L.1.6.6 Conceptual Design and Cost Estimation

Conceptual designs and cost estimations of Master Plan projects regarding MSWM are done in this section.

- Storage and Discharge System
- Collection and Transportation System
- Final Disposal System
- Maintenance of Vehicle and Equipment

L.1.6.6.1 Design Conditions

a. Target year

The projects in the MSWM Master Plan to be examined here is all projects which are planned to be implemented or operated in the year 2010.

b. Key Design Data

- ASG of waste when it is transported by refuse vehicles without compaction: 300 kg/m^3
- ASG of waste when it is transported by refuse vehicles with compaction: 500 kg/m^3
- Average waste transportation distance (a round trip): 20 km
- Operation time of waste collection time: 7.0 hours/day
  6 days/week

c. Life Year

- Handcart 3 years
- Trucks and heavy equipment: 7 years
- Machinery: 15 years
- Building and Civil works: 30 years

d. Waste Amount

The forecasted waste amount in 2010 is shown below. The details are described in the section, 2.6.1 Future Waste Amount and Composition.

- Waste Generation: 123.4 ton/day
- Recycling at Generation Source: 10.8 ton/day
- Waste Discharge: 102.0 ton/day
- Self-disposal at Generation: 10.6 ton/day
- Collection: 102.0 ton/day
- Illegal Dumping: 0.0 ton/day
- Recycling at Disposal Site: 0.0 ton/day
- Other Wastes: 2.5 ton/day
- Final Disposal: 104.5 ton/day

L.1.6.6.2 Storage and Discharge System

The proposed receptacles are nylon sacks, plastic bags and dustbins. These belong to individuals basically. Therefore, costs of them are not subjects of the cost estimation.

L.1.6.6.3 Collection and Transportation System

As a result of the examination in "Section L.1.6.3.6 Selection of an Optimum Technical System", the compactor truck is proposed as the waste collection vehicle.

a. Required Number of Vehicles

a.1 Compactor truck ($12m^3$)

The waste amount (household, restaurant, other shop market, street sweeping and institutional waste) in need of collection by compactor trucks in 2010 will be 100.2 ton/day. The required number of $12m^3$ compactor trucks will be 9 units according to the following calculation.

- Waste volume dealt with per day (Vd)

  $Vd = 100.2 / 0.5 \times 7/6 = 233.8\ m^3/day$

  - Waste amount in weight: 100.2 ton/day
  - ASG of waste: 0.5
  - Working days per week: 6 days

- Number of trips per day (Tr)

  $Tr = (7.0-(0.5+0.5)) / (20/40+1.25+0.2) = 3.08$ Say 3 trips

  - Working hours per day: 7.0 hr
  - Daily inspection and fueling time before working: 0.5 hr
  - Daily inspection and washing time after working per day: 0.5 hr
  - Travel distance per trip: 20 km
  - Velocity: 40 km/hr
  - Loading time: 1.25 hr
  - Unloading time: 0.2 hr

- Required number of vehicles (Nv)

  $Nv = Vd / (12x0.8) / Tr \times 1.1 = 233.8 / (12x0.8) / 3 \times 1.1 = 8.93$

  Say 9 units

  - efficiency of loading capacity: 0.8
  - reserve rate of vehicle: 0.1

a.2 Tipper truck ($10m^3$)

The waste amount (bulky waste) in need of collection by a tipper truck in 2010 will be 1.8 ton/day. The required number of $10m^3$ tipper truck will be 1 unit according to the following calculation.

- Waste volume dealt with per day (Vd)

  $Vd = 1.8 / 0.3 \times 7/6 = 7.0\ m^3/day$

  - Waste amount in weight: 1.8 ton/day
  - ASG of waste: 0.5
  - Working days per week: 6 days

- Number of trips per day (Tr)

  $Tr = (7.0-(0.5+0.5)) / (20/40+1.0+0.2) = 3.53$ Say 4 trips

  - Working hours per day: 7.0 hr
  - Daily inspection and fueling time before working: 0.5 hr
  - Daily inspection and washing time after working per day: 0.5 hr
  - Travel distance per trip: 20 km
  - Velocity: 40 km/hr
  - Loading time: 1.0 hr
  - Unloading time: 0.2 hr

- Required number of vehicles (Nv)

  $Nv = Vd / (10x0.8) / Tr \times 1.1 = 7.0 / (10x0.8) / 4 \times 1.1 = 0.24$

  Say 1 unit

  - efficiency of loading capacity: 0.8
  - reserve rate of vehicle: 0.1

a.3 Wheel Loader

A small type of wheel loader is suitable fo the work, i.e., elimination of illegal dumping waste balky waste from parks ad green areas. Then, a 75ps wheel loader is recommendatabe.

a.3 Handcart

The required number of handcarts is 30 units, suppose that the number of sweepers will not change so much in 2010 compared with in the present.

b. Cost Estimation

Table L-64 shows the approximate collection cost.

Table L-64: Cost of Collection Service

Description	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Investment Cost												
Compactor	C$1,000	4,267	853	0	0	853	853	0	5,120	853	0	0
Tipper truck	C$1,000	598	0	0	0	0	0	0	598	0	0	0
Wheel loader	C$1,000	768	0	0	0	0	0	0	768	0	0	0
Handcart	C$1,000	67	0	0	67	0	0	67	0	0	67	0
Total	C$1,000	5,700	853	0	67	853	853	67	6,486	853	67	0
O&M Cost												
Fuel cost	C$1,000/y		218	251	251	251	283	316	316	349	349	349
Labor cost	C$1,000/y		901	1,011	1,011	1,011	1,121	1,231	1,231	1,341	1,341	1,341
Maintenance cost	C$1,000/y		779	804	804	804	828	852	852	877	877	877
Total	C$1,000/y		1,898	2,066	2,066	2,066	2,232	2,399	2,449	2,567	2,567	2,567

The total cost up to 2010 will be as follows:

- investment cost 19,972 (C$1,000)
- O&M cost 22,827 (C$1,000)
- total cost 42,799 (C$1,000)

L.1.6.6.4 Final Disposal System

a. Conditions

- site: San Jose de la Viuda
- planed year: 2010

  The new landfill is planed to be used from 2001 to 2010. The design capacity should cover the use of the period. Meanwhile, the existing landfill, La Joya, would be operated up to 2000.

- total waste amount disposed (2001 to 2010): 291.5 (1,000ton)

  364.6 (1,000m^3)

  ASG of waste is 800 kg/m^3, when it is compacted at a disposal site.

- total covering soil amount (2001 to 2010): 73.1 (1,000m3)

  Covering soil is 20% to waste amount in quantity.

- required landfill capacity: 388 (1,000m3)

  364.6+73.1=437.7 say 438 (1,000m^3)

- sanitary level: level 4

b. Technical Description

b.1 Construction

The landfill site should be made up with the following facilities.

- Access Road
- Main Facilities
  - Enclosing bund, divider
  - Drainage system
  - Approach road, on-site road
- Environmental protection facilities
  - Buffer zone
  - Gas removal facilities
  - Leachate collection facilities
  - Leachate regulation pond
  - Leachate treatment facility
- Building and accessories
  - Site office
  - Weigh bridge
  - Safety facilities: Gates, fences, lighting
  - Fire prevention facilities: Water tank, extinguisher,
  - Other: Parking lot, greenery, car wash, etc.

1) Enclosing Structure

The purpose of enclosing structure is to limit an area in which waste is disposed, and to prevent stormwater from coming in and going out of the area. There are some kinds of enclosing structures.

Enclosing Bund

- The enclosing bund banked with earth limits the area in which waste during planed usage period is disposed.

Divider

- The divider limits the area in which waste is disposed during a certain short period (ex. 4months, 6months or 1year). The main purpose of a divider is to reduce quantity of leachate.

2) Drainage System

Drainage system has very important role to maintain the site and roads in good condition and also to control leachate.

Side Drain

The side drain is constructed around the enclosing bund to protect it from being destroyed by stormwater drain from the outside, and to drain stormwater out of the inside.

3) Access

Approach Road

The approach road is constructed to connect the road running in front of the site and the landfill for waste collection vehicles. This is the asphalt paved road from the road to the weigh bridge, and the rest(weigh bridge to the landfill) is the gravel paved road.

On-site Road

The on-site road is constructed on the enclosing bund to maintain it and the side drain ditch. This is the gravel paved road.

4) Environmental Protection Facilities

The facilities are for the prevention of primary and secondary pollution outbreak during and after completion of landfill operations.

Buffer Zone

Buffer zone is provided circumference of the landfill for the purpose of ;

- To screen the landfill,
- To reduce the noise and vibrations emitted during landfilling operation,
- To balance the site with the natural surroundings in a harmonious fashion.

The buffer zone is formed with green belt made of plants and its width is 20m.

Gas Removal Facilities

The facilities are to exhaust gas made by decomposition of organic waste.

Leachate Collection Facilities

The facilities are to collect leachate (i.e. the rainwater contaminated by waste and the water generated when waste is decomposed). This facilities consist of some structures.

Leachate Regulation pond

The facilities are to regulate the amount of leachate going to leachate treatment facility.

Leachate Treatment Facility

The leachate treatment facility consists of a facultative lagoon and a maturation pond, which is basically a same treatment used in the Teperate sewage treatment plant.

Impermeable Layer

This is a layer provided on the bottom of the landfill area to prevent a leachate seepage. This can be clay material.

5) Building and Accessories

These facilities include a site office, a weigh bridge, safety facilities, fire prevention facilities, parking and car washing yard, monitoring facilities, etc.

b.2 Equipment

Some heavy equipment and trucks are needed for operating the landfill. The followings are considered as the operating equipment in this M/P.

- Bulldozer (219 HP): 1 unit
- Excavator (83 HP): 1 unit
- Tipper truck (8 ton): 1 unit
- Sprinkler truck (6 - 7 ton): 1 unit

Bulldozer

This is used for smoothing and compacting waste. The required number is 1 unit according to the following calculation.

- Probable cycle time (Cm)

Pushing: 15 m @ 60 m/min	= 0.250 min
Returning: 15 m @ 80 m/min	= 0.188 min
Fixed time, loading and shifting gears	= 0.200 min
Total cycle time	= 0.638 min

- Capacity per hour (Qh)

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

Qh: Capacity per hour	(m^3/h)
q: Capacity per pushing	2.0 m^3
f: Conversion factor of waste	1.0
E: Operation efficiency	0.5
Cm: Cycle time	0.64 min

Qh = 60 x 2 x 1.0 x 0.5 / 0.64 = 93.8 m^3/h

- Waste volume dealt with per day (Vd)

The waste amount disposed in the landfill in 2010 is 104.5 ton/day. This becomes 246.8 m^3/day.

- waste brought by compaction trucks
  - amount: 100.2 ton/day
  - ASG: 0.5
- waste brought by a tipper truck
  - amount: 1.8 ton/day
  - ASG: 0.5

- other waste
  amount: 2.5 ton/day
  ASG: 0.3

$Vd = (100.2 / 0.5 + 1.8 / 0.5 + 2.5 / 0.3) \times 7/6 = 247.7\ m^3/day$

working days per week: 6 days

- Required number (Nv)

$Nv = Vd / (Qh \times 7) = 247.7 / (93.8 \times 7) = 0.38$ say Nv = 1 unit

working hours per day: 7 hours

Excavator

This is used mainly for dealing with covering soil. The required number is 1 unit according to the following calculation.

- Probable cycle time (Cm): 0.75 min
- Capacity per hour (Qh)

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

Qh: Capacity per hour	(m^3/h)
q: Capacity of bucket	0.45 m^3
f: Conversion factor of waste	1.0
E: Operation efficiency	0.5
k: Bucket efficiency	0.85
Cm: Cycle time	0.75 min

$Qh = 60 \times 0.45 \times 1.0 \times 0.5 \times 0.85 / 0.75 = 15.3\ m^3/h$

- Soil volume dealt with per day (Vd)

The covering soil volume in 2010 is 23.1 m^3/day.

$104.5 / 0.9 \times 20\% = 23.2\ m^3/day$

- Required number (Nv)

$Nv = Vd / (Qh \times 7) = 23.2 / (15.3 \times 7) = 0.22$ say Nv = 1 unit

Tipper Truck

This is used for transporting covering soil. The required number is 1 unit according to the following calculation.

