CHAPTER 9

EVALUATION OF THE ISWM MASTER PLAN

CHAPTER 9 EVALUATION OF THE ISWM MASTER PLAN

9.1 Cost Estimation

9.1.1 Assumptions of ISW Flow in 2010

a. Principle

There is a wide variety in features and descriptions of ISW, whose treatment and disposal also vary in application. Current treatment/disposal systems of ISW in the MR are mainly landfill disposal in municipal landfill sites. In view of the principle policies of the Government of Chile, it is judged that establishment of technical systems of treatment/disposal of ISW in the MR is promoted by private sectors. Consequently, it is difficult to forecast on what technological level treatment/disposal technical systems will be realized and commercialized in 2010.

It is, however, one of the principal targets of the Study to estimate the magnitude of ISWM business in 2010. It is necessary for the estimation to assume an outline of technical system (storage, collection, transportation, treatment and disposal) in 2010, and set up the amount of ISW and unit costs of treatment/disposal in the system. Therefore, the Team, judging from present industries features and economic trends, quantity and quality of ISW, and natural conditions and so on in the MR, assumed intermediate treatment and disposal flows corresponding to 24 ISW and followingly calculated a rough estimate of projects costs for the amount forecasted of said ISW to be treated and disposed in the year 2010.

b. Assumption on Technical System in 2010

ba. Amount of ISW Subject to the Cost Estimation

The amount of ISW subject to this cost estimation are defined:

- estimated total generation amount of ISW in 2010 minus estimated recycled amount in 2010.

Recycled amount of ISW in 2010 is forecasted for 24 ISW categories respectively by:

- "estimated generation amount" times " recycle ratio assumed (refer Table 9.1.1a below)".

bb. Recycling Ratios

Recycling ratios of ISW in the MR in 2010 are estimated, with reference to empirical data in Japan, results of the Team's factories survey and the consultants' experiences in other projects, as shown in the Table 9.1.1a.

Table 9.1.1a Recycle Ratio

unit: %

Type of Waste	Empirical data in Japan in 1991	Recycling ratio in 1995 surveyed	Recycling ratio assumed for the MR in 2010
C-1	10%	65%	40%
C-2	48%	9%	40%
C-3	2%	0%	2%
C-4	2%	0%	2%
C-5	-	0%	0%
C-6	45%	80%	45%
C-7	26%	13%	25%
C-8	-	37%	40%
C-9	40%	71%	40%
C-10	-	0%	0%
C-11	-	0%	0%
C-12	-	65%	25%
C-13	68%	96%	80%
C-14	24%	15%	20%
C-15	92%	74%	90%
C-16	63%	80%	70%
C-17	17%	36%	25%
C-18	27%	1%	25%
C-19	64%	33%	50%
C-20	-	2%	2%
C-21	47%	94%	90%
C-22	74%	4%	40%
C-23	39%	0%	35%
C-24	1%	0%	1%

Source : Empirical data in Japan in 1991 is from "Solid Waste in Japan in 1994" by Ministry of Health and Welfare of Japan.
Recycling ratio in 1995 surveyed was obtained by JICA's Factories' Survey (see Table C.5.1o in Annex C).

bc. Volume Change Through Intermediate Treatment

The volume of ISW is changed through intermediate treatment. The following assumptions are employed in ISW volume changes for determining ISW flows.

i. Dehydration of sludge

Moisture content of sludge (before and after dehydration) is assumed as shown in the Table 9.1.1b.

Table 9.1.1b Assumed Sludge Moisture Content

	Before dehydration	After dehydration
C-3 Inorganic sludge	90%	85%
C-4 Organic sludge	99%	85%

ii. Volume reduction through incineration

Volume reduction ratios of ISW through incineration treatment vary depending on the characteristics of respective ISW incinerated. Table 9.1.1c shows assumptions employed in estimation of volume reduction through incineration:

Table 9.1.1c Volume reduction ratio assumed

	Before incineration	After incineration	
		C-1	C-2
C-8 Solvent	100%	2%	2%
C-9 Oily waste	100%	5%	5%
C-11 Organic chemical residues	100%	10%	10%
C-24 Other solid waste	100%	10%	10%

iii. Volume change through solidification, neutralization and chemical treatment

Although slight volume changes (increase or decrease) occur through application of chemical agents, the differences are negligible. Therefore volume changes through solidification, neutralization and chemical treatment are neglected. Whereas it is assumed that neutralization and chemical treatment transform the entire amount of treated ISW into C-3 or C-4.

c. Assumption of Treatment/Disposal Flows for 24 ISW Categories

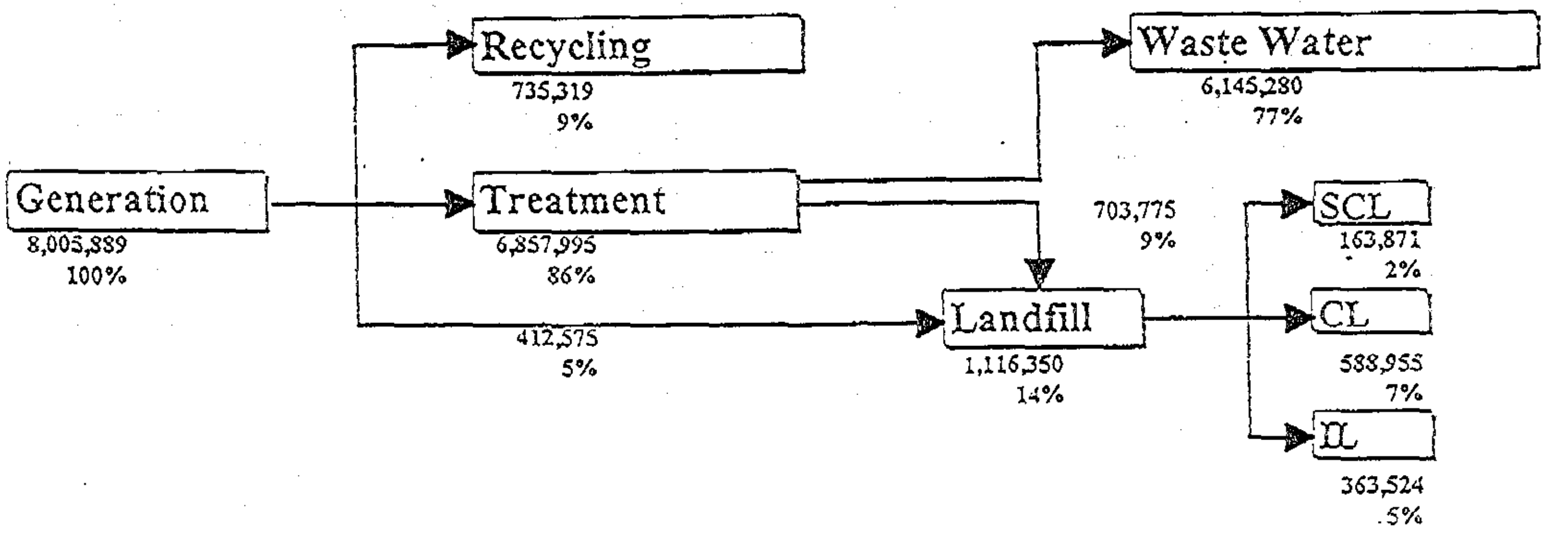
For estimating costs of treatment/disposal, flows of treatment/disposal for 24 ISW categories (in 2010) are estimated based on the consultants' experiences and present situation of the MR (e.g. sites available for ISW final disposal facilities are comparatively many and land acquisition cost is not so expensive like in Japan. And intermediate treatment facilities are to be constructed mainly aiming at "transforming ISW into harmless" rather than aiming at "volume reduction" unlike in some industrialized countries, ect.).

Treatment/disposal flows assumed for above 24 ISW categories are indicated by ratios as shown in Table 9.1.1d. Treatment/disposal amount in total in 2010 are summarized in the flow shown below the Table 9.1.1d by multiplying respective forecast amount of 24 ISW with ratios assumed above.

Table 9.1.1d Treatment/ Disposal Rations Assumed for 24 ISW Categories in 2010

Type of Waste		Recycling	Treatment or Disposal	Intermediate Treatment						Treatment Ratio	Change to other type waste						Waste Water Treatment	Landfill			Total
							Dehydration				No.1		No.2		No.3						
				Solidification	Neutralization	Chemical	Non-Hazad.	Hazardous	Incineration		TW	Ratio	TW	Ratio	TW	Ratio		SCL	CL	IL	
C-1	Ash including from incinerator	40.0%	60.0%							0.0%								30.0%	15.0%	15.0%	60.0%
C-2	Dust and APC products	40.0%	60.0%	25.0%						25.0%								25.0%	25.0%	10.0%	60.0%
C-3	Inorganic sludge	2.0%	98.0%				90.0%	8.0%		98.0%							32.7%	5.3%	30.0%	30.0%	98.0%
C-4	Organic sludge	2.0%	98.0%				70.0%	28.0%		98.0%							91.4%	1.9%	4.0%	0.7%	98.0%
C-5	Asbestos	0.0%	100.0%	50.0%						50.0%								50.0%		50.0%	100.0%
C-6	Acids	45.0%	55.0%		55.0%					55.0%	C-3	27.5%	C-4	27.5%							0.0%
C-7	Alkalis	25.0%	75.0%		75.0%					75.0%	C-3	37.5%	C-4	37.5%							0.0%
C-8	Solvents	40.0%	60.0%						60.0%	60.0%	C-1	1.2%	C-2	1.2%							0.0%
C-9	Oily waste	40.0%	60.0%						60.0%	60.0%	C-1	3.0%	C-2	3.0%							0.0%
C-10	Inorganic chemical residues	0.0%	100.0%	12.5%		50.0%				62.5%	C-3	50.0%						12.5%	25.0%	12.5%	50.0%
C-11	Organic chemical residues	0.0%	100.0%			50.0%			25.0%	75.0%	C-1	2.5%	C-2	2.5%	C-4	50.0%			12.5%	12.5%	25.0%
C-12	Other liquid waste	25.0%	75.0%			75.0%				75.0%	C-3	37.5%	C-4	37.5%							0.0%
C-13	Waste from food production	80.0%	20.0%							0.0%									20.0%		20.0%
C-14	Glass and ceramics	20.0%	80.0%							0.0%										80.0%	80.0%
C-15	Metal and scrap	90.0%	10.0%							0.0%										10.0%	10.0%
C-16	Paper and cardboard	70.0%	30.0%							0.0%									30.0%		30.0%
C-17	Plastics	25.0%	75.0%							0.0%										75.0%	75.0%
C-18	Rubber	25.0%	75.0%							0.0%										75.0%	75.0%
C-19	Textile and leather	50.0%	50.0%							0.0%									50.0%		50.0%
C-20	Waste similar to domestic waste	2.0%	98.0%							0.0%									98.0%		98.0%
C-21	Wood	90.0%	10.0%							0.0%									10.0%		10.0%
C-22	Slag from melting	40.0%	60.0%							0.0%								30.0%	0.0%	30.0%	60.0%
C-23	Construction waste	35.0%	65.0%							0.0%									15.0%	50.0%	65.0%
C-24	Other solid waste	1.0%	99.0%						9.0%	9.0%	C-1	0.9%	C-2	0.9%					45.0%	45.0%	90.0%

Assumed ISW Flow in 2010



9.1.2 Assumption for Cost Estimation

These cost estimation are conducted based on the following assumption and the value presented in the cost estimation are "net present value (NPV)" in 1995.

a. Currency Exchange Rate

The following exchange rates are employed in the cost estimation:

1 US$	=	416.2 Chilean pesos *1
	=	102.4 Japanese yen *2

Note: *1 Exchange rate of US$/Chilean peso referred the value shown on the column of "interbancario" of the newspaper "El Mercurio" dated 28th October 1995.

