N
• preparation of infectious waste management manual	M, N
• establishment of a manifest system	M, N
• preparation of storage container	hospital
• segregation of waste	hospital
• construction of discharge point	hospital
• education of waste supervisor	M, N, hospital
• establishment of independent collection system	M
• execution of landfill as a temporary disposal method	M

2nd phase

• establishment of final disposal method(incineration)	M, N
• preparation of environmental standards with introduction of incinerator	M, N
• installation of autoclave, incinerator etc. in the hospital.	hospital

note: N = task of national government, M = task of municipality

The Laotian side will complete the items listed under 1st phase before the opening of the Project. The Japanese side will assist the Laotian side to establish an independent collection system and temporary disposal method by procurement of collection vehicle and the construction of the landfill area for exclusive dispose of infections medical solid waste.

Execution of waste segregation and establishment of independent collection system shall be done at the same time. Hospital waste disposal officers reported that the infectious waste is presently not segregated from general waste; this is because the infectious waste is collected and disposed of together with the general waste by the collectors.

Introduction of an incinerator is not recommended since the running costs of incinerators would be disproportionally high and does not fit in the target of the Project establishing stable operation of MSWM. Therefore, landfill is recommended as a temporary disposal method for infectious waste.

In adopting the landfill method, quicklime shall be scattered on the infectious waste before covering with soil in accordance to WHO guidelines. It is expected that quicklime is efficacious against sterilization of infectious waste, because it causes an intense exothermic reaction with water, and becomes hard. The occurrence of this phenomenon is expected to prevent outflow of liquid from the infectious waste. There are many cities such as Mexico City and Critiba in Brazil using this landfill method for infectious waste, and no serious problems have been reported.

The planned treatment of infectious waste in the Project will improve the present dangerous situation and establish waste segregation and a collection-haulage system. Furthermore this system will be necessary for management of the proposed incineration method as a future treatment.

(7) Water supply to the surrounding residents of KM-18 disposal site

In the F/S it was recommended that the ground water around KM-18 disposal site should not be used for drinking because it might be polluted by the leachate. The Japanese side requested the Laotian side to carry out construction of the facilities for water supply during the basic design study. But the Laotian side replied they would not be able to do so because of budget constraint. Therefore, the Laotian side requested the Japanese side to include water supply in the Project.

Considering the following, drinking water will be supplied to the surrounding residents of the KM-18 disposal site.

- The ground water may be polluted by the waste.
- The KM-18 disposal site will be used more the 10 years after completion of the Project.

(8) Execution of public education campaign

Execution of public education campaign is not included in the Project in

spite of its importance as indicated in the F/S, because the undertaking of the campaign was defined as the matter of Laotian side. However it shall be included in the Project taking the following into consideration.

The physical and financial resources of both the service supplier (Vientiane municipality) and service user (residents) are not sufficient at present. To remedy this situation public participation in the cleansing activities is vital. Especially for ensuring the budget which is sufficient to cover the personnel expenses, running costs for the equipment will be procured etc.. Consequently execution of the public education campaign to stimulate people to participate and cooperate with MSWM is so important that the procurement of equipment for sanitary education campaign is considered to be included in the Project.

2-2-2 Basic Concept of the Project

(1) Procurement of collection and haulage equipment

a. Overall concept

The waste amount Vientiane municipality and private companies will have to collect in 1998 is estimated at 75.6 ton/day to achieve the target defined previously. The municipality will have to collect the waste amount of 65.6 ton/day, through on appropriate collection system as shown in table 2-2.

The amount of recycle, self disposal and direct haulage which are not collected by the service are respectively 29.7, 70.4 and 3.0 ton/day.

Table 2- 2 Outline of Planned Discharge, Storage, Collection and Haulage System

Generation Source	Discharge & Storage	Collection & Haulage	Discharge frequency
1. Domestic Waste - H & M density - Low density	Bamboo basket or Plastic bag	- Compactor truck - Dump truck	once a week
2. Commercial Waste	Bamboo basket or Plastic bag	- Compactor truck	once a week
3. Market Waste	container($5m^3$)	Detachable container truck	when necessary
4. Office Waste	Container($5m^3$)	Detachable container truck	when necessary
5. Hospital Waste (general) - Large Hospitals - Small Hospitals	- Container($5m^3$) - Bamboo basket or Plastic bag	Detachable container truck Compactor truck	when necessary
6. Road Sweeping - Road sweeping - Sprinkling road - Drain cleaning - Grass cutting - Cleansing Act.	Container($5m^3$) - heaping on the road - heaping on the road	Detachable container truck Water tanker Wheel loader & Small DT Grass cutters Wheel loader & Small DT	everyday (exc. Sun.) once a week once in 6 months once in 2 months once in 2 months
7. Infectious Medical Waste	Plastic bag inside cardboard box	Special truck for the exclusive use for IW	everyday (exc. Sun)

b. Equipment planning

Equipment for collection and haulage of general waste are listed in above table. Compactor truck and special truck for exclusive use for infectious waste were added to the original request according to the following.

i) Compactor truck ($8m^3$)

Presently entire waste collection and haulage in the Vientiane municipality is done by dump trucks. The dump truck was also recommended in the F/S as a collection vehicle according to the following reasons;

- The waste was difficult to compact because the soil content of the waste was high at that time.
- The road condition was so bad in 1991 that vehicles with small space under the deck such as compactor truck could not operate properly.

The current collection method consists of a collector, walking beside

the truck, he lifts up bamboo baskets filled with garbage handing it to a worker who loads the waste onto the truck. Efficiency of manual loading is low. In addition to this, the collection worker is at a risk of being injured by the waste. Therefore the present loading method should be improved.

The introduction of compactor trucks which is a very popular collection method was examined for improving the collection system.

- Collection efficiency of compactor trucks is almost double that of dump trucks if the loading room is the same, because the waste volume is reduced to half by compacting.
- The operation costs of MSWM will be lower if it uses compactor trucks are used, because the number of compactor trucks required is half the number of dump trucks.
- The loading deck of compactor trucks is low to achieve easy and safe loading.
- Compactor truck hauls the waste without scattering.

According to the site survey, it was discovered that the soil content of the waste is low in the high dense urbanized area and medium density urban areas so waste can be compacted effectively. In addition, the road condition in the high and medium density urban areas is comparatively good, so there would be no problem for passage of compactor trucks in these areas. The maintenance skill level of the bus company being managed by the DCTPC is sufficiently high that the compactor trucks could be maintained properly. Furthermore, a compactor truck belonging to a private company is currently working without any trouble in Vientiane.

Taking into account the above, compactor trucks are recommended for collection and haulage equipment for the waste generated in the high and medium density urban areas instead of dump trucks as proposed in the F/S.

ii) Special truck for exclusive use for infectious waste

The Laotian side requested a small dump truck for collection of

infectious medical waste. However the structure of the truck bed for infectious waste should be a closed leak-proof truck. And a dumping mechanism shall be equipped to this truck in order to prevent the worker coming in direct contact with the dangerous waste.

c. Environmental countermeasures

During collection and haulage work there is the fear of scattering waste from the vehicles. So the closed dump truck, container truck and closed type container is selected as the collection and haulage equipment to prevent scattering waste. In addition to this measure, equipment which cannot be designed as closed-type shall be equipped with a hood.

(2) Construction of final disposal site

a. Facilities planning

i) Civil works

The request was made according to the results of the F/S. Consequently all the facilities at the disposal site shall be reviewed based on the disposal amount in 1998.

The main facilities for improvement at the KM-18 final disposal site are indicated as below;

- Improvement of present situation
  - disposal of scattered waste by sanitary landfill
  - isolation of disposal site by fencing
- Short term improvement
  - construction of facilities for execution of sanitary landfill
    - approach road
    - landfill working area
    - water supply
    - vehicle wash

ii) building works

Site office and truck scale are recommended for the KM-18.

b. Equipment planning

Following equipment are considered for execution of the sanitary landfill.

- Bulldozer : waste spreading and compacting
- Excavator : cover soil excavation
  drain construction and maintenance
- Crawler type loader : cover soil
- Soil dump truck : cover soil hauling

c. Environmental countermeasures

Following environmental countermeasures are considered

i) Contamination of ground water

Leachate treatment will not be carried out in the Project. But the amount of leachate will be considerably reduced as the permeation of rain water will be reduced by the covering soil on the waste and the surface rain water will be drained separately from the leachate. Judging from the results of interview survey that the water smells in dry season, it seems that the ground water surrounding the KM-18 disposal site is contaminated by leachate from the existing waste. Therefore the facilities of water supply for drinking will be included in the Project.

ii) Scattering waste and dust from the covering work

The scattering of waste can be prevented by daily covering of the disposed waste. To prevent dust from the covering works, the soil shall be sprinkled with water as needed. The construction of a washing pond to clean the tires of the collection vehicles before going out of the disposal site will be done to keep the surrounding area clean.

iii) Destruction of scenic beauty

View of landfilling is disagreeable. Therefore the construction of a dike is recommended to be an obstacle which nobody can see the landfilling. Also anybody will not be able to see the disposed waste since the waste will be covered quickly. In addition to these countermeasures, a green buffer zone is also recommended along the roads abutting the disposal site which include National Route 13 to the north and a rural road to the west.

(3) Construction of the maintenance shop at KM-7

a. Facilities planning

i) Civil works

The site is located 100m to the east of National Route 13 , 7 km from the center of Vientiane. The area is about 3,800m^2 and connected to the national road by a 3 m wide laterite road. The site and approach road are susceptible to flooding in the rainy season as the surface levels of both are 1.0m lower than that of national road.

Construction of the maintenance workshop will also include the following works to improve the above situation.

- Widening and paving of approach road : 2 way to ensure 2 ways traffic
- Filling of site and approach road : to prevent flooding
- Concrete paving of the site : to protect equipment under repair from dust
- Construction of drainage facilities : to prevent water pollution by lubricants.

ii) Building works

Office of the municipal cleansing section and maintenance workshop shall be constructed at KM-7.

- Office

Table 2- 3 Staff Schedule of Municipal Cleansing Section

year	1995	1998(Beginning year)		
	Present	KM-7	KM-18	Total
Manager	6	8	1	9
Engineer	1	1	0	1
Supervisor	7	9	0	9
Mechanic or Operator	2	7	2	9
Clerk or Fee collector	10	33	1	34
Driver	12	30	1	31
Worker	84	102	1	103
total	122	190	6	196
planned capacity		40	4	-

Consequently the scale of the office is designed to house the number of staff who are the managers, engineers, supervisors, mechanics and clerks expected in 1998.

- Maintenance shop

  The maintenance shop consists of a storage room for spare parts and maintenance tools, a service shop, tire shop, and battery shop, etc.. There will be 4 bays in the service shop and one of these will be equipped with an inspection pit.

b. Equipment planning

The following equipment are recommended for periodical maintenance and minor repairs

- Tools for periodical maintenance
- Tools for repairing and replacement of tire
- Battery charger
- Welding equipment
- Vehicle washing equipment

c. Environmental countermeasures

A water contamination countermeasures by lubricants used for maintenance works are recommended for the maintenance shop, because the surrounding area consists of paddy fields. The waste water of maintenance shop including oil will be drained to an existing drain through an infiltration manhole after elimination of the oil though an oil trap

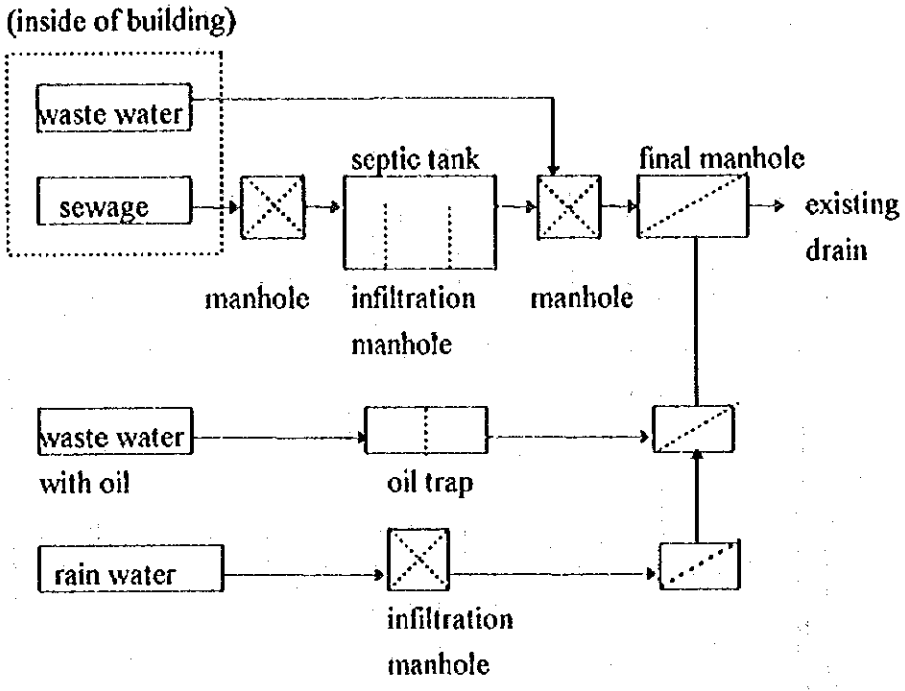


Figure 2- 2 Drainage System of the Maintenance Shop

(4) Execution of public education campaign

The procurement of equipment for sanitary education campaign is recommended for the Project in order to expand the collection area and promote inhabitants' participation in the cleansing activities in public areas.

