on collection time and collection amount of one cycle time.

db. Cost of Park and Green area Cleansing

According to the above mentioned method, the unit cost of public area cleansing service for each alternative was calculated and tabulated in Table H.5.2s.

Table H.5.2s Public Area Cleansing Cost

	Unit	A-1	A-2	A-3	A-4	A-5
Cleansing Services Cost	C$/ton	2927.28	2927.28	2927.28	2927.28	2927.28
	mill.C$	5.34	5.34	5.34	5.34	5.34
Collection & Haulage Cost	C$/ton	173.37	223.40	213.14	176.56	216.69
	mill.C$	0.32	0.41	0.39	0.33	0.40
Total Public Area Cleansing Cost	C$/ton	3100.65	3150.68	3140.42	3103.85	3143.97
	mill.C$	5.66	5.75	5.73	5.67	5.74

H.5.2.6 Sanitary Landfill

a. Introduction

A sanitary landfill is generally the basic element for modern solid waste management in acknowledgement of the fact that in spite of efforts to reuse (recycle) or utilize (incineration, composting) waste, there is still a considerable quantity to be disposed of. A sanitary landfill is, therefore, included in all the alternative plans.

The enforcement of landfill activities should be taken, therefore, as a first step towards modern solid waste management, while keeping in mind that its environmental impact must be minimized. Once the requirements for the sanitary landfill are clarified and the proper design and operation implemented, other treatment methods can then be considered.

This section presents the basic layout and cost estimate of a landfill in accordance with the concept of the alternative plans.

The location of the proposed landfill sites for each alternative plan are shown in Figure H.5.2c.

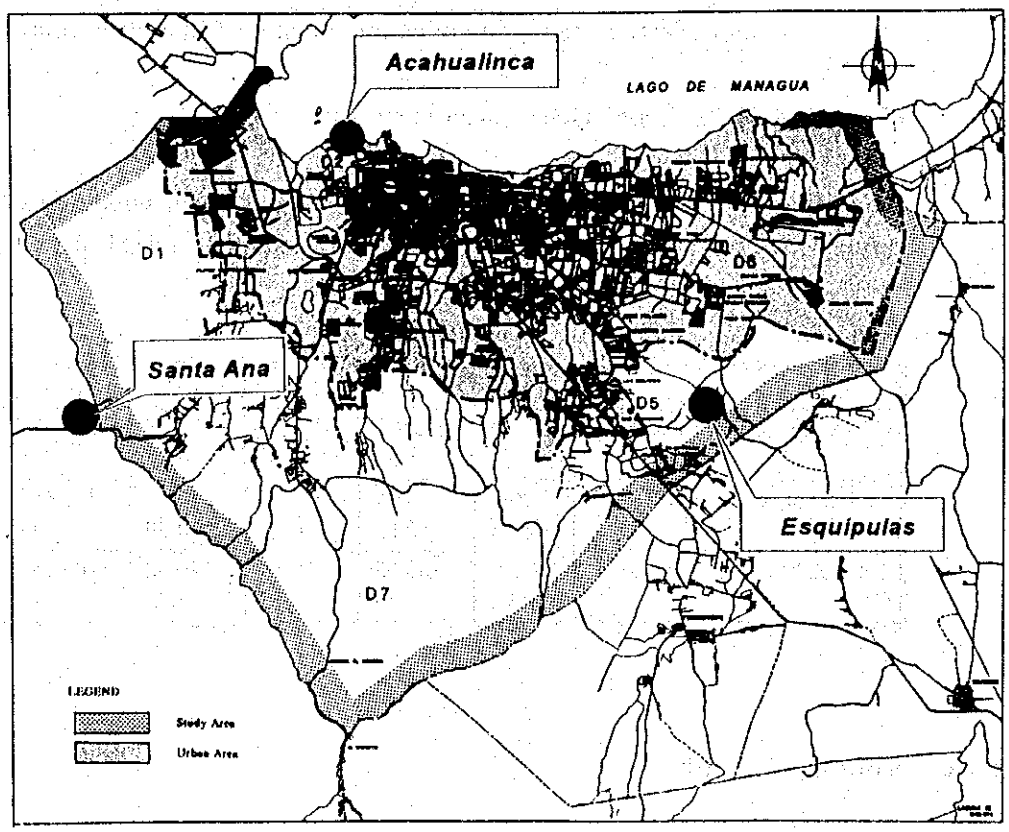


Figure H.5.2c Locations of the Landfill Sites of Each Alternative Plan

Table H.5.2t shows the disposal sites (alternatives) requiring cost estimates. The final disposal costs for Alternatives A-2 and A-3 are the same because their estimates only differ in transportation cost.

Table H.5.2t Disposal Sites Requiring Cost Estimates

No.	Name of Disposal Site	Total Capacity (ton in 2010)	Cost Estimate
A-1	Acahualinca	715,000	Necessary
A-2	Santa Ana (without T/S)	715,000	Necessary
A-3	Santa Ana (with T/S)	715,000	Same cost as case A-2.
A-4	Esquipulas	715,000	Necessary
A-5	a. Santa Ana	286,000	Necessary
	b. Esquipulas	429,000	Necessary

b. Method of Cost Estimation

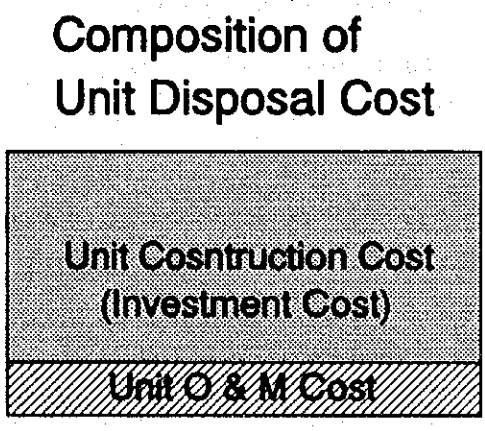
ba. Assumptions for the Cost Estimation

This cost estimation does not include the following:

- interest rate for the purchase of equipment, materials, etc.
- land acquisition price

bb. Procedure of Cost Estimate

Cost estimate is carried out to determine the unit disposal cost of each alternative. A unit disposal cost generally consists of a unit investment cost and unit O & M cost.



The concepts for each cost estimate are given in Table H.5.2u.

Table H.5.2u Concept of Cost Estimation

Facility	Unit Investment Cost (C$/ton)	Unit O & M Cost (C$/ton)
Final Disposal Site	$= \frac{\textit{Total Investment 1997 till 2010}}{\textit{Disposal Amount 1997 till 2010}}$	$= \frac{\textit{O-M Cost, 2010}}{\textit{Disposal Amount, 2010}}$
Leachate Treatment Plant	$= \frac{\textit{Total Investment 1997 till 2010}}{\textit{Life Year} \times \textit{Disposal Amount, 2010}}$	$= \frac{\textit{O-M Cost, 2010}}{\textit{Disposal Amount, 2010}}$

c. Design Conditions

The following assumptions were set up:

- Commencement of landfill operation:
  Beginning of 1997

- Sanitary level of landfill operation:
  Level 4

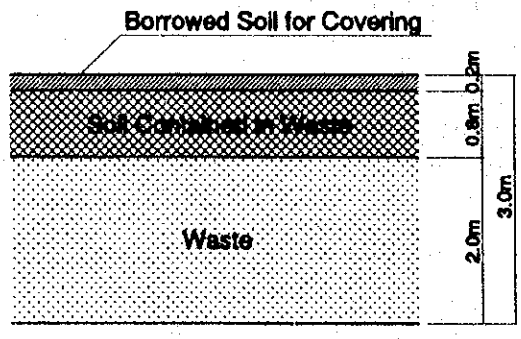
- Design capacity of the final disposal sites:

  V1 is the required capacity of the landfill section to receive waste for 14 years from 1997 until 2010. This is calculated assuming that the unit weight of the waste compacted in a landfill is 1.0 ton/m^3.

$$V1\ (cub.m) = \frac{Total\ Amount\ (ton)}{Unit\ Weight\ (ton/cub.m)}$$

  V2 is the required volume of daily coverage soil which is equivalent to 6.7% of the total waste volume disposed as explained below.

$$Rate\ of\ Coverage\ Soil = \frac{Thickness\ of\ Soil\ Cover}{Total\ Thickness\ of\ One\ Layer} = \frac{0.2\ m}{3.0\ m} = 6.7\ \%$$



Hence, the required capacity of the landfill sections are calculated and presented in Table H.5.2v.

Table H.5.2v Disposal Site Cost Estimate

No.	Disposal Site	V1 Total Disposal Amount from 1997 till 2010 (m^3)	V2 Amount of Daily Cover Soil (m^3)	ΣV Design Capacity (m^3)
A-1	Acahualinca	6,000,000	400,000	6,400,000
A-2, A-3	Santa Ana	6,000,000	400,000	6,400,000
A-4	Esquipulas	6,000,000	400,000	6,400,000
A-5	a. Santa Ana	2,400,000	160,000	2,560,000
	b. Esquipulas	3,600,000	240,000	3,840,000

d. Technical Description of Facilities

It is assumed that the following facilities are installed for each candidate disposal site.

- **Main Facilities**

  . Enclosing structure:
  Enclosing dike and divider
  . Drainage system:
  Surrounding drain, on-site open drain, on-site culvert drain, catch pit, intercepter drain
  . Access road:
  Rehabilitated roads, new roads, temporary roads

- **Environmental protection facilities**

  . Buffer zones
  . Littering prevention facilities
  . Gas removal and leachate collection facilities
  . Seepage control facilities
  . Daily soil cover
  . Final soil cover

- **Building and accessories**

  . Site office
  . Truck scale

. Storage building
. Safety facilities:
  Gates, fences, street lights
. Fire prevention facilities:
  Water tank, extinguisher,
. Others:
  Parking lot, greenery, car wash, etc.

da. Enclosing Structure

The purpose of the enclosing structure is to store waste and to control leachate from waste in a landfill site. There are several kinds of enclosing structures.

- **Enclosing Dike**

The enclosing dike banked with earth around the filling area is required to prevent seepage of rainwater. Because the disposal site is located in a flat area, a dike shall be used to enclose the landfill site for the prevention of rain water infiltration. The dimensions of the enclosing structure is set up as follows.

. Gradient of Slope:	1 : 2
. Crown Width:	5.0 m
. Height of 1st Dike:	5.0 m (10.0 m for Santa Ana)
. Height of Upper Dike:	2.5 m
. Berm:	2 m width berm for every 5 m high
. Material of Dike Structure:	Soil

- **Divider**

The divider which is made of soil is provided inside the enclosing dike to block rain water seepage into the waste dumped. The purpose of a divider is to reduce quantity of leachate. Four hectares of the dumping area is provided with a divider. The dimensions of the enclosing structure is set up as follows.

. Gradient of Slope:	1 : 2
. Crown Width:	2.0 m
. Height of Dike:	2.5 m
. Material of Dike Structure:	Soil

db. Drainage System

A drainage system plays a very important role in maintaining the site and roads in good condition and also in minimizing the influence of rainwater on leachate control facilities. Different types of drainage are adopted for this alternative study,

as described below:

- **Surrounding Drain**

The surrounding drain is generally constructed around the landfill to intercept rain water from the landfill area and to expel them from the site. The dimensions adopted for this study are shown below.

.	Top Width:	3.0 m
.	Bottom Width:	1.0 m
.	Gradient of Slope:	1 : 1
.	Depth:	1.0 m
.	Surface of Drain:	No lining

- **On-site Open Drain**

The on-site open drain keeps the working area within the landfill site dry. The drain shall have no lining.
The dimensions of the on-site open drain for surface water adopted for this study are shown below:

.	Top Width:	2.0 m
.	Bottom Width:	1.0 m
.	Gradient of Slope:	1 : 1
.	Depth:	0.5 m
.	Surface of Drain:	No lining
.	Interval of installation:	Every 100 m

- **On-site Culvert Drain**

This type of drainage discharges rain water outside via the surrounding drain.
The dimensions of the on-site culvert drain adopted for this study are shown below:

.	Pipe Diameter:	0.6 m
.	Wing wall:	Concrete walls are provided on both ends

- **Intercepter Drain for Reclaimed Area**

The intercepter drain is provided to intercept surface water on the completed landfill area preventing seepage of rain water into the waste layer and also to protect the slope of the enclosing dike.
The dimensions of the intercepter drain adopted for this study are shown below.

.	Top Width:	2.0 m
.	Bottom Width:	1.0 m

- Gradient of Slope: 1 : 1
- Depth: 0.5 m
- Surface of Drain: 0.05 m thick mortar lining

dc. Access

The condition of the access road is very important to the effectivity of the work process. Good road conditions minimize and prolong equipment maintenance cost and life span, respectively. Access roads are categorized into the following types.

- Rehabilitated roads
- Newly constructed roads
- Temporary roads

Rehabilitated roads refer to improved existing roads. The surface of rehabilitated and newly constructed roads are paved with asphalt. The surface of the temporary roads are paved with crushed stone.

- **Buffer Zone**

A buffer zone is constructed between the disposal site and the residential area to:

- Screen the landfill site from the residents,
- Reduce noise and vibrations emitted during landfilling operation,
- Reduce odors,
- Create environmental equilibrium.

The buffer zone is in the form of a green belt of plants with a width of 50 m.

- **Littering Prevention Facilities**

Litter control within the landfill site is principally the same measure as that taken for disaster and pest control wherein the covering material acts as the main agent. Nevertheless, littering is inevitable during landfill operations before the covering material is placed. As a means of prevention, a mobile fence will be put up to prevent waste from scattering.

- **Gas Removal and Leachate Collection Facilities**

Microbial decomposition of organic matters during landfilling operations produces water, gas and inorganic chlorides. If the landfill structure houses aerobic matters, this gives rise to aerobic bacterial activity which accelerates decomposition and produces carbon dioxide, water, ammonia etc. On the other hand, if the structure

houses anaerobic matters, this gives rise to anaerobic bacterial activity and slow decomposition, which produces odors and combustible gases, such as methane, carbon dioxide, hydrogen sulfide and ammonia, that badly affect the environment.

Generally, as for the outbreak of gas in landfill sites, gushing and exhausting are common at weak points on the boundary surface between the landfill site and surrounding structures. Disaster prevention measures, through gas removal facilities, are necessary at points where gas pockets burst unexpectedly and thus produce fires, odors etc.

Three types of gas removal facilities, i.e. by evacuation, pumping and ventilation, were taken into consideration. Within these designs, the most economical gas removal facility, the one by evacuation, has been selected.

The completed landfill site is designed to incorporate 3–4 ventilators per hectare, an effective prevention measure. However, the covering material is the most important factor for gas removal, as it is necessary not to leave waste exposed over a long time.

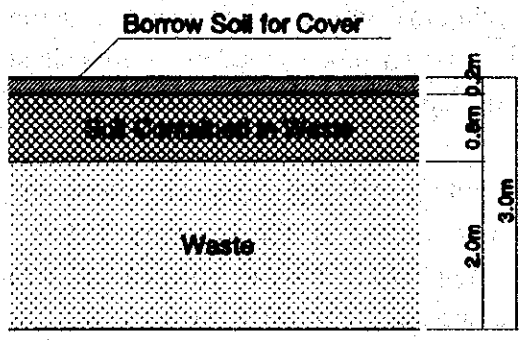
The function of leachate collection facilities is only limited to the collection of water contaminated with waste and decomposed polluted water, and the carrying of these to the leachate control facilities with care so as to avoid spitlage and ground water infiltration.

