10.2 Description of the Master Plan

10.2.1 Waste Collection Coverage Improvement

Provision of waste collection service to the whole citizens of Panama District, or achievement of 100% collection coverage, is one of missions assigned to DIMAUD by the mayor of Panama Municipality. As of the end of 2001, the collection coverage was about 92%. Rising up the collection coverage 2% in every year, it will reach to 100% in 2006.

10.2.2 Recycling System

Waste minimization includes Generation control, Discharge control and Resource recovery as shown in the figure below. It will not be successful until achieving dischargers' better understanding and cooperation and also managing organizations' capacity building.

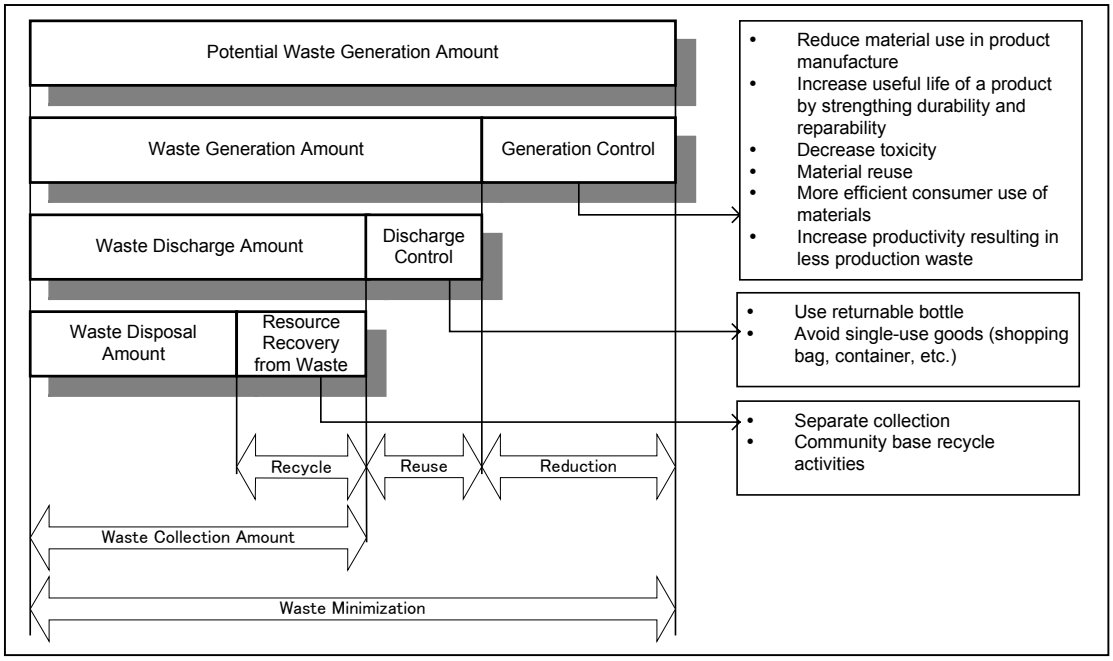

Figure 10-4: Concept of Waste Minimization

In this concept, it is Resources recovery only that is handled through the MSWM, i.e., introduction of separate collection and formation of market mechanism for recovered resources.

At present, the resource recovery is undertaken by waste-pickers in the streets and the final disposal site. The recovered materials are provided from junk dealers to recycling manufacturers, and finally to ultimate customers. This kinds of recycling activities are commonly seen both in developing and semi-developed countries. As long as people can manage to live on the activity, a recycle market is spontaneously formed although security

and sanitary problems of waste-pickers who directly collect materials remain. However, as economy grows and people's income level increases, the activity gradually becomes inactive. In this case, administration side needs to take the responsibility instead of waste-pickers. This concept is shown below.

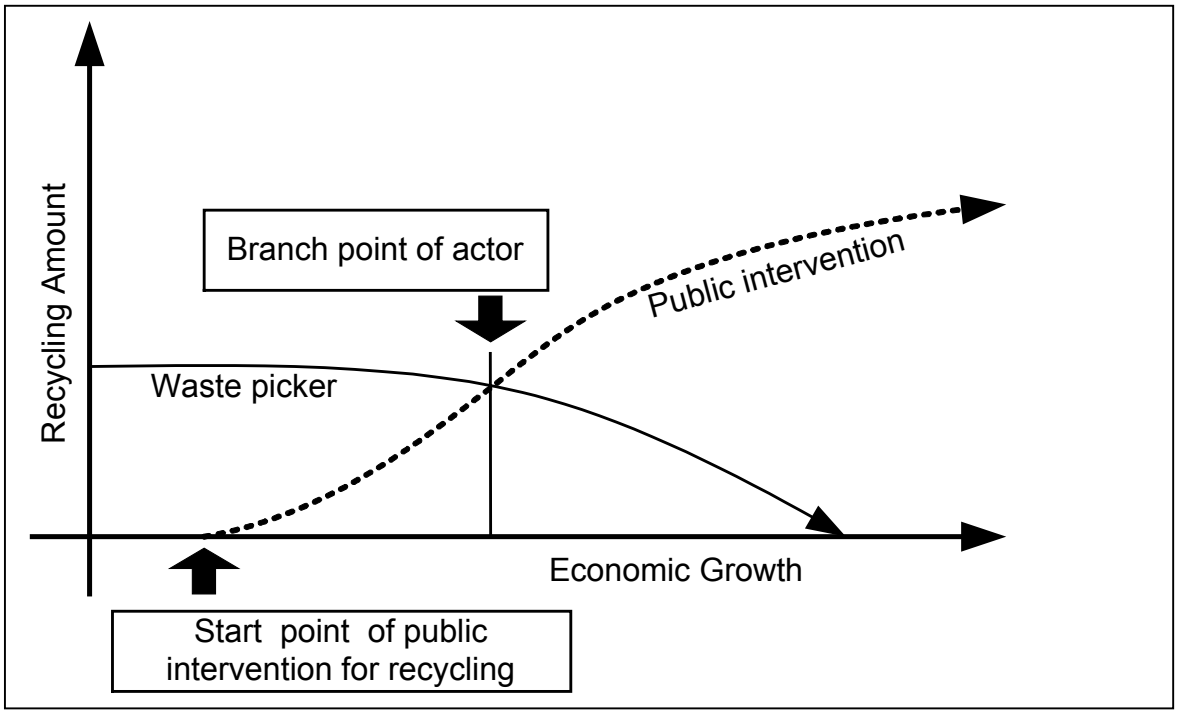

Figure 10-5: Concept of Public Intervention for Resources Recovery

It is impossible to estimate the time of the branch point in this figure. However, considering the Panamanian economy, it is surely the near future and it indicates that DIMAUD take an important action to the resource recovery from this time on. Moreover, for the establishment of the recycle system, a plan from technological, social and legislative aspects will be necessary.

The concept of recycle plan is as follows.

- ***Successful recycling is not guaranteed, however. Program managers must give special attention to making the program economically efficient and maximizing public participation.***
- ***Establishing an effective recycling program presents a major administrative and political challenge to a community.***
- ***In successful programs, procedures are continually reviewed and adjusted according to changing conditions.***
- ***Program managers should continually strive to provide a consistent stream of high-quality (free of contaminants) recovered materials that meet the standards of the marketplace.***

source : Decision-Makers' Guide To Solid Waste Management, Volume II, 1995, US EPA

The following figure shows a procedure to make the concept practical, the relation with this study and roles played by DIMAUD as an execution organization of the recycle program.