2-3 Basic Design

2-3-1 Design Concept

Basic design of the facilities, buildings and equipment included in the Project will be carried out in accordance with the following.

(1) Particulars of the Project

i) to conform to the regional climate, topography, life style etc.

ii) to procure that material, when possible, in Vientiane in order to that

future maintenance can be carried out.

iii) to design structures simply but durable for long use and easy maintenance.

iv) to follow Laotian law and standards concerning construction, if there is no applicable standard, Japanese standards will be used.

v) to consider continuation of regular MSWM during construction of new facilities.

vi) to plan the facilities and equipment to be operated and maintained by the Laotian side.

(2) Natural conditions

Each facilities is designed considering economy, safety and natural conditions.

(3) Social conditions

Facilities are designed considering local customs, history, traditional culture, religion and local architecture, etc..

(4) Condition of construction and procurement of construction materials

Construction: Laotian technical level of construction is under developing. However Laotian workers have a good attitude towards work so the quality can be expected to be adequate under suitable supervision.

Procurement of materials: The ordering of large quantities or special material or qualitative material is limited in Vientiane because most of the materials are imported from Thailand or Vietnam. Consequently the contractor will be requested to be well experienced. There is no difficulty in hiring construction equipment, because several lease companies exist in Vientiane.

There are suppliers of ready-mixed concrete but the supply capacity and quality of the

concrete are substandard so site mixed concrete is preferred for structural works.

In order to maintain the terms of work, quality, low costs, and to transfer technology, the facilities will be constructed by local construction companies under supervision of a Japanese construction firm.
In principle, construction materials will be procured in Laos.

(5) Maintenance and operational competence by the executing agency
The executing agency is the Vientiane Municipal DCTPC cleansing unit. The Laotian side's capability concerning operation of the system was confirmed in the F/S. But the scale of present facilities, equipment and executing organization are relatively small compared to the proposed system. In order to make up the deficiency in personnel, DCTPC will employ new staff according to the staff schedule recommended in the F/S, for implementation of the Project. DCTPC has a plan to send new staff to the other sections for maintenance training, equipment operation etc..

(6) Scope and scale of the Project
Capability of the facilities and equipment planned for the Project is designed for treating the waste amount shown in Table 2-4.

Table 2- 4 Amount of Waste to be Collected (unit: ton/day)

Target year	1998		
	VTE muni.	Private	Total
1. Domestic waste	48.2	6.0	54.2
2. Commercial waste	9.2	1.0	10.2
3. Market waste	4.2	2.9	7.1
4. Office waste	1.0	-	1.0
5. Hospital waste (general)	1.4	-	1.4
6. Road sweeping waste	1.7	-	1.7
a. Collection amount	65.7	9.9	75.6
b. Direct haulage	-	-	3.0
c. Disposal amount	-	-	78.6
d. Infectious medical waste	0.25	-	0.25

Table 2- 5 Annual Disposal Amount at KM-18 (unit: ton/year)

year	1998	1999	2000
General waste	28,689	35,296	41,428
Infectious medical waste	91	95	99

(7) Terms of the works

Terms of works are planned considering the following.

- Earthworks shall be done during the dry season
- Completion of the construction of the facilities shall be adjusted so it coincides with the same delivery of the equipment.

The approval of concerned residents and the agencies responsible for construction shall be obtained before the commencement of the Project. Therefore the Laotian side shall obtain approval for the construction from the concerned agencies and residents as early as possible, before decision of commencement for the smooth implementation of the Project by the Japanese side.

2-3-2 Basic Design

(1) Collection and haulage equipment plan

Table 2- 6 Outline of Equipment Plan for Collection and Haulage

Purpose	Equipment
1) Collection & haulage of domestic, commercial waste in high density and medium density urban areas	Compactor truck ($8m^3$)
2) Collection & haulage of domestic waste in low density urban area	Dump truck ($10m^3$)
3) Collection & haulage of office, market, road sweeping and hospital(general) waste	Detachable container truck container ($5m^3$)
4) Street cleaning (drain cleaning)	Small dump truck & wheel loader
5) Street cleaning (grass cutting)	Grass cutter
6) Street cleaning (sprinkling of road) and sprinkling of covering soil at disposal site	Water tank truck
7) Cleansing activities	Small dump truck
8) Collection & haulage of infectious medical solid waste	Small dump truck for exclusive use of infectious medical solid waste
9) Supervision of MSWM	Pick-up
10) Fee collection	Motorcycle

a. Basic specification and estimation of required number of equipment, b. adjustment of present equipment and c. list of required equipment for

collection and haulage are examined as follows.

a. Basic specification and estimation of required number of equipment for each type of waste

i) Domestic waste in high and medium density urban area

Compactor truck: 6 units

Basic specification

The proposed equipment consists of compactor trucks for collection of domestic waste in the high and medium density urban areas. The required specifications of compactor trucks are:

- maximum load, weight not less than 4,000kg
- maximum load, volume not less than 8 m^3
- type of cabin forward control type

Required number of vehicles

• collection amount

Table 2- 7 Waste Amount Collected by Compactor Truck per Day in 1998

	Domestic Waste	Commercial Waste	Total
① Weight of waste (ton/day)	38.2	9.2	47.4
② Volume of waste (m^3/day)	76.4	18.4	94.8
③ Daily volume (m^3/day)	89.1	21.5	110.6

② = ① / 0.5 : specific gravity of compacted waste is assumed to be 0.5

③ = ② x (7/6) : collection is done 6 days a week (excluding Sundays)

• required number of vehicles

Required number of compactor trucks is estimated based on the above table.

110.6 / (8 m^3 x 0.85) / 3 trips x 1.1 = 5.96 say 6 vehicles required

0.85	:	85% of loading capacity
3 trips	:	see the calculation of number of trips in Table 1-8
1.1	:	10% reserve is included

Table 2- 8 Calculation of Number of Trips per Compactor Truck

• Working time (hr)	7.0	
• Round trip distance (km)	36.0	
• Speed (km/hr)	40.0	7.0 - (0.5 + 0.5)
• Collection time (hr)	1.0	36/40 + 1.0 + 0.25
• Unloading time (hr)	0.25	= 2.79
• Opening check time for vehicle (hr)	0.5	say 3 trips
• Closing check and washing time for vehicle(hr)	0.5	

ii) Domestic waste in less urbanized area

Closed type dump truck: 5 units

Basic specification

Dump trucks will be used for collection in low density urban areas where the road condition is poor and the waste includes more soil than urban and semi-urban areas. A closed type bed is adopted for preventing waste scattering. The required specifications of closed type dump trucks are;

- maximum load, weight not less than 4,000kg
- maximum load, volume and type not less than 10 m^3, closed type
- type of cabin forward control type

Required number of vehicles

• collection amount

Table 2- 9 Waste Amount Collected by Dump Truck per Day in 1998

	Domestic Waste
① Weight of waste (ton/day)	10.0
② Volume of waste (m^3/day)	57.8
③ Daily volume (m^3/day)	67.4

② = ① / 0.173 : Specific gravity of waste is assumed 0.173

③ = ② x (7/6) : Collection is done 6 days a week (excluding Sundays)

- required number of vehicles

Required number of dump trucks is estimated based on the above table.

67.4 / (10 m^3 x 0.85) / 2 trips x 1.1 = 4.36 say 4 vehicles required

0.85 : 85% of loading capacity is considered

2 trips : see the calculation of number of trips in Table 2-10

1.1 : 10% reserve is considered

Table 2- 10 Calculation of Number of Trips of Compactor Truck

• Working time (hr)	7.0	
• Round trip distance (km)	36.0	
• Speed (km/hr)	40.0	7.0 - (0.5 + 0.5)
• Collection time (hr)	2.0	36/40 + 2.0 + 0.25
• Unloading time (hr)	0.25	= 1.90
• Opening check time for vehicle (hr)	0.5	say 2 trips
• Closing check and washing time for vehicle(hr)	0.5	

iii) Commercial, Market, Office, Hospital and Road sweeping waste

Detachable container truck: 4 units

Container: 41 Nos

Basic specification

5 cubic meter containers will be placed at offices and markets that generate large amounts of waste. And detachable container truck is proposed to collect and haul it. The required specifications of detachable container trucks and containers are ;

Detachable container truck

- maximum load, weight — not less than 4,000kg
- body type — 2 hydraulic lifting arms for container(5m3)
- type of cabin — forward control type

Container

- material & type — Steel container, Closed type
- volume — not less than 5 m^3

Required number of vehicles

• collection amount

- Market waste

Collection amount of the market is shown in Table 2-11

Table 2- 11 Daily Amount of Waste from Markets

Market	Number of Stores ①	Weight of Waste (ton/day)		Volume of Waste (m^3/day)	
		1995 ②	1998 ③	1995 ④	1998 ⑤
Sikhai	427	0.56	0.62	2.47	2.73
Nongdouang	270	0.35	0.39	1.54	1.72
Kok Pho	113	0.15	0.17	0.66	0.75
Phone Thong	124	0.16	0.18	0.70	0.79
Nong Chanh	1,022	1.33	1.47	5.86	6.48
That Luang	961	1.25	1.38	5.51	6.08
total	2,917	3.80	4.21	16.74	18.55

② = ① x 1,300(g/day) :1,300(g/day)collection amount per store surveyed in F/S

③ = ② x 1.034	:3.4 %/year	rate of increase
④ = ② / 0.227	:0.227 t/m^3	apparent specific gravity of the waste
⑤ = ③ / 0.227		

According to the above calculation, the collection amount in 1998 is estimated as follows :

Weight of the waste	4.21 ton/day
Volume of the waste	18.55 m^3/day

- General hospital waste (except infectious waste)
  Amount of general hospital waste from each hospital is shown in the below table.

Table 2- 12 Daily Amount of Waste from Hospital

Hospital Name	No. of Beds	Weight of Waste (ton/day)		Volume of Waste (m^3/day)	
	①	1995 ②	1998 ③	1995 ④	1998 ⑤
Mahosot	550	0.45	0.50	3.24	3.60
Police	60	0.05	0.06	0.36	0.43
103 Hospital	450	0.37	0.41	2.66	2.95
Setthathirat	200	0.16	0.18	1.15	1.29
Lao Soviet	150	0.12	0.13	0.86	0.94
National	80	0.07	0.08	0.50	0.58
total	1,490	1.22	1.36	8.77	9.79

② = ① / 816 g/day	:816 g/day	waste amount to be collected surveyed in F/S
③ = ② x 1.034	:3.4 %/year	rate of increase
④ = ② / 0.139	:0.139 t/m^3	apparent specific gravity of the waste
⑤ = ③ / 0.139		

According to the above calculation, collection amount of the general hospital waste in 1998 is estimated as below.

Weight of the waste 1.36 ton/day
Volume of the waste 9.79 m^3/day

- Office waste

There are 9 offices where the waste will be collected by the municipality.

Public Health College, Municipality police, French embassy, Indonesia embassy, Lao Beer, USA embassy, Soviet embassy, DCTPC.