- **Seepage Control Facilities**

A lining sheet serves as a seepage control facility on the bottom of the landfill area to prevent leachate seepage.

- **Daily Soil Cover**

Firstly the waste layer will be covered by soil which was separated from the incoming waste. This soil layer shall be 0.8m thick. Borrow soil, 0.2m thick, will be then compacted onto its surface, as shown below.



- **Final Soil Cover**

The final soil cover on the completed section of the landfill will be 0.5 m thick for future use.

de. Buildings and Accessories

These facilities include a site office, trucks, safety facilities, fire prevention facilities, storage building, monitoring facilities, car wash etc..

e. Preliminary Design

ea. Alternative A-1: Acahualinca

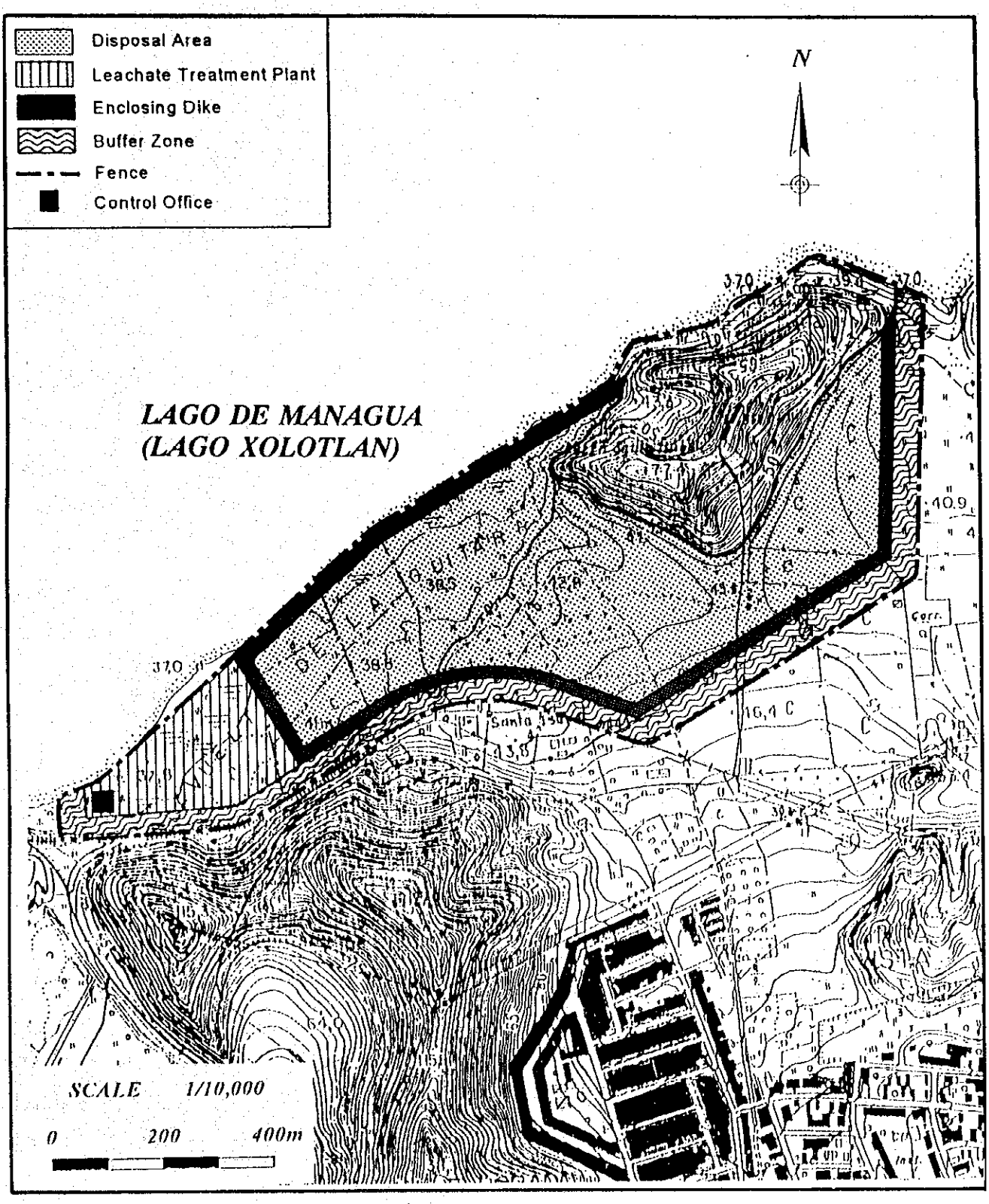


Figure H.5.2d Preliminary Design of the Acahualinca Disposal Site

eb. Alternative A-2 and A-3: Santa Ana

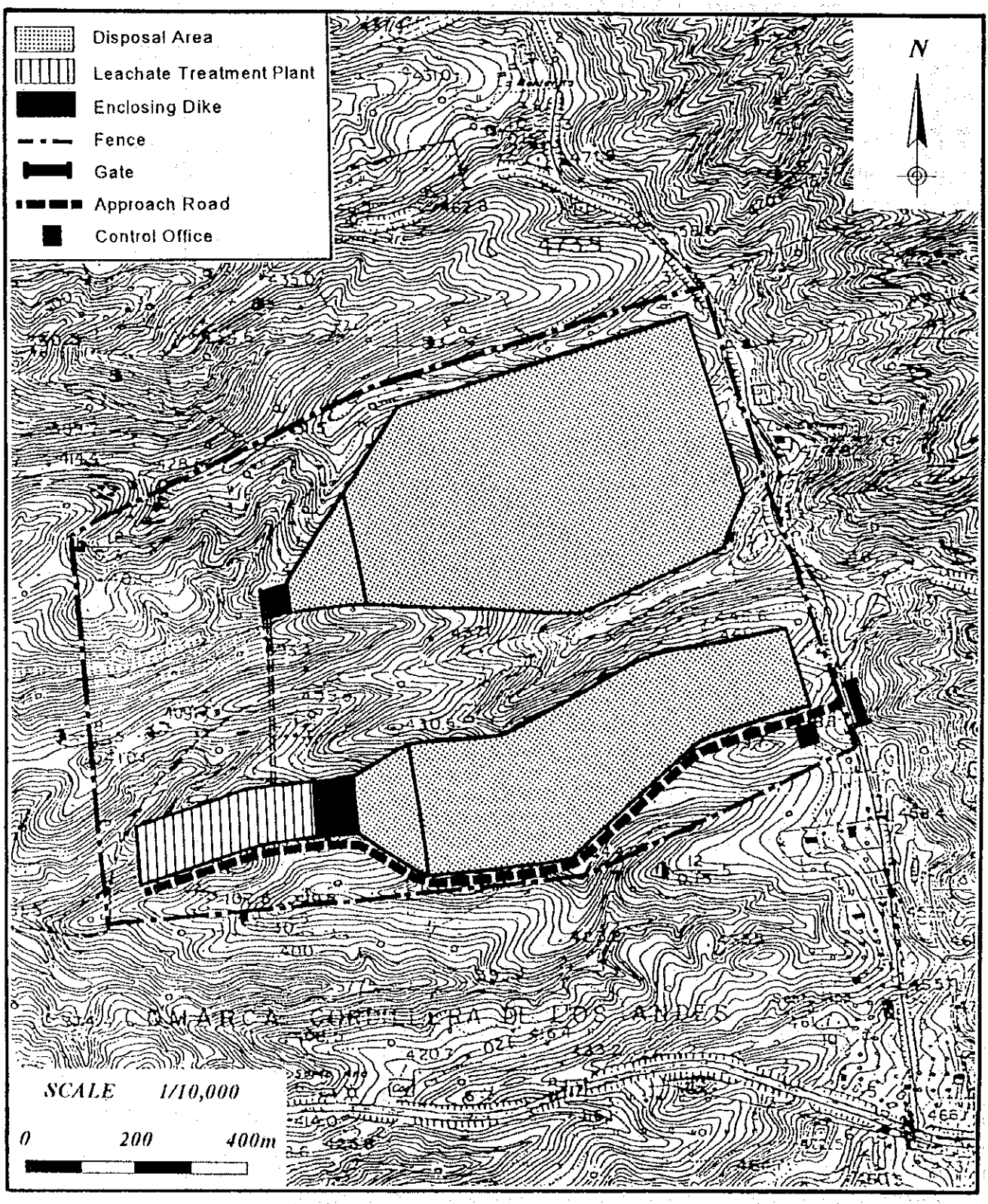


Figure H.5.2e Preliminary Design of the Santa Ana Disposal Site (1)

ec. Alternative A-4: Esquipulas

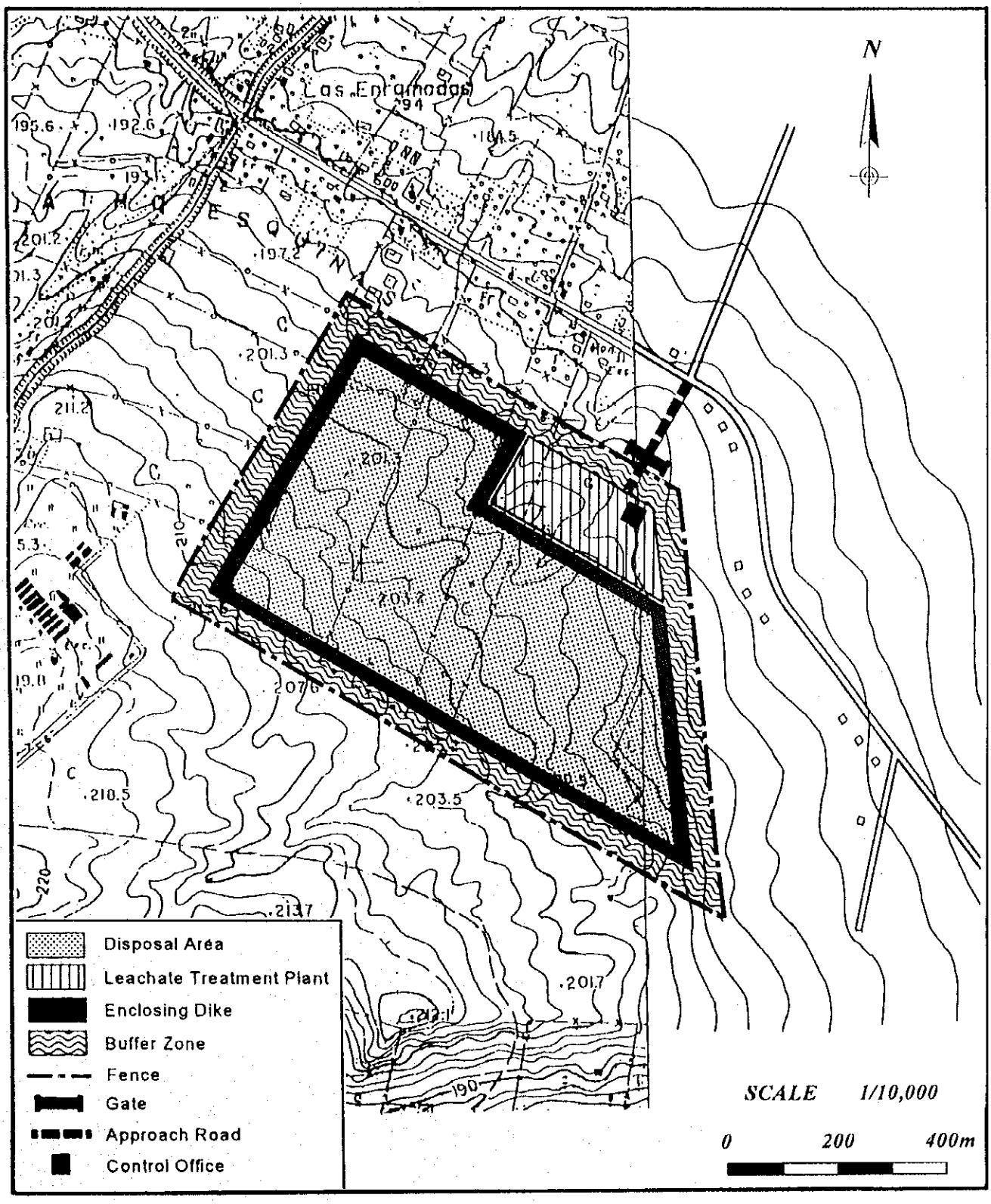


Figure H.5.2f Preliminary Design of the Esquipulas Disposal Site (1)

ed. Alternative A-5

eda. Santa Ana

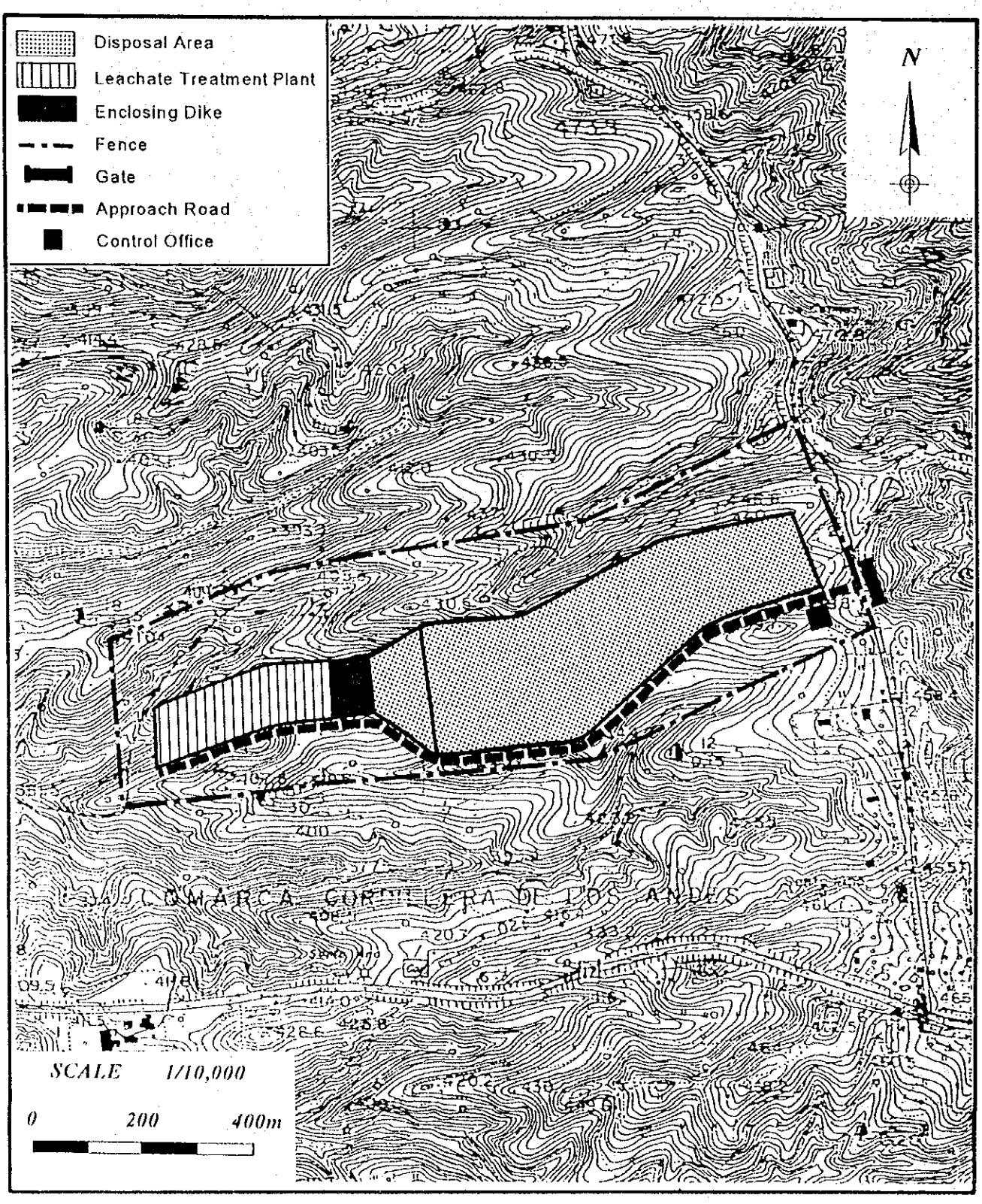


Figure H.5.2g Preliminary Design of the Santa Ana Disposal Site (2)

