CLIMATE

D A I L Y D A T A

	21/10	22/10	26/10	27/10	28/10
TN =	24.6	24.0	26.1	23.6	23.5
TX =	29.6	26.7	31.0	33.6	36.0
TM =	25.5	24.8	26.9	27.3	28.5
UN =	64.5	79.0	61.0	54.0	39.5
UX =	83.0	83.0	81.0	82.0	83.0
UM =	80.0	81.5	76.5	74.0	66.7
U8 =	8h30	15h30	3h48	10h18	7h24
U9 =	0h00	0h00	0h00	0h00	0h00
RG =	125	153	100	1269	1768
BA =	5.64	5.36	5.52	5.64	5.24
VX =	3	6	4	5	5
IVX =	20h36	14h36	22h24	23h30	6h30
VT =	12	35	26	84	71
VN =	0	3	0	2	1
VNE =	1	4	0	3	4
VE =	2	1	8	33	31
VSE =	3	2	13	42	28
VS =	1	7	1	3	2
VSW =	1	6	0	1	1
VW =	0	5	0	1	1
VNW =	0	7	0	1	2
ITN =	17h48	7h36	17h54	6h24	6h24
ITX =	11h48	13h18	15h42	13h48	14h36
IUN =	11h54	14h06	15h48	13h48	14h48
IUX =	23h54	0h48	23h54	3h18	3h24

Where:

TN = Minimum Temperature in °C
ITN= Time of Occurence of TN
TX = Maximum Temperature
ITX= Time of Occurence of TX
TM = Mean Temperature
UN = Minimum Temperature
IUN= Time of Occurence of UN
UX = Maximum Temperature
IUX= Time of Occurence of UX
UM = Mean Temperature
U8 = Duration of Relative Humidity: 80%≤U≤90%
U9 = Duration of Relative Humidity: U≥90%
BA = Batterry Voltage
VX = Max. Wind Speed in m/sec.
IVX= Time of Occurence of VX
VT = Total Wind Passed in Km.
VN = Total Wind Passed coming from North in Km.
VNE= Total Wind Passed coming from Northeast
VE = Total Wind Passed coming from East
VSE= Total Wind Passed coming from Southeast
VS = Total Wind Passed coming from South
VSW= Total Wind Passed coming from Southwest
VW = Total Wind Passed coming from West
VNW= Total Wind Passed coming from Northwest

H O U R L Y D A T A

21/10	T	U	U9	VT	RG	22/10	T	U	U9	VT	RG
01h00	///	///	///	///	///	01h00	24.6	82.5	0h00	1	0
02h00	///	///	///	///	///	02h00	24.6	82.0	0h00	1	0
03h00	///	///	///	///	///	03h00	24.3	82.0	0h00	1	0
04h00	///	///	///	///	///	04h00	24.4	82.0	0h00	1	0
05h00	///	///	///	///	///	05h00	24.8	80.5	0h00	2	0
06h00	///	///	///	///	///	06h00	24.5	81.0	0h00	3	0
07h00	///	///	///	///	///	07h00	24.2	81.5	0h00	1	2
08h00	///	///	///	///	///	08h00	24.2	82.0	0h00	2	4
09h00	///	///	///	///	///	09h00	24.4	81.5	0h00	1	12
10h00	///	///	///	///	///	10h00	24.3	82.0	0h00	1	8
11h00	///	///	///	///	///	11h00	24.9	82.5	0h00	2	20
12h00	29.4	66.0	0h00	0	18	12h00	26.1	82.0	0h00	3	40
13h00	28.6	72.5	0h00	0	46	13h00	26.1	81.0	0h00	2	40
14h00	26.4	78.0	0h00	2	14	14h00	25.9	79.0	0h00	5	18
15h00	25.8	79.5	0h00	3	16	15h00	25.2	80.5	0h00	4	8
16h00	26.0	80.0	0h00	0	24	16h00	25.7	81.5	0h00	4	2
17h00	25.3	81.0	0h00	1	6	17h00	###	###	0h00	1	0
18h00	24.9	82.0	0h00	1	0	18h00	###	###	0h00	0	0
19h00	24.5	82.0	0h00	0	0	19h00	###	###	0h00	0	0
20h00	24.5	82.0	0h00	1	0	20h00	###	###	0h00	0	0
21h00	24.4	82.0	0h00	3	0	21h00	###	###	0h00	0	0
22h00	24.4	82.5	0h00	0	0	22h00	###	###	0h00	0	0
23h00	24.3	82.5	0h00	0	0	23h00	###	###	0h00	0	0
24h00	24.4	82.5	0h00	1	0	24h00	###	###	0h00	0	0

26/10	T	U	U9	VT	RG	27/10	T	U	U9	VT	RG
01h00	///	///	///	///	///	01h00	24.6	81.0	0h00	3	0
02h00	///	///	///	///	///	02h00	24.3	81.0	0h00	4	0
03h00	///	///	///	///	///	03h00	24.0	82.0	0h00	5	0
04h00	///	///	///	///	///	04h00	24.0	81.5	0h00	5	0
05h00	///	///	///	///	///	05h00	23.8	81.0	0h00	6	0
06h00	///	///	///	///	///	06h00	23.6	81.5	0h00	4	0
07h00	///	///	///	///	///	07h00	24.4	80.5	0h00	5	20
08h00	///	///	///	///	///	08h00	26.4	73.0	0h00	5	86
09h00	///	///	///	///	///	09h00	29.0	67.0	0h00	2	116
10h00	///	///	///	///	///	10h00	30.9	61.5	0h00	0	152
11h00	///	///	///	///	///	11h00	31.3	60.5	0h00	2	202
12h00	///	///	///	///	///	12h00	32.1	59.5	0h00	2	200
13h00	///	///	///	///	///	13h00	32.0	61.5	0h00	1	136
14h00	###	###	0h00	0	0	14h00	32.8	57.5	0h00	0	158
15h00	29.3	70.5	0h00	0	4	15h00	31.0	65.5	0h00	3	92
16h00	29.6	65.5	0h00	0	68	16h00	31.0	65.0	0h00	3	78
17h00	27.5	76.0	0h00	1	26	17h00	29.1	72.5	0h00	2	26
18h00	26.1	79.5	0h00	0	2	18h00	27.7	76.5	0h00	1	2
19h00	26.3	79.5	0h00	2	0	19h00	26.9	79.0	0h00	1	0
20h00	25.9	79.5	0h00	5	0	20h00	26.2	79.0	0h00	5	0
21h00	25.6	80.0	0h00	5	0	21h00	25.6	80.0	0h00	7	0
22h00	25.3	81.0	0h00	5	0	22h00	25.6	80.5	0h00	7	0
23h00	24.9	80.5	0h00	4	0	23h00	24.8	80.5	0h00	5	0
24h00	24.8	81.0	0h00	4	0	24h00	24.4	81.5	0h00	6	0

H O U R L Y D A T A

28/10	T	U	U9	VT	RG
01h00	23.8	82.0	0h00	6	0
02h00	24.0	83.0	0h00	7	0
03h00	23.8	83.0	0h00	7	0
04h00	24.0	82.5	0h00	6	0
05h00	24.0	82.0	0h00	6	0
06h00	23.7	82.0	0h00	6	0
07h00	24.0	82.0	0h00	5	12
08h00	26.8	72.5	0h00	6	84
09h00	29.8	67.0	0h00	3	164
10h00	31.9	60.0	0h00	2	206
11h00	33.7	51.5	0h00	2	244
12h00	34.8	43.0	0h00	4	282
13h00	34.5	43.0	0h00	3	270
14h00	35.0	41.0	0h00	4	260
15h00	33.3	45.5	0h00	3	192
16h00	###	###	0h00	1	54
17h00	###	###	0h00	0	0
18h00	###	###	0h00	0	0
19h00	###	###	0h00	0	0
20h00	###	###	0h00	0	0
21h00	###	###	0h00	0	0
22h00	###	###	0h00	0	0
23h00	###	###	0h00	0	0
24h00	###	###	0h00	0	0

Where:

T = Temperature in °C
U = Hourly Relative Humidity
U9= Duration of Humidity: 90≥U
VT= Total Wind Passed in Km.
Rg= Global Radiation in Joules/cm²

Atmospheric Pressure at Montalban (Project Site)

Oct. 21	1200	999.1	Oct. 22	0200	995.3
	1300	997.6		0500	993.6
	1400	997.2		0800	994.7
	1500	997.0		0900	994.3
	1600	996.7		1000	993.9
	1700	996.9		1100	992.8
	2000	997.4		1200	991.4
	2300	997.4		1300	990.4
				1400	989.2
				1500	988.5
				1600	987.4

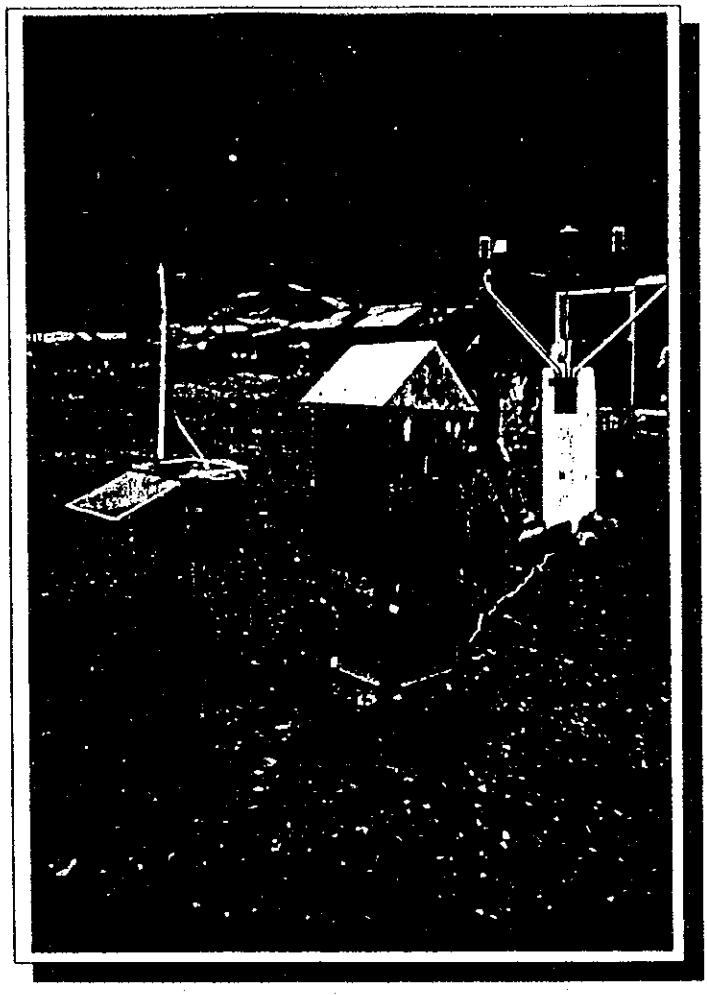
Oct. 26	1400	1000.9	Oct. 27	0200	1003.3
	1500	1000.5		0500	1003.6
	1600	1000.7		0800	1005.3
	1700	1000.9		0900	1005.4
	2000	1003.2		1000	1005.4
	2300	1003.6		1100	1004.5
				1200	1003.6
				1300	1002.5
				1400	1002.0
				1500	1001.3
				1600	1001.6
				1700	1002.1
				2000	1004.3
				2300	1005.4