Table 2- 13 Amount of Office Waste in 1998

No. of Offices	Weight of Waste (ton/day) ①	Volume of Waste (m^3/day) ②
9	1.0	13.0

② = ① / 0.077 :0.077 t/m^3 apparent specific gravity of the office waste surveyed in as determined in the F/S.

- Road sweeping waste

Table 2- 14 Amount of Road Sweeping Waste in 1998

Length of Road Swept (km)	Weight of Waste (ton/day) ①	Volume of Waste (m^3/day) ②
30	1.74	31.07

① = 30km x 58,000 :58,000 g/km/day Collection amount per km as determined in the F/S

② = ① / 0.056 :0.056 t/m^3 Apparent specific gravity of the road sweeping waste

• Required number of containers

One container will be located at sources that generate less than 5 m^3. For other sources where amount of the waste is over 5 m^3, the appropriate number of containers will be placed according to the amount to be collected and collection location.

Table 2- 15 Arrangement Plan for the Containers

		Volume of Waste (m^3/day)	Number of Containers (No.)
Market	Sikhai	2.69	1
	Nongdouang	1.72	1
	Kok Pho	0.70	1
	Phone Thong	0.79	1
	Nong Chanh	6.48	2
	That Luang	6.08	2
sub-total		18.46	8
Hospital	Mahosot	3.60	1
	Police	0.36	1
	103 Hospital	2.95	1
	Setthathirat	1.29	1
	Lao Soviet	1.01	1
	National	0.50	1
sub-total		9.71	6
Office		13.00	9
Road sweeping		31.07	14
Spare containers			4
total		72.24	41

• Required number of detachable trucks

- Discharge frequency per week

according to the amount of waste and the arrangement plan of the containers

- weekly collection amount
  505.68 m^3/week (= 72.24 m^3/day x 7days)
  The sum total of containers' volume :185 m^3 (= 5 m^3 x 37 units)
  505.68 m^3/week / 185 m^3 = 2.7 times/week
  Therefore the required frequency of collection is, on average, 3 times per week.

- Number of trips
  37 units x 3 times / 6 days = 18.5 units/day
  6 days :working days per week (excluding Sundays)
  Consequently, the number of trips to the disposal site becomes 19 per day.

- Required number of detachable container trucks
  19 units / 5 trips x 1.1 = 4.18 say 4 unit
  5 trips : by the results of calculation of the number of trips is shown below.
  1.1 : 10% reserve is included

Table 2- 16 Calculation of Number of Trips of Detachable Container Trucks

• Working time (hr)	7.0	
• Round trip distance (km)	36.0	
• Speed (km/hr)	40.0	$\frac{7.0 - (0.5 + 0.5)}{36/40 + 0.15 + 0.25}$
• Collection time (hr)	0.15	= 4.62
• Unloading time (hr)	0.25	say 5 trips
• Opening check time for vehicle (hr)	0.5	
• Closing check and washing time for vehicle(hr)	0.5	

iv) Public cleansing

iv)-1 Drain cleaning

Small dump truck: 2 units

Wheel loader: 1 unit

Basic specifications

Small dump trucks and wheel loader are proposed for collection and haulage of the waste from drain cleaning. The required specifications of these equipment are;

Small dump truck

- maximum load, weight	not less than 2,000kg
- maximum load, volume	not less than 1.5 m^3
- type of cabin	forward control type

Wheel loader

- operational weight	not less than 6,500 kg
- horsepower	not less than 75 HP
- bucket volume	not less than 1.2 m^3
- operation deck	ROPS canopy

Required number of vehicles

• collection amount

The amount of the drain cleaning waste to be collected by the wheel loaders and the small dump trucks is estimated as follows.

0.3m x 0.1 m x 60,000m/(365/2) - 9.9 m^3/day

0.3m	: mean width of drain
0.1m	: thickness of mud settled at the bottom of drain over 6 months
60,000m	: length of the drain (both sides of a 30 km road)

Therefore daily collection amount of drain cleansing waste become ;

9.9 x 7 / 6 = 11.6 m^3/day

• required number of equipment

- Small dump truck

11.6 / (1.5 m^3 x 0.85) / 5 trips x 1.1 = 2.0 2 units

0.85	: 85% of loading capacity
5 trips	: see the calculation of number of trips in Table 1-17
1.1	: 10% reserve is considered

Table 2- 17 Calculation of Number of Trips of Small Dump Truck

• Working time (hr)	7.0	
• Round trip distance (km)	36.0	
• Speed (km/hr)	40.0	7.0 - (0.5 + 0.5)
• Collection time (hr)	0.15	36/40 + 0.15 + 0.25
• Unloading time (hr)	0.25	= 4.62
• Opening check time for vehicle (hr)	0.5	say 5 trips
• Closing check and washing time for vehicle(hr)	0.5	

- Wheel loader

  One wheel loader is considered for loading the waste from drain cleaning into small dump trucks estimated above.

iv)-2 Grass cutting

Grass cutter: 10 units

Basic specification

Grass cutter carry type

Required number of machines

Ten grass cutters are required for cutting the grass along 30 km of road according to the following calculation.

$30{,}000m \times 2 / (30days \times 2 \times 6/7) / 350m^2 = 10$ units

30,000m : road length

3m : width of grass cutting

$350m^2$: daily capacity of grass cutting

iv)-3 Road and disposal site sprinkling

Water tanker: 2 units

Water tankers are necessary for sprinkling unpaved roads and the covering soil at the disposal site.

Basic specification

Water tanker

- maximum load, weight not less than 6,000kg
- tank capacity not less than 6,000 l
- type of cabin forward control type

Required number of vehicles

150km / (12km x 6days) = 2.08 say 2 units

150km : road length to be sprinkled

12km : sprinkled road length per day

iv)-4 Public cleansing activities

Small dump truck: 1 unit

Small dump trucks are required for the waste collected by public cleansing activities.

Basic specification

Small dump truck

- maximum load, weight not less than 2,000kg
- maximum load, volume not less than 1.5 m^3
- Type of cabin forward control type

Required number of vehicles

One small dump truck is assigned for public cleansing activities.

v) Infectious medical waste

Small dump truck for exclusive use of infectious medical waste: 1 unit

Infectious medical waste is collected and hauled by using a specially equipped dump truck for the exclusive use.

Basic specification

Special equipped dump truck for the exclusive use of transporting infectious medical waste.

- maximum load, weight not less than 1,500kg
- body type enclosed box made of stainless steel, low deck
- type of cabin forward control type

Required number of vehicles

- Collection amount

0.25 ton/day / 0.139 = 1.8 m^3/day

0.139 ton/m^3 : Apparent specific gravity

The daily collection amount of infectious waste from hospitals is estimated as follows,

$1.8 \times 7 / 6 = 2.1\ m^3/day$

- Required number of trucks

Required volume capacity of dump truck for the exclusive use of infectious medical waste is ;

$L \times W \times H = 2.7 \times 1.6 \times 1.3 = 5.6\ m^3$

75 % of the above is assumed as available loading capacity.

$5.6\ m^3 \times 0.75 = 4.2\ m^3$

The available loading capacity is bigger than the daily collection amount of infectious medical waste calculated above. Therefore one truck is assigned for the collection of infectious medical waste.

vi) Administration

Pick-up: 1 unit

One pick-up is recommended for administration works including supervision of the collection and landfill works. The specification of pick-up is ;

- Type: 4 wheel drive, w-cabin
- Engine: 4 cycle diesel engine not less than 2,000cc
- Cabin: double cabin

vii) Fee collection

Motorcycle: 20 units

Motorcycles are recommended for collecting of the waste collection fee.

Basic specification

- Engine: not less than 100cc

Required number of motorcycles

The number of motorcycles required are calculated as follows;

86,592 / 5.9 / 750 = 19.6 say 20 units

86,592 persons : residents receiving collection services

5.9 person/family : average persons per family

750 families : number of families a collector can collect fees from per month.

b. Adjustment to the present equipment

The equipment currently belonging to the cleansing unit are listed as below Table.

Table 2- 18 List of the Present Equipment of DCTPC Cleansing Unit

	Reg. No.	Country	Year Manufactured	Condition
Flat truck	0246	USSR	1983	50%
Flat truck	0192	USSR	1984	50%
Dump truck	0384	USSR	1988	60%
Dump truck	0385	USSR	1988	60%
Small dump truck	0746	China	1994	50%
Small dump truck	0747	China	1994	50%
Small dump truck	0748	China	1994	50%
Small dump truck	0749	China	1994	50%
Small dump truck	0750	China	1994	50%
Small dump truck	0383	Japan	1992	80%
Water tanker	0163	USSR	1984	50%
Road sweeper	0388	France	1995	95%
Pick-up truck	0720	Japan	1978	70%
Pick-up truck	0683	Australia	1988	45%
Motorcycle	8345	Japan	1975	40%
Motorcycle	0673	Japan	1990	70%
Motorcycle	0685	Japan	1992	80%
Motorcycle	0784	Japan	1995	90%
Motorcycle	3634	Japan	1993	70%

The remaining working life of the present equipment is estimated to be only 5 years, due to the poor maintenance and difficulty in obtaining spare parts, except for the Japanese made vehicles. Consequently it is forecast that the following equipment will still be able to be used in 1998.

Table 2- 19 Equipment Operational in 1998

Equipment		Country Made	Remaining Working Life (1998)
Small dump truck	(5 units)	China	1 year
Road sweeper	(1 unit)	France	2 year
Motorcycle	(1 unit)	Japan	1 year

Based on the above, the present equipment is not considered for MSWM in 1998. On the other hand, the working life of the equipment planned to be introduced along with the maintenance shop through this project in 1998 is 7 years, because it will be operated with regular maintenance.

c. Required equipment

i) Required equipment for collection and haulage are listed in Table 2-20.

Table 2- 20 List of Collection and Haulage Equipment

Equipment	Basic Specification		Quantity
1) Compactor truck (8 m^3)	a. Maximum load b. Body capacity c. Type of cab	:not less than 4,000kg :not less than 8 m^3 :forward control type	6 units
2) Dump truck (10m^3)	a. Maximum load b. Body type and capacity c. Type of cab	:not less than 4,000kg :not less than 10m^3, closed type :forward control type	4 units
3) Detachable container truck	a. Maximum load b. Body type c. Type of cab	:not less than 4,000kg :2 hydraulic lifting arms for container :forward control type	4 units
4) Container	a. Material & Type b. Volume capacity	:steel container, closed type :not less than 5m^3	41 units
5) Small dump truck - Drain cleaning 2 unit - Public sanitation activities 1 unit	a. Maximum loading capacity b. Body capacity c. Type of cab	:not less than 2,000kg :not less than 1.5m^3 :forward control type	3 units
6) Wheel Loader	a. Operational weight b. Horsepower c. Bucket volume d. Operation deck	:not less than 6,500kg :not less than 75HP :not less then 1.2m^3 :ROPS canopy	1 unit
7) Grass cutter	a. Type	:Carry type	10 units
8) Water Tank Truck	a. Maximum load b. Tank capacity c. Type of cab	:not less than 6,000kg :not less than 6,000l :forward control type	2 units
9) Small Dump Truck (for exclusive use of medical infectious waste)	a. Maximum load b. Body type c. Type of cab	:not less than 1,500kg :closed box made of stainless steel :forward control type	1 unit
10) Pick up Truck	a. Type b. Engine	:4 wheel drive :4 cycle diesel engine, not less than 2,000cc	1 unit
11) Motorcycle	a. Engine	:not less than 100cc	20 units
12) Spare Parts	a. For above equipment		1 set

ii) Spare parts

Procurement of spare parts for the above equipment is recommended except for containers and motorcycles.

Maintenance works in the planned maintenance shop are to be periodical and light repairs. Therefore the contents of spare parts for 2 or 3 years procured shall be adjusted to these maintenance works, and will be selected according to the following priority;

1. Spare parts shall be exchanged periodically (such as gasket, seals etc. for element exchange)
2. Spare parts such as break drums to be exchanged after breakdown.
3. Spare parts for measures to the oil leak (such as seal)
4. Spare parts such as electric instruments, hoses, belts etc. whose functional life is shorter than that of vehicle itself.
5. Parts needing high technology to repair or expensive parts such as hydraulic pump and cylinder.