edb. Esquipulas

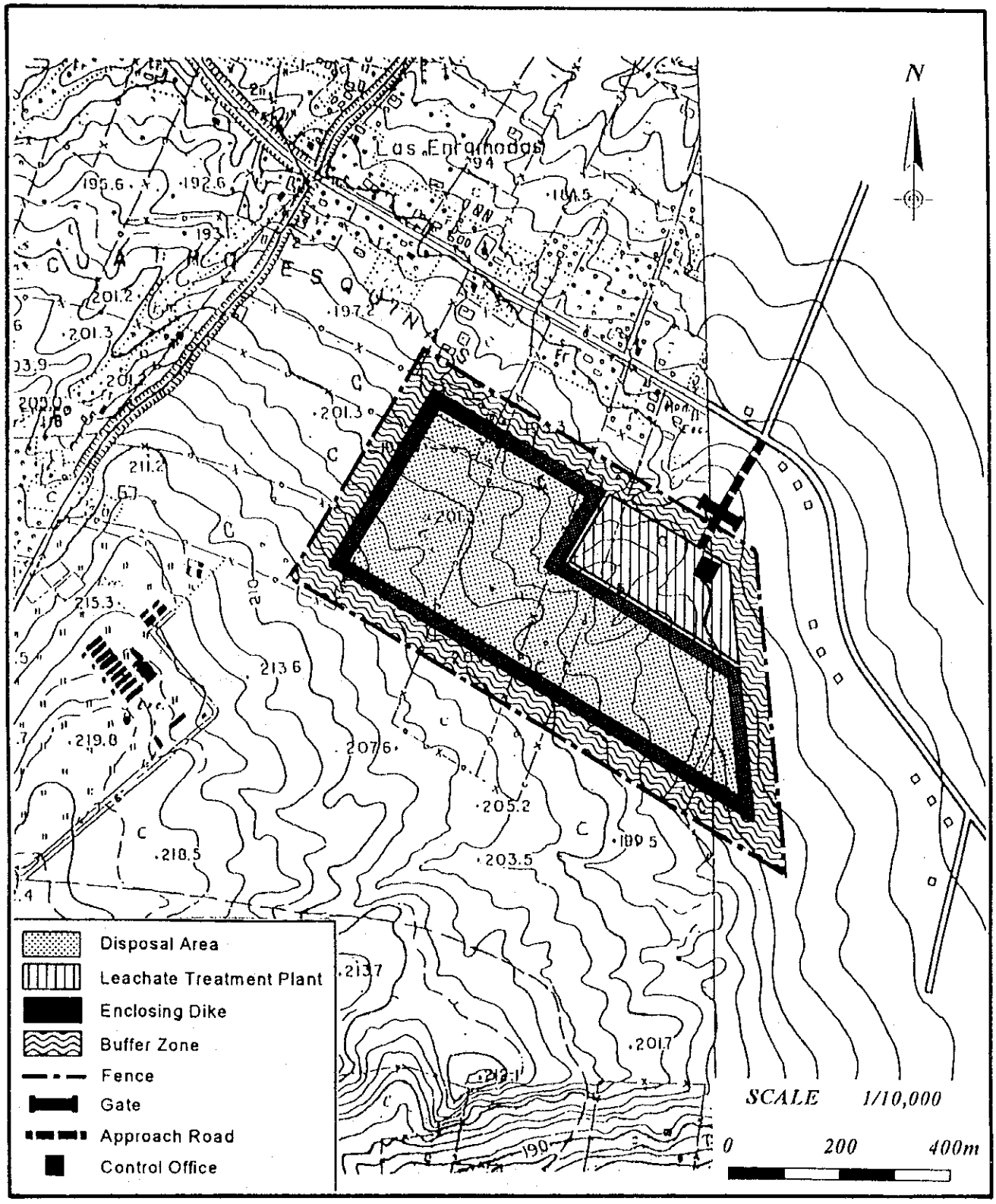


Figure H.5.2h Preliminary Design of the Esquipulas Disposal Site (2)

f. Cost Estimate

fa. Final Disposal Site

It is very difficult to differentiate investment and the O & M cost of the disposal works as each tipping area is completely filled within less than a year. Therefore, only the cost involved in the spreading and compacting of waste is included in the O & M cost estimation.

faa. Investment

i. Assumptions on cost estimate

The material for the landfill structures such as enclosing dikes and dividers will be taken from the following:

- Soil will be taken from within the disposal site.
  A-1, A-2, A-3, A-5a
- Soil will be carried to the site from a distance of 10 to 15km.
  A-4, A-5b

ii. Cost estimation

The estimation of investments for the final disposal sites are presented in Table H.5.2w.

Table H.5.2w Estimation of Investment by Alternative

unit: thousand C$

No.	Items	A-1	A-2, A-3	A-4	A-5a	A-5b
1	Preparation Work (Site clearing)	1,840	2,160	1,800	880	1,160
2	Main Facilities	18,814	12,316	39,877	5,800	32,409
2.1	Enclosing Structure	17,268	7,017	33,510	3,368	26,435
2.2	Drainage	1,127	3,679	1,217	1,372	824
2.3	Access Road	420	1,620	5,150	1,060	5,150
3	Environmental Protection Facilities	66,286	77,606	65,962	39,022	40,353
3.1	Buffer zone	165	0	240	0	195
3.2	Littering prevention facilities	891	1,242	756	567	621
3.3	Gas and leachate collection facilities	17,870	20,564	17,606	7,975	11,121
3.4	Seepage control facility	25,600	32,000	25,600	12,800	15,360
3.5	Daily Soil Cover	13,600	13,600	13,600	13,600	8,160
3.6	Final Soil Cover	8,160	10,200	8,160	4,080	4,896
4	Borrow Soil	0	0	5,580	0	3,798
5	Building and Accessories (10%)	8,694	9,208	10,764	4,570	7,392
6	Miscellaneous (20%)	17,388	18,416	21,528	9,140	14,784
7	Total Direct Cost	113,023	119,706	145,511	59,413	99,896
8	Overhead (30%) (7 x 30%)	33,907	35,912	43,653	17,824	29,969
9	Total Construction Cost (7 + 8)	146,930	155,618	189,165	77,237	129,865
10	Design and Supervision (10%) (9 x 10%)	14,693	15,562	18,916	7,724	12,986
11	Total Project Cost (9 + 10)	161,623	171,180	208,081	84,960	142,851
Unit Construction Cost (C$/ton)		26.94	28.53	34.68	35.40	39.68

fab. O & M Cost

The required number of spreading and compacting equipment, i.e., bulldozer, can be used as an index for the O & M cost. In this estimation, the required number of bulldozers is estimated first, and the cost for site maintenance and miscellaneous works is estimated in accordance with the determined number of bulldozers.

The required number of bulldozers is calculated as follows.

$$n = \frac{\textit{Annual Disposal Amount (ton/year)}}{240\ \textit{cub.m/day} \times 297\ \textit{days/year} \times 1\ \textit{ton/cub.m}}$$

n = Required number of bulldozers
Capacity of a bulldozer is 240 m^3/day

The distribution of the estimated number of manpower and equipment are presented in Table H.5.2x.

Table H.5.2x Distribution of Estimated Number of Manpower and Equipment in 2010

Items	unit	Annual Disposal Amount of Waste ($x10^4$ ton)							
		21.4–28.5	28.5–35.6	35.6–42.8	42.8–50	50–57	57–64.2	64.2–71.3	71.3–78.4
Machinery									
Bulldozer 210HP	units	4	5	6	7	8	9	10	11
Personnel									
Manager	pers.	.1	1	1	1	1	1	1	1
Foreman	pers.	1	1	2	2	2	2	3	3
Operator & Clerk	pers.	6	7	8	9	10	11	12	13
Truck scale operator	pers.	4	6	6	6	6	8	8	8
Worker	pers.	4	5	6	7	8	9	10	11
Material									
Diesel	kl	237	297	356	415	475	535	594	653
Oil and Lubricant(3%)	L.S.	1	1	1	1	1	1	1	1

The annual O & M costs for the final disposal operation, estimated based on the data given in Table H.5.2x, are presented in Table H.5.2y.

Table H.5.2y Estimation of Annual O & M Cost for Final Disposal Operation

unit: thousand C$

Items	Annual Disposal Amount (x10⁴ ton/year)							
	21.4–28.5	28.5–35.6	35.6–42.8	42.8–50	50–57	57–64.2	64.2–71.3	71.3–78.4
Machinery	1,314	1,643	1,971	2,300	2,629	2,957	3,286	3,614
Bulldozer 210HP	1,314	1,643	1,971	2,300	2,629	2,957	3,286	3,614
Personnel	328	398	453	485	517	588	642	674
Manager	63	63	63	63	63	63	63	63
Foreman	22	22	43	43	43	43	65	65
Operator & Clerk	114	133	152	171	190	209	228	246
Truck scale operator	76	114	114	114	114	152	152	152
Worker	54	67	81	94	108	121	134	148
Material	460	575	690	805	920	1,035	1,150	1,265
Diesel	447	558	670	782	893	1,005	1,117	1,228
Oil and Lubricant(3%)	13	17	20	23	27	30	34	37
Total	2,102	2,616	3,114	3,590	4,066	4,580	5,078	5,554
Site maintenance cost (30%)	631	785	934	1,077	1,220	1,374	1,523	1,666
Total O & M Cost in 2010	2,733	3,401	4,048	4,667	5,286	5,954	6,601	7,220
Unit O & M Cost in 2010 (C$/ton)	12.77	11.93	11.37	10.90	10.57	10.45	10.28	10.13
Disposal site to be constructed	A–5a			A–5b				A–1 A–2 A–3 A–4

fb. Leachate Treatment Plant

fba. Basic Design of Leachate Treatment Plant

i. Basic design data

- Catchment area for leachate: 4 ha

- Precipitation:
  Annual average precipitation: 757 mm/year
  Largest monthly precipitation: 133 mm in November

- Leachate amount:
  Annual average leachate amount :
  $Qa = 80{,}000m^2 \times 0.757m = 60{,}560m^3/210days$
  $= 288.4m^3/day$
  Maximum leachate amount:

$$Ql = 80{,}000m^2 \times 0.133m = 10{,}640m^3/30days$$
$$= 354.7m^3/day \rightarrow 360m^3/day$$

The design leachate amount is established at $360m^3$/day. The amount exceeding this set amount shall be stored in a pond in the final disposal site.

- Leachate and effluent quality

The established design leachate quality is based on the data shown in Table H.5.2z, and is shown below.

Table H.5.2z Design Quality of Leachate and Effluent

mg/lit

Items	Leachate	Effluent
BOD	1,000	50
COD	2,300	150
As	0.05	0.01
Cd	0	0.005
Cr_{6+}	0	0.005
Cu	0.06	0.05
Hg	0.5	0.05
Pb	0.2	0.01

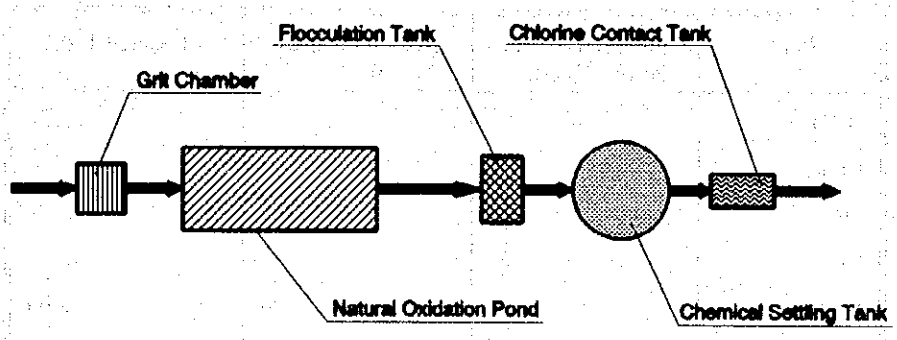
Table H.5.2a' Comparison of Leachate and Effluent Quality

mg/lit

Items	Requirement for Potable Water [1)]	Requirement by WHO	Measured Data
BOD			132
COD			2,273
pH	6.5 – 8.5	6.5 – 8.5	
Cl	25	250	1,357
SO_4^{2-}	25	400	2,900
Ca^{2+}	100		
Mg^{2+}	30		
Na	25		
K	10		
NO_3^-	25	10	
NO_2	–	–	
NH_4	0.05	–	
Fe	0.05	0.3	
Mn	0.02	0.1	
As	0.01	0.05	0.04
Cd	0.005	0.005	Not detected
CN	0.05	0.1	–
Cr_{6+}	0.05	0.05	Not detected
Cu		0.05	0.06
Hg	0.001	0.001	0.4
Ni	0.02		–
Pb	0.01	0.05	0.14
A+	0.005		–
Se	0.01	0.01	–

Note: 1) Normas de Calidad del Agua para Consumo Humano Revisada eu Marza de 1994 Comite Coordinador Regional de Instituciones de Agua Potable y Saneamiento de Centroamerica, Panama, y Republica Dominicana

- Design Flow of Leachate Treatment Plant



fbb. Investment

The estimated investment for the leachate treatment plant based on the preliminary design is presented in Table H.5.2b'.

Table H.5.2b' Estimate of Investment Cost for Leachate Treatment Plant

Item	Amount (thousand C$)
- Civil works	18,495
- Mechanical, electrical work	8,418
Total Direct Cost	26,913
Overhead (30%)	8,100
Total Construction Cost	35,013
Design and Supervision (10%)	3,508
Total Investment Cost	38,521

The Investment cost estimated for the leachate treatment plants of A-1, A-2, A-3 and A-4 is C$ 38,521,000 as presented in Table H.5.2c'.