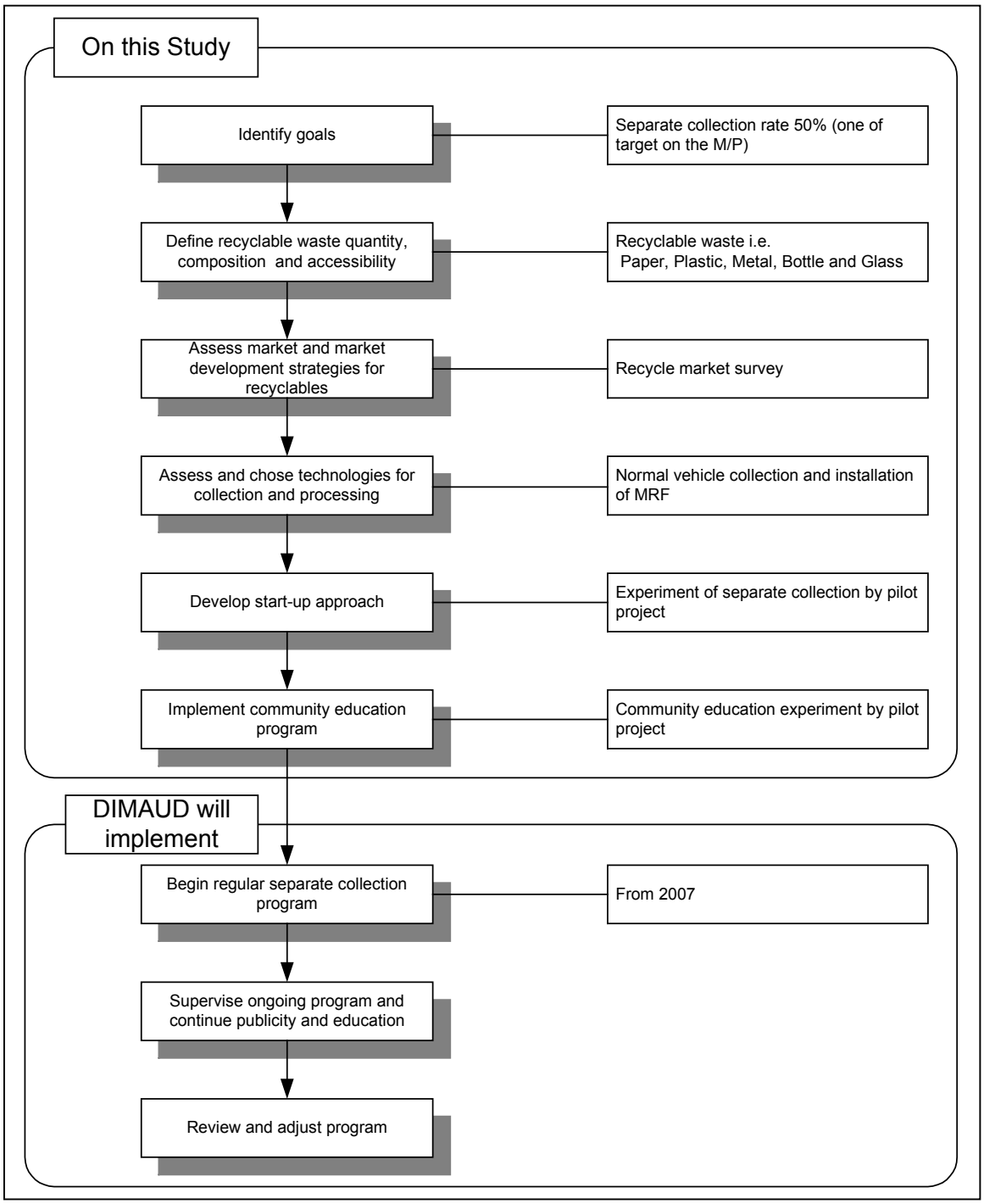

Figure 10-6 : Approach Sequence of Recycling Program

As shown above, basic matters and community education to establish an appropriate recycle system in Panama municipality will be initiated through this study, and then, DIMAUD will take over the recycle program based on the results of this study.

10.2.3 Technical System

a. Discharge and Storage System

In the M/P, separation into two waste types is proposed, i.e., recyclable and non-recyclable. Details are given below.

Table 10-9: Separate Collection Item

Category	Name of Waste
Recyclable	Paper
	Plastic
	Metal
	Bottle and glass
Non-recyclable	Kitchen waste
	Textile
	Grass and wood
	Rubber leather
	Soil and stone
	Others

According to this discharge classification, dischargers are requested only to keep recyclable materials in other containers, so that the plastic bags many dischargers are currently using as discharge containers can be directly used.

Therefore, dischargers can perform separate collection without preparing any special containers. However, the classified two wastes should be collected respectively. Storage time for some waste will become longer than the present mixed collection, e.g. the present every day collection becomes every other day collection of non-recyclable waste and every third day collection of recyclable waste. This will be a negative impact for dischargers. Therefore, dischargers' understanding and cooperation need be asked through community education.

b. Collection and Transport System

b.1. Improvement of Collection Efficiency and Street Sweeping

b.1.1 Collection Efficiency

The results of the pilot project of Collection Improvement tells that costs for collection works can be reduced by 21% with manners applied in the same pilot project. DIMAUD will expand this pilot project to other areas and improve collection efficiency with experiences obtained from the pilot project and the manual prepared by the Study Team.

b.1.2 Street Sweeping

Manual sweeping is applied to clean the streets at present. It is not efficient from a technical viewpoint. However, this manual sweeping is carried out as a kind of measures to counter

unemployment. Actually, the central government subsidizes about 2 million US dollars every year for this activity. Therefore, it is necessary to take into account this social issue, when efficiency of the street sweeping is discussed.

The Study Team has prepared a guideline based on diagnosis of the present street sweeping works in order to improve its efficiency. DIMAUD will follow the guideline.

Meanwhile, when job opportunities are increased with economic growth, labor forces will move to more economically efficient and effective activities, then it will be inevitable to introduce a mechanical sweeping system. DIMAUD, in the near feature, should prepare such situation.

b.2. Collection System

Collection system is planned on the assumption that the two types separate collection will be implemented in the year 2007. The following table shows separate collection amount.

Table 10-10: Separate Collection Amount

Unit: ton/day

Item \ Year		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Waste collection amount (ton/day)		964.9	994.9	1,028.9	1,065.3	1,107.9	1,141.9	1,170.0	1,200.7	1,231.2	1,264.0	1,297.3	1,333.1	1,369.2	1,408.4
Potential Recyclable waste amount		293.4	303.7	315.2	327.8	342.4	354.2	364.1	374.2	384.7	395.9	407.0	418.9	431.2	444.1
Separate collection amount	Overall	0.0	0.0	0.0	0.0	0.0	11.7	24.0	37.0	63.5	91.5	120.9	152.1	185.0	222.1
	DIMAUD	0.0	0.0	0.0	0.0	0.0	9.7	20.0	30.9	52.9	76.2	100.9	126.9	154.6	185.6

b.2.1 Required Number of Collection Vehicles

The ordinary compactors are to be used for recyclable waste collection. The number of collection vehicles will be determined based on loading capacity, compaction efficiency and the number of trips per day. The more number of vehicles will be needed to collect recyclable waste than collecting the same weight of mixed waste because of low bulk density and low compaction efficiency of the recyclable waste. In the M/P, the following parameters are used to estimate the number of collection vehicles.

