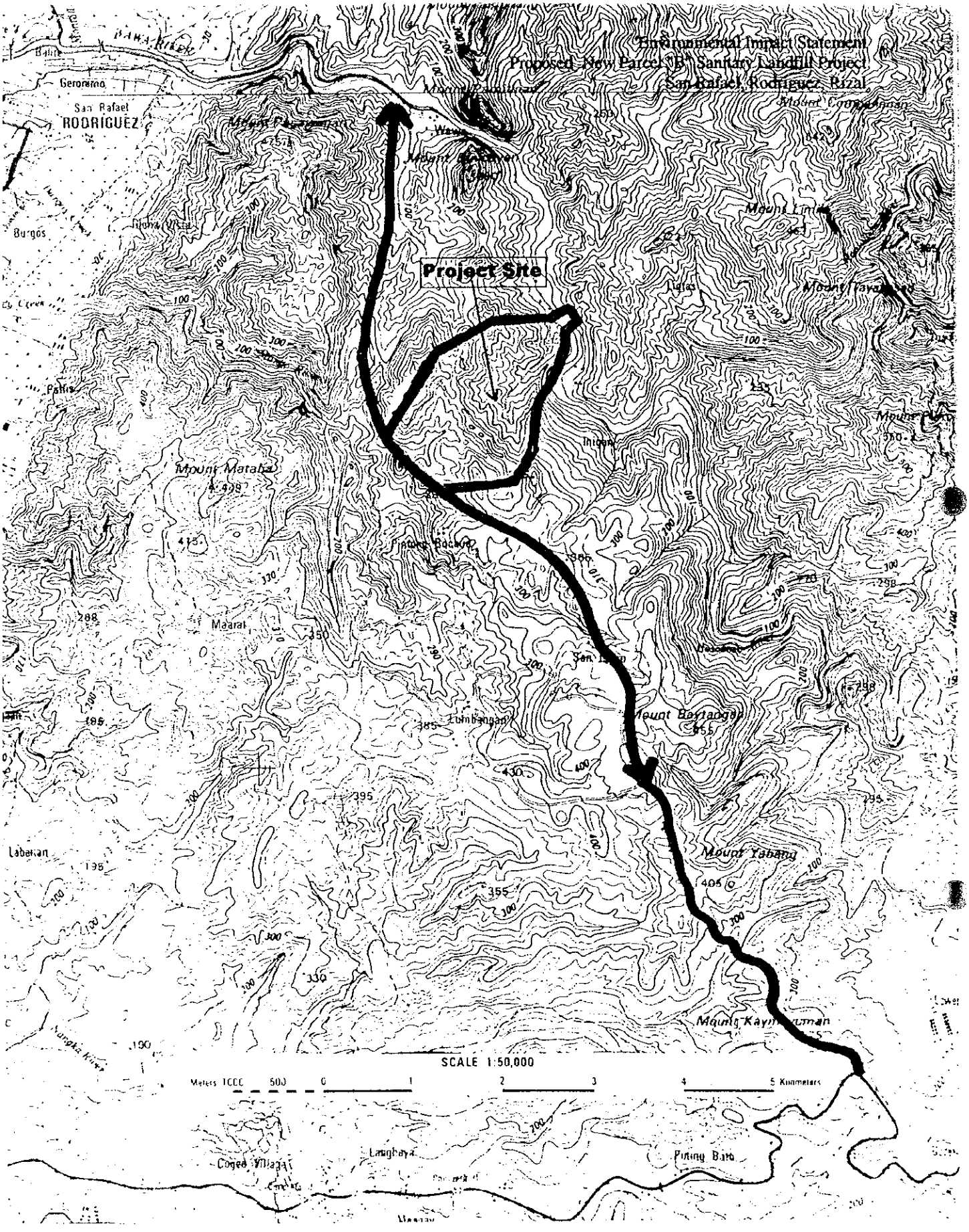


Figure 1.2.1a Location Map of the Proposed SLF Project in Sitio Inigan, San Rafael, Rodriguez, Rizal.

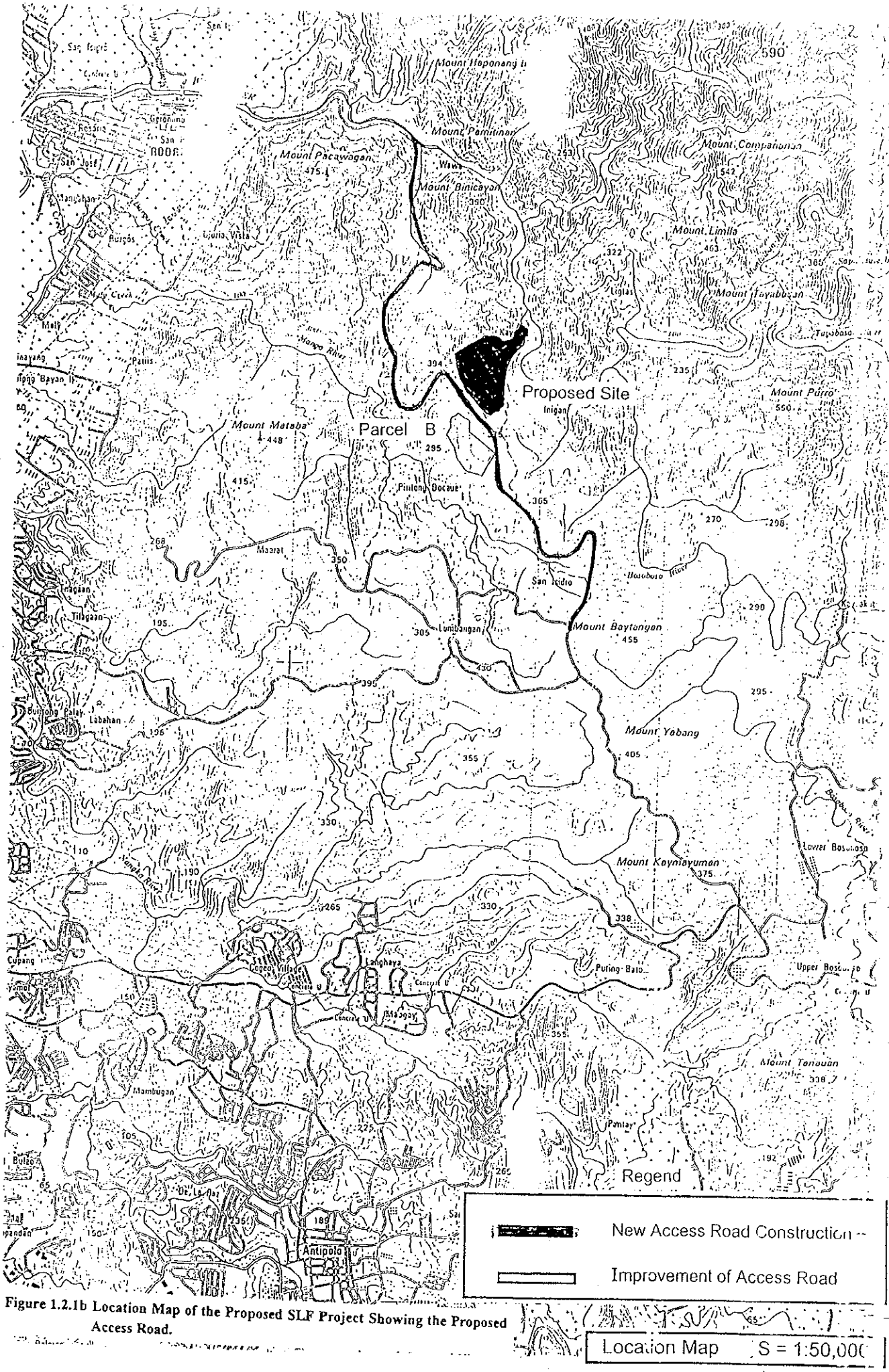


Figure 1.2.1b Location Map of the Proposed SLF Project Showing the Proposed Access Road.

