where recyclers criticized the lack of institutional involvement. In some cases, the recycling companies themselves have carried out studies to evaluate and improve the present situation. The industries explicitly manifested their willingness to share the studies with the government side and to cooperate in any institutional action. In general, the involvement of the government side was considered to be more effective than the creation of a recyclers' association for each sector.

F.5 Prices of Recyclable Materials

a. Prices Obtained by the Survey

aa. Glass

The price list received during the survey to recyclers (July 1995) from Cristal Chile, the main glass manufacturer and recycler in the MR, is presented below:

Table F.5a Base Price Paid by Cristal Chile

Type of Glass	(Pesos/Kg)
White Glass	21.0
Amber Glass	20.0
Semi-White Glass	19.0
Green Glass	18.0

Table F.5b Bonus Addition to Base Price for Larger Volumes

TONS/Two months	(Pesos/Kg)
25 - 49	0.50
50 - 74	1.00
75 - 99	1.50
≥ 100	2.50

b. Prices from Cade-Idepe Recycling Report

The prices of recyclable materials which were collected at the time of CADE-IDEPE's Study (October 1993) is as follows:

ba. **Plastic**

Table F.5c Consumption of the Main Raw Materials

	Metric Tons			Average Prices US$ CIF		
	1989	1990	% var. 90/89	1989	1990	% var. 90/89
High density polyethylene	21,995	23,804	8.22	1,041	931	10.57
Low density polyethylene	14,528	14,153	-3.25	1,053	947	-10.07
High impact polystyrene	5,385	6,482	20.37	1,356	1,162	-14.31
General use polystyrene	3,707	3,977	7.28	1,300	1,063	-18.23
Expandable polystyrene	887	1,819	105.07	1,712	1,472	-14.02
PVC suspension	22,478	27,234	21.16	840	707	-15.83
PVC emulsion	2,350	2,100	-10.64	1,220	1,136	-6.89
PVC compound	1,608	1,433	-10.88	1,430	1,397	-2.31
PVC/PVA copolymers	1,458	925	-36.56	1,202	1,174	-2.33
Polypropylene	13,649	12,273	-10.08	953	844	-11.44
Isocyanate for manufacturing plastic foam	3,826	4,024	5.18	2,413	2,341	-2.98
Polyols for manufacturing plastic foam	4,937	6,152	24.61	1,295	1,334	3.01
Styrene monomer	4,429	5,505	24.29	1,169	1,005	-14.03
Vinyl acetate monomer	3,701	3,459	-6.54	977	805	-17.60
Methyl meta acrylate monomer	440	435	-1.14	1,569	1,620	3.25
Phthalic anhydride	6,368	2,057	-67.70	643	512	-20.37
Stabilizers for artificial resins	725	735	1.38	3,088	2,943	-4.70
Polyester resins	5,240	4,411	-15.82	1,664	1,452	-12.74
Acrylic resins	2,258	2,423	7.31	2,460	2,707	10.04
Polyamide resins	661	540	-18.31	3,364	3,232	-3.92
Polyurethane resins	465	441	-5.16	4,275	4,759	11.30
Epoxy resins	1,044	1,805	-3.74	3,264	2,994	-8.27
Propylene-glycol	1,693	1,579	-6.73	1,121	1,069	-4.64
Silicon resins	539	480	-10.95	5,578	6,218	11.47
Phenolic resins	1,284	1,627	26.71	1,755	2,055	17.09
Totals	12,755	129,573	3.03			

Source: Foreign Commerce Department of the Banco Central de Chile

bb. Paper

Presented below are the prices paid by Sorepa in May 1992. As this is the company handling the largest volume of paper recovery, it is considered to set the market price.

Table F.5d Price List for Paper by Sorepa

PRICE LIST	(Pesos/kg)
White (blank)	105.00
Special white	67.00
White with print	60.00
Mixed - 2	37.00
Kraft - 2	42.00
Corrugated cardboard	42.00
Print - 2	34.00
Duplex	29.00
Newspaper	26.00
Returned newspaper	39.00

bc. Scrap

Table F.5e Scrap Price at Two Different Stages

	Middleman	Foundry
Scrap iron or tin-plate	12-14 pesos/kg	16-20 pesos/kg
Fe-Pieces; in long pieces and width larger than 2mm.	24 pesos/kg	26-28 pesos/kg
Fe-Pieces; smaller pieces and Cast-Iron.	17-22 pesos/kg	20-28 pesos/kg

bd. Non Ferrous Metals

Table F.5f Average Prices Observed among Re-selters

Copper	550-650 pesos/kg
Bronze-Brass	400-550 pesos/kg
Zinc	100-120 pesos/kg
Bronze dust	300-330 pesos/kg
Lead	80-100 pesos/kg
Aluminum	200-330 pesos/kg
Tin	700 pesos/kg
Nickel	2,500 pesos/kg
Offset plates	400-450 pesos/kg

ANNEX G

OTHER FIELD SURVEYS

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ANNEX G OTHER FIELD SURVEYS

G.1 Field Survey on Industrial/Medical SWM in Brazil

G.1.1 Purposes and Contents of the Survey

Since Brazil is one of the most industrialized countries in Latin America, certain advanced industrial/medical SWM have been established. In order to examine the applicability of their management and/or systems to Chile, a field survey on industrial/medical SWM in Brazil was conducted. The main subjects surveyed are as follows:

- present ISWM by CETESB (Companhia de Tecnologia de Saneamento Ambiental) in the Sao Paulo Metropolitan Area; and
- present medical SWM by local government(s).

G.1.2 Industrial/Medical SWM in Brazil

a. Hierarchy of the Governmental Policies

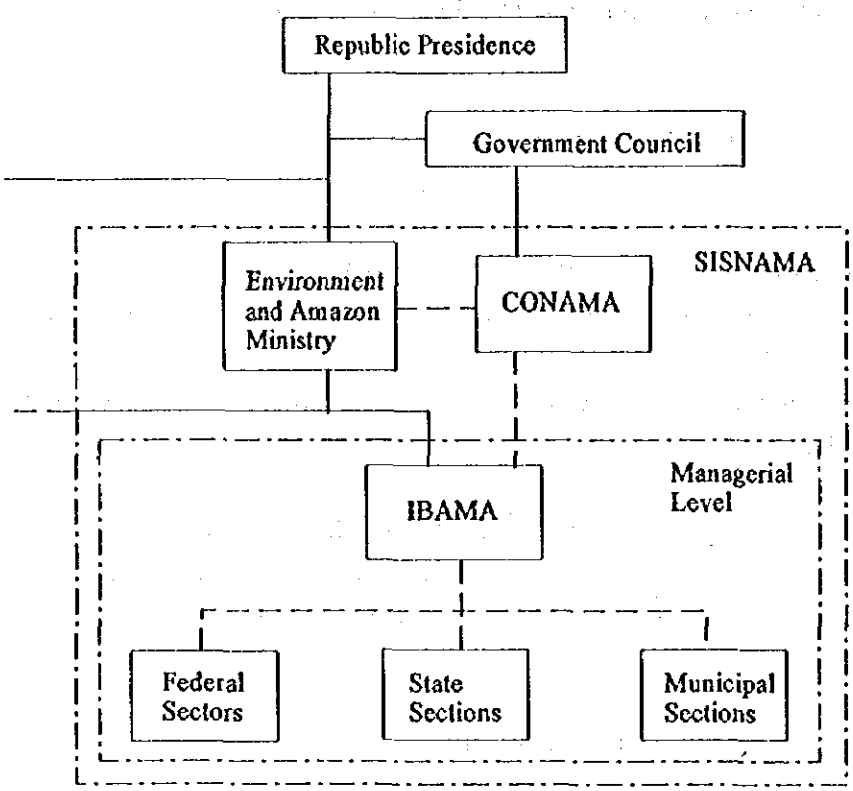
As a federal republic, federal regulations are prevalent in Brazil. Each state, however, has its own set of regulations which are equally or more restrictive than those at the federal level, and are subject to be adapted by municipalities according to their particular interests.

The National System for the Environment (SISNAMA) (see Figure G.1.2a) includes a high level debating body - National Environmental Council (CONAMA)-, and a national executive body - Brazilian Institute for Environmental and Renewable Natural Resources (IBAMA)- which are affiliated to the Ministry of the Environment. It also includes state and municipal bodies.

Each Brazilian state has its own normative and executive environmental organization, mostly composed by the State Secretary, a Technical Entity and an Environmental Council with civil representatives.

Large and medium size municipalities have a Secretary or an entity (eventually a

Council) to take care of environmental matters.



SISNAMA = Environmental National System
CONAMA = Environmental National Council
IBAMA = Environmental and Renewable Natural Resources Brazirian Institute

Figure G.1.2a Environmental Federal Organism in Brazil

b. Important Federal Regulations

A) Decree-law No. 1413 and Decree No. 76.389/75: *regarding industrial pollution control*

- defines industrial pollution
- establishes vulnerable geographical areas for pollution control
- forces the authorities to set criteria and standards, to propose loans and incentives for equipment, to set penalties.

B) Law No. 6.803/80: basic directives for industrial zoning in sensitive areas in order to achieve pollution control.

C) Law No. 6.938/81 amended by law No. 7804/89: establishes the National Policy for the Environment and the relationship between Federal, State and Municipal bodies which constitute the National System for the Environment (SISNAMA); it also establishes the instruments for implementing this Policy.

D) Law No. 7.347/85: on public civil actions referring to environmental damage; economic compensation must go to a fund for reconstitution of damaged goods or environment.

E) Decree-law No. 2.063/83 and Decree No. 96.044/88: establish the Regulations for Road Transportation of Dangerous Goods, on the basis of similar regulation by the United Nations.

F) Decree-law No. 98.973/90: establish the Regulation for Rail Transportation of Dangerous Goods.

G) Decree No. 875/93: subscribe to Basel Convention over Traffic and Storage Control of Border-crossing Hazardous Waste.

H) Interministerial Directives No. 19/81 and SEMA No. 01/83: on PCB's products, prohibiting their production, commercialization and use; regulating the handling, storage, transportation and disposal of PCB's and contaminated material.

I) CONAMA's Resolution No. 001-A/86: regulation for transportation of dangerous goods.

J) CONAMA's Reduction No. 20/86: worth classification according to their predominant usages.

K) CONAMA's Resolutions No.s 1/86 and 9/87: responsibilities, criteria and general directives for Environmental Impact Assessment and its Environmental Impact Report (RIMA), as well as for public hearing for this report.

L) CONAMA's Resolution No. 09/87: public audience for projects that might be submitted to Environmental Impact Asessment.

M) CONAMA's Resolution No. 06/88: establish the industrial waste control might be explained in the licensing processes.

N) CONAMA's Resolution No. 03/90: standards for air quality.

O) CONAMA's Resolution No. 08/90: limits for atmospheric emission from fixed sources.

P) CONAMA's Resolution No. 02/91: on contaminated, out of specification, deteriorated and abandoned products: responsibilities, control and treatment as waste.

Q) CONAMA's Resolution No. 08/91: prohibit admission of residues for disposal or incineration in Brazil.

R) CONAMA's Resolution No. 05/93: on solid waste generated through medical services and their transportation terminals; concepts, classification, segregation, packing, transportation, treatment, disposal, Management Plan;

S) CONAMA's Resolution No. 09/93: on worn out lubricant oils; responsibilities, storage, transportation; prohibition of disposal; enforcement for recycling; new non-recyclable oils are not allowed, and the manufacturers are responsible for waste resulting from those presently being produced.

c. Nationally Recommended Standards Selected from ABNT (National Association for Technical Standards)

This is a liable private association licenced by the Brazilian Government to take care of standardization of materials, technical services, laboratory essays and so on.

NBR 10.004 - Solid Wastes - Classification
NBR 10.005 - Leachate Test of Waste
NBR 10.006 - Solubility Test of Waste
NBR 10.007 - Sampling of Waste
NBR 8.418 - Design Presentation for Hazardous Industrial Waste Landfill Sites
NBR 8.419 - Design Presentation for Sanitary Landfills
NBR 10.157 - Hazardous Waste Landfills - Design, Construction and Operation Criteria
NBR 10.703 - Soil Degradation - Terminology
NBR 12.807 - Health Services Waste - Terminology
NBR 12.808 - Health Services Waste - Classification
NBR 12.809 - Health Services Waste - Handling

NBR 12.810 - Health Services Waste - Collection
NBR 9.190/91/95 - Plastic Bags for Wastes - Classification/ Specification/ Dropping Resistance
NBR 9.690 - Polymers Impervious Liners (PVC)
NBR 13.221 - Waste Transportation
NBR 7.500/01/02/03/04 - Transportation of Dangerous Goods
NB 1.183 - Storage of Hazardous Waste
NB 1.264 - Storage of Inert and non-Inert Waste
NB 11.265 - Incineration of Hazardous Waste - Performance Standards

d. Industrial and Medical SWM in Brazil - a general view

da. Industrial Solid Waste

The first ISWM project in Brazil, elaborated for the Petrochemical Complex of Camaçari (State of Bahia), established the principle in 1976: "the generator is responsible for the residues generated", with the concept of responsibility understood under its broadest meaning (technical, economical, social). The same project set a preference for an integrated collection/treatment/disposal system for collective use, specially regarding ISW, as well as for central plants instead of individual ones to cope with the processing, treatment and disposal of waste. Both principle and preference became general rules all over the country. The ISWM systems in the petrochemical poles of Camaçari and Triunfo (State of Rio Grande do Sul), and in the Chloro-chemical Pole of Alagoas State were the first to be performed in Brazil. They are owned and operated by companies shared by the State and the industries located in the pole, with a tendency towards the State's participation being reduced.

In general, the government works in the formulation of directives, laws, standards and loan criteria, besides its specific role to control and inspect the implemented ISWM systems.

However, the role of the State and Municipal Executive and Legislative Powers has been to determine the feasibility of those systems planned for collective use (collection systems and central plants): 1) the market depends on the official enforcement; 2) the legal restrictions and the popular opposition against a central plant are strongly influenced by politicians.

Some experiences in Brazil should serve as good examples. The three referred ISWM systems were easily realized because they were part of the industrial pole project.

i. In São Paulo State:

- several individual on-site facilities were installed to incinerate hazardous waste, providing services to others according to marginal capacity: BASF, Hoechst, Ciba-Geigy, Elanco.
- several industries have their own soil-disposal system, but are forbidden to receive outside waste.
- a landfill for collective use was installed by CETESB (State Environmental Entity) together with the municipal government of Sorocaba.
- four private collective landfills are in operation in other cities.
- two private central treatment/disposal plants are in the stage of obtaining a permit, awarded by CETESB and the respective municipalities.
- some private initiatives faced popular or municipal opposition, or land use restrictions;

ii. *In Rio de Janeiro State:*

- a private central system cleared by State authorities was delayed for 5 years because of municipal opposition;
- a similar system was rejected during the public hearing of an environmental report (RIMA);
- some large industries have their own treatment/disposal systems, and one of them (Bayer) sells the marginal capacity of its incineration;

iii. Curitiba, the capital of Parana State, prepared an ISW Master Plan that recommended a central plant in a selected area. The Municipal Government sold the area to a private company to build and operate the central plant and the project is permitted by the State.

iv. The industries of Rio Grande do Sul State, with political support of the municipality of Caxias do Sul, built a warehouse and are now developing the project of a central plant for the region; other associate industries are trying to get permit for their projects.

v. Waste incineration or co-disposal in cement and quick-lime kiln furnaces:

- Some states like Paraná, Minas Gerais and Rio de Janeiro, authorized processes in the form of "tests" for oily residues and, to

some extent, for paint residues or sludge, and some other kinds of sludge.

- The environmental entities did not regulate nor approve these processes, but authorized them as "testing operations" and required emissions' measurement and certain control.
- A committee with representatives of the environmental entity of these states with Rio Grande do Sul State is studying the matter to fix enforcements and permit the co-processing.
- A blending plant starts operation to prepare solids plus liquids for co-processing in cement kilns and other industrial thermal equipments in the State of São Paulo in November 1995.

db. Medical Waste

Resolution No. 5/93 from CONAMA established procedures to manage solid waste generated by health services, as follows:

i. Responsibility of the generator, from generation to final destination of residues. They must submit the Waste Management Plan to the State Agency for Environmental Control (SAEC)

ii. Treatment and disposal plants must obtain a license from SAEC, and should be controlled by this and other competent bodies of public health and sanitary control.

iii. Classification as A, B, C, D groups:

Group A: waste constituting biohazard; includes blades, sharp objects, blood and all materials coming from potentially contaminated areas (including dinning rooms and toilets).