(2) Final disposal site

a. Overall plan

Contents of improvement of the final disposal site are as follows;

i) Preparation of temporary disposal yard for the construction period
ii) Sanitary landfill of existing waste at landfill site
iii) Construction of final disposal site
iv) Procurement of landfill equipment

Table 2- 21 Contents of the Improvement Plan of Final Disposal Site

Item	Contents	Quantity
1) Preparation of temporary disposal yard	a. dike construction	360m
	b. construction of approach road	65m
	c. construction of gas removal facilities	2 points
2) Sanitary landfill of existing waste	a. sanitary landfill of existing waste	70,000m^3
	b. dike construction	660m
	c. construction of gas removal facilities	8 points
3) Construction of final disposal site	① Main facilities	
	a. dike	1,010m
	b. drainage	2,310m
	c. approach road	1,760m
	② Administration House etc.	
	a. administration house	97 m^2
	b. truck scale	1 set
	c. gate	1 set
	d. fence	1,670m
	e. water supply	9,050m
	③ Environmental facilities	
	a. buffer zone	15,550 m^2
	b. gas removal facilities	1 points
4) Procurement of landfill equipment	a. crawler type loader	1 unit
	b. crawler type excavator	1 unit
	c. dump truck for soil	2 units
	d. bulldozer	1 unit

b. Facilities plan

i) Preparation of temporary disposal yard for the construction period

Disposal yard with a capacity of 20,000 m^3 will be prepared for disposal haulage into KM-18 during construction.

i)-1 Capacity

present disposal amount per day: 28.9 ton/day

say 30 ton/day

disposal amount during construction: 20,000 m^3

Table 2- 22 Disposal Volume during Construction

Disposal Amount (ton/day)	Disposal Volume (m^3/day)	Covering Amount (m^3/day)	Total (m^3/day)
30.0	42.9	15.0	57.9
57.9 × 30days × 11months ≒ 20,000 m^3			

i)-2 Contents of the construction

- dike : 360 m
- approach road : 65 m
- gas removal facilities : 2 points

ii) Disposal of scattered waste

The waste dumped in the open at KM-18 will be moved to the front area of the final disposal site and covered with soil. This land will become useful in the future, and land where the waste is to be removed will be used as a future landfill.

ii)-1 Present volume of waste dumped at KM-18

- waste dumping area :62,000 m^2
- thickness and distribution of the waste :h= 0.3 m 10%
  h= 0.5 m 10%
  h= 1.0 m 40%
  h= 1.5 m 30%
  h= 2.0 m 10%
- mean thickness of the waste

h_{av} = (0.3 x 10 + 0.5 x 10 + 1.0 x 40 + 1.5 x 30 + 2.0 x 10) / 100

= 1.13 m

• volume of waste to be removed

$V = 1.13 \times 62,000 = 70,050$

$= 70,000\ m^3$

ii)-2 Contents of construction works

- Landfill volume of the existing dumped waste : 70,000 m³
- Dike construction : 660m
- Number of gas removal facilities : 8 points

Gas removal facilities are installed at intervals of 50m to remove gas generated by decomposition of the waste away.

iii) Construction of final disposal site

Final disposal site will be constructed according to the short term improvement plan. 3 landfill blocks will be formed by the enclosure dike, and a capacity of each block is equivalent to the annual disposal amount. Furthermore each block will be divided into 4 sections by the divider to reduce generation of leachate as much as possible.

iii)-1 Required disposal capacity

Capacity of the final disposal site until the year 2000 is estimated as follows;

Disposal site for general waste :203,200m³

Disposal site for infectious waste :549m³

Table 2- 23 Daily Disposal Amount of General Waste

Year	Weight of Waste (ton/day)	Volume of Waste (m^3/day)	Covering Material (m^3/day)		Total (m^3/day)
1998	78.6	112.3	39.3	(29.4)	151.6
1999	96.7	138.1	48.3	(38.4)	186.4
2000	113.5	162.1	56.7	(46.8)	218.8
2001	131.3	187.6	65.7	(55.8)	253.3
2002	150.3	214.7	75.1	(65.2)	289.8
2003	170.2	243.1	85.1	(75.2)	328.2

note: - specific gravity of the waste compacted is assumed to be 0.7 ton/m³

- quantity of covering soil is considered as 35% of the waste

volume

- numbers in bracket show the required quantity of covering soil i.e. the volume obtained from drain cleaning has been subtracted.

Table 2- 24 Annual Disposal Amount of General Waste

Year	Weight of Waste (1,000ton/year)	Volume of Waste (1,000 m^3/year)	Covering Material (1,000 m^3/year)		Volume of Waste (1,000m^3/year)
1998	28.7	41.0	14.4	(10.7)	41.0
1999	35.3	50.4	17.6	(14.0)	50.4
2000	41.4	59.1	20.7	(17.1)	59.1
2001	47.9	68.4	23.9	(20.4)	68.4
2002	54.9	78.4	27.4	(23.8)	78.4
2003	62.1	88.7	31.0	(27.4)	88.7

According to the above calculation, the disposal amount of general waste from 1998 to 2000 totals 203,200 m^3.

i.e. $55.4 + 68.0 + 79.8 = 203{,}200 m^3$

Disposal capacity for infectious waste

Table 2- 25 Daily Disposal Amount of Infectious Medical Waste

Year	Weight of Waste (ton/day)	Volume of Waste (m3/day)	Covering Material (m3/day)	Total (m3/day)
1998	0.25	0.36	0.13	0.49
1999	0.26	0.37	0.13	0.50
2000	0.27	0.39	0.14	0.53
2001	0.28	0.40	0.14	0.54
2002	0.29	0.41	0.14	0.55
2003	0.30	0.43	0.15	0.58

note: - specific gravity of the waste compacted is assumed 0.7 ton/m^3

- quantity of covering soil is considered as 35% of the waste volume

Table 2- 26 Annual Disposal Amount of Infectious Medical Waste

Year	Weight of Waste (ton/year)	Volume of Waste (m^3/year)	Covering Material (m^3/year)	Total (m^3/year)
1998	91.3	130.4	45.6	176.0
1999	94.9	135.6	47.5	183.1
2000	98.6	140.9	49.3	190.2
2001	102.2	146.0	51.1	197.1
2002	105.9	151.3	53.0	204.3
2003	109.5	156.4	54.7	211.1

According to the above calculation, the disposal amount of infectious medical waste from 1998 to 2000 totals 549.3 m^3.

i.e. $76.0+183.1+190.2=549.3m^3$

iii)-2 Decision on the capacity of final disposal site

① Disposal site for general waste

The disposal site is divided into 3 blocks. Volume of standard size block is calculated by the following formula.

$203,200\ m^3 / 3\ year = 67,733 \fallingdotseq 68,000\ m^3$

The disposal area is divided into 3 areas, see following figure, by assuming a standard size block of about 70,000 m^3.

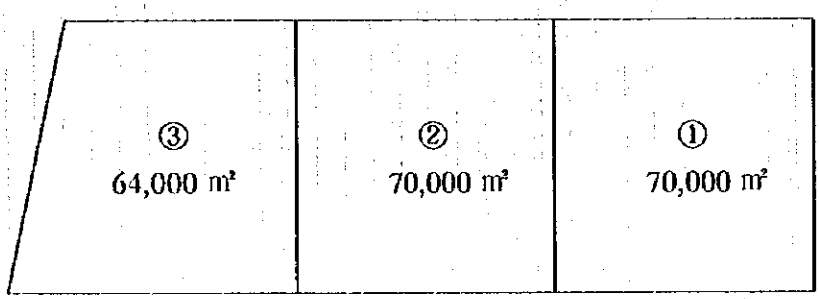


Figure 2- 3 Partition of Disposal Area into 3 Blocks

② Disposal site for infectious medical waste

According to the calculation of the required capacity, disposal area was estimated as 549 m^2. However this volume is too small to effectively operate a landfill therefore the following area is planned.

length (east- west)	:60 m
width (north- south)	:40 m
capacity volume	:3,600 m³

iii)-3 Thickness of covering soil

① daily cover : t = 25cm

② final cover : t = 50cm

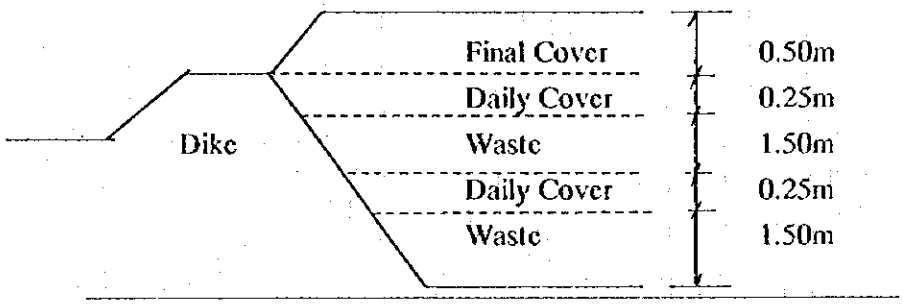


Figure 2- 4 Cross Section of Landfill

iii)-4 Contents of construction works

① Main facilities

a. construction of dike :1,010m

i. dike :883m

ii. divider :126m

b. Drainage work :2,310m

i. drain for surrounding area :1,317m

ii. drain within disposal area :468m

iii. vertical drain :10m

iv. open drain with cover crossing dike :8m

v. culvert drain crossing dike :52m

vi. side ditch :454m

c. Approach road :400m

i. approach road :487m

ii. internal road :1,314m

iii. access road :3 points

② Administration building and surrounding facilities

a. administration building :97 m²

i. administration building
ii. parking for vehicles
iii. parking for heavy equipment
iv. tire wash

b. Truck scale :1 set
c. Gate facilities :1 set
d. Fence :1,670m
e. Water supply :9,050m

③ Environmental facilities

a. buffer zone :15,550m^2
b. gas removal facilities :1 point

c. Landfill equipment plan

i) Landfill working plan

Main works of the landfill are shown in below Table 2-27.

Table 2- 27 Main Works of the Landfill

Working Items	Equipment
① Excavation of covering soil	Crawler type loader
② Loading of covering soil	Crawler type excavator
③ Haulage of covering soil	Dump truck for soil
④ Spread and compaction	Bulldozer
⑤ Sprinkling	Water tanker (using in combination with road sprinkling)
⑥ Maintenance of internal drainage, roads and dikes	Crawler type excavator etc.
⑦ Development and extension of disposal site	Crawler type loader and bulldozer

i) Examination of required number of equipment

① Basic specification

Basic specifications of required equipment are decided considering to the working schedule and scale.

a. Crawler type loader

i.	Operational weight	:not less than 14,000kg
ii.	Horsepower	:not less than 120HP
iii.	Bucket size	:not less than 1.5m^3
iv.	Operation deck	:ROPS canopy

b. Crawler type excavator

i.	Operational weight	:not less than 11,500kg
ii.	Horsepower	:not less than 80HP
iii.	Bucket size	:not less than 0.45m^3

c. Dump truck for soil

i.	Maximum load	:not less than 8,000kg
ii.	Volume of body	:not less than 6m^3
iii.	Cab type	:forward control type

d. Bulldozer

i.	Operational weight	:not less than 16,000kg
ii.	Horsepower	:not less than 165HP
iii.	Special fittings	:for waste disposal site
iv.	Operation deck	:ROPS canopy

② Working capability of equipment per hour

a. Crawler type loader 1.5m^3

$$Q = \frac{60 \times q \times f \times E \times k}{Cm}$$

Q(m^3/h)	:working capacity per hour	
q(m^3)	:bucket volume	1.5 m^3
f	:soil conversion factor	1.0
E	:working efficiency	0.5
k	:bucket coefficient	0.85
Cm(min)	:cycle time	0.9min

Generally, E is 0.3 - 0.8; k is 0.8 to 1.1; and Cm is 0.6 - 0.9. However; the above values were adopted after considering the site conditions, operators skill, site clearing and grubbing,

limitation of works in the rainy season, and location of the site. Therefore the working capacity of crawler type loader becomes 42.5 m^3/h.

$$Q=\frac{60\times1.5\times1.0\times0.5\times0.85}{0.9}=42.5\ m^3/h$$

b. Crawler type excavator 0.45m^3

$$Q=\frac{60\times q\times f\times E\times k}{Cm}$$

Q(m^3/h)	:working capacity per hour	
q(m^3)	:bucket volume	0.45 m^3
f	:soil conversion factor	1.0
E	:working efficiency	0.5
k	:bucket coefficient	0.85
Cm(min)	:cycle time	0.75min

Working capacity of the crawler type excavator becomes 15.3 m^3/h by following calculation.

$$Q=\frac{60\times0.45\times1.0\times0.5\times0.85}{0.75}=15.3$$

c. Dump truck 6.0m^3

$$Q=\frac{60\times q\times f\times E\times k}{Cm}$$

Q(m^3/h)	:working capacity	
q(m^3)	:body capacity	6.0 m^3
f	:soil conversion factor	1.0
E	:working efficiency	0.5
k	:body coefficient	0.85
Cm(min)	:cycle time	15min (internal haulage)

Working capacity of the dump truck is calculated at 10.2 m^3/h.

$$Q= \frac{60\times 6.0\times 1.0\times 0.5\times 0.85}{15} = 10.2\ m^3/h$$

d. Bulldozer 16ton class

$$Q= \frac{60\times q\times f\times E}{Cm}$$

Q(m^3/h)	:working capacity per hour	
q(m^3)	:dozing volume	2.0 m^3
f	:soil conversion factor	1.0
E	:working efficiency	0.5
Cm(min)	:cycle time	0.64min

(forward:15m / 60m/min + backward:15m / 80m/min + others:0.2min = 0.64)

Working capacity of the bulldozer therefore equals 93.8 m^3/h.

$$Q= \frac{60\times 2.0\times 1.0\times 0.5}{0.64} = 93.8\ m^3/h$$

③ Calculation of daily working time of the equipment

Working time of equipment is obtained from the working volume defined in ② divided by working capacity.