- Probable cycle time (Cm): 40 min
- Capacity per hour (Qh)

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

Qh: Capacity per hour	(m^3/h)
q: Capacity of body	6.0 m^3
f: Conversion factor of waste	1.0
E: Operation efficiency	0.5
k: Bucket efficiency	0.85
Cm: Cycle time	40 min

Qh = 60 x 6.0 x 1.0 x 0.5 x 0.85 / 40 = 3.8 m^3/h

- Soil volume dealt with per day (Vd)

The covering soil volume in 2010 is 23.1 m^3/day.

104.5 / 0.9 x 20% = 23.2 m^3/day

- Required number (Nv)

Nv = Vd / (Qh x 7) = 23.2 / (3.8 x 7) = 0.87 say Nv = 1 unit

Sprinkler truck

This is used for preventing waste and soil from scattering. This works with the bulldozer, therefore, the required number is 1 unit.

c. Cost Estimation

Table L-65 shows the approximate construction cost of the landfill.

Table L-65: Construction Cost of Landfill

Unit: C$ 1,000

Description	2000	2005
Direct cost	1,500	-
1. Access road	3,950	-
2. Site buildings and administration	10,889	5,294
3. Sanitary landfill	6,400	-
4. Leached treatment	22,739	5,294
Sub total	2,274	524
Physical contingency	25,013	5,818
Total direct cost		
Overhand	6,252	1,455
Total construction cost	31,265	7,273
Design and supervision	3,127	727
Total project cost	34,392	8,000
Land Acquisition	600,000	0
Total	42,992	

Table L-66 shows the approximate equipment cost and O&M cost of the landfill.

Table L-66: Equipment and O&M cost of Landfill

Description	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Investment Cost												
Bulldozer	C$1,000/y	1,639	0	0	0	0	0	0	1,639	0	0	0
Excavator	C$1,000/y	979	0	0	0	0	0	0	979	0	0	0
Tipper truck	C$1,000/y	407	0	0	0	0	0	0	407	0	0	0
Sprinkler truck	C$1,000/y	572	0	0	0	0	0	0	572	0	0	0
Total	C$1,000/y	3,597	0	0	0	0	0	0	3,597	0	0	0
O&M schedule												
Fuel cost	C$1,000/y	0	108	116	120	126	135	156	165	172	181	191
Labor cost	C$1,000/y	0	203	203	203	203	203	203	203	203	203	203
Maintenance cost	C$1,000/y	0	139	139	139	139	139	139	139	139	139	139
Total	C$1,000/y		450	458	462	468	477	498	507	514	523	533

The total cost of the landfill up to 2010 will be as follows:

- investment cost
  - construction 42,992 (C$ 1,000)
  - equipment 7,194 (C$ 1,000)
- O&M cost 4,890 (C$ 1,000)
- total cost 55,076 (C$ 1,000)

L.1.6.6.5 Maintenance of Vehicle and Equipment

A new workshop for maintaining vehicles and equipment is recommended in the M/P.

Design Conditions

- Location: Modulo de Operacion (MOD)
- Function: preventive services
- Number of vehicles dealt with:

Compactor truck	9 units
Tipper truck(waste)	1 unit
Bulldozer	1 unit
Excavator	1 unit
Tipper truck	2 unit
Sprinkler truck	1 unit
Wheel loader	1 unit

Cost Estimation

- building work: 1,285 (C$ 1,000)
- maintenance machinery: 2,888 (C$ 1,000)
- total cost 4,173 (C$ 1,000)

O&M cost has already been calculated in the cost estimation of collection vehicle and landfill equipment.

L.1.7 Industrial Solid Waste Management

L.1.7.1 Major Findings of the Industrial Waste Survey

Industrial solid waste (ISW) generated amount in Granada is estimated about 1,000 ton/year, which is the smallest generation of ISW among the 3 cities. The industries in CIIU3111 (livestock slaughtering and meat production) is the main source of ISW generation in Granada, which counts for about 50% of ISW generation in Granada. The ISW of these industries (i.e., CIIU3111) mainly consists of organic compounds, and therefore it is less possible that hazardous ISW be included therein. Meanwhile the industries with high potentiality of generating hazardous waste in Granada is CIIU3231 (leather tanning), whose ISW counts for about 10% of the total ISW generation in Granada.

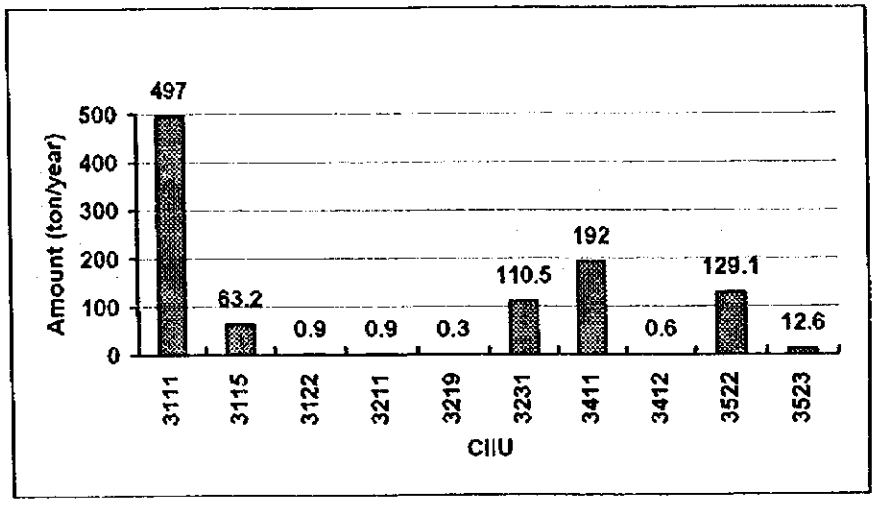

Figure L-29: Solid Waste Generation Amount

The great majority of the ISW generated from industries in Granada are disposed of at the municipal SW dumping site without control and in a disordered manner.

However, under such circumstances, legislation for treatment and/or disposal of ISW is not established at this moment, which is urgently needed and awaited.

L.1.7.2 General Recommendations on Technical System

a. Technical System

a.1 General Aspect

In the same principle for the IWWM, cost of safe treatment/disposal of ISW should be born by the industries by all means based on the "polluter pays principle (PPP)", since the ISW is generated and disposed of as a result of industrial production activities.

On the other hand, from a technological management viewpoint, the following will be listed as the key solutions for the problems:

- Reduction of ISW generation amount and reduction of its generated pollution load by means of production processes (including raw/auxiliary materials) conversions; and
- Establishment of appropriate treatment/disposal technologies.

In practice among others, the disorderly mixed dumping of ISW and domestic SW in the present landfill should be immediately prohibited.

In this context, legislation on appropriate management of ISW should be established in order for authorities to take administrative measures (e.g. manifest system) and be empowered in doing so. On the other hand, an integrated system to bind both industries and authorities in facilitating the appropriate ISW management should be sought and established.

a.2 Industrial Waste Management System

The treatment/disposal of ISW generated by the company's activities should be undertaken and its cost covered by the company which profits from its activities. On the other hand, the authorities should arrange necessary administrative measures including legislation/rules in order for ISW to be properly treated, and carry out necessary monitoring/supervision as well as instruct the companies to make sure that they observe these legislation and rules. The following items are recommended to be put into practice urgently for the effective monitoring and guidance.

- Introduction of a manifest system
- Classification of industrial solid waste
- Hazardous solid waste management
- Treatment and disposal system of industrial solid waste.

a.2.1 Manifest System

A manifest system needs to be introduced so that the authorities know where the ISW are generated and the routes which the ISW are transported from the generation sources and where and how it is finally disposed of according to the type of IW.

By introducing the following manifest system (see Figure L-30), the process of solid waste from its generation to final disposal can be understood by waste generators and competent authorities. Moreover, whether or not the ISW is properly treated/disposed of in accordance with its characteristics can be monitored.

- The generator of ISW issues the manifest sheet comprising 6 carbon copies((A) to (F)) which indicates type of solid waste, its volume, and the date of discharge, etc.
- The generator keeps one copy (A) of the manifest sheet and submit one copy (B) to the competent authorities.
- Four copies from (C) to (F) should be handed to the ISW transporter together with the ISW and the transporter should keep one (C) of these copies.
- Copies from (D) to (F) should be handed to the agent of the ISW final disposal site together with the ISW.
- The agent of the ISW final disposal site should keep one (D) of these copies and return (E) of the manifest sheet to the waste generator and (F) to the competent authorities.
- Competent authorities and the waste generator shall collate the manifest sheet they received from the agent of the ISW final disposal site with the manifest sheet they have been keeping and confirm whether the ISW was treated/disposed of properly or not.

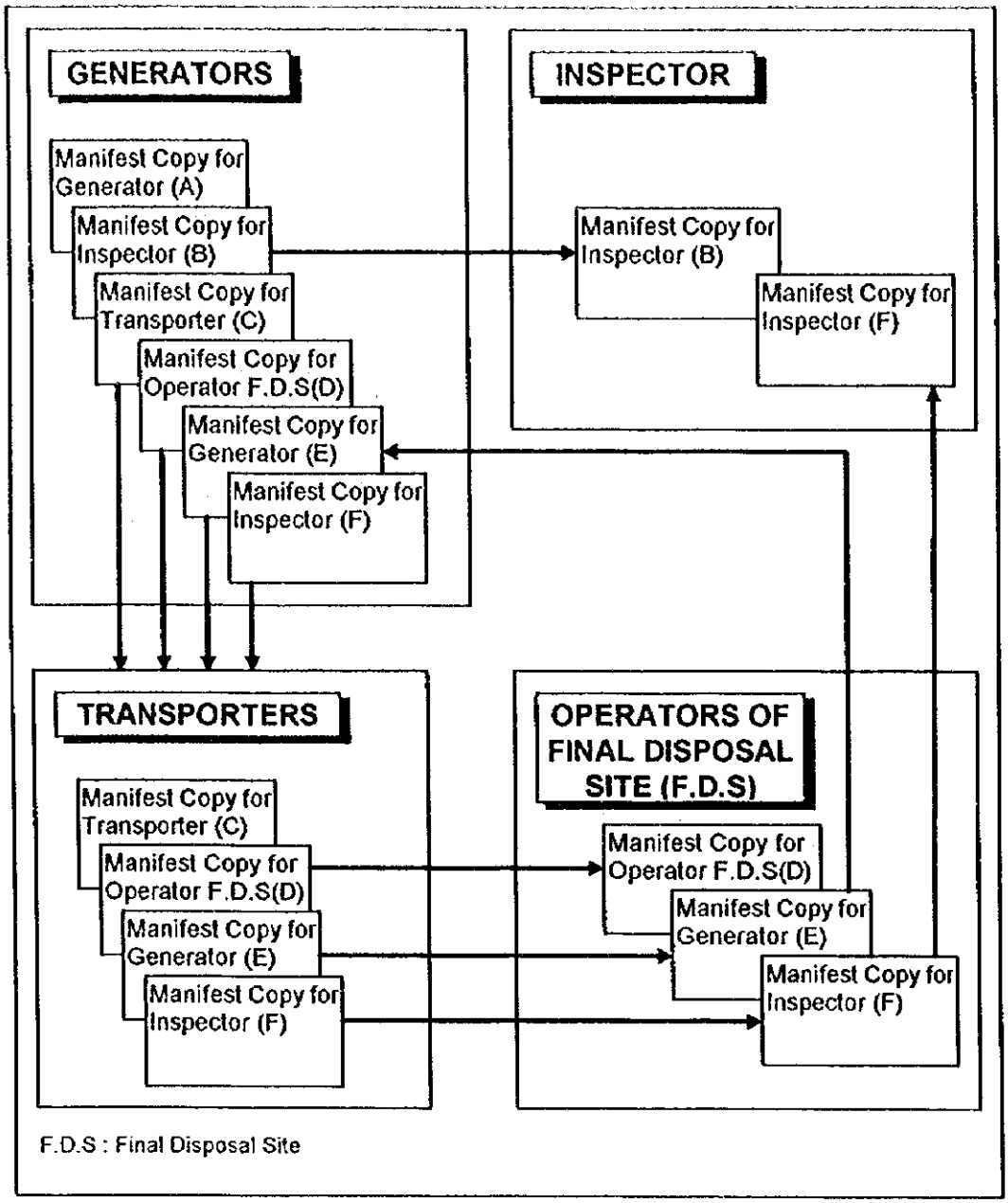

Figure L-30: Concept of Manifest System

a.2.2 Definition of the Waste

ISW types are diverse and its characteristics, such as its hazardousness, also differ. In order to manage various ISWs, it is indispensable to define the types and characteristics of the solid wastes and manage them based on the definition.