Table 10-11: Assumption of Collection Vehicle Conditions

	Mixed collection or Non-recyclable waste	Recyclable waste
Type of vehicle	16 yd^3 Compactor truck	16 yd^3 Compactor truck
Loading volume (m^3)	12.24	12.24
Daily trip (nos./day)	2.5*	2.5*
Compaction ratio	3	2

notes : * average value of DIMAUD collection vehicle is 2.519 trip/day (Jan.2001 to July 2002 from Cerro Patacon weighing data)

b.2.2 Bulk Density

Considering the bulk density of waste, impurity rate and waste composition of other waste under separate collection, the bulk density of recyclable and non-recyclable waste is recalculated in the table below.

Table 10-12: Estimated Bulk Density

Unit: kg/liter

	Household			Commercial		Institutional	Market	Street Sweeping
	High income	Middle income	Low income	Restaurant	Others			
Recyclable waste	0.13	0.13	0.13	0.16	0.05	0.06	0.16	-
Other than recyclable waste	0.16	0.20	0.21	0.23	0.07	0.07	0.26	0.10
Whole waste	0.14	0.18	0.17	0.20	0.06	0.06	0.22	0.10

b.2.3 Future Waste Collection Amount and Volume

The following table shows estimation of DIMAUD's future waste collection amount and the waste collection amount of both recyclable and non-recyclable waste taking the impurity rate into account.

Table 10-13: Total DIMAUD Collection Amount

unit : ton/day

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Household	373.8	392.0	411.5	432.1	454.0	468.0	482.8	498.7	515.5	533.4	552.7	573.1	595.0	618.2
Restaurant	79.0	81.0	83.3	86.0	89.5	93.0	95.3	97.7	100.0	102.4	104.7	107.1	109.4	111.7
Other than restaurant	85.9	88.0	90.6	93.5	97.3	101.1	103.6	106.2	108.8	111.3	113.8	116.4	118.9	121.5
Institutional waste	21.8	22.4	23.0	23.8	24.7	25.7	26.3	27.0	27.6	28.2	28.9	29.6	30.2	30.8
Industrial waste	107.6	110.2	113.5	117.2	122.1	126.9	130.1	133.4	136.6	139.8	143.0	146.3	149.5	152.8
Market	23.4	23.4	23.4	23.4	23.4	23.4	23.4	23.4	23.4	23.4	23.4	23.4	23.4	23.4
Street sweeping	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4
Sub-total	**699.9**	**725.4**	**753.7**	**784.4**	**819.4**	**846.5**	**869.9**	**894.8**	**920.3**	**946.9**	**974.9**	**1,004.3**	**1,034.8**	**1,066.8**
Hospital (inc. common waste)	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1
Bulky waste	9.5	9.9	10.9	11.1	12.2	13.3	13.6	14.9	15.3	16.6	17.3	18.8	19.4	21.2
Chatarra (large bulky)	0.7	0.7	0.8	0.8	0.9	1.0	1.0	1.1	1.1	1.2	1.3	1.4	1.4	1.6
Despojos (small bulky)	8.8	9.2	10.1	10.3	11.3	12.3	12.6	13.8	14.2	15.4	16.0	17.4	18.0	19.6
Caliche (demolition waste)	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Sub-total	**30.7**	**31.1**	**32.1**	**32.3**	**33.4**	**34.5**	**34.8**	**36.1**	**36.5**	**37.8**	**38.5**	**40.0**	**40.6**	**42.4**
Total	**730.6**	**756.5**	**785.8**	**816.7**	**852.8**	**881.0**	**904.7**	**930.9**	**956.8**	**984.7**	**1,013.4**	**1,044.3**	**1,075.4**	**1,109.2**

Table 10-14:DIMAUD Recyclable Waste Collection Amount

unit : ton/day

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Household	0.0	0.0	0.0	0.0	0.0	5.4	11.2	17.4	29.9	43.3	57.7	73.0	89.7	108.4
Restaurant	0.0	0.0	0.0	0.0	0.0	1.1	2.2	3.4	5.8	8.3	10.9	13.7	16.5	19.7
Other than restaurant	0.0	0.0	0.0	0.0	0.0	1.2	2.4	3.7	6.3	9.1	11.9	14.8	17.9	21.3
Institutional waste	0.0	0.0	0.0	0.0	0.0	0.3	0.6	0.9	1.6	2.3	3.0	3.8	4.5	5.4
Industrial waste	0.0	0.0	0.0	0.0	0.0	1.5	3.0	4.6	7.9	11.4	14.9	18.7	22.6	26.7
Market	0.0	0.0	0.0	0.0	0.0	0.3	0.5	0.8	1.4	1.9	2.4	2.9	3.6	4.1
Street sweeping	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sub-total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**9.8**	**19.9**	**30.8**	**52.9**	**76.3**	**100.8**	**126.9**	**154.8**	**185.6**
Hospital (inc. common waste)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bulky waste	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chatarra (large bulky)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Despojos (small bulky)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Caliche (demolition waste)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sub-total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**9.8**	**19.9**	**30.8**	**52.9**	**76.3**	**100.8**	**126.9**	**154.8**	**185.6**

Table 10-15: DIMAUD Non-Recyclable and Mixed Waste Collection Amount

unit : ton/day

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Household	373.8	392.0	411.5	432.1	454.0	462.6	471.6	481.3	485.6	490.1	495.0	500.1	505.3	509.8
Restaurant	79.0	81.0	83.3	86.0	89.5	91.9	93.1	94.3	94.2	94.1	93.8	93.4	92.9	92.0
Other than restaurant	85.9	88.0	90.6	93.5	97.3	99.9	101.2	102.5	102.5	102.2	101.9	101.6	101.0	100.2
Institutional waste	21.8	22.4	23.0	23.8	24.7	25.4	25.7	26.1	26.0	25.9	25.9	25.8	25.7	25.4
Industrial waste	107.6	110.2	113.5	117.2	122.1	125.4	127.1	128.8	128.7	128.4	128.1	127.6	126.9	126.1
Market	23.4	23.4	23.4	23.4	23.4	23.1	22.9	22.6	22.0	21.5	21.0	20.5	19.8	19.3
Street sweeping	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4
Sub-total	**699.9**	**725.4**	**753.7**	**784.4**	**819.4**	**836.7**	**850.0**	**864.0**	**867.4**	**870.6**	**874.1**	**877.4**	**880.0**	**881.2**
Hospital (inc. common waste)	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1
Bulky waste	9.5	9.9	10.9	11.1	12.2	13.3	13.6	14.9	15.3	16.6	17.3	18.8	19.4	21.2
Chatarra (large bulky)	0.7	0.7	0.8	0.8	0.9	1.0	1.0	1.1	1.1	1.2	1.3	1.4	1.4	1.6
Despojos (small bulky)	8.8	9.2	10.1	10.3	11.3	12.3	12.6	13.8	14.2	15.4	16.0	17.4	18.0	19.6
Caliche (demolition waste)	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Sub-total	**30.7**	**31.1**	**32.1**	**32.3**	**33.4**	**34.5**	**34.8**	**36.1**	**36.5**	**37.8**	**38.5**	**40.0**	**40.6**	**42.4**
Total	**730.6**	**756.5**	**785.8**	**816.7**	**852.8**	**871.2**	**884.8**	**900.1**	**903.9**	**908.4**	**912.6**	**917.4**	**920.6**	**923.6**

b.2.4 Required Number of Collection Vehicles

Based on the aforementioned results and the results of future waste amount estimation, initial volume of separated waste will be calculated, and then, using the parameters for collection vehicles, the number of collection vehicles required in future will be estimated in the table below.