*2 Exchange rate of US$/Japanese yen referred the value shown on the newspaper "Nikkei Shimbun" dated 30th October 1995.

b. Estimation of Tipping Fee for Intermediate Treatment Facilities

Tipping fees including profits and insurance costs for intermediate treatment facilities are estimated below.

ba. Construction Cost of Intermediate Treatment Facilities

Estimation of construction cost for intermediate treatment facilities are mainly referred to "The World Bank Technical Paper # 93, The World Bank". Since this paper presented costs in 1980's in US dollars, inflation rate in USA of 3.0% per year is assumed for 1980's to 1995 in order to convert those cost into the present value.

bb. Financial Resource for Facilities Construction

It is assumed that financial resource for land acquisition cost and construction cost of intermediate treatment facilities are to be covered by loans for all the amount. Loans conditions are assumed as follows:

- payback period: 15 years;
- interests rate: 6.0% per year

The value (for 14 years payback) indicated in "Evolucion de la Economia en 1994 y

Perspectivas para 1995, Banco Central de Chile, September 1994" is employed for the above assumption.

bc. Net Cost of Intermediate Treatment

Net cost of intermediate treatment is estimated, assuming the life span of an intermediate treatment facility is 15 years. Consequently, unit cost for intermediate treatment is calculated as: "Total net cost (total loan payback and O&M costs for 15 years)" divided by "total ISW amount to be treated for 15 years", i.e., NPV US$ per ton. The calculation is expressed as follows:

$$A = (B + C) / D$$

A: unit (US$/ton) cost;
B: total loan payback;
C: total O&M costs for 15 years (NPV); and
D: total ISW amount to be treated for 15 years.

bd. Tipping Fees

Tipping fees for treatment facilities are calculated by adding profit to the above-mentioned unit cost. Profit of the intermediate treatment handling agents are assumed to be 10%, which should cover the cost of restoration from accidents (such as insurance cost, etc.).

c. Collection and Transport Costs

Collection cost, transport cost, collection and transport cost are defined as follows:

- collection cost: cost incurred from "loading ISW at source" to "transport up to intermediate treatment facilities";
- transport cost: cost incurred from transport of "intermediate treatment facilities" to "final disposal site"; and
- collection and transport cost: cost incurred from "loading ISW at source" to "transport up to final disposal site".

d. Dehydration

All sludges to be generated in factories are assumed to be dehydrated on-site (i.e. at each generation source), and the scale of a dehydration facility is calculated at an average discharge amount which comes from division of total sludge generation amount by number of factories generating sludges.

e. Storage Cost

Storage is defined as:

- storage on-site, and
- storage at intermediate treatment facilities.

In the Study the former cost is not counted because it shall be born by the generators. Whereas the latter cost is included in the tipping fees of intermediate treatment facilities.

9.1.3 Cost Estimation

An estimation of ISWM business scale is illustrated below. Estimation of cost associated with construction and O&M of intermediate treatment facilities are induced from the consultants' experiences and "The World Bank Technical Paper # 93, The World Bank". Meanwhile cost associated with collection, transport and final disposal are estimated referring to current prices of activities in the MR and tipping fees of 3 categories of landfills in Brazil.

As a summary of the cost estimation, unit costs (including profits, etc.) estimated for collection, transport, intermediate treatment and final disposal are listed in Table 9.1.3a.

Table 9.1.3a Unit Costs Estimated

Item	Unit. Cost (US$/ton)
Collection and Transportation (C & T)	
"Collection" for ISW	6.0 US$/ton
"Collection" for Medical Waste	40.0 US$/ton
"Transportation" for ISW and Medical Waste	6.0 US$/ton
"Collection and Transportation" for ISW	12.0 US$/ton
Intermediate Treatment	
Solidification	23.0 US$/ton
Neutralization	2.4 US$/ton
Chemical Treatment	3.4 US$/ton
Dehydration outside (Non-HW)	35.7 US$/DS-ton
Dehydration on-site (Non-HW)	32.6 US$/DS-ton
Dehydration outside (HW)	107.1 US$/DS-ton
Dehydration on-site (HW)	98.6 US$/DS-ton
Incineration	151.0 US$/ton
Waste Water Treatment outside	0.85 US$/ton
Waste Water Treatment on-site	1.02 US$/ton
Disposal	
SCL for ISW (HW)	90.0 US$/ton
CL for ISW (Non-HW/Non-Inert)	18.0 US$/ton
IL for ISW(Inert)	1.5 US$/ton

Note: DS-ton : Dry solid ton

Estimation of ISWM business scale (i.e. total costs) are forecasted by multiplying "amounts estimated of ISW to be collected, transported, treated and disposed in 2010" and "respective unit costs estimated above" in total, which are shown in Table 9.1.3b.

Table 9.1.3b ISW Handling Cost (Costs of Collection, Transportation, Intermediate Treatment and Final Disposal for 24 ISW Categories) in 2010

Unit: US$/year

Type of Waste	Intermediate Treatment		Final Disposal	Collection and Transportation	Total
	Outside	On-Site			
C-1	0	0	430,000	103,000	533,000
C-2	243,000	0	1,148,000	305,000	1,696,000
C-3	105,000	1,257,000	3,557,000	2,524,000	7,443,000
C-4	18,000	9,465,000	15,904,000	5,168,000	30,555,000
C-5	5,000	0	18,000	5,000	28,000
C-6	28,000	0	0	70,000	98,000
C-7	5,000	0	0	14,000	19,000
C-8	62,000	0	0	2,000	64,000
C-9	373,000	0	0	15,000	388,000
C-10	139,000	0	484,000	274,,000	897,000
C-11	386,000	0	24,000	73,000	483,000
C-12	13,000	0	0	24,000	37,000
C-13	0	0	1,001,000	667,000	1,668,000
C-14	0	0	191,000	1,527,000	1,718,000
C-15	0	0	10,000	83,000	93,000
C-16	0	0	727,000	484,000	1,211,000
C-17	0	0	36,000	285,000	321,000
C-18	0	0	21,000	171,000	192,000
C-19	0	0	103,000	69,000	172,000
C-20	0	0	1,070,000	714,000	1,784,000
C-21	0	0	243,000	162,000	405,000
C-22	0	0	365,000	96,000	461,000
C-23	0	0	30,000	67,000	97,000
C-24	825,000	0	532,000	688,000	2,045,000
Total including dehydration on-site	2,202,000	10,722,000	25,894,000	13,590,000	**52,408,000**
Total excluding dehydration on-site	2,202,000	-	25,894,000	13,590,000	**41,686,000**

9.2 *Outline of the Master Plan*

The outline of the ISWM Master Plan to be established by year 2010 is presented in Table 4.6a Technical System and Table 4.6b Institutional System respectively. It should be noted that various assumptions were made in order to present the technical system, especially be minded that al sludges to be generated in factories are assumed to be dehydrated on-site, i.e. at each generation source.

Table 9.2a Outline of Technical System in the Master Plan

Items	Description (assumed in the target year 2010)
1. ISW Generation Amount	8,006,000 ton/year (without dehydration of sludges)
2. Storage system	On-site
3. Collection and Transportation (C&T)	
3.1 sectors	Private ISWM enterprises and generators
3.2 amount	1,180,000 ton/year
- Collection	64,000 ton/year
- Transportation	31,000 ton/year
- C&T	1,085,000 ton/year
4. Recycling system	
4.1 sectors	Private ISWM enterprises and generators
4.2 amount	735,000 ton/year (9.2% of total)
5. Treatment system	
5.1 sectors	Private ISWM enterprises (other than dehydration on-site)
5.2 amount	
- Solidification	15,000 ton/year
- Neutralization	14,000 ton/year
- Chemical treatment	24,000 ton/year
- Dehydration	6,795,000 ton/year
On-site	6,758,000 ton/year (by generators)
Outside	37,000 ton/year
- Incineration	11,000 ton/year
6. Waste water treatment	
6.1 sectors	Private ISWM enterprises (other than waste water treatment on-site)
6.2 amount	6,145,000 ton/year
On-site	6,125,000 ton/year (by generators)
Outside	20,000 ton/year
7. Final disposal	
7.1 sectors	Private ISWM enterprises
7.2 amount	
- SCL	164,000 ton/year
- CL	589,000 ton/year
- IL	364,000 ton/year

Table 9.2b Summary of Institutional System in the Master Plan

Items	Goals to be achieved by the target year 2010
1. Legislative system	
a. legislative system of ISWM	1. legislation of basic responsibilities of waste generators. 2. legal empowerment for administrative measures including penalties. 3. legislative framework for permission of facilities siting and operation permit. 4. legislative framework for funds/insurance for ISWM facilities.
b. other legislative system	5. obligation of pre-treatment before sewage discharge.
c. standard & guideline	6. standards for structure, O&M of ISWM facilities. 7. guidelines for EIA of facility localization.
2. Organization	
a. national level	1. unified/centralized national organization responsible for ISWM. (i.e, CONAMA and MS).
b. local level	2. strengthening and amplification of local (MR) authorities' organization. i.e., be capable to place appropriate monitoring and guidance (SESMA). 3. institutional framework to promote policies on ISW inter-relating with air and water pollution prevention.
c. private sectors	4. organizational system to guarantee responsibilities of waste generators, and to establish reliable technology management. 5. organizational improvement of ISW handling agents and recyclers, in order to facilitate the system to guarantee responsibilities and promote technology management thereof. 6. promotion of other private sectors' activities, i.e., analysis laboratories, facilities/equipment manufacturers, insurance companies/fund to support the sectors.
3. Financial framework	
a. authorities administration cost	1. policies and measures to secure authorities' administration cost for proper monitoring and guidance.
b. market mechanism of ISWM	2. formulation of feasible price level in the market to allow sound and appropriate treatment and disposal.

9.3 Evaluation of the Master Plan

The principal objective of evaluation here is to appraise the necessities and viabilities of the Master Plan of industrial SWM in MR. The evaluation is to be carried out from the economic, technical, and environmental viewpoints.