Table 2- 28 Daily Working Volume and Time of Equipment

	Crawler type loader	Crawler type excavator	Dump truck	Bulldozer
Working capacity (m^3/h)	42.5	15.3	10.2	93.8
1998 (m^3/day)	34.3	34.3	34.3	176.9
(h)	0.8	2.2	3.4	1.9
1999 (m^3/day)	44.8	44.8	44.8	217.5
(h)	1.1	2.9	4.4	2.3
2000 (m^3/day)	54.6	54.6	54.6	255.3
(h)	1.3	3.6	5.4	2.7
2001 (m^3/day)	65.1	65.1	65.1	295.5
(h)	1.5	4.3	6.4	3.2
2002 (m^3/day)	76.1	76.1	76.1	338.1
(h)	1.8	5.0	7.5	3.6
2003 (m^3/day)	87.7	87.7	87.7	382.9
(h)	2.1	5.7	8.6	4.1
2004 (m^3/day)	90.7	90.7	90.7	395.9
(h)	2.1	5.9	8.9	4.2

note: - Working volumes of crawler type loader, crawler type excavator and dump truck are obtained by dividing the weekly required covering soil tabulated in Table 1-23 by 6 days.
- Working volume of the bulldozer is obtained by dividing the weekly disposal amount tabulated in Table 1-23 by 6 days.

④ Examination of the number of dump trucks

According to the results of the above calculations, it is known that the working time of dump truck has big influence on the whole working schedule.

Consequently two cases of working efficiency are examined in order to decide the number of dump trucks required.

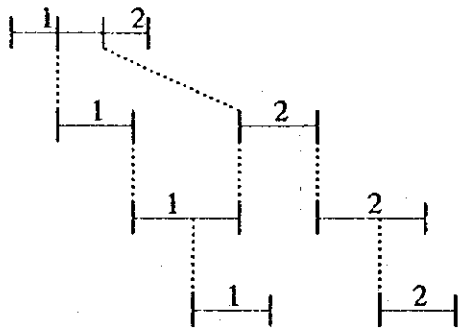
Case-1 : One dump truck

Excavation : Crawler loader

Loading : Crawler excavator

Haulage : Dump truck

Spread & Compaction : Bulldozer



Case-2 :Two dump trucks

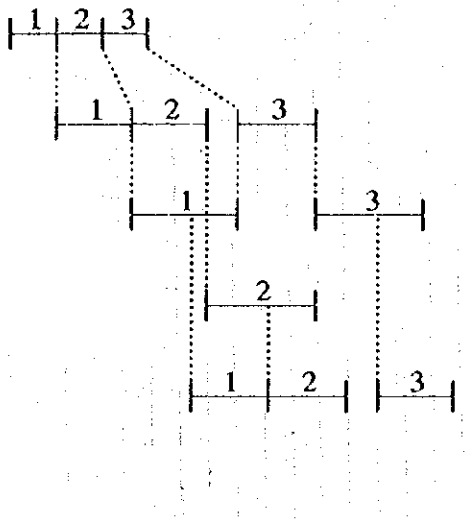
Excavation : Crawler loader

Loading : Crawler excavator

Haulage : Dump truck A

: Dump truck B

Spread & Compaction : Bulldozer



Those conceptual figures show that;

Case-1 Hauling time of the dump trucks affects all other vehicles, except the excavators. The working efficiency of this case is bad, because the excavator and bulldozer have to be stopped while the dump truck is hauling the covering soil.

Case-2 In this case, the working capacity of the excavator controls all the landfill works. Therefore working efficiency is increased by the addition of one more

dump truck.

⑤ Decision on the number of equipment to be procured

The number of equipment to be procured is decided in accordance with the results of ①, ②, ③, ④. This equipment can be used until 2004, because the working life of this equipment is estimated to be 7 years and working capacity of this equipment corresponds with the disposal amount of 2004 under the assumption that the working time is less than 6 hours/day.

7 hr. - (Opening check time 0.5 hr. + Closing check time 0.5 hr.)
= 6 hours

a. Crawler type loader : 1 unit
b. Crawler type excavator : 1 unit
c. Dump truck for soil : 2 units
d. Bulldozer : 1 unit

Crawler type excavator is used for maintaining the internal drainage, roads, and dike. Crawler loader and bulldozer are used for extending of the disposal site after 2001.

iii) Number of equipment required

DCTPC does not have any landfill equipment at present. For managing the sanitary landfill planned in the Project, the following equipment have to be procured.

Table 2- 29 List of Landfill Equipment to be Procured

Equipment	Specification		Quantities
a. Crawler type loader	i. Operational weight	:not less than 14,000kg	1 unit
	ii. Horsepower	:not less than 120HP	
	iii. Bucket volume	:not less than 1.5m^3	
	iv. Operation cabin	:ROPS canopy	
b. Crawler type excavator	i. Operational weight	:not less than 11,500kg	1 unit
	ii. Horsepower	:not less than 80HP	
	iii. Bucket volume	:not less than 0.45m^3	
c. Dump truck	i. Maximum loading capacity	:not less than 8,000kg	2 units
	ii. Body capacity	:not less than 6m^3	
	iii. Type of cabin	:forward control type	
d. Bulldozer	i. Operational weight	:not less than 16,000kg	1 unit
	ii. Horsepower	:not less than 165HP	
	iii. Special fittings	:for waste disposal work	
	iv. Operation cabin	:ROPS canopy	

(3) Maintenance shop

a. Land and layout plan

i) Land

The site of maintenance shop is at a distance of about 100 m from National Route 13. The width of access road is only 3 m which is not enough for 2 way passing. However widening and paving of this narrow road is proposed in the Project.

Existing level of the land for maintenance workshop and access road is about 1.0 m lower than that of route 13, so the land is flooded sometimes. To improve this condition, the land and access road will be built up to the level of route 13.

ii) Layout plan of facilities

The office and maintenance shop are separated to prevent accidents. Accordingly, the office is located on the south-east side and the maintenance shop is located on the north-west side of the building. Function of maintenance shop is summarized in Table 1-30.

Table 2- 30 Function of Maintenance Shop at KM-7

Items	Facilities	Major function
Maintenance shop	- Service shop	- regular inspection and maintenance oil change valve adjustment change of fuel elements minor repair - final inspection after repair - issue of the repair record
	- Storage of Lubricant	- lubricant dispenser, tool shelf
	- Battery & tire shop	- inspection and charge of battery
	- Storage of Parts & tools	- control and storage of spare parts and tools
	- Inspection pit	- inspection of vehicles - washing vehicles and equipment
Office	- Manager's room	- explanation & important meeting
	- Research & development unit	- monitoring of cleansing services, study and development of appropriate technology, study expanding service area
	- Administration unit	- finance & account control
	- Cleansing unit	- collection service unit, public cleansing unit, night soil collection service unit
	- Operation & maintenance unit	- maintenance unit
Parking & Access road	- Parking space for large vehicles	- for 17 large vehicles
	- Parking space for small vehicles	- for 4 light vehicles
	- Parking space for visitors	- for 1 pick up and 3 cars of visitors
	- Parking space for motorcycles	- for 20 motorcycles
	- Asphalt paved road	- width = 6 m, length = 135 m

b. Building plan

i) Maintenance shop

① Examination of facility's scale

Required number of bays estimated as follows

- Work items

• Periodical inspection

Periodical inspection and maintenance is the main work for this facility.

• Overhaul

Overhaul of the main parts such as engine, breaks, suspension and

electrical parts devices is done during the working life of the equipment.

• Repairs

Repairs are done when the equipment breakdown unexpectedly. Light repairs such as sheet metal work and welding work are done if the equipment is damaged due to accident.

- Basic data to estimate number of bays

• Vehicles to be maintained 21 units

heavy vehicles 16 units

light vehicles 4 units

pick up 1 unit

• Running distance and working days of equipment

daily running distance 100 km

monthly working days 26 days

annual working days 312 days

• Operation days of maintenance shop

daily operation hours 7 hours

monthly operation days 26 days

annual operation days 312 days

- Time, frequency and required time for maintenance

• periodical inspection and maintenance

Time	Frequency	Required time
1,500km (every 15 days)	24 times/year	7 hours
5,000km (every 2 months)	6 times/year	10 hours
15,000km (every 6 months)	2 times/year	20 hours

• overhaul

once every 4 years required time : 215 hours

• frequency of break down

twice a year per unit required time : 7 hours

• frequency of accident

once a year per unit required time : 70 hours

- Calculation of required number of bays

Required number of bays is calculated by using following formula.

Number of Bays = { (Standard working time) x (No. of vehicles) x (No. of maintenance time per year) } / (annual working time)

• No. of bays for periodical inspection and maintenance

$$\text{1,500km inspection} = \frac{\text{7 (hours) x 21 (units) x 24 (times/year)}}{\text{312 (days/year) x 7 (hours/day)}} = 1.62$$

$$\text{5,000km inspection} = \frac{\text{10 (hours) x 21 (units) x 6 (times/year)}}{\text{312 (days/year) x 7 (hours/year)}} = 0.58$$

$$\text{15,000km inspection} = \frac{\text{20 (hours) x 21 (units) x 2 (times/year)}}{\text{312 (days/year) x 7 (hours/day)}} = 0.38$$

based on the above calculation, required number of bays estimated as;

$1.62 + 0.58 + 0.38 = 2.58$

• Required number of bays for overhaul

$$\frac{\text{215 (hours) x 21 (units) x 1 (time/year)}}{\text{312 (days/year) x 7 (hours/day) x 3.5 (years)}} = 0.59$$

• Required number of bays for light repairs

$$\frac{\text{7 (hours) x 21 (units) x 2 (times/year)}}{\text{312 (days/year) x 7 (hours/days)}} = 0.13$$

• Required number of bays for heavy repairs

$$\frac{\text{70 (hours) x 21 (units) x 1 (times/year)}}{\text{312 (days/year) x 7 (hours/day)}} = 0.67$$

Total required number of bays are 4 according to the above calculation.

periodical inspection and maintenance	: 2.58
overhaul of equipment	: 0.59
light repairs	: 0.13
heavy repairs	: 0.67
Required no. of bays	: 3.97
	≒ 4

② Scale of facilities

According to the above, 4 bays are constructed in the maintenance shop.

Area of each shop is decided as shown Table 2-31 considering the shape of the land, function and characteristic of equipment to be installed.