Group B: waste constituting a hazard to public health or the environment due to chemical characteristics. Includes drugs as well as toxic, corrosive, flammable and reactive materials.

Group C: radioactive waste (controlled by specific federal body - CNEN, according to its Resolution No. 6.05).

Group D: "common" waste, not classified in previous groups.

iv. Segregation at the source is recommended; residues A and D, non classified must be managed as group A.

v. Waste from areas with endemic diseases must be classified as A.

vi. General recommendations: preference should be given to collective plants for treatment and disposal; transportation should be carried out in appropriate vehicles that are compatible with waste characteristics.

vii. Specific recommendations for Group A: must be put in bags printed with the "infectious" symbol, except cutting or perforating objects which must be packed in hard, sealed boxes. They should not be recycled and they must be treated before being disposed to the environment; recommended treatments are incineration or steam sterilization. After undergoing treatment, A waste becomes D waste for disposal purposes.

viii. Group B waste must be treated and disposed according to its hazardousness.

ix. Group D waste should be collected, treated and disposed as domestic waste.

At present, a few cities have started to practice (partially) these procedures.

To evaluate the magnitude of the problem, see Tables G.1.2a and G.1.2b.

Table G.1.2a Medical Services (for Human Health) in Brazil

Kind	Public	Private	Total
Hospitals	1,377	5,155	6,532
Clinics	2,126	6,170	8,296
Quick Medical Services	19,510	329	19,839
Accident & Emergency	188	98	286
Various Units	657	91	748
Total	23,858	11,843	35,701

Table G.1.2b Cities with Separate Collection of Medical Waste and their Disposal Practice

Municipalities with Separate Collection	2,516
Incineration	61
Special Landfill	19
Landfills	2,447
Other Methods	23
Municipalities without Separate Collection	1,909

G.1.3 Industrial and Medical SWM in the State of São Paulo

a. General Information

The State of São Paulo covers an area of 248,000 km^2 and a population of 36 million inhabitants (1995), distributed in 583 municipalities. This population represents 22% of the nation and accounts for 45% of all industrial production in Brazil, distributed among approximately 60,000 establishments.

The Metropolitan Area of São Paulo (RMSP), formed by 38 municipalities, is inhabited by 19 million people and the largest share of industrial production.

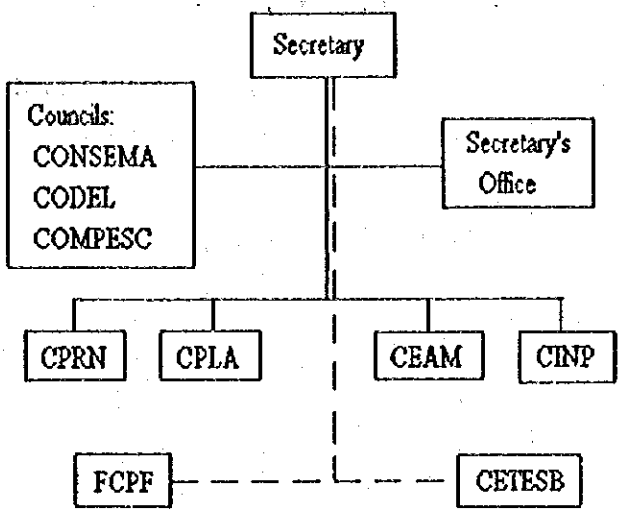
Figure G.1.3a shows the state bodies concerned with environmental matters, where CETESB - Companhia de Tecnologia de Saneamento Ambiental (Environmental Sanitation Technology Company)- is the principal normative and executive entity, and CONSEMA - Conselho Estadual do Medio Ambiente (Environmental State Council)- plays the advisory function of evaluating all EIA's (Environmental Impact Assessment) and their RIMA's (Environmental Impact Report), and deciding whether a public hearing is in order, according to the case.

Two relevant State Laws are No. 898/75 and 1.172/76, which define Areas of Water Sources Protection, comprising 53% of RMSP's territory (the whole area of six cities and eighteen partial municipal areas), and prohibits waste disposal in these areas. These acts restrain the action of Municipal Governments and the State Government, also responsible for all kinds of waste disposal in the RMSP, apart from that approved by CONSEMA of the location and mitigation measures proposed in disposal projects.

Complaints have increased dramatically since the new Brazilian Constitution of 1988. The Public Ministry, as an autonomous national power, together with local Curators for Environmental Protection play an important role during public hearings. Consequently, CETESB is requested to answer questions and to assist municipalities, leading technicians and communities whenever necessary.

State Law No. 997/76 and Decree No. 8.468/76 established that potentially polluting activities, which include those related to waste management, should obtain two successive permits: one for installation (LI) and one for operation (LF) . These permits are issued by CETESB, which is also in charge of inspecting and imposing financial penalties or interdiction.

To assist enterprises in their projects of pollution control systems, where solid waste control is included, the State of São Paulo created, a Pollution Control Program (PROCOP) in 1980, allocating its own money and others from the World Bank. CETESB is the technical body while BADESP (State Development Bank) is the financial agent for this program.



Note:

———	:	Subordination Line
— — —	:	Attached entities
COSEMA	:	Environmental State Council
CODEL	:	Coastal Protection Committee
COMPESC	:	Fishery State Council
CPRN	:	Coordination of Natural Resources Protection
CPLA	:	Environmental Planning Coordination
CEAM	:	Environmental Education Coordination
CINP	:	Technical Information, Documentation and Environmental Research Coordination
FCPF	:	Forest Conservation and Production Foundation

Figure G.1.3a Environmental Secretary of the State of São Paulo

b. ISW Generation

Among the 60,000 industries installed in the State, CETESB selected 1,480 which generate about 70% (132,961 t/day in 1989) of the total ISW.

These residues were classified according to the NBR 10004 standard in:

- Class I- hazardous
- Class II- active
- Class III- inert

The classification is shown in Tables G.1.3a and G.1.3b.

Table G.1.3a Generation and Destination of ISW in the State of São Paulo (information regarding approx. 70% of total generated)

Unit: metric tons per day

Region	RMSP (482 industries)				Other Cities (988 industries)			
Class	I	II	III	Total	I	II	III	Total
Generation	514	6,575	180	7,269	732	113,763*	11,197	125,692
Soil Disposal	228	2,897	142	3,267	272	30,004	4,096	34,372
Treatment	286	3,678	38	4,002	460	83,759	7,101	91,320

Source: CETESB/1989

* Inclusive 71,230 tons/day of sugar cane bagasse generated in sugar and alcohol plants.

Table G.1.3b Generation of ISW in the RMSP

Unit: metric tons per year

BRANCH OF INDUSTRY	Class I	Class II	Class III	Total
1. Metal Extraction	55,931.8	802,629.2	4,005.0	862,611.0
2. Vehicles and auto-parts	20,429.7	552,135.0	23,370.1	595,934.8
3. Paper, Cardboard	3,960.4	478,648.7	2,040.0	484,649.1
4. Chemicals	76,527.6	105,993.8	14,347.4	196,868.8
5. Non metallic Minerals	2,130.4	65,155.2	16,887.0	84,172.6
6. Food	223.5	67,388.8	60.0	67,672.3
7. Mechanical	8,254.2	55,619.8	36.0	63,910.0
8. Beverage	0.0	40,569.4	1,962.0	42,531.4
9. Rubber	6,345.1	29,610.2	336.0	36,291.3
10. Graphics	147.7	33,988.7	0.0	34,136.4
11. Electric, Communication	2,624.4	22,775.2	1,242.2	26,641.8
12. Pharmaceutical	4,635.4	18,097.9	28.6	22,761.9
13. Textile	535.1	18,149.6	1,344.0	20,028.7
14. Plastics	2,401.0	12,486.9	132.0	15,019.9
15. Perfumes, soaps	90.2	7,752.9	0.0	7,843.1
16. Commercial Services	0.0	6,334.2	0.0	6,334.2
17. Miscellaneous	510.2	5,458.2	78.0	6,046.0
18. Wholesale Trade	1,266.0	2,808.0	0.0	4,074.0
19. Tobacco	1,440.0	1,816.0	0.0	3,256.0
20. Clothes, Shoes	3.2	1,960.9	16.8	1,980.9
21. Leather and Similar	165.6	1,527.6	0.0	1,693.2
22. Maintenance Services	10.8	476.0	0.0	486.8
23. Furniture	48.0	360.0	0.0	408.0
24. Public Utilities	0.0	360.0	0.0	360.0
Total	187,680.3	2,332,102.2	65,930.1	2,585,712.6

Source : CETESB/1989

c. ISW Control Program

ca. The Program

Since 1989, CETESB has been managing a program which is structured into five items:

I. Closure or regulation of unsatisfactory treatment and disposal facilities
II. Generators' control
III. Transportation control
IV. Control of new treatment and disposal sites.
V. Inspection

This program will be summarized below:

I. Closure or regulation of unsatisfactory treatment and disposal facilities

An analysis of the physical, urban and environmental conditions indicates whether the site can continue its operation under the present conditions or, further steps need to be taken to improve the situation. Also, if the area is absolutely unsuited for this purpose, the need for some kind of environmental relief will also be determined.

II. Generators' Control - correction and prevention:

II.1 Generators already installed - correction.

The control of these generators started with the inventory of waste. The priority set by CETESB was to control those industries with a higher potential of producing pollutants, both in terms of quality as well as quantity. This selective criterion resulted in controlling:

- metal extraction industries with more than 100 employees;
- chemical industries with more than 50 employees;
- industries which have chemical treatment of effluents from the industrial process; and
- industries of any kind that generate toxic waste.

These the number of industries to be initially controlled rules reduced to 500 in the RMSP and to 1,000 in the other cities of the State, representing 70% of all waste produced by a total 60,000 industries in the State.

CETESB asked each of those industries to present its Waste Disposal Plan, which is analyzed and assessed by CETESB and is under continuous evaluation until its final approval and the subsequent issuance of permits (LI and LF).

When the industry intends to send waste for treatment/disposal to an outside plant, and provided that such facility is appropriate, CETESB issues a document called CADRI - Approval Certificate for Destination of ISW.

II.2 New Generators - preventive control

New or growing industries need installation and operation permits (LI and LF), which are awarded by CETESB after approval of their collection, storage, transportation, treatment and disposal system of ISW. CETESB allows for the storage of waste up to three years, awaiting for an adequate disposal.

III. Transportation Control

Transportation companies should first register at the Federal competent body, and then at CETESB, which issues the annually renewed CATRI - Approval Certificate for Transportation of ISW- if the applicant is deemed capable.

To evaluate the capability of the applicant, CETESB asks for the following information: description of equipment and facility, name of owners and responsible persons for the firm, federal register, types of residues intended to be transported, and name of generators.

Hazardous waste must be transported according to the Federal Regulation (Decree No. 96.044/88) and ABNT standards.

IV. Control of New Treatment/Disposal Sites

New sites need permits LI and LF from CETESB, which should be issued after approval of the location (with EIA/RIMA approval), the engineering design and the operational plan. Water systems and lakes must be at least 200 meters from a landfill site and residential areas must be located beyond the 500 meters radius. The project of a facility is evaluated according to risks and compatibility with the environment. Occasionally, the Environmental Secretary asks for a Risk Analysis (by CETESB) instead of an EIA/RIMA, to evaluate a proposal (through CONSEMA).

V. Inspection

CETESB's inspection of generators, transporters and receivers includes:

- periodic inspections to check, if the design and building conditions, the operation and the re-storage that were demanded in the approval of the enterprise have been met;
- compliance of the monitoring system installed in the treatment/disposal facility.

cb. Results and Comments

A large share of the industries solved their problems with class II and class III wastes, where the recycling and recovering of materials must have contributed to the reduction of waste in the environment.

Destination for Class I waste requires central treatment and disposal plants, as an economical means of bringing adequate technology and facilitating CETESB's control. Meanwhile, the generators are storing waste inside their property, according to CETESB's recommendations. However, the risks involved and the lack of space in most industries located in consolidated urban areas suggest it is a weak and ineffective practice.

CETESB, in its aim at going further in the search of a solution to this serious problem, has some short term objectives:

- evaluate the aptitude of regions for treatment/disposal plants (incinerators, special landfills, chemical treatment plants), pointing out the places where such activities would not find any obstacles, neither physical, legal nor environmental;
- adapt its institutional and legal structure in order to manage the ISW requirements more rapidly;
- improve the financing lines towards the implementation of central treatment/disposal plants and of industrial processes that aim at waste minimization and recycling;
- induce industries to join themselves towards looking for collective treatment/disposal plants.

CETESB is gathering data on RMSP areas which have been degraded by industrial and domestic solid waste deposits as well as methods to recover these sites.

d. Medical SWM

The waste generated in health services and related business (hospitals, clinics, ambulance service, pharmacies, laboratories) in the RMSP is separately collected by contractors in special vehicles and delivered to two old municipal incinerators ("Vergueiro" and "Ponte Pequena" sites) of São Paulo.

The net average treated by the incinerators is 130 t/day, collected from the 38 municipalities of RSMP plus 8 others nearby.

No special payment is borne by generators other than the usual tax for domestic refuse; the municipalities pay the contractors and São Paulo maintains the two incinerators.

The waste is packed in white bags.

In order to prevent atmospheric pollution, the incineration of municipal waste in individual plants is forbidden in the MRSP. It is allowed, however, in other cities and CETESB's standards are applied: No. E 15.011 "Sistema para Incineração de Resíduos de Serviços de Saúde"(Health Services Residues Incineration Systems).

Although the Health Secretary in the State of São Paulo offers a public model to manage municipal waste, and proposes a segregation of residues similar to that recommended by CONAMA's Resolution No. 05/93 (item 4.2), this practice is as rare as appropriate management.

Table G.1.3c shows a CETESB's evaluation of municipal waste disposal.

Table G.1.3c Final Disposal of Medical Waste in the State of São Paulo

Evaluation of CETESB	Unit: metric tons per day		
	RMSP	Other Cities	Total
Adequate or Controlled	112	26	138
Inadequate	3	104	107
Total	115	130	245

Source: CETESB/1990

G.1.4 Industrial SWM in the State of Rio de Janeiro

a. General Information

The State of Rio de Janeiro extends over an area of 44,268 km^2 with 15 million inhabitants, producing 10% of all Brazilian industrial production.

Environmental matters are managed by an Environmental Secretary, the Environmental Control State Commission (CECA) - a multi-representative commission-, and the Environmental Engineering State Foundation (FEEMA) - the principal technical and inspection body. The legal acts and penalties are proposed by FEEMA but dictated by CECA.

Rio de Janeiro State pioneered some important procedures and activities in Brazil. For instance:

- Polluting Activities Permit System (SLAP) - Decree No. 134/75 and Instruction NA-002/78;
- Self-Control of Effluents by Generators;
- Waste Stock-Exchange - Directive DZ 949;
- ISW Manifest System - Directive DZ 1310;
- Accidental Pollution Response Service (coordinating and executive body);
- Routine for Analysis of an Environmental Impact Assessment (EIA) and its Environmental Impact Report (RIMA) - NA 042;
- Citizen Participation in Environmental Impact Evaluation - NA 043;
- Waste Minimization Program - State Law No. 2011/92.

FEEMA maintains an inventory of ISW generated within the State. The destination of ISW is guided by Directive DZ - 1311.

b. Selected Aspects of Related Documents

The permit system SLAP is composed of three permits:

- previous permit (LP): authorizes the type of activity and location proposed, and appoints conditions for the project; EIA/RIMA approval is generally necessary for LP;
- installation permit (LI): approves the engineering design and authorizes its construction;

- operation permit (LO) : approves the construction, after inspection and tests, authorizing the operation for a limited period (generally 5 years). At which time the permit needs to be renewed.