9.3.1 Economic Evaluation of the Master Plan

In conducting the economic evaluation of the master plan, it should be taken into account that industrial solid waste handling activities are principally developed by the private sector in MR on the basis of free market policy. The main roles of public sector is to control and supervise ISWM by ISW generators and ISW handling agents. In this regard, the economic evaluation of the master plan here is focused on the following subjects:

a. Evaluation on the Prospect of ISW Handling Business in 2010

One of the important economic benefits to be created by the master plan is the expansion of ISWM business market in MR. The anticipated market scale of ISWM business may also be some of Chilean entrepreneurs' primary concern. Therefore, as a part of economic evaluation, the Study projected the future market scale of ISWM business in MR by estimating the total ISW handling price for each type of business, namely collection and transport, intermediate treatment, and final disposal on the basis of forecasted ISW generation and estimated unit price of ISW handling. Table 9.3.1a on next page shows the market scale of ISW handling business on handling price basis for each type of waste.

Table 9.3.1a Market Scale of ISW Handling Business in 2010 (1995 handling price basis)

Unit: US$/year

Type of Waste	Collection & Transport	Intermediate Treatment	Final Disposal	Total
Ash (including those from incinerator)	103,000	0	430,000	533,000
Dust and APC products	305,000	243,000	1,148,000	1,696,000
Inorganic sludge	2,524,000	105,000	3,557,000	6,186,000
Organic sludge	5,168,000	18,000	15,904,000	21,090,000
Asbestos	5,000	5,000	18,000	28,000
Acids	70,000	28,000	0	98,000
Alkalis	14,000	5,000	0	19,000
Solvents	2,000	62,000	0	64,000
Oily waste	15,000	373,000	0	388,000
Inorganic chemical residues	274,000	139,000	484,000	897,000
Organic chemical residues	73,000	386,000	24,000	483,000
Other liquid waste	24,000	13,000	0	37,000
Waste from food production	667,000	0	1,001,000	1,668,000
Glass and ceramics	1,527,000	0	191,000	1,718,000
Metal and scrap	83,000	0	10,000	93,000
Paper and cardboard	484,000	0	727,000	1,211,000
Plastic waste	285,000	0	36,000	321,000
Rubber waste	171,000	0	21,000	192,000
Textile and leather waste	69,000	0	103,000	172,000
Waste similar to domestic waste	714,000	0	1,070,000	1,784,000
Wood	162,000	0	243,000	405,000
Slag from melting	96,000	0	365,000	461,000
Construction waste	67,000	0	30,000	97,000
Other solid waste	688,000	825,000	532,000	2,045,000
Total	13,590,000	2,202,000	25,894,000	41,686,000

Remark: APC=Air pollution control

The total ISW handling business market in MR is estimated to be around 41.7 million US dollars (October 1995 price) based on handling price. It covers about 0.036% of the forecasted GNP of 114.9 billion dollars in 2010 or 0.067% of GNP in 1995 (62,500 million US dollars). Final disposal business forms the biggest market which is about 62% of the total ISW handling business market. The remaining market is covered by collection and transport (33%) and intermediate treatment (5%).

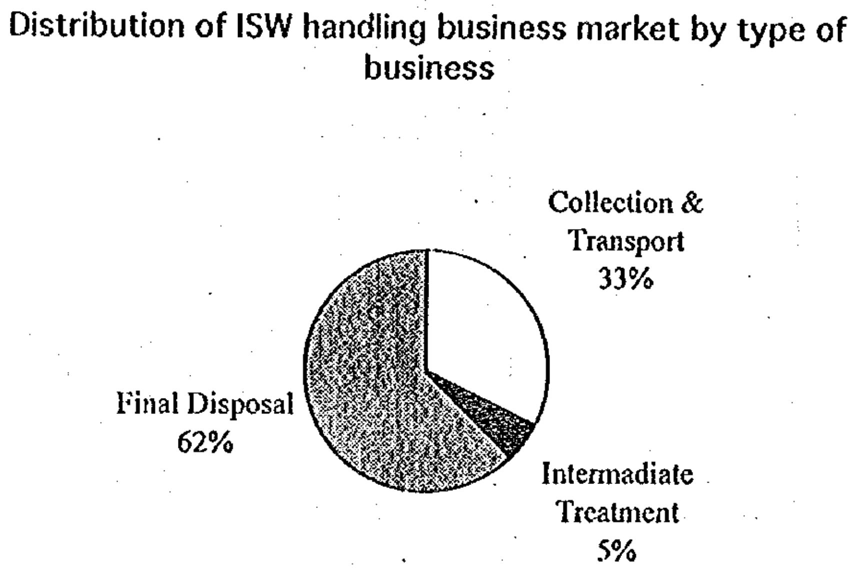


Figure 9.3.1a Distribution of ISW Handling Market by Type of Business

b. Evaluation on the Reasonability of the Cost of Public Administration and Generators for Implementing the Master Plan

The expansion of the ISW handling business market is to be realized by the improved public administration on ISWM in accordance with the master plan. Therefore, the incremental cost of public administration on ISWM is needed to be examined from a cost-efficiency viewpoint. In addition, since the total ISW handling business market is fully based on whether the generators have an intent of paying the cost of ISW handling, it is necessary to examine the generators' financial capabilities.

ba. Cost of Public Administration

Based on the manpower plan for the newly established organization PROGRESI, the Study estimated the public administration cost as given in Table 9.3.1b below.

Table 9.3.1b Estimation of Incremental Cost of Public Administration for the Implementation of the Master Plan (Year 2010)

Program	Manpower Formation	Manpower Cost (US$/month)
Overall Program	Chief(1) Deputy chief (1) Secretary (1) Lawyer (2)	7,100
Logistic support	Manager (1) Secretary (1) Typist (1) Documentation staff (8) General service staff (6)	8,400
Air emission control	Chief (1) Deputy chief (1) Secretary (1) Engineers for emission permits management (4) Engineers and experts for inspection (5) Engineers and experts for audit (2)	19,100
Solid waste management	Chief (1) Deputy chief (1) Secretary (2) Engineers and experts for manifest system control (4) Technical experts for SWM (1) Engineers and experts for permission & license (7) Engineers and experts for Hazardous SW control (5) Monitoring experts (5)	28,200
Liquid effluent control	Chief (1) Engineer for effluent discharge permits (1) Monitoring staff (2)	4,000
Cleaner production	Chief (1) Training expert (1) Information management expert (1) Engineers for technological appraisal (2)	6,800
	Manpower cost total (US$/month) (US$/year)	73,600 883,200
Overhead cost (50% of manpower cost)		441,600
Total (US$/year at 1995 price)		**1,324,800**

The incremental cost of public administration for implementing the master plan is, as given in the table above, estimated to be about 1.3 million US dollars in 2010. Its ratio to the total ISW handling business market (on handling price basis) is only about 1.7%. Accordingly, it indicates that approximately 80 million dollars of ISW handling business market is to be created by conducting the proper control and management of ISW in accordance with the master plan at a cost of 1.3 million US dollars.

bb. Sensitivity analysis on the generators' cost of ISW handling

To assess viability of the cost to be covered by ISW generators, the Study made a sensitive analysis by setting up an alternative scenario of ISWM in 2010. The difference between the alternative scenario and the master plan is in the reduction ratio of sludge amount on-site (inside factories). In the alternative scenario, the water content of sludge at generation source is assumed as 90% for inorganic sludge and 99% for organic one respectively while the master plan assumes that it is 85% for both types of sludge on-site. In other words, the alternative scenario assumes that sludge dehydration is made only outside factories by ISW handling agents and there is no reduction of sludge amount on-site by generators. Table 9.3.1c compares the total ISW handling cost between the case of alternative scenario and master plan.

Table 9.3.1c Comparison of ISW Handling Cost in 2010 Between Alternative Scenario and Master Plan

Unit: US$/year

	Alternative Scenario	Master Plan
Collection & Transportation	50,562,000	13,590,000
Intermediate Treatment (dehydration on-site)	0	10,722,000
Intermediate Treatment (outside factory)	8,932,000	825,000
Final Disposal	25,894,000	25,894,000
Total	**85,388,000**	**52,408,000**

As obviously found in the table above, reduction of sludge amount at generation source is a crucial factor to limit incremental cost of ISW handling especially for collection and transportation in future. In addition, the necessity of in-factory reduction of sludge amount is also supported by the estimation results regarding the ratios of the total ISW handling cost to the total output value for each type of manufacturing industry in 2010.

In this estimation, the total ISW handling cost includes collection and transportation, intermediate treatment (both on-site and outside factories), and final disposal. The total output value for each type of manufacturing industry, on the other hand, is forecasted by utilizing the increase rate of production which was used for projecting the number of employees and existing output value data available in the CORFO (Corporación de Fomento de la Producción) Study. Table 9.3.1d and 9.3.1e show the results of estimation for each case of alternative scenario and master plan respectively.

Table 9.3.1d Ratio of ISW Handling Cost to the Output Value in Manufacturing Industry in 2010 (Alternative Scenario)

CIIU	Sub-Sector	Sales per employee in 2010 (US$/year)	ISWM cost per employee (US$/year)	Ratio (%)
311	Food Manufacturing	18,966	261	1.38%
313	Beverage Industries	54,504	759	1.39%
314	Tobacco Industries	64,890	96	0.15%
321	Textile Industries	14,033	54	0.38%
322	Wearing Apparel Manufacturing	10,508	5	0.05%
323	Leather Industries	12,639	613	4.85%
324	Leather Footwear manufacturing	10,243	3	0.03%
331	Wood & Cork Industries	11,704	45	0.38%
332	Wooden Furniture & Fixture	9,264	19	0.20%
341	Pulp & Paper Manufacturing	43,292	1,524	3.52%
342	Printing and Publishing	26,125	40	0.15%
351	Industrial Chemical Products	32,785	742	2.26%
352	Other Chemical Products	59,672	133	0.22%
354	Petroleum & Coal Products	20,224	238	1.18%
355	Rubber Products Manufacturing	23,455	196	0.83%
356	Plastic Products Manufacturing	20,693	16	0.08%
361	Potteries, Tiles, and Other Clays	8,469	370	4.37%
362	Glass Products Manufacturing	39,637	450	1.14%
369	Non-Metallic Mineral Products	46,882	926	1.98%
371	Iron & Steel Industries	19,460	696	3.58%
372	Non-Ferrous Metal Products	50,131	48	0.10%
381	Metal Products Manufacturing	20,393	66	0.32%
382	Non-Electrical Machinery	20,380	9	0.04%
383	Electrical Machinery	33,582	48	0.14%
384	Transport Equipment	16,107	15	0.09%
385	Professional, Scientific, Optics	23,359	163	0.70%
390	Other Manufacturing Industries	5,539	15	0.26%
	Average			1.10%

Table 9.3.1e Ratio of ISW Handling Cost to the Output Value in Manufacturing Industry in 2010 (Master Plan)