Table 10-16: Required Number of Vehicles

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Separate collection case (m^3/day)														
Recyclable waste	0.0	0.0	0.0	0.0	0.0	42.0	82.3	127.6	219.3	316.1	415.3	522.0	635.6	757.7
Non-recyclable	0.0	0.0	0.0	0.0	0.0	50.2	98.4	152.8	262.5	378.6	497.6	625.6	761.9	909.1
Other than separate collection	5,991.1	6,187.8	6,410.5	6,655.5	6,944.9	7,102.0	7,212.3	7,323.7	7,342.3	7,356.6	7,374.1	7,386.2	7,388.3	7,381.9
Total	**5,991.1**	**6,187.8**	**6,410.5**	**6,655.5**	**6,944.9**	**7,194.2**	**7,393.0**	**7,604.1**	**7,824.1**	**8,051.3**	**8,287.0**	**8,533.8**	**8,785.8**	**9,048.7**
Non-separate collection case (m^3/day)														
Non-separate collection case	**5,991.1**	**6,187.8**	**6,410.5**	**6,655.5**	**6,944.9**	**7,187.4**	**7,379.9**	**7,583.8**	**7,789.3**	**8,001.3**	**8,221.5**	**8,452.0**	**8,686.5**	**8,931.1**
Number of vehicles (nos.)														
Separate collection case														
Recyclable waste	0	0	0	0	0	1	2	3	4	6	7	9	11	13
Non-recyclable	0	0	0	0	0	1	2	2	3	5	6	7	9	10
Without separate collection	65	67	70	72	76	77	78	80	80	80	80	80	80	80
Total	65	67	70	72	76	79	82	85	87	91	93	96	100	103
Non-separate collection case														
Non-separate collection case	65	67	70	72	76	78	80	82	85	87	89	92	94	97
Difference	0	0	0	0	0	1	2	3	2	4	4	4	6	6

b.3. Transfer and Transport System

Necessity of introduction of transfer and transport system was examined, which is presented in detail in the section of Feasibility Study. Results of the examination say that it is recommendable to introduce the transfer and transport system in the East (Tocumen, Pacora and San Martin), however, it is not recommendable for the North (Chilibre). In this section, a recommended transfer and transport system for the East is presented.

b.3.1 Waste Handling Amount

Table 10-17 shows waste collection amount forecast. Table 10-18 presents required capacity of a transfer station with taking into account number of operation days, 300 days per year.

Table 10-17: Forecast of Waste Collection Amount in the East

Year		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Population	Pacora	79,175	86,108	93,648	101,848	110,766	120,465	131,014	142,486	154,963	168,532	183,290	199,339	216,795
	San Martín	3,990	4,139	4,293	4,453	4,619	4,792	4,970	5,156	5,348	5,547	5,754	5,969	6,191
	Tocumen	98,708	104,501	110,633	117,126	123,999	131,276	138,980	147,136	155,770	164,911	174,589	184,834	195,681
	Total	181,873	194,748	208,574	223,427	239,384	256,533	274,964	294,778	316,081	338,990	363,633	390,142	418,667
Waste Amount (ton/day)		205.2	221.8	240.3	261.0	280.6	299.4	319.5	340.5	362.9	386.8	411.6	438.1	466.0

Table 10-18: Required Capacity of Transfer Station in the East

Unit: ton/day

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Required capacity	250	270	300	320	350	370	390	420	450	480	510	540	570

b.3.2 Outline of the System

Table 10-19 shows outline of the recommended transfer and transport system.

Table 10-19: Outline of the Transfer and Transport System

Item	Specification
Transfer station	Type: Direct dump station Capacity: 600 ton/day in total First phase; 300 ton/day Second phase; 300 ton/day
Transport equipment	Tractor: 300-350 Hp Trailer: payload 20 ton, 65 m^3 (85 yd^3) with hydraulic ejector blade
Collection equipment	Compactor: 12.2 m^3 (16 yd^3) compactor truck

b.3.3 Execution Scheme

Through consultation with the counterpart, construction of the first part of the transfer station is set in year 2004. Then, operation is planed to begin in year 2005. As for the remaining part,

it is supposed that construction would be carried out in year 2007 and operation would start in year 2008. The schedule is schematized in Table 10-20.

Table 10-20: Execution Scheme

Item	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Design and supervision	⟷	⟷			⟷								
Phase I Construction		⟷											
Operation			⟷	⟷	⟷	⟷	⟷	⟷	⟷	⟷	⟷	⟷	⟷
Phase II Construction					⟷								
Operation						⟷	⟷	⟷	⟷	⟷	⟷	⟷	⟷

c. Intermediate Treatment System

c.1. Material Recovery Facility (MRF)

c.1.1 Required Capacity

Material Recovery Facility (MRF) is planned to be installed as an intermediate treatment facility. The facility shall be constructed within the Cerro Patacon Final Disposal Site because it is economical to locate facilities adjacently. The following table shows planned input amount of recyclable waste and required capacity of the MRF in each year.

Table 10-21 : MRF Input Amount

unit : ton/day

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Potential amount	293.4	303.8	315.2	327.8	342.4	354.2	364.1	374.2	384.7	395.9	407.1	418.9	431.2	444.0
Recyclable waste collection amount	0.0	0.0	0.0	0.0	0.0	11.7	24.0	37.0	63.5	91.5	120.9	152.1	185.0	222.0
DIMAUD collection amount (ton/day)	0.0	0.0	0.0	0.0	0.0	9.7	20.0	30.9	52.9	76.2	100.9	126.9	154.6	185.6
MRF Installation plan						25		40		60		60		37
MRF total capacity						25	25	65	65	125	125	185	185	222

c.1.2 Treatment System

Since recovered materials are paper, metals, aluminum, plastics and bottles, manual sorting line will be the principal equipment in the facility. In addition, materials collected in plastic bags will be taken out manually before the sorting process. A flow sheet of the treatment system is shown below.

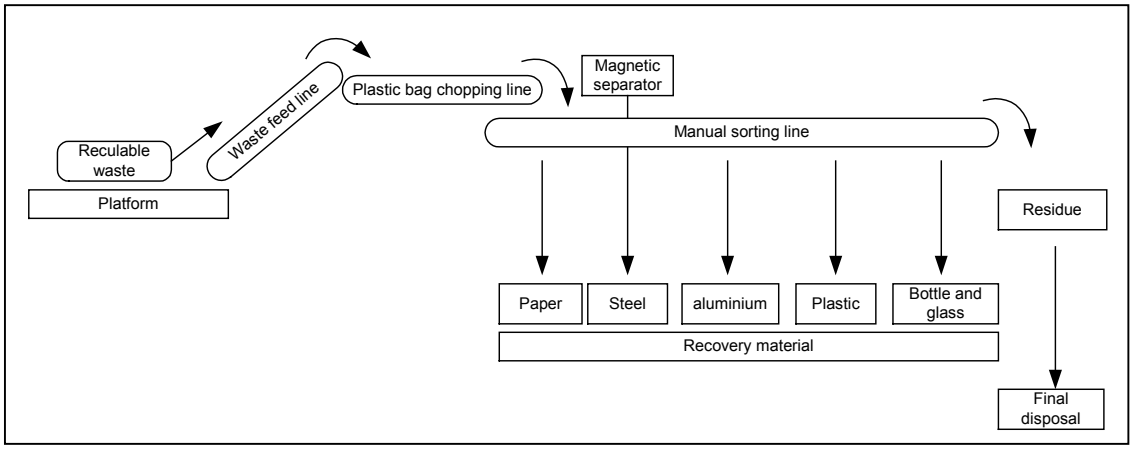

Figure 10-7 : MRF System Flow Sheet

c.1.3 Recovery Amount

Based on the flow sheet above, impurity rate and recovery ratio of each waste item brought to the MRF are shown below.