To obtain an LP, the enterprise should present an EIA/RIMA according to special guidelines supplied by FEEMA. Upon receiving the EIA/RIMA, FEEMA studies the project. FEEMA also contacts executive and legislative institutions that should have an interest, as well the Justice Curator, nearby inhabitants, associations and groups involved in the protection of activities in the proposed area. Some copies of RIMA are distributed while others remain at FEEMA's library as a reference for anyone interested in the subject. FEEMA/CECA produces a public announcement and give no less than 45 days for public manifestation. Depending on the environmental and political importance of the project, CECA may call for a public hearing by stating the subject, place and date of the meeting at least 45 days in advance. The public opinion, manifested before and during the hearing, should be considered in FEEMA/CECA's decision of approving or rejecting the RIMA, although it is not mandatory.

Directive DZ 1311 regarding the destination of ISW emphasizes recycling and collective systems for treatment/disposal, sets the responsibilities of generators, transporters and receivers, and appoints criteria for storage and destination. A landfill for toxic waste must be at least 300 m away from any water system or lake, 50 m from a road, and 1,000 m from residential or communal areas; it must also be surrounded by trees. The bottom of the landfill must be at least 2.0 m higher than any underground water level, protected by a clay barrier and by two liners of compatible membrane. Obviously, the location must be previously approved (RIMA and LP), and the enterprise must own the sites for landfills, additional installations and a surrounding area sufficiently large to accommodate a buffer zone.

Waste minimization program has not been instated, but Law No. 2.011/92 provides several alternatives to reduce waste generation. It also sets goals for annual reduction and delivers the regulation and management of the program over to FEEMA.

c. Medical Waste Management in the State of Rio de Janeiro

Rio de Janeiro, the capital, and most cities in the State did not yet implement segregation and separate collection and disposal of medical waste, but hospitals must have special incinerators (2 combustion chambers) for infectious waste. The municipal cimpan (COMLURB) collects refuse in the hospitals in the capital and dispose of the waste (incinerated or not) in its sanitary landfills, in reserved area. The company use special truck-collectors for mostly of this service.

G.1.5 Criteria for Landfills Design in Brazil

The US-EPA standards (RCRA/HSWA from November 8th, 1984), are generally used criteria for landfills design in Brazil but the State Environmental Agency discuss with the project promoting sectors and could accept alternatives according to the natural conditions of the site and according to the kind of waste to be landfilled. The permits are very specific for the kind or class of waste.

i. The State of Bahia

In the State of Bahia, the principal restrictions are as follows.

It is not allowed to dispose in landfill:

- liquid residues; pasty or solid derived from a liquid phase;
- residues with more than 10% (in weight) of water-soluble solids;
- non-packed powder residues, or residues generating emission of volatile compounds or strong odors;
- residues containing more than 1% of mercury;
- metal finishing residues containing more than 5 ppm of cyanide or 20 ppm of Cr^{+6};
- residues with organics content higher than:
    - 10% volatiles (referred to dry weight determined by calcination);
    - 5% matter extracted by means of n-hexane;
- toxic waste to be incinerated, in compliance with the law, and in any case containing:
    - organic solvents over 5% (in weight);
    - halogenated organic solvents over 1% (in weight);
- residues which generate a leachate not compatible with the receiving standards of the liquid effluent for centralized treatment;
- flammable, reactive, or radioactive wastes.

The standards for the landfills of CETREL since 1993 are as follows (see Figure G.1.4a):

- clay liner: $\leq 10^{-7}$ cm/sec; thickness $\geq$ 1.0m
- plastic liner (HDPE): thickness $\geq$ 2.0mm
- drainage system:
    - gravel diameter 8 to 16mm
    - pipes diameter 300mm PVC (changing to HDPE)

- protection of slopes: soil-cement cover
- covering:
  - draining earth ~0.40m
  - clay ~0.60m
  - cultivable soil ~0.30m
  - grass

ii. The State of São Paulo

In the State of São Paulo, CETESB's criteria for landfills considers basically the class of work (class 1 - Hazardous, class 2- Non-inert, Non-Hazardous) and natural conditions of the site: geology, groundwater level, meteorology, as showed in Figures G.1.4b, G.1.4c, G.1.4d, G.1.4e, G.1.4f and G.1.4g.

iii. The State of Rio de Janeiro

In the State of Rio de Janeiro, the criteria are presented in Directive DZ-1311 (see section G.1.4b).

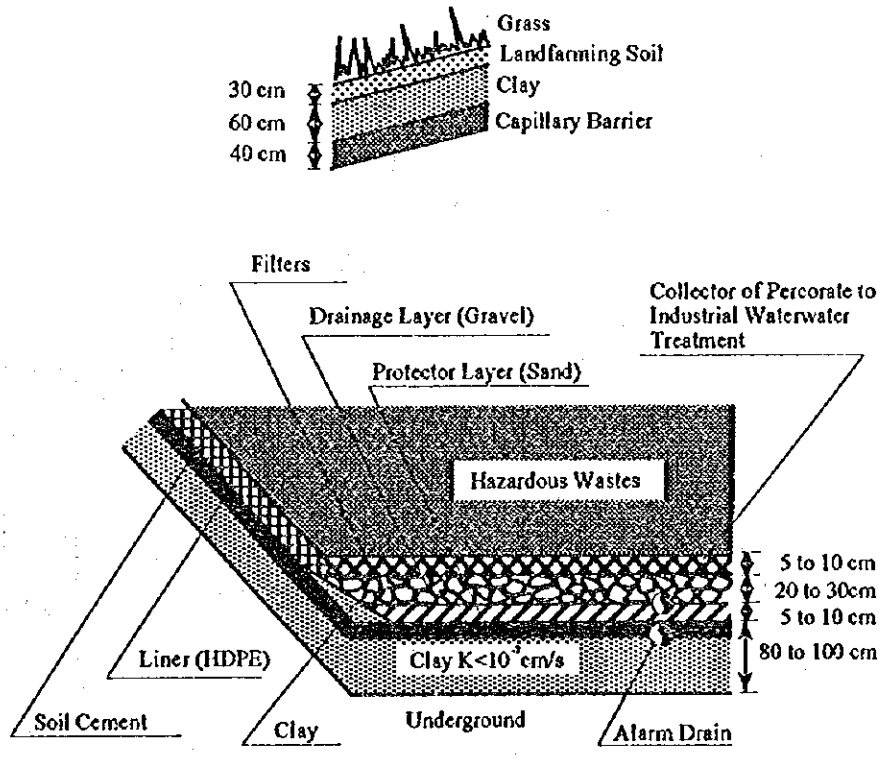


Figure G.1.4a Landfill Standard of CETREL (Hazardous Waste)

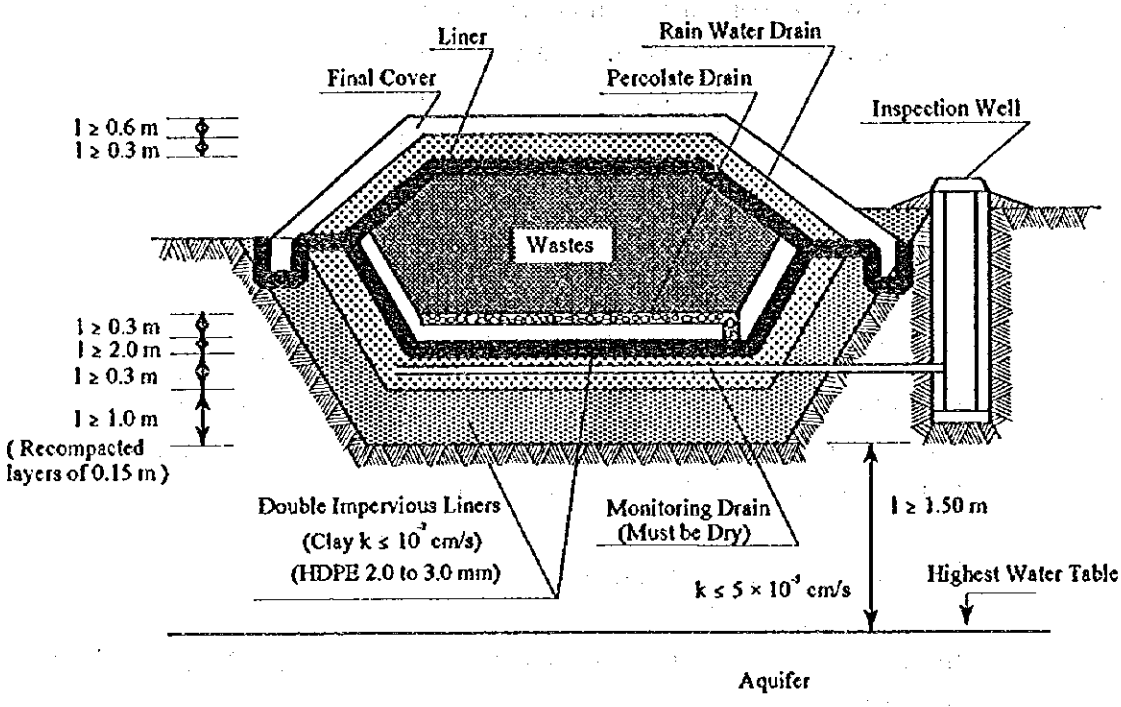


Figure G.1.4b CETESB's Criteria for Hazardous Waste (Class-1, Admitted) Landfill

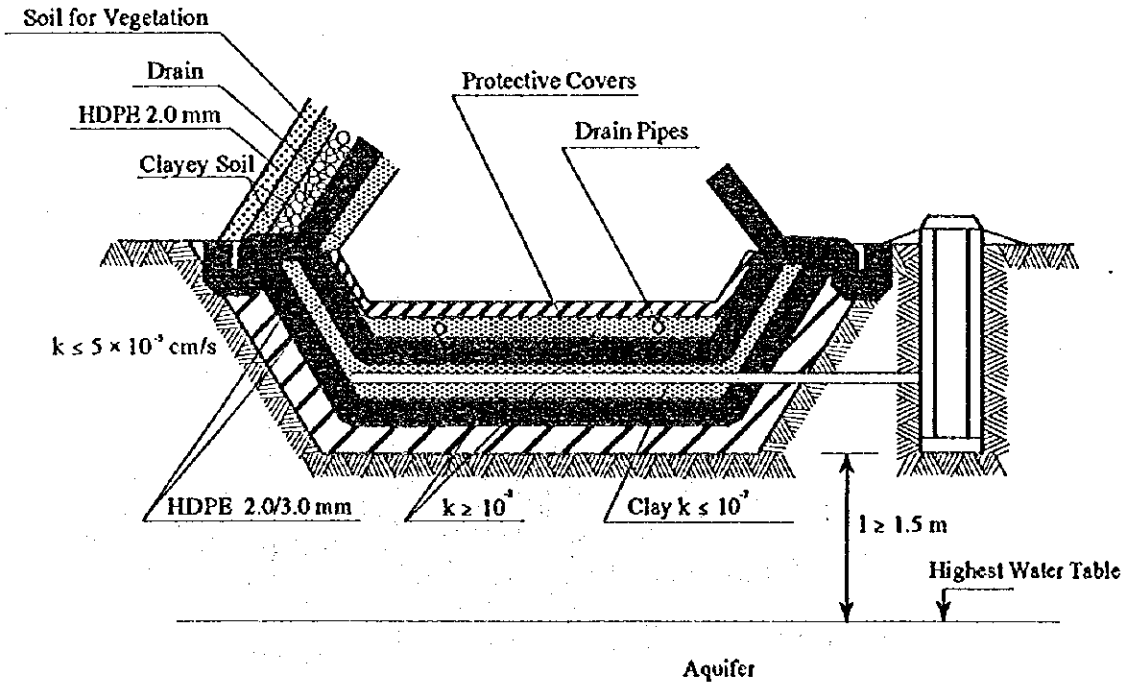


Figure G.1.4c CETESB's Criteria for Hazardous Waste (Class-1, Recommended) Landfill

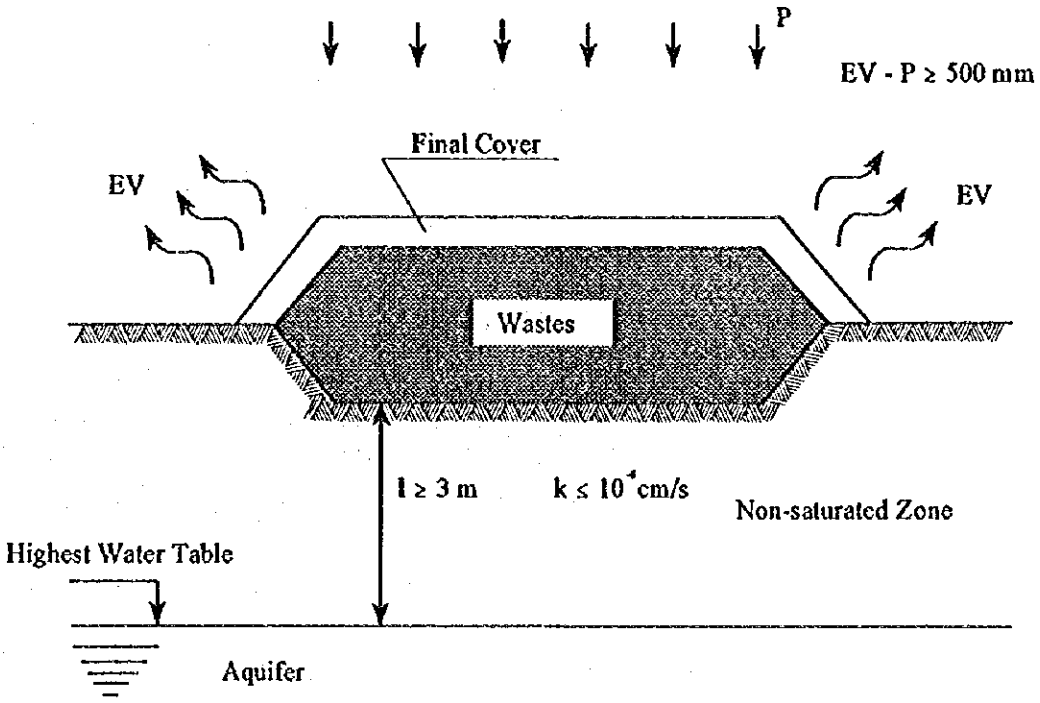


Figure G.1.4d CETESB's Criteria for Non Hazardous Non-Inert (Class-2) Landfill with Good Hydrogeologic and Good Meteorologic Conditions

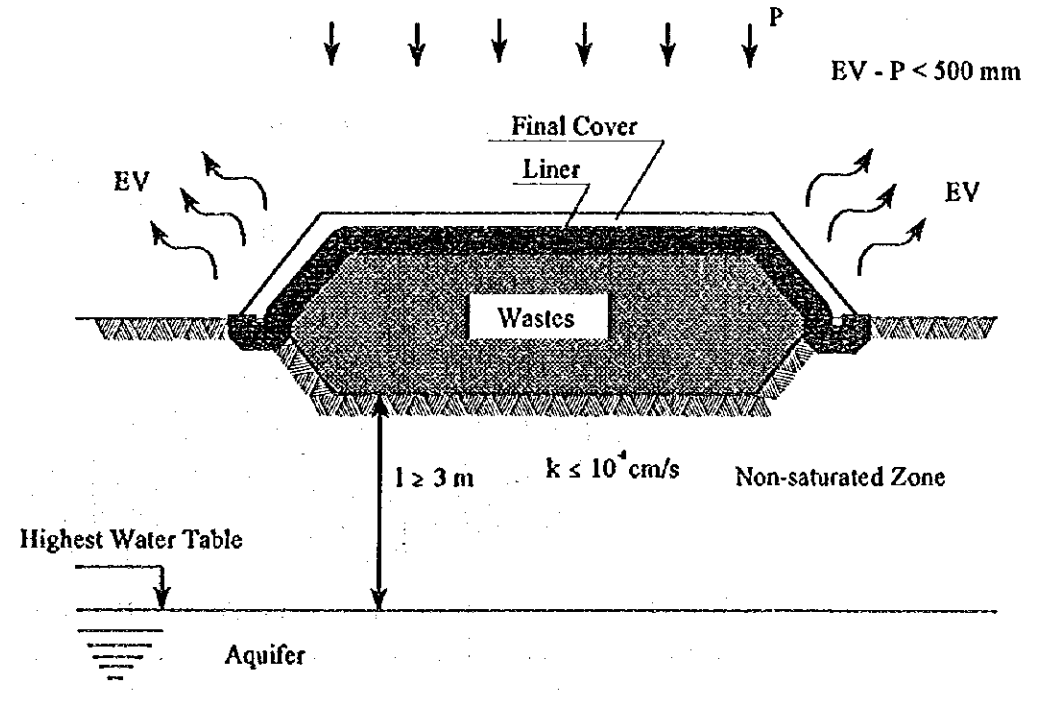


Figure G.1.4e CETESB's Criteria for Non Hazardous Non-Inert (Class-2) Landfill with Good Hydrogeologic and Bad Meteorologic Conditions