CIIU	Sub-Sector	Sales per employee in 2010 (US$/year)	ISWM cost per employee (US$/year)	Ratio (%)
311	Food Manufacturing	18,966	155	0.82%
313	Beverage Industries	54,504	485	0.89%
314	Tobacco Industries	64,890	96	0.15%
321	Textile Industries	14,033	34	0.24%
322	Wearing Apparel Manufacturing	10,508	4	0.04%
323	Leather Industries	12,639	345	2.73%
324	Leather Footwear manufacturing	10,243	3	0.03%
331	Wood & Cork Industries	11,704	45	0.38%
332	Wooden Furniture & Fixture	9,264	19	0.20%
341	Pulp & Paper Manufacturing	43,292	855	1.98%
342	Printing and Publishing	26,125	40	0.15%
351	Industrial Chemical Products	32,785	406	1.24%
352	Other Chemical Products	59,672	77	0.13%
354	Petroleum & Coal Products	20,224	131	0.65%
355	Rubber Products Manufacturing	23,455	124	0.53%
356	Plastic Products Manufacturing	20,693	12	0.06%
361	Potteries, Tiles, and Other Clays	8,469	354	4.19%
362	Glass Products Manufacturing	39,637	289	0.73%
369	Non-Metallic Mineral Products	46,882	604	1.29%
371	Iron & Steel Industries	19,460	447	2.29%
372	Non-Ferrous Metal Products	50,131	44	0.09%
381	Metal Products Manufacturing	20,393	51	0.25%
382	Non-Electrical Machinery	20,380	9	0.04%
383	Electrical Machinery	33,582	42	0.12%
384	Transport Equipment	16,107	9	0.06%
385	Professional, Scientific, Optics	23,359	162	0.69%
390	Other Manufacturing Industries	5,539	10	0.18%
	Average			0.75%

As a result, the average ratio of ISW handling cost to the total output value is 1.10% in alternative scenario, which is much higher than the ratio of 0.75% in the master plan. This result also implies that reduction of sludge amount at generation source is a reasonable option to be employed by generators for limiting the incremental cost of ISW handling in future. However, it should be noted that dehydration cost of sludge on-site is calculated based on the average sludge discharge amount. Therefore, the cost for small and medium scale industries shall be higher than the average.

On the other hand, even in the case of master plan, there are 6 types of manufacturing industries in which the ratio of ISW handling cost exceed 1% of the total output value. Because the affordable limit of ISW handling cost is said to be 1% of the total output value in Japan, it may be hard for these industries to pay the cost of ISW handling. Table 9.3.1f specifies the percentage distribution of ISW handling cost by type of waste for these 6 industries.

Table 9.3.1f Waste-specific Percentage Distribution of ISW Handling Cost

Type of industry	Waste-specific percentage distribution of ISW handling cost (%)			
Leather industry	Organic sludge 71.7%	Inorganic sludge 17.5%	Leather waste 6.8%	Others 4%
Paper & pulp	Organic sludge 72.5%	Inorganic sludge 17.7%	Paper & cardboard 2.9%	Others 6.9%
Industrial chemical products	Organic sludge 76.5%	Inorganic sludge 18.6%	Other liquid waste 2.3%	Others 2.6%
Potteries & ceramic products	Glass & ceramics 78.4%	Dust & APC 14.6%	Organic sludge 4.2%	Others 2.8%
Non-metallic mineral products	Organic sludge 49.4%	Inorganic sludge 12.0%	Dust and APC 7.4%	Others 31.2%
Iron & steel industry	Organic sludge 51.9%	Inorganic sludge 12.6%	Slag 12.1%	Others 23.4%

Except for potteries and ceramic industry, sludge handling cost still covers a big part of ISW handling cost in the 5 industries. Therefore, it may be necessary for these industries to make further efforts of efficiently handling sludge generated, such as the application of low cost treatment technology, recycling of treated sludge, and so forth.

Regarding potteries and ceramic industries, on the other hand, the possibility of limiting the handling cost may be found in recycling of glass and ceramic wastes as well as sludge and dust.

Moreover, reduction of sludge amount at source by generators may be a heavy burden especially for small industrial enterprises. Accordingly, it is important that the authority shall promote joint construction and operation of dehydration facilities, recycling of ISW and so on.

c. Benefits of the Master Plan for the Future Chilean Economy

In addition to the direct economic effect of creating a new ISW handling business market, implementation of the master plan is inferred to bring the following positive effects towards the future economy in MR:

ca. Benefits to the Future International Trade and/or the Standard for Environmental Management of ISO (International Organization for Standardization) 14000

As found in the recent trend of the establishment of provision regarding environmental management in NAFTA and formulation of the international environmental management standard, ISO 14000, implementation of proper environmental management is estimated to be a principal term of participating in the international trade market in the near future. Therefore, to develop and expand the international market for the Chilean domestic products, domestic enterprises in Chile have to comply with the environmental management required under NAFTA and ISO 14000 as soon as possible. In this regard, execution of the master plan will be also important for all the Chilean entrepreneurs to expand their market at an international level.

cb. Benefits in Terms of Developing Relevant Industries

Establishment of overall ISWM system in MR will not only expand the market of ISW handling business, but also create new or additional business opportunities relevant to ISWM. The expected types of business market to be created or increased are:

- Pollution abatement equipment manufacturing industry
  (Flue gas/waste water treatment facilities and equipment, environmental monitoring equipment, etc.)
- Industries relevant to the introduction of cleaner production technology
  (energy / material saving equipment, water recirculation technology, waste heat collection and recycling technology, etc.)
- Environmental service industries
  (Plant design and engineering service related to the introduction of CPT, environmental monitoring service, environmental consulting service, etc.)

cc. Benefits in Terms of Introducing Foreign Capital Investment to MR.

Establishing proper environmental management system including ISWM is one of the important conditions to promote foreign capital investment in the MR since in most of developed countries, foreign investment projects are also required to conduct strict environmental management as required in domestic investment. Therefore, foreign investment to less environmentally conscious countries may decrease in the near future. On the other hand, if overall ISWM is executed in accordance with the master plan in Chile, a high quality ISW treatment and disposal is made possible with much lower cost than developed countries. It may be a big advantage in promoting foreign capital investment to MR. Thus, implementation of the master plan can also be identified as an important policy measures for the promotion of foreign capital investment.

9.3.2 Technical Evaluation of the Master Plan

The basic objective of the master plan on ISWM in MR is to establish the most appropriate public administration system for properly controlling ISW handing process from generation source to the final disposal based on the accurate identification of waste characteristics. Hence, technical evaluation of the master plan here is to examine whether the public administration system development plan is well established enough to manage and supervise ISW emission control (storage, treatment, and disposal) at source (ISW generators) and ISW handling (collection and transportation, intermediate treatment, and final disposal) by private sector. From this viewpoint, the Study made technical evaluation of the master plan with respect to administrative measures applied and technical capability of implementing the above measures.

a. Evaluation of the Administrative Measures to Be Applied

Administrative measures that were adopted in the master plan were settled as shown in Table 9.3.2a below.

Table 9.3.2a Administrative Measures for Supervising ISWM in the Process from Generation to Final Disposal

ISWM Stage		Administrative Measures
ISWM at source (inside factory)	@	Waste generation control by manifest system (declaration system) (Investigation items) - Identifying generation characteristics of ISW for each type of industry based on the data of material & energy input, types of products, and material input/output balance. - Identifying the potential of environmental pollution by flue gas and waste water. - Clarifying present condition of ISW generation. - Clarifying present condition of in-factory ISW management, treatment, and disposal. - Clarifying present condition of consigned ISW handling
ISWM outside factory	@	ICRT (Ignitability, Corrosivity, Reactivity, and Toxicity) test (Testing items) - Identifying hazardous/non-hazardousness - Identifying appropriate intermediate treatment methods - Identifying appropriate disposal methods
	@	Leaching test (Testing item) - Identifying hazardous/non-hazardousness of the wastes after intermediate treatment - Identifying appropriate type of disposal site (SCL/CL/IL)
	@	Solubilization test (Testing item) - Identifying appropriate type of disposal site (CL/IL)

The above administrative measures are to be taken on the basis of self-reporting by the waste generators and waste handling agents. Accordingly, re-examination of the report forms an important part of public administration so as to avoid false reporting by the generators and/or agents. It is also important to establish legal framework that strictly regulates the self-reporting system. These necessary actions of public administration are all specified in the master plan in detail. As far as the public administration of ISWM is carried out in accordance with the master plan, therefore, the objective of the master plan will certainly be accomplished by the year 2010.

b. Evaluation on Technical Capability of Implementing the Master Plan

Regarding the municipal solid waste management in the MR, the technology level is high enough even comparing with developing countries', especially on landfill technology. Therefore, it is considered that the Chilean private sector has enough capability of handling advanced ISW treatment and disposal technologies. Concerning ISWM, on the other hand, a number of mishandling cases can be found mainly due to the lack of knowledge on ISW itself and its proper handling methods. In order to improve such present conditions, the Study gives extensive instructions in the master plan. For instance, the study formulated conceptual flows of waste treatment and disposal for each type of waste so as to help generators and ISW handling agents understand proper ISWM. This material can be used by public administrators as background information to supervise on-going ISWM as well. Improvement of the on-going manifest system in accordance with the recommendations given in the master plan will help waste generators be more aware of ISWM by providing accurate knowledge on ISW. Moreover, a series of testing procedure established in the master plan for selecting proper treatment and disposal options will be supported by the reference laboratory in the CENMA (Centro Nacional del Medio Ambiente), which is planned to be established in the Province of Santiago.

Consequently, since the master plan gives enough instructions and supporting technical information necessary for its implementation as described above, it is technically feasible enough to realize the master plan in the MR.

9.3.3 Environmental Evaluation of the Master Plan

Improvement and conservation of the environment is the principal objective of the master plan in this Study. Moreover, the master plan focuses on the improvement of public administration for ISWM such as institutional, organizational, legal frameworks. Therefore, the approach of environmental evaluation should be different from that which is generally conducted for the master plan of facility development projects. Although environmental evaluation is in general conducted to examine negative impacts of implementing the master plan on the environment, in this case the main objective of environmental evaluation is to examine and verify positive impacts of the master plan on the environment. Accordingly, environmental evaluation here is made by identifying the environmental impact which may arise without the master plan in MR. In addition, for better understanding of the magnitude of environmental impacts, some pollution hazard cases in foreign countries are also introduced.

a. Environmental Risks of Improper Flue Gas and Waste Water Treatment in Factory

As found in the result of the factory survey in the Study, considerable amount of flue gas and waste water are directly emitted and discharged into atmosphere and watercourse in the MR. Some of them may contain hazardous substances. It is also implied in the factory survey that such improper control of emission and effluent are mainly due to the lack of knowledge on ISW and its hazardousness. These improper emission and effluent treatment may cause air and water pollution which have serious impacts on human health.

To help understand the magnitude of impacts, the Study briefed two representative cases of pollution occurred in Japan.

aa. A Case in the City of Yokkaichi (SOx pollution)

aaa. Outline

In 1959, a large oil refinery plant started operation in the City of Yokkaichi. While additional two plants were developed up to 1972 and the total oil refining capacity reached 5050 thousand barrels, complaints about asthma from the people living in the neighborhood gradually increased. Air pollution monitoring and public health survey had been carried out since 1960. In 1962, hourly average SO_2 concentration reached 0.5ppm for 3% of the total monitoring hours and sometimes it exceeded 1ppm, which is 100 times the current environmental standard of 0.01ppm. The Mie University Hospital started free medical examination for pollution affected disease patients in August 1962 and Yokkaichi Municipal Government initiated a system to cover all medical expenses for the patients who was recognized as pollution affected patients in May 1965. Despite of these remedies, suicide of patients and deaths of younger people increased.