Table 10-22: Impurity rate and MRF Recovery Ratio

	Impurity rate of MRF input	MRF recovery ratio
Kitchen Waste	20%	0%
Paper	50%	60%
Textile	20%	0%
Grass, Wood	20%	0%
Plastic	50%	60%
Rubber, Leather	50%	0%
Metal	50%	60%
Bottles, Glass	50%	60%
Soil, Stone	50%	0%
Others	50%	0%

Based on the values shown above and the MRF input amount, material recovery amount is estimated in the following table.

Table 10-23:MRF Recovery Amount

unit : ton/day

	2007	2008	2009	2010	2011	2012	2013	2014	2015
Kitchen Waste	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Paper	2.8	5.8	8.8	15.2	21.7	28.8	36.2	44.0	52.6
Textile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Grass Wood	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Plastic	1.2	2.5	3.9	6.6	9.4	12.5	15.8	19.2	23.0
Rubber Lather	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Metal	0.4	0.8	1.3	2.1	3.1	4.0	5.1	6.2	7.4
Bottles Glass	0.6	1.2	2.0	3.3	4.6	6.2	7.7	9.5	11.3
Soil Stone	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	5.0	10.3	16.0	27.2	38.8	51.5	64.8	78.9	94.3

d. Final Disposal System

Figure 10-8 shows the layout of the Cerro Patacon Final Disposal Site. Etapa 1 and Etapa 2 are the existing landfills. It is estimated that those will be full by 2005. The existing landfills have imperfections in view of sanitary landfill. Furthermore, there is no concrete plan to ensure final disposal of waste after 2005. Therefore, this M/P provides plans, i) Improvement of existing landfills and ii) New Landfill Development.

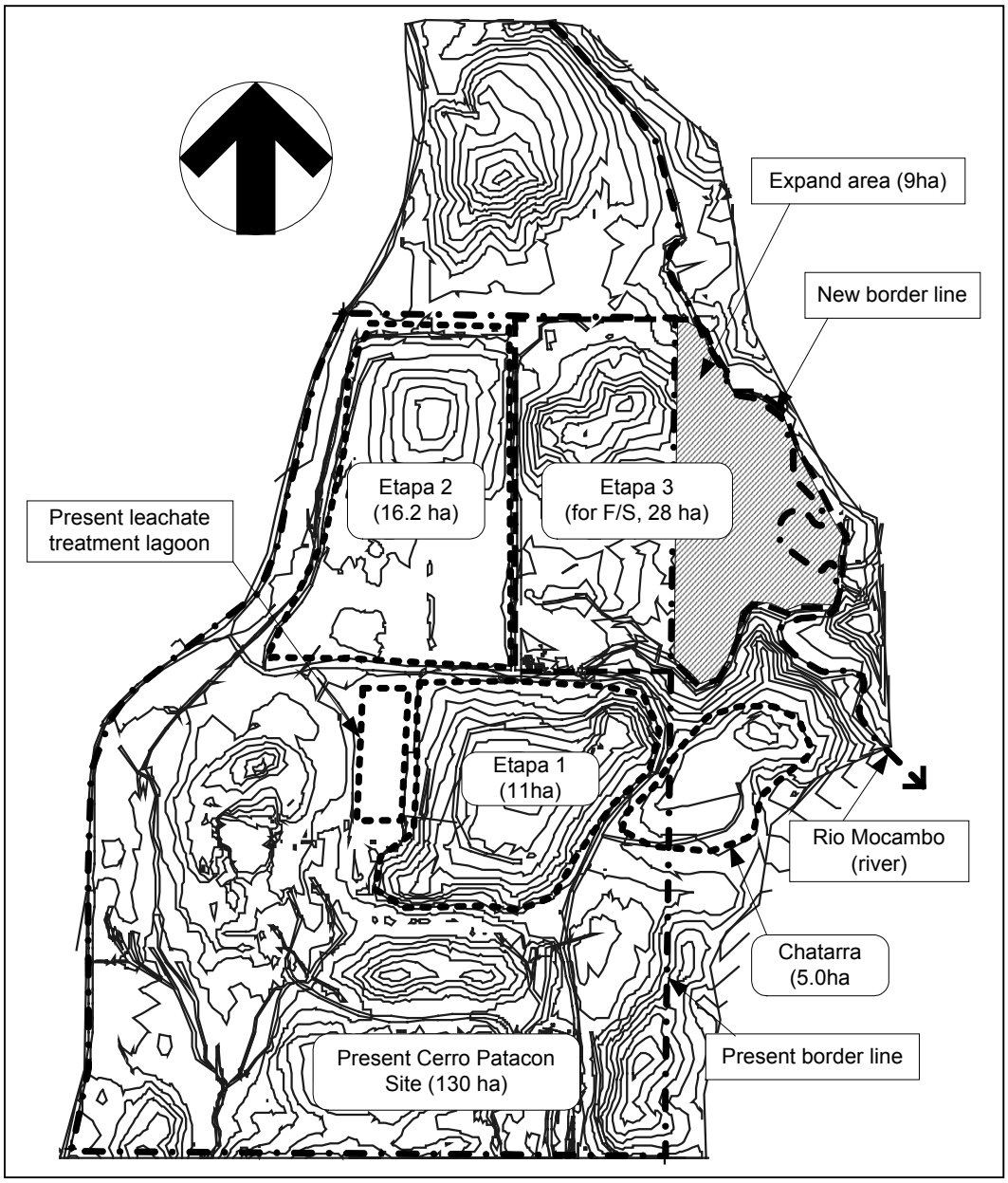

Figure 10-8: Cerro Patacon Landfill Site

d.1. Improvement of Existing Landfills

Etapa 1 and Etapa 2 have been used alternately. It is planed that Etapa 1 will be full and closed by the beginning of 2003. Then, Etapa 2 is estimated to operate by 2005 with development of Phase 4 of Etapa 2. Besides, there is another landfill called as *Chatara* where mainly bulky waste is disposed of.

These existing landfills have following problems.

- Daily soil cover is not strictly implemented.
- Leachate collection and treatment systems are functioning insufficiently.

Etapa 1 is to be closed in a few months. Preparation of a plan how to close it properly is an urgent need. Therefore, the M/P provides a plan to meet with the need. Proposed closure manner of Etapa 1 is presented in Figure 10-9.