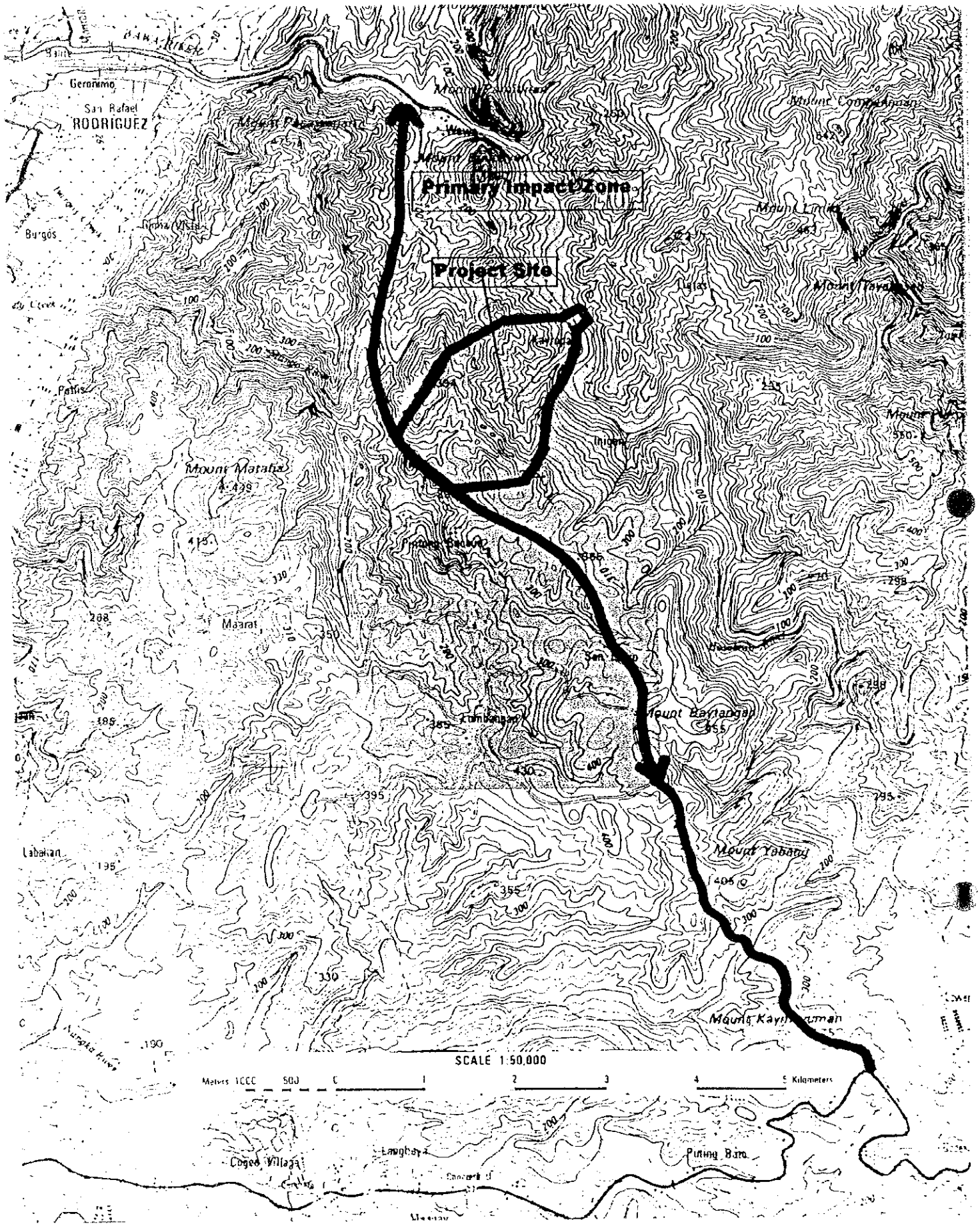


Figure 1.2.2a Delineation of Primary Impact Zone

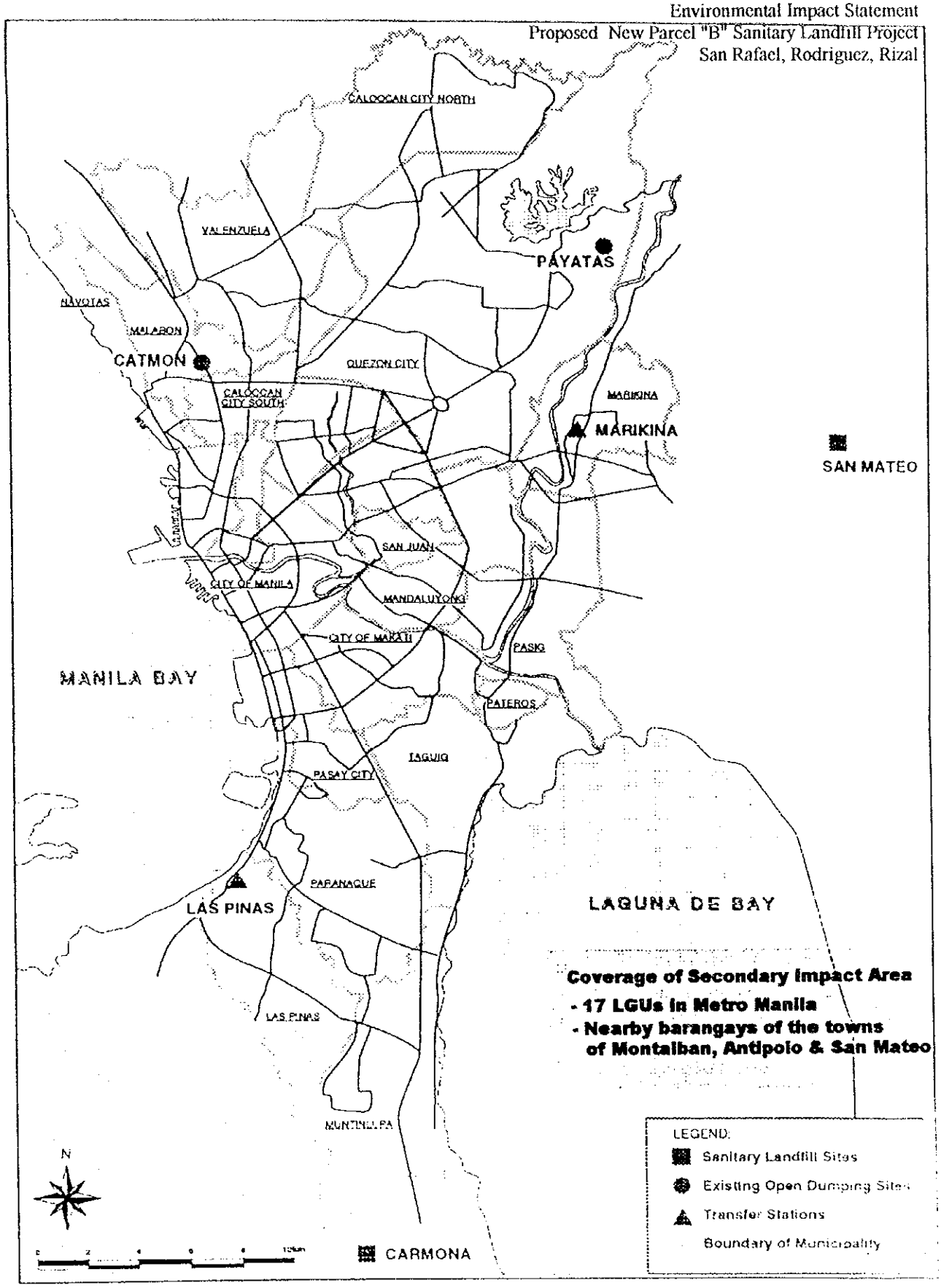


Figure 1.2.2b Delineation of the Secondary Impact Zone

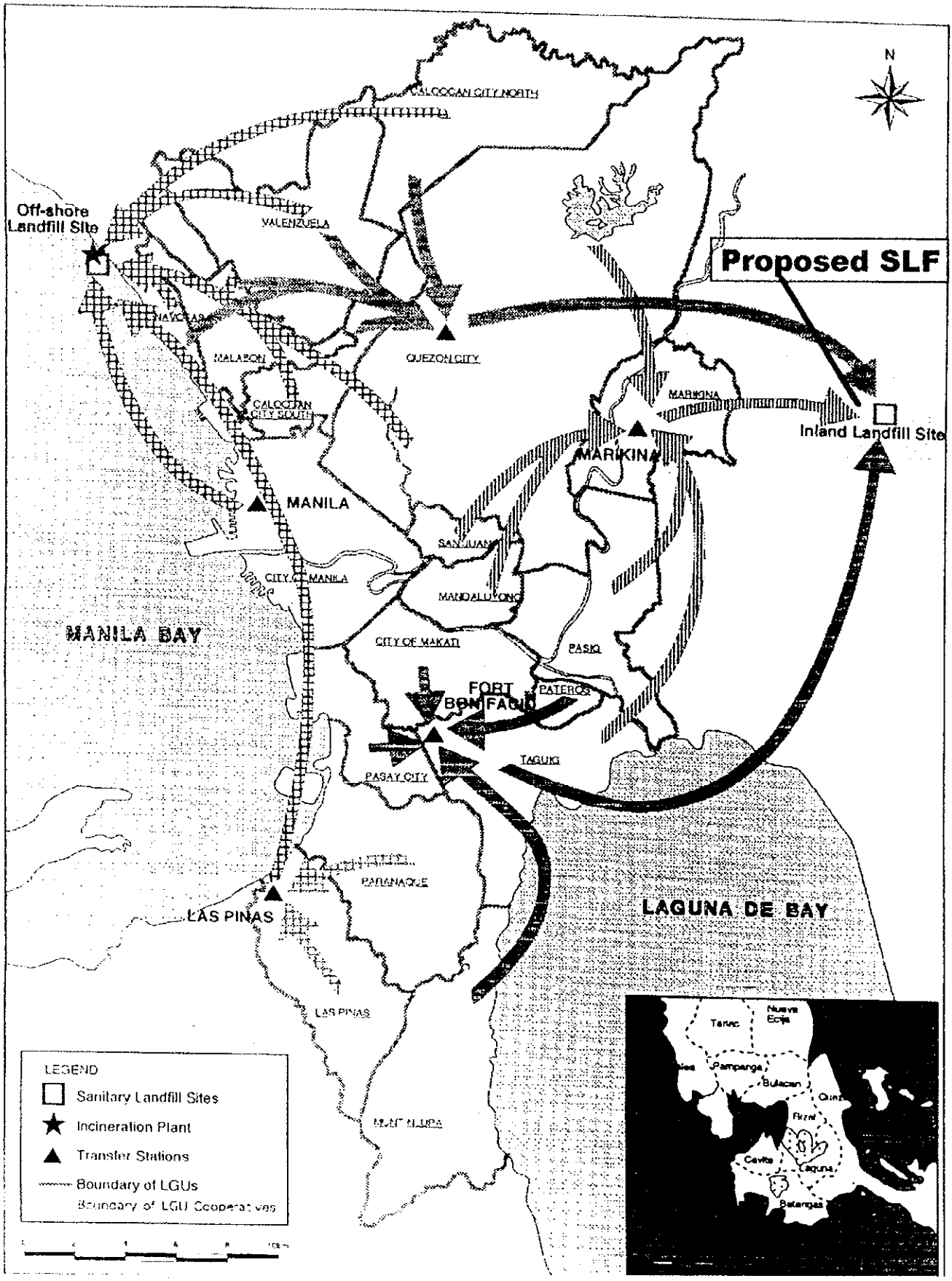


Figure 1.2.3 Conceptual Illustration of the Nine Priority Projects Recommended by JICA.

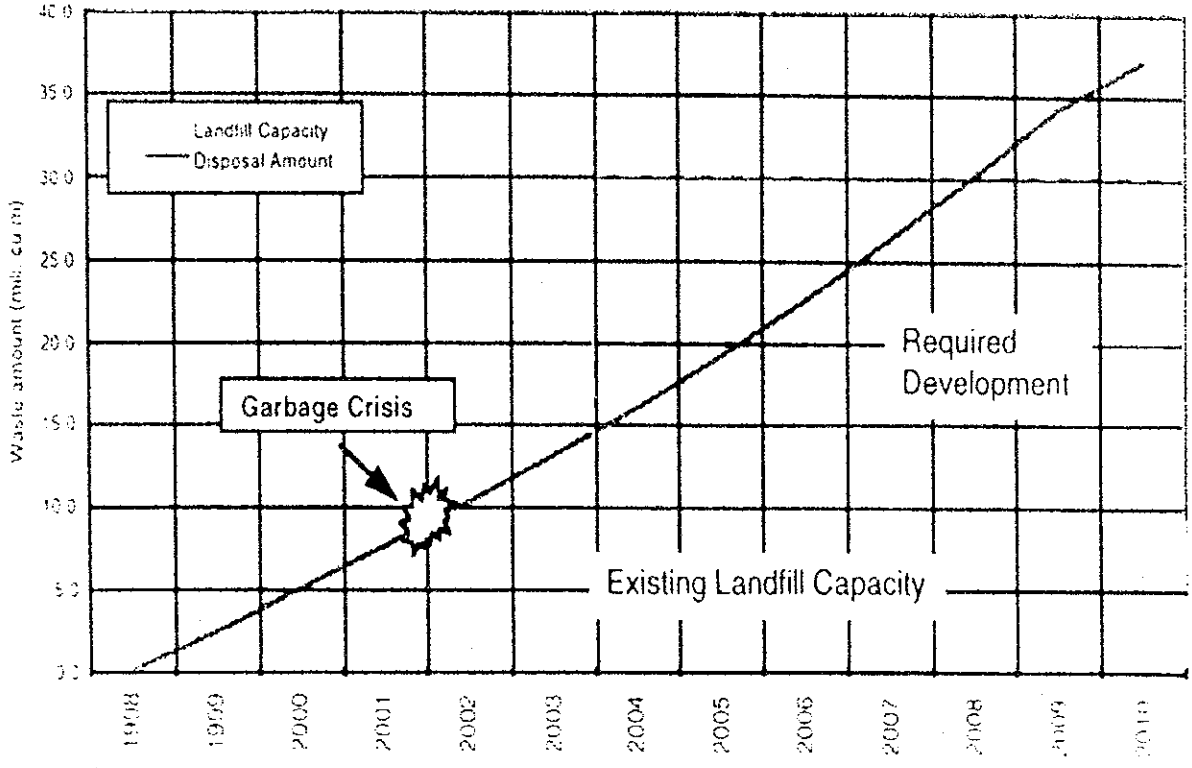
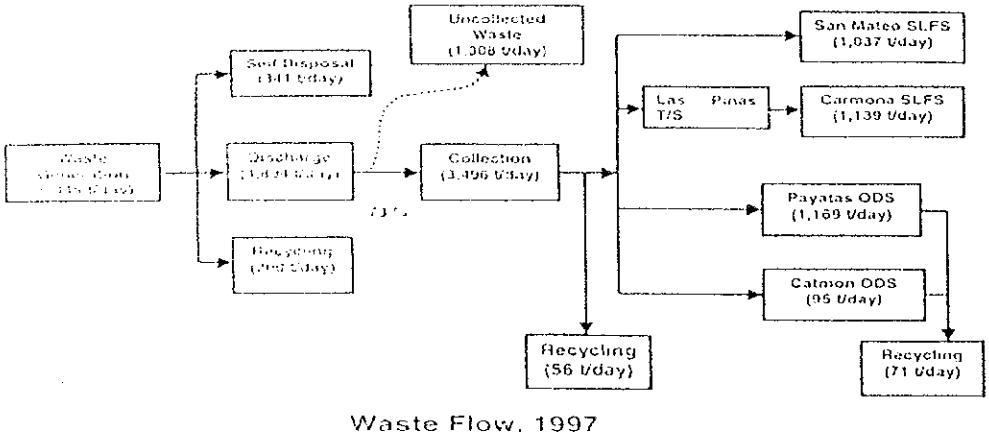
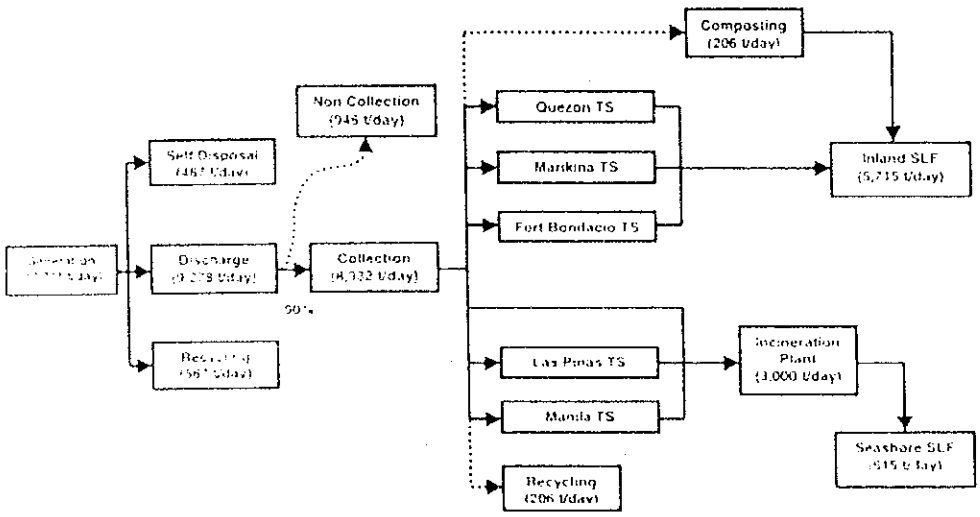


Figure 1.3.1. Projection on the Occurrence of Garbage Crisis in Metro Manila



Waste Flow, 1997

Figure 1.3.2. Metro Manila's Waste Flow in 1997



Waste Flow, 2010

Figure 1.3.3 Metro Manila's Projected Waste Flow in the Year 2010.

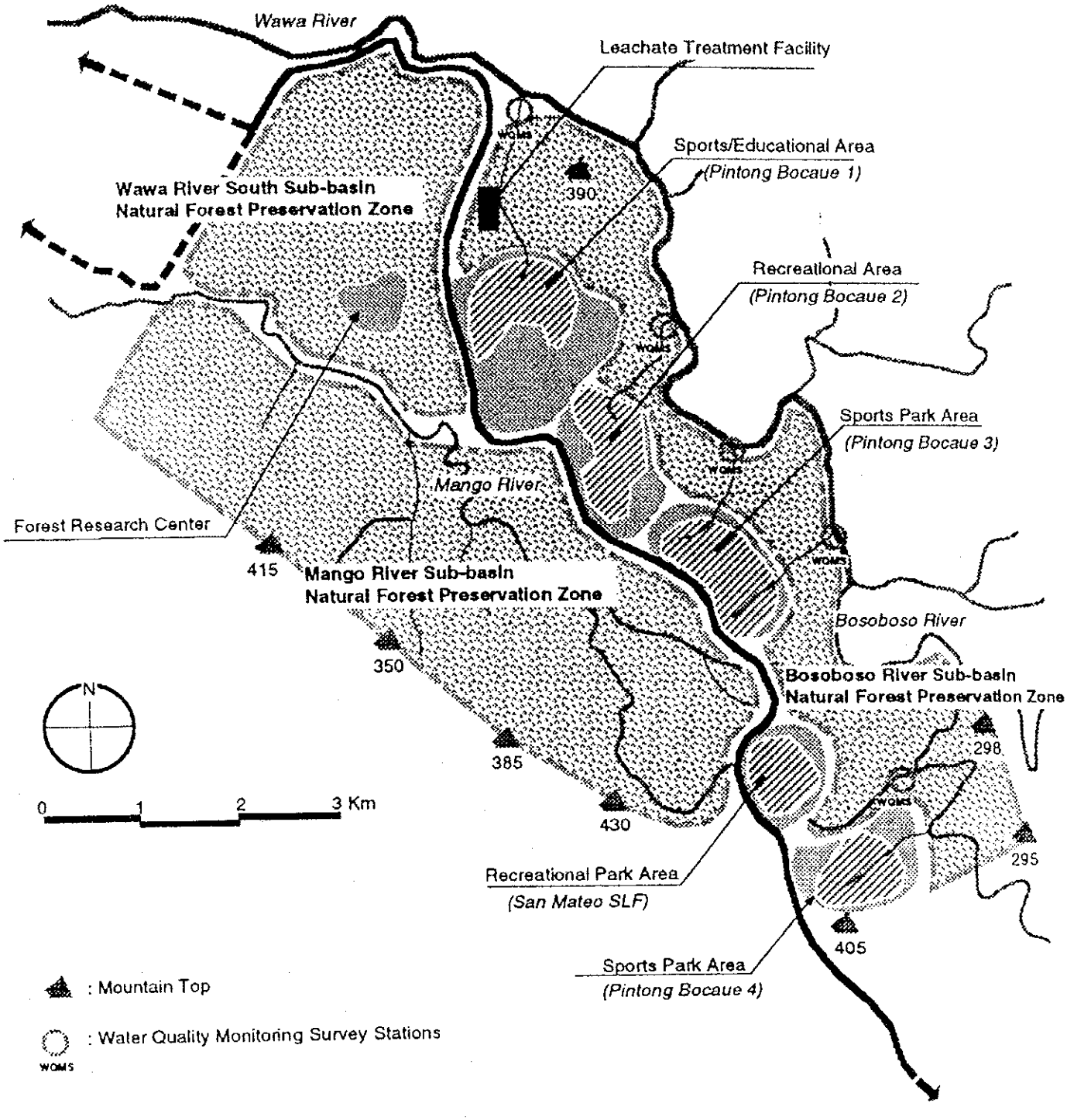


Figure 1.4.1 The Marikina Environmental Forest Environmental Project (MEFCON Concept)