The definition of ISW is basically classified into either hazardous or non-hazardous waste which is then divided into liquid, solid, and semisolid.

The following are the definitions determining the kind of solid wastes that are hazardous.

- Definition given in the Basel Convention

- Definition given by the European Union (EU)
- Definition given in the domestic laws in developed countries such as RCRA (Resource Conservation and Recovery Act) of the U.S.

However, expensive analysis facilities and high analytical skills are indispensable in order to identify and manage hazardous and non-hazardous solid wastes based on the definition used in these developed countries. In view of the present conditions in Nicaragua from the technological and economic perspectives, it is judged that it is unrealistic to manage ISW using these definitions because it lacks prevalence in adequate analyses facilities and skills.

Therefore, the following method is recommended to classify and manage ISW until technological base is established and administrative measures are economically arranged.

- Roughly judge whether solid waste is hazardous or non-hazardous from the outward appearance (liquid, solid, or semisolid) and its generation process (type of business of waste generators)

To put it more concretely,

- Make a list of industrial classification according to high, middle, and low potential of generating hazardous waste referring to cases from developed countries.
- Make a list of ISW classification according to either high or low potential of being hazardous wastes from the outward appearance referring to cases from developed countries.

The possibility of wastes being hazardous or non-hazardous is judged from the ISW classification and industrial classification of waste generators referring these lists. Secondly, ISW, which is judged as a highly potential hazardous waste, is treated and managed as hazardous wastes unless the waste generator (polluter) proves that the wastes they generated to be non-hazardous at their own cost of laboratory analysis.

a.2.3 List of Potential Hazardous Waste

The study team classified ISW into 24 categories and carried out a survey on the amount of waste generation etc. for the factory survey referring to the present condition in Nicaragua and some cases of other countries.

The characteristics of hazardous solid waste are defined as follows here.

- Ignitable
- Corrosive
- Reactive
- Toxic (Acute, Non-acute)

Table L-67 shows the assumption made on the respective characteristic of hazardousness for each of 24 ISW categories referring to the past cases, which was employed in the Team's factory survey.

It is necessary to note that this hazardousness assumption (i.e., Table L-67) was made referring to past cases. This judgment chart shall be used for the ISW management for the time being and if some inconvenience emerges, the respective hazardousness assumption should be re-examined in order to meet the actual condition in Nicaragua.

Table L-67: Relations of 24 Industrial Waste Classification and Hazardous Waste

No.	Type of Waste	Liquid or Not	Hazardous Waste					Non-hazardous Waste	
			Ignitable	Corrosive	Reactive	Toxic		Non-inert	Inert
						Acute	Non-acute		
1	Ash, combustion residue	No	No	Possible	Possible	Possible	Possible	Possible	Possible
2	Dust	No	Possible	Possible	Possible	Possible	Possible	Possible	Possible
3	Slag from melting	No	No	Possible	Possible	Possible	Possible	Possible	Possible
4	Sludge	Possible	Possible	Possible	Possible	Possible	Possible	Possible	Possible
5	Asbestos	No	No	No	No	No	Possible	No	No *2
6	Acid	Possible	Possible	Possible	Possible	Possible	Possible	Possible	Possible
7	Alkalis	Possible	Possible	Possible	Possible	Possible	Possible	Possible	Possible
8	Oily waste	Possible	Possible	No	Possible	Possible	Possible	Possible	No
9	Chemical residue	Possible	Possible	Possible	Possible	Possible	Possible	Possible	No
10	Waste from food production	Possible	No	No	No	No	No	Possible	No
11	Waste similar to domestic waste	No	No	No	No	No	No	Possible	No
12	Animal manure	No	No	No	No	No	No	Possible	No
13	Carcasses	No	No	No	No	No	No	Possible	No
14	Glass and ceramics	No	No	No	No	No	No	Possible *1	Possible
15	Metal and scrap	No	No	No	No	No	No	Possible *1	Possible
16	Paper and cardboard	No	No	No	No	No	No	Possible *1	No
17	Plastic	No	No	No	No	No	No	Possible	Possible
18	Rubber	No	No	No	No	No	No	Possible	Possible
19	Textile	No	No	No	No	No	No	Possible	Possible
20	Leather	No	No	No	No	No	No	Possible	Possible
21	Wood	No	No	No	No	No	No	Possible	No
22	Construction and demolition waste	No	No	No	No	No	No	Possible	Possible
23	Water	Possible	Possible	Possible	Possible	Possible	Possible	Possible	Possible
24	Others	Possible	Possible	Possible	Possible	Possible	Possible	Possible	Possible

*1: Considering a possibility used as containers contaminated with non-inert

*2: Asbestos without treatment is considered as hazardous waste

a.2.4 Industrial Category of Potentially Hazardous Waste Generators

Table L-68 shows industrial category (using the CIIU code) of potentially hazardous waste generators, based on past cases.

This table also needs to be reexamined in the future, in order to meet the actual condition in Nicaragua.

Table L-68: Potentiality of Hazardous Waste Generation Industrial Category

Potentiality	CIIU Code	Industrial Category
Highly potential Industries	351	Manufacture of industrial chemical products
	352	Manufacture of other chemical products
	354	Oil and coal products
	356	Other non-classified plastic products
	371	Iron and steel industries
	372	Basic metal industries
	381	Manufacture of metal products except machinery & equipment
Potential Industries	3211	Textile processing and materials manufacturing
	3231	Leather tanning and finishing
	3232	Fur dressing, dyeing and other fur and skin articles
	3319	Other non-classified wooden products
	341	Paper, printing and publishing industries
	3420	Printing, photoengraving, publishing and the likes
	355	Manufacture of rubber products
	362	Glass and glass products
	3699	Other non-metallic mineral products
	382	Manufacture of machinery except electrical
	383	Manufacture of electrical machinery
	384	Manufacture of transport equipment
	385	Manufacture of science, measuring, controlling equipment (inc. lens)
	390	Other manufacturing industries
	625	Gasoline filling stand
	952	Laundries and dry cleaners
Less Potential Industries	311	Food manufacturing
	312	Other food manufacturing
	313	Beverage industries
	314	Cigarettes, cigars and tobacco
	3212-3219	Textile industries
	322	Garment industries
	3233	Leather products (exe. footwear)
	324	Leather footwear
	3311-3315	Wood and cork industry
	332	Furniture, fixture and the likes
	361	Potters and ceramic products
	3691-3696	Manufacture of non-metallic mineral products

Regarding the authorities' management of ISW, hazardous wastes generating industries should be mainly monitored and supervised, referring to Table L-68 for the time being, and at the same time, whether or not the proper treatment and disposal is done for respective ISW category should be monitored by utilizing Table L-67.

a.3 Industrial Waste Reduction

Most of the ISW are the scraps and residues of raw materials incorporated in the manufacturing process and if it is treated or disposed of at the "end-of-pipe", the cost of treatment/disposal becomes very large.

Therefore, as the first step of ISW management by industries, it is rational to use up raw materials as much as possible in the manufacturing process than treating or disposing of ISW at the "end-of-pipe". In other words, Cleaner Production Technology (CP Technology) should be introduced, which keeps the generation amount of waste to a minimum through: improvement and/or conversion of the manufacturing process; raw materials conversion to what improves material efficiency in products.

The introduction of CP Technology brings about the following beneficial impacts to the industries.

- Increase profits by improving material efficiency in products.
- Reduce ISW treatment/disposal cost by reducing the ISW amount generated.

It can be concluded that the introduction of CP Technology is not only a great advantage but also reduces environmental impact by ISW.

Therefore, the reduction of ISW amount by rationalization of manufacturing process should be carried out before the "end-of-pipe" treatment is implemented.

Figure L-31 illustrates the example of the reduction of COD discharge amount when CP Technology was applied to pulp and paper industry in Japan.

Moreover, as significant amount of ISW consists of left-over of raw materials from manufacturing products, it is necessary to set up a mechanism which facilitates the exchange of information on solid waste among companies so that the wastes generated from company A can be used as a raw materials by company B if this mechanism functions.

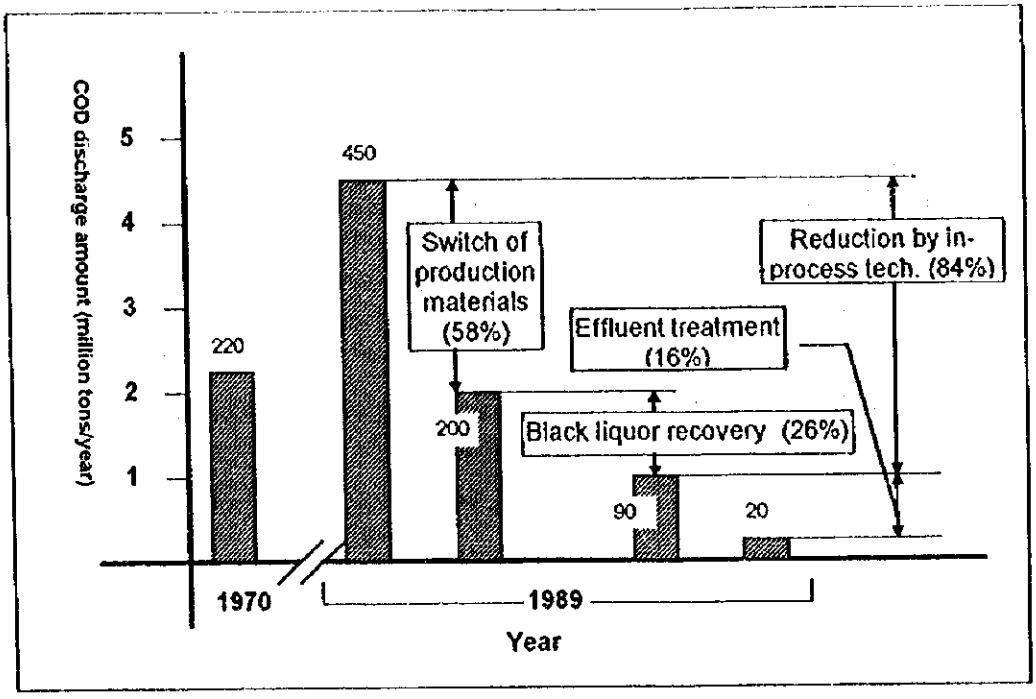

Figure L-31: Reduction of COD Discharge from Pulp and Paper Industry in Japan [6]

a.4 Industrial Waste Treatment/Disposal by Third Party

The demand for the treatment/disposal of ISW is predicted to increase in the future. This is attributed to the increase of ISW generation amount in correlation to the economic growth in Nicaragua, and strengthening legislation which restricts discharge of ISW, and international trend of environmental protection such as ISO14000.

Therefore, the authorities needs to encourage creation of safe and reliable ISW treatment/disposal sectors in Nicaragua based on the market principle, in parallel with the economic growth and strengthening of legislation on ISW.

a.5 Outline of Industrial Waste Treatment / Disposal Method

a.5.1 Industrial Waste Treatment/Disposal Flow

In order for ISW to be properly treated/disposed of, it is vital to understand the characteristics of ISW, and select the most appropriate treatment/disposal method which best suits its characteristics. Figure L-32 shows the process of implementing appropriate treatment/disposal for ISW in general.