Oct. 28	0200	1004.4
	0500	1003.4
	0800	1006.3
	0900	1006.4
	1000	1006.3
	1100	1005.6
	1200	1005.0
	1300	1004.1
	1400	1003.3
	1500	1003.1
	1600	1003.2

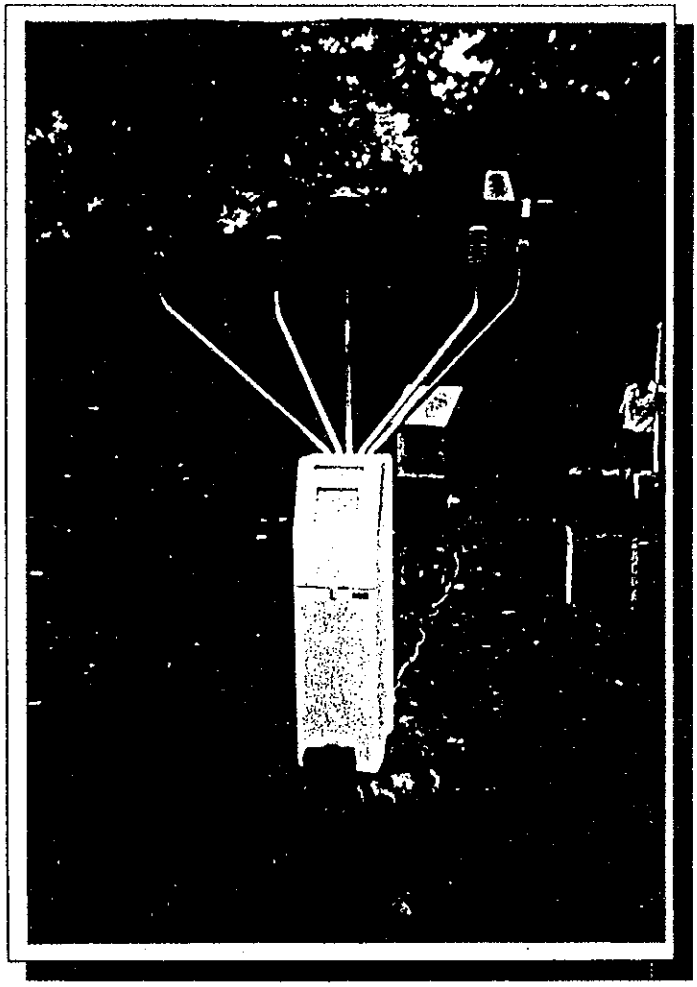
PICTURES

Installation of the equipment for air and odor sampling at sta. PB-4 near Wawa Dam.

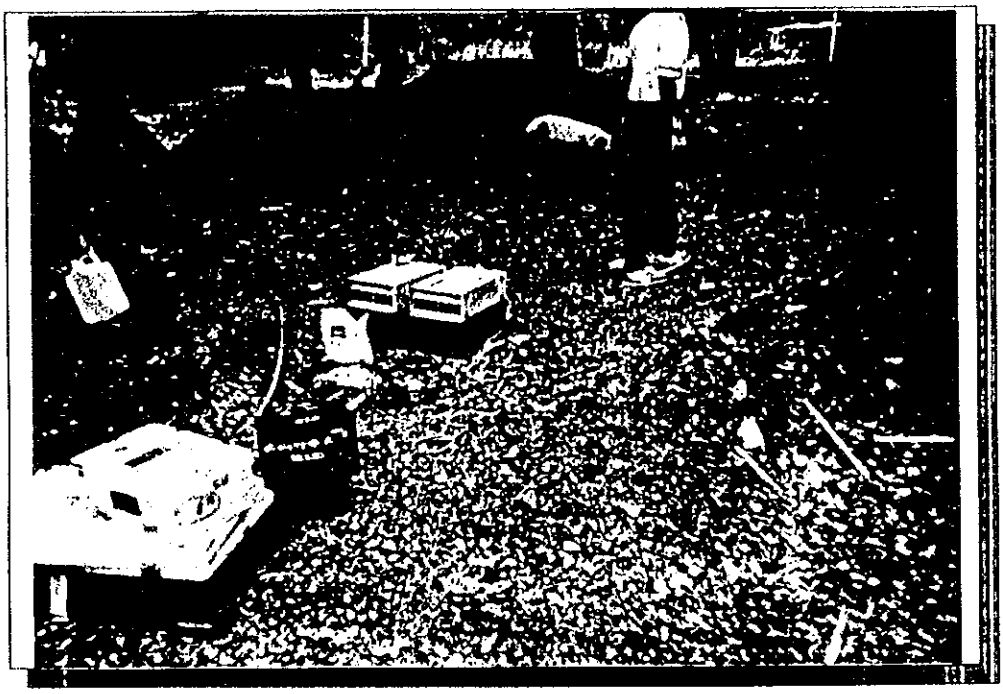
Installation of the instrument for climate reading at sta. PB-4 near Wawa Dam.



The equipment used in the air and odor sampling at sta. PB-4. Underneath the equipment is a barograph used in measuring the atmospheric pressure of the area.



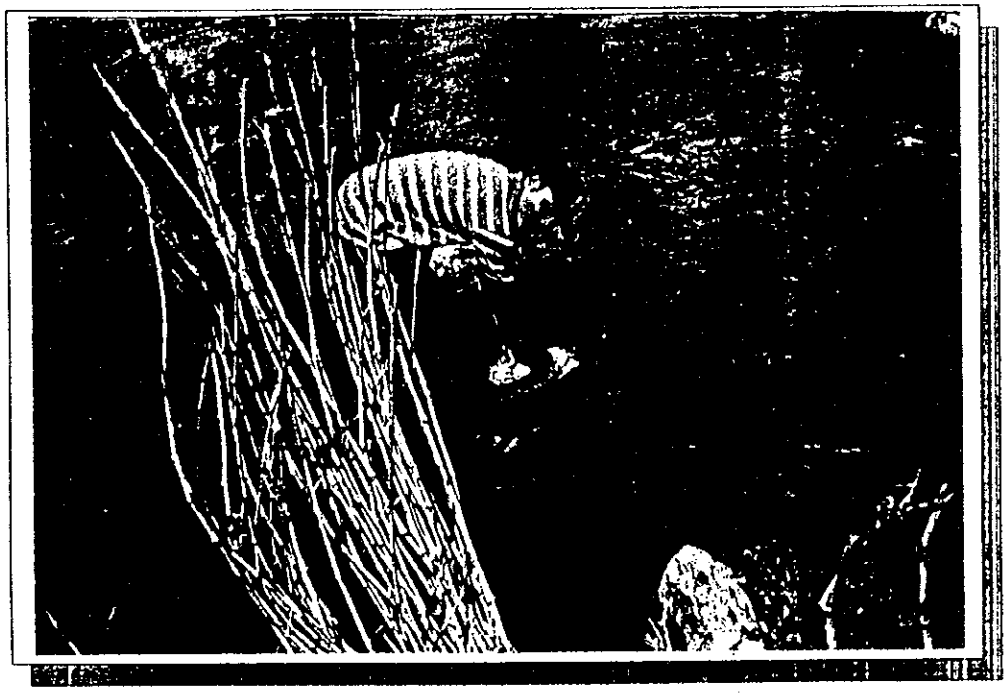
The instrument used in determining the temperature, wind velocity & direction, and humidity of the area at sta. PB-4.



Vibration and noise test conducted at sta. PB-4 near Wawa Dam.

Vibration and noise test conducted at sta. PB-7.

Water sampling at sta. PB-5



Water sampling at sta. PB-6

Water sampling done at one of the spring at sta. PB-8.

23.2.2 EIA Report

LIST OF ABBREVIATIONS/ACRONYMS

BOD	-	Biological Oxygen Demand
COD	-	Chemical Oxygen Demand
DAO	-	Department Administrative Order
DENR	-	Department of Environment and Natural Resources
DENR	-	Department of Environment and Natural Resources
EMB	-	Environmental Management Bureau
IUCN	-	International Union for Conservation of Nature
JICA	-	Japan International Cooperation Agency]
MEFCON	-	Marikina Environment Forest Conservation Project
MMDA	-	Metro Manila Development Authority
NYMBY	-	Not In My Back Yard
PAGASA	-	Philippine Atmospheric Geophysical and astronomical Services Administration
PEA	-	Public Estate Authority
PPA	-	Philippine Ports authority
PPP	-	Polluter Pay Principle
PTFSWM	-	Philippine Task Force on Solid Waste Management
SLF	-	Sanitary Landfill
SWM	-	Solid Waste Management
TSP	-	Total Suspended Particulate
WACS	-	Waste Amount and Composition Survey

EXECUTIVE SUMMARY

Environmental Impact Statement
for the
Proposed New Parcel "B" Sanitary Landfill Project

EXECUTIVE SUMMARY

1 PROJECT DESCRIPTION

1.1 The project is identified as follows:

Official Name of the Project	:	Proposed New Parcel "B" Sanitary Landfill Project, San Rafael, Rodriguez, Rizal
Proponent	:	Metro Manila Development Authority (MMDA)
Contact Person	:	Mr. Rogelio U. Uranza Assistant General Manager, MMDA MMDA Building, Orense St., cor. EDSA Guadalupe, Makati City 1200 Tel No. 817 5631/812 1449

1.2 Project Location

The proposed sanitary landfill is located in Sitio Inigan, Barangay San Rafael, Rodriguez (formerly Montalban), Rizal. It covers a total area of 130.2 has. The proposed project site is within the jurisdiction of the Marikina Watershed Area as declared under NIPAS. It is a government owned area.

The project site is about 4 to 5 kilometer northeast of the existing San Mateo Sanitary Landfill (SLF) at San Mateo, Rizal and about 16 kilometer northeast of Quezon Circle, Quezon City. To access the site, an access road of approximately 9-km will be constructed. From the south, the site can be accessed via the existing San Mateo disposal site, using the Marcos Highway and Cogeo Road. From the north, the site can be accessed by taking the Quezon Circle passing through Payatas, Rodriguez and Wawa.