Based on this estimated cost, the Investment costs for A-5a and A-5b are adjusted as follows.

$$PC(2) = \frac{1}{2} \times PC(1) \times \left(1 + \frac{C(2)}{C(1)} \right)$$

PC(1): Investment cost of the treatment plant for A-1, C$ 38,521,000
PC(2): Investment cost to be estimated
C(1): Capacity of the disposal site for A-1
C(2): Capacity of the disposal site where the cost for the leachate treatment plant has to be estimated

In addition, the earthwork costs to be estimated for each alternative are expected to vary due to different topographical conditions, hence they shall be included in the calculation.

Table H.5.2c' Estimate of Investment Cost for Leachate Treatment Plant for Each Alternative

No.	Name of Disposal Site	Capacity (m^3)	Investment Cost of Plant ($x10^3$ C$)	Earthwork for Plant ($x10^3$ C$)	Total Cost ($x10^3$ C$)	Annual Unit Cost ($x10^3$ C$/year)	Unit Cost in 2010 (C$/ton)
A-1	Acahualinca	6,000,000	38,521	816	39,337	1,710	2.39
A-2, A-3	Santa Ana	6,000,000	38,521	17,000	55,521	2,414	3.38
A-4	Esquipulas	6,000,000	38,521	816	39,337	1,710	2.39
A-5	a. Santa Ana	2,400,000	26,965	8,500	35,465	1,542	5.39
	b. Esquipulas	3,600,000	30,817	816	31,663	1,377	3.21

fbb. O & M Cost in 2010

The estimated O & M cost for the leachate treatment plant is presented in Table H.5.2d'.

Table H.5.2d' Estimate of O & M Cost for Leachate Treatment Plant

Item	Amount ($x10^3$C$/year)
- Labor cost (6 persons)	125
- Power supply (30kw/h x 8,760 h/year = 262,800 kw/year)	134
- Maintenance cost for equipment (5% of equipment and electrical work)	325
- Maintenance cost for civil structures (1% of civil work)	159
- Chemical (360m^3/day x 365days x C$3.19/$m^3$)	419
- Miscellaneous (15%)	174
Total	1,336

Based on this estimated cost, the O&M costs for A-5a and A-5b are estimated as follows:

$$OM(2) = \frac{1}{2} \times OM(1) \times \left(1 + \frac{C(2)}{C(1)} \right)$$

OM(1): O & M cost of the treatment plant for A-1, 1,336,000C$
OM(2): O & M cost to be estimated
C(1): Capacity of the disposal site for A-1
C(2): Capacity of the disposal site where the cost of the leachate treatment plant is to be estimated

fc. Total Disposal Cost

The total disposal cost for each alternative is summarized in Table H.5.2e'.

Table H.5.2e' Disposal Sites Requiring Cost Estimates Unit: C$/ton

No.	Name of Site	Final Disposal Site			Leachate Treatment Plant			Total
		Investment	O & M	Total	Investment	O & M	Total	
A-1	Acahualinca	26.94	10.13	37.07	2.39	1.87	4.26	41.33
A-2 A-3	Santa Ana	28.53	10.13	38.66	3.38	1.87	5.25	43.91
A-4	Esquipulas	34.68	10.13	44.81	2.39	1.87	4.26	49.07
A-5a	Santa Ana	35.40	12.77	48.17	5.39	3.27	8.66	56.83
A-5b	Esquipulas	39.68	10.90	50.58	3.21	2.49	5.70	56.28

The estimates show that the unit disposal costs of A-5a and A-5b were more expensive than the others, due to the less efficient design capacities of their disposal sites.

Interest rates were not taken into account in the cost estimation as they can considerably raise the leachate treatment cost in view of the treatment plant's life span, that is 23 years. The inclusion of the interest rate may triple the cost estimated without the interest rate.

H.5.3 Summary on Technical System of Each Alternative

The technical system of each alternative is summarized in Tables H.5.3a to H.5.3e. The details of the conceptual design and cost estimation are summarized in the following tables overleaf.

Table H.5.3a Summary of Technical System for Alternative A-1

Item	System	
1. Waste Amount (ton/day)		
1-1 Generation amount		2,265
1-2 Collection amount		1,483
- Street sweeping		20
- Park and green area cleansing		5
- MSW other than the above		1,458
1-3 Transfer amount		0
1-4 Disposal amount		1,958
2. Collection & Haulage		
2-1 Collection system	Area A: Curb collection using nylon sacks or plastic bags. Area B: Container collection using public containers. Others: Container collection using public containers.	
2-2 Type and required number of containers	Container (1.0m³): 358 units (excluding street sweeping) Container (7.0m³): 934 units	
2-3 Type and required number of vehicles	Compactor (15.3m³): 86 units Compactor (15.3m³) with container: 4 units (excluding street sweeping) Hoist truck: 71 units	
2-4 Transfer station	Not required	
- Type of transfer station	-	
- Main facilities	-	
- Haulage distance	-	
- Type and required number of trailers	-	
- Number of containers	-	
3. Street Sweeping and Park & Green Area Cleansing		
3-1 System	Manual	
3-2 Length of road swept and cleansing area	350 km and 45 ha	
3-3 Type and required number of containers	Container (1.0m³): 133 units Container (7.0m³): 10 units	
3-4 Type and required number of vehicles	Compactor (15.3m³) with container: 2 units Hoist Truck: 1 unit	
4. Intermediate Treatment	No processing facilities	
5. Final Disposal		
5-1 Landfill method	Sanitary landfill (level 4)	
5-2 Disposal site	Acahualinca	
5-3 Distance from main generation source	8.3 km	
5-4 Required capacity		
5-5 Main facilities		
5-6 Environmental protection facilities		
5-7 Other facilities		
6. Cost		
6-1 Unit cost (C$/ton)	Collection & Haulage	87.57
	Street Sweeping	800.00
	Park & Green Area Cleansing	3100.65
	Disposal	41.33
	Administration	3.73
6-2 Total Cost (million C$/year)	Collection & Haulage	46.60
	Street Sweeping	5.84
	Park & Green Area Cleansing	5.66
	Disposal	29.55
	Administration	2.02
	Total Annual Cost	**89.67**

Table H.5.3b Summary of Technical System for Alternative A-2

Item	System	
1. Waste Amount (ton/day)		
1-1 Generation amount		2,265
1-2 Collection amount		1,483
- Street sweeping		20
- Park and green area cleansing		5
- MSW other than the above		1,458
1-3 Transfer amount		0
1-4 Disposal amount		1,958
2. Collection & Haulage		
2-1 Collection system	Area A: Curb collection using nylon sacks or plastic bags. Area B: Container collection using public containers. Others: Container collection using public containers.	
2-2 Type and required number of containers	Container ($1.0m^3$): 358 units (excluding street sweeping) Container ($7.0m^3$): 934 units	
2-3 Type and required number of vehicles	Compactor ($15.3m^3$): 108 units Compactor ($15.3m^3$) with container: 5 units (excluding street sweeping) Hoist truck: 122 units	
2-4 Transfer station	Not required	
- Type of transfer station	-	
- Main facilities	-	
- Haulage distance	-	
- Type and required number of trailers	-	
- Number of containers	-	
3. Street Sweeping and Park & Green Area		
3-1 System	Manual	
3-2 Length of road swept and cleansing area	350 km and 45 ha	
3-3 Type and required number of containers	Container ($1.0m^3$): 153 units Container ($7.0m^3$): 10 units	
3-4 Type and required number of vehicles	Compactor ($15.3m^3$) with container: 2 units Hoist Truck: 2 units	
4. Intermediate Treatment	No processing facilities	
5. Final Disposal		
5-1 Landfill method	Sanitary landfill (level 4)	
5-2 Disposal site	Santa Ana	
5-3 Distance from main generation source	18.0 km	
5-4 Required capacity		
5-5 Main facilities		
5-6 Environmental protection facilities		
5-7 Other facilities		
6. Cost		
6-1 Unit cost (C$/ton)	Collection & Haulage	110.96
	Street Sweeping	802.62
	Park & Green Area Cleansing	3150.68
	Disposal	43.91
	Administration	3.73
6-2 Total Cost (million C$/year)	Collection & Haulage	59.05
	Street Sweeping	5.86
	Park & Green Area Cleansing	5.75
	Disposal	31.40
	Administration	2.02
	Total Annual Cost	**104.07**

Table H.5.3c Summary of Technical System for Alternative A-3

Item	System	
1. Waste Amount (ton/day)		
1-1 Generation amount		2,265
1-2 Collection amount		1,483
- Street sweeping		20
- Park and green area cleansing		5
- MSW other than the above		1,458
1-3 Transfer amount		890
1-4 Disposal amount		1,958
2. Collection & Haulage		
2-1 Collection system	Area A: Curb collection using nylon sacks or plastic bags. Area B: Container collection using public containers. Others: Container collection using public containers.	
2-2 Type and required number of containers	Container (1.0m³): 359 units (excluding street sweeping) Container (7.0m³): 934 units	
2-3 Type and required number of vehicles	Compactor (15.3m³): 89 units Compactor (15.3m³) with container: 4 units (excluding street sweeping) Hoist truck: 77 units	
2-4 Transfer station		
- Type of transfer station	Direct re-loading type	
- Main facilities	Receiving hopper, weigh bridge, platform	
- Haulage distance	16.9 km (one way)	
- Type and required number of trailers	Open top trailer truck (70m3): 13 units (including 1 spare vehicle)	
- Number of containers	15 units (including 2 spare containers)	
3. Street Sweeping and Park & Green Area		
3-1 System	Manual	
3-2 Length of road swept and cleansing area	350 km and 45 ha	
3-3 Type and required number of containers	Container (1.0m³): 134 units Container (7.0m³): 10 units	
3-4 Type and required number of vehicles	Compactor (15.3m³) with container: 2 units Hoist truck: 2 units	
4. Intermediate Treatment	No processing facilities	
5. Final Disposal		
5-1 Landfill method	Sanitary landfill (level 4)	
5-2 Disposal site	Santa Ana	
5-3 Distance from main generation source	15.3 km (districts 1-3 to disposal site) 21.9 km (districts 4-6 to disposal site)	
5-4 Required capacity		
5-5 Main facilities		
5-6 Environmental protection facilities		
5-7 Other facilities		
6. Cost		
6-1 Unit cost (C$/ton)	Collection & Haulage	102.61
	Street Sweeping	800.27
	Park & Green Area Cleansing	3140.42
	Disposal	43.91
	Administration	3.73
6-2 Total Cost (million C$/year)	Collection & Haulage	54.61
	Street Sweeping	5.84
	Park & Green Area Cleansing	5.73
	Disposal	31.40
	Administration	2.02
	Total Annual Cost	99.60

Table H.5.3d Summary of Technical System for Alternative A-4

Item	System	
1. Waste Amount (ton/day)		
1-1 Generation amount		2,265
1-2 Collection amount		1,483
- Street sweeping		20
- Park and green area cleansing		5
- MSW other than the above		1,458
1-3 Transfer amount		0
1-4 Disposal amount		1,958
2. Collection & Haulage		
2-1 Collection system	Area A: Curb collection using nylon sacks or plastic bags. Area B: Container collection using public containers. Others: Container collection using public containers.	
2-2 Type and required number of containers	Container ($1.0m^3$): 358 units (excluding street sweeping) Container ($7.0m^3$): 934 units	
2-3 Type and required number of vehicles	Compactor ($15.3m^3$): 92 units Compactor ($15.3m^3$) with container: 4 units (excluding street sweeping) Hoist truck: 86 units	
2-4 Transfer station		
- Type of transfer station	Not required	
- Main facilities	-	
- Haulage distance	-	
- Type and required number of trailers	-	
- Number of containers	-	
3. Street Sweeping and Park & Green Area		
3-1 System	Manual	
3-2 Length of road swept and cleansing area	350 km and 45 ha	
3-3 Type and required number of containers	Container ($1.0m^3$): 133 units Container ($7.0m^3$): 10 units	
3-4 Type and required number of vehicles	Compactor ($15.3m^3$) with container: 2 units Hoist truck: 1 unit	
4. Intermediate Treatment	No processing facilities	
5. Final Disposal		
5-1 Landfill method	Sanitary landfill (level 4)	
5-2 Disposal site	Esquipulas	
5-3 Distance from main generation source	11.0 km	
5-4 Required capacity		
5-5 Main facilities		
5-6 Environmental protection facilities		
5-7 Other facilities		
6. Cost		
6-1 Unit cost (C$/ton)	Collection & Haulage	94.16
	Street Sweeping	800.73
	Park & Green Area Cleansing	3103.85
	Disposal	49.07
	Administration	3.73
6-2 Total Cost (million C$/year)	Collection & Haulage	50.11
	Street Sweeping	5.85
	Park & Green Area Cleansing	5.66
	Disposal	35.09
	Administration	2.02
	Total Annual Cost	**98.72**

Table H.5.3e Summary of Technical System for Alternative A-5

Item	System	
1. Waste Amount (ton/day)	Santa Ana	Esquipulas
1-1 Generation amount	906	1,359
1-2 Collection amount	593	890
- Street sweeping	8	12
- Park and green area cleansing	2	3
- MSW other than the above	583	875
1-3 Transfer amount	0	0
1-4 Disposal amount	783	1,175
2. Collection & Haulage		
2-1 Collection system	Area A: Curb collection using nylon sacks or plastic bags. Area B: Container collection using public containers. Others: Container collection using public containers.	
2-2 Type and required number of containers	Container (1.0m³): 359 units (excluding street sweeping) Container (7.0m³): 934 units	
2-3 Type and required number of vehicles	Compactor (15.3m³): 95 units Compactor (15.3m³) with container: 5 units (excluding street sweeping) Hoist truck: 93 units	
2-4 Transfer station		
- Type of transfer station	Not required	
- Main facilities	-	
- Haulage distance	-	
- Type and required number of trailers	-	
- Number of containers	-	
3. Street Sweeping and Park & Green Area		
3-1 System	Manual	
3-2 Length of road swept and cleansing area	350 km and 45 ha	
3-3 Type and required number of containers	Container (1.0m³): 134 units Container (7.0m³): 10 units	
3-4 Type and required number of vehicles	Compactor (15.3m³) with container: 2 units Hoist truck: 2 units	
4. Intermediate Treatment	No processing facilities	
5. Final Disposal		
5-1 Landfill method	Sanitary landfill (level 4)	
5-2 Disposal site	Santa Ana and Esquipulas	
5-3 Distance from main generation source	15.8 km (districts 1-3 to Santa Ana disposal site) 10.0 km (districts 4-6 to Esquipulas disposal site)	
5-4 Required capacity		
5-5 Main facilities		
5-6 Environmental protection facilities		
5-7 Other facilities		
6. Cost		
6-1 Unit cost (C$/ton)	Collection & Haulage	92.76
	Street Sweeping	801.09
	Park & Green Area Cleansing	3143.97
	Disposal	56.50
	Administration	3.73
6-2 Total Cost (million C$/year)	Collection & Haulage	49.37
	Street Sweeping	5.85
	Park & Green Area Cleansing	5.74
	Disposal	40.40
	Administration	2.02
	Total Annual Cost	**103.37**

H.5.4 Evaluation

Generally, the optimum technical system would be selected by evaluating the following aspects:

- technical
- social
- environmental
- economical and financial

H.5.4.1 Technical Evaluation

a. Evaluation condition

Large technical differences with the alternatives lie in the introduction of the transfer and final disposal systems including the location of a disposal site. Therefore, the evaluation of the technical system of the alternatives is done according to the following

- working condition
- operation and maintenance
- construction
- the level of sanitary landfill

The comparison of technical systems for each alternative is shown in Table H.5.4a.

b. Evaluation

ba. Working condition

Workers involved in solid waste management are engaged in different types of work such as collection, transportation, operation of transfer station and final disposal. The following three types of works in particular require improved working conditions to ensure both safety and hygiene.