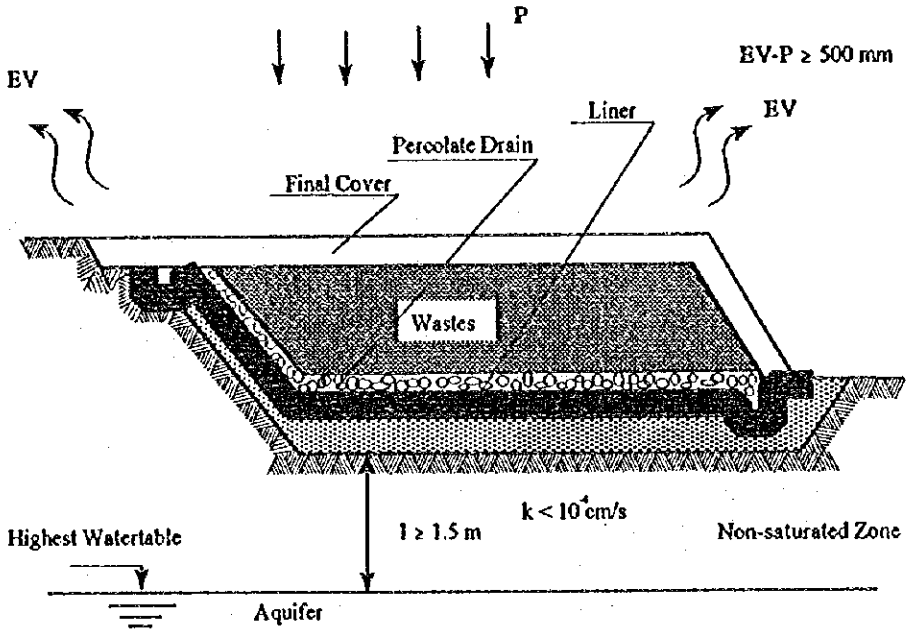


Figure G.1.4f CETESB's Criteria for Non Hazardous Non-Inert (Class-2) Landfill with Bad Hydrogeologic and Good Meteorologic Conditions

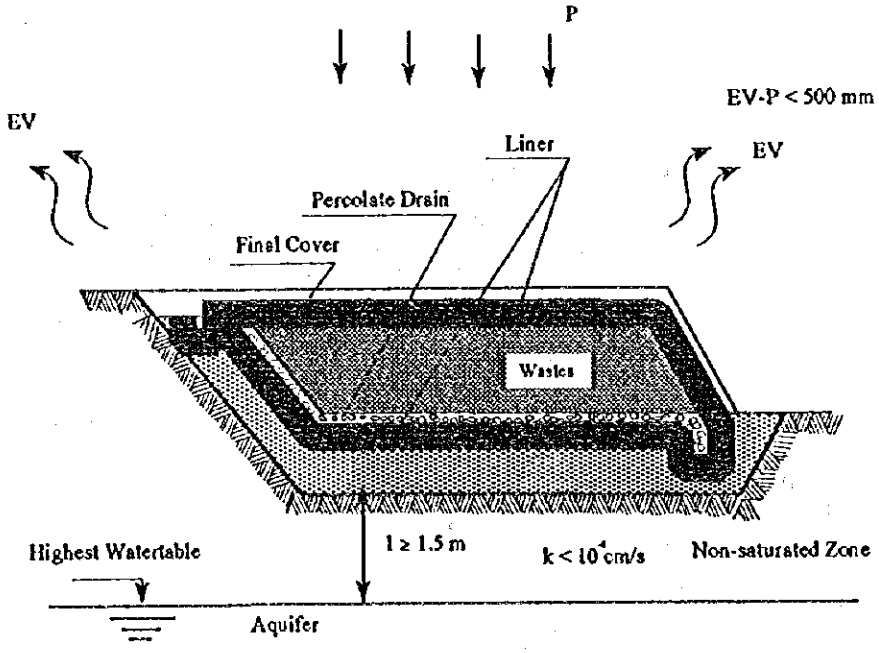


Figure G.1.4g CETESB's Criteria for Non Hazardous Non-Inert (Class-2) Landfill with Bad Hydrogeologic and Bad Meteorologic Conditions

G.1.6 Cost of Industrial/Medical SW Treatment/Disposal in Brazil

There are no special facilities and/or sites for industrial/medical SW treatment/disposal in the MR at present. In this regard, the following treatment/disposal costs in Brazil were investigated in order to present a reference for tipping fees to be charged in the MR when facilities and/or sites for industrial/medical SW treatment/disposal are established in future.

Table G.1.6a Cost of industrial/medical SW treatment/disposal in the Sao Paulo state

Treatment/Disposal Facilities	Category of Waste	Treatment/ Disposal Cost	Remarks
ECOSISTEMA Disposal Site	Hazardous Waste	US$ 140/Ton	Including transportation cost of 50 km
	Non-hazardous Waste	US$ 16-20/Ton	Including transportation cost of 50 km
San Jose Campos Medical Waste Incinerator	Medical Waste	US$ 1,500/Ton	Including collection and transportation cost
San Jose Campos Municipal Landfill	Municipal SW	US$ 27/Ton	Collection/transportation costs (US$ 17/ton) are not included
	Industrial SW	US$ 38/Ton	Collection/transportation costs are not included

G.2 Regulations on Localization of ISWM Facilities

G.2.1 Metropolitan Regulatory Plan of Santiago

a. Outline of the Metropolitan Regulatory Plan

Prepared in January 1993 by the Department of Urban Development and Infrastructure, Ministry of Housing and Urban Development, the Metropolitan Regulatory Plan of Santiago is the planning tool that regulates and directs the urban development process in the city of Santiago (covering all of the Santiago province plus five adjacent comunas). The outline of the Plan is as follows:

Title 1. General Provisions

Title 2. Territorial Scope of the Metropolitan Plan

Title 3. Metropolitan Urban Area

Chapter 1 Zoning
Chapter 2 Relationships between Land Uses
Chapter 3 General Rules
- Land Occupation Intensity
- Sloping Land
- Modification of Water Courses
- Zones of Metropolitan Interest
- Green Areas

Title 4. Intensity of the Metropolitan Land Use

Title 5. Metropolitan Equipment

Chapter 1 Metropolitan and Intercomunal Equipment
Chapter 2 Metropolitan System of Green and Recreational Areas
- Metropolitan Parks
- Intercomunal Parks
- Additional Green Areas
- Recreational and Sport Equipment
- Parks-Cemeteries
- Areas of Historical and/or Cultural Interest

Title 6. Productive and Service Activities

Chapter 1 Productive and Service Activities of Industrial Nature
- Classification and Topology
- Qualification
- Zoning and Rules
- Emissions

Chapter 2 Extractive Activities
- Mining
- Extraction of Non-metal Minerals for Construction Purposes
- Time Limit for Well Exploitation

Title 7. Metropolitan Infrastructure

Chapter 1 Transportation Infrastructure
- Metropolitan Public Ways
- Parking
- Retailing Establishments of Liquid Fuels
- Terminals of Collective Urban Transportation
- Feasibility of Transportation Systems

Chapter 2 Sanitary Infrastructure
- Potable Water
- Used Water Sewage
- Final Disposal of Solid Waste

Chapter 3 Rain Water Infrastructure

Title 8. Restricted Area or Area Excluded from Urban Development

Chapter 1 General Rules

Chapter 2 Zoning and Specific Rules
- High Risk Areas for Human Settlements
- SSSI
- Due to Hazardous Activities
- Area of Natural Value and/or Silvi-agricultural Interest
- Of Natural Value
- Of Silvi-agricultural Interest
- For Protection of Metropolitan Infrastructure

Transitory Articles
- Community Equipment
- Rain Water

- Restricted Areas of Eulogio Sanchez Errazuriz Airport
- Rules of Geographical Subsectors
- Public Ways at Communal Level
- Terminals and Fuel Plants of Maipu

b. Metropolitan Sanitary Structure and Restrictions over the Localization of Facilities for ISW Treatment/Disposal

Of special interest for the Study are the provisions included in the Plan regarding "Sanitary Infrastructure" (Title 7, Chapter 2), and specifically those regarding "Final Disposal of Solid Waste". These provisions require that final disposal facilities of ISW include, within their premises, a minimum buffer zone of 600 m to the neighboring land. In view of such stringent requirement, the Counterpart requested the Study Team to provide information on similar regulations in other countries (e.g. Japan, Denmark, Brazil). Such regulations are then summarized in the following section.

G.2.2 Regulations in Japan

Although the City Planning Law in Japan regulates areas where final disposal sites are not allowed to be located (i.e. residential areas, etc.), for where such localization is allowed there is no specific legislative regulation which specifies e.g. minimum distance from houses to facilities.

However, the local authority which has the power of granting permission for localization and construction of ISW treatment/disposal facilities; i.e. prefectural governors establish related regulations (e.g. minimum percentage of green area to be retained in the project area, buffer distance to the adjacent areas, etc.) and require ISWM sectors to refer and reflect those requirements into their proposals. In effect, proposals which do not meet these requirements will not receive permit for localization and/or construction.

Among the items which the Japanese prefectural governors require, the following requisites might be similar in nature to that which the Chilean authority requires:

- "Percentage of green area in the project area": In general, **25% to 40% of the project area** (except area occupied by facilities) **should be maintained as a green area.** Where the green area does not exist originally, afforestation is necessary.

- "Buffer distance": It defines the distance from the ISWM facilities to the periphery of the project area. In general it requires a few tens of meters. **50 meters may be the maximum required in Japan.**

Apart from the above-mentioned requirements, local governments generally require the ISWM sector to include attainment of neighborhood consensus (of about 70% to 100%) from habitants between 100 meters to 500 meter from the site for the proposal. As a consequence of difficulties in obtaining neighborhood consensus, ISWM sectors generally select less populated area as their facility candidate site. In effect, majority of ISWM facilities are located in remote areas.

On the other hand, since municipalities are responsible for domestic SWM, domestic SWM facilities located in populated area are quite common in Japan.

G.2.3 Regulations in Denmark

The regulations on localization of facilities for solid waste treatment and disposal in Denmark are divided into two parts: The procedure related to Physical Planning, and that related to the Environmental Impact Assessment/Environmental Permits. The procedures are the same whether they deal with a treatment or a disposal facility.

a. Physical Planning Procedures

No treatment or disposal facility can be established without a proper planning procedure, which involves Regional Planning (conducted by the Regional Authorities of which there are 16 in Denmark, having 5 million inhabitants), and Municipal and Local Planning (conducted by the Local Authorities of which there are 275 in Denmark). Both regions and municipalities are governed by publicly elected, Regional and Local Governments.

The **Regional Plans** are comprehensive physical plans for the region, dealing with overall land use (urbanization, water courses and water supply, waste treatment and disposal, nature conservation, energy supply, traffic pattern development, etc.) Draft plans are made public and the population may comment on them, but there is no obligation for the Regional Government as to comply with the observations made by individuals or interest groups. The plans are not very detailed and should in general be regarded as area reservation plans, i.e. the foreseen development will not necessarily take place, but development in opposition to the plan is not allowed. For example, a

landfill cannot be established in an area laid out for forest or agriculture unless the plan is changed. The plans are revised every 4 years.

The **Municipal Plans** are physical plans in more detail than the regional plans, but mainly dealing with urban and local infrastructure development within the single municipality. In these plans such issues as maximum building area or volume in the different parts of the municipality are specified, as are areas for housing, trade and industry, public purposes (including waste treatment and disposal), parks, and the open land (agriculture, forests, etc.). Some purposes may be mixed, for example will landfills always be situated in the open land, most commonly on agricultural land which is temporarily taken out of use. As for Regional Plans, draft plans are made public and the population may comment on them, but there is no obligation on the Local Government as to comply with the observations made by individuals or interest groups. No Municipal Plan can be adopted against the provisions laid down in the Regional Plan. The plans are revised every 4 years.

The **Local Plans** are related to the realization of specific projects, whether it be housing, industries, parks, road construction, waste treatment or disposal plants, etc. They will contain very specific information in relation to such issues as building height, building are and volume, green area requirements, and localization of buildings within the area - and, in case of landfills, for the final shape and after-treatment of the area. Local Plans are also closely related to environmental considerations, as they are adopted by the Local Government parallel to the treatment by the environmental authority of the EIA/Environmental Application. Therefore, they may contain provision related to environmental issues, such as road access and noise prevention. Again, draft plans are made public, but there is no obligation for the Local Government as to comply with the observations made by individuals or interest groups. No Local Plan can be adopted against the provisions laid down in the Municipal Plan.

Sometimes a waste treatment or disposal facility will be agreed upon within a planning period. In such cases it is possible for the Regional and Local Governments to adopt supplements to the existing Regional and Municipal Plans, applying the same procedures as at normal revisions.

It should be noted that no planning document dealing with a waste treatment or disposal facility will have provisions related to the minimum distance to other activities, for example that there must be a buffer zone around a proposed landfill site. In practice there will, however, be limitations, as no one will consider building houses or conduct other sensitive activities in the vicinity of a planned landfill.

In day-to-day administration waste incineration plants will normally be located in areas

for heavy industry, but relatively close to the populated areas to make good account of the generated energy (like power plants). Waste transfer stations may be located similarly for practical reasons, but not in odor-sensitive surroundings. Landfills and composting plants will be located in open lands as far from housing as possible to avoid public nuisances, mainly noise and odor problems.

b. Environmental Impact Assessment/Environmental Permit Procedure

The types of activities which must undergo an EIA and/or provide an Environmental Application (EA) to the authorities are listed in an appendix to the Environmental Protection Act.

In the EIA/EA documents the applicant must make a full statement of plant localization, planned production/operation, expected emissions, emission reduction measures, expected environmental impact, and initiatives to reduce impact from dangerous operations.

The authority may ask for more detailed information if the one received is deemed unsatisfactory.

In the final permit document the authority may make more strict requirements than suggested by the applicant, for example better air emission reduction or better monitoring.

The permitting authority in relation to almost all waste treatment and disposal facilities will be the Regional Authority, also because most facilities are municipally owned and the municipality cannot grant permits to itself.

For landfills the requirements related to localization will normally be:

- Access roads. These should not take the traffic through small villages on small roads. In some cases the landfill owner has been requested to build a new access road.
- Noise level. There are rather strict requirements on this. The landfill owner will normally have to construct sound-absorbing banks around the site, as well as establish plantations and fencing. If the noise level at the nearest residents cannot be reduced sufficiently - but the location is otherwise suitable - the landfill owner may have to buy the houses.
- Odors and pest control. This is normally done through requirements related to cleanliness and daily cover of the waste, and rat extermination

if necessary.

It should be noted that there are no requirements as to neighborhood consensus. Neighbors dissatisfied with the landfill may complain to the Ministry of Environment which may alter the decision of the Regional Authority.

There is legislative background for public acquisition of privately owned land if necessary for the construction of a waste treatment and disposal facility. This option is often applied.

G.3 Leachate Quality Survey

G.3.1 Background

Responding to the request of the Chilean side to the Study Team to examine whether hazardous materials are disposed in the municipal landfills or not, expressed at the Meeting of the Progress Report Explanation held from 10th to 14th March 1995, the Team conducted "The Leachate Quality Survey" in June 1995.