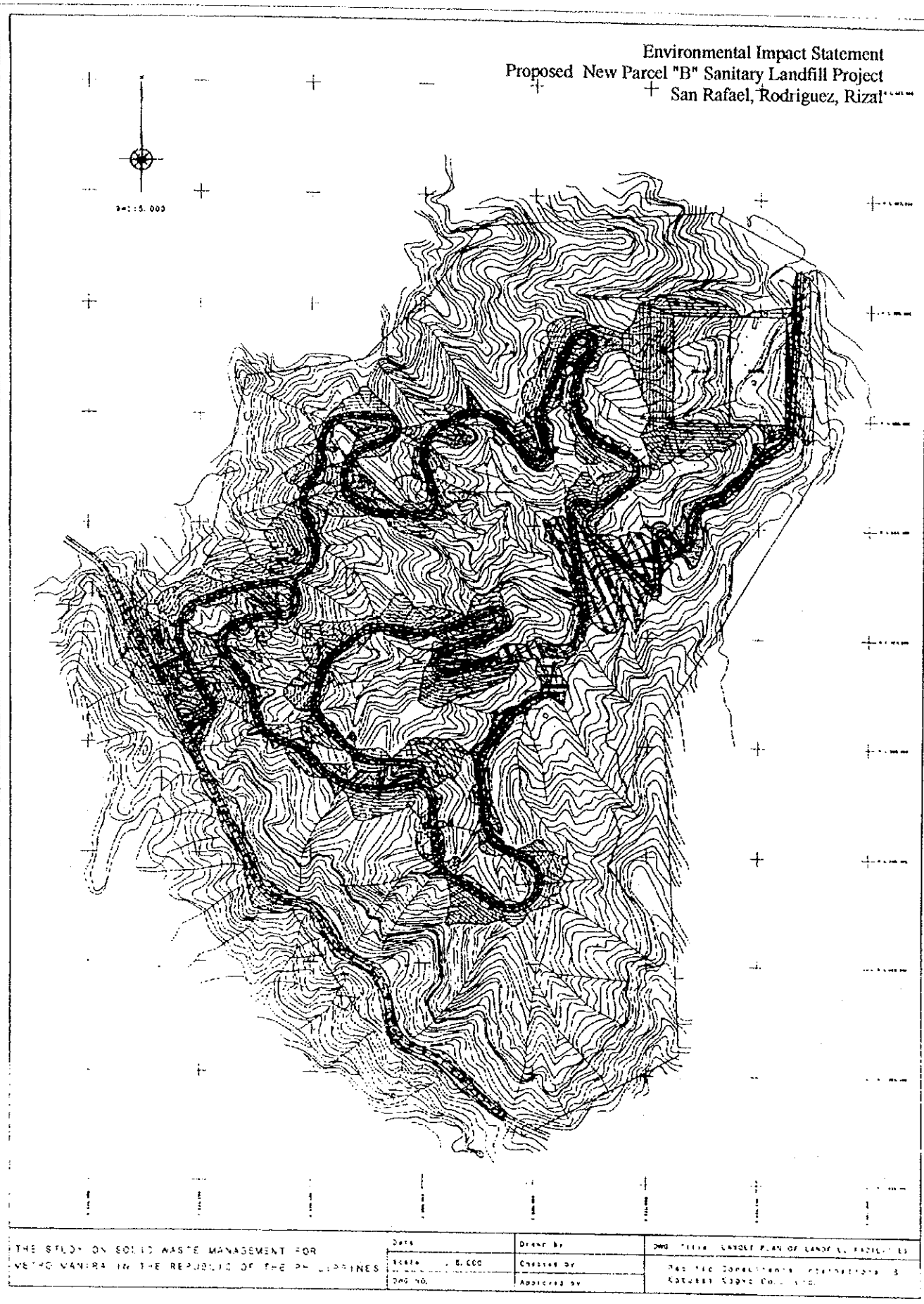


Figure 1.5.1 a. Layout Plan of Landfill Facilities

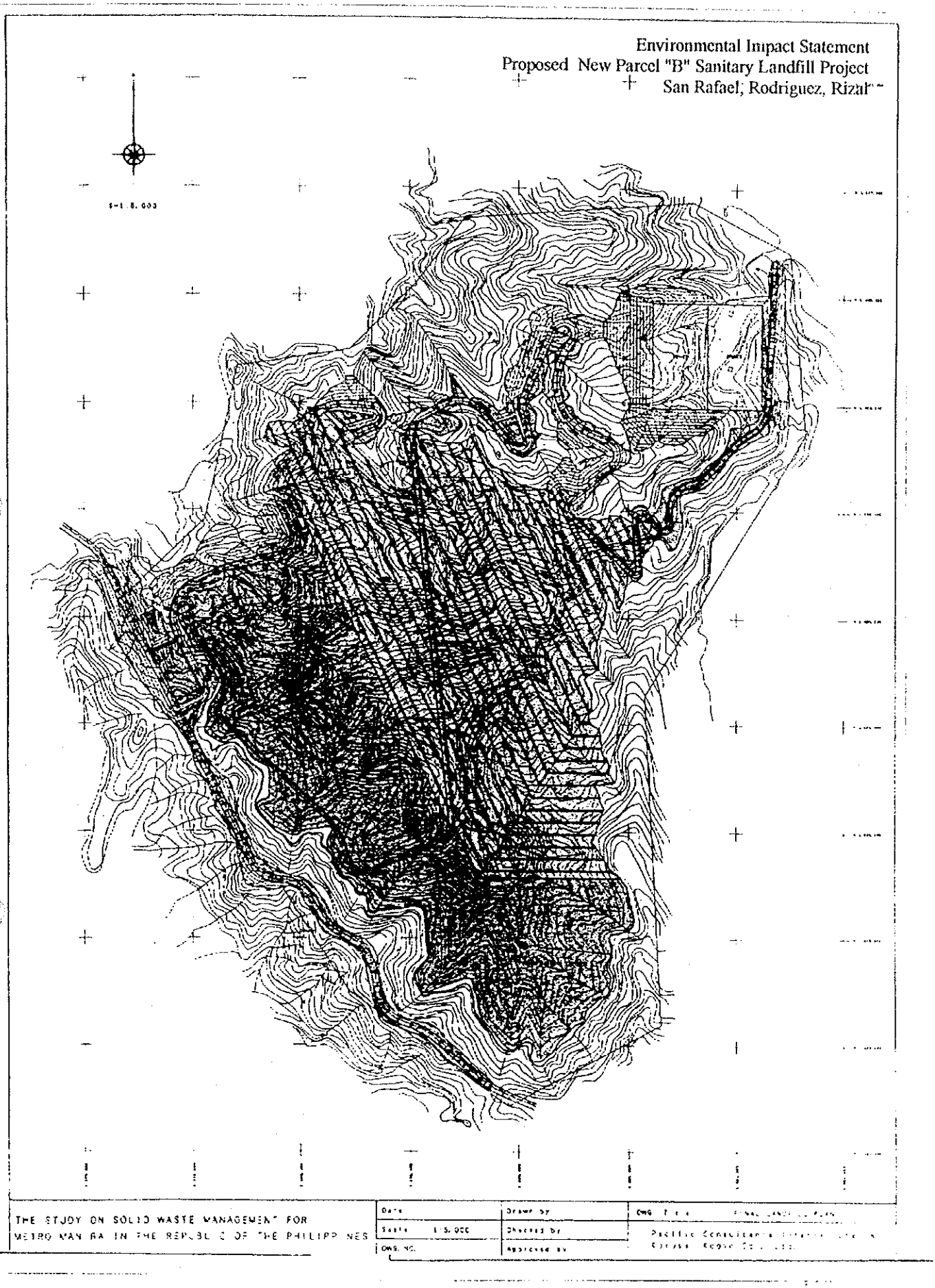


Figure 1.5.1 b. Final Landfill Plan

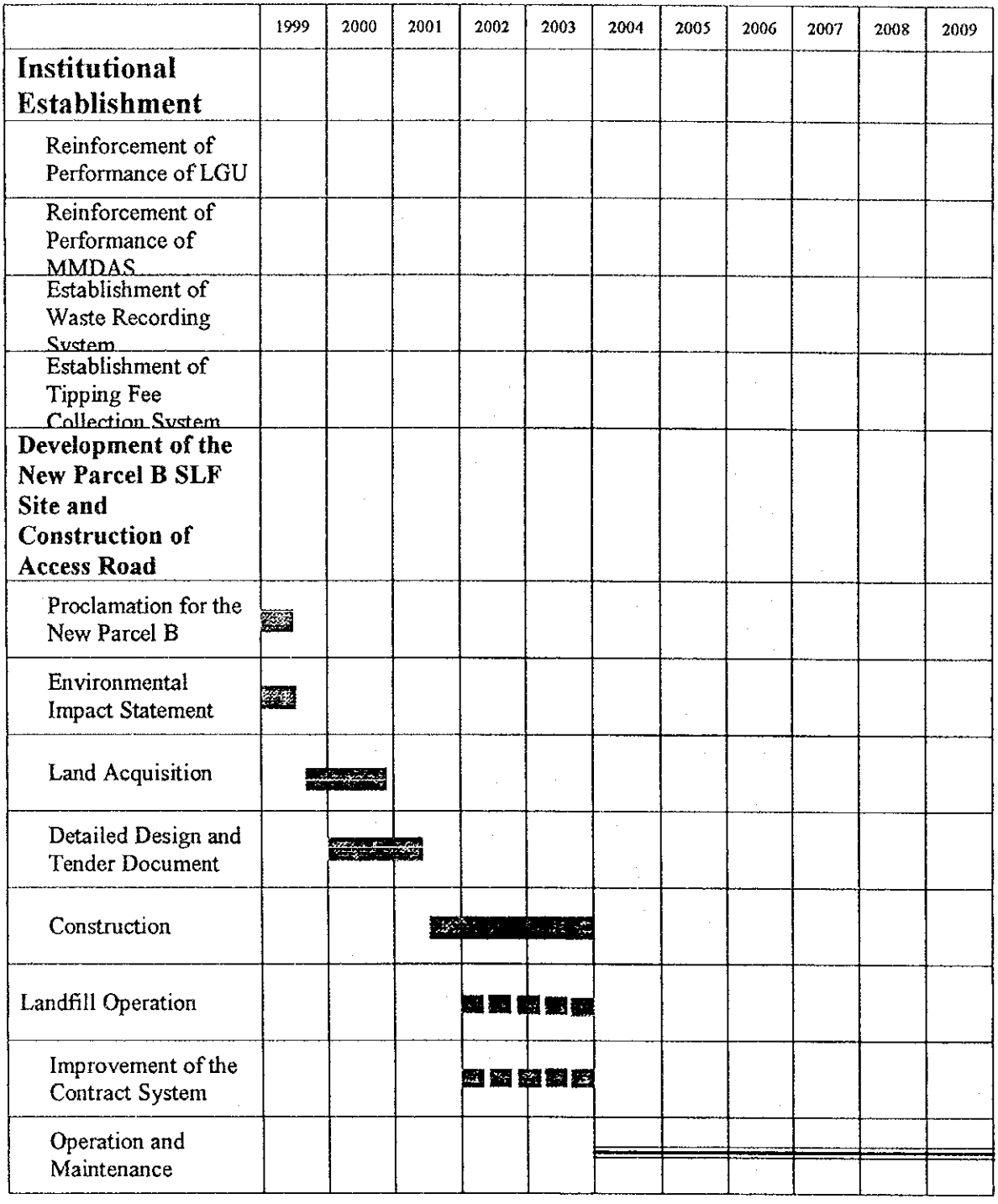


Figure 1.6.1 Implementation Schedule for the Proposed SLF

CHAPTER 2

BASELINE ENVIRONMENTAL CONDITIONS

CHAPTER 2 BASELINE ENVIRONMENTAL CONDITIONS

2.1 The Atmosphere

2.1.1 Meteorological Conditions

The climate of the proposed project site is similar to that of the existing sanitary landfill in San Mateo, Rizal. 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 excessive rainfall amounts received during the very wet months are due the geographical location of the area making it exposed to the moist southwest monsoon and the fact that the tropical cyclone seasons coincides with the peak of the monsoon.

2.1.2 Rainfall

The area receives an annual average rainfall of 2,561.0 mm. Based on records, there are about 162 rainy days within the year. 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, during which the monthly means all exceed the 400-mm mark, and with only 7 dry days per month.

2.1.3 Temperature

The project site has cooler temperatures than most of other nearby areas. The monthly mean temperatures range from 24.1 °C in December to 27.3°C in May. The early mornings in December are the coldest with minimum temperature average to 19°C. During the early afternoons in April, the temperature reaches a reading of 33.4°C.

2.1.4 Relative Humidity

The mean annual relative humidity is 78%. The project site is most humid from July to September with the atmospheric moisture index soaring to 85%. The monthly values dip to 66% in April.