1.3 Project Rationale and Need for the Project

The fast economic growth of the 17 LGUs in Metro Manila and its neighboring town have been accompanied by the rapid deterioration of its environment. One area of concern, which is considered a very serious problem besetting the area, is solid waste disposal. It is estimated that of its total solid waste generation of 5,000 to 6,000

tons/day, only around 3,500 tons/day are handled, while the rest are illegally dumped on vacant land, thrown in rivers, etc.

Metro Manila has four (4) disposal sites, namely; (1) San Mateo Sanitary Landfill in Rizal, (2) Carmona Sanitary Landfill in Cavite, (3) Payatas Open Dump Site in Quezon City, and (4) Catmon Open Dump Site in Malabon. The only disposal sites being used for Metro Manila's waste as of September 1998 are San Mateo, Payatas and Catmon. President Estrada also ordered the closure of Payatas open dump site by the end of December 1998.

According to JICA's study, the remaining life span of the three existing disposal sites is only 3 to 4 years. The projection is based on the assumption that Payatas and Catmon open dumpsites would be closed by the end of 2000. In case Payatas will be closed this year, the apparent life span of the remaining disposal sites will be shorter than this projection.

Without proper planning and concrete SWM program in the metropolis, the threat of garbage crisis is just around the corner. The most recent incidence on the mid of January of the current year, where the people of Antipolo, San Mateo and Montalban barricaded Marcos Highway, provided a five-day snap glimpse of garbage crisis, if the issue is not immediately and properly addressed by the government. Under the present situation, JICA study revealed that a garbage crisis would likely to happen in the year 2001.

1.4 Alternatives

1.4.1 Alternative Sites

In the conduct of this study, there were five alternative or candidate sites considered for the project. The list includes the following:

1) San Rafael, Rodriguez under the concept Marikina Environment Forest Conservation Project (MEFCON),
2) Maragondon, Cavite
3) Kalawakan, Bulacan
4) Bacolor, Pampanga
5) Sea Landfill

These sites were assessed in terms of topography and accessibility using field surveys and aerial observation results. From the results of the evaluation and investigation, Sitio Inigan was selected for the development of an inland sanitary landfill site.

1.4.2 Appropriate Disposal Technology Alternatives

Options for the appropriate disposal technology alternatives were evaluated according to the following criteria: technical evaluation, environmental evaluation, economic and Financial evaluation, social evaluation, and overall evaluation.

Based on the results of the evaluation, those alternatives that propose on the improvement of haulage efficiency, introduction of intermediate treatment facilities for waste volume reduction, and the establishment of multiple disposal sites are recommended.

2 THE EIA PROCESS ADOPTED

An environmental impact assessment study was undertaken for the proposed "New Parcel 'B' Sanitary Landfill Project". The resulting study was documented in the form of an Environmental Impact Statement (EIS), a requirement for the issuance of the Environmental Compliance Certificate (ECC) by DENR. The proponent shall use the result of the EIA study in planning the detailed engineering designs, site selection for facilities and the formulation of appropriate environmental management plan for the project.

During the planning and feasibility study stages of the proposed project, multi sectoral consultations in various fora and seminars were undertaken to solicit and provide inputs to the overall planning of the project. As a result of this initiative, environmental, political and socio-economic issues and concerns were already incorporated in the very early stage of project planning and conceptual design. Expert advice of JICA consultants were also solicited to ensure technical soundness of the proposed project.

Bearing in mind the importance of scoping at the early at the early stage of project planning, formal scoping session with DENR staff and members of the EIA-Review Committee was held at PTFSWM office at EMB-DENR. A second level scoping session held at the municipality of Montalban followed this.

The Consultants considered the issues and concerns that were raised by concerned people of Montalban during the aforementioned sessions. Likewise, the Consultants were further guided by using guidelines and references prepared by international institutions like the Word Bank and the Asian Development Bank (ADB) in the conduct of the impact assessment of the proposed project. In addition, the preparation of the EIS document was guided by the following documents:

- DENR DA0 96-37 otherwise known as the Revised Implementing Rules and Regulation of PD 1586 (Environmental Impact Statement System);

- DAO 98-49 (Technical Guidelines for Municipal Solid Waste Management)
- DAO 98-50 (Adopting the Landfill Site Identification and Screening Criteria for Municipal Solid Waste Disposal Facilities).
- DAO 35 (Revised Effluent Regulations of 1990, Revising and Amending the Effluent Regulations of 1982)
- DAO 34 (Revised Water Usage and Classification /Water Quality Criteria Amending Section Nos. 68 & 69, Chapter III of the 1978 NPCC Rules and Regulations))
- DA0 14 (Revised Air Quality Standards of 1982, Revising and Amending the Air Quality Standards of 1978)
- RA 6969 (Toxic & Hazardous Waste Materials)
- and other pertinent DENR and other government agencies' regulations

2.1 Description Of Data Gathering

Baseline data collection for air, water, land and socio-economic modules was conducted following the procedures prescribed by the Department of Environment and Natural Resources. Since the study required the services of a multi-disciplinary investigation, services of various specialists and experts were hired to complete the study.

Primary data were collected from various surveys undertaken while secondary data were gathered from various private and government agencies.

2.2 Description of the Project Environment

2.2.1 Meteorological Characteristics

The project site falls within the Type I Classification of the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA). It is characterized by two distinct pronounced seasons: extremely wet from May to October and quite dry from November to April.

The first four months of the year are very dry compared with the monthly averages during the rest of the year. Its wettest months are the 3-month period from July to September. The monthly mean temperatures range from 24.1 oC in December to

27.3oC in May. The early mornings in December are the coldest with minimum temperature average to 19oC. During the early afternoons in April, the temperature reaches a reading of 33.4oC.

In the project area, tropical cyclones contribute largely to the copious rainfall received from July to September. There are at least five tropical cyclones in the year that cross the geographical zone to which the project site and the rest of Metro Manila belong. The passage of these cyclones is mostly expected during the months of August to October.

2.2.2 Air Quality and Noise Characteristics of the Area

Measurement of the primary data on air quality was undertaken during the wet and dry season. The parameters measures include NOx, SOx, odor, TSP, H2S and methane.

The air quality of the area is typical of a country side areas. All the measured air quality parameters registered ambient concentration that are well below the standard. Similarly, noise level in the area is very low.

2.2.3 Topography

Within the project area, the topography is generally rolling to moderately rugged with elevation of more than 300-m amsl on its highest peak. The area is drained, by a northeasterly flow minor river that empties into the Wawa River. The drainage valleys are often V-shaped with steep banks and constricted channels along the upper reaches. At the downstream section as it joins the Wawa River, the valley widens smoothly and its flow becomes sluggish.

2.2.4 Geology

Prominent active faults such as the Marikina and Montalban faults are known to exist within a 100-km radius of the project area but only the Philippine Fault has been verified of its Movement on the basis of Quaternary displacements.

The project site is considerably far from the existing active faults in the area. It is about 2 km south/south-west of the north-west trending Montalban Fault and about 7 km east of the East Fault of the Marikina Valley thus, it is less proximate to areas of major and active erosion. Besides, the absence of notable cracks and slippage shows no signs of instability in the project site.

Within the project area, the volcanic rock concentrated on the upper reaches of the river consists principally of basalt which occurs as lava flow of the Kinabuan formation. The basalt generally exhibits dark-gray color with glassy matrix. It is generally massive and rarely fractured and sheeted and weathering usually leaves a few meters of clayey to silty soil cover. Few joints are observed but they are relatively tight and filled-up with secondary minerals, The flow rock in the area is intrinsically impermeable.

2.2.5 Hydrology

The source of water supply in the entire Montalban municipality is largely dependent on groundwater through deepwells. The deepwells were basically drilled to a depth range of 50 - 210 m within the valley and lowlands. At the eastern highlands where groundwater potential is low due to the occurrence of relatively impermeable rocks, groundwater abstraction is generally limited through shallow tube wells (<20 m-depth).

Few springs of low-yielding capacity are noted to exist within the project site. They usually occur from the minor fractures and openings of the older rock units. In few instances, other springs are noted to occur as seepage lines where the land surface intersects the water table. The perennial discharge capacity of most of these springs does not exceed 2 L/s.

Directly adjacent to the proposed sanitary landfill project is Wawa River which drains towards the Wawa Dam. An ocular inspection of the river during dry season would reveal that the quality of river water has been deteriorated over time. Possible sources of water pollution are the following (1) industries operating upstream of the river, (2) built-up areas such as residential communities and subdivision which directly discharge their domestic wastewater to Wawa river or its tributaries, and (3) heavy siltation of the river due to quarrying and denudation of the surrounding mountains.

2.2.6 Vegetation

The study indicated that most trees in the primary impact zone are of non-dipterocarp species. There are no dipterocarp trees were found in the identified study area. Of the eight-(8) common species of plants identified, none were considered threatened, endangered or rare species. No dominant species of dipterocarp plants have been identified within the proposed project site. Of the 8 species of plants identified in the study area, 5 were non-dipterocarps, 2 species are of grasses and a species of bamboo. This number of plants indicates low species diversity in the study area due to existing land use. The types of plants identified were mostly common species and part of secondary growth vegetation.

Based on the vegetation survey conducted and available secondary information, no threatened, endangered or rare species of plants are identified in the project site.

2.2.7 Fish and Wildlife

No major rivers or surface water bodies are found within the proposed project site. Due to this, there were no freshwater fish species noted in the area.

Within the identified primary impact zone, no significant bird population was noted. During a number of ocular visits and conduct of vegetation survey, no bird calls were observed along the main roads and trails around the proposed project site. Available secondary information indicated that there are no threatened, endangered or rare species of animals identified in the project sites.

2.2.8 Vibration Investigation, Traffic Count and Noise Survey

Ground vibration measurements were conducted in the vicinity of the Waste Disposal Sanitary landfill Area in San Mateo, Rizal, to estimate the level and characteristics of ambient ground vibration at various conditions in the site. Measurements were conducted within a span of 24 hours to determine differences in ground behavior between day and night activities in the site. Seismic instrumentation was installed at identified observation sites. The observation points were installed to measure the ground motion resulting from vehicular traffic, mainly garbage trucks and heavy equipment like bulldozers. To support the study, an hourly traffic count was also carried out along the two measurement points with relatively heavy vehicular activity.

2.2.9 Socio-Economic Aspects

The demography of the area was studied in terms population size and growth, population density, household size and sex composition, dependency ratio and educational attainment.

Housing Characteristics was also studied in terms of house ownership, structure and materials, toilet and water facilities. Socio-economic parameters like social services, employment and income were also considered.

A survey among the households in Sitio Inigan and Barangay San Rafael measured their perception of their community problems and the impact of the proposed project. To determine whether the proposed project will respond to existing community problems, the respondents were asked to identify these problems. The results indicate of the survey show anxiety of the local people to host the proposed sanitary landfill.