In September 1967, the residents living in Isozu district brought a case before court for claiming damage compensation against the 6 owner companies of the plants. In July 1972, the court judged the illegal act of the accused. The number of patients become around 1200 at its maximum in 1975.

aab. Comparison of Damage Cost and Pollution Abatement Cost

The Study on Japanese Experience on Environmental Pollution, which was carried out by the Global Environment Economy Research Group, Environmental Agency of Japan (hereinafter mentioned as EAJ Study), estimated the damage and pollution abatement cost regarding the case in Yokkaichi. Table 9.3.3a below indicates the result of estimation.

Table 9.3.3a Estimated Damage Cost and Pollution Abatement Cost (The Case of Yokkaichi)

Damage cost(1) (million US$/year)	Pollution abatement cost(2) (million US$/year)	Damage cost if no remedial action is taken until the damage extended to the whole city of Yokkaichi(3) (million US$/year)
12.99	144.48	205.15

(1) Damage cost is estimated by the following formula:
(Average annual damage compensation amount) + (Average annual redemption amount of indemnity which was ordered by the court judgement in 1972)

(2) Pollution abatement cost is estimated by the following formula:
(Average annual pollution abatement equipment investment by private enterprises since 1971) + (Average annual cost of monitoring system development and environmental green area development which are covered by public sector)

(3) The anticipated damage cost is estimated based on the assumption that the patients of Yokkaichi Asthma had been broken out at a patient rate of 7.27%, at which rate number of patients was actually reported in Isozu District in 1975, in the whole Yokkaichi in 1975.

The damage cost of about 13 million US dollars would not have been born if necessary remedial actions had been taken earlier. In addition, if no remedial action is taken, the annual average damage cost will reach 205 million US dollars, beyond the present average annual pollution abatement cost. This case study result indicates that pollution abatement investment should be carried out before the actual damage occurs so as to minimize the damage to human health as well as to reduce the damage cost.

ab. A Case in the City of Minamata (Inorganic Mercury Pollution)

aba. Outline

In 1908 a nitrous fertilizer production factory was located in the City of Minamata. There were a number of fishermen living in Minamata, but it was a very small city with a population of only 12 thousand at that time. Right after the operation of the factory, however, the City showed constant socio-economic growth with the expansion of the nitrous fertilizer factory and the population reached about 50 thousand in 1956. On the other hand, problems regarding the compensation for fishing had already arisen in 1920. The cause of sea pollution was waste water from the factory.

Minamata Disease started from a report on the outbreak of a patient having a symptoms of brain damage in 1956 although the following survey confirmed that there had been some patients since 1953. Minamata disease is a neural disease caused by methyl mercury compounds that were generated from production process of acetaldehyde and discharged into sea. The condition was caused by ingestion of contaminated fishery products. Right after the outbreak of the first patient, Minamata

Municipal Government organized the Remedy Committee for the Disease of Unknown Etiology to identify the nosogeny of the disease. However, although the government had stated in 1962 that the methyl-mercury compound is the nosogeny of the Minamata disease, mercury contained effluent was continuously discharged into the sea up until July 1966, when new production processes was installed in the factory. The outbreak mechanism of Minamata disease was finally clarified in September 1968 right after the suspension of acetaldehyde production in May 1968. The annual amount of mercury effluent had reached about 11 tons at peak in 1959. Discharged mercury was gradually accumulated in fish and shell-fish. For example, the total mercury concentration in a short-necked clam had been about 80ppm, although it decreased to 4 ppm in 1971. By the end of March 1991, the number of designated Minamata disease patients reached 2,248, of which 1,004 are dead.

abb. Comparison of Damage Cost and Pollution Abatement Cost

According to the EAJ Study, there are three types of damages that can be financially estimated i.e., damages on human health, damages due to sediment pollution in the Bay of Minamata, and damages on fishery. Concerning the pollution abatement cost, pollution abatement equipment investment, operation cost, and loan interest payment is included in the estimation. The result of estimation is given in Table 9.3.3b below.

Table 9.3.3b Estimated Damage Cost and Pollution Abatement Cost (The Case of Minamata)

Damage cost (million US$/year)			Remedy cost (million US$/year)
Damage on human health(1)	Damage on sea bottom sediment(2)	Damage on fishery(3)	
74.91	41.70	6.73	1.20

(1) Damage cost includes average annual compensation amount to be paid by the factory in accordance with the compensation agreement which was concluded with the pollution victims group in 1973.
(2) Damage cost incudes the average annual cost of dredging the mercury contained sediments.
(3) Damage cost includes average annual cost of compensation for fishermen.

In this case, the amount of damage cost is far higher than the remedy cost. This is a typical example that indicates the cost efficiency of taking proper remedial actions in the early stages of factory operation. If proper remedy had been taken before operation, the damage cost would not have arisen.

As given in detail above, Japanese experience in environmental pollution implies that pollution abatement remedies should be taken as soon as possible before the damages arise. In this regard, the master plan gave top priority to the proper control of flue gas and waste water in accordance with the formulated legal and regulatory frameworks.

In addition, in-factory ISW emission control through the manifest system will increase generators' attention to what they produce to the environment besides the products. A series of testing process recommended in the master plan will avoid the diffusion of hazardous substances. Thus, implementation of the master plan will minimize or even prevent the future possible environment pollution by flue gas and waste water if it is carried out on schedule.

b. Environmental Risks of Improper Management of ISW

Presently in the MR, there are some improper handling of ISW, such as the disposal of hazardous ISW to the municipal landfill, illegal dumping, unauthorized on-site disposal of ISW, and so forth. If these improper ISWM is neglected as it is, serious groundwater pollution and soil pollution may break out by the leak of hazardous substances from the ISW disposed. Once groundwater and/or soil pollution occur in the MR, the magnitude of damage is unpredictable because hazardous substance will spread extensively through the soil and watercourse. So far, there are very few studies discussing groundwater and/or soil pollution caused by the leak of hazardous substances from the landfill. Instead, the Study here took one case of soil pollution in connection with a big mining industry in Japan so as to help understand the magnitude of soil pollution by the leak of hazardous substances.

ba. A Case in Kamioka Mine

baa. Outline

Kamioka Mine, which had produced gold since the year 720, became a large mining industry of lead and zinc since 1887. The lead and zinc production had increased annually and became one of the most famous mines in the world. However, from the beginning of mining operation, considerable amount of heavy metals such as cadmium had been discharged into the upstream of Jinzu River through waste water. At the catchment area of Jinzu River, damages on agriculture had been found in addition to the outbreak of a disease of unknown etiology since Taisho era (1910-1925). The residents living in the catchment area claimed for damage compensation and installation of mineral pollution abatement equipment. Although a sedimentation pond was installed in 1932, the amount of slag and waste water increased successively with the growth of mining production. Due to the accumulation of heavy metals in soil, cadmium concentration in the soil reached 4.85 ppm at maximum and 1.12 ppm on average during 1971-1976 at the agricultural land located in the catchment area of Jinzu River. The concentration in unpolished rice reached 4.23 ppm at maximum and 0.99 ppm on average. The disease of unknown etiology broken out here was called

Itai-itai disease and had a symptom of terebration for every part of the body and bones were easily fractured with a slight movement. After extensive research on the nosogeny of Itai-itai disease since 1950, responsibility of the mining factory was finally found in court. By the end of March 1991, 129 people were adjudged to be the victim patients (of which 116 are dead).

bab. Comparison of Damage Cost and Pollution Abatement Cost

In the EAJ Study, damage cost estimation is made for three types of damages i.e., damages on human health and damages on agriculture. Meanwhile pollution abatement cost includes the cost of waste water and smoke treatment and other related remedies. Table 9.3.3c indicates the result of estimation.

Table 9.3.3c Estimated Damage Cost and Pollution Abatement Cost (The Case of Itai-itai Disease)

Damage cost (million US$/year)		Remedy cost (million US$/year)
Damage on human health(1)	Damage on agriculture(2)	
7.26	17.33	5.88

(1) Damage cost includes the annual average amount of damage compensation and redemption of indemnity.
(2) Damage cost includes the annual average amount of compensation for cancellation of cultivation and restoration of contaminated soil.

As found in other cases of pollution, preventive cost is lower than the damage cost to be born resulting from no remedial action against pollution. Although this example does not discuss disposal site of ISW, similar leak of hazardous materials may occur at present landfill in MR if no measures are taken to improve present improper disposal practices.

However, in order to improve the present ISWM, the master plan formulated overall ISWM supervising system in accordance with the conceptual waste flow of treatment and disposal for each type of waste. Following this ISWM supervising system, improper handling of ISW will be improved and illegal handling practice will be reduced. Consequently, future possible environmental hazard will be minimized and even evaded.

PART III

THE MEDICAL SWM MASTER PLAN

CHAPTER 10

THE MEDICAL SOLID WASTE MANAGEMENT MASTER PLAN

CHAPTER 10 THE MEDICAL SOLID WASTE MANAGEMENT MASTER PLAN

10.1 Definition and Classification of Medical Solid Waste

Prior to presentation of the Master Plan for medical SWM in the Metropolitan Region (MR) it is appropriate to propose a definition and a classification of medical SW. The proposal is based on a combination of the classification recommended by WHO and the definition of waste types applied by US-EPA.

Medical (solid) waste is defined as follows in the context of the present Master Plan study:

(Solid) waste generated in the diagnosis, treatment or immunisation of human beings or animals, in related research, or in the production or testing of biological agents.

There are several classification systems for medical SW. They all originate in the philosophy that a part of the waste being similar to municipal SW (and may be collected and treated as such) and a part being either infectious (including unaesthetic waste) or of general hazardous character (like hazardous waste from the industries). The following waste classification system for medical SW is proposed:

- Pathological waste *,
- Human blood and blood products *,
- Cultures and stocks *,
- Sharps *,
- Infectious waste *,
- Animal waste *,
- Chemical waste,
- Radioactive waste,
- General (non-hazardous) waste.

The waste types marked with * are defined as infectious waste. Table 10.1a presents the detailed contents of the waste types.