[6] Source : J. Nakanishi, "Technological Measures to Eliminate Pollution in the Last Tow decade in Japan"

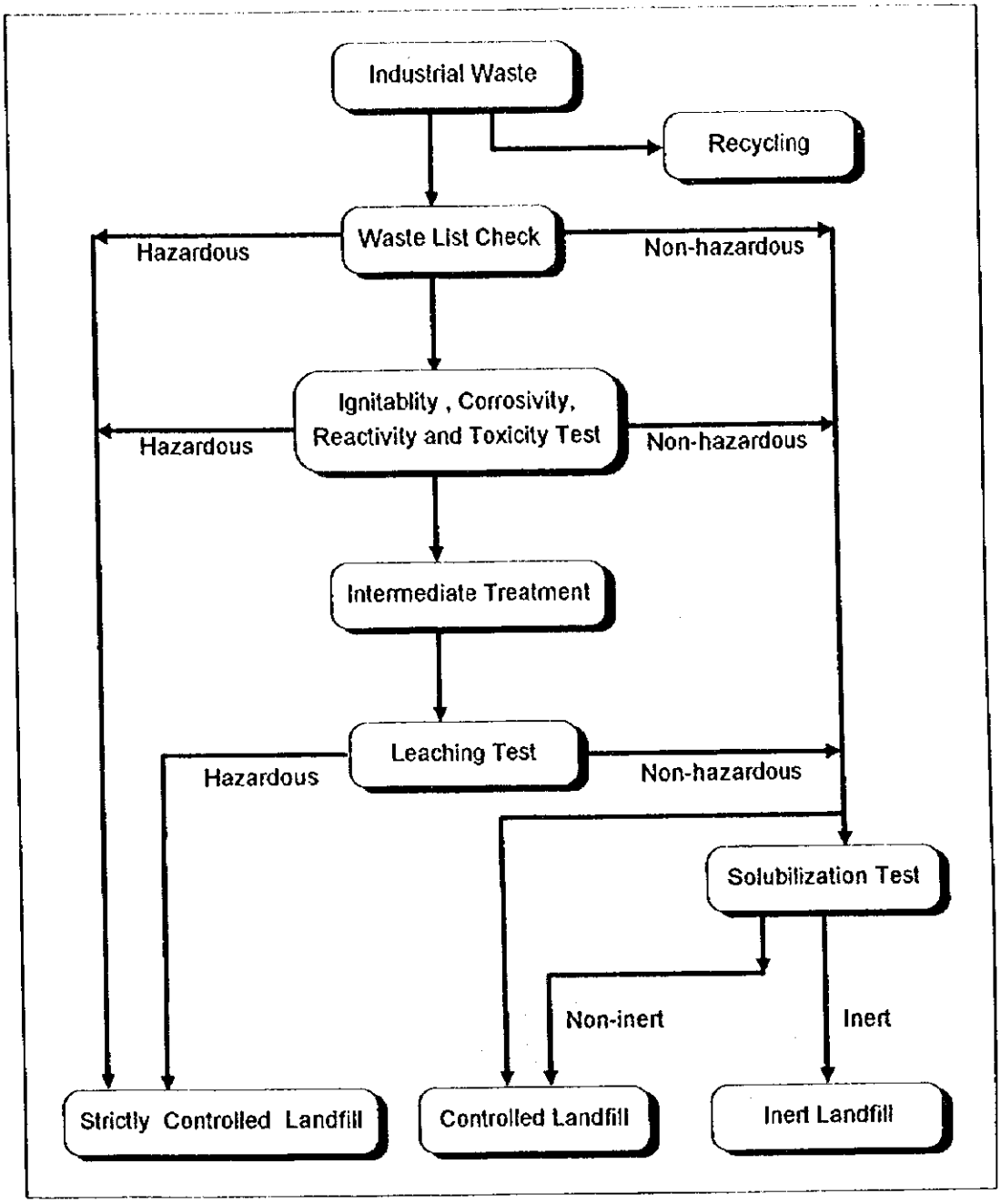

Figure L-32: Industrial Waste Treatment/Disposal Flow

a.5.2 Industrial Waste Treatment / Disposal Method

The industrial waste treatment/disposal method is diversified as the types and characteristics of ISW are diverse. It is, therefore, indispensable to understand the characteristics of the solid waste and select treatment/disposal method most suitable for its characteristics.

However, as the intermediate treatment facility requires considerable expenses in its construction, maintenance & operation, the following treatment should be practiced for the time being considering the present economic condition in Nicaragua.

- Simple intermediate treatment (such as neutralization), and

- Treatment/disposal by utilizing existing production facility. (As a concrete example, a large amount of fossil fuel is used in the calcination process of cement. In this process, if hazardous wastes such as waste oils, solvents and tires etc. are incinerated with fuel in a small appropriate ratio, it works not only as cement production but also as ISW disposal.)

Therefore, landfill disposal shall be adopted as a main ISW treatment/disposal method for the time being. In this case, it is essential that ISW should be disposed of at a landfill appropriately structured depending upon the characteristics of the solid wastes to be disposed.

To put it concretely, the following three types of final disposal sites need to be established.

- Strictly Controlled Landfill (SCL) where substances which are hazardous and difficult to handle are disposed of.
- Controlled Landfill (CL) where wastes which are not hazardous but require leachate control (mainly organic wastes) are disposed of.
- Inert Landfill (IL) where non-hazardous inert wastes such as earth and sand etc. which do not require leachate control are disposed of.

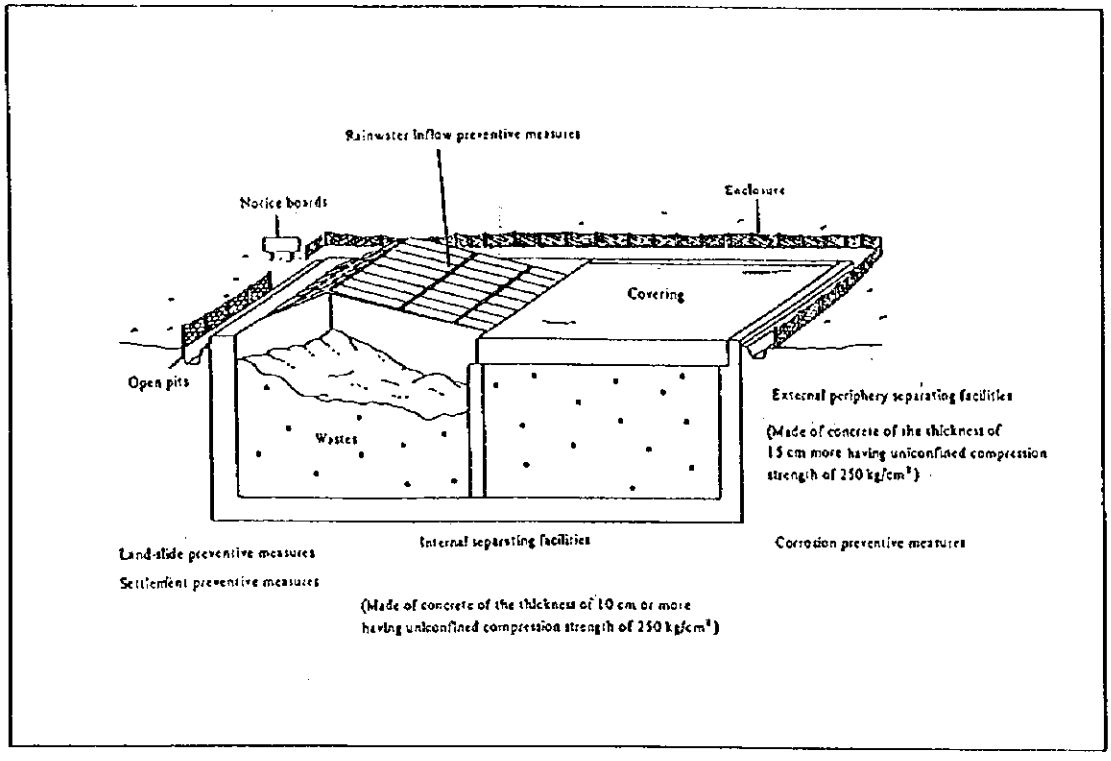

Figure L-33: Structure of Strictly Controlled Landfill

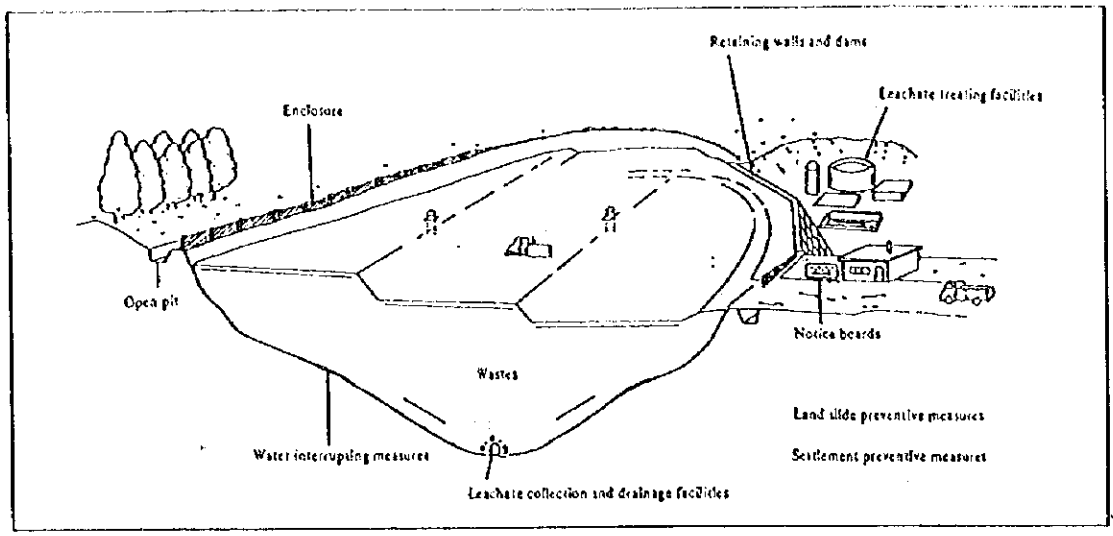

Figure L-34: Structure of Controlled Landfill

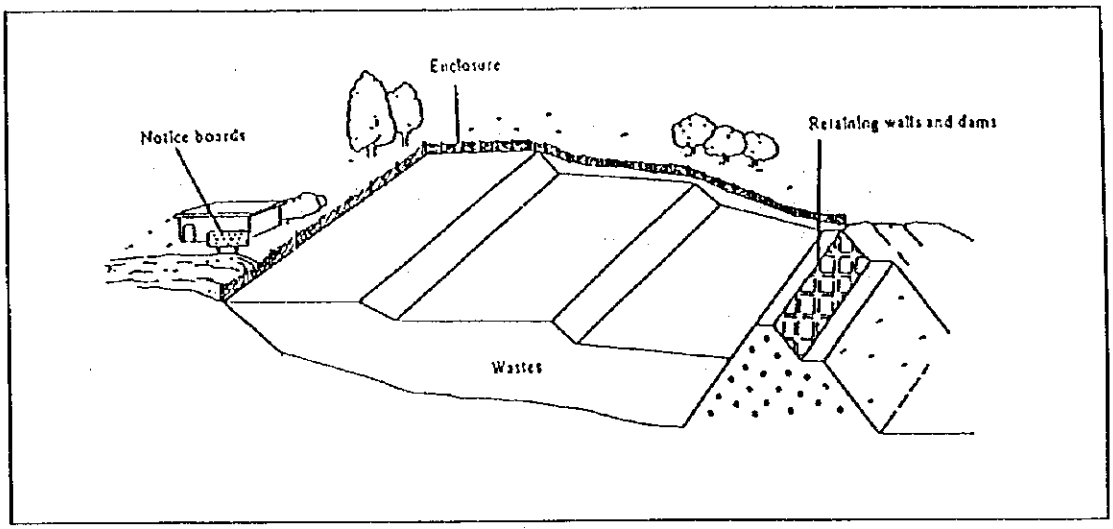

Figure L-35: Structure of Inert Landfill

L.1.7.3 Recommendations on Institutional System

a. Roles of Public Sector

MARENA is the competent authority for the management of industrial solid waste (ISW) and industrial wastewater (IWW) by the Law No. 217-96 and Decree 33-95. MARENA should establish the regulations related to ISW and IWW, as well as restrictions for its disposal and the operational limits of the municipality. It should also expedite early understandable instructions to facilitate technical information to the IW generators, professionals, university students, and those interested in about IW and the IW management services that can be provided for industries in Nicaragua. On the other hand, MARENA should help and encourage industries in finding accessible financial resources or grants to support their projects of IW treatment/disposal and/or "cleaner production".

The competence to inspect and penalize the IW management belongs to MARENA and MINSA. INAA is also competent whenever they receive wastewater. The municipality can establish legal and technical norms restricted to the municipality which can not be more tolerant than the national norms (see Annex N).

The Annex N shows "Instructions and/or Regulations (as well as Tables with Strategies and Intersectorial Integration)" which is recommended for MARENA, and complementarily for MCT, MINSA and the municipality. Furthermore, the Regulation on agro-toxic materials, in its final phase, will be very important to the municipality.

b. Polluter Pays Principle (PPP) and Authorities' Management

The IW are qualitative and quantitative dependent of the type of industry, industrial process, of the raw materials, source of energy, and the management of the generator establishments, especially the training and discipline of the personnel, also the equipment maintenance and the working environment.