G.3.2 Contents of the Leachate Quality Survey

This leachate quality survey comprised the following works;

i. Sampling Points:
The leachate sampling points were at the present landfill sites; Lo Errazuriz, Cerro de Renca and Lepanto.

ii. Analysis Items:
The fourteen (14) items listed below were tested.
pH, COD, BOD, Total Nitrogen (T-N), SO_4^{2-}, Chloride Ion (Cl^-), Pb, As, Cd, Cr^{6+}, Total Mercury (Hg), CN, Cu, Zn.

iii. Sampling Number:
3 samples were taken at respective sampling points i.e 9 samples in total.

iv. Sampling Timing:
Samples were taken after three consecutive days of fine weather (without rain).

v. *Analysis Method:*
Chilean standard. AWWA (American Water Works Association) standard was applied only to items where Chilean standard does not exist, i.e. COD and Cl^-.

vi. Others
The following items are measured at the time of sampling (in-site;)
- Ambient temperature ; and
- pH

G.3.3 Sampling and Results of the Laboratory Analysis

a. Sampling

Sample identification (i.e. each sample code with its sampling date and time, in-situ pH and temperature) are shown in Table G.3.3a.

Table G.3.3a Sampling Date and Time of the Leachate Quality Survey

Item	Description	Date and Time	pH	Temperature °C
E-1	Lo Errazriz 1st Sampling	13/Jun/95, 10:15a.m.	7.50	24.3
E-2	Lo Errazriz 2nd Sampling	20/Jun/95, 10:10a.m.	7.92	18.2
E-3	Lo Errazriz 3rd Sampling	23/Jun/95, 16:30p.m.	8.00	22.2
C-1	Cerro de Renca 1st Sampling	13/Jun/95, 13:30 p.m.	7.80	19.0
C-2	Cerro de Renca 2nd Sampling	20/Jun/95, 13:00p.m.	8.03	9.9
C-3	Cerro de Renca 3rd Sampling	23/Jun/95, 14:00p.m.	7.80	11.0
L-1	Lepanto 1st Sampling	20/Jun/95, 11:25 a.m.	6.32	10.9
L-2	Lepanto 2nd Sampling	23/Jun/95, 15:00p.m.	6.27	12.8
L-3	Lepanto 3rd Sampling	27/Jun/95, 10:30a.m.	6.78	13.5

b. Results of the Laboratory Analysis

Results of the Laboratory Analysis are shown in Table G.3.3b.

Table G.3.3b Results of the Laboratory Analysis

No.	Item	Unit	E-1	E-2	E-3	C-1	C-2	C-3	L-1	L-2	L-3
1.	pH (in Lab.)		8.26	8.10	7.9	8.53	8.15	7.5	6.9	6.50	6.70
2.	Temperature (in Lab.)	°C	15.7	20.8	20.0	15.4	15.5	15.5	17.0	15.0	20.0
3.	COD	mg/l	7,400	9,400	7,500	4,500	5,700	4,050	63,000	61,000	78,400
4.	BOD	mg/l	5,000	6,000	3,600	2,200	2,500	2,400	42,000	49,000	43,000
5.	Total Nitrogen (T-N)	mg/l	2,350	2,180	2,400	1,064	835	890	1,590	1,635	1,570
6.	SO_4^{-2}	mg/l	54	66	50	58	128	60	1,030	1,250	1,100
7.	Chloride Ion (Cl^-)	mg/l	4,150	3,740	4,080	4,250	4,200	4,200>	3,400	3,890	3,400
8.	Pb	mg/l	0.70	0.90	0.15	0.27	<0.33	<0.03	0.70	<0.03	0.62
9.	As	mg/l	0.019	0.016	0.031	0.013	0.008	0.021	0.038	0.030	0.030
10.	Cr^{+6}	mg/l	1.09	1.12	1.06	0.20	0.29	0.31	0.35	0.28	0.28
11.	Total Mercury (Hg)	mg/l	0.001	0.001	0.001	0.001	0.001	<0.001	0.002	0.001	0.001
12.	CN	mg/l	<0.05	<0.05	<0.05	0.07	<0.05	<0.05	<0.05	<0.05	<0.05
13.	Cu	mg/l	0.46	0.41	0.44	0.05	0.08	0.05	0.76	0.49	0.32
14.	Zn	mg/l	1.50	0.91	1.30	0.16	0.19	0.15	1.05	2.30	2.30

Notes : The leachate of Lo Errazuriz and Cerro de Renca landfills was sampled from the leachate ponds, which collects rather matured leachate. On the contrary, the leachate at Lepanto landfill was sampled from the pit which was excavated at the slope end of the latest landfilled area. This is the reason why BOD and COD of the leachate sampled in the Lepanto is extremely higher than the other two.

G.3.4 Findings

a. Comparison of Laboratory Analysis Data and Maximum Permissible Concentration

Table G.3.4a shows comparison of:

- the mean values (of 3 samples) for respective landfills obtained from the laboratory analysis,
- maximum concentration of contaminants (MCC) for the toxicity characteristic

Table G.3.4a Comparison of Laboratory Analysis Data and Maximum Permissible Concentration

		Result of Survey (mean value)			MCC by US-EPA
		Lepanto	Renca	Lo Errazuriz	
pH		6.7	8.1	8.1	-
Temp.	C	17.3	16.1	18.8	-
BOD	mg/l	44,667	2,367	4,867	-
COD	mg/l	67,467	4,750	8,100	-
Cl	mg/l	3,563	4,217	3,990	-
SO4	mg/l	1,127	82	57	-
T-KN	mg/l	1,598	930	2,310	-
Hazardous Substances					
CN	mg/l	ND	0.06	ND	-
Pb	mg/l	0.66	0.30	0.58	5.0
As	mg/l	0.033	0.014	0.022	5.0
Cd	mg/l	0.05	0.01	0.04	1.0
Cr+6	mg/l	0.30	0.27	1.09	(Cr) 5.0
Hg	mg/l	0.001	0.001	0.001	0.2
Cu	mg/l	0.52	0.06	0.44	-
Zn	mg/l	1.88	0.17	1.24	-

The table shows that:

- All data obtained from the laboratory analysis was within the CMP for the application of the Leachate Toxicity Test drafted by the Ministry of Health (except Cd, which is not specified under the CMP). Therefore, the leachate sampled do not correspond to "leachate from hazardous waste" specified by the "Rules for Sanitary Management of Hazardous Solid

Waste" (First Working Draft).

- In relation to Standard Nch2280 which specifies maximum limits for industrial liquid waste discharges into the public system of waste water collection, BOD and T-KN (as parameters of organic polluting substances) exceeded the permissible limits. Meanwhile, in relation to hazardous substances (i.e. heavy metals), only the leachate sampled in Lo Errazuriz exceeds the threshold limit for Cr^{+6}.

In this regard, as far as viewing the outcome of the laboratory data of the Leachate Quality Survey, leachate from 3 respective landfills:

- do not exceed the limits defining "leachate from hazardous solid waste" specified in the draft standards of Ministry of Health.
- exceed a few items of limits allowing discharge to the sewage line. Therefore these leachates cannot be discharged to the sewage line without treatment.

Consequently, as far as the outcome of the laboratory data this survey indicate, if viewing the whole landfill site, leachate obtained from the 3 respective landfill sites is not deemed as hazardous.

b. Characteristics of the leachate

Table G.3.4b shows comparison of:

- outcome of this Leachate Quality Survey,
- leachate data from landfills of mix disposal of municipal SW and ISW (UK, Norway and USA), and
- leachate data from a landfill where only municipal SW is disposed (Japan).

Remarks: $KMnO_4$ (COD_{Mn}) is used as an oxidizer for an analysis of COD in Japan. However, $K_2Cr_2O_7$ (COD_{Cr}) is used as an oxidizer for an analysis of COD not only in Chile but also in many countries. In terms of the oxidation ratio $K_2Cr_2O_7$ is higher than $KMnO_4$, as shown in the Figure G.3.4a . The ratio of COD_{Cr} / COD_{Mn} is approximately 3 accordingly. In addition, the analysis result of COD used $KMnO_4$ as an oxidizer could be smaller than the value of BOD.

Table G.3.4b Comparison of Several Leachate Data

		Result of Survy (mean value)			Pitsea* (UK)	Granmo* (Norway)	Cedar Hills* (USA)	Japan
		Lepanto	Renca	Lo Errazuriz	43%ISW	66%ISW	ISW/MSW	100% MSW
pH		6.7	8.1	8.1	8.0 to 8.5	6.8	5.4	-
Temp.	C	17.3	16.1	18.8	-	-	-	-
BOD	mg/l	44,667	2,367	4,867	80 to 250	320	24,500	250 to 1,200
COD	mg/l	67,467	4,750	8,100	850 to 1,350	470	38,800	(COD_{Mn})100to480
Cl	mg/l	3,563	4,217	3,990	3,400	680	NA	-
SO_4	mg/l	1,127	82	57	NA	NA	NA	-
T-KN	mg/l	1,598	930	2,310	(NH_4-N)200 to 600	(NH_4-N)120	NA	(T-N)100 to 480
Hazardous Substances								
CN	mg/l	ND	0.06	ND	0.01	NA	NA	NA
Pb	mg/l	0.66	0.30	0.58	0.10	0.004	1.40	0.04
As	mg/l	0.033	0.014	0.022	NA	NA	NA	0.170
Cd	mg/l	0.05	0.01	0.04	0.02	0.0005	0.03	0.0085
Cr^{+6}	mg/l	0.30	0.27	1.09	(Cr) 0.05	(Cr) 0.02	(Cr) 1.05	(Cr)0.026
Hg	mg/l	0.001	0.001	0.001	NA	NA	NA	NA
Cu	mg/l	0.52	0.06	0.44	0.02	0.09	1.30	0.003
Zn	mg/l	1.88	0.17	1.24	0.16	0.06	155.00	0.004

NOTE * SOURCE : The Safe Disposal of Hazardous Wastes Vol.2 (Word Bank Technical Paper Number 93)

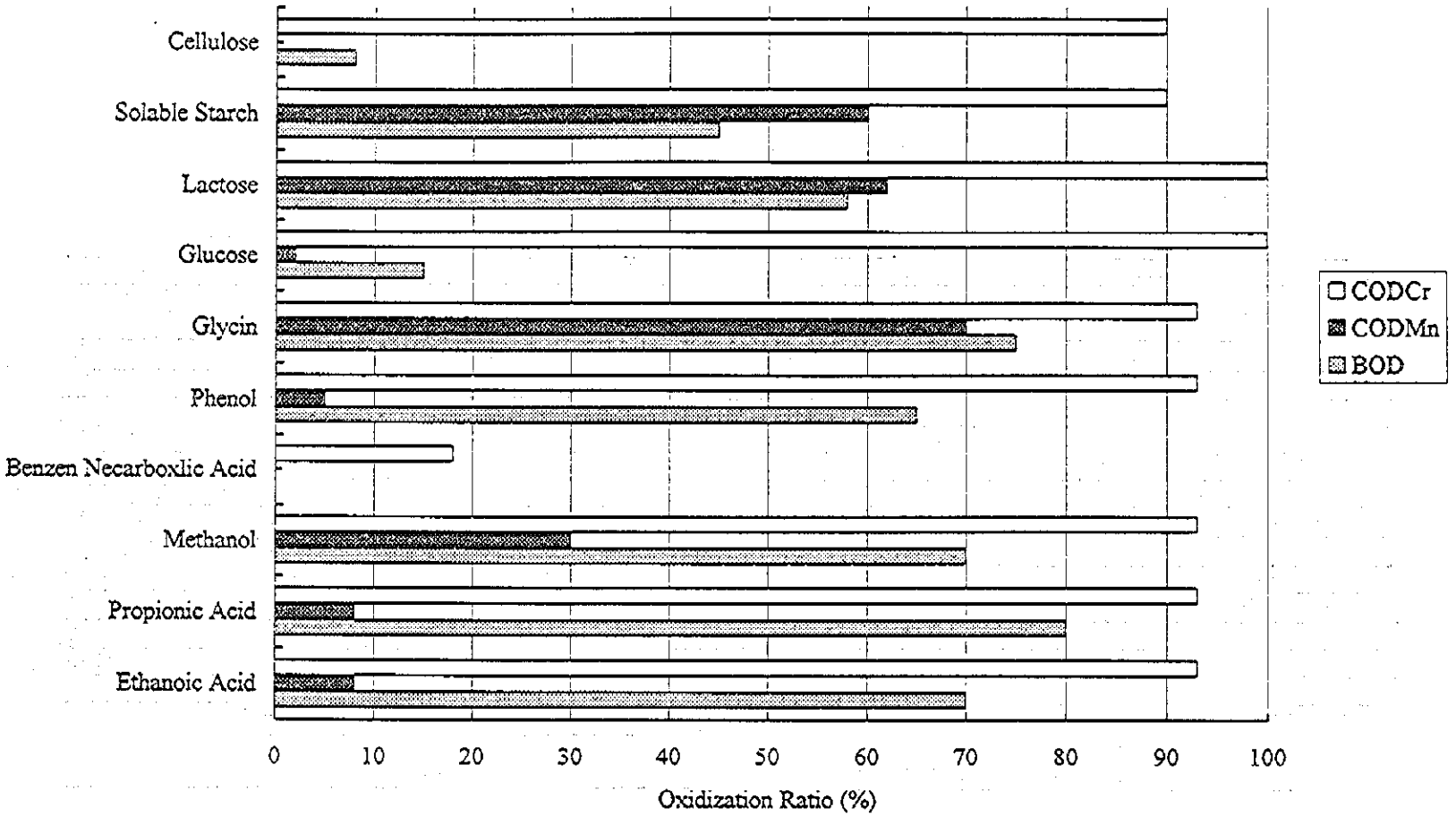


Figure G.3.4a Comparison of Oxidization Ratio

Leachate sample of Japan in the Table shows characteristics derived from its background i.e.:

- Because landfills in Japan are planned and operated aiming to shorten the time (as much as possible) to stabilize organic contents, landfills have such structure whereby SW is placed under aerobic conditions to accelerate oxidative decomposition.

On the other hand:

- In north and south American countries including Chile, SW is placed under anaerobic conditions with the objective of recovering bio-gas.

Therefore, Table G.3.4b show significantly different values of parameters of organic polluting substances (i.e. BOD and T-KN).

i. pH, BOD, COD

The pH of Lepanto is 6.7, whereas pH of the other two landfills is 8.1. This may suggest that:

- SW filled in Lepanto is in the initial stages of decomposition, and the landfill of Lepanto is comparatively in the earlier stages of its economic life.
- SW filled in Lo Errazuriz and Cerro de Renca are in the later stages of decomposition, and the landfills of the 2 sites are comparatively in the final stages of its economic life.

This is suggested from the following reasons. (see Figure G.3.4b)

- Anaerobic decomposition of organic materials by micro-organisms initially takes place at acidic conditions. When organic content in SW decreases by the decomposition in acidic conditions, decomposition in alkaline conditions starts. Organic materials turns into in-organic substances at the end of the alkaline decomposition. At this moment SW filled in landfill sites becomes "stable".
- BOD and COD (as parameters of organic content) in Lepanto are 5 digits, whereas those in other 2 landfill sites are 4 digits. This means decomposition of organic content in SW in Lepanto is much accelerated than those in other 2 landfills.