3 Impact identification and assessment

A systematic identification, prediction, and evaluation of the project's potential impacts to the environment was undertaken. Analyses were made on the potential impacts during construction and operation phases. The construction phase is expected to last for about two to three years while the projected operation stage is expected to last for a little more than six years. Though the abandonment phase is not comprehensively discussed in this study, the abandonment cum rehabilitation plan will be studied through the detailed feasibility study and master plan for MEFCON (Marikina Environment forest Conservation) and concept. This will be undertaken by MMDA through the assistance from JICA experts in the near future.

3.1 Impact Assessment Approach

Identification of the potential environmental impacts was done comprehensively by evaluating the project's features and operations against the known list of potential impacts identified by various sources for this type of project. These sources include the environmental assessment guidelines prepared by international financing institutions such as the Asian Development Bank Environmental Guidelines for Selected Infrastructure Project - Landfill Project (ADB, 1993) and the World Bank (WB, 1991). Other information sources were also consulted (Canter, 1977; Rau and Wooten, 1980; Carpenter and Maragos, 1989).

Results of the impact analysis are presented in the form of a scaling checklist, which indicates the nature of likely impacts and their predicted significance.

3.1.1 Construction phase Impacts

The predicted impacts during the construction phase are shown in the matrix below:

Scaling Checklist for Unmitigated Construction Phase Impacts

Impact Area	Impacts	Nature	Magnitude
Physico-Chemical Environment			
Hydrology/Sediments	Obstruction to Natural drainage	Negative	Significant
	Increase in soil erosion/erosion of silt runoff	Negative	Significant
Groundwater quality	Water Pollution	Negative	No effect
Surface water	Water Pollution due to sanitary waste disposal	Negative	Minimal
Air quality	Generation of air pollutants	Negative	Minimal
Noise and vibration	Increase in noise and vibration levels	Negative	Minimal
Traffic	Increase in traffic congestion	Negative	Minimal
Geology/Seismology	Induced seismicity	Negative	No effect
Topography/ Physiography	Alteration of natural terrain	Negative	Minimal
Natural resource use	Loss or conversion of agricultural/forest land	Negative /positive	Significant
Biological Environment			
Flora and fauna	Loss of Vegetation	Negative	Significant
	Fish and wildlife disturbance	Negative	Minimal
Socio-economic Environment			
Population size	In crease in population due to influx of outside labor and their households	Negative	Significant
Displacement of communities	Resettlement of 75 families to be displaced by the project	Negative	Significant
Dependency burden	Increase capability to support dependents	Positive	Significant
Education	Greater capability to support dependents	Positive	Significant
Sex ratio	Imbalance of sex ratio due to male preference as construction workers	Negative	Minimal
Housing characteristics	Increase capability to improve housing and utilities	Positive	Significant
Social services	Increase use of roads	Negative /positive	Minimal
Health and safety	Greater capability to afford food and medical care	Positive	Significant
	Exposure to air- and waterborne diseases	Negative	Significant
Employment and Income	Reduction of unemployment and increase in income	Positive	Significant
Women's welfare	Employment in services catering to workers	Positive	Minimal
Farm production	Reduction of farm production	Negative	Minimal
Displacement of communities	Resettlement of families to be displaced by the project	Negative	Significant

3.1.2 Operation phase impacts

The operation phase impacts are shown in the matrix below:

Operation Phase Impacts

Impact Area	Impacts	Nature	Magnitude
Physico-Chemical Environment			
Hydrology/Sediments	Disruption or impairment of surface hydrology	Negative	Significant
	Disruption of groundwater hydrology	Negative	Minimal
Groundwater quality	Water Pollution due to leachate infiltration	Negative	significant
Surface water	Water Pollution due to leakage or discharge of untreated leachate	Negative	Significant
Air quality	Generation of air pollutants such as methane, obnoxious/foul odor and gas pollutants	Negative	Moderate
Noise and vibration	Increase in noise and vibration levels due to hauling trucks and use of heavy equipment	Negative	Minimal
Traffic	Increase in traffic congestion due to hauling trucks	Negative	Minimal
Geology/Seismology	Induced seismicity	Negative	No effect
Topography/ Physiography	Alteration of natural terrain	Negative	No effect
Biological Environment			
Flora and fauna	Tree planting and reforestation within the project and buffer zone area	positive	Significant
	Fish and wildlife disturbance	Negative	Minimal
Socio-economic Environment			
Population size	Increase in population due to influx of outside labor and their households	Negative	Significant
	Increase in population due to influx of scavengers and/or squatters in the area	Negative	Significant
Dependency burden	Increase capability to support dependents	Positive	Significant
Education	Greater capability to support dependents	Positive	Significant
Sex ratio	Imbalance of sex ratio due to male preference as construction workers	Negative	Minimal
Housing characteristics	Increase capability to improve housing and utilities	Positive	Significant
Social services	Increase use of access roads	Positive	Significant
Health and safety	Greater capability to afford food and medical care	Positive	Significant
	Exposure to air- and waterborne diseases	Negative	Significant
	Occurrence of traffic-related accidents	Negative	Minimal
Employment and Income	Reduction of unemployment and increase in income	Positive	Significant
Women's welfare	Employment in services catering to workers	Positive	Significant
	Employment in junk shops and recycling centers	Positive	Significant
Farm production	Farm to market transport of agricultural produce	Positive	Significant

3.2 Environmental Risk Assessment

Environmental Risk Assessment (ERA) of the proposed SLF project is basically an examination of what can go wrong and whether plausible risk scenarios are considered to be unacceptable.

Risk is defined as the probability or chance of occurrence of an event. The event which is considered negative or undesirable is the focus of the ERA. A risk is often expressed as a statistic on the probability of an accident or death due to specific situations or conditions. A hazard on the other hand is defined as an inherent physical or chemical characteristics that has the potential for causing harm, while a hazard evaluation study is an organized effort to identify and analyze the significance of hazardous situations associated with a process or activity (AIChE, 1992).

In this ERA, the hazard evaluation study is focused on the hazardous situations associated with the operation of the proposed SLF.

3.2.1 Hazard Identification and Evaluation

The hazard evaluation used for this study is the "what-if Analysis" (WIA) technique. Other methods which are usually applied to already constructed systems were not considered. The WIA technique is selected since it does not require detailed information of the facility design and has broad flexibility for identifying and evaluating hazards. The hazard evaluation includes:

- Seismic Hazards Evaluation
- Fire Hazard Evaluation
- Leachate Pollution/Leakage Hazard Evaluation

3.2.2 Risk Management

Risk management usually refers to the examination of the economic and social implications of each level of protection. In this ERA, it refers to the social preferences, political issues, and technological feasibility.

The important issue for management is the propose layout plan and land use zoning of the areas around the propose SLF. Technical prevention of hazards is also important.

3.2.3 Risk Acceptability

In general, the risk associated with the use of properly sited and competently designed SLF is acceptable worldwide since the design and construction would be guided by

International Standards. Improvements on landfill technology during the past years have also contributed significantly on the safety of waste disposal.

4 Environmental Management, Monitoring and Institutional Plans

This section deals with the Environmental Management Plan (EMP), Monitoring Plan and Institutional Plan. These plans are designed to implement the proposed SLF project in an environment-friendly manner.

The EMP is the plan on what to do with the potential impacts identified in this study. The purpose of the EMP is to enhance the beneficial impacts and to lessen the adverse impacts of the project at different stages of its development.

The Monitoring Plan is a pro-active plan that will serve as a blue print in overseeing and preventing the occurrence of some adverse impacts during the construction and operation phases of the SLF project implementation. The monitoring works will be undertaken by a multi-partite, multi-sectoral monitoring team (MMT) to be created for the project. The result of the monitoring initiative will be used by MMDA in gauging their compliance performance on matters that are stipulated in this EIS document and ECC. Included as part of the monitoring plan is the formulation of a "Reporting System" within SLF management body and among the members of the MMT.

The Institutional Plan is equally important. The purpose is to clearly delineate the functions of each of the players in this SLF project, especially the function of the Environment Officer (EO) (equivalent to a Pollution Control Officer, PCO). The position entails for the overall management and planning of all environment-related issues and concerns that may arise during the construction and operation stages of the proposed SLF project.

4.1 Mitigating/Enhancement Measures for the Construction Phase

Duration of the impacts identified for the construction phases are all short-term in nature. The adverse ones can easily be mitigated. The identified potential sources of significant adverse impacts during construction stage that may need mitigating measures are as follows:

4.1.1 Soil Erosion

Soil erosion during rainy days of the construction periods is unavoidable. However, this can be controlled by the use of structural erosion prevention and sediment control practices which will divert the storm water flows away from the exposed areas, prevent sediments from moving offsite, and reduce the- erosive forces of runoff

waters. These may include the following: (1) interceptor dikes, (2) pipe slope drains, (3) straw bale barrier, (4) sediment trap, and (5) temporary sediment basin.

4.1.2 Dust Generation Control

Measures are recommended by the study team:

- Coordinate with local government units in the creation of a 1-kilometer buffer zone from the center of the landfill of open or agricultural use and in no circumstance should it be developed for residential or commercial use during the life of the landfill. This buffer zone is expected to receive the maximum dust ground concentration level
- Watering of soil cover for dust suppresion
- Provision and use of dust mask for all on-site workers

4.1.3 Traffic Plan

In order to minimize and prevent any possible traffic related problems; a centralized scheduling of trips through a dispatching officer will be implemented. Further, the use of radio communication gadgets will allow trip flexibility and helps avoid unnecessary trips.

As has been experience in the operation of the San Mateo SLF, people of Antipolo are complaining about the frequency of traffic related accidents. The main cause of the problem as they observed it is the poor driving habits/attitudes of garbage hauling drivers in the area. To avoid this kind of problem, the drivers who will be commissioned for the delivery of construction materials will undergo education /guidance program on safe driving.

4.1.4 Noise Generation

Noise levels as previously discussed will be tolerable. The buffer zone, which will be planted with trees and other vegetation, will help attenuate the noise generated from the landfill area. Nevertheless, equipment with less noise generation will be used during construction.

4.1.5 Greening of the Project Site to Improve Aesthetics

The project development will be implemented in phase development scheme. This would mean that clearing and other required civil works to be undertaken in the project area during construction stage will not result to monotonous barren area. Only the section subject for SLF development will be void of green vegetation. Per SLF layout, planting of grasses and tree and other ornamental plants in open spaces

intended for greening purposes will be immediately undertaken. The purpose is to enhance the aesthetic appeal of the project area.

Tree buffer zones will also be established around the perimeter of the project area. Fast growing species of trees adopted to local condition will be used to improve aesthetic value of the project site.

6. Workers and Public Safety

In order to ensure the workers' safety during construction stage, the project proponent and its commissioned constructor will adhere to the Department of Labor and Employment Occupational Safety and Health Hazard Standards with particular emphasis on the following:

- personal protective equipment (Rule 1040) which specify the use and type of eye and face protection, respiratory protection, hand and arm protection, safety belts life lines and safety nets, safety shoes.