The IW is strictly industries' responsibility. Since the costs of IW management are included in the products price, the company that generates no-hazardous IW and/or less IW, they could achieve lower production cost. In addition, the "environmentally friendly products" are commonly an important marketing element with respect to customers consciousness.

It is an premise universally accepted premise: **"The generator is responsible for the waste generated by him or her"**, i.e., he or she is responsible for the management of the waste and its effects on the environment and public health, with all the costs to be born therewith. These costs constitute an incentive to minimize waste, in other words, it encourages a "clean production" which is the objective of a competitive and environmentally-conscious industries.

In general, the largest part of ISW results from the industrial effluents, therefore, the management on ISW and IWW should consider all the IW in total.

The consulting and operational services related to IWM constitute an attractive economic activity, once the market has reached certain level. In this context, the public authorities could create the situation that makes such economic activity (ISWM by private sectors) viable, which solves the problems involved with industrial contamination and pollution when the regulations for the IW management is established and its requirements are enforced obviously in a stepwise manner in a feasible time frame. The municipal/national government should not invest more than necessary for the studies, cadastres, regulation, technical information, inspection, monitoring and sanction to the transgressor when it is related to IW.

L.1.8 Medical Waste Management

L.1.8.1 Future Medical Solid Waste/Wastewater Amount

a. Forecast for Major Medical Institutions

The future medical solid waste generation in the major institutions is estimated as shown in Table L-69. The growth rate of medical solid waste generation is assumed to be the same as the population growth rate of the city (i.e., medical solid waste generation ratio per capita remains the same for future). The values in 1996 are estimated on the analogy

of the data in Granada and Chinandega from the questionnaire survey carried out in February by the Study Team, which is why the institutions did not give the reliable data.. The growth rate is assumed that it will increase in proportion to the population growth rate as shown in Table L-70. The water supply value in 1996 is obtained from the record of INAA. Wastewater generation is estimated to be 80% of water consumption in the forecast.

Table L-69: Forecast of Generation Ratio of Medical Solid Waste Management in the Medical Institutions With Beds for Inpatients(Hospital Class) in Granada

Unit : kg/day

		1996	2000	2005	2010
Population		76,250	97,078	114,760	135,106
Growth rate		1.000	1.273	1.505	1.772
Risky waste*1 (kg/day)	Risk waste *2	27.0	34.4	40.6	47.8
	hazardous waste *3	1.6	2.0	2.4	2.8
	special waste *4	0.0	0.0	0.0	0.0
	subtotal	28.6	36.4	43.0	50.6
Common waste(kg/day) *5		25.0	31.8	37.6	44.3
Grand total		53.6	68.2	80.6	94.9

Note : *1 Study team's prepared category
*2 Waste with infection (sharps, blood, blood sustained and etc.), infected waste from laboratories, waste from infectious disease patients and wastewater etc.
*3 Chemical waste (medicines, drugs, etc.), radioactive waste etc.
*4 Ash from incinerator, sludge etc.
*5 Office waste, kitchen waste, packing waste, bulky waste, garden waste, domestic wastewater etc.

Table L-70: Forecast of Medical Wastewater Generation Amount in Medical Institutions

	1996	2000	2005	2010
Growth rate	1.000	1.273	1.505	1.772
Population	76,250	97,078	114,760	135,106
Water supply by INAA(ton/day)	81.4	103.6	122.5	144.2
Wastewater generation (ton/day)	65.1	82.9	98.0	115.4

b. Forecast for Minor Medical Institutions

In the minor medical institutions without beds for inpatients(C/S,P/M class), medical solid waste amount is estimated as shown in Table L-71, assuming that it will increase in proportion to the growth rate of population. The value in 1996 is estimated on the analogy of the questionnaire survey to the institutions in Granada and Chinandega by the Study Team in February 1997. Medical wastewater is estimated assuming it will increase in proportion to the growth rate to the population. The values of water supply in 1996 are obtained from the record of INAA.

Table L-71: Forecast of Generation ratio of Medical Solid Waste Management in the Medical Institutions without Beds for Inpatients(C/S, P/M and Laboratory Class) in Granada

Medical institution		1996				2000				2005				2010			
		C/S[1]	P/M[2]	Lab[3]	Total	C/S[1]	P/M[2]	Lab[3]	Total	C/S[1]	P/M[2]	Lab[3]	Total	C/S[1]	P/M[2]	Lab[3]	total
outpatient Growth rate					1.000				1.273				1.505				1.772
Outpatients/day/ institution		52	104	0	156	66	132	0	198	78	157	0	235	92	184	0	276
No. of Institutions		3	5	1	9	3	5	1	9	3	5	1	9	3	5	1	9
Outpatients/day		156	520	0	676	198	660	0	858	235	785	0	1,020	276	920	0	1,196
Risky waste	Risk	15.5[4]	0.1[4]	5.4[4]	21.0	19.7	0.1	6.9	26.7	23.3	0.2	8.1	31.6	27.5	0.2	9.6	37.3
	Hazardous	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Special	0.3	0	0.3[4]	0.6	0.4	0	0.4	0.8	0.5	0	0.5	1.0	0.5	0	0.5	1.0
	Subtotal	15.8	0.1	5.7	21.6	20.1	0.1	7.3	27.4	23.8	0.2	8.6	32.6	28.0	0.2	10.1	38.3
Common waste		14.6[4]	0[4]	9.5[4]	24.1	18.6	0	12.1	30.7	22.0	0	14.3	36.3	25.8	0	16.8	42.6
Grand total		30.4	0.1	15.2	45.7	38.7	0.1	19.4	58.2	45.8	0.2	22.9	68.9	53.8	0.2	26.9	81.0

Note [1] C/S : Centro de Salud(Health Center) [2] P/M : Puesto de Salud or Puesto de Medico
[3] Labo : Laboratory [4] Values by Questionnaire Survey

Table L-72: Forecast of Generation of Medical Wastewater Management in the Medical Institutions without inpatient beds(C/S, P/M, Laboratory class) in Granada

Unit : ton/day

Item		1996				2000				2005				2010			
Basic data	Population				76,250				97,078				114,760				135,106
	Institution type	C/S	P/M	Lab	total	C/S	P/M	Lab	total	C/S	P/M	Lab	total	C/S	P/M	Lab	total
	Outpatient/day	156	520	0	626	198	660	0	858	235	785	0	1,020	276	920	0	1,196
Water	INAA water supply	3.0	11.5	2.1	16.6	3.8	14.6	2.7	21.1	4.5	17.3	3..2	25.0	5.3	20.4	4.8	30.5
	Wastewater	2.4	9.2	1.7	13.3	3.0	11.7	2.2	16.9	3.6	13.8	2.6	20.0	4.2	16.3	3.8	24.3

L.1.8.2 Major Findings of the Medical Waste Survey

a. Present Situation of Medical Institutions in Leon

a.1 Distribution of Medical Institutions in Leon

There are 19 medical institutions in Leon, among which, 4 institutions provides inpatient beds, on the other hand, remaining 15 institutions do not.

Table L-73: Distribution of Medical Institutions in Granada

Item			Ownership		Total
Category	inpatient beds	Type	Public	Private	
Major	with	Hospital	1(1)	1(1)	2(2)
Minor	without	C/S	3(3)	0	3(3)
Minor	without	P/S, P/M	5(0)	0	5(0)
Minor	without	Laboratory	1(1)	0	1(1)
Total			10(4)	1(1)	11(6)

Note: Values in ( ) show the institutions conducted questionnaire survey

a.2 Questionnaire Survey to the Typical Medical Institutions in Leon

In order to understand the medical waste conditions in Leon, questionnaire surveys were conducted to the 6 typical medical institutions shown in Table L-73 in September 1996 and February 1997 as follows:

(1) Questionnaire Survey in September 1996

focusing on the general information on medical waste management

(2) Questionnaire Survey in February 1997

focusing on the amount of medical waste amount and medical wastewater

b. Medical Solid Waste

b.1 Separation at Generation Source and Internal Collection and Haulage

Although 80 % of the medical institutions separate medical waste at generation source, cleansing workers mix them with non-infectious waste during internal collection and haulage as shown in Table L-74. As a result, 100% of the medical institutions store the mixed medical waste at collection point. As a result, the table indicates the necessity of following things:

- Periodical education to the medical workers including cleansing services
- Establishment of the treatment system for medical infectious wastes

Table L-74: Medical Waste Separation at Generation Source and Internal Collection and Haulage in Granada

Institution Type		Separation at Generation source	Internal collection and haulage		Total
			Separated	Mixed	
Public	Hospital	1	0	1	1
	C/S	1(syringe needle only)	0	3	3
	Others (laboratory)	1	1	0	1
Private	Hospital	1 (pathological waste only)	1 (pathological waste only)	0	1
Total		4	2	4	6
Share(%)		66.7	33.3	66.7	100.0

b.2 Internal Treatment

No internal treatment is carried out in Chinandega.

b.3 Storage Place before External Collection Service

Regarding storage places, the institutions provides the security of storage without fence and without lock mostly as shown in Table L-75, although the storage place should be restricted from people's entrance strictly.

Table L-75: Security of Storage place before Collection at 5 Typical Medical Institutions in Granada

Institution Type		Answer			No answer	Total
		With fence With lock	With fence Without lock	Without fence Without exist		
Public	Hospital	0	1	0	0	1
	C/S	0	0	2	1	3
	Others	0	0	1	0	1
Private	Hospital	0	1	0	0	1
Total		0	2	3	1	6
Share(%)		0	33.3	50.0	16.7	100.0

b.4 External Collection Service

All of the medical institutions rely on the public collection service for the disposal of medical wastes.

b.5 Final Disposal Site

The Municipal final disposal site is used for medical waste disposal.

b.6 Recycling

Recycling in the medical institutions is not conducted in Leon.

b.7 Incineration

Medical solid waste is incinerated in primitive manners by 40% of medical institutions. Remaining 60% of medical institutions dispose of medical wastes without incineration as shown in Table L-76.

Table L-76: Incineration Method in Granada

Category		With incineration				Without Incineration	Total
		Mechanical	Primitive				
		Incinerator Controllable	Furnace	Open air			
				Inside Premise	Outside Premise		
Public	Hospital	0	0	1	0	0	1
	C/S	0	0	1*1	0	1 / 1*2	3
	Others	0	1(hazardous)	0	0	0	1
Private		0	0	1	0	0	1
Total		0	1	2	0	3	6
Share(%)		0	16.7	33.3	0	50.0	100

Note: C/S Centro de Salud,
*1 Syringe needles only in 2 C/S
*2 Out of operation so far due to smoke problems in 1 C/S

c. Medical Wastewater

c.1 Present Conditions

Medical wastewater is disposed of by either discharge into sewer without treatment as shown in Table L-77.

Table L-77: Present Medical Wastewater Management in Granada

Unit: number

Item		Without		With	Total
		Discharge into		Septic Tank to River	
		Sewer	Soak pit		
Public	Hospital	0	1	0	1
	C/S	2	1	0	3
	Others	1	0	0	1
Private		1	0	0	1
Total		4	2	0	6
Share(%)		66.7	33.3.	0	100

c.2 Inspection by medical institutions

Decree No.33-95 provides that medical institutions have an obligation to inspect the quality of wastewater. However, no institutions have been carrying out the designated inspections.

L.1.8.3 General Recommendations for the Improvement of Medical Waste Management

a. Technical System

a.1 Comprehensive View Points

a.1.1 Examination on Marketability of Participation of Private Sectors for Medical Waste Management

MINSA should examine the marketability of participation of private sector on the medical waste management.

a.1.2 Examination of Regional Treatment

Since the volume of medical waste generated from the institutions in Leon, possibility of regional treatment should be examined as one of alternatives.

a.2 Medical Solid Waste

Medical waste management should be focused mainly on prevention of the secondary infection caused by the medical waste. From this point of view, the followings are recommended.

a.2.1 Separation of Infectious Waste

Segregation of infectious waste at generation source intensified. Importance of infectious waste separation should be educated to cleansing workers, otherwise medical workers' effort will be in vain to segregate the waste at generation source, which has been carried out at present.

a.2.2 Internal Treatment

In principle, medical waste is to be treated in the institutions, however, taking into account the small quantity of generation of medical waste in each institution, regional treatment plan should be included as one of alternatives.

a.3 Medical Wastewater

a.3.1 Segregation of Infectious Wastewater at Generation Source

In order to reduce the volume of infectious wastewater, it should be segregated at generation source.

a.3.2 Pretreatment before Discharge

Infectious wastewater should be pretreated at generation source for the prevention of water pollution.

b. Institutional System

MINSA is the regulating authority (Decree No. 393-88). It is recommended to establish immediate instructions, which should be improved to "Code of Practice" for Medical Waste in the near future.