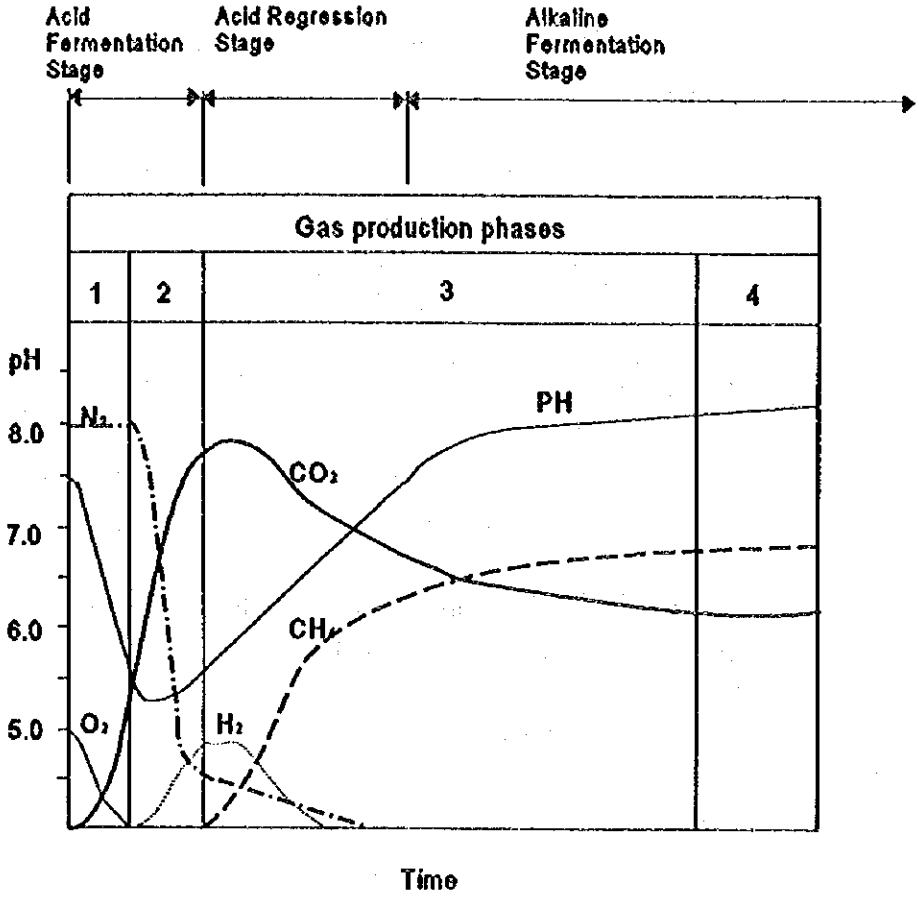


Figure G.3.4b Typical Change Pattern of Landfill pH

ii. Hazardous inorganic substances

Hazardous inorganic substances (e.g. heavy metals) unlike organic materials, are principally non-biodegradable. Elution characteristics of heavy metals vary according to alteration of pH in the course of organic decomposition (acidic to alkaline); pH 8-10 in general creates conditions unfavorable to elution of heavy metals.

Therefore elution of heavy metals must be comparatively restricted in landfills of Cerro de Renca and Lo Errazuriz, which are in the stage of alkaline decomposition. However, Cr^{+6} is detected in the Lo Errazuriz landfill, in the range from 1.06 mg/l to 1.12 mg/l, with a mean value of 1.09 mg/l.

In comparing data of hazardous substances from 3 landfills with those of other countries' landfill sites, followings are observed:

- As for CN, the value for Lepanto and Lo Errazuriz show minimal values, meanwhile the data of Cerro de Renca shows a significantly high value in comparison with the leachate data in the UK which receives ISW (43% in total).
- As for Cd, the data of 3 landfills in the MR show higher values than those values of any other foreign landfills referred in the table.
- As for Cr^{+6}, Cu and Zn, the data of 3 landfills in the MR show significantly higher value than other foreign (except USA) landfills referred in the table.

In comparison with the Japanese example, which receives 100% municipal SW, all parameters analyzed for 3 landfills show considerably high values in general. Therefore it may be quite reasonable to consider that industrial SW are disposed in these 3 landfills.

iii. Comments on leachate recycling

" Generation of methane in final disposal site " along " time passage " is shown in Figure G.3.4b Decomposition shown in the figure continues in significantly long period. However, in order to maintain this decomposition, it is necessary to keep more than 30% water content inside the buried SW in the landfill. Therefore, circulation of leachate is necessary until methane gas generation ends.

Generation amount of landfill gas decreases a bio-decomposition of SW buried progresses. When finally decomposition of organic content of waste is ended, disposed waste become stable and methane gas are not generated.

c. Conclusions

In view of the above, and as far as the outcome of the laboratory data of this Leachate Quality Survey implies, the following may be concluded.

- ISW is possibly disposed in all 3 landfills. (The Team's factory survey also received information that quite a few factories send their ISW to those present municipal landfills.)
- Since concentration values of hazardous substances are relatively high compared to foreign examples, it might be evident that hazardous substances are included in the SW disposed in those landfills. However, this evidence alone cannot justify the hazardous substances being solely attributed to ISW. The possibility of a significant amount of hazardous substances is included in municipal SW is small; this compelling fact leads

us to believe the it is attributed to the ISW disposed.

- Although hazardous substances are included in SW disposed in the 3 landfills, whose concentration do not exceed limits of maximum permissible concentration (CMP) for the application of the Leachate Toxicity Test drafted by the Ministry of Health in Chile.
- Since the data of 3 landfills' leachate exceed "maximum limits for industrial liquid waste discharges into the public system of waste water collection" (draft) to be normalized as Standard NCh 2280, the leachate can not be discharged into the sewers without treatment.

Meanwhile, as a matter of disposal site control after the operation of landfilling, it is important to maintain a weak alkaline condition (pH 8-10) inside the SW layers in landfill sites in order to restrain elution of heavy metals into leachate.

In this regard, following measures are necessary:

- Clayey materials should be applied for final covering layer of landfills in order to maintain the anaerobic conditions inside the SW layers of the site.
- Re-excavation of disposal sites after the operation of landfilling should be refrained in order to shut the oxygen supply into SW layers of the site.
- Periodical sampling and laboratory analysis should at least be maintained in order to monitor the situation of decomposition inside the SW layers of the site.

Results and maps of sampling points of the Leachate Quality Survey are shown below.

ROL 680295

INFORME DE ANALISIS

IDENTIFICACION DE LA MUESTRA : Líquidos percolados.
Vertedero Lo Errázuriz.
FECHA LLEGADA AL LABORATORIO : 14/06/95
SOLICITADO POR : Sr. Tadaya Yamamoto
KOKUSAI KOGYO CO. LTD.
METODOS DE ANALISIS : Standard Methods for the Examination of Water and Wastewater. 18th Edition, 1992, APHA, AWWA, WEF

IDENTIFICACION DE MUESTRAS

Muestra Nº	Identificación	Fecha	Hora	pH in situ	T °C in situ
1	Vertedero Lo Errázuriz.	13/06/95	10:15	7,50	24,3

RESULTADOS

	Muestra Nº 1
pH en laboratorio	8,26
Temperatura en laboratorio (°C)	15,7
DBO_5 (mg/l)	5.000
DQO (mg/l)	7.400
Cloruros (mg/l Cl)	4.150
Cianuro (mg/l CN)	<0,05
Sulfatos (mg/l SO_4)	54
Nitrógeno total Kjeldahl (mg/l N)	2.350
Plomo (mg/l Pb)	0,70
Arsénico (mg/l As)	0,019
Cadmio (mg/l Cd)	<0,01
Cromo total (mg/l Cr)	1,09
Mercurio (mg/l Hg)	0,001
Cobre (mg/l Cu)	0,46
Cinc (mg/l Zn)	1,50

Muestreo realizado por personal del Laboratorio AQUA.

Raúl Thiers S.
Químico Analista

Santiago, 05 de julio de 1995.

BLANCO ENCALADA 1975 - 2º PISO - FONOS 6727001 - 6972407 - FAX (56-2) 6727001 - SANTIAGO - CHILE

ROL 680395

INFORME DE ANALISIS

IDENTIFICACION DE LA MUESTRA : Líquidos percolados.
Vertedero Lo Errázuriz.
FECHA LLEGADA AL LABORATORIO : 20/06/95
SOLICITADO POR : Sr. Tadaya Yamamoto
KOKUSAI KOGYO CO. LTD.
METODOS DE ANALISIS : Standard Methods for the Examination of Water and Wastewater. 18th Edition, 1992, APHA, AWWA, WEF

IDENTIFICACION DE MUESTRAS

Muestra Nº	Identificación	Fecha	Hora	pH in situ	T °C in situ
2	Vertedero Lo Errázuriz.	20/06/95	10:10	7,92	18,2

RESULTADOS

	Muestra Nº 2
pH en laboratorio	8,10
Temperatura en laboratorio (°C)	20,8
DBO_5 (mg/l)	6.000
DQO (mg/l)	9.400
Cloruros (mg/l Cl)	3.740
Cianuro (mg/l CN)	<0,05
Sulfatos (mg/l SO_4)	66
Nitrógeno total Kjeldahl (mg/l N)	2.180
Plomo (mg/l Pb)	0,90
Arsénico (mg/l As)	0,016
Cadmio (mg/l Cd)	0,04
Cromo total (mg/l Cr)	1,12
Mercurio (mg/l Hg)	0,001
Cobre (mg/l Cu)	0,41
Cinc (mg/l Zn)	0,91

Muestreo realizado por personal del Laboratorio AQUA.

Raúl Thiers S.
Químico Analista

Santiago, 05 de julio de 1995.

BLANCO ENCALADA 1975 - 2° PISO - FONOS 6727001 - 6972407 - FAX (56-2) 6727001 - SANTIAGO - CHILE

aqua CALIDAD DEL AGUA LTDA.

ROL 682095

INFORME DE ANALISIS

IDENTIFICACION DE LA MUESTRA : Líquidos percolados.
Vertedero Lo Errázuriz.
FECHA LLEGADA AL LABORATORIO : 23/06/95
SOLICITADO POR : Sr. Tadaya Yamamoto
KOKUSAI KOGYO CO. LTD.
METODOS DE ANALISIS : Standard Methods for the Examination of Water and Wastewater. 18th Edition, 1992, APHA, AWWA, WEF

IDENTIFICACION DE MUESTRAS

Muestra Nº	Identificación	Fecha	Hora	pH in situ	T °C in situ
3	Vertedero Lo Errázuriz.	23/06/95	16:30	8:00	22,2

RESULTADOS

	Muestra Nº 3
pH en laboratorio	7,90
Temperatura en laboratorio (°C)	20,0
DBO_5 (mg/l)	3.600
DQO (mg/l)	7.500
Cloruros (mg/l Cl)	4.080
Cianuro (mg/l CN)	<0,05
Sulfatos (mg/l SO_4)	50
Nitrógeno total Kjeldahl (mg/l N)	2.400
Plomo (mg/l Pb)	0,15
Arsénico (mg/l As)	0,031
Cadmio (mg/l Cd)	0,04
Cromo total (mg/l Cr)	1,06
Mercurio (mg/l Hg)	0,001
Cobre (mg/l Cu)	0,44
Cinc (mg/l Zn)	1,30

Muestreo realizado por personal del Laboratorio AQUA.

Raúl Thiers S.
Químico Analista

Santiago, 05 de julio de 1995.

BLANCO ENCALADA 1975 - 2º PISO - FONOS 6727001 - 6972407 - FAX (56-2) 6727001 - SANTIAGO - CHILE

ROL 680195

INFORME DE ANALISIS

IDENTIFICACION DE LA MUESTRA : Líquidos percolados.
Vertedero Renca.
FECHA LLEGADA AL LABORATORIO : 14/06/95
SOLICITADO POR : Sr. Tadaya Yamamoto
KOKUSAI KOGYO CO. LTD.
METODOS DE ANALISIS : Standard Methods for the Examination of Water and Wastewater. 18th Edition, 1992, APHA, AWWA, WEF

IDENTIFICACION DE MUESTRAS

Muestra Nº	Identificación	Fecha	Hora	pH in situ	T °C in situ
1	Vertedero Renca.	13/06/95	13:30	7,80	19,0

RESULTADOS

	Muestra Nº 1
pH en laboratorio	8,53
Temperatura en laboratorio (°C)	15,4
DBO_5 (mg/l)	2.200
DQO (mg/l)	4.500
Cloruros (mg/l Cl)	4.250
Cianuro (mg/l CN)	0,07
Sulfatos (mg/l SO_4)	58
Nitrógeno total Kjeldahl (mg/l N)	1.064
Plomo (mg/l Pb)	0,27
Arsénico (mg/l As)	0,013
Cadmio (mg/l Cd)	<0,01
Cromo total (mg/l Cr)	0,20
Mercurio (mg/l Hg)	0,001
Cobre (mg/l Cu)	0,05
Cinc (mg/l Zn)	0,16

Muestreo realizado por personal del Laboratorio AQUA.

Raúl Thiers S.
Químico Analista

Santiago, 05 de julio de 1995.

ROL 680595

INFORME DE ANALISIS

IDENTIFICACION DE LA MUESTRA : Líquidos percolados. Vertedero Renca.
FECHA LLEGADA AL LABORATORIO : 20/06/95
SOLICITADO POR : Sr. Tadaya Yamamoto
KOKUSAI KOGYO CO. LTD.
METODOS DE ANALISIS : Standard Methods for the Examination of Water and Wastewater. 18th Edition, 1992, APHA, AWWA, WEF

IDENTIFICACION DE MUESTRAS

Muestra Nº	Identificación	Fecha	Hora	pH in situ	T °C in situ
2	Vertedero Renca.	20/06/95	13:00	8,03	9,9

RESULTADOS

	Muestra Nº 2
pH en laboratorio	8,15
Temperatura en laboratorio (°C)	17,5
DBO_5 (mg/l)	2.500
DQO (mg/l)	5.700
Cloruros (mg/l Cl)	4.200
Cianuro (mg/l CN)	<0,05
Sulfatos (mg/l SO_4)	128
Nitrógeno total Kjeldahl (mg/l N)	835
Plomo (mg/l Pb)	0,33
Arsénico (mg/l As)	0,008
Cadmio (mg/l Cd)	0,01
Cromo total (mg/l Cr)	0,29
Mercurio (mg/l Hg)	0,001
Cobre (mg/l Cu)	0,08
Cinc (mg/l Zn)	0,19

Muestreo realizado por personal del Laboratorio AQUA.

Raúl Thiers S.
Químico Analista

Santiago, 05 de julio de 1995.

BLANCO ENCALADA 1975 - 2º PISO - FONOS 6727001 - 6972407 - FAX (56-2) 6727001 - SANTIAGO - CHILE

ROL 681995

INFORME DE ANALISIS

IDENTIFICACION DE LA MUESTRA : Líquidos percolados.
Vertedero Lepanto.
FECHA LLEGADA AL LABORATORIO : 23/06/95
SOLICITADO POR : Sr. Tadaya Yamamoto
KOKUSAI KOGYO CO. LTD.
METODOS DE ANALISIS : Standard Methods for the Examination of Water and Wastewater. 18th Edition, 1992, APHA, AWWA, WEF

IDENTIFICACION DE MUESTRAS

Muestra Nº	Identificación	Fecha	Hora	pH in situ	T °C in situ
2	Vertedero Lepanto.	23/06/95	15:00	6,27	12,8

RESULTADOS

	Muestra Nº 2
pH en laboratorio	6,50
Temperatura en laboratorio (°C)	15,0
DBO_5 (mg/l)	49.000
DQO (mg/l)	61.000
Cloruros (mg/l Cl)	3.890
Cianuro (mg/l CN)	<0,05
Sulfatos (mg/l SO_4)	1.250
Nitrógeno total Kjeldahl (mg/l N)	1.635
Plomo (mg/l Pb)	<0,03
Arsénico (mg/l As)	0,030
Cadmio (mg/l Cd)	0,06
Cromo total (mg/l Cr)	0,28
Mercurio (mg/l Hg)	0,001
Cobre (mg/l Cu)	0,49
Cinc (mg/l Zn)	2,30

Muestreo realizado por personal del Laboratorio AQUA.

Raúl Thiers S.
Químico Analista

Santiago, 05 de julio de 1995.