2.1.5 Cloud Cover

Cloud cover index is parallel indicator of the rainfall amounts recorded in the municipality. The cloudiness has an average of 3 oktas (only partly cloudy) in April. During the months of July to September, the skies are overcast (7 oktas). The mean cloudiness is 6 oktas.

2.1.6 Prevailing Winds

The project site is exposed to the southwest monsoon. This made the southwesterly winds prevail during the months of late June to September. In October, the winds shift to southeasterlies because of the trade winds prevailing over the country. In November, the northeast monsoon sets in most places along the eastern coast of archipelago. However, in Montalban and the rest of the areas shielded by the mountainous region to the northeast, the winds shift to southeasterlies and stay until June when the southwest monsoon sets in again.

2.1.7 Tropical Cyclone

Tropical cyclone is the most influential factor that brings considerable rainfall in the Philippines. Typhoons usually occur from June to December with highest frequencies in July and August. The mean annual number of typhoons that pass through the Philippine Area of Responsibility (PAR) is about 20 of which an average of 9.2 actually cross the country. In addition, an average of two typhoons does not make it to the land but cause damage. The cyclones originate in the region of Marianas and Caroline Islands in Pacific Ocean. Their movements follow westerly or northwesterly course over the country and deposit substantial amount of rainfall. About 47% of typhoons are associated with cyclones.

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.

Tables 2.1.1 and **2.1.2** summarize the climatological data for the municipality of Montalban, Rizal.

2.1.8 Air Quality Survey

(1) Objective

Air quality surveys were conducted during two occasions: dry season and wet season. The objective of the survey is to obtain information on the existing conditions of the air environment around the vicinity or immediate impact area of the proposed sanitary landfill. The sampling sites used for air quality surveys are shown in **Figure 2.1.1**.

Table 2.1.1 Climatological Data for Montalban, Rizal.

Month	Rainfall (mm)	No. of Rainy days	Relative Humidity (%)	Cloudiness (0-8)	Prevailing Direction	Wind Speed (kp)
Jan	17.9	5	74	6	NE	9
Feb	9.7	3	70	5	NE	9
Mar	13.4	4	68	3	E	9
Apr	35.7	4	66	6	E	9
May	163.6	13	74	6	NE	9
Jun	342.5	19	81	6	SW	9
Jul	496.5	23	86	7	SW	9
Aug	525.	25	85	7	SW	9
Sep	469.6	23	85	7	SW	9
Oct	223.1	13	80	6	NE	9
Nov	155.5	13	80	6	NE	9
Dec	18.5	11	79	6	NE	9
Annual	2561.	163	78	6	NE	9

Source: PAGASA

Table 2.1.2 Temperature Data for the Municipality of Montalban, Rizal.

Month	Mean	Maximum	Minimum
Jan	24.2	28.9	19.5
Feb	24.6	30.1	19.1
Mar	25.9	31.8	19.9
Apr	27.1	33.4	20.8
May	27.3	32.6	22.0
Jun	26.6	31.2	22.0
Jul	26.6	30.6	22.5
Aug	25.8	29.7	21.9
Sep	25.2	29.2	21.2
Oct	25.6	30.2	21.0
Nov	25.0	30.0	20.0
Dec	24.1	19.1	19.0
Annual	25.7	30.6	20.7

Source: PAGASA

Subsequently, the results of the air quality surveys are used in the prediction and assessment of impacts of the proposed sanitary landfill in the air environment.

(2) Methods of Sampling and Measurement

The existing air quality of the area was characterized in terms of the following parameters: total suspended solids (TSP), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), hydrogen sulfide (H_2S) and odor concentration. All analyses and tests are conducted in a manner specified and prescribed by DENR Administrative Order (DAO) No. 14, Series of 1993 otherwise known as the "Revised Air Quality Standard of 1992, Revising and Amending the Air Quality Standard of 1978." The applicable methods for sampling and measurement of the aforementioned parameters are summarized in **Table 2.1.3**.

Table 2.1.3. Methods of Air Sampling and Measurement

Air Quality Parameter	Air Sampling Procedure	Method of Measurement	Units of measurement
Sulfur Dioxide	Graseby Gas Bubbler Sampler	Pararosaniline Method	µg/Ncm
Nitrogen Dioxide	Graseby Gas Bubbler Sampler	Griess Salzman Method	µg/Ncm
Total Suspended Solids	Graseby High Volume Gas Sampler	Gravimetric Analysis	µg/Ncm
Carbon Monoxide	Quest Envirotrack IV Gas Monitor (UL registered instrument with accuracy traceable to US-NIST)	Direct Reading (with disposable sensor)	ppm
Odor	Quest Envirotrack IV Gas Monitor	Direct Reading (with disposable sensor)	---
Hydrogen Sulfide	Quest Envirotrack IV Gas Monitor	Direct Reading (with disposable sensor)	Lower explosive limit (LEL)

(3) Results of the Surveys

(a) Dry Season Measurement

1) Description of Sampling Conditions and Results of the Survey

Ambient air sampling was conducted during dry weather condition from March 4 to March 7, 1998. Ambient air temperature ranges from 20 to 30 °C with daily average temperature close to 25 °C.

The sampling site is about 5 meters from unpaved road which is the main source of dust. Variation on dust concentration is attributable to frequency of vehicles coming to the area as well as the wind direction. Traffic density was very light which is composed mainly of passenger jeepneys. These jeepneys arrive and leave the area every 15 to 30 minutes during daytime. **Figure 2.1.1** depict the sampling location while **Table 2.1.4** summarizes the relevant information for this undertaking.

Table 2.1.4. Location of the Air Quality Sampling Point During Dry Season.

Survey Item		Sampling Point		Sampling Time
		No.	Location Description	
Air Quality	SOx, NOx, CO, AP, Climate (Wind Direction, Wind Velocity, Temperature, Humidity), Odor Concentration, H2S	S-12	Beside Pintong Bocaue Elementary School	March 4-7, 1998
		S-1	Inlet of leachate treatment pond (anaerobic pond)	
		S-5	Residential area at the north of the site	

2) Results of the Survey

Tables 2.1.5 and **2.1.6** show the summary results of the survey. Per DAO No. 14, the measurement of TSP, SO_2, NO_2 and CO are carried out for 24-hour averaging time and are expressed in unit weight per normal cubic meter (Ncm) at 25°C and 760 mmHg. On the other hand, the measurements for odor,

hydrogen sulfide and carbon monoxide are carried out at 30-min averaging time per DAO 14.

The results on TSP concentration show that almost all the values obtained exceeds the DENR standard of 230 µg/Ncm. The highest dust concentration of 509 µg/Ncm was recorded on March 5. The results are attributable to the arrival of more than 20 motorbikes, which held a sports cycling activity in the nearby area. The rest of the parameters registered values, which are well below the DENR ambient air quality standards. This observation suggests that during normal days, the traffic volume in the area does not cause significant contribution to the ambient SO_2, NO_2 and CO level.

Table 2.1.5 Results of the Dry Season Air Quality Survey for TSP, SO_2 and NO_2 at sampling point S-12.

Parameters	DRY SEASON			
	DENR Std.	March 4, 1998	March 5, 1998	March 6, 1998
TSP, ug/Ncm	230	231	509	356
SO2, ug/NCM	180	<4	<4	9.21
NO2, ug/Ncm	150	<0.10	<0.10	<0.10
CO, ppm	9	<1	<1	<1

Table 2.1.6. Results of the Dry Season Air Quality Survey for Odor, H_2S and CO at sampling stations S-1 and S-5.

Parameters	DENR Std.	Sampling Location							
		S-1				S-5			
		T1	T2	T3	T4	T5	T6	T7	T8
LEL	---	2%	1%	2%	2%	1%	1%	1%	1%
H_2S, ppm	---	<1	<1	<1	<1	<1	<1	<1	<1
CO, ppm	9	<1	<1	<1	<1	<1	<1	<1	<1

Note:

T1 - 5:00-5:30 am T5 - 5:30-6:00 am
T2 - 12:00-12:30 pm T6 - 12:30-1:00 pm
T3 - 6:00-6:30 pm T7 - 6:30-7:00 pm
T4 - 0:00-12:30 am T8 - 12:30-10:00 am

% LEL is percent of the lower explosive limit. In the absence of odor measurement procedure, H_2S and methane, which are the common sources of odor in a landfill, are measured. Methane has a lower explosive limit of 5% by volume or 50,000 ppm (material Safety Data Sheet). Therefore, the 1% reading represents methane concentration (assuming that all combustible gases that is detected is methane) of approximately 500 ppm

Similarly, the measured concentration levels for odor, carbon monoxide and hydrogen sulfide indicate that all the values obtained are well below the DENR standard. Based on the registered data, the hydrogen sulfide level in the area is less than 1 ppm or insignificant. Combustible gases read 1% and 2% of the LEL on separate occasions. Since air samples are obtained near the anaerobic treatment pond for leachate, ambient levels may be slightly higher than the immediate environment far from this pond. Although these pollutants may be considered low, it may still exert moderate health impact to those workers who are already afflicted with respiratory diseases. In general, these values are still considered insignificant to generate adverse impact in the environment.

(b) Wet Season Measurement

Ambient air sampling was conducted during wet weather condition from October 17 to 28, 1998. **Table 2.1.7** summarizes the relevant information for this undertaking. **Figure 2.1.1** shows the location of the sampling stations.

Table 2.1.7. Location of the Air Quality Sampling Point During Wet Season.

Survey Item		Sampling Point		Sampling Time
		No.	Location Description	
Air Quality	SOx, NOx, CO, AP, Climate (Wind Direction, Wind Velocity, Temperature, Humidity), Odor Concentration, H2S	S-12	Beside Pintong Bocaue Elementary School	October 17-28, 1998
		S-1	Inlet of leachate treatment pond (anaerobic pond)	
		S-5	Residential area at the north of the site	
		PB4	Area near Wawa Dam	
		PB2	At Pintong Bocaue	

2) Results of the Survey

Table 2.1.8 presents the summary results for TSP, SO_2 and NO_2 measurements at sampling point S-12. Compared with DENR ambient standards, each of the air pollutants measured registered a notably very low ambient concentration levels. Comparing the results with those data gathered

during dry season, the values for wet season are far lower which indicate that there are no significant sources of these pollutants in the area. Further, the down pour of rains during wet season help attenuate the ambient levels of these pollutants thus resulting to a much lower value compared to the dry season values. Similarly, this observation suggests that during normal days of wet season, the traffic volume in the area does not cause significant contributions to the ambient SO_2, NO_2 and CO level.

Table 2.1.8 Results of the Wet Season Air Quality Survey for TSP, SO_2 and NO_2 at sampling station S-12.

Parameters	WET SEASON			
	DENR Std.	Day 1	Day 2	Day 3
TSP, ug/Ncm	230	52.12	37.16	38.97
SO2, ug/NCM	180	<4	5.83	<4
NO2, ug/Ncm	150	3.78	4.72	4.72

Table 2.1.9 Results of the Wet Season Air Quality Survey for TSP, SO_2 and NO_2 at sampling station PB-4.

Parameters	WET SEASON			
	DENR Std.	Day 1	Day 2	Day 3
TSP, ug/Ncm	230	23.38	64.87	43.60
SO2, ug/NCM	180	<4	<4	<4
NO2, ug/Ncm	150	3.71	7.69	1.92

Table 2.1.10 Results of the Wet Season Air Quality Survey for Odor, H_2S and CO at sampling stations S-1 and S-5.

Parameters	DENR Std.	Sampling Location							
		S-1				S-5			
		T1	T2	T3	T4	T5	T6	T7	T8
LEL	---	<1	1%	<1	<1	<1	<1	<1	<1
H_2S, ppm	---	<1	<1	<1	<1	<1	<1	<1	<1
CO, ppm	9	<1	1	2	<1	<1	<1	<1	<1

Note:

T1 - 6:15-6:45 am T5 - 6:20-6:50 am
T2 - 12:20-12:50 pm T6 - 12:25-12:55 pm
T3 - 7:30-8:00 pm T7 - 7:35-8:05 pm
T4 - 11:00-11:30 pm T8 - 11:11-40:00 pm

% LEL is percent of the lower explosive limit. In the absence of odor measurement procedure, H2S and methane, which are the common sources of odor in a landfill, are measured. Methane has a lower explosive limit of 5% by volume or 50,000 ppm (material Safety Data Sheet). Therefore, the 1% reading represents methane concentration (assuming that all combustible gases that is detected is methane) of approximately 500 ppm

Table 2.1.11 Results of the Wet Season Air Quality Survey for Odor, H_2S and CO at sampling stations S-1 and S-5.

Parameters	DENR Std.	Sampling Location							
		S-1				S-5			
		T1	T2	T3	T4	T5	T6	T7	T8
LEL	---	<1	<1	<1	<1	<1	<1	<1	<1
H_2S, ppm	---	<1	<1	<1	<1	<1	<1	<1	<1
CO, ppm	9	<1	1	<1	<1	<1	<1	<1	<1

Note:

T1 - 6:00-6:30 am T5 - 5:00-5:30 am
T2 - 12:00-12:30 pm T6 - 12:00-12:30 pm
T3 - 7:15-7:45 pm T7 - 7:00-7:30 pm
T4 - 10:45-11:15 pm T8 - 11:00-11:30 pm

% LEL is percent of the lower explosive limit. In the absence of odor measurement procedure, H2S and methane, which are the common sources of odor in a landfill, are measured. Methane has a lower explosive limit of 5% by volume or 50,000 ppm (material Safety Data Sheet). Therefore, the 1% reading represents methane concentration (assuming that all combustible gases that is detected is methane) of approximately 500 ppm.

The results for odor, H_2S and CO measurements also suggest that during wet season, there are no significant sources of these pollutants in the area. In Case of the sampling station within the existing landfill, it should be noted that S-1 is just located at the inlet of the leachate anaerobic treatment pond. One possible reason is that during wet season and colder period in the area, microbial activities responsible for the emissions of these air pollutants are less active. Hence, the result of the measurements is lower than those registered during dry season wherein the surrounding is much warmer. Warmer environment induce more active microbial activities in the area.

2.2 Terrain

2.2.1 Physiography

The regional physiographic features relevant to the project area consist of Sierra Madre Mountain Range and Marikina Valley.