- loading of solid waste into collection trucks
- work in transfer station
- landfill work at disposal site

Since the same technical systems will be applied to the discharge/storage, collection and final disposal, there is little difference in the working conditions of the alternatives. However, the work in the transfer station of A-3 is less compared to other Alternatives.

bb. Operation and maintenance

Operation and maintenance difficulties in the disposal site are estimated to be almost the same with every alternative plan. Only few problems can be observed in the operation and maintenance work at the transfer station as they only involve the transportation of large containers.

bc. Construction

The construction of the transfer station, will require highly advanced technology. The technology presently used in Nicaragua will be good enough for the construction of all facilities except the transfer station.

bd. The level of sanitary landfill

The target sanitary landfill level is Level 4 (sanitary landfill with leachate treatment) for all alternatives. Level 4 will be introduced in A-1 to prevent the contamination of Managua Lake. Level 4 will be introduced in other alternatives to prevent any adverse impact on groundwater, used as drinking water.

c. Summary of Technical Evaluation

Technical evaluation is summarized in Table H.5.4a.

Table H.5.4a Summary of Technical Evaluation

Criteria	Alternative				
	A-1	A-2	A-3	A-4	A-5
a. Working condition	A	B	B	B	B
b. Operation and maintenance	A	B	B	A	B
c. Construction	A	C	C	C	C
Overall Assessment	A	B	B	C	C

Note: A: good B: fair C: poor

H.5.4.2 Social Evaluation

a. Evaluation Factors

Social evaluation of each alternative was conducted based on the following factors, and the plans were ranked accordingly as shown in Table H.5.4.b.

- possibility of land acquisition
- possibility of obtaining neighborhood consensus
- compatibility with regional development plans

b. Evaluation

ba. Possibility of land acquisition

There are no strict regulations concerning the use of the three candidate disposal sites; all the sites except Acahualinca are privately owned, therefore, compensation is required for the two sites if they were to be selected. Santa Ana is under the jurisdiction of the Villa El Carmen municipality. If this site is to be used, negotiations will have to be conducted to incorporate the site within the Managua municipal boundary as soon as possible.

Candidate sites for the transfer station were not selected during the 1st study work in Nicaragua. If A-3 is selected as optimum alternative, candidate sites will be discussed at the IT/R meeting with the Nicaraguan side.

bb. Possibility of obtaining neighborhood consensus

A neighborhood consensus is necessary to Santa Ana and Esquipulas because its peripheral areas are inhabited.

bc. Compatibility with regional development plans

Since an Urban Development Master Plan is not established in the study area, the three candidate sites will not face problems concerning this matter.

c. Summary of Social Evaluation

Social evaluation is summarized in Table H.5.4b.

Table H.5.4b Summary of Social Evaluation

Criteria	Alternative				
	A-1	A-2	A-3	A-4	A-5
a. Possibility of Land Acquisition	A	C	C	B	C
b. Possibility of Getting Neighborhood Concensus	A	B	B	B	B
c. Compatibility with Regional Development Plans	A	A	A	A	A
Overall Assessment	A	B	B	B	B

Note: A: good B: fair C: poor

H.5.4.3 Environmental Evaluation

a. Items for Evaluation

The items for evaluation are listed in Table H.5.4c, and pertain to the social environment (9), natural environment (8), and pollution (6).

Table H.5.4c Items for Evaluation

Categories	Social Environment	Natural Environment	Pollution
Items	(1) Resettlement (2) Economic Activities (3) Traffic and Public Facilities (4) Community Separation (5) Remains and Cultural Property (6) Water Right and Right to Common (7) Public Health Condition (8) Waste (9) Natural Disaster	(1) Topography and Geology (2) Soil Erosion (3) Groundwater (4) Flow Condition of Lakes, Marshes and Rivers (5) Coastal Zone (6) Flora and Fauna (7) Meteorology (8) Landscape	(1) Air Pollution (2) Water Condition (3) Soil Contamination (4) Noise and Vibration (5) Land Subsidence (6) Offensive Odor
Total	9	8	6

b. Evaluation Method

ba. Evaluation Terms

The proposed alternative subject for evaluation was limited to the environmental conservation measures indicated in Table H.5.4d.

bb. Evaluation Method and Results

Evaluation was carried out by comparing the contents and geographical position of each alternative with every environmental item. Table H.5.4e shows the evaluation of the social environment, Table H.5.4f, the evaluation of the natural environment, and Table H.5.4g shows the results of the evaluation of items related to pollution.

Table H.5.4d The Environmental Conservation Measures as The Bases of Evaluation

Alternative	A-1, A-2, A-3, A-4, A-5	A-3
Environmental Items	Disposal Site	Transfer Station
Air Pollution	- Implementation of dust reduction measures, i.e., water sprinkling and surface compaction. - Installation of gas exhaust pipes. - Covering of waste layers. - Use of treated leachate for sprinkling.	- Nothing in particular
Water Pollution	- Installation of seepage control facilities. - Installation of leachate treatment facilities.	- Transfer of domestic waste water and water used to wash the floor of the working place to the final disposal site for treatment
Noise and Vibration	- Reduction of the noise created by the heavy machineries for landfill works and transportation vehicles. - Carrying out speed control and better clutch control.	- Work will be carried out in enclosed areas; noise will be minimized as mich as possible. - Work space will be enclosed. - Better clutch control.
Offensive Odor	- Covering of soil - Sanitary landfilling	- Constant washing of the floors of the work place - Avoid longterm waste storage - Transfer wastes in enclosed areas to avoid the spread of offensive odor - Work apace will be enclosed
Landscape	- Construction of a Buffer zone (planting trees). - Establish a land use plan which incorporates the desires of the locals and is compatible with surrounding landuse. - The construction of an artificial shore line for Acahualinca Lake.	- Construction of a Buffer zone (planting trees). - Establish a land use plan which incorporates the desires of the locals and is compatible with surrounding landuse.
traffic	- The accurate installation of traffic control indicators at exits and entrance areas disposition of a guard. - Selection of hauling route to considerably reduce impact on surrounding traffic - Educate operators on safe driving	- Accurate installation of traffic control indicators at exits and entrance areas; installation of traffic lights and disposition of a guard. - Selection of hauling route to considerably reduce impact on surrounding traffic - Educate operators on safe driving

Table H.5.4e The Results of The Preliminary Social Environmental Impact Assessment of the Proposed Alternatives

Alternative			A–1	A–2	A–3	A–4	A–5
Disposal Site			Acahualinca	Santa Ana		Esquipulas	Santa Ana & Esquipulas
Transfer System			without		with	without	
(1) Resettlement	Disposal Site	Human Habitation	None (no impact)	The borderline of the Project Area is slightly populated (small impact)		None (no impact)	A–2 (small impact) A–4 (no impact)
	Transfer Station	Human Habitation			Selection of an uninhabited area (no impact)		
(2) Economic Activity	Disposal Site	Land Utilization	The Project Area is mostly wasteland and partly graze land (small impact)	The Project Area is made up of agricultural lands, abandoned cultivated lands and forests (small impact)		The Entire Project Area is made up of cultivated agricultural lands (has an impact)	A–2 (bears little impact) A–4 (has an impact)
	Transfer Station	Land Utilization			Close to a residential district (no impact)		
(3) Traffic and Public Facilities	Disposal Site	Collection Vehicles	A plan to use the same road presently used when sending in load (no impact)	The use of collection vehicles will bring about new impacts (has an impact)		Same as A–2 (has an impact)	Combination of A–2 and A–4 (has an impact)
	Transfer Station				Additional impact from traffic in surrounding area (has an impact)		
(4) Community separation	Disposal Site	Regional Social Structure	There are no regional structures to be divided (no impact)				
		Road connecting regional areas	None (no impact)				
	Transfer Station	Regional Social Structure			None (no impact)		
(5) Remains and cultural property	Disposal Site		Historic relics and cultural properties were not found (no impact)				

Alternative			A-1	A-2	A-3	A-4	A-5
Disposal Site			Acahualinca	Santa Ana		Esquipulas	Santa Ana & Esquipulas
Transfer System			without		with	without	
(5) Remains and cultural property	Transfer Station				None (no impact)		
(6) Water right and right of common	Disposal Site		Both rights do not exist (no impact)				
	Transfer Station				None (no impact)		
(7) Public health condition	Disposal Site	Generation of noxious insects and entry of vermin	Possible reduction through the implementation of sanitary landfilling and cover soil (small impact)				
	Transfer Station				possible reduction through cleaning (small impact)		
(8) Waste by construction of the facilities	Disposal Site	Generation of hazardous materials and large volume of sand	Not generated (no impact)				
	Transfer Station				Not generated (no impact)		
(9) Natural Disaster	Disposal Site	The occurrence of calamities i.e., landslide, flood	Not possible (no impact)	Reduction of calamitous occurrences, stabilizing the dam body, establishing a regulating pond (small impact)		Not possible (no impact)	A-2 (small impact) A-4 (no impact)
	Borrow-Pit	Occurrence of a landslide at the site where excavations are carried out for the extraction of cover soil	Possible (small impact)				
	Transfer Station	Occurrence of calamities i.e., landslide, flood			Not possible (no impact)		

Table H.5.4f The Results of The Preliminary Natural Environmental Impact Assessment of The Proposed Alternatives

Alternative			A-1	A-2	A-3	A-4	A-5
Disposal Site			Acahualinca	Santa Ana		Esquipulas	Santa Ana & Esquipulas
Transfer System			without		with	without	
(1) Topography and Geological Features	Disposal Site	Remarkable Topography and Geology	None (no impact)				
		Earthworks	Small scale reclamation works at the flat area (small area)	Small scale earthworks for the reclamation of the valley area (small impact)		Small scale reclamation works at flat areas (small impact)	Combination A-2 and A-4 (small impact)
	Transfer Station	Earthworks			Construction of low building on flat area (small impact)		
(2) Soil Erosion	Disposal Site	Earthworks	Small scale reclamation works at flat areas (small impact)	Small scale reclamation to build a waste landfill site at the valley area (small impact)		Small scale reclamation work on a relatively flat area (small impact)	Similar to the assessments for A-2 and A-4 (small impact)
	Transfer Station				Construction of low building on flat area (small impact)		

Alternative			A–1	A–2	A–3	A–4	A–5
Disposal Site			Acahualinca	Santa Ana		Esquipulas	Santa Ana & Esquipulas
Transfer System			without		with	without	
(3) Groundwater	Disposal Site	Leachate from disposal site and groundwater artery	Located at the utmost downstream area of the groundwater artery facing Managua Lake. Leachate is discharged in Managua Lake after treatment. Leachate hardly affects groundwater in a direct way. (small impact)	Located outside the administration limits of Managua City. Located at the utmost upstream area of the groundwater artery facing the Pacific Ocean. Leachate is discharged downstream after treatment. Leachate does not affect groundwater directly. (small impact)		Located mid–stream of the groundwater artery facing Managua Lake. The groundwater artery is used for waterworks. Leachate is discharged in canals after treatment. Leachate has no direct effects. (small impact)	Combination of A–2 and A–4
		Groundwater artery and treated water	Treated water will not be directly infiltrated by groundwater. (small impact)	Discharged treated water permeates under the ground while flowing in the highly permeable canal and can possibly affect groundwater directly. (small impact)		Treated water discharged infiltrates in the highly the ground as it flows permeable canal and can possibly affect groundwater directly (small impact)	Combination of A–2 and A–4 (small impact)
	Transfer Station	Groundwater artery and leachate			Rinse water will not affect groundwater as it shall be totally treated at the final disposal site (no impact)		

Alternative		A–1	A–2	A–3	A–4	A–5
Disposal Site		Acahualinca	Santa Ana		Esquipulas	Santa Ana & Esquipulas
Transfer System		without		with	without	
(4) Flow condition of lakes, marshes, rivers	Disposal Site	The Project Area will be located at the coast of Lake Managua. Flow condition of lakes and marshes will not be affected as charges will not be carried out on Lake Managua. (no impact)	No surface water flow observed in the Project Area or in surrounding canals. A regulating pond is constructed to counteract flood. No affects observed on canal water flow even on freshet time. (small impact)		Same as A–2 (small impact)	A–2 (small impact) A–4 (small impact)
	Transfer Station			Smaller than the Disposal Site; has a slight impact on canal water flow condition. (small impact)		
(5) Coastal zone	Disposal Site	No sea coast; no sea area (no impact)				
	Transfer Station					
(6) Flora and fauna	Disposal Site	Shrubberies constitute most of the Project Area which can be viewed from the coast of Lake Managua. This area is partly used for grazing. There are some endangered species in the area. (small impact)	The Project Area is basically made up of farms, abandoned cultivated lands and surrounded by forests. there are no endangered species in the Area. (small impact)		The entire Project Area is made up of cultivated lands. There are no endangered species in the Area. (no impact)	A–2 (small impact) A–4 (no impact)

Alternative		A-1	A-2	A-3	A-4	A-5
Disposal Site		Acahualinca	Santa Ana		Esquipulas	Santa Ana & Esquipulas
Transfer System		without		with	without	
	Transfer Station			There are no endangered species in the area to be urbanized as its smaller than the Disposal Site. (no impact)		
(7) Meteorology	Disposal Site	The landscape of the hill on the eastern side of the Project Area shall be partly altered. The effect on the climate is small. (small impact)	The valley area will be made into a waste landfill; partial alteration of landscape is possible. The effect on the climate is small. (small impact)		Waste will be heaped on flat fields; partial alteration of landscape is possible. The effect on the climate is small. (small impact)	A-2 (small impact) A-4 (small impact)
	Transfer Station			Changes brought about by the construction of the Transfer Station will be small compared to the changes accompanying the construction of the Final Disposal Site. The effect on the climate is small. (small impact)		

Alternative		A-1	A-2	A-3	A-4	A-5
Disposal Site		Acahualinca	Santa Ana		Esquipulas	Santa Ana & Esquipulas
Transfer System		without		with	without	
(8) Landscape	Disposal Site	The hill on the eastern side of the Project Area shall be partly altered. Traces of the Disposal Site's existence will be observable. The landscape will be affected. (has an impact)	The flattening of the valley area for the construction of a waste landfill will affect the landscape. (has an impact)		The landscape will be affected by the heaping of waste in the flat field. (has an impact)	Same as A-2 and A-4. (has an impact)
	Transfer Station			New building will affect the landscape. (has an impact)		

Table H.5.4g The Results of The Preliminary Impact Assessment of The Proposed Alternatives on Pollution