Table 10.1a The Proposed Classification of Medical Solid Waste

Waste type	Description
Pathological waste	Tissues, organs, body parts, human fetuses and other human parts (recognizable and unrecognizable).
Human blood and blood products	Liquid human blood and products of blood; items saturated and/or dripping with human blood (including caked blood); including serum, plasma and other blood components and their containers.
Cultures and stocks	Cultures and stocks of infectious agents and associated biologicals, including cultures from medical and pathological laboratories; cultures and stocks of infectious agents from research and industrial laboratories; waste from the production of biologicals; discarded live and attenuated vaccines; and culture dishes and devices used to transfer, inoculate, and mix cultures.
Sharps	Sharps that have been used in animal or human patient care or treatment or in medical research, or industrial laboratories, including hypodermic needles, syringes, pasteur pipettes, scalpel blades, blood vials, needles with attached tubing, and culture dishes (regardless of presence of infectious agents). Broken or unbroken glassware that were in contact with infectious agents, such as used slides and coverslips. Hypodermic needles, suture needles, syringes, scalpel blades and other unused, but discarded sharp items.
Infectious waste	Biological waste and discarded materials contaminated with blood, excretion, exudates, or secretion from humans who are isolated to protect others from certain highly communicable diseases, or isolated animals known to be infected with highly communicable diseases.
Animal waste	Contaminated animal carcasses, body parts, and bedding of animals known to have been exposed to infectious agents during research, production of biological or testing of pharmaceuticals.
Chemical waste	Discarded solid, liquid and gaseous chemicals, for example from diagnostic and experimental works, disinfecting procedures, conservation purposes, and cleaning and housekeeping. Hazardous chemicals includes waste that is toxic, corrosive, flammable, reactive and genotoxic (cytotoxic).
Radioactive waste	Includes solid, liquid and gaseous waste contaminated with radionuclides generated from analysis of body tissues and fluids, body organ imaging and tumour localization, and therapeutic procedures.
General non-hazardous waste	Domestic-type waste, including packaging materials, kitchen waste, non-infectious waste from wards and other substances that do not pose a special handling problem or hazard to human health or the environment.

10.2 Forecast for the Future Medical Solid Waste Generation

The forecast of medical SW generation for the period 1995 - 2010 is developed for infectious waste only. Because only infectious waste requires a special handling system. Non-infectious waste should be included in the system for municipal SW and is therefore of minor importance in the context of this study.

The future generation of infectious waste depends on a number of factors such as the population, the general hygiene standard, and application of preventive medicine and of curative methods. A number of these factors are not statistically quantifiable. Thus, for the Master Plan it is proposed to predict the future medical SW generation based on the development of the population (linear projection) combined with an assumption of an annual increase of the waste quantity of 1% for the expected impact of improved hospital hygiene and the assumed wider use of disposable equipment. The increase of 1% only, reflects that some growth is expected, but that emphasis on waste minimization in general and better knowledge of the hazards connected to infectious waste will reduce the growth. The latter is important as improper knowledge of the actual risk not only lead to improper management, it may also have the opposite effect in the form of a less strict sorting of infectious waste items.

Table 10.2a presents the projection of medical SW generation for selected years.

Table 10.2a Projection of Medical Solid Waste Generation 1995-2010 (Infectious Waste Only)

Year	Projection of population		Effect of improved hospital hygiene	Projected generation of infectious medical SW
	Total	Index		
1995	5,642,000	100.00	100.00	7,300 tons
1996	5,738,000	101.70	101.00	7,500 tons
2001	6,190,000	109.71	106.15	8,500 tons
2006	6,610,000	117.16	111.57	9,500 tons
2010	6,931,000	122.85	116.10	10,400 tons

10.3 Establishment of Planning Framework

The present medical SWM is based on individual solutions for the medical institutions with the public authorities involved in control and enforcement only. Although, the health sector is partly public it is the intention to maintain medical SWM as the responsibility of the single medical institution and to maintain the public in a controlling and supervising role. This policy is adopted as a pre-condition in the Master Plan.

a. Goals

The proposed goals of the Master Plan 1996-2010 are:

- Improved medical SWM facilities and practices at medical institutions in MR to obtain basic hygienic conditions.
- A standardized labelling and packaging system for infectious medical SW.
- A low-cost final disposal option based on safe disposal of infectious medical SW at a controlled landfill for municipal SW.
- In time, thermal treatment of infectious medical SW, possibly as co-treatment with industrial waste (ISW).

b. Targets

The targets of the Master Plan are presented in Table 10.3.a for three periods, the short-term period 1996-2000, the medium-term period 2001-2005 and the long-term period 2006-2010.

c. Strategy

Supervision and enforcement of applicable standards are the authorities' only tool to accomplish the goals and targets. As no pubic involvement in technical facilities etc. is envisaged, enforcement of proper medical SWM practices will create a need of provision of waste management services by the private sector. This cannot be satisfied immediately by the private sector today and this is considered in the implementation plan (section 10.9), where authorities' necessary actions in relation to involvement of the private sector are identified.

ADIMARK's RESHOS Study disclosed that the present costs of medical SWM are insignificant for many medical institutions. However, it can be expected that any increase of the costs will meet opposition. Thus, it will be necessary to build up environmental awareness and commitment at the medical institutions in order to create an understanding of the need of increased budgets for provision of improved medical SWM.

Thus, the Master Plan strategy is based on a combination of cooperative actions and enforcement. The cooperation will concern preparation of a Code of Practice, where the medical institutions should participate alongside the authorities in the standard setting, while enforcement will concern inspections on-site and, if necessary due to continuous violations of prescribed practices, legal prosecution actions.

Table 10.3a Targets of the Master Plan 1996-2010.

Short-term targets (year 1996-2000)
- Preparation of a Code of Practice as a guideline for the medical institutions and as a basis for authorities' enforcement.
- Preparation of a simple labelling system for immediate implementation.
- Packaging of sharps and pointed objects in unbreakable - not reusable packagings at the source of production (also in cases where the waste subsequently is treated internally by incineration or autoclave).
- Improvement of internal collection points with respect to: . Cleanliness, . Separate storage of waste categories, . Prevention of public access, . Elimination of manual loading procedures for medical SW.
- Development of safe disposal of medical SW at a controlled landfill for municipal SW (for immediate implementation).
- Separate collection of medical SW for landfilling.
- Preparation of project for thermal treatment of medical SW, possibly at a new facility for ISW treatment (co-treatment).
- Implementation and enforcement of new environmental standard for new incinerators at hospitals.
Medium-term targets (year 2001-2005)
- Implementation and enforcement of new environmental standard for existing waste incinerators at hospitals.
- Development of thermal treatment of medical SW, possibly at a new facility for ISW (co-treatment).
- Continued improvements of standardized collection system, including improvements of collection points.
- Enforcement.
Long-term targets (year 2006-2010)
- Phasing out of landfilling for replacement by centralized thermal treatment (possibly as co-treatment with ISW).
- Enforcement.

10.4 Examination of an Optimum Technical System and the Applicable Technical Standards

The proposed technical system is summarized in table 10.4a.

a. Collection System at Sources of Production

Immediate classification and packaging of infectious medical SW is the basic principle in a modern medical SWM system. This principle should be the governing principle in planning and execution of the waste handling. It could be relevant to develop national specifications for relevant packagings for the different waste items (maximum capacities, strength of material, etc.) in order to simplify the market of packaging system, to ease the shopping for the medical institutions and to reduce the unit costs.

At the institution level, the internal sorting instructions should be accomplished to comply with the Code of Practice and then implemented internally through instruction, training and control.

The central collection points should be improved with respect to the sanitary conditions and equipped with containers to avoid mixing of segregated waste and to ensure proper working conditions for the staff during storage and loading.

Table 10.4a Summary of Technical System

Waste category	Packaging	Internal treatment	Collection point	External treatment
Pathological waste	Strong plastic bags, plastic buckets, or coated cardboard boxes. Pointed items such as a bone pieces should be packed in unbreakable packaging. Bags, buckets etc. should be sealable.	Incineration in hearth type incinerator to ensure complete destruction and combustion.	Separate storage, if necessary cooled (depends on the storage time).	Burial at cemetery or controlled landfilling (short-term). Incineration in hearth type incinerator (long-term).
Human blood and blood products	Sealable plastic buckets, bottles or blood bags.	Infected blood and blood products should be sterilized (autoclave). Small quantities of non-infectious blood can be discharged to the sewer. Large quantities should be landfilled or incinerated.	Separate storage of infectious wastes, if necessary cooled (depends on the storage time).	Controlled landfilling or incineration.
Cultures and stocks	Same as human blood and blood products. However, highly infectious and communicable microbiological agents must be sterilized immediately at the source of generation.			
Sharps	Unbreakable and sealable containers.	Incineration is applicable depending on the ash discharge system and the disposal method (to avoid prick accidents). Infected sharps may be sterilized by autoclave, but it should not change the subsequent safe handling of sharps to avoid accidents.	Separate storage of infectious wastes.	Controlled landfilling or incineration.
Infectious waste	Sealable strong plastic bags, plastic buckets, or coated cardboard boxes.	Incineration is applicable.	Separate storage of infectious wastes.	Controlled landfilling or incineration.
Animal waste	Sealable strong plastic bags, plastic buckets, or coated cardboard boxes.	Incineration is applicable.	Separate storage of infectious wastes.	Controlled landfilling or incineration. Note, destruction is required for highly communicable animal diseases according to veterinary regulations.
Chemical waste	Sealable strong plastic bags, plastic buckets or bottles etc. depending on the physical and chemical properties. Original packaging also applicable.	No internal treatment.	Separate storage of chemicals (well ventilated store).	Treatment and disposal facilities for (general) hazardous waste.
Radioactive waste	Sealable strong plastic bags, plastic buckets or bottles etc.	Dilution or separate storage until acceptable radiation is reached. Radioactive liquids may be discharged to the sewer after dilution.	Separate storage. Control of radiation during storage and before shipment to collection point.	Controlled landfilling or incineration.
General (non-hazardous) waste	Plastic bags, containers etc.	Incineration is applicable, but in most cases not cost effective.	Separate storage in containers.	Controlled landfilling (or MSW incineration)

b. Treatment System at Sources of Generation

Except for highly infectious and communicable biological agents that require sterilization using an autoclave, there is no demand for internal treatment at the medical institutions provided safe external treatment/disposal methods and appropriate packaging and transport systems are employed.

Sterilization using an Autoclave

The present reuse of laboratory glassware in medical institutions makes it appropriate to consider sterilization (autoclave) of not only the highly infectious and communicable biological agents, but all infected agents to reduce the risk of accidents with splashes and broken glass during the manual cleaning.

Correct sterilization by use of autoclave requires that the waste is accessible for the steam, i.e. that it is not sealed or in another way packed in steamtight packagings. Thus, autoclave is applied best near the source of production to avoid unpacking of waste or internal transport of inappropriately packed waste.

Incineration

Local incinerators at medical institutions constitute a problem in terms of observance of proper environmental standards. Furthermore, the incinerators are often inadequately located resulting in unacceptable working conditions for the staff during manual loading procedures etc.

It is recommended to upgrade hospital incinerators to pollution and operational standards comparable to internationally recognized standards for large-scale incinerators for municipal SW. The main emphasis should be put on:

- Continuously operation to avoid low temperatures during start and closing-down,
- High operating temperatures,
- Auxiliary burners to prevent fluctuations of the temperature,
- Sufficient retention time of flue gasses to ensure burning out of particles,
- Reduction of the total dust emission, and
- Reduction of the emissions of heavy metals.

Pollution standards for municipal SW incinerators include typically emission standards for NO_x and HCl also. Application of rigorous demands for these emissions for hospital incinerators may involve excessive costs compared to the environmental benefit. Thus, these should be considered subject for special terms in the process of standard setting. Dioxin and furanes are a major concern, but yet applicable emission standards are to be recognized internationally. At present, stabilized, high combustion are recognized as the best way to eliminate dioxin and furanes.