- personal protective equipment, and minimum space requirements for gas, electric welding and cutting operations (Rule II 00)

- fire protection and control rule (Rule 1940)

- notification, record keeping requirements (Rule iO5O)

4.1.6 Local Labor Employment

Prioritization of local labor for employment will maximize the positive impact of the project. Priority in employment may be given to those households whose properties will be negatively affected by the project. The employment of any of their household members can be part of the compensation package.

4.1.7 Compensation of Crop Damages

Before and/or during construction phase, crops, which may be affected by the activities, will be assessed and appropriately valued. Crop valuation may be based on prevailing market rates or as prescribed by the Assessors office. This process will be jointly undertaken by MMDA, the LGUs, the farm owner, and a third party.

The start of the construction should be made before the planting season and after the harvest season. This will minimize the value of the crop damage that may be incurred. If the site clearing will be made, it must be in the staggered basis and done only in areas that will be immediately developed. This will further reduce crop damage. Besides, it will enable the farmers recoup their farm investment and can

decide to work on the project while the fields unaffected by the project are left to fallow.

4.1.8 Control of Non-Compatible Land Use

The Municipality of Rodriguez and the host barangay of the project site should generate a land use and zoning plan of the area around the project site. This plan should be integrated with the municipality's city's investment plan and tax assessment map. Strict implementation is the secret of the success of every plan. The land use and zoning plan will prevent the creation of undesirable housing clusters and incompatible industrial and commercial establishments. These housing clusters and establishments may be attracted by the improved access and employment opportunities. The construction of the SLF encourage lower-income migrants to move in and may displace the resident lower-income in the area who may have to occupy open areas for free. The land use and zoning plan will also prevent commercial establishments from establishing themselves in predominantly restricted areas, easement from critical installations including the SLF vicinity or near critical environment such as riverbanks.

4.2 Mitigating/Enhancement Measures for the Operation Phase

Mitigating measures for the operation phase are essentially long-term in nature. The proposed environmental management plans are as follows:

4.2.1 Stormwater Regulation

The projected increase in stormwater due to the increase in impervious areas will be prevented as much as possible. The storm-water from the surrounding areas will be collected by an open drain system which shall be placed around the landfill area. A horizontal drainage system will be installed in the landfill area to collect the storm-water and divert it to the vertical drain. Perforated pipes will be placed along the present creeks to collect groundwater and to prevent its seepage into the landfill layers.

4.2.2 Leachate Treatment

The design treatment capacity is decided based on the rainfall data taken over the last 20 years. The design capacity of the leachate treatment facilities is set at 1,400 m3/day, under a condition of maximum use of active landfill area.

The design of the leachate treatment facility shall satisfy the standard established by the DENR for Class C or D receiving water. The treatment method includes a circulation system in which the collected leachate circulates between the landfill waste and the anaerobic lagoons in the dry season. In addition, the system, shall be

installed with sand filtration and active carbon systems for the final phase of leachate treatment to obtain a better effluent quality.

Management of the SLF wastewater will be easy since these are mainly floor drains from administration building and those generated by the people's use of the sanitary facilities.

4.2.3 Control of Air Pollution

The most probable sources of air pollutant as presented in Chapter 3 are hauling and the SLF itself. From the point of view of regulation, these sources of air pollution are very difficult to control and regulate.

For methane gas, gas vents will be provided for methane gas escape to the atmosphere. Since large- scale generation of methane gas at the early years of SLF operation, it expected that pollution from methane gas emission insignificant. For advance information, technical possibility of recovering landfill gas for energy production is also under study by MMDA for possible implementation in the near future. In this case, its effect to the environment would be minimized and the methane contribution from the proposed SLF to global warming would similarly be minimized. Study show that methane gas effect as green house gas is 20 times more potent than carbon dioxide.

4.2.4 Hazardous Wastes Management

The proposed SLF is designed to for the final disposal of municipal solid waste from its service areas. At no circumstances the management of SLF will allow the disposal of toxic and hazardous waste in the SLF. In case toxic and hazardous are delivered for disposal, measure will be undertaken to bring back the toxic and hazardous from its legitimate owner or origin. The management will likewise comply with the provisions of the implementing rules and regulations (IRR) of RA 6969 ("Toxic Substances and Hazardous and Nuclear Wastes Control Act of 1990"). Under this IRR, the DENR encourages proper management of toxic and hazardous wastes.

4.2.5 Increase Demand on Road Services vis-a-vis with Traffic Generation

During the implementation period of the proposed SLF project, the traffic situation at the entrance and exit area along the national highway would still be manageable and could easily be handled by providing the necessary personnel to direct the flow of traffic. The proposed access road in which hauling trucks can access the SLF from two directions will surely ease the traffic congestion in the impact area. MMDA shall likewise formulate a more comprehensive and integrated vehicular traffic plan that

will address the traffic circulation-related impacts including travel times, degree of congestion, effect on public transit mobility and traffic safety.

4.2.6 Implementation of Pro-Active Pollution Prevention Program

In order to prevent the occurrence of any pollution-related problems arising from the operation of the proposed SLF, (i.e., contamination of ground water by infiltration to the acquifer by leachate, proliferation of blown up solid waste especially plastics in the surrounding area, etc), a pro-active pollution prevention program will be formulated. Based on the experiences of MMDA it gained from the operation San Mateo SLF, it will reformulate its pollution prevention program side by side with any pollution control measures that are proposed for incorporation in this project. This is highly recommended approach in preventing or reducing the creation of pollutants during the operation cycle of any project. This program could be patterned with those practices being applied in advance counties operating SLF projects.

4.2.7 Management Residual Impacts

The adverse residual impacts associated with the construction phase are not alarming as these will be temporary and on manageable levels. Strict implementation of the erosion prevention and sediment control methods during rainy days and dust control during the dry seasons will keep the problems in manageable levels. Residual magnitudes of the mitigated adverse impacts during the operation phase will also be at acceptable levels under strict implementation of the mitigating measures. Diligent monitoring will ensure that these levels will be maintained.

4.2.8 Contingency Plans

In the presence of any undesirable situation related to environmental disaster, emergency preparedness is therefore important. It is necessary that the proposed SLF project formulate contingency plans for dealing with emergencies and should be made available to the administrator of the SLF. At any undesirable event or accident, the Environmental Officer must:

- notify the DENR (required by RA 6969) and the industrial park administrator
- submit plans on containment, decontamination, and disposal
- immediately issue notification of any release.

4.3 Impact Monitoring and Reporting Plan

The environmental impact of leachate and landfill gas on the site and the surrounding area should be minimized not only during the period of operation but also even after its closure and conversion to another land use. Therefore, the periodic monitoring of what is expected to impact to the environment must be implemented for a long period of time. S review of the plans of facilities and landfill work, and the proper preventive plan will be comprehensively formulated. Items to be considered are as follows:

- Leachate Monitoring (Quantity and Quality)
- Water Discharged (Quantity and Quality)
- Landfill gas
- OdorOdor
- Noise and Vibration (Noise, vibration and traffic volume)

4.3.1 Monitoring of Construction Phase Impacts

Usually, construction phase impacts are short-term in nature. For this reason, monitoring plan during this phase of the project implementation may be carried by checking the adherence of the contractor to fundamental engineering construction protocol. Likewise, an on the spot inspection of the contractors/constructor performance and adherence to the mitigating measures indicated in the EIS can be checked.

4.3.2 Monitoring of Operation Phase Impacts

The monitoring plans during operation phase are summarized below.

Summary Table of the Proposed Monitoring Plan

Monitoring Item	Measurement Item	No. of Location	Frequency of Test	Total No. of Tests	Remark
1. Leachate	Quantity and Quality	2	(2x12)/year	48	21 years
2. Leachate Treatment Plant Effluent	Quantity and Quality	2	(2x12)/year	48	21 years
3. Landfill Gas	Quantity and Quality	10	(2x12)/year	48	21 years
4. Ground Water	Quality	3	12/year	8	21 years
5. Odor	Intensity	4	2 / year	8	During landfill operation
6. Noise and Vibration	Noise, vibration and Traffic Volume	4	2 / year	8	During landfill operation

4.3.3 Impact Reporting

The proposed impact monitoring and reporting plans are intended for the continued observation and evaluation of the mitigated impacts during the construction and operation phases. The proponent will closely coordinate with the DENR on the monitoring and reporting activities. It shall provide the DENR with a quarterly environmental status report. The proponent will appoint an Environmental Coordinator.

4.4 FSLF Organization, Staffing and Training

An appropriate organization, staffing and training are based of the efficient operations and management of the proposed SLF. It is of great importance to create a functional and integrated organization. This shall include continuous training and education of SLF to perform their various functions effectively and efficiently. Delicate staff requirement planning will have the following advantages:

- It creates a possibility to keep the total number of staff at the lowest possible level
- It creates an organizational flexibility to meet the demands at peak hours
- It is a means for human resource development

4.4.1 Organization

The study on SLF organization, staffing and training is conducted based on the existing organizational framework of other very successful SLF outside the country. The proposed SLF organization is elsewhere in the document. The proposed number of staff for both the MMDA and the Contractor were recommended.

4.4.2 Training

There are training programs for SLF operation and maintenance being offered private institutions locally and abroad. There is, however, a need of developing a local training program for the staff of the SLF section in order to adjust the training closely to the local conditions. There are two main objectives to be achieved by this local training program:

a) prepared the staff for the new conditions, facilities and equipment they will meet at the SLF ; and

b) give the staff of each class sufficient training and education in various functions at the SLF.

There is also a need of a training program for management staff. An integrated organization needs staff with integrated competencies It is very evident that the staff

have to be familiar with the new establishment, facilities and equipment and well trained to handle them. Sufficient time to perform such training has to be planned normally within a few months before the opening of the new SLF when the construction works are almost completed.

CHAPTER 1

PROJECT DESCRIPTION

Chapter 1 PROJECT DESCRIPTION

1.1 Basic Project Information

Official Name of the Project	:	Proposed New Parcel "B" Sanitary Landfill Project, San Rafael, Rodriguez, Rizal
Proponent	:	Metro Manila Development Authority (MMDA)
Contact Person	:	Mr. Rogelio U. Uranza Assistant General Manager, MMDA MMDA Building, Orense St., cor. EDSA Guadalupe, Makati City 1200 Tel No. 817 5631/812 1449
Environmental Consultant	:	Woodfields Consultants, Inc. 3rd Floor, 153 Kamias Road East Kamias, Quezon City Tel No. 436 7360/436 7365 Attn: Dr. Rey Medina President

1.2 Project Location

The proposed sanitary landfill is located in Sitio Inigan, Barangay San Rafael, Rodriguez (formerly Montalban), Rizal. It covers a total area of 130.2 has. The project site is about 4 to 5 kilometer northeast of the existing San Mateo Sanitary Landfill (SLF) at San Mateo, Rizal and about 16 kilometer northeast of Quezon Circle, Quezon City.