Table 2- 31 Facilities in the Maintenance Shop

Shops	Area(㎡)	Remarks
Service shop	240	(5.0m x 2.0m)/unit x 4 bays=240 ㎡
Lubricant shop	16	
Battery & tire shop	64	
Spare parts & tools storage	86	
Maintenance Administration	10	
Unit	—	installed outside of building
Car wash		
Total	416	

iii) Office

①Scale of the office

Area of each room is decided taking into consideration the following standards;

- Manager 13.0 ㎡/person
- Engineer 7.0 ㎡/person
- Supervisor 6.5 ㎡/person
- Mechanic 6.0 ㎡/person

- Clerk 4.5 ㎡/person

• Arrangement of staff

Table 2- 32 Arrangement of Staff

Room	Manager	Engineer	Supervisor	Mechanic	Clerk	Total
Manager's room	1					1
Research & development unit	1	1		1		3
Administration unit	1				6	7
Cleansing service, unit	3		7	2	3	15
Campaign & enforcement unit	1		1		2	4
Operation & maintenance unit	1		1	4	4	10
Total	8	1	9	7	15	40

• Area of each room

- Research and development

1person x 13.0 ㎡ + 1person x 7.0 ㎡ + 1person x 6.0 ㎡ = 26.0 ㎡

- Administration / campaign & enforcement

2person x 13.0 ㎡ + 1person x 6.5 ㎡ + 8person x 4.5 ㎡ = 68.5 ㎡

- Cleansing service

3person x 13.0 ㎡ + 7person x 6.5 ㎡ + 2person x 6.0 ㎡
+ 3person x 4.5 ㎡ = 110.0 ㎡

- Operation & maintenance

1person x 13.0 ㎡ + 1person x 6.5 ㎡ + 4person x 6.0 ㎡
+ 4person x 4.5 ㎡ = 61.5 ㎡

Total = 266.0 ㎡

• Room area

Area of each room is decided in accordance with the shape of building, extent, working condition etc.

Table 2- 33 Area of the Room

Room	Area(㎡)
Research and development	24
Administration / campaign & enforcement	72
Cleansing service	120
Operation & maintenance	48
sub total	264
Meeting room	48
Manager's room	24
Common area	144
Total	480

iv) Parking and approach road

① Parking

589.5 ㎡ of parking area is allotted for all vehicles except for landfill equipment. A portion of parking space is used for the maintenance works during the day time, the 12 large vehicles, 4 small vehicles and 20 motorcycles can be parked in the remaining area which is 401 ㎡.

Table 2- 34 Parking Space

Equipment	unit	Parking area
Compactor truck	6	(3.5 m x 7.0 m) / unit x 17 unit = 416.5 ㎡
Large dump truck	4	294 ㎡ of parking space is available during the day time.
Detachable container truck	4	
Water tanker	2	
Wheel loader	1	
Small dump truck	4	(3.0 m x 5.5 m) / unit x 4 unit = 66.0 ㎡
Pick up	1	(2.5 m x 5.0 m) / unit x 4 unit = 50.0 ㎡
For visitors	3	day time parking is allowed
Motorcycle	20	9.5 m x 6.0 m = 57.0 ㎡ day time parking is allowed
Total	45	589.5 ㎡

② Approach road

Approach road from National Route 13 to the site will be widened to 6 meters and paved. The 6 m of width is enough for 2 way passing.

Length to be improved	: 135 m
Road width to be paved	: 6 m

v) Structural plan

v)-1 Sectional

① Roof clearance is 3.0m which is the standard clearance in Laos.

② Clearance of the maintenance shop is raised to 5.5m considering height of some vehicles.

v)-2 Structural plan

- Basic concept

① Main frame of the office building will be reinforce concrete. Outer wall and divider walls are constructed of brick.

② Steel frame is adopted for the maintenance shop, and the outer wall is constructed of brick.

③ Spread foundation is recommended for the maintenance shop and office building, because this type of foundation is popular in the surrounding areas.

④ The design will not consider earthquakes.

- Design Concept

① Dead load	The dead load shall be estimated considering the building structure, materials.
② Live load	The live load shall be estimated considering the uses of each room.
③ Design standards	Laotian or Japanese standards are adopted for structural design.

v)-3 Installation plan

<u>Electrical installation</u>

① Transformer

- electric supply

22 KV electricity is supplied from the national grid by

Laotian side.

- High tension electricity is fallen down is reduced from 380V to 220V : 50 Hz through a transformer.

② Main electric power

- Main electric power is distributed to the equipment through the national grid.

③ Telephone

- 2 direct lines and extension lines to each room will be installed.

④ Lightning rod

- Lightning rod is installed, because of the high frequency of lightning around the project area.

Water supply

Water will be diverted from the mains, a 250mm diameter under National Route 13, through a branch line to be constructed. The water will be stored in a tank. The water will be pressurized and distributed to faucets.

① Capacity of water storage tank

The capacity of water storage tank is designed to be equivalent to the daily required volume calculated as follows;

40 persons x 100 liter/person/day = 4,000 liters

40 persons : No. of staff considered to be working on the site

100 liter/person/day : daily average volume of use per person

② pressure pump

In addition to the above volume, the maximum water volume to be used for car washing is considered to estimate the capacity of pump.

for personnel use : 4,000 liter /7 hr / day × 2
= 1,143 liter/h

for car washing : 1,200 liter/h

Therefore the specification of pressure pump is shown as follows.

Pressure pump (controlled constant pressure type)

Capacity : 20 liter/min.
Pressure : 25 m
Operation : Single reciprocal operation with (reserved pump)

Sewage

Infiltration method with septic tank is a popular method of sewage treatment in Laos. Consequently this method will be adopted for treatment of sewage from the maintenance shop. The drainage system is described in Chapter 1-2-2 Basic concept of the Project.

Facilities for personal hygiene

Shower room will be included for the use of the workers.

Air conditioner

Air conditioner will be installed in each room.

Fire fighting

Fire extinguishers will be placed in the maintenance shop.

v)-4 Construction materials

① Exterior

- Maintenance shop
  - roof : steel frame + slate
  - wall : brick wall + mortar + paint
- Office
  - roof : wooden frame + slate
  - wall : brick wall + mortar + paint

② Inside

- Maintenance shop
  - floor : concrete + mortar
- Office
  - ceiling : plaster board
  - wall : brick + mortar + paint
    tile is used for the wall surface in the toilet and shower room
- Floor : floor tiles

c. Equipment plan

i) Selection of maintenance equipment

Maintenance equipment to be installed are selected considering the main works, such as, periodical inspection and maintenance. The maintenance equipment for landfill machine will be considered periodical one.

The maintenance equipment shall be procured as part of the Project, since DCTPC does not have any maintenance equipment for MSWM at the present.

(4) Procurement of equipment for sanitary education campaign

The sanitary education campaign will be carried out for the residents and pupils in the Project area. The procurement of equipment for the sanitary education campaign which will be executed by the Vientiane municipality is included in the Project.

CHAPTER 3 IMPLEMENTATION PLAN

CHAPTER 3 IMPLEMENTATION PLAN

3-1 Implementation Plan

3-1-1 Implementation Concept

The Laotian side will make a contract with a Japanese consultant for a detailed design and supervision of the Project, after the Exchange of Notes is signed by the Laotian government and Japanese government. The consultant will execute the detailed design of the facilities and equipment based on the results of this basic design, and prepare tender documents. The tender will consist of constructing the facilities, and procurement of the equipment to be held by the Laotian side, and a Japanese construction company and trading company will be selected.

Construction of the facilities and equipment supply will be commenced after signing of the contract between the Laotian side, a construction company, and a trading company.

In the detailed design stage the consultant will carry out more precise site investigations to make the basic design more practical. The consultant will try to use local consultants as much as possible to incorporate Laotian procedures, customs, and traditional building styles into the design of the facilities

The Project consists of the construction of the facilities and procurement of the equipment. Each contractor shall complete their own duty within the terms of the works. For implementation of the Project, the following need to be considered;

- construction is to be done by a local sub-contractor under supervision of a Japanese construction company,
- construction schedule should be planned considering the capability level of local resources,
- earth works should not be carried out during the rainy season when possible,
- English language will not be helpful on the site.

The contractor shall pay close attention to selecting and organizing its staff and the local sub-contractors, because the progress of the works,

construction methods etc. should be relayed carefully to the local staff for the construction of the facilities. The Project will not include unfamiliar methods or equipment to facilitate the operation of the facilities and equipment.

3-1-2 Implementation Conditions

(1) General

a. transportation

The sites are in the Vientiane municipal area, and both of them are located along National Route 13 which is the biggest trunk road in Laos. Consequently there will be no problem for transportation of the construction materials. And materials made in Thailand can be obtained easily due to completion of "Friendship" bridge across the Mekong.

b. electricity, telephone, water supply

Electricity is supplied to the site at present. However, telephone cables are not connected to the site, but the Laotian side will install telephone lines by the commencement of the project. Water is supplied to KM-7, but not to KM-18, therefore the residents surrounding the disposal site are using ground water for drinking.

c. labor force

There is a high latent labor force in Vientiane, however, skilled labor is scarce. Consequently training of the labor is necessary at the beginning of construction. The construction is expected to be carried out smoothly, after training. However salary of skilled labor is relatively high, 2 to 4 times that of untrained.

(2) Construction condition

Construction condition to be considered for implementation

a. Continuation of MSWM during construction

Solid waste management shall not be interrupted. The appropriate management of landfill and collection works shall be maintained during construction of the final disposal site and maintenance shop. For

construction of the maintenance shop, parking space for the present collection equipment and a temporary office for the cleansing unit shall be prepared.

b. Earthwork shall not be done during the rainy season

There are two seasons in Vientiane, the rainy season from May to October and the dry season from November to April. The monthly average of daylight hours from June to August is only 60 to 90 hours, this means rain is falling almost everyday. The laterite soil of the Vientiane area is so silty that it cannot be worked in the rainy season. Therefore the earthworks should not to be carried out in the rainy season as much as possible.

3-1-3 Scope of Works

The scope of works for each side confirmed at a meeting held during the basic design study in September in 1995 are shown in Table 3-1.

Table 3- 1 Scope of Works

Items	Japanese side	Laotian Side
Equipment for Collection & Haulage	- Procurement of equipment for collection / haulage	- Preparation of parking space for equipment
KM-18 Final Disposal Site	- Disposal of the existing waste by covering with soil and gas removal facilities. - Construction of approach road - Construction of administration building - construction of internal drainage system - Construction of fence - Installation of Truck Scale - Construction of water pipe for disposal site and surrounding residents - Procurement of landfill equipment - Preparation of sanitary landfill manual	- Electricity supply - Rehabilitation of the present internal road - Construction of western gate - Construction of the drain on the along Route 13. - Removal of the waste dumped illegally
KM-7 Maintenance Shop	- Construction of foundation work - Construction of access road - Construction of maintenance shop and office building - Construction of inspection pit - Installation of car washing equipment - Installation of maintenance equipment	- Land acquisition for widening of access road - Demolition of the present building - Electricity, telephone and water supply
Sanitary education campaign	- Procurement of equipment for sanitary education campaign	- Execution of the sanitary education campaign

3-1-4 Consultant Supervision

The consultant will send a Japanese resident civil engineer to supervise the construction, because construction of the maintenance shop and final disposal site will be carried out concurrently. There are many kind of works such as civil works, building works, equipment installation etc. and the construction period is limited. Consequently one resident engineer will not be able to supervise all works by himself, the consultant will employ local engineers to assist him. The building construction

specialist, equipment installation, solid waste management for sanitary education campaign should be given sufficient time.
Therefore the consultant will select a resident engineer who is not only familiar with the Japanese grant aid system but also having much experience in overseas works.

Staff schedules for supervision of the municipal cleansing unit, the consultant and the contractor who will be selected through tender are shown in Table 3-2.

Table 3- 2 Staff Schedule for Supervision

	Field	No.	Period
Cleansing Unit of Vientiane Municipality	Project management	1	Whole
	Civil engineering	2	Whole
	Architectural engineering	1	7 months
	Mechanical engineering	1	3 months
	Operation & maintenance	3	1 month
	Sanitary education	2	3 months
Consultant	Project management	1	Whole (1 months)
	Civil/Architectural engineering	1	Whole
Contractor	Construction supervision	1	Whole
	Structural supervision	1	7 months
	Administration	1	4 months
Equipment supply	Vehicle	1	0.5 month
	Heavy equipment	1	0.5 month
	Maintenance equipment	1	1.0 month

3-1-5 Procurement Plan

According to the basic concept, construction materials will be procured in Laos as much as possible. The origin of equipment to be procured;

a. Procurement in Laos is given priority, if a product is produced or sold in Laos.

b. The cheapest price is considered for the project cost as a rule. However, if procurement of cheapest spare parts is difficult, the price will not be the only factor considered.