It could be claimed that the contribution to the general pollution from inadequate incineration of medical SW at hospitals is insignificant in the global view and, thus, should not be subject to enforcement of rigorous pollution standards, which require filter installation, as long as the incinerators are operated without creating direct nuisances for the neighbors. Such a view could be defended for a transition period during which existing incinerators are modernized/replaced to apply modern standards for emissions and operation, but for a modern medical SWM strategy, the standards applied for hospital incinerators should be comparable to the standards applied for other waste incinerators, although some exceptions are mentioned above.

c. External Transportation

Efforts are required to ensure that sharps and infectious waste are kept out of the municipal SW collection service. With the mechanical handling employed in collection of municipal SW collection (use of compactors) and at the municipal landfill (use of bulldozers and compactors), the waste is likely to be exposed and thereby pose a risk to the staff involved in vehicle maintenance and landfill operation. Separate collection and transportation systems without compaction and/or transfer procedures are required for infectious waste, including sharps.

d. *Intermediate Treatment and Final Disposal*

Incineration is the preferred method for treatment of medical SW. However, the costs are high. Controlled landfilling of medical SW is an environmentally acceptable alternative to incineration, however, in the long-term perspective, a complete destruction by incineration should be the goal.

Landfilling of infectious medical SW requires a separate cell of a controlled municipal SW landfill is prepared for infectious medical SW only. Safe landfilling of infectious medical SW requires direct unloading into a pit without mechanical operations, immediate covering with quick lime and soil. Careful compaction (after covering) is required to prevent exposure of the waste.

Leachate from the separate cell is not expected to be of particular concern. Firstly, infectious agents will be heavily diluted and secondly, they will have poor conditions for survival in the acid environment in landfill leachate. However, it is recommended to construct a separate leachate collection system for the cell and implement regular monitoring, so special sanitation measures can be introduced if necessary.

e. Chemical Waste (Hazardous Waste)

The present absence of handling systems for chemicals (hazardous ISW) affects the management of chemicals at the medical institutions too. Discharge to the sewer is convenient and, thus, quite common.

Improved management of chemicals should be part of the Code of Practice, however, the optimum management system requires that treatment and disposal facilities for ISW are available as quantities generated in medical institutions are too small for independent management.

f. Radioactive Waste

Radioactive sources applied at the medical institutions are in most cases low radiation sources and so the waste generated.

Like for infectious medical SW, radioactive waste should be classified immediately after the production and by the same personal who made the medical treatment or laboratory analysis.

The typical disposal of solid radioactive waste includes one of the following options:

i. Disposal as general waste provided the waste is inactive.

ii. Disposal by incineration provided the waste has low radiation.

iii. Disposal by special treatment (normally supervised by the national nuclear administration) provided the waste that cannot be disposed of according to i. or ii..

Liquid radioactive waste may be disposed of via the sewer, directly or after dilution depending on the radiation. Liquid waste with too high radiation for disposal via the sewer must be subject to special treatment.

Information collected at the medical institutions in MR indicates that radioactive waste is stored until it can be classified as inactive and disposed of together with municipal SW. In principle, such procedure is acceptable as long as sufficient and applicable storage capacity is available and as long as the safety procedures for the storage and the shipment are satisfactory. However, it is recommended to intensify the control of all medical institutions working with radioactive waste to confirm the proper handling.

10.5 Estimation of Costs and Financial Responsible Bodies

10.5.1 Cost Estimation

For many medical institutions the proposed upgraded technical system will require allocation of additional funding for operation of the medical SWM system. However, a part of these extra costs are required to introduce acceptable sanitary conditions and, thus, could be characterized as a necessary relief of former negligence. The actual increase will be for packaging systems and treatment by upgraded incineration via hospital incinerator or central incinerator.

As a rough guideline for the cost estimation, the following estimates are used. Since packaging of infectious type wastes shall be born by each medical institutions as well as on-site medical SWM like storage, etc., it is excluded from the estimation of total costs, i.e. magnitude of medical SWM to be done by the private ISW handling agents. Estimation of medical SWM scale (i.e. total costs) are forecasted by multiplying "amounts estimated of infectious waste to be collected, transported, treated and disposed in 2010" and "respective unit costs in Table 10.5.1a" and totaled, which are shown in the Table 10.5.1b.

Table 10.5.1a Basic Cost Estimation

	Cost in US$ per tonne
Packaging	
Inner packaging such as strong type plastic bags, buckets and bottles to be applied no matter the treatment/disposal system	40
Container system or simple cardboard boxes for internal transport in case of internal treatment	40
Coated cardboard boxes for external transport in case of external treatment by incineration or landfilling	100
Collection and Transportation	
Collection and transportation within the Santiago Urban Area	40
Transportation from central waste incinerator to new controlled landfill	6
Treatment and disposal	
Treatment at central waste incinerator (co-treatment with ISW)	151
Disposal at separate cell of controlled landfill	18

Table 10.5.1b Cost of Infectious Waste Collection, Transportation, Intermediate Treatment and Disposal in 2010

unit: US$/ year

Type of waste	Collection and Transportation	Intermediate Treatment	Disposal	Total
Infectious waste	425,000	1,570,000	0	1,995,000
C-1	0	0	19,000	19,000
C-2	0	0	9,000	9,000
Total	425,000	1,570,000	28,000	2,023,000

10.5.2 Financing Responsible Bodies

The Ministry of Health (MS) has a double role in relation to the public medical institutions as the ministry provides the general budget and enforces hygiene conditions as well.

The function as budget provider, places the MS in a central position to motivate improvements in the public health sector. It is suggested that the MS take a leading role in improvement of the medical SWM standard, starting with preparation of the Code of Practice followed by negotiation of budget allocation for medical SWM. Thereby, the technical standards will be linked to the financial resources (and vice versa). The role of the MS towards the private health sector is enforcement of sanitary conditions only.

10.5.3 Cost Recovery

Cost recovery - or more relevant for medical institutions, cost allocation requires motivation and commitment of the management of the medical institutions. As stated earlier, the commitment to ensure even in-expensive improvements seems low today and lacking commitment is probably the main obstacle for introduction of improvements. However, it should be mentioned that not all resistance is based in lack of commitment, but in determination of budgets for the hospitals, the management will face strong arguments for medical improvements (new equipment etc.) instead of *improvement of the medical SWM. This position emphasizes the important role of the* MS mentioned above.

10.6 Code of Practice

The Code of Practice is the key tool to obtain the proper standard for medical SWM.

The Ministry of Health (MS) is the obvious responsible body for preparation of the Code of Practice. A large number of institutions and specialists should participate in the work as proposed in detail in Annex M. Some important representatives are:

- Sanitary inspection (e.g. SESMA)
- Occupational health inspection (Ministry of Labor)
- Air pollution inspection (e.g. PROCEFF)
- Environmental authorities (CONAMA (national and regional))
- Health authorities (e.g. 'Instituto de Salud Pública de Chile')
- Representatives from the hospitals
- Representative for a waste collection company and a waste treatment company.

The complete proposed list of contents is presented in Annex M. The headlines are:

1: Introduction
2: Legal background
3: Definition of medical SW
4: Background for planning of handling systems for medical SW
5: Source segregation, packaging, internal collection and storage
6: External collection and transport
7: Treatment and final disposal
8: Checklists for control of existing and new medical SWM systems

10.7 Examination of Institutional System

10.7.1 Present System

Hospitals manage their SW according to their own resources and directives, as well as giving general consideration to the Sanitary Code and to the guidelines set by the Commission for Intra-Hospital Infections CIIH), Occupational Health and the Chilean Commission for Nuclear Energy (CCHEN), the latter with regard to radioactive waste.

The CIIHs are coordinated by a national commission (CNIIH) which is subordinated to the Epidemiology Department of the MS.

Medical and paramedical activities are regulated by the MS, whose most consistent document regarding SWM was created by SESMA as a "recommendation". Municipalities are in charge of collection and disposal of medical and municipal SW, under rules issued as Ordinances.

10.7.2 Recommended System

The MS should establish a Regulation for the internal and external management of medical waste, in accordance with this section of the Master Plan. Meanwhile, SESMA will issue Technical Norms adapting the Regulation to the local conditions and will also enforce compliance by applying the sanctions established in the Regulation and the Sanitary Code.

At the same time, the Environmental Programs Department of the MS will carry out and coordinate the preparation of the Code of Practice, which will consolidate all necessary requirements for medical waste management. The participants will not be changed, but they shall behave in accordance to the Organizational Chart shown in Figure 10.7.2a, without overlapping and with respecting the generator's responsibility (i.e. medical institution's responsibility).