Alternative			A-1	A-2	A-3	A-4	A-5
Disposal Site			Acahualinca	Santa Ana		Esquipulas	Santa Ana & Esquipulas
Transfer System			without		with	without	
(1) Air Pollution	Disposal Site	Impact of waste	Possible reduction particle dispersion and the generation of harmful matter from waste by water sprinkling, sufficient surface compaction of cover soil and sanitary filling. (small impact)				
		Effect of collection vehicles on traffic	The portion of collection vehicles in any given traffic in the area is small; the volume of gas emitted by these vehicles is small. (small impact)				
	Transfer Station	Effect of facility construction works			None. (no impact)		
		Effect of collection vehicles			Same as the Disposal Site. (small impact)		
(2) Water Pollution	Disposal Site		The water quality of Lake Managua is deteriorating due to the discharge of domestic waste water and industrial waste water. The discharge of treated water does not affect the lake's water quality as it is of better quality than the latter. (small impact)	Although groundwater flows into the Pacific Ocean, it hardly carries any effect as the population in basins along the area is small. Water does not constantly flow into the downstream canal of the Project Area. Treated leachate is discharged into highly permeable canals and flows into the Pacific Ocean. Treated water seeps under as it flows in the canal and can possibly affect groundwater quality. (has an impact)		Groundwater flows into Lake Managua. Water does not constantly flow into the downstream canal of the Project Area. Treated leachate is discharged in highly permeable canals. Treated water seeps under as it flows in the canal and can possible affect groundwater quality. (has an impact)	A-2 (has an impact) A-4 (has an impact)

Alternative			A-1	A-2	A-3	A-4	A-5
Disposal Site			Acahualinca	Santa Ana		Esquipulas	Santa Ana & Esquipulas
Transfer System			without		with	without	
(2) Water Pollution	Transfer Station				Waste water is carried to the Final Disposal Site for treatment. Waste water does not directly affect groundwater quality. (no impact)		
(3) Soil Contamination	Disposal Site		Leachate is discharged after treatment; its discharge is not considered harmful to the air and bears little impact on the soil. (small impact)				Same as A-2 and A-4. (small impact)
	Transfer Station				Waste water is carried to the Final Disposal Site for treatment. Waste water does not directly affect groundwater quality. (no impact)		
(4) Noise and vibration	Disposal Site	Effects of vehicles and machineries	Noises from the use of transportation vehicles and machineries for the reclamation works can be reduced by speed reduction and better clutch control. (small impact)				
		Impact of transportation vehicles on roads	Use of existing access roads (no impact)	Generation of additional noise and vibration due to the passage of transportation vehicles. (has an impact)			

Alternative			A–1	A–2	A–3	A–4	A–5
Disposal Site			Acahualinca	Santa Ana		Esquipulas	Santa Ana & Esquipulas
Transfer System			without		with	without	
(4) Noise and vibration	Transfer Station	Impact of transportation vehicles on roads			Same as the impacts of the transportation vehicles of disposal sites A–2 and A–4. (has an impact)		
(5) Land Subsidence	Disposal Site	Groundwater pumping	Land subsidence will not occur as groundwater pumping will not be implemented. (no impact)				
	Transfer Station				Land subsidence will not occur as groundwater pumping will not be implemented. (no impact)		
(6) Offensive Odor	Disposal Site		Generation of offensive odor can be reduced through the implementation of sanitary landfill and cover soil works. (small impact)				
	Transfer Station				Reduction of offensive odor by washing the floors of the working area and transfer of wastes in an enclosed area. (small impact)		

bc. General Evaluation of alternatives

The results of the general evaluation of the 5 alternatives on environmental issues are shown in Table H.5.4i. The evaluation points A–1 out as the most suitable optimum alternative. The outline of the evaluation is explained hereafter.

bca. Selection of the Optimum Alternative

Optimum alternative is an alternative with the least impact on the environment. The best alternative for the city of Managua is one which bears the least impact on groundwater, the city's water source. A–1 was found to satisfy this requirement, whereas the other 4 alternatives failed.
Alternative A–1 was also observed to have the least impact on other environmental items in comparison with the other alternatives.
The impacts of the other 4 alternatives on the social environment, natural environment, and pollution were evaluated to be almost the same. No indisputable differences were observed. Among these four, however, Alternative 3, which has a transfer station, and alternative 5, which has 2 final disposal sites, will be ranked at the bottom as they are considered to have the largest impact on the environment.

bcb. Selection of the second and third best alternatives

Alternative 4 is considered as the second best alternative while Alternative 2 is considered the third, as both have respectively the least environmental impact among the remaining 4 alternatives.

bcc. Selection of the fourth and fifth best alternative

The fourth best alternative is Alternative 3 as it has a low impact on the environment and has a final disposal site and a transfer station. The fifth best alternative is A–5.

Table H.5.4h General Evaluation of Alternatives

Alternative		A-1	A-2	A-3			A-4	A-5		
Items for Evaluation		Final Disposal Site		Final Disposal Site	Transfer Station	Evaluation	Final Disposal Site	Final Disposal Site		
								A-2	A-4	Evaluation
1. Social Environment										
(1) Resettlement		A	B	B	A	B	A	B	A	B
(2) Economic Activities		B	B	B	A	B	C	B	C	C
(3) Traffic and Public Facilities		A	C	C	A	C	C	C	C	C
(4) Community Separation		A	A	A	A	A	A	A	A	A
(5) Remains and Cultural Property		A	A	A	A	A	A	A	A	A
(6) Water Right and Right to Common		A	A	A	A	A	A	A	A	A
(7) Public Health Condition		B	B	B	B	B	B	B	B	B
(8) Waste		A	A	A	A	A	A	A	A	A
(9) Natural Disaster		A	B	B	A	B	A	B	A	B
Evaluation of the Social Environment	A	7	4	4	7	4	6	4	6	4
	B	2	4	4	1	4	1	4	1	3
	C	0	1	1	1	1	2	1	2	2
2. Natural Environment										
(1) Topography and Geological Features		B	B	B	B	B	B	B	B	B
(2) Soil Erosion		B	B	B	B	B	B	B	B	B
(3) Groundwater		B	C	C	A	C	C	C	C	C
(4) Flow Condition of Lakes, Marshes, Rivers		A	B	B	B	B	B	B	B	B
(5) Coastal Zone		A	A	A	A	A	A	A	A	A
(6) Flora and Fauna		B	B	B	A	B	A	B	A	B
(7) Meteorology		B	B	B	B	B	B	B	B	B
(8) Landscape		C	C	C	C	C	C	C	C	C
Evaluation of the Natural Environmental Sector	A	2	1	1	3	1	2	1	2	1
	B	5	5	5	4	5	4	5	4	5
	C	1	2	2	1	2	2	2	2	2
3. Pollution										
(1) Air Pollution		B	B	B	A	B	B	B	B	B
(2) Water Pollution		B	C	B	A	C	C	C	C	C
(3) Soil Contamination		B	B	B	A	B	B	B	B	B
(4) Noise and Vibration		A	C	C	C	C	C	C	C	C
(5) Land Subsidence		A	A	A	A	A	A	A	A	A
(6) Offensive Odor		B	B	B	B	B	B	B	B	B
Evaluation of the Sector on Pollution	A	2	1	1	4	1	1	1	1	1
	B	4	3	3	1	3	3	3	3	3
	C	0	2	2	1	2	2	2	2	2
Sum Evaluation of the 3 Sectors	A	11	6	6	14	6	9	6	9	6
	B	11	12	12	6	12	8	12	8	1
	C	1	5	5	3	5	6	5	6	6
Ranking of the Alternatives		1	3	4			2	5		

(A:almost without any impact, B:small impact, C:has an impact)

H.5.4.4 Financial and Economic Evaluation

a. Financial Evaluation

aa. Evaluation Method

Financial evaluation was carried out by determining the alternative with the least cost, since their benefits do not significantly differ and evaluation can only be carried out qualitatively. The alternative that would satisfy the environmental standards, with the least cost shall be selected as the optimum alternative.

The financial feasibility of MSWM was studied by taking into account the waste disposal cost affordable to the residents according to the Public Opinion Survey Results.

ab. Expenses

The costs MSWM to be financially evaluated will be taken as the waste disposal cost of Managua City in the year 2010. These include Operation and Maintenance Cost, and Depreciation Cost; interest rates are excluded.

ac. Evaluation Results

aca. Evaluation using the Least Cost Method

Table H.5.4i shows the cost of every alternative. Alternative A-1 is selected as the optimum alternative as it bring about the least cost. The next choices are Alternatives A-4, A-3, A-5 and A-2, respectively.

i. Alternative A-1

The final disposal site proposed in Acahualinca brings about the least cost in terms of collection, haulage and transport of waste to disposal site in comparison to all alternatives.

ii. Alternatives A-2, A-3

The collection and haulage cost of A-2, which has no transfer station, is 12% higher than A-3, which has a transfer station. However, if the final disposal site will be located in Santa Ana, the construction of a transfer station is considered to be more economical. Nevertheless, the cost of A-3 is still 11% higher than A-1,

in spite of the construction of the transfer station as a cost reduction measure.

iii. Alternative A-4

The final disposal site proposed in Esquipulas, represented as alternative A-4, brings about a collection and haulage cost 8% higher than A-1; the total cost is also 10% higher. This is mainly attributed to the fact that the covering material is taken from outside of the disposal site, hence the higher costs for its transport to the final disposal site.

iv. Alternative A-5

This Alternative is ranked below A-4 in terms of collection and haulage cost. The total cost will be 15% higher than A-4 due to the operation cost of the 2 final disposal sites proposed in this alternative.

Table H.5.4i Financial Evaluation (Unit:million Cordobas)

Alternative		A-1	A-2	A-3	A-4	A-5
Total cost (including depreciation cost)		89.67	104.08	99.60	98.73	103.37
Collection, transportation expenses		46.60	59.05	50.48	50.11	49.37
Transfer station expenses		-	-	4.13	-	-
Street cleansing expenses		5.84	5.86	5.84	5.85	5.85
Park cleansing expenses		5.66	5.75	5.73	5.66	5.74
Final disposal expenses		29.55	31.40	31.40	35.09	40.40
Management expenses		2.02	2.02	2.02	2.02	2.02
O&M cost		37.93	45.60	41.03	39.88	41.26
Evaluation using the least cost method	Total cost	1	5	3	2	4
	O&M cost	1	5	3	2	4

ad. Financial Feasibility

Although Section H.6.5 deals with how these costs are to be shared, Table H.5.4j shows the distribution of the cost among the residents, industries and Managua City, and the percentage the cost covers in the family income and the city budget.

Residents – cost for collection, haulage and disposal of household wastes in Collection Area A

Industries – cost for collection, haulage and disposal of wastes generated through industrial activities (commercial, hospital, industrial and market waste)

Managua city
- cost for collection, haulage and disposal of household waste from Collection Area B;
- cost for collection haulage and disposal of waste generated by institutions;
- cost for cleansing, collection, haulage and disposal of waste in streets, parks, etc..

Table H.5.4j Residents', Industries' and Managua City's Share of MSWM Costs

Alternative		A-1	A-2	A-3	A-4	A-5
Total cost (C$ 1,000,000)		89.67	104.08	99.60	98.73	103.07
Distribution of costs	Residents	41.11	49.21	46.62	45.61	47.52
	Industries	13.23	14.83	14.47	15.24	16.82
	Managua city	35.32	40.04	38.52	37.88	39.05
Allocation of residents' share in the expenses	Household population in area-A	156,286				
	Average family income/month	2,689				
	Percentage of expenses in family income	0.82	0.98	0.92	0.90	0.94
Managua city's share in the expenses	Total budget	464.06				
	Percentage of expenses in city budget	7.61	8.63	8.32	8.16	8.41

Note: 1) Share imposed based on the volume of waste discharged
2) June 1994 exchange rate: US$ 1.00 = C$ 6.62

The waste disposal cost of each alternative covers less than 1% of the family income. Conclusively, the residents can afford waste disposal services.

The Public Opinion Survey states that residents in Collection Area-B are willing to spend up to 1.5% of their family income for waste disposal services. Although the Master Plan study exempts this collection area from payment, based on the residents willingness to pay, any expense involving the carrying of waste to the containers will be the responsibility of the residents.

The municipal share in the SWM cost is estimated to be 7.6% to 8.6% of the whole municipal budget in 2010, almost equal to the current financial budget. However, the inclusion of interest rates will actually raise the cost.

Although a detailed economic analysis would be necessary in this assumption, the percentage calculated above makes it possible to conclude that MSWM operations can still be continued in the year 2010.

b. Economic Evaluation

A full scale economic evaluation will be carried out in the Feasibility Study. This section only deals with the qualitative evaluation of the benefits that can be derived from the implementation of the alternatives.

ba. Benefits

The benefits that can be derived from the alternatives are the improvement of sanitary conditions and the use of a final disposal site. Only qualitative comparisons were conducted since quantitative evaluations were difficult to carry out.

i. Improvement of Sanitary Conditions

The best benefit that the alternatives can contribute to the residents of Managua City is improved sanitary conditions, through the expansion of collection areas, and landfilling methods. There are no differences in the benefits of the alternatives; they will all effect the same level of improved sanitary conditions.

ii. Ultimate Use of Final Disposal Sites

The use of these areas shall be limited to greenbelt zones or parks. With this as a premise in the selection of disposal sites, those closest to urban areas are favorable. Based on the benefits that can be derived from the use of these areas, Alternative A-1 is considered to be the optimum alternative, respectively followed by A-4, A-5, A-2 and A-3.

iii. Increase in Job Opportunities

More jobs will arise from the expansion of collection areas and the improvement of final disposal sites.

H.5.4.5 Overall Evaluation

The overall evaluation of each aspect i.e. technical, social, environmental and financial is given hereafter.

a. Evaluation

aa. Alternative A-1

A-1 is the best alternative regarding all evaluation aspects. The following aspects are superior to other alternatives.

- disposal site acquisition is simple as it is municipal property
- no impact on drinking water
- least cost alternative

However, the operation of a disposal site will ruin the aesthetic view of Lake Managua. In order to solve this problem, the following shall be conducted:

- daily covering of incoming waste
- establishing suitable future land use plan for the site
- construction of a buffer zone

ab. Alternative A-2

A-2 is unsuitable due to the following aspects:

- land acquisition will require negotiation with another municipality
- longest haulage distance
- impact on drinking water by leachate
- most expensive alternative

ac. Alternative A-3

A-3 is unsuitable due to the following aspects:

- land acquisition is difficult as it is privately owned
- transfer station needs to be constructed to reduce haulage distance
- impact on drinking water by leachate
- cost is higher than A-1

ad. Alternative A-4

A-4 is unsuitable due to the following aspects:

- land acquisition is difficult as it is privately owned
- impact on drinking water by leachate
- cost is higher than A-1

ae. Alternative A-5

A-5 is unsuitable due to the following aspects:

- land acquisition is difficult as it is privately owned
- two disposal site leads to high construction cost and complex management system
- impact on drinking water by leachate
- cost is higher than A-1

b. Summary of Overall Evaluation

Overall evaluation is summarized in Table H.5.4k.

Table H.5.4k Summary of Overall Evaluation

Criteria	Alternative				
	A-1	A-2	A-3	A-4	A-5
a. Technical Evaluation	A	B	B	B	B
b. Social Evaluation	A	B	B	B	B
c. Environmental Evaluation	A	C	C	C	C
d. Financial Evaluation	A	B	B	B	B
Overall Assessment	A	B	B	B	B

Note: A: good B: fair C: poor

In addition to the above-mentioned advantages, in Alternative A-1 Acahualinca landfill can be Level 3 which will not treat leachate. The reasons are:

- For sanitary landfill Level 3, the costs for investment and operation and maintenance are cheaper than Level 4 by C$ 39.3 million and C$ 1.34

million/year, respectively.