Table 3- 3 Considered Origin of the Equipment

Equipment	Main Specification	Origin
Collection / Haulage Equipment		
1. Compactor truck	4 ton class, 8 m³	Japan
2. Dump truck	ton class, 10 m³	Japan
3. Detachable container truck	5 m³ for container haulage	Japan
4. Container	5 m³	Thai
5. Small dump truck	2 ton class, 1.5 m³	Japan
6. Wheel loader	75 HP class	Japan
7. Grass cutter	carry type	Japan
8. Water tanker	6 ton class, 6,000 l	Japan or 3rd Country
9. Small dump truck for exclusive use of infectious medical waste	1.5 ton class, stainless steel, closed body	Japan
10. Pick up	2000cc, 4-WD, W-cabin	Japan
11. Motorcycle	100cc class	Laos
12. Truck scale	30ton class	Japan
Landfill Equipment		
1. Bulldozer	165 HP class	Japan
2. Excavator	80 HP class, 0.45 m³	Japan
3. Crawler type loader	120 HP class	Japan or 3rd Country
4. Soil dump truck	8 ton class, 6 m³	Japan
Maintenance Equipment		
1. Maintenance equipment		Japan

3-1-6 Implementation Schedule

The Project will be implemented under the financial system of Japan so it is necessary the schedule will be kept.

The Project will be carried out within a single phase because the implementation period for construction of the facilities and procurement of the equipment planned is 11 month shown as table 3-4. Detailed design, construction of the facilities and procurement of the equipment will be implemented by Japanese side based on this schedule. The implementation schedule was prepared on the assumption that the obligation of the Laotian side will be finished on schedule.

(1) Detailed design

The detailed design will be commenced after verification of the agreement of consultancy services by the Japanese government. The tender documents will be prepared based on the results of this basic design study. The contents of detailed design will be decided through discussion between the consultant and Laotian persons concerned. And tender documents will be agreed upon by the Laotian side before the tender notice.

4.5 months is required for detailed design. Tender notice, pre qualification of the bidders, delivery of the documents, tender, contract and commencement of the construction will be conducted within around 2 months after completion of the detailed design.

(2) Construction of the facilities

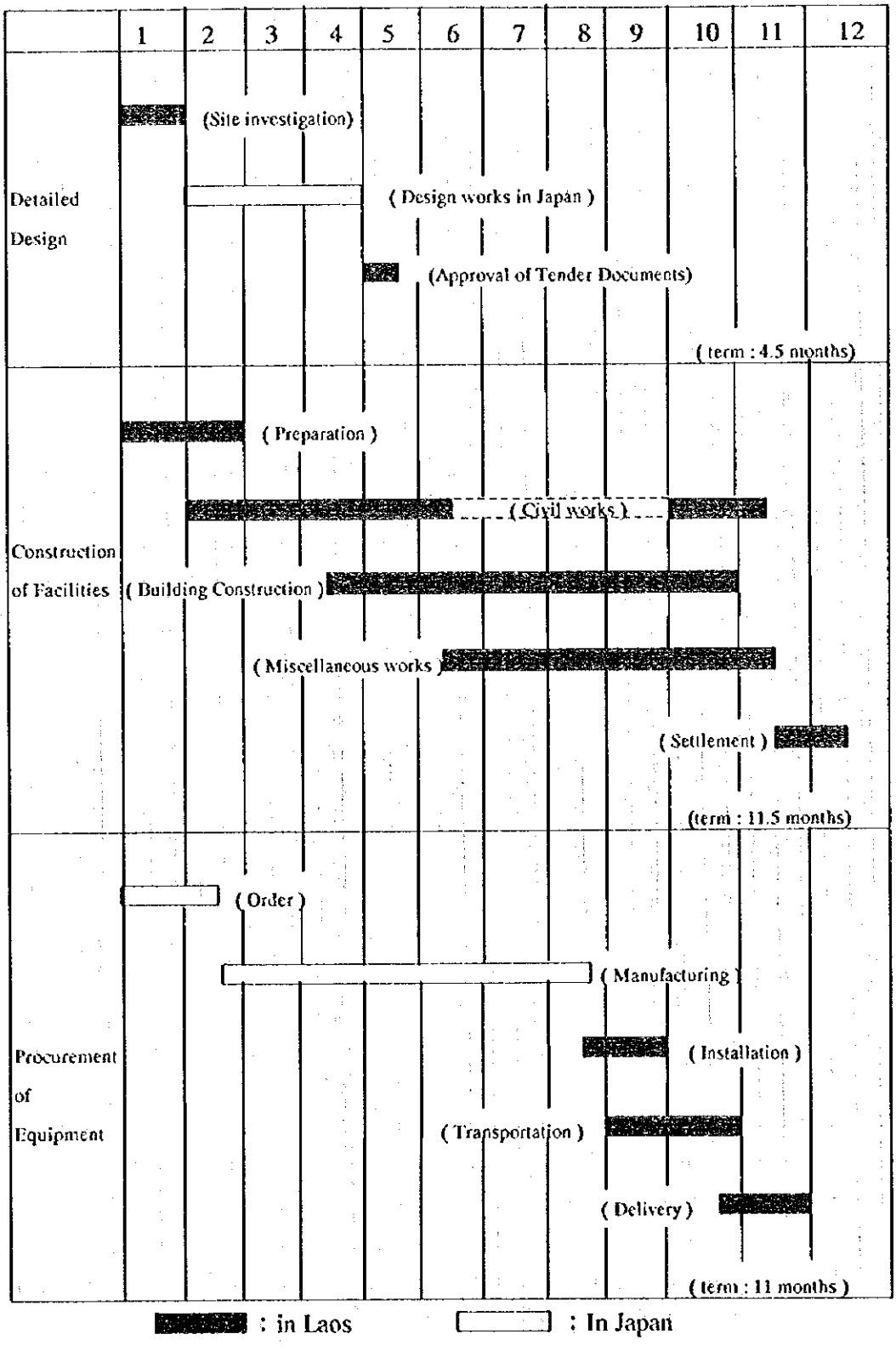
Construction of the facilities will be commenced after verification of the contract between the Laotian government and the contractor by the Japanese government. The contents of the facilities to be constructed being the final disposal site and maintenance shop.

(3) Procurement of the equipment

Procurement of the equipment will be commenced after verification of the contract between the Laotian government and the supplier by the

Japanese government. Total time for procurement is estimated to be 11 months consisting of 7.5 months for ordering and manufacturing, 2 months for sea and inland transportation, 1.5 month for installation, training and final inspection.

Table-3- 4 Implementation Schedule



3-1-7 Obligations of the Government of Laos

On condition of receiving Japan's grant aid the Government of Laos is required to undertake necessary measures.

1) To provide the land for a temporary side office, warehouse and stock yard during the implementation of the Project,
2) To provide necessary facilities for the Project such as electricity and other incidental facilities,
3) To bear commissions to the Japanese foreign exchange bank for the Banking Arrangement (B/A),
4) To exempt the equipment from taxes and to take necessary measures for customs clearance at the port of disembarkation in Laos.
5) To accord Japanese nationals whose services may be required in connection with the supply of products and the services under the verified contract such facilities as may be necessary for their entry into Laos and stay therein for the performance of their work,
6) To maintain and use properly and effectively the equipment provided under the grant,
7) To bear all the expenses, other than those to be borne by the grant, necessary for construction and the installation of the equipment.

Moreover, since the Project is to be implemented in accordance with the budget system of Japan, the period for the completion of the Project is severely restricted. Therefore, the Laotian side is obliged to undertake these necessary measures without delay.

3-2 Operation and Maintenance Plan

(1) Operation and maintenance after opening

a. Operation and maintenance of equipment

i) Establishment of organization

The cleansing unit does not have any organization for the maintenance of equipment at the present. But the construction section and bus company under DCTPC are maintaining their own equipment with high level skill.

So the cleansing unit has a plan to send maintenance staffs who will be employed based on the Appendix 7 (job descriptions) attached at the end of this report to these workshop and train required skill. As a periodic and light maintenance of the equipment being procured in the Project can be done in the maintenance shop, the planned waste management will work well.

Before the delivery of equipment, the operators should be prepared. In principle the operator will execute daily maintenance by themselves. So the operator will be trained appropriate maintenance method based on the operation and maintenance manual.

ii) Preparation of spare parts

Supply of spare parts is very important to keep the equipment good condition. Considering the financial condition of cleansing unit, it seems that rapid increase of the budget for procurement of spare parts is difficult. So the supply of spare parts for the equipment being procured will be included in the Project. But the quantities and kinds of spare parts procured in the Project will be so limited that the cleansing unit should prepare appropriate budget.

b. Operation and maintenance of facilities

i) Establishment of organization

Ordinary ,periodical or unexpected maintenance will be carried out by the engineer with suitable knowledge. Therefore, DCTPC trains the staffs who will be employed through supervision of the construction of the facilities with the Consultant.

ii) Preparation of spare parts

In principle, the construction materials are procured in Laos. But most of these are imported from Thailand. Serial number, manufacturer and dealer should be recorded to specify the material for repair the facilities when the construction of the facilities completed. And the budget for procurement of the material maintaining the facilities should be prepared.

c. Financial plan

i) Expenditure

Expenditure of the municipal solid waste management consists of operation and maintenance costs and depreciation costs. The solid waste management can be done during equipment are working. But it will be difficult to keep a smooth management if the equipment have been used after durable years, because frequent repair of the decrepit equipment will disturb it. Therefore a depreciation costs should be considered in the expenditure even it is not direct expenses.

- Operation and maintenance costs

Operation and Maintenance costs consist of (1) fuel and lubricant for operation of the collection and haulage and landfill equipment etc., (2) maintenance cost for procurement of spare parts to keep these equipment good condition etc., (3) personnel expenses for the salary of staffs. The operation and maintenance costs in 1998 are estimated as follows.

Table 3- 5 O & M Costs

Items	O&M costs
(1) Fuel and Lubricant Cost	124,000,000 kips/year
(2) Maintenance Cost	125,000,000 kips/year
(3) Personnel Expenses	64,420,000 kips/year
Total	318,420,000 kips/year
Disposal amount	28,689 ton/year
Unit O&M Cost	11,099 kips/ton

Table 3- 6 Depreciation Period (unit: year)

Items	Depreciation Period
Container, Grass Cutter, repairing tools	5
Vehicles, Heavy equipment	7
Maintenance equipment	18
Building, Infrastructure	30

ii) Revenue

A revenue for solid waste management consists of budget from municipality,

collection fee, tipping fee and cleansing tax being newly introduced. The collection and tipping fee are assumed as same as a fee adopted in F/S shown in Table 3-7 for making a financial plan. The cleansing tax will be charged to the companies and shops registered to the municipality annually. The number of registered companies and shops are forecasted in Table 3-8.

Table 3- 7 Waste Collection Fee

		1998 year	2000 year
Basic fee (kip/month)		1,000	1,200
Extra fee (kip/basket)		250	
Special fee (kip/container/month)		30,000	50,000
Tipping fee (kip/unit)	small	600	900
	medium	800	1,200
	large	1,200	1,500

Table 3- 8 Number of Registered Companies and shops

	1995 year	1998 year	1999 year	2000 year
• Manufacturer	323	357	369	381
• Shop	2,141	2,366	2,447	2,530
• Restaurant and tea shop	718	793	820	848
• Others	438	484	500	517
Total	3,620	4,000	4,136	4,276

iii)Balance

The balances between expenditure and revenue from 1998 to 2000 are forecasted in Table 3-9 under following assumptions.

- The municipal budget will increase baste on the actual one in 1994 with 8% which is a growth ratio of GDP from 1993 to 1994.
- Cleansing tax is 40,000 kips per year.