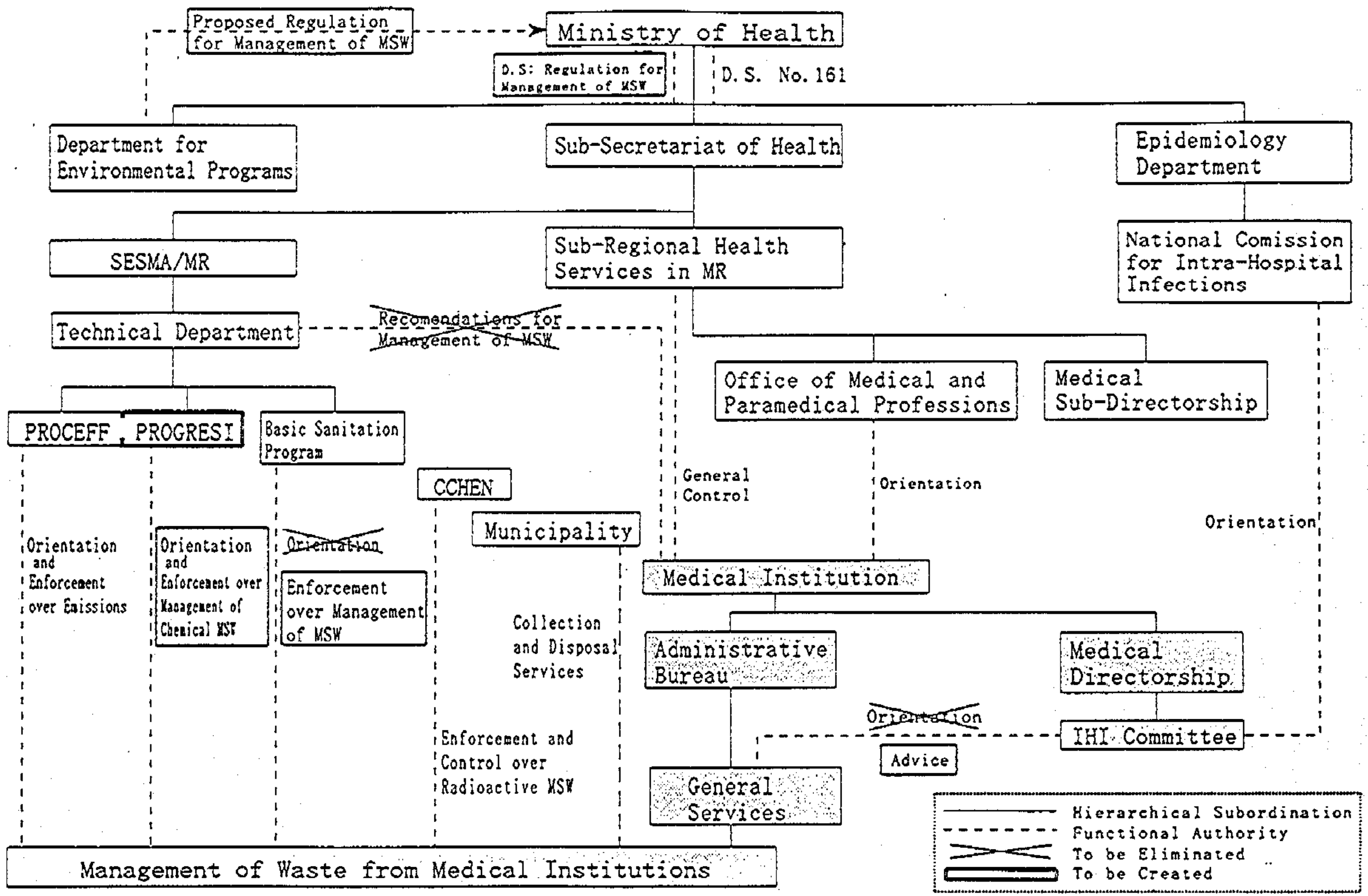


Figure 10.7.2a Proposed Organizational Development Related to Medical SWM

10.7.3 Human Resources Development

The competent authority (SESMA) will have to add a sanitary engineer and a social spokesman to their staff. It will have to concentrate efforts for, in short term, elaborating technical instructions to orient the management of the medical SW, and to promote a training program of the operative and executive personnel of the medical institutions.

The operation personnel shall be trained to sort and place the waste at the source, to operate the sterilization and incineration equipment, and to carry out maintenance, cleaning and disinfection of floors, vehicles and storage rooms. The selected head-person for this personnel shall be appropriately qualified for planning and executing these services.

Medical and paramedical staff, particularly nurses, shall be motivated for the waste management system and shall be trained to sort and place waste at the source, as well as to use the sterilization and autoclave equipment.

10.8 Evaluation of the Master Plan

10.8.1 Economic Evaluation

Economic evaluation of medical SW management master plan here is conducted form the following viewpoints :

- evaluation on the prospect of medical SW handling business market in 2010
- evaluation on the cost of medical SW handling covered by generators (hospitals, clinics, etc.)

a. Evaluation on the prospect of medical SW handling business market in 2010

According to the cost estimation of medical SW handling in chapter 10.5.1, the medical SW handling market is estimated to be about 2.02 million US dollars in 2010, which is as much as 4.8% of the total ISW handling market in 2010. The distribution of medical SW market by type of waste handling is given in Table 10.8.1a below.

Table 10.8.1a Distribution of Medical SW Market in 2010

Type of business	Scale of market (US$)	Ratio to total (%)
Collection & transportation	425,000	21.0
Intermediate treatment	1,570,000	77.6
Disposal	28,000	1.4
Total	2,023,000	100.0

As found in the table above, nearly 80% of the total market is covered by intermediate treatment, in this case incineration of infectious wastes in accordance with the master plan. Because the total medical SW generation amount of 10,400 ton per year is to be reduced in the process of incineration by 85%, final disposal cost is estimated to be very low in comparison with other costs.

b. Evaluation on the cost of medical SW handling covered by generators

In accordance with the forecasted amount of infectious waste generation and estimated total cost, the unit cost of infectious waste handling is about 195 US dollars per ton in 2010. If converting the handling cost of infectious waste into per bed in 2010 based on the projection of the number of beds with the assumption that ratio of bed to the total population is the same as in 1995, the unit cost of infectious waste handling will be around 114 dollars per bed per year. This amount of expenses seems relatively light for the medical institutes to achieve minimum standard of sanitary conditions to be required. In addition, most of the internal incineration of medical SW presently carried out are inappropriate in terms of environmental aspects and should be improved if they continuously burn them out, but installation of new incinerators or upgrading of the existing incinerators may not be the cost-effective options for most of medical institutes. The introduction of a modern centralized incinerator is the most possible and cost-effective option to safely treat infectious wastes by proper collection and transportation from medical institutes. Internal incineration of medical waste should be limited to, as mentioned in the master plan, those which is not infectious. Thus, implementation of the master plan is the most cost-effective way of handling infectious medical waste in MR.

10.8.2 Technical Evaluation

Similar to the case of ISWM, the master plan of medical SWM is focused on the improvement of public administration of medical SW. Therefore, technical evaluation of the medical SWM master plan here is to be carried out by examining whether public administration plan is formulated properly enough to improve present medical SWM at generators (hospitals, clinics, etc.) and outside generators.

a. Evaluation of administrative measures to be taken for improving medical SWM at generators

The principal policy instrument of improving the present medical SWM at generators is the Code of Practice (CoP), which is to be prepared and enforced by the authorities responsible for medical SWM. The CoP recommended in the master plan comprehensively covers the provisions necessary to properly handle medical SW from the generation source to final disposal in detail. In addition, standards for landfilling and incineration of medical SW should be prepared in parallel, either as an integral part of the CoP or separate legal tools. Strict enforcement of the above policy measures should be carried out especially towards the handling of medical SW of infectious nature to minimize its danger to the human health as well as to the environment. Early implementation of the above policy measures in accordance with the master plan will also minimize or even eliminate the possible risks of patients, workers in medical institutes who conduct internal medical SW handling.

b. Evaluation of administrative measures for external medical SWM

Since no public involvement is planned regarding the development of medical SW treatment and disposal facilities, promoting the involvement of private sector is indispensable to ensure the implementation of the master plan on schedule. In this regard, the master plan recommends the following measures to be taken by the public authorities:

ba. Development of landfill for medical SW

The public authorities (in this case, maybe CONAMA-RM in cooperation with the Ministry of Health) should conduct negotiations with relevant landfill operators in the MR regarding the establishment of landfill capacity for disposal of medical SW and with relevant haulage contractors for provision of an appropriate standardized collection and transportation system. This negotiation should be carried out before the enforcement of the CoP and related standards to make ways of proper medical SWM towards generators.

bb. Development of centralized incineration for medical SW

In principle, development of centralized incineration for medical SW depends on the development schedule of ISW incineration plants. As ISW treatment and disposal activities are left to private ISW agents, a strict time schedule can not be determined in the master plan. However, taking into account the enforcement schedule of the ISWM master plan, the period 1999-2001 is proposed for development of a solution with the companies engaged in ISWM and incineration maybe being available from the beginning of next century. Accordingly, negotiation with the landfill operators regarding the development of landfill capacity for medical SW should be based on the careful estimation of accumulated generation amount of infectious medical SW to be generated up until this period. As far as taking proper care about the above issues, proper medical SWM can be realized through the implementation of the master plan.

10.8.3 Environmental Evaluation

The objective of environmental evaluation here is to identify what environmental risks may otherwise bring about if the master plan is not implemented. The problems related to continuation of the present medical SWM practice are more related to occupational health and the aesthetic well-being of the Public than to the risk or nuisances caused by environmental pollution although it cannot be ignored. The possible problems which may occur in the absence of the medical SWM master plan are:

- Uncontrolled dumping may offend (and cause a risk to public). Who would like to find syringes or blood bags in the forest or syringes at children's playground?

- Improper disposal of medical SW at the municipal SW landfills may create a bad image for landfills and reduce the neighbourhood acceptance. Also, it creates mistrust to the capability of the responsible authorities.

- Old type hospital incinerators are a significant sources of air pollution (e.g. dioxin). Furthermore, inappropriate location and a low chimney may create nuisances such as smoke, soot and odours in the nearby neighbourhood. With respect to occupational health aspects, incinerators with poor access conditions, no/poor equipment for automatic feeding of the waste and for ash discharge may cause work related accidents.

- The medical staff have a higher risk of attracting infection, etc. from the use of syringes, scissors etc. during the execution of the work (operations, etc.) than the risk posed on the persons involved in the subsequent medical SWM. However, improper treatment of infectious wastes may increase possible infection by those who handle medical SW such as:

    - staff responsible for packaging and collection at the medical institutions,
    - staff involved in public recycling activities in case the segregation is not complete,
    - scavengers at landfills where medical SW is improperly disposed.

- In the extreme situation, improper medical SWM may endanger not only the hygienic conditions at the medical institutions, but also outside them.

Thus, proper medical SWM in accordance with the master plan needs to be implemented as early as possible to avoid the future accumulated negative impacts on the environment, even on human health.

10.9 Implementation Plan

The Implementation Plan presented in figure 10.9a includes the most important activities to implement the Medical SWM Master Plan.

Preparation of the Code of Practice is scheduled for 2 years (1996 and 1997). It could be prepared faster, but it is recommended to allocate at least 1.5 years for the work as it will be the foundation for the upgrading of the Medical SWM.

Parallel to preparation of the Code of Practice, standards for landfilling and incineration of medical SW should be prepared (also at national level) - either as an integrated part of the Code of Practice or as separate standard setting activities. The standard for landfilling is less complicated and it should be possible to complete the work in less than one year. The standard for waste incineration will require more time for preparation.

In order to ensure a reasonable speed of implementation and to eliminate the uncertainties as far as possible, CONAMA-RM should take a leading role in provision of adequate landfill capacity and provision of a standardized collection and transportation system for medical SW - the main elements of the technical Master Plan.

Thus, it is proposed that CONAMA-RM conducts negotiations with relevant landfill operator(s) in MR concerning establishment of landfill capacity adequate for disposal of medical SW and with relevant haulage contractors for provision of an appropriate standardized collection and transportation system - both as private activities on commercial terms.

Implementation of centralized incineration of medical SW is made dependent on implementation of incineration for ISW and, thus, also being depending on the implementation schedule for this. The period 1999-2001 is proposed for development of a solution with the companies engaged in ISW management and a solution may be available from the beginning of next century.

	SHORT-TERM					MEDIUM-TERM					LONG-TERM				
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Preparation of Code of Practice															
Preparation of standard for landfilling of Medical Solid Waste															
Preparation of standard for incineration of Medical Solid Waste															
Legal implementation of standard for Medical Solid Waste incineration for new incinerators															
Legal implementation of standard for Medical Solid Waste incineration for existing incinerators															
Negotiations on landfill for Medical Solid Waste															
Landfill for Medical Solid Waste in operation															
Negotiations on collection and transportation system for Medical Solid Waste															
Collection and transportation system for Medical Solid Waste in operation															
Development of centralized incineration for Medical Solid Waste (co-treatment with ISW)															
Centralized incineration for Medical Solid Waste (co-treatment with ISW) in operation															
Phasing out of landfilling of Medical Solid Waste															

Figure 10.9a Implementation Plan for Medical SW Master Plan

JICA