These norms should emphasize the management inside the generator establishments where waste will be classified and separated for a safe collection and disposal. Medical workers and cleaning workers must be oriented and trained for this purpose.

Hazardous medical waste should be defined and regulated by MARENA (Law No. 217-96). Meanwhile, MINSA should establish temporary instructions as the superior Ministry dealing with medical activities, mainly with regard to infectious waste.

The Municipality will operate, without monopolize them and at a reasonable price, the collection services and disposal of non-hazardous waste, proved in accordance with competent instructions.

The Annex N presents recommendations for the regulating acts and intersectorial actions.

The Main Report for F/S of Volume III includes (item 4.3.2) the proposed Regulation on SWM for Granada, that might be the same for the other municipalities.

L.1.9 Evaluation of the USE M/P

L.1.9.1 Technical Evaluation

The outcome of the review whether or not the technical system proposed in M/P creates some problems technically in terms of facility construction, its management, and maintenance and administration is stated below. This was examined against the prevalent technical level of the executing bodies (i.e., Granada municipality, and INAA Region IV.

- Technical system of water management proposed in M/P is the expansion of the existing facilities so that the possibility to create technical problems in facility construction, its management, and maintenance and administration is very low.
- Technical system of SWWM (Off-site) proposed in M/P is the expansion of the existing facilities so that the possibility to create technical problems in facility construction, its management and maintenance and administration is very low.
- On-site collective treatment plan regarding SWWM is only implemented partly on an experimental basis in Leon city, etc. in Nicaragua. Therefore, this is inexperienced area for Granada municipality and INAA Region IV.
- Nicaragua does not have any experience of sanitary landfill operation in municipal waste disposal site in the past. Although a JICA study recommended to launch a sanitary landfill project for the capital, Managua, it has not been realized so far. Therefore, this is inexperienced area for Nicaragua and Granada city.

Except for the above and on-site collective treatment regarding DWWM and the sanitary landfill operation in municipal waste final disposal site, the possibility that problems will be created is very low in implementing projects and it is technically appropriate since the rest of the technology is already widespread in Nicaragua including Granada city.

On the other hand, with regard to the on-site collective treatment of DWWM and sanitary landfill operation in municipal waste final disposal site, pilot projects will be implemented in the following areas and its technical workability will be examined in the Study.

- Collective treatment system of DWW

- Hygienic land reclamation in municipal waste final disposal site

L.1.9.2 Social Evaluation

The major objective of social evaluation could be to identify what risks (catastrophe in some cases) to the citizens today and/or future may otherwise bring about if the M/P is not implemented. In this context, it should be clear that proper USE management in accordance with the M/P needs to be implemented as soon as possible to avoid the today's and future accumulated negative impacts on Granada citizens.

Social evaluation is carried out herewith in view of "contribution for social fairness and justice" and "whether or not the M/P be socially accepted".

Sewer service rate and waste collection rate in Granada are presently inferior to other principal cities in Nicaragua. USE improvement in those indicators, in realizing the M/P for Granada, may also justify the social welfare contribution by the M/P.

All other technical systems proposed than the two systems to be experimented through pilot projects (DWW on-site collective treatment/disposal and sanitary landfill) are evaluated to be socially compatible and enforceable, since they have commonly practiced in Granada or other cities in Nicaragua.

In this regard, these 2 technical systems proposed were examined whether socially acceptable or not (in other words, whether neighborhood understanding and cooperation be attained or not) through the pilot projects in 3rd Study Work in Nicaragua. The pilot projects was implemented together with public campaign. Consequently, the technical system (DWW on-site collective treatment/disposal and sanitary landfill) are evaluated to be acceptable and enforceable.

L.1.9.3 Environmental Evaluation

The major objective of environmental evaluation is to identify what risks (catastrophe in some cases) to the environmental setting may otherwise bring about if the M/P is not implemented. On the other hand this environmental evaluation should identify what kind of environmental adverse impacts should the Granada's environmental setting should bear in implementing the M/P. Therefore, the M/P should seek and propose the overall framework that shall expand the beneficial environmental impacts by the M/P and minimize the adverse environmental impacts to incur through the implementation of projects based on the M/P.

It is evaluated that total beneficial impacts on environment in implementing the M/P is much greater than the adverse impacts on environment by that.

The new municipal landfill in SJV, which is planned in line with the M/P and adverse impacts are envisaged only therewith, is examined with an environmental survey carried out in 3rd Study Work in Nicaragua. The environmental survey examined the extent of the adverse impacts envisaged in detail. Consequently mitigation measures for those impacts were proposed.

L.1.9.4 Financial Evaluation

a. Methods and Major Assumptions

The financial evaluation of M/P aims to investigate the possibility of realizing the proposed plan under the financial capabilities of the executing bodies (INAA, Granada Municipality), whose services include fee collection.

a.1 Evaluation method

The user fee is established in consideration of the present payment system, present fee imposed, and the average actual costs within the periods 2001～2005 and 2006～2010. The respective revenue and expenditures of the executing bodies are evaluated as follows.

① Criteria

- Households -

  The ratio of the average of the total expenses for water supply, wastewater management and waste collection in the family income.

- Companies and offices -

  The ratio of the total expenses for water supply, wastewater management and waste collection in the GRDP.

- Granada Municipality -

  The ratio of the expenses for municipal SWM in the municipal budget

② Evaluation period: ten years, from 2001 until 2010

③ Executing bodies and major financial resources

	Executing Bodies	Major Financial Resources	Comments
Water supply	INAA	Fee collection services	
Wastewater management (off-site)	ditto	ditto	
Wastewater management (on-site)	ditto	Cross-subsidy from other revenue of INAA	
Municipal SWM	Granada Municipality	Municipal budget; Fee collection services, & tipping fee collection at the disposal site	More than half of the actual costs for domestic waste management is assumed to be shouldered by households. The actual costs for the management of commercial waste and other wastes shall be totally shouldered by companies, etc.
Storm water management*	ditto	Municipal budget financed by various aids	

Note: * The financial and economic evaluation will be done in the F/S.

a.2 Project costs

(Investment costs)

- The investment costs of the M/P for the water supply and off-site wastewater management systems are basically based on the F/S by INAA.

- The estimates of the JICA Study Team are used to represent the investment costs of the M/P for the on-site wastewater management, storm water management and municipal SWM systems.
- The replacement investment costs for collection vehicles, heavy equipment at disposal site, and workshop equipment are considered in the formulation of yearly plans.
- The replacement investment costs for the existing water supply and wastewater management systems are not considered because they are assumed to be included in the operation costs of these systems.
- Land costs are precluded.

The total investment costs of the projects are summarized in the following table.

Table L-78: Investment Costs

Unit: C$ 1,000

	Initial Investment for the Proposed system	Replacement Investment	Total
Water supply	82,554	0	82,554
Wastewater management (off-site)	41,068	0	41,068
Wastewater management (on-site)	31,902	0	31,902
Municipal SWM (collection)	8,259	7,540	15,799
Municipal SWM (workshop)	2,729	1,444	4,173
Municipal SWM (Disposal)	38,589	11,597	50,186
Storm water management	13,570	0	13,570
Total	218,671	20,581	239,252

(Annual costs)

- Actual annual costs consist of operation and maintenance costs, depreciation costs and loan interest.
- Operation and maintenance costs consist of utilities cost, personnel cost and other costs. The annual costs are calculated in proportion to the volume of waste collected.
- The operation and maintenance costs of the workshop are included in the operation and maintenance costs for collection and disposal services.
- The respective costs for the existing water supply and off-site wastewater management systems are considered based on the evaluation of their revenues and expenditures.
- The operation and maintenance of the storm water management is assumed to be carried out by the resident.

- The equal-annual-payment method is used in the calculation of the depreciation costs, under the following assumptions:

	Useful Life (Years)	Residual Value (%)
Hand carts	3	0
Vehicles, heavy equipment & workshop equipment	7	10
Processing equipment & pipes	15	0
Building & civil works	30	0

Note: The useful life of the disposal site depends on the number of years it shall be operated.

a.3 Financing Plan

Long term loans are made to finance the investment costs for the water supply and wastewater management systems. The loan conditions shown below are the same as those adopted in the INAA F/S:

- 40 years repayment with 10 years grace period
- the interest rate in the grace period is 1% per annum, and 2% per annum for the actual repayment period.

The loan conditions for the municipal SWM system are assumed to be similar to the above mentioned conditions.

b. Water Supply System and Wastewater Management System Master Plans

b.1 Expenditure Plan

The Annual Investment Plan and Expenditure Plan for the water supply system were estimated based on the above conditions, and shown in the attached Table L-79.

The actual annual costs estimated in consideration of the operation and maintenance costs, depreciation costs and loan interest rates are shown in the following table.

Table L-79: Annual Costs (1995, 2001~2005, 2006~2010)

Unit: C$ 1000

		1995	2001~2005 (average)	2005~2010 (average)
Proposed system only	water supply		5,066	8,288
	wastewater management (off-site)		1,397	2,938
	wastewater management (on-site)		809	2,215
Proposed system & existing system combined	water supply	5,783	12,589	15,811
	wastewater management (off-site)	303	1,794	3,335
	wastewater management (on-site)		809	2,215

Note : The separation is calculated based on the figures of 1996.

On the other hand, the waste collection volume is summarized in the following table.

Table L-80: Waste Collection Volume in 1995 and Average Waste Collection Volume for 2001~2005, and 2006~2010

Unit : m³/day

		1995	2001~2005 average	2005~2010 average
Proposed system only*	water supply		1,711	4,887
	wastewater management (off-site)		2,109	6,448
	wastewater management (on-site)**		1,211	3,379
Proposed system & Existing system combined	water supply	9,464	17,727	20,903
	wastewater management (off-site)	2,592	5,510	9,850
	wastewater management (on-site)	0***	1,211	3,379

Note:

* difference between the volume treated in 2000 and other years

** the inflow volume in 2005 and 2010 was respectively calculated as 2,901m³/day and 398m³/day based on the service population.

*** Some samples of private on-site treatment are shown in Granada, but they are excluded from the financial evaluation.

Based on the preceding two tables, the unit cost of each system is calculated as shown in the table below.

Table L-81: Unit cost in 1995, 2001~2005 , and 2006~2010

Unit: C$/m³

		1995	2001~2005 average	2006~2010 average
Proposed system only	water supply		8.11	4.64
	wastewater management (off-site)		1.81	1.25
	wastewater management (on-site)		2.31	2.14
	Total of off-site & on-site		2.15	1.55
Proposed & Existing systems combined	water supply	1.67	1.95	2.07
	wastewater management (off-site)	0.42	0.89	0.93
	Total of off-site & on-site	0.42	1.06	1.15

b.2 Revenue Plan

The payment system of M/P was set under the following assumptions:

- Considering the present average payment based on the volume, the monthly fee of water consumption is set. The fee after 2001 is assumed to be equal to the monthly payment, though there will be a little change in water consumption.
- For business use, the present average fee of C$ 5.47/m³ calculated from the 1996 year payment is used as basic fee, The fee after 2001 is assumed to be calculated base on this unit price.
- As for the fee for wastewater services, the present average fee waste set at C$ 16.7/household/month. The fee after 2001 is assumed to be equal to the monthly payment, though there will be a little change in wastewater discharge.

- The fee to be imposed for companies and businesses is set at C$ 41.70/m^3, and the fee after 2001 is assumed to be calculated based on this unit price.

Table L-82: Fees for Water Supply and Wastewater Management Services

		1995~2000	2001~2005	2006~2010
Water supply	Households	C$ 49.8/m³/month/ household (C$ 2.03/m³)	C$ 49.8/month/ household (C$ 1.77 m³)	C$ 49.8/month/ household (C$ 1.77/m³)*
	Companies, Businesses	C$ 5.47/m³	C$ 5.47/m³	C$ 5.47/m³
Wastewater management	Households	C$ 16.7/month /household (C$ 0.70/m³) (33.5% of water supply fee)	C$ 16.7/month/ household (C$ 0.72/m³)** (33.5 % of water supply fee)	C$ 16.7/month/ household (C$ 0.72/m³)** (33.5% of water supply fee)
	Companies, Businesses	C$ 1.70/m³ (31.1 % of water supply fee)	C$ 1.70/m³ (31.1 % of water supply fee)	C$ 1.70/m³ (31.1% of water supply fee

* The number of family will increase from 1995 to 2000, and the unit consumption of water is assumed to increase in these period.