The north-northwest oriented Sierra Madre Mountain Range is characterized by a predominantly youthful topography. Its extremely rugged and deeply dissected topography produces slopes, which are highly precipitous, and ridges that are commonly truncated. Prominent mountain peaks within this mountain belt rise to more than 1000 m-elevation.

The Marikina Valley, considered as an integral part of the Central Luzon Plain, lies directly west of the Sierra Madre Range. It is characterized by flat to gently rolling topography with elevations that range from 6 m above mean sea level (amsl) at the vicinity of Marcos Highway to about 30 m amsl on the northern Montalban. Considered by many as a graben, the valley is roughly rectangular on a northeast-southwest trend. Its valley floor is about 2.5-3.0 km wide in its upper reach and widens considerably to more than 10 km towards the southern extension, in the vicinity of Laguna Lake.

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.

The topography of the area, based on the available 1:10,000 scale map from NAMRIA is shown in **Figure 2.2.1.**

2.2.2 Regional Geology

The project area is located on the south-western slopes of the Sierra Mountain Range, in the former Central basin which is filled-up mainly with volcanic deposits.

The stratigraphic sequence of the region can be indicated by the following rock succession within the study area:

Age	Stratigraphy
Quaternary	Alluvium
Pleistocene	Guadalupe Formation
----------	Uncomformity
Middle Miocene	Madlum Formation
Lower Miocene	Angat Formation
----------	Uncomformity
Cretaceous	Kinabuan Formation

Along the Marikina Valley, the recent Alluvium is composed of unconsolidated detrital deposits, mainly silt and clay. According to drilling data in the area, the thickness of the alluvium varies greatly from place to place, particularly along the Marikina River where erratic thickness patterns of the deposit are observed.

2.2.3 Structural Geology

Prominent active 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. In relation to the Quaternary faulting in the region, PHIVOLCS geologists have recently reported the presence of active faults along the fringes of Marikina Valley. **Figure 2.2.2** shows the geological map of the study area.

(1) Marikina Fault

Marikina Valley lies only about less than 10 km from the project site. Topographic indications and field evidences revealed that the valley is largely viewed as a graben. It is manifested by the presence of steep escarpment on the west portion of the valley and fault warps that bordered the east section.

The fault west of the Marikina Valley trends north-northeast and dips steeply to the past. It has a traceable strike length of about 100 km from near the Taal Lake area up to Angat area in Bulacan. Topographic evidences along certain sections of the fault revealed that the eastern block moved down relative to the western side.

The East Marikina Valley Fault is less persistent than the West Marikina Valley Fault with only traceable strike length of about 20 km. The presence of fault warps along sections of Montalban area up to Marikina supported the existence of this fault which can also be categorized as a gravity fault,

(2) Montalban Fault

This northwest-trending fault is apparently cut by the much younger East -Marikina Fault as reported by the Bureau of Mines and Geo-Sciences. Although unknown yet if it is active, it is a nearly left-handed strike slip fault that cuts across the north limestone ridge of Wawa Dam area and into the Boso-Boso River valley.

2.2.4 Local Geology

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.

The core of the Sierra Madre Mountain in the province of Rizal is comprised mainly of the Kinabuan Formation. Considered the base rock in the region because of its

extensive distribution, it is composed chiefly of altered spillitic basalt and pillow basalt in the lower sequence, tuff breccia and agglomerate with minor beds/lenses of chert at the middle part, and tuffaceous elastic rocks such as shale, siltstone and sandstone as upper members of the formation. Owing to slight metamorphism it has undergone, the whole formation is broadly folded thus, it is easily distinguished from the younger formational units.

The Kinabuan Formation is widely distributed on the south-western slopes of the Sierra Madre Mountain Range, covering the south-eastern part of Rizal Province and in the upper reaches of Montalban. Limited exposures were noted downstream of the Wawa Dam and along the minor river that traverses the project area.

Uncomformably overlying the Kinabuan Formation is the Angat Formation which is dated Lower Miocene. The formation is composed principally of basal conglomerate, limestone, calcareous shale and clayey sandstone. It occurs as isolated -N-S elongated patches near the Wawa Dam area and upstream portion of the Montalban River.

The limestone member exposed at Wawa Dam is generally massive and apparently closely folded into a north-northeast trending anticline. Steep and closely spaced bedding joints are common features of the layering in the limestone body. Typically karstic, large solution cavities and channels and caverns are extensively developed in the limestone.

The Middle Miocene Madlum Formation overlies conformably the Angat Formation. The exposures of this whole formation which includes the calcareous sandstone, shale, siltstone and minor conglomerate are limited to the Wawa Dam area and on the upstream section of the Montalban River. In Bulacan, the whole formation is widely distributed.

Dated Pleistocene, the Guadalupe Formation is vastly distributed west of the Marikina River in the northern part of Quezon City extending to the southern municipalities of Bulacan. Extensive outcrop could also be found within the Antipolo Plateau where it truncates the older Kinabuan Formation.

The upper part of this formation is the Diliman Tuff which is extensively exposed in most part of Quezon City. The principal members of this formation comprised the lithified volcanic ash, lapilli tuff and tuffaceous conglomerate and sandstone.

The lower Alat Conglomerate is widely distributed within the southern municipalities of Bulacan. It consists principally of massive thick consolidated conglomerate with interbedded finer welded ash sequence.

Starting at the confluence of the Wawa River and the minor river that occupies the project area up to the middle reaches, a massive agglomerate which is belong to the younger Madlum Formation is exposed. It is sometimes intercalated with basalt and andesite flows. The massive agglomerate is oftentimes jointed and sheeted with dips of moderate angles towards east and southwest.

The agglomerate and other volcanic flows are generally well cemented and indurated which leaves only thin weathering on the surface. Even with the presence of few joints and minor fractures, the massive agglomerate has a rather low permeability.

The bottom of the project site is underlain with moderately thick clayey silt layer and comparatively consolidated layer of sandy silt with minor gravels -both belongs to the Kinabuan Formation and Angat Formation.

Results of the drilling for geo-technical investigation within the project site revealed the occurrence of moderately thick surficial soil cover consists mainly of clayey silt. The depth of this layer could reach down to about 8 m below ground level. Below the clayey silt layer, another relatively unconsolidated layer is penetrated down to a depth of about 15 m below ground surface. Encountered at drill holes located at the middle upslopes (BH-C) of the project site, the layer is dominated with large fractions of sandy silt materials with minor traces of fine gravels. The presence of coarse materials (sand and gravels) in the entire sections of the holes could suggest that this layer is probably the weathering product of the Madlum Formation consists mainly of agglomerate and andesite flows.

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.

2.2.5 Summary Result of the Subsurface Investigation

The actual drilling for the geotechnical investigation conducted for the project was done during the period October 29 to November 3, 1998. Some 12 shallow boreholes grouped into 6 general locations were undertaken at the proposed site to determine the thickness of the overburden soils which is of particular interest. In addition, some 18 test pits were also excavated at the proposed site at an average depth of about 1 meter to extract samples for laboratory Compaction Tests (moisture Density Relation of Soil) and Laboratory Permeability Tests. Locations of boreholes and/or test pits are depicted in **Figure 2.2.3** and detailed in **Table 2.2.1**.

The soil investigation results show that a two-layer overburden soils (Clayey Silt (MH) and Clayey Silt (ML) constitute the project site. The generalized subsurface stratification is described below:

Layer 1 — Consisting of light to yellowish gray Clayey SILT (MH), medium plasticity, stiff to very stiff in the uppermost 3 to 5 meters depth (N-values range from 10 to 23, average of 28) and hard consistency (N-values greater than 30) down to depth of about 7 to 8.5 meters depth.

Layer 2 — Consisting of light gray Sandy Silt (MH), low plasticity to non-plastic with traces of fine gravel, encountered at depth of 3.5 to about 10 meters in the vicinity of BH-D1 and at depth of 6.0 to 15 meters in the vicinity of BH-C. Consistency of this layer is generally hard to very hard (N-values range from 41 to 89).

The test pit investigations also showed that surficial soils consist mainly of Clayey Silt (MH and ML) in the uppermost 1 meter depth, with medium to low plasticity. Natural moisture content of these soil types range from 19% to 37%, average of 27%. Liquid limits range from 43% to 63%, average of 55%. Plasticity Index (PI) range from 11 to 29%, average of 19%. Optimum Moisture content (OMC) determined from laboratory compaction tests (Standard Proctor Test) for the Clayey Silt soils range from 21% to 35%, average of 29%. Maximum Dry Density (MDD) is average 1.424 g/cc. Laboratory permeability test of the Clayey Silt have coefficient of permeability, k_{20} to range from 1.326 x 10-5 cm/s to 4.068 x 10-5 cm/s. Such range of the coefficient of permeability values is categorized as impervious, such that a naturally occurring impermeable barrier against seepage prevails at the project site.

Based on this investigation, it is recommended that for the design of the foundation structures, a very competent layer is found within the normal founding levels of footings for light to moderately loaded structure. Assuming a footing of 2 meters below existing ground surface, an allowable bearing capacity of 1.5 tons per square foot (1,614 g/cm^2) is recommended.

2.2.6 Chemical Characteristics of the Soil

During the conduct of the geotechnical investigation, soil samples were taken from sampling points D(TP-1), C(TP-3), F(TP-2) and B(TP-1). These sampling locations are shown in **Figure 2.2.4.** The depth of the sampling points ranges from 1 meter to 5 meters below ground level. The soil samples are sealed in a plastic container and were submitted for the laboratory analyses of the following heavy metals: cadmium (Cd), chromium (Cr^{+6}), copper (Cu), lead (Pb), arsenic (As), iron (Fe), and mercury

(Hg). These heavy metals are considered toxic and hazardous to human health. **Table 2.2.2** shows the results of the laboratory analyses.

The results show that the concentration levels of these heavy metals contained in the soil samples are considered very low especially for a place which is rich in volcanic debris (as discussed in the preceding sections). On the basis of the result of the spring and ground water samples analyses presented elsewhere in this document, it suggest that in most of the time, the heavy metals in the soil are low in concentration and are not readily leach-out to the nearby spring, ground water or surface water bodies. This observation can be made because water samples from spring and deep wells, which registered low concentration levels of heavy metals, were collected from the vicinity of the soil sampling points.

Table 2.2.2 Chemical Characteristics of the Soil Samples

Heavy Metals	Sampling Points			
	D(TP-1)	C(TP-3)	F(TP-2)	B(TP-1)
Cd, ppm	0.78	0.77	0.58	0.87
Cr+6, ppm	NIL	NIL	NIL	NIL
Cu, ppm	20.03	16.67	11.59	22.51
Pb, ppm	13.08	12.52	22.12	10.34
As, ppm	3.18	19.04	1.51	2.47
Fe, %	4.51	4.31	2.39	4.31
Hg, ug/kg	3	4.2	2	5.5

2.3 Hydrology

2.3.1 Groundwater Source

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).

At the project site where about 57 families thrive in the entire minor river catchment area, the source of water supply largely comes from springs and open dug wells. No single well is known to exist in the area to be the source of water supply. Elsewhere, upstream of the existing Wawa Dam towards the confluence of Wawa River and the minor river that traverses the project site, several shallow tube wells are being utilized by residents to be their source of water supply. The depth of these wells does not

exceed 20 m and they are mostly located along the flatter embankment of the Wawa River.

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.

In the absence of wells, groundwater abstraction within the catchment area of the project site is practically nil. The minor discharges of water from open dug wells and few springs do not represent artificial groundwater extraction. Rather, they are outflows of groundwater from the already saturated aquifer.

On the account that groundwater may be abstracted within the catchment area of the project site, replenishment can be attained through direct infiltration of rainfall into the permeable land surface of alluvium and weathered sections and minor fractures/ openings of the older rock units. The surface flow of the river in the area would likewise, indicate contribution to the relatively permeable upper sections of the rock units. In most likely manner though, the entire catchment area serves as recharge point for the lowlands towards the Marikina Valley. Greater amount of water will continue to flow towards the lower elevations.

There is no clear case of study yet evaluated on the recharge potential over the Kinabuan and Angat formations in the entire region. Previous hydrogeological studies revealed that for other outcrops such as the permeable Guadalupe Formation, recharge potential was evaluated to be in the range of 5-10% of the total rainfall. For the permeable alluvium in the region, recharge amount is reportedly assigned within the range of 15-25 % of the total rainfall. Considering the low permeability potential of the Kinabuan and Angat formations, recharge over the combined alluvial and weathered outcrops and the two formations can be tentatively evaluated at 10 % of the total rainfall. The assumption may not be geared towards accurate evaluation because of the absence of detailed data on runoff and evapotranspiration in the area.

Using the above assumption and considering an average rainfall over the whole area of 2400 mm/yr (1990 PAGASA Rainfall Records), direct recharge within the minor catchment area of the project site can be preliminary evaluated as follows:

Infiltration	=	Catchment Area x Rainfall/year x % of Rainfall
	=	1.4 km2 x 2400 mm/yr x 10%
	=	0.28 MCM/yr

2.3.2 Quality of Groundwater

For most part of the Montalban area, chemical quality of groundwater for the deeper aquifers produced positive data. Within the project area and immediate vicinity, samples of groundwater through a shallow tube well (S-4) and one spring (S-1) were collected for chemical quality. The same sampling points were considered for the Bacteriological Analysis of groundwater. The locations of these sampling points are shown in **Figure 2.2.4**. The results of the laboratory analyses are presented in **Table 2.3.1.**

Table 2.3.1 Laboratory Analysis of Water Samples from Spring (S-1) and Shallow Well (S-4), San Rafael, Montalban.

Parameters	Source of Water Samples	
	Spring (S-1)	Shallow Well (S-4)
pH	5.9	6.8
DO, mg/L	6	7
BOD, mg/L	1	1
TSS, mg/L	1	1
Cr+6, mg/L	<0.01	<0.01
As, ppm	<0.001	<0.001
Cd, ppm	<0.003	<0.003
Cu, ppm	<<0.005	<<0.005
Fe, ppm	<0.02	<0.02
Pb, ppm	<0.01	<0.01
Hg, ppm	<0.01	<0.01
Total Coliform (MPN/100 ml)	≥1600	≥1600
Fecal coliform (MPN/100 mL)	≥1600	≥1600
Heterotrophic Plate Test (CFU/ml)	3900	5000
Presence of E-coli	Negative	negative

To qualify any source of drinking water as a safe source of potable drinking water, the water quality must have passed the National Standards for Drinking Water (NSDW) of the Philippines. It should also have the characteristics of a Class AA water as specified in DAO 34, Series of 1990 of DENR, otherwise known as the "Revised Water Usage and Classification/Water Quality Criteria Amending Section Nos. 68 and 69, Chapter III of the 1978 NPCC Rules and Regulations". The water quality standards set by these two regulations are specifically intended to protect public health.