Specifically, the proposed project site is located at the left bank of Wawa River in the upstream section of Marikina River. The project site is situated in the following coordinates: 14° 42' 30' of north latitude and 121° 11' 30" of east longitude. The project site measures 130.2 has.

The location map of the proposed project site is shown in **Figures 1.2.1a** and **b**.

1.2.1 Accessibility

The candidate site is located somewhere in between the existing San Mateo Sanitary Landfill and Wawa Village. To access the site from either direction, an access road of approximately 9 km will be constructed. From the south, the site is 48 km from central Metro Manila and can be accessed via the existing San Mateo disposal site, using the Marcos Highway and Cogeo Road. From the north, the site is also about 48 km from central Manila. It can be accessed by taking the Quezon Circle passing through Payatas, Rodriguez and Wawa. The fact that the existing San Mateo sanitary landfill can only be accessed from the southern route is a cause of traffic problems.

To ensure the accessibility of the site from both directions, traffic congestion caused by the waste haulage vehicles will be relieved.

1.2.2 Property Ownership

The proposed project site is within the jurisdiction of the Marikina Watershed Area as declared under NIPAS. It is a government owned area. Sitio Inigan of Barangay San Rafael, Rodriguez is the host community of the proposed project. As of this report, there are about 75 households living inside the project area.

1.2.3 Delineation of the Primary and Secondary Impact Areas

On the basis of environmental considerations, the whole of Barangay San Rafael (the host barangay for the project) can be considered as the area within the primary impact zone. It is in this area that almost all activities related to pre-construction, construction, operation and abandonment phases of the proposed project would be felt and evident. Likewise, the expected positive and negative impacts of the proposed project would be strongly experienced by the communities who are living within this primary impact zone.

In terms of influence (service area), the secondary impact zone shall include all the towns and cities of Metro Manila including the areas such as other barangays in Rodriguez, Antipolo and San Mateo.

The delineation of the primary and secondary impact zones is shown in **Figures 1.2.2a** and **1.2.2b.**

1.3 Project Rationale

1.3.1 Background

On January 1995, the Philippine Government submitted an official request for support for a Master Plan and Feasibility Study to the Government of Japan. In response to the request, The Government of Japan decided to conduct the Study on Solid Waste Management in Metro Manila.

On February 1997, the MMDA, with the assistance of the Japan International Cooperation Agency (JICA), has commenced the project "The Solid Waste Management (SWM) Study for Metro Manila". The SWM Master Plan involved a tedious planning process considering the number of stakeholders and the complexity of constraints at hand. Several survey on the technical, institutional, environmental and socioeconomic aspects were considered to understand the existing system, to establish trends and to protect project future requirements.

The study has recommended nine priority projects, which are geared toward the establishment of functional SWM technical system for the year 1999 to 2010. The identified priority projects are:

1. Improvement of the existing San Mateo Sanitary Landfill (SLF)
2. **Development of an Inland (SLF) under the land use concept of Marikina Environmental Forest Conservation Project (MEFCON Project).**
3. Development of an Offshore SLF (Off- Navotas)
4. Development of Transfer Stations (4 locations)
5. Phased Development of Incineration Plant(s)
6. Development of Composting Plants (2 locations)
7. Development of recycling Centers (2 locations)
8. Improvement of Collection and Haulage System
9. Institutional building for Capacity Building

This priority projects are envisioned to be completed in the year 2010. The conceptual illustration of these nine priority projects is presented in **Figure 1.2.3.**

1.3.2 Need for the Project

The fast economic growth of the 17 LGUs in Metro Manila and its neighboring town have been accompanied by the rapid deterioration of its environment. One area of concern, which is considered a very serious problem besetting the area, is solid waste disposal. It is estimated that of its total solid waste generation of 5,000 to 6,000 tons/day, only around 3,500 tons/day are handled, while the rest are illegally dumped on vacant land, thrown in rivers, etc.

Metro Manila has four (4) disposal sites, namely; (1) San Mateo Sanitary Landfill in Rizal, (2) Carmona Sanitary Landfill in Cavite, (3) Payatas Open Dump Site in Quezon City, and (4) Catmon Open Dump Site in Malabon. The only disposal sites being used for Metro Manila's waste as of September 1998 are San Mateo, Payatas and Catmon. President Estrada also ordered the closure of Payatas open dump site by the end of December 1998.

In the light of modern standards of sanitation, the surrounding environment of Payatas and Catmon are wholly unacceptable. The open dumpsites are characterized by foul odor, dust, noise, vermin and other eyesore features, and have become source/s of pollution.

According to JICA's study, the remaining life span of the three existing disposal sites is only 3 to 4 years. The projection is based on the assumption that Payatas and Catmon open dumpsites would be closed by the end of 2000. In case Payatas will be

closed this year, the apparent life span of the remaining disposal sites will be shorter than this projection.

Without proper planning and concrete SWM program in the metropolis, the threat of garbage crisis is just around the corner. The most recent incidence on the mid of January of the current year, where the people of Antipolo, San Mateo and Montalban barricaded Marcos Highway, provided a five-day snap glimpse of garbage crisis, if the issue is not immediately and properly addressed by the government. Under the present situation, JICA study revealed that a garbage crisis would likely to happen in the year 2001. This is depicted in **Figure 1.3.1**.

As mentioned in section 1.3.1, the JICA study has recommended nine priority projects. Of these, the development of a new sanitary landfill to avoid a garbage crisis in 2001 is recommended.

The onset of La Niña in the country has further compounded the problem caused by solid waste, especially in Metro Manila. Based on the report of DPWH and MMDA, the clogging of esteros and drainage canal in Metro Manila is mainly caused by uncollected or intentionally dumped solid waste in these waterways. This pronouncement is substantiated by the 1997 Waste Amount and Composition Survey (WACS) conducted by MMDA though the assistance of JICA. The study showed that about 1,308 tons/day of solid waste is found in esteros and canals. The results of the survey shown in **Figure 1.3.2** reflect that there is significant amount of uncollected waste in Metro Manila, and resource recovery or recycling is poorly practiced.

It is often said nowadays that only in this country that no less than the President of the country is committed in implementing measures to prevent the outset of the fearful garbage crisis and consequent flooding during the period of heavy rains. This catastrophic incidence could be avoided with the implementation of the JICA's nine priority project, in which the proposed sanitary landfill in Rodriguez is included as one of the top priority projects under the MEFCON concept. **Figure 1.3.3** shows the expected improved waste flow in Metro Manila if the proposed priority projects would be implemented in the 2010.

1.4 Alternatives

1.4.1 Site Alternatives

In the conduct of this study, there were five alternative or candidate sites considered for the project. The list of candidate site was drawn up based on the information provided by MMDA, DENR-EMB, PNR, PEA, etc. **Table 1.4.1** shows the list of these alternative sites.

Table 1.4.1. Candidate Disposal Sites

Candidate Sites	Area (ha)	Information Source
1. San Rafael, Rodriguez under the concept Marikina Environment Forest Conservation Project (MEFCON)	365	DENR-EMB
2. Maragondon, Cavite	100	MMDA, NEDA
3. Kalawakan, Bulacan	1000	DENR, Malolos
4. Bacolor, Pampanga	300 or more	DENR, Region III
5. Sea Landfill	---	PEA, etc.

These sites were assessed in terms of topography and accessibility using field surveys and aerial observation results. The following section provides a brief description of the five alternative sites.

(1) MEFCON (Sitio Inigan, San Rafael, Rodriguez), Rizal

Sitio Inigan is located within the Marikina watershed, about 36 km east of Manila City, and 3 km north of the existing San Mateo disposal site. The DENR proposes the use of this site in the future as an extension of the San Mateo disposal site. The site has already undergone complete topographic leveling, geologic survey and other pre-engineering studies needed in the acquisition of the Environmental Compliance Certificate (ECC). Sitio Inigan is highly preferred among the candidate sites.

Experience of existing disposal sites indicates no difficulty in accessing this site with a 10-wheel dump truck. If a transfer station is to be considered for effective haulage services, a 3.6 km section of the existing access road should be improved, otherwise it will be difficult for trailer trucks to access the site due to the steepness of the grade.

For the realization of the Marikina Environment Forest Conservation Project (MEFCON), an extensive land use plan has been conceptualized and formulated for the existing San Mateo disposal site, the proposed Sitio Inigan SLF on the left bank of the Marikina River, and the adjacent three areas that can be reclaimed in the future. This conservation project entails the development of public space for the residents of the area and Metro Manila, by conserving line natural environment in the watershed of Marikina River

A water quality monitoring system, as well as other relevant systems, will be established along the Marikina River to have an extensive and effective control of leachate seepage from the proposed sanitary landfill site within the project area, This project aims to establish a harmonious relationship between man and nature. The MEFCON concept is shown in **Figure 1.4.1.**

(2) Maragondon, Cavite

Maragondon is located along the seacoast in the southwest part of Cavite, about 60 krn from Manila. The candidate disposal site is in a mountainous section l0 km south of the town. To access this site, a new road (8km) leading to the site will be constructed connecting to the existing road. The operation of this site would incur high transportation costs due to its distance from the metropolis considering its limited area of 100ha. The site will also have a short life span. Without an intermediate treatment facility for a large-scale waste volume reduction, this candidate disposal site can only be used for a short period of 5 years. Accordingly, the money invested on infrastructure improvement, e.g. road construction, would not be recoverable.

(3) Kalawakan, Bulacan

This site is a vast tract of land within the mountainous region northeast of the metropolis and, therefore, can be used for a long time. For access, an existing two way paved road should be extended a further 10-km all the way to the site. This candidate disposal site is about 90 krn from Manila. As it is located within a nature reserve, necessary procedures should be taken to gain permission for development. Incorporating the development of this candidate site into the long-term plan is advantageous.

(4) Bacolor, Pampanga

This candidate disposal site is at the foot of Mt. Pinatubo Volcano, about 80 krn north-northwest of Manila. The disposal site shall be developed on the land on the riverside of the mega-dike to prevent lahar mudflows resulting from volcanic deposits. Access is not difficult due to the existence of a well-paved road that connects the site to the metropolis. This candidate disposal site will also have sufficient storage capacity.

Although mudflow volume has decreased, discharge is intermittent. Hence, as a disposal site, development should commence only after the flow is controlled. As in Kalawakan, the incorporation of the development of this candidate site into the long-term plan is appropriate.