- Contaminant load of sewage on Managua lake is considerably heavier than leachate from the landfill. For the improvement of lake water quality, treatment of the sewage is more desirable than the leachate. If a sewage treatment plant is constructed in the future, the leachate will be able to be treated at the plant.

H.6 Institutional Requirements

H.6.1 Administration

The institutional requirements concerning the administration of the Solid Waste Management System will be dependent upon the decision of the municipality concerning the organizational model to be chosen by the heads of the municipal administration.

The municipality has to decide on the degree of centralization or decentralization. This shall be followed by resolutions concerning administration and decisions will be made as to whether there will be some kind of privatization or contracting out of the Solid Waste Management activities and to what extent.

These decisions will determine the type of administration that will be best suited for the organization in charge of collection, street cleansing and disposal services. This has to be made by those responsible within Managua City administration, following formal consultations by the Study Team.

Today, the administration of the Solid Waste Management System is entirely dependent upon the municipal government and does not rely on private contractors. However, many alternatives of private participation may be considered, such as:

a) Private operation (with provision of drivers and collection crew) using municipal trucks, equipments and buildings.

b) Private maintenance of trucks only and municipal ownership and operation.

c) Private collection operation with private ownership of trucks, equipment and buildings.

d) Private provision of trucks and drivers and allocation of collection crew by the municipality.

Taking into account the surplus of collection trucks' donated to the Municipality of Managua, the most plausible ways to deal with privatization should be alternatives a) or b).

H.6.2 Organization

The type of organization that will be required to manage the institutional system will be fully dependent on the type of administration selected, which in turn will be conformed with taking into account private sector involvement and the degree of independence and autonomy of the solid waste management agency.

If privatization is acceptable to a certain extent, the organizational structure shall incorporate control and supervision of the private service providers, which will be very different from the structure required, if services are to be provided by the municipality.

Proposed organization of Public Cleansing Office is shown in Figure H.6.2a.

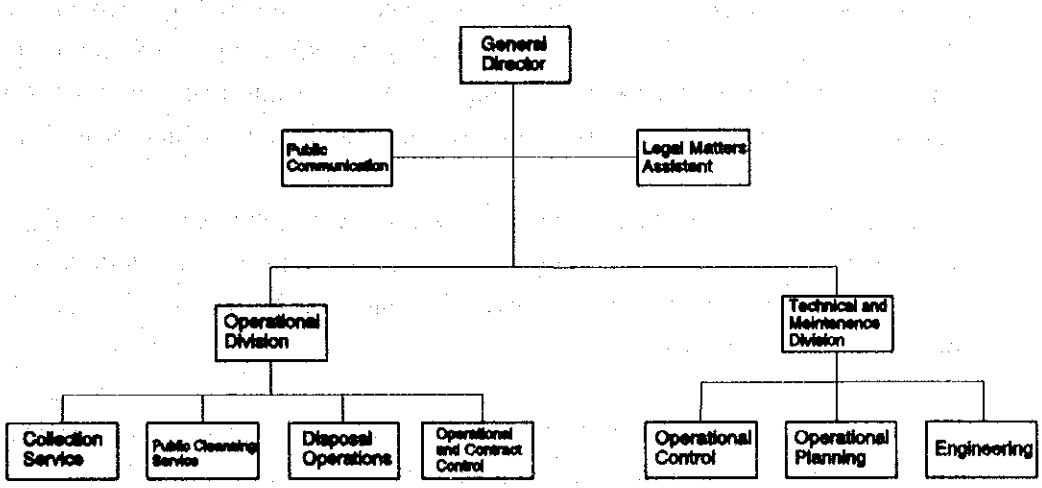


Figure H.6.2a Public Cleansing Office Direct Administration Centralized

H.6.3 Legislation and Enforcement

Legislation concerning Solid Waste Management is almost non-existent in Managua, but there are some rather general and outmoded ordinances on cleansing of open areas and the prohibition of discharging wastes to the streets or water bodies. In order to cope with the lack of appropriate ordinances, a Solid Waste Code shall be prepared so that the Municipality can define grounds to compel the citizens to behave properly, mainly on littering matters.

This code shall be simple and objective, clearly defining punishments and fines for the offenders, so that the people cooperate with the efforts to keep the city clean and beautiful.

A good initiative that shall be closely evaluated is the one that was started by the Ministry of Health with the assistance of the National Police to enforce the Sanitary Code, mainly on matters related to Solid Waste.

The results of this initiative indicate that the issuance of a new Code is important but not the key factor for achieving the goals of changing the behavior and attitudes of the people. The key issue in fact is the effectiveness of the enforcement. If there is a political decision and will, the existing laws, although rather general and not specific to littering, are good enough to alter habits for the better.

Also, it shall be stressed that before the issuance of new codes and regulations, a public education program on environmental and sanitation matters shall be developed and implemented in the city, with emphasis in the areas where public cooperation is a necessity.

This initiative will make the enforcement program more effective and sustainable and most comprehensive to the general populace.

H.6.4 Privatization

a. Municipal Public Services

The municipal services constitute a group of technical activities performed by the municipal administration in a general, permanent, uniform and continuous way in order to satisfy the basic needs of the community.

Public cleansing, collection and disposal of solid wastes are closely related to the prevention of diseases and to the health of the nation, and as a public service, is considered relatively high in the list of national priorities.

The municipal law defines public hygiene, public cleansing, collection and disposal of solid wastes as a municipal duty.

In order to assure the delivery of the cleansing services permanently, and with the quality required by the population, it is important for the Municipality to have the necessary human, material and financial resources.

b. Possibility of Privatization of some Cleansing Services

ba. Goal of Privatization

The goal of privatization is to strengthen the private sector of the country, and at the same time diminish governmental burden.

bb. Concept of Privatization

The concept of privatization is the transfer of responsibility in delivering certain goods and services, with the purpose of achieving better efficiency and economic effectiveness through a competitive market.

bc. Objectives of Privatization

The objectives of privatization are:

- to manage with a reduced budget and increase incentives to individuals and communities
- to develop conditions whereby public services can be improved

- to increase tax collection rate

- to encourage the participation of new investors to enable the upgrading of technologies

bd. Perspective of Privatization of Some Cleansing Services

The Master Plan will provide opportunities for the decision makers in the Municipality of Managua to review the Solid Waste Management situation in the Study Area.

The current Cleansing Head Office was originally under a Municipal Enterprise, however, this system was unsuccessful, as the Solid Waste system was integrated without having its different roles clearly defined. Therefore, for future privatization, the objectives within each system shall be differentiated and made more comprehensive.

The Municipality of Managua has enough human and material resources, but lack of sufficient financial resources.

However, within 5 to 6 years, the quality of collection equipment will begin to deteriorate, requiring more spare parts, which is scarce and costly. Eventually these equipment will have to be replaced in order to contend with the rise in waste generation in conjunction to population increase.

The private sector could be a good alternative for delivering collection services to residents in a given area. However, under privatization, the contractors shall own the equipment but must meet all performance criteria established in the contract with the local authorities.

In order to efficiently introduce privatized collection service, local governments must establish regulatory control over SWM activities, which shall include: developing and implementing ordinances and regulations; establishing inspection, monitoring, and investigating complaints; initiating enforcement; and developing bid specifications and awarding contracts for services to be provided by private firms.

Privatization, however, involves social and economic risks and profits, such as job losses or gain.

Some present conditions provide a favorable outlook for private operation:

- The public has a positive view towards the involvement of the private sector in public services.

- Public sectors are flexible in terms of shifts which should produce cut backs in labor costs and other expenses.

- The local government will have less responsibilities on administrative details (ie. workshop, spare parts, manual labor for the maintenance of the equipment, etc.) in the collection system.

- The ability of the Municipality to provide public services cannot meet the demands brought on by the population growth rate.

H.6.5 Revenue Sources

The expenses for the cleansing services in the city of Managua are basically supposed to be covered by fees imposed for the collection of waste. In 1993, however, the collected amount of fees was only 5,100,000 cordobas, 22% of the 23,400,000 cordobas brought about by the cleansing services. The rest were allocated from the general accounts of the Municipality of Managua.

The targeted amount for collection in 1994 is 20,000,000 cordobas. Without inflation induced price increases, the accumulation of the said sum is estimated to cover 85% of the cleansing expenses. Unfortunately, only 40% of the sum was collected by June. Furthermore, an inflation rate of more than 10%, based on the exchange rate of the Cordoba to the US Dollar, makes it doubtful whether 30% of the cleansing expenses will be covered at all.

The establishment of an independent financial resource is desirable in order to secure the financial resources for the cleansing services in 2010 proposed in the Master Plan. But, in so doing, the following should be considered:

- establishment of a "Beneficiary Pay Principle"
- imposition of fees in accordance with the economic standing of the residents
- appropriate allocation of budget from the general accounts of the Municipality

a. Establishment of a Beneficiary Pay Principle

aa. Beneficiary Pay Principle

Cleansing services are indispensable to a comfortable urban life. Nevertheless, as the service level is improved, the volume of waste discharged tends to increase, consequently raising the expenses of the cleansing services.

An appropriately implemented solid waste management system, with the cooperation of the residents, will help control the generation of waste, which in turn will contribute to the curtailment of the expenses of the cleansing services.

A "beneficiary pay principle" will promote the payment of fees set according to the volume of waste discharged. However, the huge discrepancy in the income of the people of Managua City is a factor that could make fee collection incredibly difficult if the amount imposed is based on the volume of waste discharged. This particular principle would be a burden to the low income household group.

ab. The Economic Condition of the Residents

Only a maximum of 7% of the whole household population in Managua City receiving waste collection services are paying the fees. Before 1992, payment for household waste was added to the electric bill of households exceeding 100 kWh per month. Nevertheless, only about 30% was collected at that time since other residents such as collection area B did not pay the collection fee nor the local tax imposed.

According to the Public Opinion Survey (POS), about 1.0 – 1.3% of the monthly family income of both high and middle income groups such as collection area A are allocated to collection fees.
Given this condition, the collection fee for household waste will be examined, as below.

i. Collection Area A

In accordance with the "beneficiary pay principle", a waste collection, haulage, treatment and disposal fee will be collected from household waste dischargers of Collection Area A.

ii. Collection Area B

No charges will be imposed on this area for the collection method using container trucks in consideration of the improvements in the environment that will result from its implementation, i.e., prevention of illegal dumping and the elimination of RIDS (registered illegal dumping sites). The expenses brought about by this service will be allocated from the general accounts of the Municipality of Managua.

However, to heighten the residents' awareness about the importance of waste problems, they are obliged to carry their wastes to where the containers are located for collection.

ac. Collection System

About 80 % of the fees presently collected is from large generation sources such as industries, commercial area markets and offices, while less than 20% comes from households. Three quarters of the amount collected in 1992 were payments added to household electric bills.

Fee collection can be carried out in several ways, either directly or indirectly, as shown in Table H.6.5a.

The present collection system does not only take up plenty of time, but does not also give dischargers incentives for the discharge of less waste volume. In order to encourage many residents to pay, new methods should be applied and overall collection efficiency should be improved.

The proposed collection system is shown in Table H.6.5b.

For efficient collection services, the following are considered to be of extreme importance: appropriate disposition of staff and the use of high technology, e.g., computerized data base.

Table H.6.5a Comparison of Collection Methods

	Standard	Advantages	Disadvantages
Direct Collection			
Collection fees (current system)	Present system (length of lands of houses facing access road.)	- Easily collectible along with property tax	- Imposed fee is not in proportion to the volume of waste discharged - Disparity in service levels is not reflected in the imposed fee - Municipality income gets relatively lower than expenses due to inflation - expensive collection fee
Waste collection fee	Volume of waste	- Disparity in service levels is easily reflected in the imposed fee	- Requires the establishment of a new fee collection system - The fee imposed on low income groups increases - Measurement of waste volume is difficult
Indirect Collection			
Addition of the amount to the electric bill	Consumption of electricity, etc.	- Cost of fee collection is inexpensive	- Creates dissatisfaction as the collection fee imposed does not meet the quality of the cleansing services
Addition of the amount to community fees	Per household	- Cost of fee collection is inexpensive	- The fee imposed is not in proportion to the volume of waste discharged

Table H.6.5b Fee Collection System

Beneficiaries	Collection System	Collection Method
Residents		
Collection Area A	Waste collection fee	- Collectors are presently employed, but in the future, payments will be made through banks or at the office.
Collection Area B	Addition of amount to community fees	- A representative of the community directly makes the payment at the office.
Large Generation Sources		
General Collection	Waste Collection fee	- Payments through the bank or at the office
Collection of Large Quantities	Collection fee (based on the volume of the wastes)	- Payments through the bank or at the office
Direct Transport of Waste	Tipping fee (based on the weight of the waste)	- Payments directly at the disposal site - Payments through the bank or at the office

b. Appropriate Imposition of Fee and Allocation of Budget

The establishment of independent financial sources should be promoted in a step by step basis and will be pursued in the Master Plan under two phases.

- To ensure that by the year 2000 the O&M costs for collection, haulage, treatment, disposal, including some part of depreciation costs will be covered by the waste collection fees.

- To ensure that by the year 2010 the O&M costs for collection, haulage, treatment, disposal, including depreciation costs, will be covered by the waste collection fees.

H.6.6 Public Cooperation

a. Background

In order to gain acceptance for the proposed solid waste system, the formulation of a public education program is imperative. The need for a sanitary and efficient system should be made clear to the public.

Individual instruction may be conducted by the city council after its members are acquainted with the problems and possible solutions of SWM.

The most effective public cooperation is attained voluntarily through informative, educational and persuasive measures. If residents are involved, they are more likely to be motivated and cooperative.

b. Attainment of Public Cooperation

Public cooperation can be obtained through the following:

- public relations and communication
- good relations through effective SWM
- public education
- handling complaints

c. Items for Attaining Public Cooperation

ca. Public Relations and Communications

Public relations are methods and activities that should be employed by the Municipality to promote a favorable relationship with the public.

Residents are to be informed about SWM i.e. magnitude of the problem, costs, organization of the system, collection schedules and their deviations, rules for collection and penalties, new methods of waste disposal, etc..

The information should be presented attractively and in a manner designed to

obtain full cooperation. A system of communication must be implemented to familiarize, interpret, and clarify solid waste services to those who use them.

Public approval and good will, follow the realization that public services are rendered efficiently and that public employees are competent, willing and pleasant.

It is essential for the citizens to be aware of sincere desire of the public officials to render good services at low cost, and through such understanding, recognize the need for municipal regulations and the advantages of citizens cooperation.

cb. Good Relations Through Effective SWM

All municipal employees are obliged to be courteous and polite to the public who are in effect customers. Solid waste collectors, in particular should be more polite as they have more direct contact with residents than those working in other sections. This calls for proper training of the employees to conduct waste collection and thus eliminating complaints and promoting better public relations. The employees should look presentable, be courteous and answer in clear and definite terms whatever queries are put to them. The language and the tone of voice used by the workers should be considerate.

cc. Public Education

The carelessness and thoughtlessness of citizens and their disregard for even the simplest rules of cleanliness and sanitation, is reflected in littered streets, alleys, parks, vacant lots, and even private premises. This tends to produce an untidy appearance throughout the community and a general lowering of public morale.