Based on the results of the laboratory analyses, BOD and TSS are just within the tolerable limits set by the standards. In terms of heavy metals, all are within the safe limits. In general, the spring and shallow deep well can be considered safe as far as its chemical loads are concerned.

In terms of its biological characteristics, both sources of potable drinking water are considered unsafe because the results of the microbial content analyses show considerably high levels of biological contaminants. The high concentration levels for total coliform, fecal coliform and heterotrophic plate test are indicators that the water source is biologically contaminated. It is possible that the sources of contamination are from human and/or animal feces that are being discharge within the immediate vicinity of the spring or shallow well. It should be noted that in the 1985-1990 health records of Montalban, the following ranks among the top ten leading causes of morbidity: rank 5 is parasitism; rank 6 is skin disorder; rank 7 is gastro intestinal disorder. These causes of morbidity are directly related to the degree of biological contamination of foods and water being taken by the local populace of Montalban.

2.3.3 Groundwater Pollution Susceptibility

The proposed project site is underlain with moderately thick clayey silt layer and sandy silt deposit down to a depth of about 15 m below ground surface. The lower layer, based on the lithology of the drilled holes in the area, shows slight consolidation and can be considered as the weathered portions of the older volcanic units. While the thickness of these two layers may vary from place to place or distinct discontinuity may occur over short distances, the permeability potential of these two layers are relatively low because of the clayey nature of most of the sectional portions.

Beneath the surficial clayey layer and weathered sectional bottom deposit, massive volcanic rocks of basaltic and andesitic compositions were encountered. The permeability of the volcanic rock which belongs to the Kinabuan and Angat formations is intrinsically low even with the presence of minor fractures anti joints. Considering the moderate thickness of the soil cover and weathered sections of the older volcanics and their relative low permeability, potential, pollution of groundwater from the upper source sections would be slower and less intense even before it reaches the massive volcanic rock formation which has a relatively lower permeability potential.

Migration of polluted water in the area through groundwater path on a regional scale would likewise be insignificant as the project site is considerably far from the active

faults encountered in the area. The distance of these faults practically excluded the project site from the intense and active erosion movements and the presence of slippage and numerous cracks which may become paths and channels for the further invasion of polluted waters in the lowlands.

2.3.4 Surfacewater Source

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.

In order to determine the actual water quality of Wawa River, the study team has collected a number of samples in the upstream and downstream side of the river. Running creeks within the immediate vicinity of the project site and drains toward Wawa River was also considered. Sample collection was undertaken in two occasions: (1) during the period October 2, 22, 26 and 28 1998 for the analysis of pH, BOD, SS, DO, *E. coli*; and (2) November 13 and 14 1998 for the analysis of heavy metals and microbiological contents of river water samples. The location of the sampling points for each sampling occasions are illustrated **Figure 2.1.1**. The results of the water quality survey are shown in **Tables 2.3.2** and **2.3.3**.

The results of the water survey show that the concentration level of BOD, which is one of the primary indicators of the degree of pollution of water body, is not that high. Based on DAO 35 of the DENR, the registered BOD value is good enough for Class D water. Class D water is for agriculture, irrigation, livestock, watering, etc. In terms of DO, the water samples also registered quite high values. The possible reason for this kind of results are as follows: (1) BOD is low due to the dilution effect of runoff water from many parts of the watershed areas that drains towards Wawa River since the collection was done during wet season, and (2) DO is high since the river flow during wet season is turbulent that favors the dissolution of oxygen in river water due to good contact of atmospheric oxygen with that of the turbulent water surface of Wawa River.

The pH of the river is just within normal range expected for a water body such as Wawa River. The suspended solids registered quite an erratic trend possibly due to the intensity of rain that poured in the area. The heavier the rain is, the more suspended solids are drained to the river due to surface run-off.

One interesting result obtained is the quality of water in the creek at San Isidro. The BOD value is high possibly because of the discharge of domestic wastewater of the residents living along the creek. The inverse proportionality of BOD with that of DO is observed in this creek. The DO value measured for the creek is quite low which support the data for its high BOD load.

The heavy metals load of Wawa River is relatively low as shown in the above table. However, arsenic concentrations for both samples are relatively high compared with the DENR standard for Class D water which is 0.1 mg/L. All the rest of the results could not be directly compared with the standards described in DAO 35. Most of the results are indicative only (e.g., say less than a certain value). This is probably because of the limitations of the detection limits of the method of analysis employed in the laboratory. Overall, the heavy metals content of Wawa river samples except for Arsenic is considerably low .

Table 2.3.2. Surface Water Quality Survey River During Wet Season (From the period October 21, 22, 26 and 28, 1998)

Station No	Location/Description	Parameters						
		Ta	Tw	DO	pH	BOD	SS	E-coli
PB-6	Wawa River Downstream	25	26	7.3	7.7	10	25	neg
PB-5	Creek Tributary to Wawa River	25	26	7.6	7.6	10	115	neg
PB-3	Wawa River Upstream	25	26	6.7	7.7	12	9	neg
PB-9	Creek at San Isidro	25	26	2.7	7.6	129	200	neg
PB-8	Stream Tributary to Wawa River	35	30	5.5	6.7	1	14	Neg

Note:
Ta - ambient temperature, °C
Tw - ambient water temperature, °C
DO - Dissolved Oxygen, mg/L
pH - pH scale
BOD - Biological oxygen Demand, mg/L
SS - suspended solids, mg/L
E-coli - E. coli bacteria, MPN/100 mL

Table 2.3.3. Surface Water Quality Survey River During Wet Season (From the period November 13 & 14, 1998)

Parameter (Heavy Metals)	Downstream of Wawa River (PB-6)	Upstream of Wawa River (PB-3)
Cr+6, mg/L	<0.01	<0.01
As, ppm	1.907	0.136
Cd, ppm	<0.003	<0.003
Cu, ppm	0.016	<0.005
Fe, ppm	<0.01	<0.01
Pb, ppm	<0.001	<0.001
Hg, ppm	<0.01	<0.01

2.4 Vegetation

2.4.1 Method of Data Collection and Identification of Plant Specimen

The proposed sanitary landfill is envisioned to be an expansion of the existing site. The proposed site is characterized by steep rolling hills. This topographic character prevents normal utilization of the area for economic purposes. The steep ravines along the sides of the proposed landfill site are covered with secondary growth of vegetation.

To determine the characteristic vegetation at the primary impact zone, plant samples were collected at identified vegetation patches. These samples were classified and identified through the use of available references. Final confirmation has been done through samples kept at the National Herbarium/Botany Division of the Philippine National Museum.

2.4.2 Ecology and Vegetation of the Proposed Sanitary Landfill Project

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.

The morphological and physiological responses of the plants to climate dictate the kinds of plant species of the primary impact zone. This indicates similarity in most

vegetated sections within 5-kilometer radius. The homogenous climatic condition in most sections of the study area has caused very minimal observable biodiversity patterns attributed to low altitude, rolling steep slopes and low soil fertility. The most dominant plant species are the grasses followed by ipil-ipil, mango and guava.

Identification of the plant species found in the study area revealed that most of the samples were considered to have either medicinal or construction value aside from being edible for human consumption. However, the abundance of these species is rather low as they are found only in patches within the project site. This low abundance of economically important plant species is expected as the project area is considered a secondary growth vegetation.

Ocular inspection within 10-km radius of the proposed project site indicated that the floral composition of the area is mostly of secondary growth vegetation. This could be attributed to existing land use.

Eleven (11) species of plants were identified outside the primary impact zone. **Tables 2.4.1** and **2.4.2** provide the listing of these plants. Of the 11 species of plants identified 9 species were non-dipterocarps, 1 species of bamboo and 1 species of grass. As these plants are found within the vicinity of residential areas, the residents often cultivate most of these. Notable of these cultivated species are santol, bayabas and mangga.

2.4.3 Endangered/Threatened/Rare Species

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

2.5 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.

The past and existing land use in the proposed project site likely affect wildlife species. Due to steep hills, no wildlife has been identified in the area. Likewise, no endangered, threatened or rare species of animals have been identified here.

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.

Table 2.4.1 List of Identified Vegetation within the Project Site/Primary Impact Zone

Scientific Name	*Common Name*	*Economic Importance*
A. Non-Dipterocarps		
Pterocarpus indicus	Narra	Wood is excellent for furniture, cabinet and other decorative work; flowers have some medicinal value.
Premma odorata	Alagao	Leaves have medicinal value.
Mangifera indica Linn	Mango/Mangga	Fruit is edible, wood suitable for cabinet work
Leucaena leucocephala	Ipil-ipil	Wood is good for firewood and charcoal; bark produces brown dye; leaves can be used for animal feeds; seeds can be substituted for coffee; has some medicinal properties.
Psidium guajava Linn.	Bayabas/Guava	Decoction of leaves is good for stomach ache and as vermifuge. Tea can be made from leaves. Fruit is used for manufacture of jellies. Wood for light construction
B. Grasses		
Imperata cylindrica	Kogon	Good for house roofing
Brachiaria reptans	Marakauayan	Good fodder for stock animals
C. Bamboo		
Bambusa arundinacea	Indian bamboo	Useful raw material for building construction and for articles in cottage industry

Table 2.4.2 List of Identified Vegetation Outside the Project Site/Primary Impact Zone

Scientific Name	Common Name	Economic Importance
A. Non-Dipterocarps		
Psidium guajava Linn. (Myrtaceae)	Bayabas	Decoction of leaves is good for stomach ache and as vermifuge. Tea can be made from leaves. Fruit is used for manufacture of jellies. Wood for light construction
Macaranga tanarius	Binunga	Bark and leaves are used for fermentation; sap as glue
Acacia mangium	Yellow acacia	Wood used for light construction; reforestation species
Terminalia catappa	Talisay	Wood used for light construction; seeds edible; bark produces brown dye; ornamental tree
Sandoricum koetjape	Santol	Toxic bark; pounded bark may be applied to ringworm; roots are much used in Malayan medicine as preventive after childbirth and generally toxic; fruit is edible; wood is good for carving turned products
Hibiscus rosasinensis	Gumamela	Ornamental plant, leaves are used in treating skin boils
Mangifera indica Linn.	Mango/Mangga	fruit is edible, wood suitable for cabinet work
Tamarindus indica	Sampaloc	Young leaves, flowers and pods are used for seasoning foods; fruits are used in the manufacture of jam, sweets and drinks; bark is source of ink; source of oil for varnish
Leucaena leucocephala	Ipil-ipil	Wood is good for firewood and charcoal; bark produces a brown dye; leaves can be used as animal feeds; seeds used as substitute for coffee
B. Grasses		
Brachiaria reptans	Marakauayan	Good fodder for stock animals
C. Bamboos		
Bambusa blumeana	Kawayan	Young shoots are edible

2.6 Vibration Investigation, Traffic Count and Noise Survey

2.6.1 General

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. The activity was undertaken during the dry season from February 19-21, 1998 and wet season from October 29-31, 1998.

2.6.2 Survey and Data Analysis Methods

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.

For each observation point, horizontal and vertical seismometers with 1.0 sec natural period were deployed and connected to two digital recorders (EDR-1000). Horizontal sensors were positioned radially from the main source of ground vibration and in this case, considered to be mostly from traffic along the main road. Recording parameters and threshold were set to be similar for all recorders. A series of five-minute ground motion data sample were simultaneously recorded on all points every hour for at least 24 hours. The hourly record of cacti recorder consists of five one-minute files to represent the activity of the hour. Data are digitally stored by the recorders on a 3.5-high-density diskette.

Waveform analysis was conducted using an Epson program. FDRSEL to view EDR-1000 waveform data and determine maximum velocity values. Selected waveforms to represent background noise and vehicular noise were converted and imported to DADiSP for spectral analysis,

Ambient source of ground motion in the area is primarily dominated by the passing heavy trucks. To correlate this to the variation of ground motion amplitude, traffic count was carried out at points where these trucks are passing by. During the traffic count, vehicles were classified according to their direction and their estimated weights. A garbage truck was considered heavy while jeepneys and cars were classified as light vehicles.

2.6.3 Results of the Dry Season Investigation

The investigation was conducted from 19-21 February 1998 on four sites within the vicinity of San Mateo Landfill. All computer outputs and figures related to this section are found in **Attachment B**.

Figure 2.6.1 shows the location map of the four observation points. The first two points are both along the main road, one leading to the entrance/exit of the Garbage Landfill area (P1), and the other along the road a few kilometers before the Landfill Site at Sapinit Elementary School, San Juan, Antipolo, Rizal (S6). The third observation point (S5) lies along file road, a few meters away from the flow or turning point of garbage trucks to Landfill dumping site. The fourth point (S1) is located several meters from the main road. It is near the leaching ponds and is proximal to the compaction and dumping site.

Basically, measurements were made to assess the ground motion resulting from passing vehicles on the road and from other sources like bulldozers and other compaction equipment. Points PI and S6 are the closest to the flow of traffic. Although point S5 is also along the road, it is relatively farther from the source of noise affecting points PI and S6, Likewise, Point S1 is relatively farther from vehicular noise but is the closest to other heavy equipment. This monitoring configuration is designed to estimate the extent of vibration generated by these possible sources of ground vibration and the differences among affecting sources to the vibration recorded at different sites.

Vibration signature excited by traffic exhibits gradual increase in amplitude while a vehicle travels from distance towards the observation site, and then, exhibits a smooth decay while the vehicle is moving away as shown in **Figure 2.6.2**. In some recorded vibrations at points P1 and S6, sudden changes in amplitudes were also recorded due to the condition of the road's roughness and smoothness.

(1) Temporal Variation of Noise Level (Background & Vehicular)

The level of vibration at all sites is not uniform throughout the observation period. There are two levels of temporal variation in the data gathered. The first level is the general difference in the daytime and night time noise level in the area.