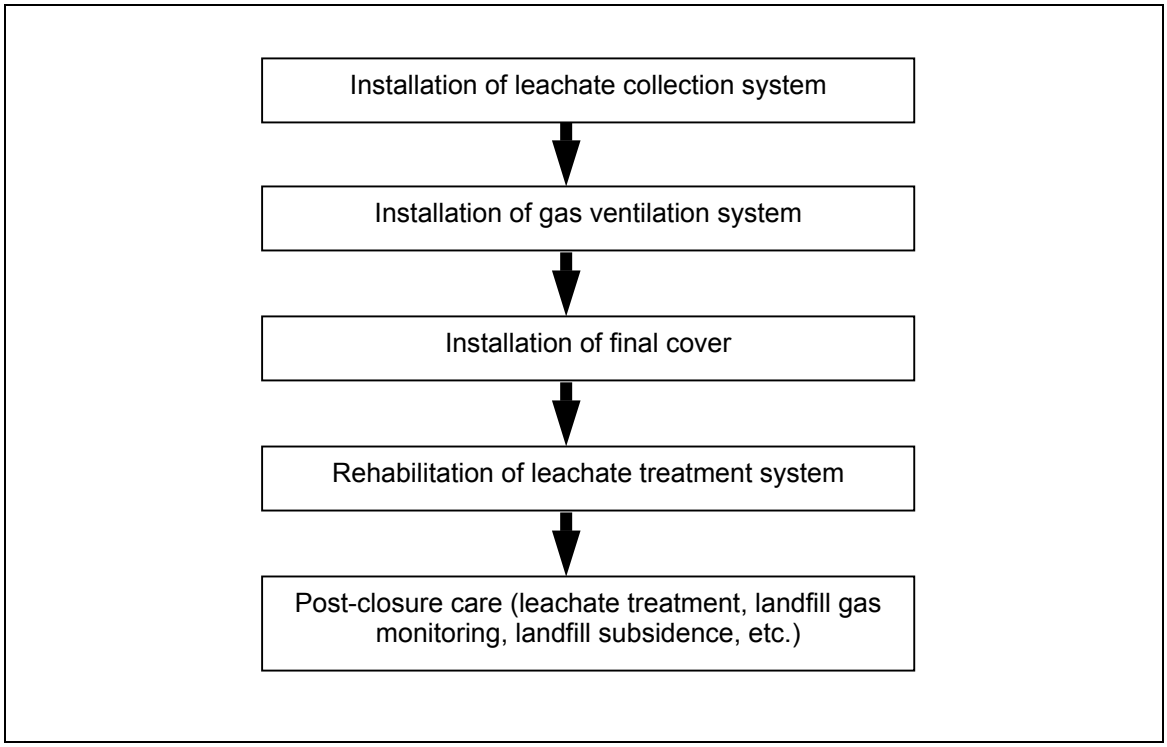

Figure 10-9: Closure Procedure of the Existing Landfill

d.1.1 Closure Design of the Existing Landfills

Figure 10-10 and Figure 10-11 shows closure design; leachate collection system, landfill gas ventilation system and final cover. Etapa 1 and Etapa 2 will employ this closure design.

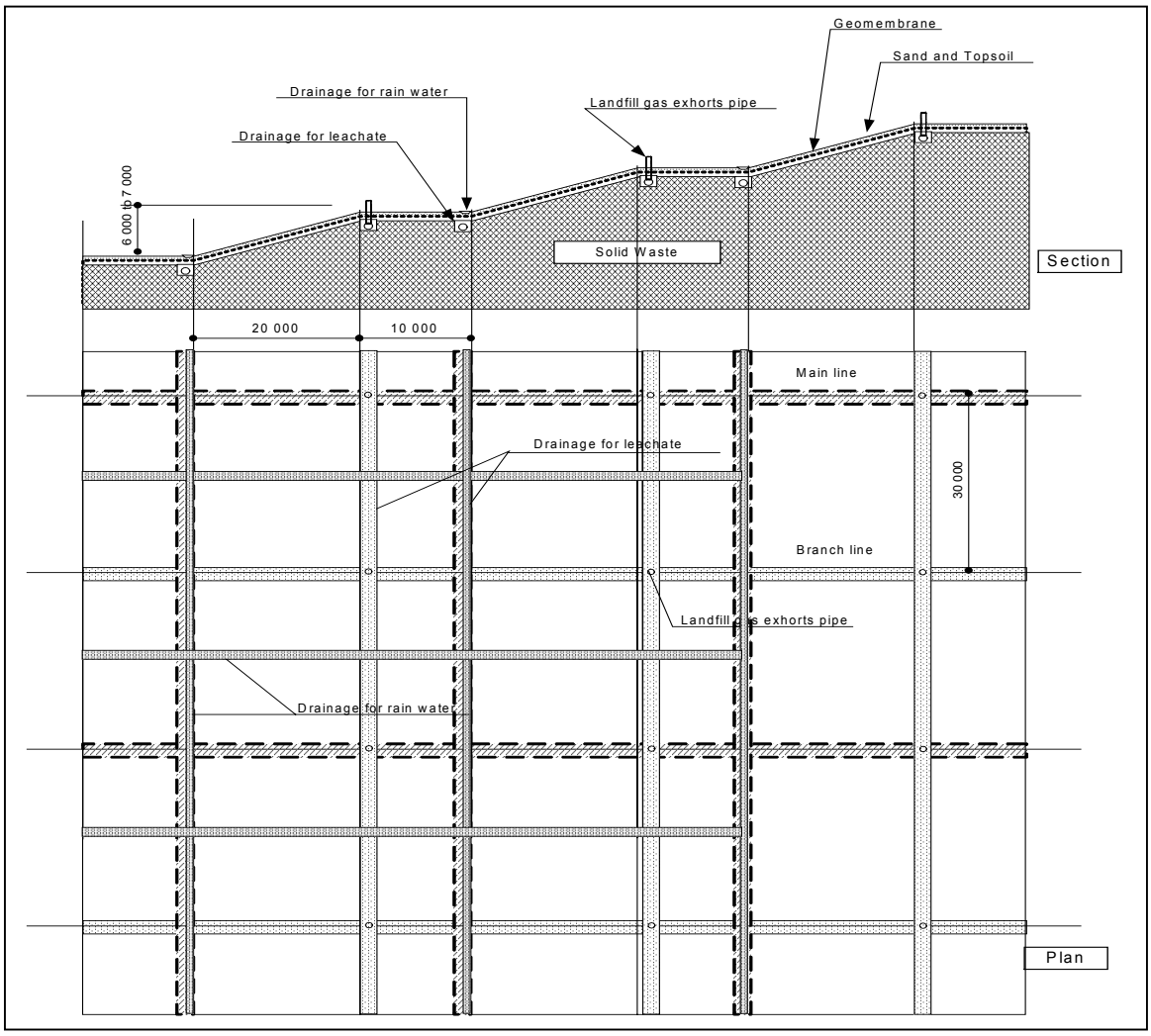

Figure 10-10: Closure Design of the Existing Landfill (1)

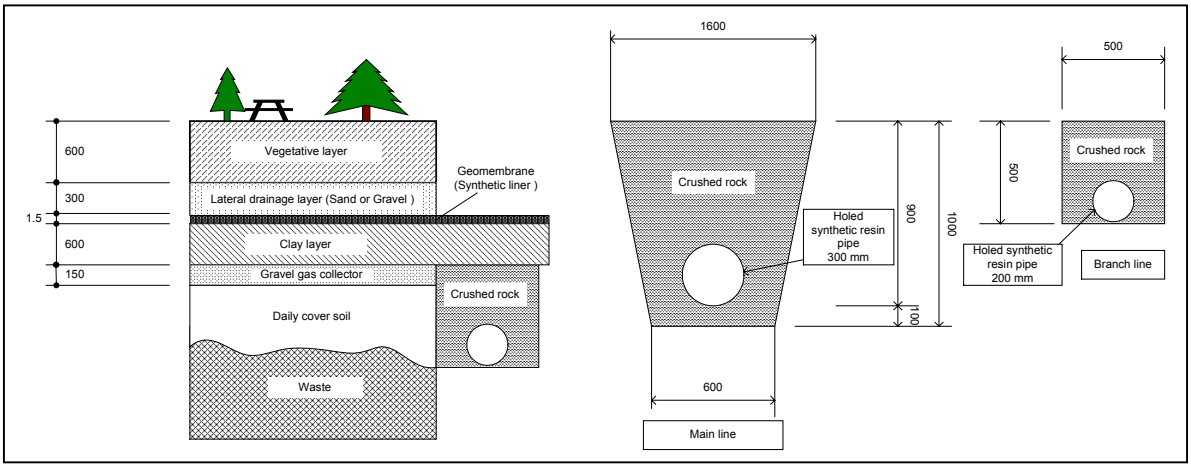

Figure 10-11: Closure Design of the Existing Landfill

d.1.2 Leachate Treatment System

- **Outline of the Present Facility**

Figure 10-12 shows layout of the existing landfill facilities, or Etapa 1, Etapa 2, *Chatara* and Lagoon.