Table 3- 9 Financial Plan of MSWM (unit: million kips)

	1994 year	1998 year	1999 year	2000 year
Budget Municipality	64.3	87.5	94.5	102.1
Cleansing tax	-	160.0	165.4	171.0
Collection fee	40.4	204.8	260.1	310.8
Total Revenue	104.7	452.3	520.0	583.9
O & M Costs	100.0	318.4	391.7	459.8
Balance	4.7	133.9	128.3	124.1
Depreciation Costs	-	118.8	118.8	118.8

Tabulated financial plan as above shows that the planed solid waste management is feasible. There is no financial problems if the required budget will be provided and the cleansing tax will be introduced and the public participation will be obtained.

d. Management Plan

A municipal solid waste management is executed by the cleansing section which is strengthened from unit under DCTPC based on the secure financial background as above mentioned.

CHAPTER 4 PROJECT EVALUATION & RECOMMENDATIONS

CHAPTER 4 Project Evaluation & Recommendations

4-1 Verification of the Project's Suitability to the Area, and Benefits of the Project

This project will (1) improve the waste collection and haulage equipment, (2) improve the final disposal site, (3) construct a maintenance shop, and (4) procure the equipment for sanitary education campaign; factors essential to the conduct of waste management services in the municipality of Vientiane in 1998. Parallel with these improvement works, the organizational structure and system of the waste management services will be established.

4-1-1 Effects of Project Implementation

(1) Improvement of Waste Collection and Haulage Equipment

The implementation of this project will raise the collection rate in densely populated areas from 75% to 100%, 25% in other areas, and 50% over the entire project area. Ninety thousand (90,000) residents will be the direct recipients of collection services. However, improved environmental conditions due to the decrease in polluted conditions caused by uncollected waste will benefit the entire project area population (180,000).

The provision of equipment for the collection of infectious medical waste will also help establish a totally segregated collection and haulage system for such waste, consequently eliminating the danger of exposing the collection workers, hospital staff, and residents along the haulage route to secondary contamination.

(2) Improvement of Final Disposal Site

Wastes hauled to the present final disposal site (KM-18) are just dumped without further measures, resulting in the scattering of plastics and other light wastes in the vicinity. This insanitary condition gravely endangers the environment as it promotes the breeding of harmful insects, produces annoying odors, and may cause fire. The improvement of the final

disposal site will prevent these factors from occurring as it entails the immediate covering of wastes.

There are about 95 villages in the neighboring area of the disposal site utilizing groundwater as their source of drinking water. The use of this disposal site for the past 20 years is feared to have contaminated groundwater quality through the seepage of leachate into the ground. Although the Japanese study team members who conducted the development study and the basic design study recommended the termination of the use of groundwater as a potable water source, economic difficulties made it impossible to do so. Taking the health of the residents into account, this project plans to install water pipes to supply potable water to the residents and to the final disposal site.

(3) Construction of a Maintenance Shop

At present, the municipality of Vientiane does not have any facility for the maintenance and management of waste collection and disposal equipment. This is the reason why the equipment has gradually become inoperative, significantly affecting the efficiency of the regular operation of the collection services. Accordingly, this project plans to construct a facility that will provide periodical check-ups and minor repair services for the collection and haulage vehicles, and landfill equipment to be granted by this project.

The implementation of the project will therefore result in efficient and reliable waste collection services.

(4) Procurement of Equipment for Sanitary Education Campaign

The waste management services offered by the municipality of Vientiane covers waste discharge, storage, collection and haulage, and the final disposal method. Of these, the project shall only cover the establishment of the storage, collection and haulage systems, and the final disposal method. The discharge and storage of household waste, which is 75% of the entire amount of waste generated in the project area, will be conducted by the residents themselves.

The deterioration of the sanitary conditions of the urban environment is not just the effect of the deficient collection capability of the Vientiane Municipality, but also due to the residents lack of concern for sanitation and the manner adopted concerning waste discharge. It is extremely necessary to educate the residents on sanitation to achieve a sanitary urban environment. Further, because the discharge and storage of waste has a direct bearing on the conservation of the sanitary conditions of the urban environment, resident participation is indispensable to the promotion of this project. By providing educational tools and equipment, the project will enable the municipality of Vientiane to extend sanitary education to the residents of the area. Moreover, together with the establishment of the aforementioned collection systems, waste management services can be aggressively promoted.

The aforementioned equipment and facilities to be provided through this project complement each others functions in the promotion of waste management services, thereby improving the sanitary conditions of the urban environment of the municipality of Vientiane. The improvement in the sanitary conditions of the urban environment through the implementation of the project is considered to raise resident awareness concerning sanitation, and expected to expand the waste management services.

4-1-2 Justification of the Implementation of the Project through the Grant Aid Program

The following justifies why this project should be implemented under the Japanese grant aid program:

(1) This project will be carried out in the urban area of the municipality of Vientiane, and will improve the living environment of the 180,000 residents of the area, as well as provide other benefits.

(2) Waste management services evolve from the cooperation of the residents, the producers of waste, and the municipality, the collector and disposer of

waste. The current waste management services in the municipality of Vientiane, however, only collect about 12% of the waste due to lack of equipment. The discharge and storage manners of the residents also contribute to the increase in uncollected wastes, which usually defile the area and cause environmental conditions to deteriorate.

Aside from the construction and improvement of equipment and facilities, this project also entails the reinforcement of the waste management system and the education of the residents regarding sanitation. By considering the immediate improvement of the sanitary conditions of the urban environment, this project aims to establish a waste management service or system that is based on the cooperation of the municipality and the residents.

(3) As a means of fortifying the Cleansing Section which is in charge of the waste management services, the municipality of Vientiane intends to employ more people and has accordingly approved the allocation of 70 million kips in 1997 for waste management services. It has further agreed to adopt a measure for establishing a budget, for the management of the services in the first year after the project is completed, that is in accordance with the financial plan for the Cleansing Section. The municipality is considered capable of continuously providing the finances of the waste management services based on the fact that planned budget for 1997 will only amount to 3 ~ 4% of the municipal budget, only a slight increase from the 2.8% allocated in 1994.

(4) The financial plan proposed in chapter 3-2 states the importance of imposing limitations on the operation of the services after the completion of the project, e.g., exclusion of extra profit in the waste collection and disposal fees. This financial plan has been basically approved by the municipality of Vientiane.

(5) The considerations of the impact of the project on the environment has led to the formulation of countermeasures, e.g., prevention of the scattering of waste during haulage, immediate waste covering activities at the disposal site, complete separation of leachate and rain water, and

countermeasures for drainage from the maintenance shop, that are considered suitable to the present conditions.

4-2 Technical Cooperation • Cooperation with Other Donors

Under the guidance of the WHO, the Ministry of Health of Laos is currently formulating national guidelines for handling infectious medical wastes. The guidelines will be used in this project for the establishment of the collection system for infectious medical waste and the sanitary landfill site system, a tentative countermeasure. Accordingly, the cooperation of the Ministry of Health and WHO is necessary for the implementation of the project.

4-3 Items of Concern

(1) Rules and Criteria in Handling Infectious Medical Waste, and the Establishment of a Separate Collection System

This project intends to establish the collection and haulage system for infectious medical waste, as well as the sanitary landfill system - a tentative measure. However, to effectively implement these systems, it is extremely important to establish the rules, criteria and the system for the collection of such wastes, and inform the people or institutions constantly handling these wastes.

(2) Reinforcement of the Waste Management System

For the reinforcement of the waste management system, 72 people, including those to be temporarily employed, will be hired. Although the job description for the staffs of cleansing section is described in Appendix 7, the conduct of the hiring and training activities should not lag behind the scheduled completion of the project.

(3) Privatization

This project will not be subject to privatization. As a tentative measure,

however, some of the collection services in the project area will be entrusted to a private company until the project is completed. Moreover, the consignment of collection services to 2 private companies is also planned after the completion of the project. In order to clarify the areas to be covered by the municipality and the private companies, the latter shall be assigned the services for zones outside the project area.

(4) Request for the Dispatch of Experts in Waste Management

The implementation of this project will increase the waste collection capability of the municipality threefold, and will involve the implementation of a new operation and maintenance system. To effectively use these capabilities, the municipality of Vientiane requires the guidance and supervision of experts in waste management.

[Appendices]

1. Member List of the Study Team
2. Survey Schedule
3. List of Party Concerned in the Laotian Side
4. Minutes of Discussion
5. Cost Estimation Borne by the Laotian Side
6. Drawings of Basic Design
7. Job Description for the Staffs of Cleansing Section

APPENDIX 1 : Member List of the Survey Team

First Survey Team

1.	KOBAYASHI SHIGEKI	Leader Grant Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs
2.	NAGAI YOSHIAKI	Technical Adviser Waste Management Division,. Water Supply and Environmental Sanitation Department, Environmental Health Bureau, Ministry of Health and Welfare
3.	ISHIMORI TOMOHIRO	1st Basic Design Study Division, Grant Aid Study & Design Department, JICA
4.	ANAI JUNJI	Chief Consultant / Operation and Maintenance Planner Kokusai Kogyo Co., Ltd.
5.	MARUFUJI NOBORU	Facilities Planner Kokusai Kogyo Co., Ltd.
6.	MORI IKUO	Equipment Planner Kokusai Kogyo Co., Ltd.

Second Survey Team

1.	YANAGISAWA KAE	Leader Deputy Director, Study Review and Coordination Division, Grant Aid Study & Design Department, JICA
2.	MARUYAMA MAKI	Project Coordinator 1st Basic Design Study Division, Grant Aid Study & Design Department, JICA
3.	ANAI JUNJI	Chief Consultant / Operation and Maintenance Planner Kokusai Kogyo Co., Ltd.
4.	MARUFUJI NOBORU	Facilities Planner Kokusai Kogyo Co., Ltd.
5.	MORI IKUO	Equipment Planner Kokusai Kogyo Co., Ltd.
6.	Precha CHUNTAKORN	Interpreter Kokusai Kogyo Co., Ltd.

APPENDIX 2 : Survey Schedule

Firstn Survey

No.	Date		Schedule		Note
1	9/10	SUN	Dep.NRT, Arrv.BKK	Bangkok	
2	9/11	MON	Dep.BKK, Arrv.VTE	Vientiane	Visit EOJ、VTE Municipality
3	9/12	TUE		Vientiane	Discussion with DCTPC
4	9/13	WEN		Vientiane	Site survey
5	9/14	THU		Vientiane	Site survey
6	9/15	FRI		Vientiane	Site survey and discussion on the M/M
7	9/16	SAT		Vientiane	Site survey and discussion on the M/M
8	9/17	SUN	Leader Arrv. VTE	Vientiane	
9	9/18	MON		Vientiane	Discussion on the Minutes, Site survey
10	9/19	TUE		Vientiane	Discussion on the Minuets
11	9/20	WED	Leader Dep. VTE	Vientiane	Report to the EOJ
12	9/21	THU		Vientiane	Site survey
13 ～ 27	9/22 ～ 10/6	FRI ～ FRI		Vientiane	Site survey, Discussion with DCTPC
28	10/7	SAT		Vientiane	Discussion with DCTPC
29	10/8	SUN	Dep.VTE, Arriv.BKK	Bangkok	
30	10/9	MON	Dep.BKK, Arriv.NRT	Tokyo	

Second Survey Schedule

No.	Date		Schedule		Note
1	1/24	WED	Dep.NRT, Arriv.BKK	Bangkok	
2	1/25	THU	Dep.BKK, Arriv.VTE	Vientiane	Visit EOJ, VTE municipality
3	1/26	FRI		Vientiane	Explanation of Draft Report, Site survey
4	1/27	SAT		Vientiane	Discussion with DCTPC
5	1/28	SUN		Vientiane	
6	1/29	MON		Vientiane	Signature to M/M, Report to the EOJ
7	1/30	TUE	Leader Dep.VTE	Vientiane	Supplementary survey
8	1/31	WED		Vientiane	Supplementary survey
9	2/1	THU	Dep.VTE, Arriv.BKK	Bangkok	
10	2/2	FRI	Dep.BKK, Arriv.NRT	Tokyo	

APPENDIX 3 : List of Party Concerned in the Laotian Side

1.	Vientiane Municipality	Department of Communication, Transport, Post & Construction
		Cabinet & Economic External Relation, DCTPC
		Urban Sanitary Department
2.	Department of Asia - Pacific & Africa, Ministry of Foreign Affairs	
3.	Ministry of Public Health	Department of Hygiene and prevention
4.	Lao Water Supply Authority	NAMPAPA LAO