Amplitude levels recorded at point S5 showed relatively insignificant variation between ambient natural disturbance (or background noise level) and vehicular noise as shown in **Figure 2.6.3**. Likewise, compaction and other heavy equipment activity did not significantly affect point S1 **(Figure 2.6.4)**. These imply that the recorded ground vibrations at these points were within their natural or background noise level.

However, maximum velocity values of each five- minute records show increase of background noise (natural disturbance) during daytime which corresponds to an increase ill vehicular activity from distant places and/or those directly affects points along the flow of traffic at points P1 and S6.

The second level of temporal variation is in the hourly variation of traffic volume during daytime. Maximum velocity values of ground motion taken from recorded vehicular activity at points PI and S6, behave in periodic highs and lows (**Figures 2.6.5 and 2.6.6**). The changes in envelops of the highs and lows of the hourly maximum amplitudes was observed to correspond to the change in volume of vehicular activity (**Figures 2.6.7 and 2.6.8**). These show better correlation with the level of traffic and the hourly count of passing vehicles in the area (**Figures 2.6.9 and 2.6.10**).

(2) Temporal Variation of Spectral Content

Spectral analysis from hourly samples of records of tire passing vehicles at point P1 clearly show that the predominant frequency of vehicular activity lies within 25 Hz. Using this marker frequency, it can be seen that there is significant increase in background noise along this frequency during episodes of increased vehicular activity (**Figure 2.6.11a to 2.6.11w**).

Extracting two recorded data from S1 at different recording times (12:00 MN and 8:00 AM), response spectra show that the predominant frequency at point S1 lies within a bandwidth from 3 Hz to 20 Hz. Low Frequency content corresponds to the oscillation of liquid in the leachate treatment ponds which is being affected by the operating heavy equipment in the nearby dumping site. Attenuated amplitudes of higher frequency contents correspond to vehicular activity in the nearby area (**Figure 2.6.12**).

(3) Conclusion

Response spectra of the vibration measurement showed that the predominant wave frequency content lies within 25 Hz. This corresponds to vehicular activity mainly resulting from successive vehicular garbage trucks, and sometimes increased by other type of vehicles during daytime.

Traffic count affirmed the amplitude fluctuation of the recorded vibration at two points located along the road (PI and S6). However, at point S5 there's no significant variation of the vibration between natural disturbance and the traffic. Moreover, compaction equipment and traffic did not show any significant effect at observation

point SI located near the leaching ponds or several meters away from dumping site and road.
Amplitude levels at points S5 and SI does not reach similar levels as P1 and S6 which indicate that ground vibration due to vehicular activity is significantly attenuated.

Pavement discontinuities and road condition, vehicle type and condition can alter the source feature.

2.6.4 Results of the Wet Season Investigation

During wet season, the investigation was conducted in two different areas. The first observation area is within San Mateo Landfill., the observation sites are the same sites with that of the sites during the dry season measurements. The location map of this sites are previously shown in **Figure 2.6.1**. The second area are situated on four sites proximal to Wawa River and Boso-boso River, which are respectively located 6 kilometers northwest and 4 kilometers southwest of the San Mateo Landfill. The location map is shown in **Figure 2.6.14**. **Tables 2.6.1** and **2.6.2** summarize relevant information about these observation sites.

(1) At Observation Sites within San Mateo Landfill

(a) Temporal Variation of Ground Vibration Level

On measurement sites located along the main road (S-5, S-6 & S- 11), the maximum amplitude levels of recorded vehicular activity follows a sinusoidal trend (**Figures 2.6.15, 2.6.16, 2.6.17, 2.6.18, 2.6.19 and 2.6.20**). In S-5 & S-11 this trend continues until midnight and appears to start again in the morning (**Figure 2.6.15 and 2.6.17**). While the actual amplitude levels of vehicular activity may not follow the same trend as the traffic counts histogram done on S-11, amplitude levels of background noise appear to fairly correlate with it. However, an envelope of the maximum amplitudes of vehicular records (**Figures 2.6.18, 2.6.19 and 2.6.20**) appears to agree with the vehicular count (**Figure 2.6.21**). In S-1, maximum ground vibration due to vehicular activity does not temporally follow traffic count histogram and may indicate other sources such as dumping and compaction activities in the landfill area (**Figure 2.6.22**).

(b) Spectral Variation of Ground Shaking Level

Spectral content of records at each site was determined during periods of heavy vehicular and light activity. During both periods, Pont S-11 shows a predominant peak at 5 Hz, either representing a site-specific predominant frequency or a marker frequency for a distal source of vibration. However, spectra of vehicular activity

show a seemingly harmonic polymodal predominant peaks at approximately 8, 13 and 20 Hz. Similar cases can be seen in other recording stations near the landfill.

(c) Acoustic Level

Acoustic measurement (in dB) were randomly conducted in the three areas. In the landfill area, Point S-1 has relatively lower acoustic values than the other three sites (**Figure 2.6.23**).

(d) Conclusion

Recent measurements of ground vibration generally show higher amplitude levels at the same sites than in the survey made in February 1998. Frequency content also changed showing predominance of lower frequencies than before. This shift may be an effect of the smoother concrete road constructed in the sites. Rough roads tend to produce higher frequency content than smoother roads.

(2) At Observation Sites Proximal to Wawa River and Boso-boso River

(a) Temporal variation of Ground Vibration Level

Vehicular counts in boso-boso show low activity during nighttime and resumes during daytime (**Figure 2.6.24**). This trend can be seen in measurements of maximum amplitudes of ground vibration in both the upstream and downstream recording sites in Boso-boso (**Figures 2.6.25 and 2.6.26**).

The number of passing vehicles in Wawa does not change at nighttime as more heavy vehicles begin to dominate the histogram unit late midnight. This is then followed by the same trend in boso-boso. While records of maximum amplitudes of ground vibration at WDS or PB-7 (**Figure 2.6.27**) follow the number of passing vehicle (**Figure 2.6.28**), this is not readily observable at point WUS or PB-4 (**Figure 2.6.29**). However, enveloped peaks of maximum ground vibration show a steady increase of amplitudes that follow the trend for heavy vehicles for WDS or PB-7 (**Figure 2.6.30**).

(b) Spectral Variation of Ground Shaking Level

At point WUS or PB-4, it appears that the there is no distinct predomeinant frequency for very quiet periods and a peak at 25 Hz for records of high amplitudes. At Point WDS or PB-7, a predominant peak of 5 Hz appears on both periods with polymodal peaks at 8, 13 and 23 Hz. A predominant at peak at 5 Hz is visible of 15 Hz at point BUS or PB-2, while at point BDS or PB-1, peaks at 3 and 8 Hz are visible for records of background noise and 8 and 15 Hz for records of vehicular activity.

(c) Acoustic Level

Acoustic measurements (in dB) were randomly conducted in the area. Acoustic measurements in Boso-boso areas show that the values of upstream sites are lower than of downstream sites (**Figure 2.6.31**) and Wawa has relatively higher values than Boso-boso (**Figure 2.6.32**).

2.7 Socio-Economic Aspects

2.7.1 Demography

(a) Population Size and Growth

Barangay San Rafael serves as the project's site. The barangay's population comprise 15 % of the total population of Rodriguez, the municipality where it belongs. It has a population of 10,548 in 1990 and 12,285 in 1995 (**Table 2.7.1**). Within ten-year period, Barangay San Rafael sustained a growth rate of 3.1 % per year. This is just slightly lower than the growth rate of Rodriguez which is 3.5% during the same period. The national population growth rate is only 2.3% per year.

Although the growth rate of Barangay San Rafael and the municipality of Rodriguez is already high, it is still not as high as in Metro Manila. The metropolis which is the service area of the project has 7,948,392 persons in 1990 and 9,454,040 in 1995. The population growth rate of Metro Manila during the same period is 3.6 percent.

Table 2.7.1 Population Size, Growth and Density of Barangay San Rafael, Rodriguez Municipality and Metropolitan Manila: 1990-1995

Item	Barangay San Rafael	Rodriguez Municipality	Metropolitan Manila
1990 Population	10,548	67,074	7,948,392
1995 Population	12,285	79,588	9,454,040
Yearly Growth Rate	3.1	3.5	3.6
Total land area (in sq. km)	12	108	636
No. of persons per sq. km.	1024	737	14,865

Source: National Statistics Office and Municipality of Rodriguez

The increase of population is a result of natural increase (number of birth minus number of death) and net migration (number of in-migrants minus number of out-migrants). With 27 births per 1,000 population and 9 deaths per 1,000, the rate of natural increase in Rodriguez is 18 persons per 1,000 population. This is lower than Metro Manila's 24 persons per 1000 population natural increase. Thus, the reason behind the high population growth of Rodriguez is the same as in the metropolis: in-migration. This may be also largely responsible for the high growth rate in Barangay San Rafael for there is no reason for its natural increase rate to divert from the

municipal level. In the project site (Sitio Inigan) all are migrants who established their residence and farm when the then Ministry of Natural Resources (MNR) abandoned its operation in Wawa Dam Watershed.

(b) Population Density

Barangay San Rafael is one of the most dense in the municipality of Rodriguez. Its population density of 1,024 persons per sq. km is much higher than the municipal density. With a total land area of 108 sq. km, Rodriguez has only an average population density of 737 persons per sq. kilometer. This is still much lower than the population density of Metropolitan Manila with 14,865 persons per sq. kilometer. This point out that Rodriguez has not yet reached density level prevailing in the metropolis. The expansion of the municipality is limited by the high mountains that characterize its terrain. The national density is 230 persons per sq. kilometer.

(c) Household Size and Sex Composition

The population of San Rafael is distributed among 2,660 households resulting to an average of 4.6 members per household (**Table 2.7.2**). This household size is lower than the average for Metropolitan Manila which has 4.8 members. But in Sitio Inigan, the household size is much bigger with 5.9 members. The difference with the other impact areas reflects the highly agricultural economy of project site and the households as the basic production unit . The high labor requirement of agricultural operation requires the recruitment of more workers but its household level operation prompts the maintenance of a large household. The household members are recruited as the workforce.

The household members in Barangay San Rafael and Rodriguez Municipality are dominated by males. In both the barangay and municipal levels, there are 102 males for every 100 females. The same ratio prevails over Sitio Inigan. This is reflective of its economic base where agriculture and industries predominate. Metro Manila has only 95 men per 100 women.

(d) Dependency Ratio and Educational Attainment

The household size in Barangay San Rafael, Rodriguez Municipality and Metro Manila indicates a shrinking household size. This means that children in the households move out earlier than in Sitio Inigan. This is seen in the smaller dependency burden in the sitio. Only 26% of its population are aged below 15 years. Those aged over 64 years compose 1 percent. Both age groups are considered dependents of the economically active population whose ages range from 15 to 64

years. The economically active persons constitute 73% of the population. Thus, every 100 economically active persons in the city has only 38 dependents. This means that for every dependent, there are two or three economically active persons whose production capacity supports the dependent.

The dependency burden in San Rafael is heavier with 43 dependents per 100 economically active adults. At the municipal level, it is even much heavier at 66 dependents per 100 economically active adults. Metro Manila has only 56 dependents per 100 economically active adults. The national dependency ratio is 75 dependents per 100 economically active adults.

Among persons aged seven years and over, only 2% do not have any education in Sitio Inigan and 1% in San Rafael. The municipal level has greater proportion of persons who are without education at 4 percent. The same persons constitute only 1% in Metro Manila. But in terms of average educational attainment of the

population, it is rather low in Sitio Inigan. The average person has only completed five years of school or has reached Grade 5. In San Rafael, it is Grade 6 while in Rodriguez Municipality, it is First Year High School. In Metropolitan Manila, it is Third Year High School.

Table 2 .7.2 Selected Demographic Characteristics of Barangay San Rafael, Sitio Inigan, Barangay Rodriguez and Metropolitan Manila

Item	Sitio Inigan	Barangay San Rafael	Rodriguez Municipality	Metropolitan Manila
Average members per households	5.9	4.6	4.8	4.7
Number of males per 100 females	102	102	102	95
No. of Dependents per 100 persons (in percent)	38	43	66	56
Persons over 6 years old without education (in percent)	2	1	4	1
Average number of years spent in school	5	6	7	9

Source: National Statistics Office and November 1998 Survey

2.7.2 Housing Characteristics

(a) House Ownership, Structure and Materials

All the households in Sitio Inigan own their houses but only 94% do so in Barangay San Rafael (**Table 2.7.3**). This ownership rate is high considering that in the Municipality of Rodriguez, only 73 own their houses. This ownership rate in Metropolitan Manila is even lower at 61 percent. This means that housing is less scarce and more affordable in the municipality than in the metropolis.

But the ownership of home lot is much better in Metro Manila and in the municipality of Rodriguez. None in Sitio Inigan and only 8% of Barangay San Rafael own their home lot. A large part of the barangay is a government watershed reservation and the land, until now, cannot be alienated. About 60% own their home lot in the Municipality of Rodriguez or higher than the home lot ownership rate in Metro Manila which is 57%. Those who do not own their home lot are mostly occupying it for free. In Sitio Inigan and Barangay San Rafael, all non-homely owners are free-occupant because the land is government-owned. They only constitute 30% in Rodriguez Municipality and 27% in the metropolis.

The type of housing structures likewise reflects the level of housing affordability. The more affordable housing is, the more households live in a single house. All the households in Sitio Inigan and Barangay San Rafael live in single detached units. Only 89% of the households in Rodriguez Municipality and 61% in Metro Manila live in a single house. The lower housing ownership rate indicates the urban character of the municipality and the metropolis and the increasing home lot scarcity. More households are living in multiple-unit housing structures.

The housing materials used indicate the economic status of the population. The use of concrete and other permanent materials for housing is taken as an indicator of higher economic status. The material most widely used for roofing in all impact areas is galvanized iron (GI) sheet. This material is used by 60% of the houses in Sitio Inigan and 78% in Barangay San Rafael. In Rodriguez Municipality, its 76%. In the Metro Manila, the households who use GI sheet is at 80 percent. Although coconut and nipa are still used by 40% in Sitio Inigan, these materials as well as other types are less used in the barangay, municipality and metropolis.