BLANCO ENCALADA 1975 - 2° PISO - FONOS 6727001 - 6972407 - FAX (56-2) 6727001 - SANTIAGO - CHILE

ROL 680495

INFORME DE ANALISIS

IDENTIFICACION DE LA MUESTRA : Líquidos percolados.
Vertedero Lepanto.
FECHA LLEGADA AL LABORATORIO : 20/06/95
SOLICITADO POR : Sr. Tadaya Yamamoto
KOKUSAI KOGYO CO. LTD.
METODOS DE ANALISIS : Standard Methods for the Examination of Water and Wastewater. 18th Edition, 1992, APHA, AWWA, WEF

IDENTIFICACION DE MUESTRAS

Muestra Nº	Identificación	Fecha	Hora	pH in situ	T °C in situ
1	Vertedero Lepanto.	20/06/95	11:25	6,32	10,9

RESULTADOS

	Muestra Nº 1
pH en laboratorio	6,90
Temperatura en laboratorio (°C)	17,0
DBO_5 (mg/l)	42.000
DQO (mg/l)	63.000
Cloruros (mg/l Cl)	3.400
Cianuro (mg/l CN)	<0,05
Sulfatos (mg/l SO_4)	1.030
Nitrógeno total Kjeldahl (mg/l N)	1.590
Plomo (mg/l Pb)	0,70
Arsénico (mg/l As)	0,038
Cadmio (mg/l Cd)	0,04
Cromo total (mg/l Cr)	0,35
Mercurio (mg/l Hg)	0,002
Cobre (mg/l Cu)	0,76
Cinc (mg/l Zn)	1,05

Muestreo realizado por personal del Laboratorio AQUA.

Raúl Thiers S.
Químico Analista

Santiago, 05 de julio de 1995.

BLANCO ENCALADA 1975 - 2° PISO - FONOS 6727001 - 6972407 - FAX (56-2) 6727001 - SANTIAGO - CHILE

ROL 682195

INFORME DE ANALISIS

IDENTIFICACION DE LA MUESTRA : Líquidos percolados.
Vertedero Renca.
FECHA LLEGADA AL LABORATORIO : 23/06/95
SOLICITADO POR : Sr. Tadaya Yamamoto
KOKUSAI KOGYO CO. LTD.
METODOS DE ANALISIS : Standard Methods for the Examination of Water and Wastewater. 18th Edition, 1992, APHA, AWWA, WEF

IDENTIFICACION DE MUESTRAS

Muestra Nº	Identificación	Fecha	Hora	pH in situ	T °C in situ
3	Vertedero Renca.	23/06/95	14:00	7,80	11,0

RESULTADOS

	Muestra Nº 3
pH en laboratorio	7,50
Temperatura en laboratorio (°C)	15,5
DBO_5 (mg/l)	2.400
DQO (mg/l)	4.050
Cloruros (mg/l Cl)	4.200>
Cianuro (mg/l CN)	<0,05
Sulfatos (mg/l SO_4)	60
Nitrógeno total Kjeldahl (mg/l N)	890
Plomo (mg/l Pb)	<0,03
Arsénico (mg/l As)	0,021
Cadmio (mg/l Cd)	0,01
Cromo total (mg/l Cr)	0,31
Mercurio (mg/l Hg)	<0,001
Cobre (mg/l Cu)	0,05
Cinc (mg/l Zn)	0,15

Muestreo realizado por personal del Laboratorio AQUA.

Raúl Thiers S.
Químico Analista

Santiago, 05 de julio de 1995.

BLANCO ENCALADA 1975 - 2º PISO - FONOS 6727001 - 6972407 - FAX (56-2) 6727001 - SANTIAGO - CHILE

ROL 682295

INFORME DE ANALISIS

IDENTIFICACION DE LA MUESTRA : Líquidos percolados.
Vertedero Lepanto.
FECHA LLEGADA AL LABORATORIO : 27/06/95
SOLICITADO POR : Sr. Tadaya Yamamoto
KOKUSAI KOGYO CO. LTD.
METODOS DE ANALISIS : Standard Methods for the Examination of Water and Wastewater. 18th Edition, 1992, APHA, AWWA, WEF

IDENTIFICACION DE MUESTRAS

Muestra Nº	Identificación	Fecha	Hora	pH in situ	T °C in situ
3	Vertedero Lepanto.	27/06/95	10:30	6,78	13,5

RESULTADOS

	Muestra Nº 3
pH en laboratorio	6,70
Temperatura en laboratorio (°C)	20,0
DBO_5 (mg/l)	43.000
DQO (mg/l)	78.400
Cloruros (mg/l Cl)	3.400
Cianuro (mg/l CN)	<0,05
Sulfatos (mg/l SO_4)	1.100
Nitrógeno total Kjeldahl (mg/l N)	1.570
Plomo (mg/l Pb)	0,62
Arsénico (mg/l As)	0,030
Cadmio (mg/l Cd)	0,05
Cromo total (mg/l Cr)	0,28
Mercurio (mg/l Hg)	0,001
Cobre (mg/l Cu)	0,32
Cinc (mg/l Zn)	2,30

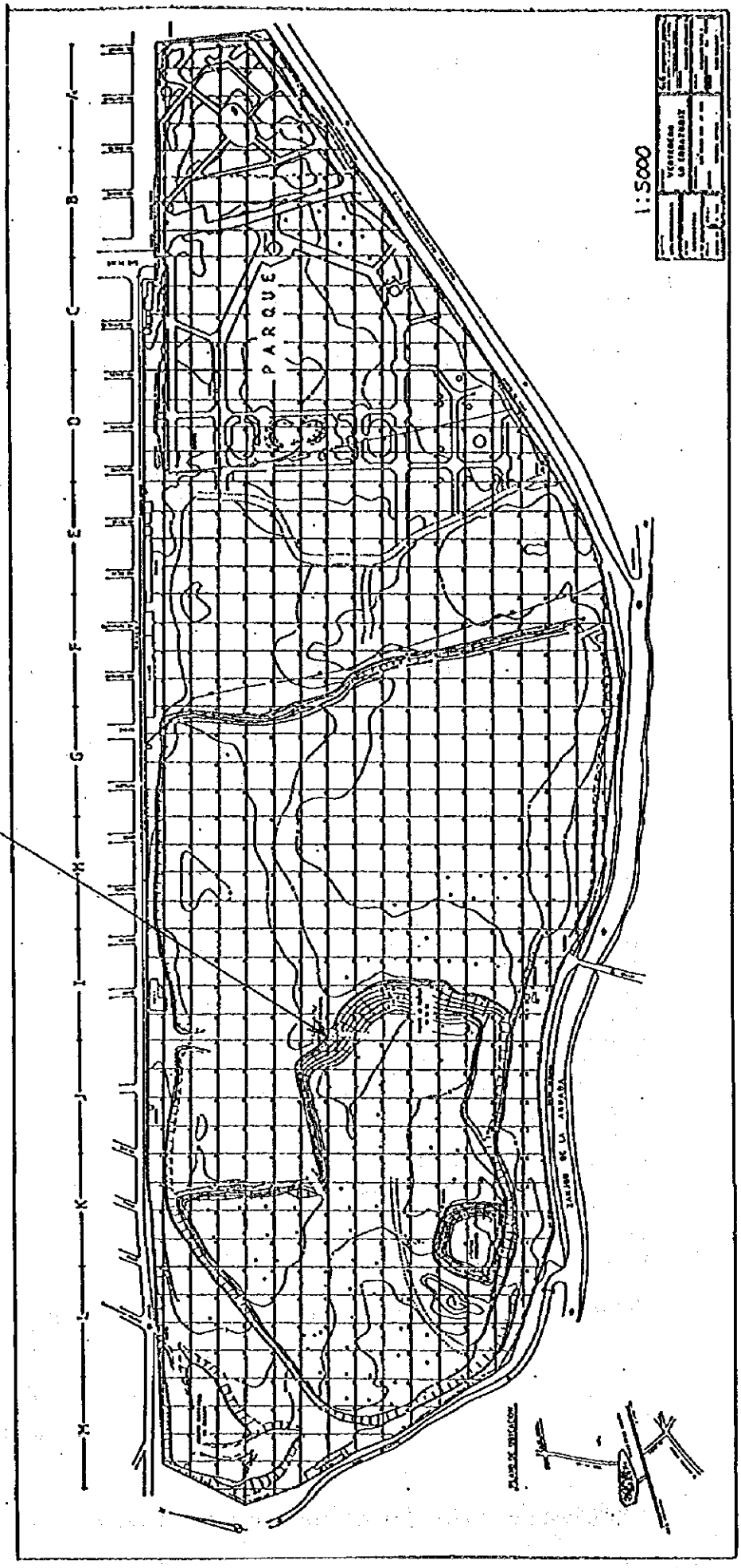
Muestreo realizado por personal del Laboratorio AQUA.

Raúl Thiers S.
Químico Analista

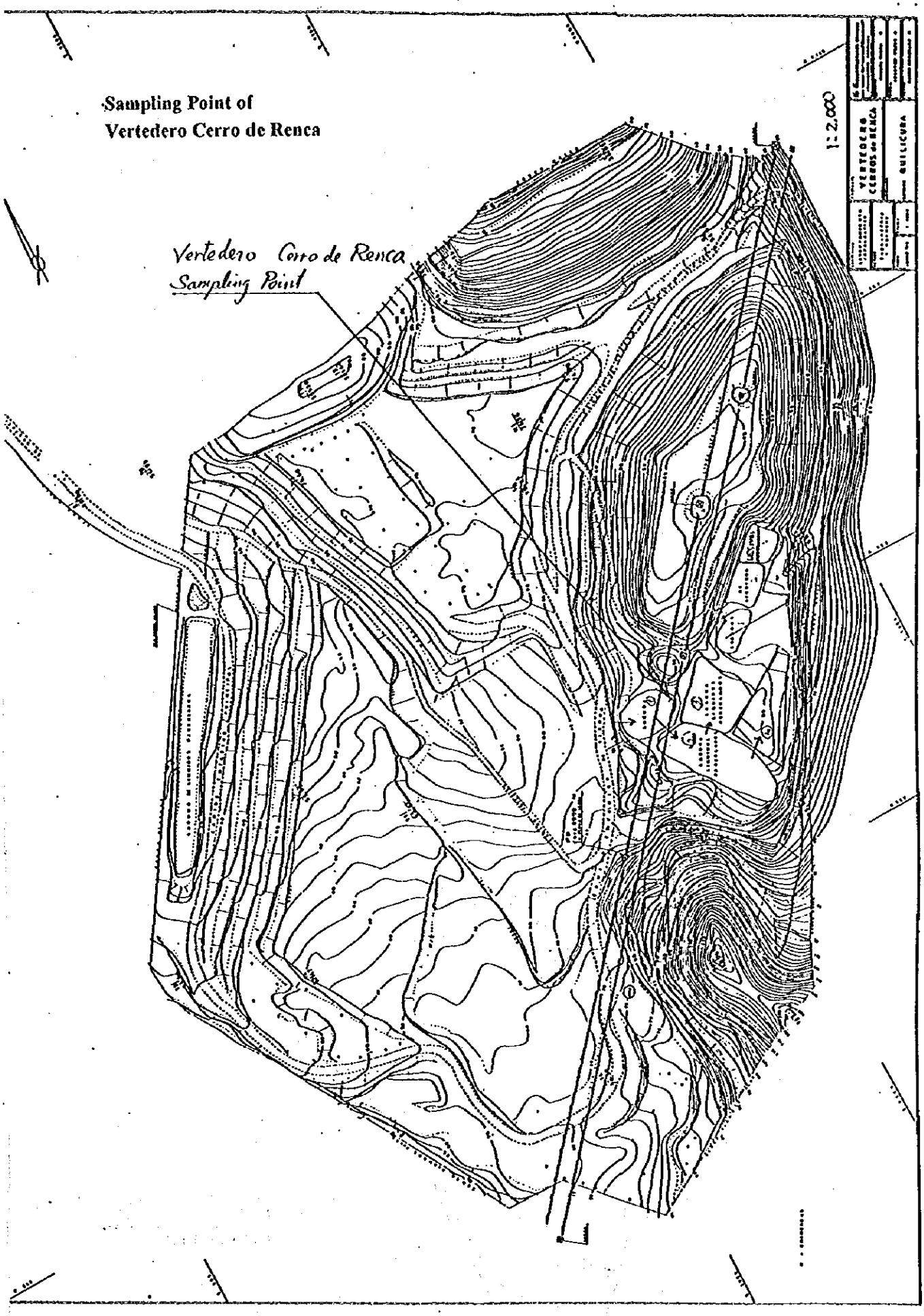
Santiago, 05 de julio de 1995

BLANCO ENCALADA 1975 - 2 PISO - FONOS 6727001 - 6972407 - FAX (56-2) 6727001 - SANTIAGO - CHILE

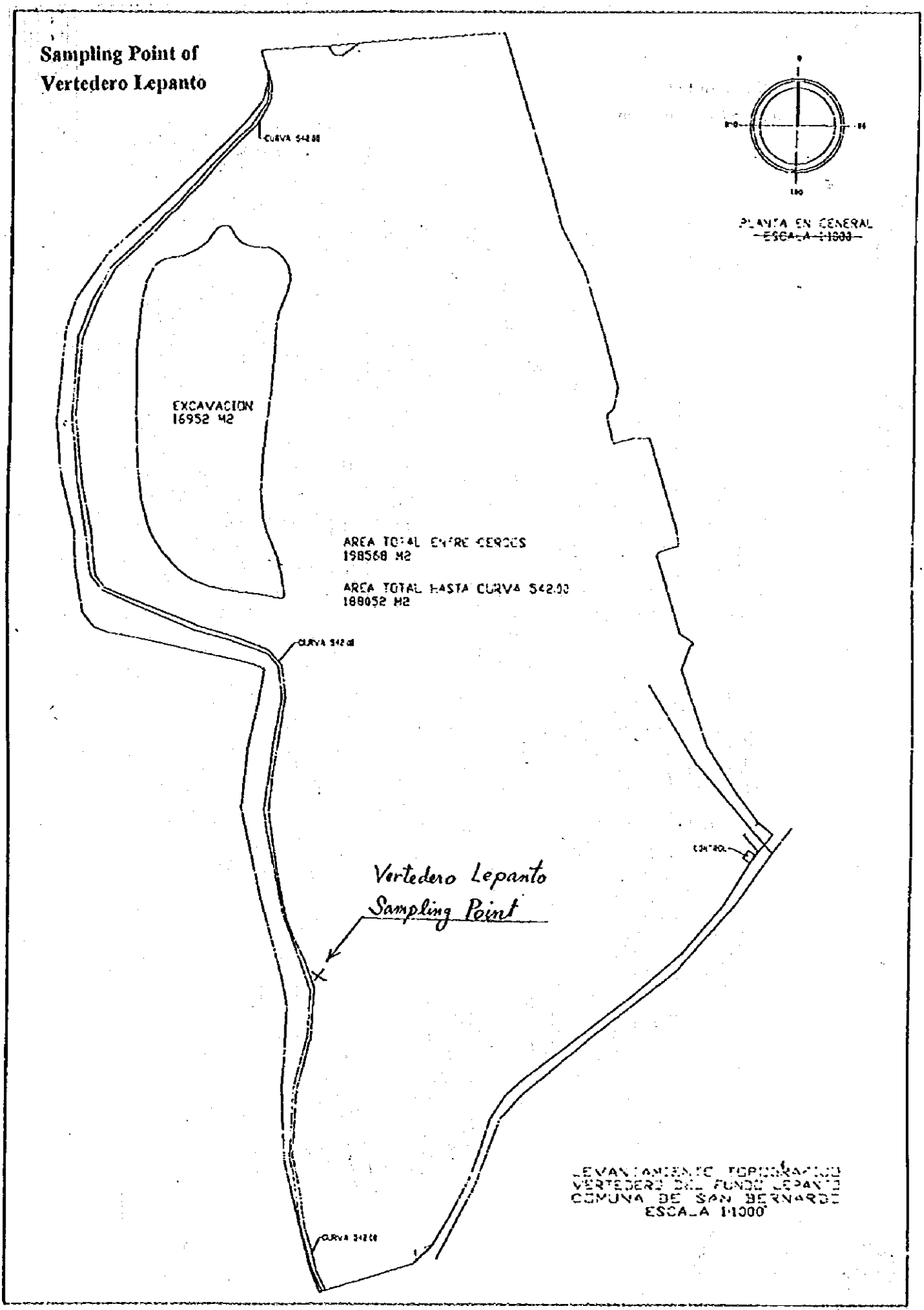
Sampling Point of Vertedero Lo Errazuriz



Sampling Point of
Vertedero Cerro de Renca



Sampling Point of Vertedero Lepanto



G.4 Comments on the Regulations for the Sanitary Management of Hazardous Solid Waste (First Working Draft)

G.4.1 Background

"Regulations for the Sanitary Management of Hazardous Solid Waste - First Working Draft" was produced by the Department for Environmental Programs, Health Programs Division, Ministry of Health, Republic of Chile. (See Annex 7) The regulations consist of the following articles:

- General dispositions (Article 1-10)
- About production and internal storage (Article. 11-20)
- About the transportation of hazardous waste (Article 21-26)
- About the security of landfills (Article 27-40)
- About the incineration of hazardous waste (Article 41-44)
- Declaration system and monitoring of hazardous waste (Article 45-53)

Responding to the Chilean counterpart's request for comments for this document, the Team summarized comments and opinions as follows through integrating Team members' national/international experiences and comments from the JICA Advisory Committee.