While ordinances, rules, regulations, and penalties have their rightful place in a solid waste management plan, their enforcement leaves much to be desired. It has been found that as a part of the public communication program, a much easier and more sensible solution is to secure public cooperation through education campaigns.

Citizen groups, such as the church, chamber of commerce, Women's Institute, Boy Scouts etc., also aid public education programs to ultimately achieve a cleaner city. Prominent members of society, including both professional and business leaders are invited to assist in such programs.

Public education through the media is valuable, especially at the start of a new solid waste collection system or when existing services are modified. Periodic news releases in the local papers and television showing the various phases of the

collection and disposal service, photographs of good and bad practices, and similar information prepared in an attractive and popular style help to increase public awareness of what has to be done to provide a good refuse collection service and arouse interest in maintaining a clean city.

Seasonal clean-up campaigns will provide opportunities for public communication and cooperation. In these campaigns the residents are persuaded to get rid of junk which has accumulated in premises, garages as well as litter in back yards.

Education programs for school children is another option; it is a good policy; is essential for developing ethics on waste treatment among the future residents of the community.

Public education concerning refuse collection and disposal should be considered a long term activity, organized by the cooperative effort of public officials and citizen groups.

Clean up campaigns include sanitation parades, decoration with pro-cleanliness posters, and trash baskets, insinuations for the public to keep their city clean.

A campaign strategy can be approached in the following manner:

- determine the extent of the problems and causes
- establish the goals and objectives of the campaign based on the problems identified
- eetermine persons, groups, associations, equipment or facilities necessary for the achievement of the objective
- develop a plan to enlist support for the project
- employ the plan to reach specific aims
- intensive propaganda throughout the media and personal persuasion to gain the objectives
- as each goal is reached, commend those involved and proceed to the next one

Public education should be related to enforcement; prosecution often is reserved for cases involving habitual violations which could result in health hazards and public nuisances. However, every effort should be made to remind residents of

their obligations to cooperate with the Municipality in the operation of the solid waste management program.

cd. Handing Complaints

The number of complaints are often indicators of how successful the city's cleansing services are conducted: positive criticisms often pave the way towards an improved implementation of these services.

The correct procedure of handling complaints involves four principal stages:

- receiving the complaint
- assignment of responsibility for investigation and correction
- follow up
- notification of correction

The attitude of the public relations officer directly receiving complaints must be of extreme politeness as those filing the criticism are often unhappy and have a tendency of being irritable.
Clear lines of authority should be established for complaints especially for some which are not of routine nature and require assessments from higher authorities and should automatically be brought to the attention of the relevant officials. When this procedure is conducted correctly, the public will soon realize the efforts of the Municipality in trying to look after their interests.

d. Public Cooperation for the Area B Container Collection System

In squat areas, community participation is an important issue concerning the successful implementation of the collection system.

In these areas the residents are forced to live without basic public services, and the lack of waste collection service creates many registered illegal dump sites in various places. The residents of these areas have economic limitations; malnutrition is common especially in infants and access to preventive medicine is low. In addition, basic knowledge of public health is low in squat areas which is directly related to lack of education.

Generally speaking, providing collection services to these areas is not a top priority

as other matters must be attended to such as legalization of land tenure, improvement of housing facilities, drinking water, electricity, reducing unemployment etc..

However, it is advisable to combine the collection project with another equally important one, forming an attractive package.

The collection system should have a service level economically sustainable by residents. There is a possibility that the population may not be able to pay the collection fee and the success of the project will depend heavily on public participation.

The transition of collection system from open heaping to container collection will face many oppositions from residents who find it difficult to change their old habits. However, this can be avoided by the manner in which the project is introduced.

In order for the project to be accepted, it is essential to involve the community leaders. They should be educated so that they can help introduce changes rather than using an outside specialist who is perhaps not well acquainted with the local situations. In this way the leaders will be responsible for motivating the people.

Effective community participation comes about when health workers and engineers interrelate with the people and information will be provided which will be most comprehensive to them. Through this a common goal is reached.

As sanitation projects depend largely upon community participation; when sufficient time is taken to clearly explain activities in detail, the public responds and assume their responsibility and participate fully.

The first task, therefore, is to establish a meeting with the community leaders to discuss the project and the benefits of public health and sanitation. The district development committee should be approached and if possible with these community leaders form a task force comprising of different leaders and officials related to health, education, civilian groups, churches, etc.. Special considerations should be made concerning women's role in society, as often they are the family members who partake in solid waste management within the household, pay collection fees and take care of general family health.

This committee reviews and decides upon all development activities that need to be carried out within the district, and health education should be available to the people through the mass media and special workshops. Officers from the Municipality and Ministry of Health should play an important role as teachers in

this kind of education programs and should explain and clarify any points which may not be understood by any group and to create a better working ambience with more involvement from the public.

H.6.7 Institutional Requirements for Master Plan Alternatives

The Master Plan alternatives will be dependent upon the improvements needed by the technical system. To improve the current level of the Solid Waste Management System, problems related to registered illegal dump sites, low coverage in the squat areas and poor final disposal must be eradicated.

Today, the technical system of the Solid Waste Management activities in Managua is rather simple: one municipality is responsible for the whole system, only basic tasks are performed (collection, street sweeping and disposal), there are no treatment facilities and transfer operations.

The institutional requirements, accordingly, shall also be simple and straightforward, depending only upon political decisions that affect administrative and organizational alternatives.

Strategically, the alternative chosen shall comply with the following goals:

- to find a cost recovery system affordable to the general populace (including the cost for juridical persons--commerce, industry and institutions)
- to achieve financial sustainability; the ability to bear costs for future capital investments and replacement of trucks and equipments
- to render services to all the residents of the city, including the low income squat areas (although with different service levels)
- to guarantee the diversity of equipment use, including the ability to assist in emergencies
- to achieve public cooperation though environmental education and insure proper enforcement of regulations and guidelines

These goals and the ways to accomplish them are better explained ahead.

a. Affordability of Costs

The affordability of costs shall be attained through the following measures:

- Design of a technical system where the chargeable amount is compatible with the paying capacity of the population.
- Imposing tax or tariff to all beneficiaries of the services, and assure 100% collection.
- Differentiate the bills, according to the affordability of the payers and insuring a cross subsidy amongst the payers.
- Creating a tax collection capacity through a collection system, so that everybody is compelled to pay. A good solution to this problem would be to charge the people through another public service (just as in the case of the joint electric/waste collection bill).

b. Financial Sustainability

Financial sustainability shall be sought through a well balanced annual budget and the creation of a fund for investments that would be used when the vehicles and equipments need replacing after they reach their economical life span. This fund should be used only for this purpose, so that the city may free itself from the endless cycle of dependency on donations of new trucks from foreign governments.

c. Full Coverage

Full coverage of the collection and street cleaning services to all the city, including the low urbanized squat areas, is a goal which shall be linked with the definition of an adequate technical system.

One of the possible alternatives shall be the employment of the micro-enterprise system, which is used in many low income sections of several Latin American cities. These micro-enterprises usually employ 10 to 15 laborers, who are also partners of the enterprise and preferably residents of the area where the services are rendered.

The fees for financing the service is collected by one member of the micro-enterprise; the municipality only supervises this.
Experiences in other Latin American cities show that the average cost per household per month for the collection service provided by the micro-enterprises is around 1US$, excluding the transportation cost from a collection point near the

neighborhood to the final disposal site and the disposal costs itself, which shall be supported by the municipality.

Another alternative is the extensive use of the small containers (around $1m^3$ capacity) on street corners. This system is much more economical than curb collection and its implementation only requires new trucks which are specific to this system and instructions to residents concerning the manner of discharge.

d. Diversified Use of Equipment

The diversified use of equipment shall be insured in a city such as Managua which is subjected to frequent natural disasters, ranging from earthquakes to floods.

For the attainment of this goal contingency plans shall be prepared and an emergency system shall be in effect throughout the year.

e. Public Cooperation

Public cooperation shall rely in environmental education programs aiming for public understanding into problems related to public health caused by the poor management of the solid wastes and how disasters can be prevented through public cooperation.

This program shall not be implemented by the Solid Waste agency but rather by the municipality as a whole. The Environmental Protection Head Office is probably best suited for this task.

ANNEX I

THE MASTER PLAN

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ANNEX I THE MASTER PLAN

I.1 Planning Framework

I.1.1 Goal, Targets and Strategy

a. Goal

For the formulation of the MSWM draft master plan, the following is proposed as the Master Plan objective:

[Development and Realization of a Beautiful and Sanitary Environment in the City of Managua towards the 21st Century through Citizens' Participation and Establishment of Self-sustainable Solid Waste Management]

b. Targets

In order to realize the goal, the targets for the Municipality are set up and tabulated in Table I.1.1a.

Table I.1.1a Targets for Collection, Street Sweeping, Public Cleansing and Final Disposal Services

		Unit	1994	2000	2010
1.	Population (Urban Area)	Inhabitants	834,427	1,131,052	1,610,943
2.	Collection Coverage	% (inhabitants)	77.0 (642,100)	90.0 (1,017,947)	100.0 (1,610,943)
	Collection Area A	% (inhabitants)	66.7 (556,563)	66.7 (754,412)	66.7 (1,074,449)
	Collection Area B	% (inhabitants)	10.3 (85,537)	23.3 (263,535)	33.3 (536,444)
3.	Street Sweeping Distance	km	331	350	350
4.	Public Cleansing Area (Park & Green Area)	ha	16.7	45	45
5.	Sanitary Landfill Level	-	Level 1	Level 3	Level 4

c. Strategy Elements

The goal is to be specifically obtained through:

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

2. Provision of collection services in the urban area of the Municipality of Managua, including the illegal settlement area, and establishment of a reliable collection system under which regular services can be provided.

3. Construction of sanitary disposal sites employing sufficient measures for human and environmental protection.

4. Establishment of efficient street sweeping and public area cleansing systems.

5. Improvement of the Waste Fee System under the Beneficiary-Pay-Principle where service recipients pay waste fees and tipping fees established according to household financial capabilities.

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

7. Establishment of proper coordination among the several institutions on both national and municipal levels dealing with solid waste management, mainly to ensure legislation enforcement.

8. Establishment of roles befitting the organizations involved in solid waste management.

9. Strengthening management and administration systems.

10. Development of public participation and education programs.

11. Development of solid waste management human resources.

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

d. Strategy for Collection Area Expansion

da. Present Conditions

In the urban area of Managua city, the subject area of the MSWM improvement plan, the distribution of collection and non-collection areas is 77.0% and 23.0%, respectively.

The collection area is divided into collection areas A and B according to the

collection system provided. In collection area A, the curb collection system – the collection of wastes discharged by residents in front of their premises by compactor trucks (15.3m³)– is practiced. Collection area B, on the other hand, is predominantly a squat area where infrastructure such as roads and electric cables are poorly established. Wastes in this area are discharged in registered illegal dump sites (RIDS) and collected later on by municipal wheel loaders and dump trucks.

The non–collection area is mainly composed of makeshift settlements as in collection area B. Waste collection is not carried out in this area, however, due to the absence of suitable equipment.

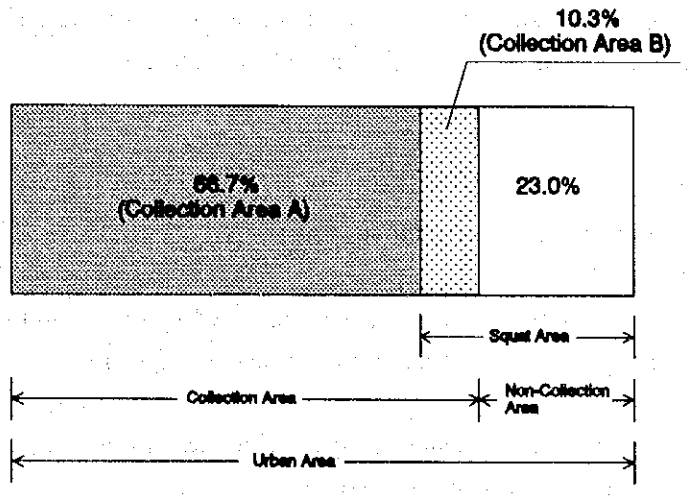

Figure I.1.1a Urban Area Definition in Terms of Collection Services

db. Forecast on Regional Structures

The population of the urban area is forecast to increase radically to 1.6 million, twice the present figure. The establishment of an infrastructure relative to the increase in population shall be a heavy burden to the municipality in consideration of present financial conditions. Accordingly, the master plan will assume that the percentage (66.7%) of the urban area population living in well developed areas will be the same in the future.

dc. Collection Area Expansion Strategies

The collection system employed in collection area A, a well developed area, will be modified, except for the use of compactor trucks. Collection area A is presently

almost completely covered by collection services that expansion is not required. Services in Collection area B, however, should be extended.

The present collection system in area B is not suited to the environmental state of the area. The General Urbanization Plan of Managua classifies Area B into 2 categories: spontaneous and progressive settlement areas. The spontaneous settlement area has no vehicular access road and constitutes 60% of Area B. The progressive settlement area is constructed with a road mainly for vehicular access and constitutes 40% of Area B.

Given these conditions, expansion of collection services in Area B will involve the use of the container collection system in the spontaneous settlement area and the bell collection system in the progressive settlement area.

Collection System

Collection Area A: Curb collection system
Collection Area B:

- Spontaneous Settlement: Container collection system
- Progressive Settlement: Bell collection system

The implementation of a container collection system in collection area B will require the following from the residents:

- Disposal of waste in the containers.
- Regular cleaning of the peripheral areas of the container.
- Inform the municipality if wastes other than household refuse is dumped, e.g. industrial and construction debris.
- Maintain a sanitary environment by sweeping streets and drains, picking up rubbish in public areas, avoid littering, etc.

dd. Collection Fee

The expansion of the collection area will not be feasible without a properly established fee collection system, in consideration of the present financial state of the municipality. Conclusively, the quality and quantity of the collection service are directly proportional to the waste fees. Charging of collection fees in collection area B is perceived to be difficult, however, because the majority of the residents are squatters.

To establish the beneficiary pay principle, the following waste fee system was

planned:

- Collection Area A

  Waste collection, haulage and disposal fees will be collected from the residents.

- Collection Area B

  Waste collection fees will be collected from the residents. The expenses for haulage and disposal services will be subsidized from the general budget of the Municipality of Managua.

- Large Generation Sources

  Waste collection, haulage and disposal fees will be collected from large generation sources.

- Direct Haulage by Waste Producers

  Waste tipping fees will be charged to waste directly hauled to the disposal site by producers and contractors.

e. Strategy for Leachate Control at the Acahualinca Newly Proposed Landfill Site (ANPLS)

ea. Background

ANPLS was selected because it will not affect groundwater quality, the drinking water source, regardless of its proximity to Managua Lake, the final destination of groundwater flow.

However, the quality of leachate originating from the present Acahualinca disposal site is worse than the quality of Managua Lake according to the water quality survey. Although the cause and effect relationship is unclear, it is quite definite that leachate is one of the factors that contaminate Managua Lake.

On the other hand, it is common knowledge that the concentration of sewage load in Managua lake is considerably heavier than leachate from the landfill.