The lagoon was constructed for treating leachate generated from Etapa 1. However, leachate did not inflow into the lagoon, then, it was not functioning well according to plan (See Table 10-24) as of September 2002.

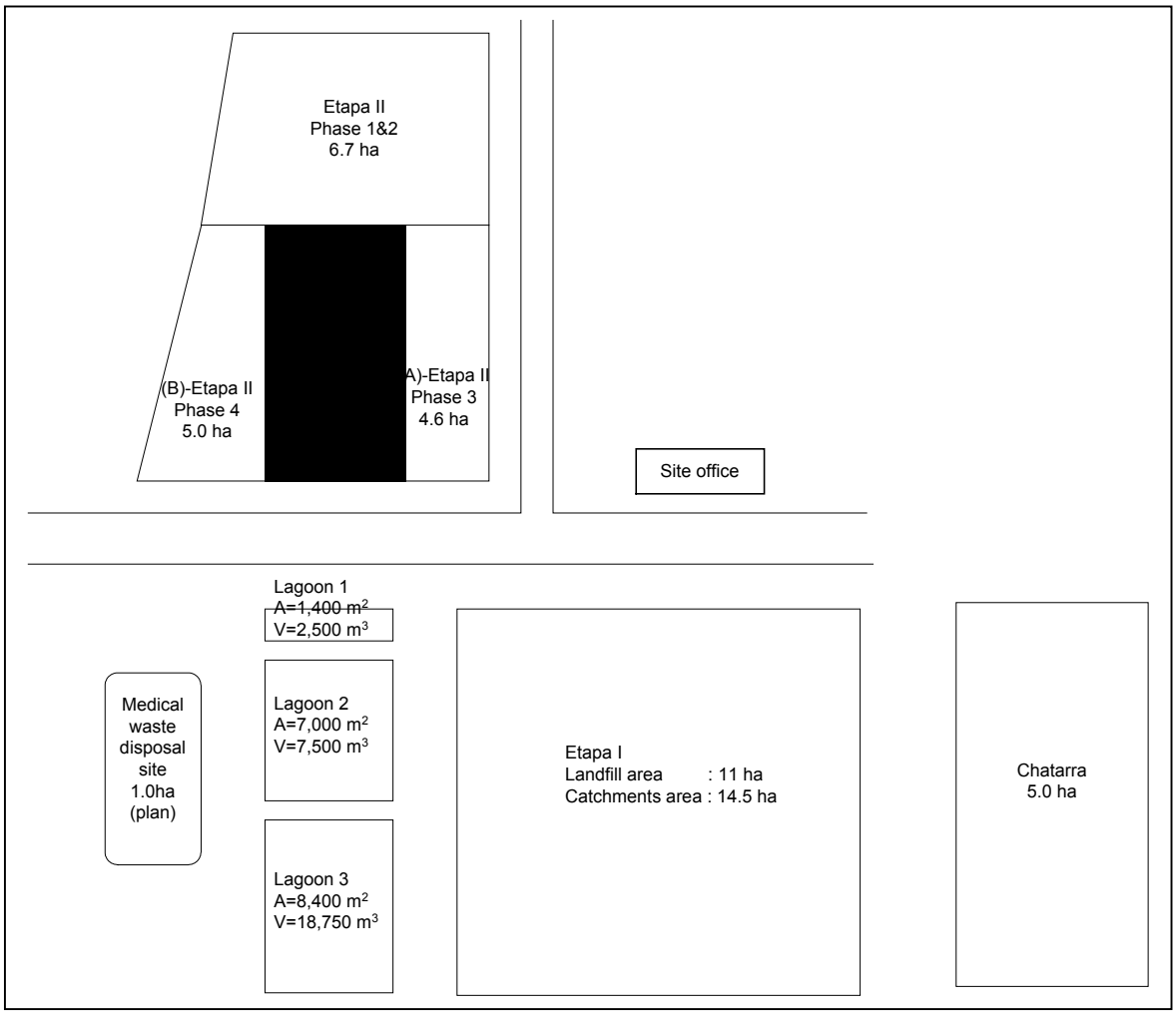

Figure 10-12: Layout of the Existing Landfill Facilities

Table 10-24: Original Design Parameter of Leachate Treatment Lagoon

Item	Specifications	Remarks
Type of lagoon	Anaerobic and aerobic	Three step lagoon (3+2+1)
Treatment capacity	40.9 m^3/day	7.5 gallon/minuets
Influent BOD concentration	7,500 mg/liter	
Effluent BOD concentration	22.5 to 90 mg/liter	
Flow pattern	Plug flow	No.3 > No.2 > No.1
Specification of the lagoon system		
Lagoon No. 3		
Effective surface area	8,400 m^2	
Volume	18,750 m^3	
Effective depth	2.5 m	
BOD surface load	200 to 500 kg/ha/day	
BOD removal rate	50 to 85 %	
Influent BOD concentration	7,500 mg/liter	
Effluent BOD concentration	3,000 mg/liter	
Lagoon No.2		
Effective surface area	7,000 m^2	
Volume	7,500m^3	
Effective depth	2.5 m	
BOD surface load	50 to 200 kg/ha/day	
BOD removal rate	80 to 95 %	
Influent BOD concentration	3,000 mg/liter	
Effluent BOD concentration	450 mg/liter	
Lagoon No.1		
Effective surface area	1,400 m^2	
Volume	2,500 m^3	
Effective depth	2.5 m	
BOD surface load	50 to 200 kg/ha/day	
BOD removal rate	80 to 95 %	
Influent BOD concentration	450 mg/liter	
Effluent BOD concentration	22.5 to 90 mg/liter	

source : Technical drawings of UNIVERSIDAD TECNOLOGICA DE PANAMA1992

- **Leachate Amount and Required Treatment Amount**

Based on meteorological data at Balboa Station (rainfall data for the last 10 years and sunshine hour data between 1908 and 1965), water balance calculation was carried out subjecting Etapa 1 and Etapa 2. Consequently, the results say that required capacity becomes the largest at the stage where landfill operation is carried out at Phase 4 in Etapa 2 as shown in Table 10-25.

Table 10-25: Required Capacity of Leachate Treatment Facility for the Existing Landfills

	Area (ha)	Operation area (ha)	Closed area (ha)	Leachate treatment amount (ton/day)	Required regulation pond volume (m^3)
Chatarra	5.0	-	26.2	-	-
Etapa I	14.5				
Etapa II phase 1,2	6.7				
Etapa II phase 3	4.6 (+0.5)*	5.1	30.8	1,000	16,888
Etapa II phase 4	**5.0 (+0.5)***	**5.5**	**35.8**	**1,200**	**17,626**
Etapa II phase 5	5.5	5.5	31.7	1,000	18,711
Medical waste landfill	1.0	-	-	-	-
Whole closed	37.8	0	37.8	500	18,448

*: added medical waste landfill area

- **Leachate Quality**

In designing a leachate treatment facility, it is indispensable to understand leachate quality to be treated. Such data had not existed, then a water quality survey was conducted in the Cerro Patacon Final Disposal Site in January 2002.

According to the result, it is inferred that the present leachate quality is 800 mg/l at BOD and 1,000 mg/l at COD. As the survey was conducted in a dry season, it is conjectured that those concentration will be lower in rain season.

- **Leachate Treatment System**

ANAM has set standards on effluent to pubic water bodies as show in Table 10-26. The planed effluent quality from the lagoon is between 22.5 and 90 mg/l at BOD level which does not meet with the ANAM's standards, as the lagoon was planned and constructed before the standards was in effect.

The effluent standards also regulate harmful substances such as heavy metals. In order to meet with the effluent standards, physical and chemical treatments will be necessary in addition to the lagoon system.