** The unit discharge of wastewater is assumed to decrease a little from 1995 to 2000.

The current fee collection rate of 96% is assumed to be maintained until 2010. Considering the difficulty to afford the operation and maintenance costs of the on-site wastewater management services, the fee is assumed to be free in the calculation. The revenues of the water supply and wastewater management services in major years are summarized in the following table.

Table L-83: Revenues of Water Supply and Wastewater Management Services (Proposed and Existing Systems)

Unit: C$ 1,000

		1995	2000	2005	2010
Water supply	Beneficiaries	64,441	82,516	97,546	114,255
	Households	6,191	8,148	9,632	11,282
	Companies, etc.	2,761	5,526	6,532	7,690
	Total	8,952	13,674	16,164	18,972
Waste water management	Beneficiaries*	16,828	22,813	62,257	114,255
	Households (Off-site)	454	704	1,461	2,459
	Companies, etc.	345	365	757	1,274
	Households (On-site)	0	0	0	0
	Total	799	1,069	2,218	3,733

Note:* total beneficiaries of the off-site system and on-site system

b.3 Revenues and Expenditures

The calculation of the revenues and expenditures of the respective services based on the preceding plans showed that it would be difficult to operate the water supply and on-site wastewater management services only through the fee collected from new beneficiaries.

The on-site wastewater management services would still be particularly difficult to operate even with a different executing body.

Table L-84: Revenues and Expenditures of Proposed Systems

Unit: C$ 1,000

		2001~2005 average	2006~2010 average	2001~2010 Total
Water supply	Beneficiaries	8,817	24,844	
	Revenue	1,461	4,139	28,002
	Cost	5,066	8,288	66,771
	Balance	-3,605	-4,149	-38,769
Wastewater (off-site)	Beneficiaries	13,179	40,304	
	Revenue	662	2,026	13,442
	Cost	1,397	2,938	21,672
	Balance	-734	-912	-8,230
Wastewater (on-site)	Beneficiaries	9,525	29,387	
	Revenue	0	0	0
	Cost	809	2,215	15,118
	Balance	-809	-2,215	-15,118

If the number of beneficiaries of the existing system is included in the calculation, the losses of the off-site wastewater management services can be covered by the water supply services, putting it in the black even in the period of 2006 - 2010. But there is no affordability to cover the on-site wastewater management services.

Table L-85: Revenues and Expenditures of Proposed and Existing Systems

Unit: C$ 1,000

			2001~2005 average	2006~2010 average	2001~2010 Total
Water supply		Beneficiaries	91,332	107,360	
		Revenue	15,134	17,813	164,736
		Cost	12,589	15,811	141,996
		Balance	2,546	2,002	22,740
Waste water	off-site	Beneficiaries	34,439	61,654	
		Revenue	1,731	3,095	24,129
		Cost	1,794	3,335	25,649
		Balance	-63	-241	-1,520
	on-site	Beneficiaries	11,078	30,940	
		Revenue	0	0	0
		Cost	809	2,215	15,118
		Balance	-809	-2,215	-15,118
Balance of Total system			1,674	-454	-6,102

If the calculations are only to be based on the wastewater management services, there is a need to markedly raise the fee from 2001 until 2010, or to delay the improvement plan for the on-site wastewater management system.

c. Municipal SWM Master Plan

c.1 Expenditure Plan

As for the investment for the disposal site, 41% shall be put down in 2000 to cope with the volume of waste to be disposed within the 2001 - 2005 period. The remaining 59% shall be made in 2005. For the workshop, a full investment shall be carried out in 2000.

Table L-86 attached herewith shows the annual investment and expenditure plans prepared based on the above conditions. The table below shows the annual costs in consideration of O/M costs, depreciation costs and loan interest.

Table L-86: Actual Annual costs in 1995 and Average Costs in 2001~2005 and 2006~2010

Unit: C$ 1000

	1995	2001~2005 average	2006~2010 average
Collection*	1,376	2,994	3,968
Disposal	55	5,027	5,335
SWM Total	1,431	8,021	9,303

Note: * including street sweeping costs

On the other hand, the waste collection volume is as shown in the following table.

Table L-87: Waste Collection Volume in 1995 and Average Waste Collection Volume in 2001~2005 and 2006~2010

Unit: ton/day

	1995	2001~2005 average	2006~2010 average
Collection	34.2	63.2	91.6
Disposal	35.2	65.4	94.0

From the preceding two tables, the disposal costs were calculated.

Table L-88: Disposal Cost in 1995, 2001~2005, 2006~2010

	1995	2001~2005 average	2006~2010 average
Collection (including street sweeping)	C$ 110.2/ton	C$ 129.8/ton	C$ 118.7/ton
Disposal	C$ 4.3/ton	C$ 210.7/ton	C$ 155.5/ton
Overall Cost (per volume collected)	C$ 114.6/ton	C$ 347.8/m3	C$ 278.3/ton

c.2 Revenue Plan

The payment system of the M/P is set under the following assumptions:

- The amount to be collected from households after 2001 is set at C$ 15/month, C$ 10/month and C$ 5/month based on the new tariff introduced in July of 1997.

- The amount to be collected from companies and businesses shall be the full amount (100%) of the actual costs involved in the collection and disposal of the corresponding waste type.

The urban waste collection fee and the collection ratio are as shown in the following table.

Table L-89: Municipal SWM Collection Fee and Collection Ratio

			1995~2000	2001~2005**	2006~2010
Collection (including street sweeping & disposal)	Households	Curb-collection with street sweeping	C$ 15/month/ household	C$ 15/month/ household	C$ 15/month/ household
		Curb-collection without street sweeping	C$ 10/month/ household	C$ 10/month/ household	C$ 10/month/ household
		Other collection	C$ 5/month/ household	C$ 5/month/ household	C$ 5/month/ household
		collection rate	16.3- >96 %	96 %	96 %
	Companies & businesses		C$ 70/ton	C$ 348/ton	C$ 2787 ton
Tipping fee at landfill site					

The municipal SWM revenue in major years is summarized in the following table.

Table L-90: SWM Revenue

Unit: C$ 1000

	1995	2000	2005	2010
Beneficiaries	45,223	61,159	101,684	135,106
Households	35	1,273	1,912	2,813
Companies & businesses	67	166	1,003	1,075
tipping fee	5	12	177	142
Total	106	1,451	3,093	4,031

c.3 Balance

Since the amount collected from households only cover less than half of the expenses, it puts the collection service in the red. If the deficit is to be allocated from the municipal budget, the amount to be covered by the municipality of Granada is as shown in the table below.

Table L-91: Fee Collection Income and Municipal Share in the Collection Expenses

Unit: C$ 1,000

		2001~2005 average	2006~2010 average	2001~2010 Total
Beneficiaries		83,833	120,978	
Cost		8,021	9,303	86,622
Revenue from fee collection	Households	1,745	2,519	21,320
	Companies & businesses	958	980	9,690
	Tipping fee	169	137	1,530
Municipal Share (percentage in municipal budget)		5,149 (25.8 %)	5,667 (23.0 %)	54,082 (24.2 %)

The share of the municipality in the collection service expenses in 2002 shall amount to 29.4% of the municipal budget if the depreciation costs should be deposited.

d. Sensitivity Analysis and Conclusion

The sensitivity analysis is done when the costs and revenue fluctuate.

d.1 Water Supply and Wastewater Management

Sensitivity analysis was carried out on the water supply and wastewater management systems proposed for INAA Region IV. The results are as shown below.

Table L-92: Sensitivity Analysis of the FIRR of INAA

Unit : %

		Revenue*		
		-10%	0%	+10%
Cost	-10%	0.6	3.5	6.8
	0%	-1.9	0.6	3.2
	+10%	n.a.	-1.7	0.6

Note: * the revenue is calculated based on the number of beneficiaries of proposed systems only.

The results shown in the table above will not satisfy the financier.

d.2 Municipal SWM

The sensitivity analysis for municipal SWM was carried out assuming that half of the expenses shall be shouldered by the municipality. The results are as shown below.

Table L-93: Sensitivity Analysis of the FIRR of Municipal SWM

Unit : %

		Revenue		
		-10%	0%	+10%
Cost	-10%	-6.2	-4.5	-2.9
	0%	n.a.	-6.2	-4.7
	+10%	n.a.	n.a.	-6.2

The results point out the need to increase the share of the municipality.

d.3 Conclusion

The share of the households, companies and businesses in the expenses is outlined in the table below.

Table L-94: Share of Residents, Companies and Businesses

Unit : C$ 1,000

			1995	2001~ 2005 average	2006~ 2010 average	2001~ 2010 Total
Household	water supply & wastewater management	Beneficiaries*	64,411	91,333	107,360	
		Total share	6,645	10,159	12,640	113,922
		percentage in recipient household income (%)	3.91	4.04	4.09	4.07
	Municipal SWM	Beneficiaries*	45,223	83,833	120,978	
		Total share	35	1,745	2,519	21,320
		percentage in recipient household income (%)	0.02	0.76	0.72	0.74
	Total	Population	71,783	107,451	126,702	
		Total share	6,650	11,904	15,158	135,312
		percentage in the income of all households in Granada (%)	3.4	4.0	4.2	4.1
Companies & businesses	water supply and wastewater management		3,106	6,707	8,268	74,873
	Municipal SWM		72	1,127	1,117	11,220
	Total		3,178	7,834	9,385	86,093
	percentage in GRDP (%)		1.3	2.1	2.0	2.0

Notes:
* beneficiaries under water supply and wastewater management refer to the population served by the water supply system, and beneficiaries under municipal SWM refer to the waste collection service population.
** refers to a low collection fee and collection rate

As was evident in preceding sections, the project is not that feasible especially in view of the considerable rate of increase in the share of households, companies and businesses in the expenses of the waste collection and water supply services. In particular, in view of the tight financial conditions of the municipality, it would be impossible to allocate from the municipal budget the amount required to cover the expenses of the services. Finding a means to solve this situation is a serious task to be undertaken in the feasibility study.

The items to study in F/S are as follows:

- Phased implementation of the on-site wastewater management plan, in cooperation with other USE projects such as the development of the storm water management and establishment of an executing body
- Study of a concrete fee collection system by reviewing the share of companies and businesses, the quality of collection services by area, and the segregation of fees by services

L.1.9.5 Economic Evaluation

a. Methods and Major Assumptions

The economic evaluation of the M/P is conducted to verify the necessity of the proposed projects from the national economic viewpoint.

According to the POS, the beneficiaries are only willing to pay an amount that is way lower than the present fee, except for the fee for municipal SWM collection services. In this study, the economic internal rate of return (EIRR) for the case where the amount the beneficiaries are willing to pay is adopted, and the EIRR for the continuance of the present payment system is calculated to evaluate the proposed projects.

Although the qualitative evaluation of environmental benefits is very difficult, a trial analysis was carried out based on the methods applied in the Feasibility study of INAA.

a.1 Benefits

The results of POS are summarized in the following table.

Table L-95: POS Results and Present Fee

	Willingness- to-Pay (1)*	Willingness-to-Pay (2)**	Present Fee
Water supply	C$11.25/month	C14.90/month	C$ 49.8/month
Wastewater management	C$16.16/month	C$8.32/month	C$ 16.7/month
Municipal SWM	C$8.54/month	C$6.48/month	C$ 10.5/month

Note:
* average of the total number of households presently receiving and not receiving the services in Granada
** average of the total number of households in three cities not receiving the services (the respective average of each of the three cities was not calculated due to limited samples)

A trial quantitative analysis was carried out on the following items using the F/S of INAA as a reference:

① effects of public health improvement

② effects of rise in real estate value

③ effects of the increase in tourist consumption

Using the methods and figures of INAA, the benefits of improvements in public health were calculated in consideration of the following factors:

- time wasted due to contagion
- medical treatment costs
- loss in life opportunities due to death (life span shortened to 10 years)

By improving public health and environment, wastewater management (per economically active population) is considered to reduce the economic costs that may be incurred by the above factors to 35%. The use of similar methods to calculate the economic costs for municipal solid waste management might also give the same results. The water supply services, however, is assumed to reduce the economic costs at a rate 1.5 times higher than that of the wastewater management.