(5) Seashore Landfill

Seashore landfill is one of the best-conceived options for final disposal, what with the accompanying difficulties in acquiring a suitable land in inland areas within the jurisdiction of Metro Manila. However, the development of a seashore landfill site is, in general, of low-cost performance, or hardly feasible because of the sizeable investment cost required for the construction of embankment, taking into account sufficient environmental measures. In order to seek a more cost-effective use of seashore landfill, a waste reduction process through incineration is desirable.

Table 1.4.2 shows a model comparison in unit cost among technical alternatives for waste disposal under several premises. As indicated in the table, the most economical way is, of course, "inland landfill without any incinerating process," or sanitary landfill, which has a unit cost of 590 pesos/ton. However, "with incineration" added to inland landfill, the unit cost goes up to be 1,300 pesos/ton.

On the other hand, a "seashore landfill without any incineration" has an estimated cost of 2,150 pesos/ton, which is 3.6 times as much as that in the inland landfill. However, it should be noted here that the "seashore landfill with incineration" would have a unit cost of approximately 2,000 pesos/ton, which is slightly less than that of "without incineration." This is derived from a mechanism whereby the cost for constructing the embankment may be lowered through waste reduction by an incineration plant, thereby offsetting the additional cost of incineration.

In addition to the above economic reason, taking into account the life span of landfill site, it is recommended that the option of seashore landfill needs to be concomitant with substantial waste reduction project(s).

Table 1.4.2 Comparison of Waste Disposal Expenses

Landfill Type	Without Incineration	With Incineration
Inland Landfill	590 pesos/ton	1,300 pesos/ton
Seashore Landfill	2,150 pesos/ton	2,000 pesos/ton

Note: The above values, including initial investment and O&M costs are estimated based on the following assumptions:

- Annual disposal amount: 1 .0 million cum (raw, waste)
- Project life: 15 years
- Volume reduction rate by incineration: 15%
- "Without incineration" means all the raw waste is disposed of via the landfill site.
- Unit costs are obtained using the following formula:
  (Initial investment + O&M cost) / Accumulated waste amount given by raw waste amount)

As for the possible locations of a seashore landfill site, It has been tentatively identified through discussions with the Philippine Estates Authority (PEA) and the Philippine Ports Authority (PPA) that only the northern or southern section of Manila

Bay are reclaimable, taking into account existing navigation routes and a number of on-going/future reclamation projects.

There is presently a plan, the "Boulevard 2000 Integrated Framework Plan,- to reclaim the southeastern shore of Cavite all the way to Las Piñas and Bacoor. There are concerns that this plan could conflict with this seashore sanitary landfill program. In the northeastern section, there is a plan to develop the offshore area of the municipality of Navotas into the "North Bay Business Park. This area will be bounded by the Navotas fishport to the south and the Navotas and Tangos rivers to the north. It is possible to develop the northern part of the planned reclamation area or the offshore area into a seashore landfill site, however, further study is necessary to verify the most suitable location.

Evaluation of Candidate Disposal Sites

From the above evaluation and for the investigation of technical alternatives, Sitio Inigan site was selected for the development of an inland sanitary landfill site. Accordingly, the technical alternatives will be formulated assuming the development of the Navotas offshore area into a seashore landfill site. The summary result of the evaluation is shown in **Table 1-4-3.**

Table 1-4-3. Evaluation of Candidate Disposal Sites

Candidate Sites	Rank
(a) Sitio Inigan	1
(b) Maragondon	3
(c) Kalawakan, Bulacan	2
(d) Bacolor, Pampanga	4
(e) Sea Landfill	1

1.4.2 Appropriate Disposal Technology Alternatives

The following sections were obtained from the results of the "Study on the Solid Waste Management for Metro Manila in the Republic of the Philippines" submitted to the Philippine Government last March 1998. Based on the recommendations of JICA to the Philippine government, the proposed sanitary landfill in San Rafael, Rodriguez, Rizal, is identified as one of the top priority projects that the Philippine government has to undertake as a component of the overall master plan for SWM in Metro Manila.

The SWM technical system is made up of several sub-systems, namely discharge and storage, collection and haulage, intermediate treatment, and final disposal. This plan entails the improvement of the current solid waste management system in Metro

Manila, in phases. Six technical alternatives (A to F) which represent different levels of improvement of the existing system were reviewed. Considering that the location of final disposal sites significantly influences the planning of these systems, two cases were conceptualized for technical alternatives:

- **Case I** in consideration of both inland and sea landfill, and,
- **Case 2** for inland landfill alone.

In total, 12 technical alternatives will be examined. The details are shown in **Table 1.4.4.**

A 1, A2: Continuation of present waste management -system

B 1, B2: Introduction of a transfer station for effective waste haulage

C 1, C2: Introduction of a compost plant for waste volume reduction, targeting 50% of market wastes for composting

DI, D2: Construction of a recycling center for waste volume reduction and introduction of separate collection

E 1, E2: Incineration of 30% of the waste disposal volume, for waste volume reduction

F1, F2: Incineration of total waste disposal volume for waste volume reduction

Thus, Alternative F stands for a more advanced option, while Alternative A, a less improved option.

These alternatives were evaluated according to the following criteria:

- **Technical evaluation.** This includes improvement of haulage efficiency, introduction of recycling facilities, multiple final disposal sites.
- **Environmental evaluation.** This include 23 environmental criteria which are grouped into three environmental components:

Table 1.4.4 Technical Alternatives

Technical Alternatives		A	B	C	D	E	F
		A1: 2 sites A2: Inland	B1: 2 sites B2: Inland	C: 2 sites C: Inland	D: 2 sites D: Inland	E: 2 sites E: Inland	F: 2 sites F: Inland
Discharged Collection		Combined	Combined	Combined	Separate	Separate	Separate
Collection (Transfer Station)		-*1)	x	x	x	x	-*1
Intermediat e treatment	Recycling Center	-	-	-	x	x	x
	Compost Plant	-	-	x	x	x	x
	Incinerator	-	-	-	-	X*3	x
Final disposal (Sanitary landfill)		Level 4	Level 4	Level 4	Level 4	Level 4	Level 4

Note: *1): Las PinasT-S
*2): Market waste
*3): 39% of disposal amount
Level 1: controlled tipping
Level 2: sanitary landfill with a dike and daily cover soil
Level 3: sanitary landfill with leachate circulation
Level 4: sanitary landfill with leachate treatment

1. *social environment* (resettlement, economic activity, traffic/public facilities, split of communities, cultural property, water rights/communal rights, public health conditions, waste, hazards (risks);
2. *natural environment* (topography/geology, soil erosion, groundwater, hydrological condition, coastal zones, flora/fauna, meteorological condition, landscape), and
3. *pollution* (air pollution, water pollution, soil contamination, noise/vibration, land subsidence, offensive odor).

- **Economic and Financial evaluation.** This includes budgetary demand of technical alternatives (financial) and the overall expenses which will be incurred in terms of cost per ton of waste.

- **Social evaluation.** This criterion is based on the concept of social acceptability and related to the acquisition of the final disposal site.

- **Overall evaluation.** Based on the combined evaluation of the aforementioned three criteria, the alternatives were ranked in accordance with their desirability.

The summary results of the evaluation are as follows:

- **Technical evaluation**

  Based on the rating scheme applied, alternatives D1, E1 and F1 are considered very effective.

- **Financial and economic evaluation**

The financial evaluation showed that the cost of Case 1 alternatives (proposed combination of inland and seashore landfill as final disposal system) is relatively high compared with Case 2 of inland landfill except E1 and E2. On the other hand, the economic evaluation showed that adopting alternatives D2, C2 and B2 would be economically advantageous. But because either alternative only proposes the development of an inland landfill, the construction of multiple final disposal sites is recommended as a risk prevention measure. Of the alternatives proposing the development of 2 disposal sites (inland and sea landfills), alternative E1 is recommended as it is the most economical.

- **Environmental evaluation**

The results of environmental evaluation showed that technical alternatives E2 and F2 are recommended as suitable for priority projects among all other alternatives. Technical alternatives C1, D1, and E1 are relatively suitable to technical system among the alternatives.

- **Social evaluation.**

In this study, social evaluation was not discussed further since the issue of whether the proposed project is socially acceptable or not can only be gauged during the public announcement of the proposed project.

- **Overall evaluation.**

From the technical standpoint, alternatives D1, El and FI, Which propose the improvement of haulage efficiency, introduction of intermediate treatment facilities for waste volume reduction, and the establishment of multiple disposal sites are recommended.

From economic and financial standpoints, the operation of alternatives A2, and B2 is deemed feasible as they propose the development of an inland landfill, with the exclusion of an incinerator, using the present SWM budget. Excluding alternatives Fl and F2, which propose the incineration of the total waste amount, all other alternatives are deemed feasible with the adoption of reasonable budgetary measures.

From the environmental point of view, alternatives E2, F2, C1, DI, and El are evaluated to have the least impact on the environment.

On the other hand, alternatives promoting the "polluter pays principle" (PPP) are considered advantageous from the social vantage point. The most important factor in solid waste management planning is the acquisition of a final disposal site. However, if the PPP concept is applied, case I is recommended as it proposes the development of a disposal site within the metropolitan area.

Sea landfill development is the only development possible within the metropolitan area, but because it necessitates an enormous capital investment, it is not financially feasible. However, as long as the possibility of a sea landfill development exists, the discharge of the total waste amount in a disposal site outside of the metropolitan area would be strongly opposed by the affected residents. Under these circumstances, a plan proposing the disposal of part of the waste in a sea landfill within the metropolitan area and the rest in a disposal site outside the metropolitan area would be more realistic. If the development of an inland landfill outside of the metropolitan area is planned, the cooperation of waste dischargers in the maximum reduction of waste volume is extremely important in gaining the understanding of the residents of areas surrounding the planned disposal site.

Accordingly, the results of the overall evaluation, which also took social considerations into account, support the selection of alternative EI. From economic and financial standpoints, however, the implementation of alternative EI would incur higher running costs and require the reconsideration of present budget appropriation policies. This alternative is also highly recommended from technical and environmental standpoints.

1.5 SLF Development, Design and Proposed Facilities

1.5.1 SLF Development

Originally, the service life of the existing San Mateo SLF can be prolonged by utilizing the 32.4338 ha of land identified as "Parcel B". This area has already been excluded from the Marikina Watershed by virtue of Proclamation No. 635. However, JICA study revealed that only 6.1 ha (equivalent to 20% of the whole area), can be utilized as a landfill site with an estimated capacity of 270,000 m^3 and a life span of only one month. This analysis came out on the basis of JICA's site alternative studies which revealed that within "Parcel B" area, there are geological fractures that makes the rest of the area not suitable for a landfill development.

Accordingly, the MMDA decided to abandon the development of Parcel B and selected "New Parcel B". New Parcel B is adjacent to Parcel B. It is the landfill site proposed in the master plan prepared by JICA to be developed following San Mateo SLF. A study conducted on the site and those in the provinces of Bulacan, Rizal,

Cavite and Laguna shows that in terms of transportation, the site is most suitable for the development of a landfill. No major difficulties are also foreseen to arise in the use of the site after San Mateo SLF.