For walling, the most widely used materials in Sitio Inigan is concrete combined with wood. Around 82% of the houses have this type of material. But only 20% used the same material in Barangay San Rafael and 22% in Rodriguez Municipality. The material is used in 30% of the houses in Metro Manila. Concrete is more widely used in the three impact areas. It is used in 47% of the houses in Barangay San Rafael, 39% in Rodriguez Municipality and 30% in Metro Manila.

Table 2.7.3 Selected Data on the Housing Characteristics in Sitio Inigan, Barangay San Rafael, Rodriguez Municipality, and Metropolitan Manila

Item	Sitio Inigan	Barangay San Rafael	Rodriguez Municipality	Metropolitan Manila
Percentage of households by home tenure				
Owned	100	94	73	61
Rented	-	6	14	30
Occupied for free	-	-	13	9
Total	100	100	100	100
Percentage of households by lot tenure				
Owned	-	8	60	57
Rented	-	-	10	16
Occupied for free	100	92	30	27
Total	100	100	100	100
Percentage of houses by type of structure				
Single house	100	100	89	61
Multi -unit structure	-	-	11	39
Total	100	100	100	100
Percentage of houses by type of roof				
Galvanized iron/aluminum	60	78	76	80
Cogon/nipa/anahaw	40	13	15	1
Makeshift	-	9	1	3
Others (tile, wood etc.)	-	-	8	16
Total	100	100	100	100
Percentage of houses by type of walls				
Concrete/brick/stone	-	47	39	30
Wood	7	17	18	25
Concrete with wood	82	20	22	30
Bamboo/cogon/nipa	11	14	16	1
Others	-	2	5	6
	100	100	100	100

Source: National Statistics Office and November 1998 Survey

The use of wood as a walling material is still widespread with 17% using it in Barangay San Rafael, 18% in Rodriguez Municipality and 25% in the metropolis.

The housing materials used in Sitio Inigan indicate that its standard of living is lower than the barangay or the municipality or the metropolis.

2.7.3 Toilet and Water Facilities

The ownership of toilet facility in Sitio Inigan, Barangay San Rafael and Rodriguez Municipality is lower than the metropolitan rate. The households who use a toilet to dispose their waste constitute 96% in Metro Manila (**Table 2.7.4**). But only 90% has toilet in Sitio Inigan, 92% in Barangay San Rafael and 91% in Rodriguez Municipality.

The most widely used toilet facility in all impact areas is the water sealed type. This is used by 50% in Sitio Inigan, 62% in Barangay San Rafael, 76% in Rodriguez Municipality and 90% in Metro Manila. The closed pit is still used by 40% in Sitio Inigan. But as with the other type of toilet facilities, this is used by lesser number of households.

With regards to sources of drinking water, the households in Sitio Inigan and Barangay San Rafael is less better off than the households in the municipality and the metropolis. The main source of water in the sitio and the barangay is the pumpwell. This is used 50% of the households in the sitio and 42% in the barangay. Around 21% of the household in the sitio and 49% of the barangay still obtain their drinking from a dug well. In the case of Sitio Inigan, 29% still draw their drinking water from a spring.

Around 44% of the households in the municipality enjoys running water from a faucet. At the metropolis, 54% draw their drinking water from the same source. Only 42% of the households in the municipality rely on a pumpwell and 39% in the metropolis.

Most households in Sitio Inigan and Barangay San Rafael take care of disposing their own garbage. Only households in the municipality and Metro Manila are served by garbage collection system. They constitute 28% in the municipality but 70% in the metropolis. Those who are outside the service area of the garbage collection system mostly burn their garbage. Those who use this mode of garbage disposal comprise 56% in the municipality and 19% in the metropolis as a whole.

2.7.4 Social Services

Sitio Inigan is accessible from Sitio Wawa of San Rafael through three-km trail. The river can be used for navigation during rainy season although it may be too shallow during dry season. But there is no regular transport plying the river except for

crossing the river in one portion of the trail. A six-km earth road connects Sitio Wawa to the barangay center of San Rafael. In the Barangay Center, a barangay hall and a heath center stand. These are the nearest government services to the households of Sitio Inigan. But most households in Sitio Inigan go to the municipal center of Rodriguez to obtain social services. The municipal center is easily accessible from the barangay center of San Rafael through a concrete road. Jeepneys ply the route at any time.

In the municipality, 313 jeepneys are registered. These are complimented by 350 tricycles, 340 private light vehicles and 122 trucks. There are 11 Barangay Health Centers, one of these is in San Rafael. These are complimented by eight private medical clinics and seven private dental clinic. These are 12 medical doctors, two in the government service and 10 in private practice. The government has also two dentists and 11 midwives. The municipality has 1,397 registered business establishments, 815 of these are general (sari-sari) stores. But these also include 4 banks, 24 hardwares, 33 poultry and piggery farms, 6 pharmacy and 10 quarry operators.

Table 2.7.4 Selected Data on the Housing Utilities in Sitio Inigan, Barangay San Rafael, Rodriguez Municipality and Metropolitan Manila

Item	Sitio Inigan	Barangay San Rafael	Rodriguez Municipality	Metropolitan Manila
Percentage of households by type of toilets used				
None	10	8	9	4
Water sealed	50	62	76	90
Closed Pit	40	30	9	2
Open pit	-	-	6	2
Others	-	-	-	2
Total	100	100	100	100
Percentage of households by source of drinking water				
Faucet	-	9	44	54
Pumpwell	50	42	42	39
Dug well	21	49	3	2
Others	29	-	11	5
Total	100	100	100	100
Percentage of households by garbage disposal method				
Picked -up by truck	-	-	28	70
Individual dumping	100	100	11	7
Burning	-	-	56	19
Others	-	-	5	4
Total	100	100	100	100

Source: National Statistics Office , November 1998 Survey

(a) Health

Barangay San Rafael does not have a record of its causes and rate of mortality and morbidity. The municipality has only a list of its ten leading causes of mortality and morbidity. These are reportedly the diseases it experienced from 1985 to 1990. The causes of morbidity includes the following: influenza, anemia, vitamin deficiency, acute respiratory infection, parasitism, skin problem, gastro-intestinal diseases, muskoletal diseases, hypertension and bronchitis. The causes of mortality are the following: pneumonia, hypertensive diseases, pulmonary tuberculosis, cardio-vascular arrest, cancer, fetal death, diabetes militus and gastroenteritis.

It can be noted that waster-borne diseases are prevalent in the municipality. These include gastro-intestinal disorder, parasitism and skin problem. In addition to the use of unsanitary water sources (dug wells and open water bodies), many households also use Wawa River for bathing. The river is reportedly used by Foremost Farms, a poultry and piggery farm associated with Lucio Tan, as a depository of its waste. Besides, run-off and raw garbage from the existing San Mateo Landfill find their way to the river through a tributary. Malaria is endemic in the area although it is not one of the leading causes of mortality and morbidity. A malaria control officer used to be stationed in the municipality.

The health situation in the metropolis is reflected in its mortality rate. Based on a four-year average, the top killer in Metropolitan Manila is pneumonia. There is an average of 65 cases per 100,000 population and its dominance as the first ranking cause of mortality is unchallenged over the four-year period. At the national level, pneumonia ranks only second as a cause of mortality and there are only 13 cases per 100,000 population.

Ranking second cause of mortality in the metropolis is vascular disease with 44 cases per 100,000 population in a four-year average. At the national level, this is the first ranking cause of mortality but with only 15 cases per 100,000 population. Other high ranking causes of mortality are cancer (37 cases per 100,000 population), pulmonary tuberculosis (34 cases per 100,000 population), accidents (30 cases per 100,000 population), hypertension (31 cases per 100,000 population) and liver disease and cirrhosis (9 cases per 1000 population).

Table 2.7.5 Causes and Rate (per 100,000 population) of Mortality in Metropolitan Manila: 1991-1994

Cause	1991	1992	1993	1994	Average
Pneumonia	60	74	66	59	65
Cancer	37	38	35	38	37
Vascular Disease	36	39	56	44	44
TB all forms	34	36	35	32	34
Accidents	34	32	31	24	30
Hypertension	33	30	30	29	31
Liver Disease and cirrhosis	11	10	7	6	9
Diabetes	10	9	9	11	10
Kidney Disease	8	-	9	8	6
Septicemia	7	12	16	9	11
Diarrhea	-	7	-	-	2

Source: Department of Health

Except for diarrhea which has disappeared, the other causes of mortality have not shown decreasing trend. The incidence rate is at best fluctuating. The ranking of the causes of mortality has also more or less stabilized. Throughout the four-year period their position remained largely the same.

2.7.5 Employment and Income

The employment characteristics of the impact areas can be seen in the industry group where persons aged 15 years old and over work. In Sitio Inigan, agriculture, hunting and forestry are the main employer having 49% of the labor force (**Table 2.7.6**). Services are the next biggest employer with 29%. The rest are employed in construction and trade. In Barangay San Rafael, agriculture, hunting and forestry diminish in importance having only 14% of the labor force. Services takes the upper hand with 60% of the labor force. Other bigger employers are trade and mining and quarrying.

In Rodriguez Municipality, the employment characteristics has become more diversified. While services are still the top employer at 26%, this is closely followed by manufacturing, employing 22%. Trade and electricity, gas and water take the third place at 17%. Agriculture, hunting and forestry is related to a lower place at 13%. This sector is almost completely gone in Metro Manila where it only employs 1%. The metropolis is dominated by persons employed in services (58%), manufacturing (17%) and trade (14%). The other sectors employ less proportion of the labor force.

Unemployment in Sitio Inigan and San Rafael stands at 8%. It is higher than the metropolitan unemployment rate which is 6 percent . The metropolis also enjoys much higher income than the two impact areas. While the average family income in

Metropolitan Manila is P14,467.00 per month, it is only P4,083 in Barangay San Rafael and P3050 in Sitio Inigan.

Table 2.7.6 Data on Employment and Income in Sitio Inigan, Barangay San Rafael, Rodriguez Municipality and Metropolitan Manila

Item	Sitio Inigan	Barangay San Rafael	Rodriguez Municipality	Metropolit an Manila
Persons aged 15 years old and over by occupation				
Agriculture, hunting and forestry	49	14	13	1
Fishing	-	-	-	1
Mining and quarrying	-	6	1	-
Manufacturing	-	-	22	17
Electricity, Gas and Water	-	-	17	1
Construction	15	20	4	8
Trade	7	-	17	14
Services	29	60	26	58
Total	100	100	100%	100 %
Percentage unemployed persons	8%	8%	-	6 %
Mean household income/ month	P3050	P4083	-	P14,467.00

Source: National Statistics Office

2.7.6 Perception of the Project

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. A sample copy of the questionnaires is found in **Attachment B**.

In Sitio Inigan, the main concern is the pollution from San Mateo Landfill being mentioned by 52% (**Table 2.7.7**). The run-off resulting from heavy rainfall on November brought down to Wawa River tons of garbage from the landfill and scattered these along the banks. Other problems mentioned in the sitio are pollution from Foremost Farms (18%), absence of electric service (14%), absence of poor roads (11%) and absence of running water (5%).

In Barangay San Rafael, the concern focused on the absence of poor roads with 50% of the respondents citing it as a community problem. The lack of work opportunities followed with 17% of the respondents mentioning it. The pollution from San Mateo Landfill is still considered a problem by 11%. Other problems mentioned are absence of electric service (12%), lack of running water (2%) and the impact of quarrying operation (8%).

No one among the respondents see benefit from the project. But all in Sitio Inigan and 57% in Barangay San Rafael mentioned adverse impacts. The major concern is pollution of air, water and the foul smell. This is mentioned by 54% in Sitio Inigan and 65% in Barangay San Rafael. The other adverse impact mentioned is the spread of diseases. This concern is expressed by 46% in Sitio Inigan and 35% in Barangay San Rafael.

About 83% of the respondents in Sitio Inigan and 69% in Barangay San Rafael offer a recommendation to eliminate or mitigate the adverse impact of the project. The transfer of the site is offered by 89% in Sitio Inigan and 88% in Barangay San Rafael. This is the overwhelming recommendation. The emplacement of a good landfill system is recommended by 8% in Sitio Inigan and 5% in Barangay San Rafael. Constant consultation is also mentioned in the sitio. In the barangay, the other recommendation is to repair/expand the existing landfill.

(a) Methodology

To gather the data required, the study uses two techniques. First is the conduct of a survey using a household questionnaire. The survey covered 30 respondents in Sitio Inigan, 20 in Barangay Pintong Bocawe (San Mateo) and 90 in Barangay San Rafael. Sitio Inigan which is a part of Barangay San Rafael is the direct impact area being the project site. The survey in Barangay Pintong Bocawe is done because an access road to the proposed landfill site will be constructed through it. Only the households along the proposed road are covered by the survey. In both Sitio Inigan and Barangay Pintong Bocawe, complete enumeration of the potentially affected households were done.

In Barangay San Rafael, a random sampling was used. The respondents were picked up from eight of its 12 sitios. Only sitios along the river are included in the survey because these are considered by the barangay officials to be the most affected by the impact of the proposed landfill. The sample size is computed to have a desired reliability of 95% and a maximum sampling error of 10 percent. The second technique is the collection of secondary data from the National Statistics Office

(NSO) and the municipal hall of Rodriguez where much of the data used to establish the existing conditions are obtained.

Table 2.7.7 Perceptions of the Respondents in Sitio Inigan and Barangay San Rafael of their Community Problems and the Impact of the Proposed Landfill Project

Item	Sitio Inigan	Barangay San Rafael
Perceived community Problems		
Absence of/ poor roads	11	50
No electric service	14	12
No running water	5	2
Lack of work opportunities	-	17
Pollution from San Mateo Landfill	52	11
Pollution from Foremost Farm	18	-
Impacts of quarrying operation	-	8
Total	100	100
Percentage of respondents by perceived positive impacts:		
None	100	100
Percentage of respondents by perceived negative impacts:		
Pollution of air, water and foul odor	54	65
Spread of diseases	46	35
Total	100	100
Percentage of respondents by recommendations given:		
Transfer the proposed land fill site	88	89
Repair /expand exiting landfill	-	6
Emplace a good landfill system	8	5
Constant consultation	4	-
Total	100	100