The equation used for the calculation is as shown below:

time wasted = Nbt x Rea x Rem x Rif x Rse x Dc x Wd
medical treatment costs = Nbt x Rea x Rif x {Rse x Ccs + (1 - Rse) x Ccg}
loss in life opportunities due to death = Nbct x Rea x Rem x Rd x Oc

where,

Nbt =	Number of beneficiaries in t year (number of beneficiaries in t year minus number of beneficiaries in 2000)
Nbct =	Number of new beneficiaries in t year (number of beneficiaries in t year minus number of beneficiaries in (t-1) year)
Rea =	Rate of economically active population (42.1%)
Rem =	Rate of employment (90.8%)
Rif =	Rate of infected population (6.8%)
Rse =	Rate of seriously ill population (25%)
Dc =	average number of treatment days (10 days)
Wd =	daily wage (c$24)
Ccs =	Costs to cure seriously ill (c$250)
Ccg =	Costs to cure the ill (c$30)
Rd =	Rate of death due to these diseases (0.02%)
Oc =	cost of loss in opportunity to work for more than ten years (c$40,095)

As in the INAA F/S, a 5% increase in real estate value can be expected from environmental improvement. The wastewater management and municipal SWM are assumed to equally contribute to this rate, with 1.67% each. However, the assumptions preclude the water supply plan as it does not involve water supply area coverage expansion. The INAA F/S unit price of C$ 57,954 for real estate properties was adopted in this study.

Although the INAA F/S did not study the effects of the increase in tourist consumption, this M/P did in view of the important role tourism plays in Granada's economy. Accordingly, with the improvement of urban sanitary conditions, tourist influx is expected to increase in Granada. The benefits were calculated under the following assumptions:

- Tourist consumption nationwide will increase between 1990 and 1995, as shown in the following table.
- The number of tourists that frequent Granada presently amounts to about 240,000, making up 10% of the tourist consumption ratio nationwide.
- A two point increase in the tourist consumption ratio is assumed due to improved urban sanitary conditions.

	1995	2000	2005	2010
Tourist consumption (US$ million)	49.5	85.6	123.9	162.3
Benefits expected in Granada due to improved urban sanitary conditions (C$ 1,000)			6,613	13,972

The water supply, wastewater management and municipal SWM sectors are assumed to evenly contribute to this rate. The off-site and on-site wastewater management systems are also considered to have equal contributions.

a.2 Conversion factors

The economic evaluation of the Master Plan was carried using established price conversion factors.

Table L-96: Conversion Factors for M/P Economic Evaluation

Items			Conversion rate
Investment	Civil		0.840
	piping		0.840
	Equipment		0.820
Operation & maintenance	Personnel cost	water supply & wastewater management	0.557
		municipal SWM	0.458
	Maintenance		0.869

b. Water Supply Master Plan

The benefits that can be expected from the water supply M/P are as shown below.

Table L-97: Water Supply M/P Expected Benefits

Unit : C$ 1,000

		2001~2005 Total	2006~2010 Total	2001~2010 Total
willingness-to-pay	C$11.25/month	866	8,207	9,073
	C$14.90/month	4,308	12,254	16,542
	C$47.8/month*	37,226	50,948	88,174
benefits of public health improvement		33	83	116
benefits of increase in real estate value		0	0	0
benefits of increase in tourist consumption		6,986	18,630	25,616

Note *: The fee adopted in the financial evaluation is used, as the present fee stated in the POS is too expensive.

The expenditures converted to economic prices are shown in the following table. In order to calculate the Economic Internal Rate of Return (EIRR), a negative figure was used to represent the residual value in 2010.

Unit : C$1,000

	2000	2001~2005 Total	2006~2010 Total	Residual value in 2011	Total
Investment	6,282	31,409	31,408	-48,654	20,445
O/M cost		14,912	17,561		

The EIRR in terms of benefits is as shown below.

Benefit	Willingness-to- Pay	EIRR	B/C (0 discount rate)
willingness-to-pay only	C$11.25/month	n.a.	0.1715
	C$14.9/month	n.a.	0.3130
	C$49.8/month	13.2%	1.6663
willingness-to-pay* and environmental improvement	C$14.9/month	-2.8%	0.7993

Note: amount present number of households not receiving services are willing to pay (average of 3 cities)

c. Wastewater Management Master Plan

c.1 Off-site system

The benefits that can be expected from the off-site wastewater management master plan are as follows:

Unit : C$1,000

		2001~2005 Total	2006~2010 Total	2001~2010 Total
willingness to pay	C$16.16/month	5,416	12,270	17,686
	C$8.32/month	2,628	7,285	9,913
	C$16.7/month	5,609	12,613	18,222
benefits of public health improvement		33	90	123
benefits of increase in real estate value		2,709	3,571	6,280
benefits of increase in tourist consumption		3,493	9,315	12,808

The expenditures converted to economic costs are shown in the following table. In order to calculate the Economic Internal Rate of Return (EIRR), a negative figure was used to represent the residual value in 2010.

Unit : C$1,000

	2000	2001~2005 Total	2006~2010 Total	Residual value in 2011	Total
Investment	3,129	15,647	15,651	-25,087	9,340
O/M cost		3,664	6,555		10,219

The EIRR in terms of benefits is as shown below.

Benefits	willingness to pay	EIRR	B/C(0 discount rate)
willingness to pay only	C$16.16/month	-1.1%	0.9042
	C$8.32/month	n.a.	0.5068
	C$16.7/month	-0.8%	0.9316
willingness to pay* and environmental improvement	C$8.32/month	5.8%	1.4890

Note: amount the present number of households not receiving services are willing to pay (average of 3 cities)

c.2 On-site

The benefits that can be expected from the on-site wastewater management master plan are as shown below.

Unit : C$1000

		2001～2005 Total	2006～2010 Total	2001～2010 Total
willingness to pay	C$16.16/month	657	2,532	3,189
	C$8.32/month	339	1,303	1,642
	C$16.7/month	680	2,616	3,296
benefits of public health improvement		3	4	7
benefits of increase in real estate value		1,308	1,639	2,948
benefits of increase in tourist consumption		1,611	4,297	5,908

The expenditures converted to economic costs are as shown in the following table. In order to calculate the Economic Internal Rate of Return (EIRR), a negative figure was used to represent the residual value in 2010.

Unit : C$1000

	2000	2001～2005 Total	2006～2010 Total	Residual value in 2011	Total
Investment	1,983	9,917	7,993	-16,197	3,636
O/M cost		1,035	3,066		4,101

The EIRR in terms of benefits is as shown below.

Benefits	willingness to pay	EIRR	B/C(0 discount rate)
willingness to pay only	C$16.16/month	n.a.	0.4122
	C$8.32/month	n.a.	0.22122
	C$19.67/month	n.a.	0.4260
willingness to pay* and environmental improvement	C$8.32/month	n.a.	1.3635

Note: amount the present number of households not receiving services are willing to pay (average of 3 cities)

d. Municipal SWM Master Plan

The benefits that can be expected from the municipal SWM master plan are as shown below.

Unit : C$1000

		2001~2005 Total	2006~2010 Total	2001~2010 Total
willingness-to-pay	C$8.54/month	13,029	16,254	29,283
	C$6.48/month	11,246	13,680	24,926
	C$10.5/month	14,726	18,702	33,428
benefit of public health improvement		328	460	788
benefit of rises of property value		4,554	3,756	8,310
benefit of increase of tourism consumption		6,986	18,630	25,616

The expenditures converted to economic costs are shown in the following table. In order to calculate the Economic Internal Rate of Return, a negative figure was used to represent the residual value in 2010.

Unit : C$1000

	2000	2001~2005 Total	2006~2010 Total	Residual value in 2011	Total
Investment	30,473	24,329	11,969	-21,627	45,144
O/M cost		8,689	10,650		19,340

The EIRR in terms of benefits is as shown below.

Benefits	willingness to pay	EIRR	B/C(0 discount rate)
willingness to pay only	C8.54/month	n.a.	0.4541
	C$6.48/month	n.a.	0.3865
	C$10.5/month	n.a.	0.5184
willingness to pay* and environmental improvement	C$6.48/month	-1.4 %	0.7238

Note: amount the present number of households not receiving services are willing to pay (average of 3 cities)

e. Sensitivity Analysis and Conclusion

This section shall deal with the conduct of a trial sensitivity analysis in case changes occur in the environmental improvement benefits and economic costs the master plans are estimated to incur.

e.1 Water Supply System

The EIRR of the water supply system master plan is shown in the following table.

		Benefits of Improvements in Urban Sanitary Conditions		
		-10%	0%	+10%
Economic Cost	-10%	-2.3	-1.6	-0.8
	0%	n.a.	-2.8	-2.1
	+10%	n.a.	n.a.	-3.2

The table shows the necessity to put more importance on environmental improvement, to consider the conservation of energy, and the implementation of policies, e.g., use of a relatively huge number of local equipment and materials, that would reduce the economic cost.

e.2 Off-site Wastewater Management System

The EIRR of the off-site wastewater management system is shown in the following table.

		Benefits of Improvements in Urban Sanitary Conditions		
		-10%	0%	+10%
Economic Cost	-10%	6.5	7.8	9.2
	0%	4.6	5.8	7.0
	+10%	3.1	4.1	5.2

This table shows that the implementation of the master plans would still be necessary even if the environmental improvement benefits are poorly evaluated.

e.3 On-site Wastewater Management System

The EIRR of the on-site wastewater management system is shown in the following table.

		Benefits of Improvements in Urban Sanitary Conditions		
		-10%	0%	+10%
Economic Costs	-10%	2.7	3.7	4.6
	0%	1.7	2.6	3.4
	+10%	0.9	1.7	2.4

e.5 Municipal SWM system

The EIRR of the municipal SWM is shown in the following table.

		Benefits of Improvements in Urban Sanitary Conditions		
		-10%	0%	+10%
Economic Costs	-10%	-0.6	0.5	1.6
	0%	-2.4	-1.4	-0.4
	+10%	-3.9	-3.0	-2.0

This figure shows the need to implement policies, e.g., use of a relatively huge number of local equipment and materials, that would reduce the economic costs, and consider the conservation of energy.

e.5 Conclusion

It is generally difficult to quantitatively evaluate the benefits that can be expected from improved sanitary conditions, and there are really no standard methods established for such evaluation. Nonetheless, a trial evaluation was carried out.

To quantitatively evaluate the benefits of the water supply, wastewater management and municipal SWM projects, a common method was used and evaluation was carried out under various conditions. The evaluation of the wastewater management project showed a high willingness to pay on the part of the beneficiaries. Also, of the three projects, it is given highest priority.

Although the water supply project is considered to bring about numerous benefits, such as effective use of spare time and improvement of public health (an intangible benefit), of the three projects, it is not highly prioritized due to the existence of an improved water supply system in Granada.

On the other hand, although the willingness to pay for municipal SWM services is low, it is necessary for the municipality of Granada to conduct the proposed M/P, because present waste conditions could contaminate drinking water resources.

In consideration of other non-quantifiable benefits (e.g., conservation of Nicaragua Lake water quality, preservation of various biological species, promotion of marine resources and luring of foreign investments), the proposed projects are considered to significantly contribute to national economic development.

L.1.9.6 Total Evaluation

Although technical and social evaluations above require examinations of the workability of the systems proposed in the M/P through pilot projects, the M/P (except the issues subject to the examination) in overall view is evaluated to be appropriate.

Environmental and economic evaluations resulted the M/P implementation being appropriate in view of environment and national economy.

On the other hand, the financial evaluation revealed that the M/P implementation will induce: citizens' cost burden increase, and the municipality's financial difficulties. Therefore, whether the citizens and municipality be able to bear the burden or not and measures to burden alleviation shall be reexamined in the F/S phase (3rd Study Work in Nicaragua) along with the reviews for follows.

- Reviews on the schedule of DWWM implementation (revision of target figures in target years);
- Reviews of technical integrity level in the new municipal landfill (necessity of impermeable liner works to be examined); and
- Review of costs for facilities proposed in the M/P through pilot projects.

L.1.10 Implementation Plan

Implementation plan of M/P, which summarized the outcome of the review up to previous section, is shown in Table L-98.

Table L-98: Implementation Program of the Master Plan