Several alternatives have been analyzed under this Study. The results of the analysis are summarized in Table 10-27. Consequently, it was turned out that only Case 4 might meet with the standards.

Table 10-26 : Discharge Limit to Water Bodies

Item	unit	maximum limit
Biochemical oxygen demand (BOD)	mg/l	35
Chemical oxygen demand (COD)	mg/l	100
Suspended solid (SS)	mg/l	35
Total coliforms	NMP/100ml	1,000

source : Resolution No. 49 of February 2, 2000. For the control of liquid effluents from domestic, commercial and industrial activities to water bodies

Table 10-27: Relation Between Treatment Process and Treated Water Quality

	Treatment process	Treated water quality
Case 0	Only present system	unknown
Case 1	Present lagoon system plus disinfection	unknown
Case 2	Case 1 plus aerator	unknown (may be organic matters are adjust ANAM STD)
Case 3	Case 2 plus chemical treatment	some time exceed ANAM STD
Case 4	Case 3 plus sand filter and activated carbon absorption	may be adjust to ANAM STD

ANMA STD : TABLA 3-1, Normas para Aguas Residuales, ANAM-PAN-BID

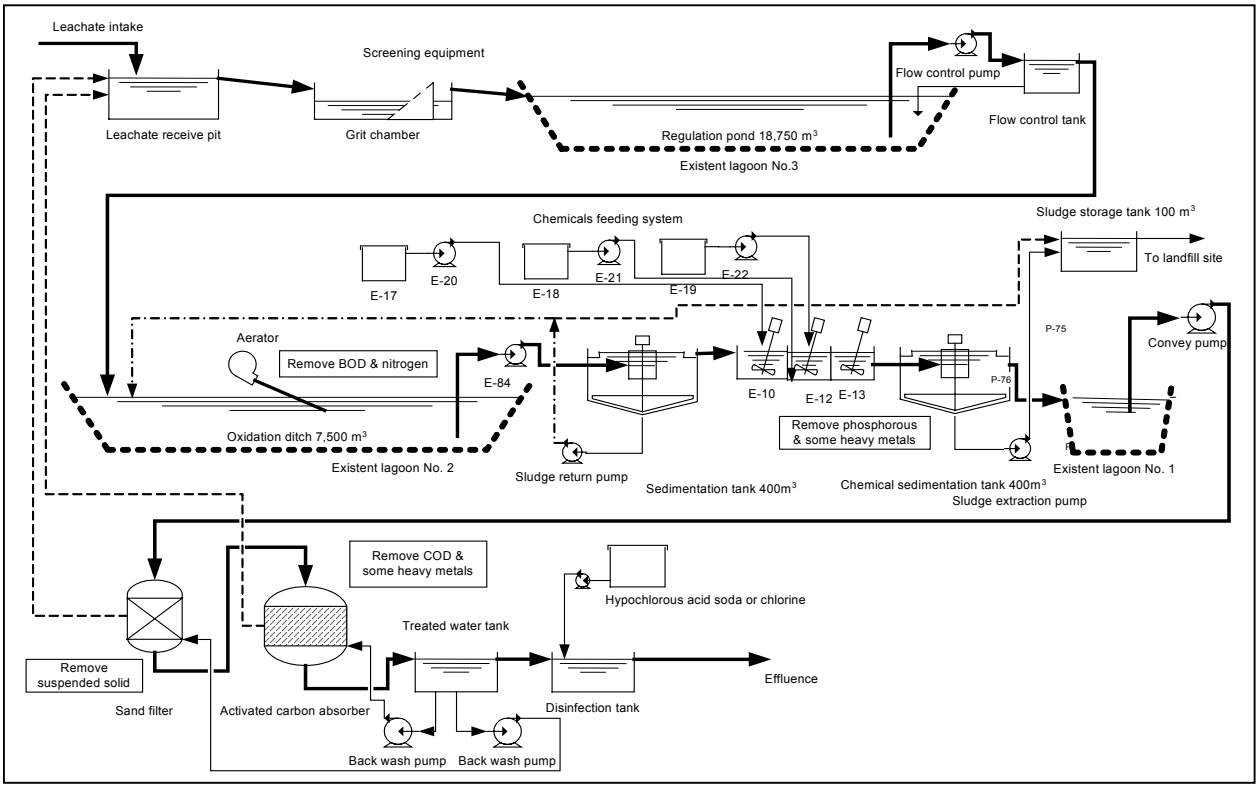

Figure 10-13: Case 4

d.2. New Landfill Development

d.2.1 Disposal Amount

The following table shows estimated waste final disposal amount by the year 2015.

Table 10-28: Prospect of Annual Waste Disposal Amount

unit : ton/year

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Panama	352,189	363,139	375,549	388,835	404,384	414,969	423,291	432,416	439,460	447,198	454,717	462,930	470,960	479,647
San Miguelito	79,059	82,636	86,615	91,250	96,835	102,602	107,164	111,909	116,910	121,910	127,057	132,495	137,970	143,628
Arraijan	10,001	11,206	12,556	14,235	16,206	18,396	20,550	23,068	25,733	28,835	32,157	35,989	40,260	44,822
Total	441,249	456,981	474,720	494,320	517,425	535,967	551,005	567,393	582,103	597,943	613,931	631,414	649,190	668,097

Based on the values shown above, supposing;

- unit weight of waste in the landfill is 1.1 ton/m^3 and
- required cover soil is 20% of dumped waste,

the final disposal amount accumulated from January 2002 to December 2015 is shown in the following table.

Table 10-29: Prospect of Annual Landfill Volume

unit : m^3/year

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Panama	320,172	330,126	341,408	353,486	367,622	377,245	384,810	393,105	399,509	406,544	413,379	420,845	428,145	436,043
San Miguelito	71,872	75,124	78,741	82,955	88,032	93,275	97,422	101,735	106,282	110,827	115,506	120,450	125,427	130,571
Arraijan	9,092	10,187	11,415	12,941	14,733	16,724	18,682	20,971	23,394	26,214	29,234	32,717	36,600	40,747
Cover soil	80,227	83,087	86,313	89,876	94,077	97,449	100,183	103,162	105,837	108,717	111,624	114,802	118,034	121,472
Total	481,363	498,524	517,877	539,258	564,464	584,693	601,097	618,973	635,022	652,302	669,743	688,814	708,206	728,833

Table 10-30: Accumulated Landfill Volume

unit : m^3

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Panama	330,126	671,534	1,025,020	1,392,642	1,769,887	2,154,697	2,547,802	2,947,311	3,353,855	3,767,234	4,188,079	4,616,224	5,052,267
San Miguelito	75,124	153,865	236,820	324,852	418,127	515,549	617,284	723,566	834,393	949,899	1,070,349	1,195,776	1,326,347
Arraijan	10,187	21,602	34,543	49,276	66,000	84,682	105,653	129,047	155,261	184,495	217,212	253,812	294,559
Waste total	415,437	847,001	1,296,383	1,766,770	2,254,014	2,754,928	3,270,739	3,799,924	4,343,509	4,901,628	5,475,640	6,065,812	6,673,173
Cover soil	83,087	169,400	259,276	353,353	450,802	550,985	654,147	759,984	868,701	980,325	1,095,127	1,213,161	1,334,633
Total	498,524	1,016,401	1,555,659	2,120,123	2,704,816	3,305,913	3,924,886	4,559,908	5,212,210	5,881,953	6,570,767	7,278,973	8,007,806

Since remaining capacity of the present Cerro Patacon Etapa II Final Disposal Site is expected about 1,800,000m^3 by the end of 2002, a new landfill will have to start its operation from the year 2006.