The proposed new landfill site is estimated to cover 130.2244 ha, with a capacity of almost 20 million m^3. Considering that the estimated waste disposal amount in 2005 is 6,000 ton per day, the life span of the landfill is 6 years and 4 months. The project covers the extension and rehabilitation of the access road for safe and efficient waste haulage.

MMDA has given first priority to the development of another landfill site in consideration of the closure of the Payatas open dumpsites and the remaining life of San Mateo SLF. To realize this, MMDA through JICA's recommendation intends to have the proposed site proclaimed as a non-NIPAS area.

1.5.2 Overall Plan

The proposed project is one of the components of the MEFCON Project, which does not only propose landfill development but also the utilization of the landfill site after closure. The MEFCON Project aims to create a recreational park, Forest Park, and educational and sports area for the host community and Metro Manila residents along the left bank of Wawa river.

The MEFCON concept is previously depicted in **Figure 1.4.1**.

1.5.3 Design Considerations

(1) Layout of the Proposed SLF

The proposed sanitary landfill will be composed of the following features:

- Project 131 - 130.2244 ha
- Waste disposal space - 20,000,000 m3
- Expected operation period - 6 years (2004 - 2009)
- Stormwater drainage system
- Leachate collection system
- Leachate treatment plant
- Administration facilities
- Internal road
- Buffer zone

The proposed layout are shown in **Figures 1.5.1 a** and **1.5.1 b.**

(2) Planned Disposal Amount

The disposal volume for landfill design is forecasted as shown in **Table 1.5.1.** Apparent values of the specific gravity of the incoming waste and disposal waste (compacted waste) used are 0.4 ton m^3 and 0.8 ton/ m^3, respectively. A reduction in the disposal amount by composting is not considered in the design. Furthermore, a required volume of the covering soil is assumed 15% of the disposal volume.

Table 1.5.1. Waste Disposal Amount Used for Planning

Year	Unit	2004	2005	2006	2007	2008	2009
Daily amount	t/day	5456	6030	6467	6904	7341	7778
Daily Incoming Volume	m^3/day	13,640	15,075	16,167	17,260	18,352	19,445
Daily Disposal volume	m^3/day	6,820	7,337	8,084	8,630	9,176	9,723
Daily Covering Soil	m^3/day	1,023	1,131	1,213	1,294	1,376	1,458
Annual disposal Volume	m^3/day	2489256	2751110	2950516	3149922	3349328	3548733
Annual Covering Soil	m^3/day	373,388	412,666	442,577	472,488	502,399	532,310
Accumulated waste volume	m^3	2,489,256	5,240,366	8,190,882	11,340,804	14,690,131	18,238,865
Accumulated covering soil	m^3	373,388	786,055	1,228,632	1,701,121	2,203,520	2,735,830
Total Disposal Volume	m^3	2,862,645	6,026,421	9,419,514	13,041,924	16,893,651	20,974,694

(3) Landfill Site Structure

The project area is estimated at 130.2 ha, consisting of three valleys with a total height differential of 180 m. The design of the landfill site is based on a phased landfilling method that will require construction of three dikes at the bottom of each valley to reduce the generation of leachate. By dividing the project area into three zones, each active landfill area can be utilized effectively, and the storm-water drainage systems can be easily established, thereby, the scale of leachate treatment facilities can be minimized through the reduction of leachate generation.

(4) Drainage System

Inflow of storm-water to the landfill area will be prevented as much as possible. The storm-water from the surrounding areas will be collected by an open drain system which shall be placed in the landfill area to collect the storm-water and divert it to the vertical drain. Perforated pipes will be placed along the present creeks to collect groundwater and to prevent its seepage into the landfill layers.

(5) Leachate Treatment System

The design of the leachate treatment facilities are based on the rainfall data taken over the past 20 years. The design capacity is set at 1,400 m^3/day, under a condition of maximum use of the active landfill area.

The design performance is set to satisfy the standard value established by DENR.

(6) Administrative Facilities

The following buildings are planned to be constructed at the administration compound using Philippine Building Standards.

- Administration Building
- Storage House
- Repair House
- Control House for Weigh Bridge

(7) Access Road and Design Traffic Volume

For the construction of the access road, the project would entail a construction of a 9.0 km new road, 1.5 km of alignment improvement and 3.5 km of rehabilitation works. All in all, the project requires about 14 km of access road development .

On design consideration, the following assumptions were used:

- A maximum traffic volume in the year 2010 is taken as the design traffic volume;
- Passenger vehicles shares 20% of all the traffic volume; and,
- All the waste haulage vehicles are assumed to be 40 m^3 container van or equivalent.

The main criteria for the access road design are summarized below:

a.	Average Daily Traffic	:	1,000 to 2,000 vehicles
b.	Design speed	:	40 km/hr
c.	Minimum Radius	:	50 m
d.	Maximum grade	:	8.0%
e.	Pavement Width	:	7.0 m
f.	Shoulder Width	:	1.0 m
g.	Superelevation	:	10%

(8) SLF Operation and maintenance

The following are the basic conditions for operation and periodic maintenance of the landfill site:

- Waste receiving and land filling will be undertaken for 6 years;

- Waste receiving and land filling will be done 24 hours a day (three shifts of 8 hours works), 7 days a week;
- Two sets of vehicles for landfill use will be provided, and each set will have an 8-hour shift;
- Soil covering work will be done 8 hours during the day, 7 days a week;
- Soil needed for covering will be obtained at the site, and the excavation work will be done for 8 hours during the day, 7 days a week;
- Monitoring will be conducted by private inspection bodies; and,
- Monitoring will be continued for 15 days after closing the landfill site. Inspections needed for every item of the environmental management procedure will be implemented at the same point once a month.

1.6 Description of Project Phases

The overall implementation schedule for the proposed SLF is shown in **Figure 1.6.1.**

1.6.1 Pre-Construction

The following activities were carried out for the proposed SLF project.

(1) Feasibility Study as a technical assistance program of JICA including:

- Solid waste forecast or projection
- Evaluation of existing SWM in Metro Manila
- Master planning
- Preliminary design
- Cost estimate
- Management and operation planning and,
- Financial and economic analysis.

(2) Air quality survey
(3) Noise and vibration surveys
(4) Vegetation survey
(5) Vehicle traffic counts
(6) Water quality survey
(7) Perception survey

1.6.2 Construction Phase

The actual construction work of the proposed SLF is expected to commence in the mid of year 2001. The construction details of the proposed project is described below.

(1) Site Condition

The proposed site is characterized by steep rolling hills. This topographic character prevents normal utilization of the area for economic purposes. The earthworks to be carried out for the project will follow the natural contour of the project site. The

purpose is to minimize unnecessary earth moving and preserve the natural integrity of the project site.

In order to preserve the surrounding site environment, the following measures will be undertaken during the construction period.

- In the course of the execution of sizable amount of the earthwork, temporary drainage will be installed on or around embankment yards so that mud and/or muddy water may not be washed away by the rain.

- Any contaminated water arising from any construction activities shall be discharged into nearby drainage / channels through treatment facilities and water quality will be controlled within allowable standard.

- During excavation, the washing away of mud and muddy water in the surrounding area shall be prevented by installing suitable drainage.

(2) Major Temporary Works

For the construction of the proposed SLF, a considerable amount of concrete cement are required to build mainly various buildings and pavements. Therefore, a concrete batching plant and a second aggregate crushing plant may be temporarily erected within or around the area of the project site.

The construction of sizable length of temporary roads are necessary within the project site, in order to haul construction materials to carry out the construction operations effectively and safely.

(3) Manpower Requirements

The construction of the SLF consists of mainly civil works and requires occupational category for this engineering work.

It is considered that common labors will be available in the area. On the other hand, skilled labors who are specialized in SLF construction will be possibly supplied from other area.

It is expected that about 500 to 700 workers, perhaps more, will work on the site at the heyday of the construction works.

The work items involve in the construction of the proposed SLF is shown in **Table 1.6.1.**

1.6.3 Operational Phase

The operation of the proposed SLF project is expected to commence in late 2003 or early 2004. The SLF shall have adequate environmental facilities including leachate treatment facility to mitigate environmental impacts. An SLF operation manual shall be produced as early as during the construction stage that shall spell out the systematized operation and maintenance requirements for this SLF project.

1.6.4 Abandonment Phase

As mentioned earlier, the project is only one of the components of the MEFCON Project. It is envisioned that after the life service of the proposed SLF, the area will be transformed into a Forest Park and recreational area (refer to **Figure 1.4.1** for the MEFCON concept). Hence, the detailed abandonment cum rehabilitation program hinges on the output of the Master Plan and Feasibility Study being undertaken for the whole MEFCON Program.

Table 1.6.1. Work Items Involved in the Construction of the Proposed SLF.

Work Items	Unit	Phase 1	Phase 2	Phase 3	Total
1 EARTH WORKS					
1.1 Clearing & Grubbing	ha	45.00	19.50	30.00	94.50
1.2 Excavation	m3	2,551,000	1,065,500	1,641,500	5,258,000
1.3 Embankment		700,000	300,000	560,000	1,560,000
1.4 Earth lining		450,000	195,000	300,000	945,000
2 SLOPE PROTECTION					
2.1 Cutting	sq.m	450,000	195,000	300,000	945,000
2.2 Embankment	sq.m	30,000		60,000	90,000
3 PAVEMENT WORKS					
3.1 Pavement	sq.m	17,000	12,600	20,000	50,700
4 DRAINAGE WORKS					
4.1 Concrete open drain	m	3,150	1,350	4,710	9,210
4.2 Concrete pipe	m	5,400	3,700	6,500	15,600
5 LEACHATE COLLECTION WORKS					
5.1 LC pipe	m	2,900	0	0	2,900
6 CULVERT					
6.1 Box culvert	m	7,900	3,030	18,400	29,330
7 MISCELLANEOUS WORKS					
7.1 Guard fence	m	5,000			5,000
7.2 Guardrail (A)	m	2,500	1,800	3,500	7,800
7.3 Road lighting	km	2.5	1.8	3.5	7.8
7.4 Electricity supply	km	2.5	1.8	3.5	7.8
7.5 Ventilator for leachate monitoring	ls.	2	2	2	6
8 ENVIRONMENTAL MITIGATION WORKS					
8.1 Leachate treatment plant	ls.	1			1
8.2 Gas extraction pipe	m	5,000	5,000	10,000	20,000
8.3 Planting tree	No.	75,500			75,000
9 BUILDING WORKS					
9.1 Administration building	ls.	3			3
9.2 Scale house	ls.	2			2
9.3 Installation of weigh bridge	ls.	2			2