G.4.2 Summary of the Team's Comments

The document reveals the intention to innovate or consolidate and generalize on a comprehensive national scale, various normative and legislative acts of the Ministry of Health. The intention is opportune and salutary. Hopefully it would expand, to the inclusion of normative and legislative acts from other Ministries about the same topic - which would result in greater clarity and effectiveness for all.

The mixed character of the document, legal and technical-normative, results in reduced effectiveness as far as obligations, deadlines and penalties are concerned, since it is detailed and too extensive as a "regulation" but sometimes too insufficient as a "technical norm." It must be considered that legal acts have a "conservative" (long-term) character, while technical norms are continually being actualized (medium-term). That is why it is undesirable that they are contained in one same document.

The classification of hazardous waste (hereinafter HW) drafted by the Ministry of Health (hereinafter MS) in the document is basically corresponding to that sanctioned by the Bazel Convention. It is fairly understandable that a developing country employs it for its administration of HW. However, D.S. (Supreme Decree) No. 745/92 of the Ministry of Health uses the generic term "hazardous industrial waste" which includes solids, semi-fluids, and liquids. It is recommendable to retain the expression "liquid waste" because there are many hazardous wastes in liquid state.

It may be practical to adopt the methods of US-EPA as analytical standards for Chile under the present circumstances. Consolidation of analytical capacity is essential for Chile to manage HW; it is recommendable to make most of CENMA (National Environment Center Project by JICA) to consolidate analytical capacity nationwide.

The overall aim of establishing a declaration system for the whole waste cycle is strongly supported. A Standard Declaration Document for general use in Chile should be developed as an integral part of the regulation.

The declaration system may be supplemented by a labelling system for the waste, to be applied in parallel to the Declaration Documents. The purpose of this would be to have an effective tool for action in emergency situations (accidents) and to secure proper treatment/disposal as foreseen in the Declaration Document.

The specific technical standards in the chapters regarding landfill construction and waste incineration should be limited to a description of issues to be considered by the authorities in each case of a plant construction.

It is further recommended that there should - in order to provide a working tool for the local authorities when deciding in matters related to landfill or incineration plant construction - be established specialist working groups established these topics. Their task should be to pioneer technical guidelines in relation to landfilling and waste incineration. In doing so, the working groups should take into consideration international conventions/agreements of which Chile is a signatory nation as well as the intrinsic conditions of hazardous waste management in Chile and the targeted level of environmental protection in the country. Besides, the guidelines should be developed with due consideration of the variation in requirements which should result from the variation in climate, land use, and population density in Chile.

As a conclusion, the revision of Regulations is recommendable, one which fixes obligations and penalties even more extensively than those in this document, and which establishes the legal bases for the administration of waste (and of its generators, transporters and receivers). Criteria and technical norms should be edited separately

for each subject, progressively and in conformity with technical-administrative needs.

Detailed comments on the draft regulations are presented below.

G.4.3 Detailed Comments

a. For general dispositions (Article 1 - 10)

The classification of hazardous waste (hereinafter HW) drafted by the Ministry of Health (hereinafter MS) in the document is basically corresponding to that sanctioned by the Bazel Convention. It is fairly understandable that a developing country employs it for his administration of HW. However, D.S. (Supreme Decree) No. 745/92 of the Ministry of Health uses the generic term "hazardous industrial waste" which includes solids, semi-fluids, and liquids. It is recommendable to retain the expression "liquid waste" because there are many hazardous wastes in liquid state.

The concept of the classification of HW adopted by the Bazel Convention is basically: HW are defined as those:

i. which are identified in specific "waste streams" (Y2 - Y18), and/or
ii. waste "having as constituents", and
iii. which indicate "hazardous characteristics".

Therefore, in order to identify and control HW, establishment of "analysis methods and allowable limits" for HW and consolidation of laboratory analytical capability in industries are essential.

It might be practical to adopt the methods of US-EPA as an analytical standard for Chile under the present circumstances. Consolidation of analytical capacity is essential for Chile to manage HW; it is recommendable to most of CENMA (National Environment Center Project by JICA) to consolidate analytical capacity nationwide. However authorities currently face problems of lacking analytical capacity in their own functions and having limitations in cost recruitment. Therefore for the time being, it may be practical to assume that waste produced by industries without proof of their safety is hazardous, and should be treated as HW. Hence industries (waste generators) shall bear the burden of proving that their waste generated (HW or liquid waste defined by SESMA-PROCEFF waste classification) are within the permissible limits: i.e. industries themselves should, at their own cost, carry out laboratory analyses (which MS defines) verifying that their waste is non-hazardous. In this context, problems may

not arise even though 2 different classifications of HW(i.e. SESMA-PROCEFF and MS) exist. Periodical reviews and revisions of the PROCEFF waste classification are necessary in reflecting the outcome continuously compiled through these laboratory analyses.

It is necessary to note that the HW classification of MS, compared with that of PROCEFF, shows little "one-to-one correspondence" between waste generated and the classification: i.e. certain waste generated may fall in various categories of the classification.

b. Production and internal storage (Article 11 - 20)

The Regulations fully establishes the need for professionals for the management of hazardous waste, furthermore the responsibilities established in Article 20 extend their position as an "employee" of the generator.

This chapter should specify the responsibility of the generator and under what circumstances they shall share responsibility with the transporter and receiver of waste; a penal system for inadequate management should be included.

Article 12 is very positive in that it refers to the "minimization of hazardous waste" - which, on the other hand, could be the subject of orientations, incentives and penalties in other documents.

Conditioning, storage and internal transportation are obligations demanded from the generator (with penalties for non-compliance), but require detailing in technical norms.

The Regulations could establish the obligation of securely storing all hazardous wastes that can not be shipped immediately. This would open the possibility of storage in establishments, specially licenced for this purpose.

c. Transportation of hazardous waste (Article 21 - 26)

The responsibility of the transporter for the load should be fixed, as well as their compliance to the Regulations for Surface Transportation of Hazardous Waste (which must exist, under the Ministry of Transportation). This establishes:

- Special training for the conductor (of hazardous waste);
- Signposting for the vehicle;

- Tools and security measures for emergency situations;
- Other regulated needs.

The Transport and Contingency Plan must be elaborated by the generator and approved by the Environmental Control Authority (ECA), but the conductor should carry the plan, as well as the "declaration system" referred to in Article 45 - 53.

There are no speculations regarding "labeling for HW transportation" in this draft regulations. It might be recommended to provide a standard labeling of the waste, both for transport and treatment/disposal purposes. Labeling of the waste means reduced risks in case of traffic accidents and reduced risk of maltreatment and inappropriate disposal. Such labeling systems have been developed by international organizations and could easily be incorporated in Chile.

d. Security of landfills (Article 27 - 40)

Whereas standardized classification and declaration/information systems as well as transport requirements are very valuable, national standards on hazardous waste treatment and disposal are more doubtful. National standards do not allow for considerations with respect to the large differences in nature, population density and climate in a country as large and especially as long as Chile, being about 4,300 kilometres from north to south and spanning over several climatic zones - from the most arid desert on Earth in the North to humid areas in the South (not to mention the polar region which is of little interest in this context).

Unnecessarily strict requirements may also deter both national and international investors from entering the SWM sectors in Chile. This would be highly disappointing as Chile relies very much on private enterprises and does not plan to establish the much needed treatment and disposal facilities by means of public investments.

An example of inconvenient standardization can be seen in relation to the requirement for landfill liners and leachate treatments systems as described in the articles 30 and 35. Such systems should be commonplace in humid regions, but in the desert regions in the North where it hardly ever rains, leachate treatment facilities would be superfluous as no leachate will be generated - or the little leachate generated would evaporate by leachate recycling over the landfill. In such areas even the bottom liner may be omitted unless there are vulnerable underground water resources.

Similarly, general laboratory facilities may be preferred from a specific laboratory at the landfill in order to save resources, and meteorological observations may be unnecessary if information is available from a nearby station.

There is no doubt, however, that these matters must be carefully considered in relation to local conditions by the CONAMA-RM when conducting an EIA and giving a permit. The problems to be considered should therefore be the content of these two chapters, rather than rigid technical requirements.

A good example of the methodology is to be found in article 31 of the draft. This article specifies that a management plan must be established for a landfill (as it should for a waste incineration plant), and specifies the items to be considered in the management plan, but leaves it to the discretion of the plant operator and the authority to specify the detailed content.

In regulatory terms it would begin by stating that, the first measures for hazardous wastes should commence inside the generating plant, and should aim to:

- Minimize hazardous waste generation;
- Utilize reusable waste (recycle, energy use, etc.);
- Treat non-reusable waste;
- Dispose of treated waste, aiming towards the least environmental impact.

The presupposition is, therefore, that only "treated" wastes are taken to landfills. That is, those with abated environmental impact. In accordance with this risk, the categories and restrictive parameters for the landfills would be established - for example, less inert landfills, or controlled landfills, or strictly controlled landfills. Obviously, the regulatory demands and costs would be increased for the said landfills.

The responsibility of the proprietor of the landfill should be established for an eventual contamination of the soil, as well as the responsibilities of its operator and of the waste generator.

The monitoring of surface and underground water, and the monitoring of unsaturated soil, are the key to the control and definition of responsibilities; limits for the location of monitoring posts (short distances from the landfill) should be established.

Some conditions should be requested regarding location, design, operation and closure of the landfill. Consistent with the specifications of each situation, technical norms will develop appropriate options.

The location should be submitted for approval with the conceptual design of the landfill and respective environmental impact study, assuring that all mitigating environmental impact measures are contained in the design. Obviously unfavorable conditions should be included in the Regulations: protection zones for water sources, environmental

reserves, geologic faults or fissures, seismic zones, flood plains or marsh areas, and others.

The design shall compile with the location and operation of the landfill in mind, and its categorization (as was previously suggested) in relation to the wastes that it will receive. This enables construction at realistic and feasible costs, without loss of security. The disposal of inflammable, reactive, corrosive, acutely toxic, liquid and semi-fluid wastes will not be permitted (after they lose negative characteristics through treatment they become acceptable). The disposal of incompatible wastes or those that may generate incompatible effluents will not be allowed in locations where they can potentially have contact with each other. The Landfill Operation and Maintenance Manual should be an integral part of the project, to be included in the engineering design.

Leachate generated at the landfill should be collected and taken for treatment at a facility, which is an extension of the landfill site and specially designed for the purpose. The landfill's gaseous effluent should likewise be collected and treated - if it were to occur (organic and volatile waste).

A record should be kept of the waste deposited, as established in Article 36, as well as the control provided in Article 40. But the cost of this control should be, included in the waste disposal costs, and the resources collected in a guaranteed financial and accounting fund, that is sufficient to carry out the control and the decontamination of the soil, if it were to occur (without a doubt, the main difficulty of landfilling).

The closure plan for the landfill should indicate the method of protection, control, monitoring and recovery of the site, as well as its potentials for future use. In this regard, it is customary that the Public Authority establishes, as of now, strict restrictions for the use of a site utilized for waste disposal, and prohibits its sale (this prohibition should be recorded in the Real Estate Registry).

Finally, some considerations about the controversial problem of the lining and the covering of the industrial landfill are presented.

More than a legal, regulatory question, this is an engineering problem, where solutions supplement real conditions different from the ideal, even at great financial cost. The legal instruments should define the responsibilities of the proprietor and users of the landfill (generators of the disposed wastes), the provision of funds for future control and corrections, the means and obligations of monitors, controls, and public inspections.

It is customary that ideal conditions are defined for the location of an industrial landfill as follow:

- Clayish soil with natural permeability of $k \leq 10^{-7}$ cm/s (deionized water at room temperature and pressure), wider than 3.0 meters above the highest water table level, in a period of occurrence no shorter than 25 years;
- Distance no less than 200 meters of a permanent body of water, 100 meters from any urban settlement, 50 meters from a highway;

At the same time, engineering works are permitted to supplement real conditions, utilizing barriers constructed with clay and/or with flexible synthetic membranes, as well as drainage systems, geo-textile membranes and other modern resources.

It is evident that the costs will be much higher if the site is further from the ideal conditions. The selection of a site will be, therefore, a technical and economic matter (as well as political), of immense importance for the proprietor of the landfill - from when the regulations establish with clarity his long-term responsibility, to the decontamination of the soil.

That is why the technical and economical feasibility of a secure landfill for hazardous waste results in the correct management of those wastes - the premise here proposed.

e. About the Incineration of Hazardous Waste (Article 41 -44)

Under regulated terms, the incineration (or more extensively "thermal destruction") of wastes may take place:

- in facilities especially designed for that purpose; and
- in industrial plants, in which wastes will ingress as an "auxiliary combustible", or to be "incorporated to the production line", or to be "recycled".

In whichever hypothesis, the plant should be licensed, which means: have its location approved (with the respective EIA/EID), its design approved, and its operation approved - this, in general preceded by a period of operational tests - and always considering the wastes (basic chemical composition) that will be incinerated.

The regulations will establish the basic operational conditions of the thermal destruction unit (or incineration): minimum temperatures in the combustion and secondary combustion chamber, minimum retention time, excess air, monitoring and

parameters to be controlled continually and periodically at the chimney, parameters that would provoke the automatic interruption of waste input, mandatory record-keeping - in addition to emission limits.

The design for approval, in turn, will present the following information:

i. Descriptive document - with, at least:

- Characterization of the materials to be entered;
- Description and specification of the design elements;
- Operation conditions of the combustion equipment;
- Incineration residues and gas treatment: characteristics and expected quantities, defined disposal;
- Plans for inspection and maintenance, training of personnel, actions incase of emergency; and
- Risk analysis for the plant.

ii. Technical document (at basic level).

iii. Technological control - with, at least:

- Plans for inspection and maintenance of combustion equipment, treatments, storage and supply;
- Monitoring plan for liquid and gaseous effluents; and
- Recording system.

f. Declaration System and Monitoring of Hazardous Waste (Articles 45 - 53)

It is understood that this chapter is an extension to the whole country of SESMA Resolution No. 5081/93. So that its effectiveness is maximized, it should be enriched by incorporating the experiences of SESMA. One point stands out: this Regulation (art. 45) is applied to "all the generators" of hazardous industrial waste, while Resolution 5081/93 is applied to "all the industrial establishments" - a concept that is not clearly defined.

One thing especially commendable is the creation of a Waste Declaration System as specified in the last chapter (articles 45 - 53) of the regulations. The option for the authorities to follow the waste on its way from generator to receiver, and the obligation of the generator to provide the information and thus consider what he is doing will be a major step forward in hazardous waste management.

In order to further facilitate information exchange, development of a Standard Declaration Document as an integral part of the regulation should be considered.

G.5 Comment for the Project of the "Centro de Tratamiento de Residuos Industriales"

G.5.1 Comment for the Project

Based on a brief check of the report we prepare the following comments for the Project of the "Centro de Tratamiento de Residuos Industriales". Since we did not have enough time to read and check the proposed plan of the project, there may be some misunderstandings to be corrected.

a. First Treatment and Disposal Facilities for Hazardous and Liquid Wastes

Basically we shall appreciate the project because the Metropolitan Region will be able to have the first treatment and disposal facility for the hazardous and liquid wastes by the implementation of the project.

b. Location

At first, the plan shall clear the present regulations concerning land use.
As far as we understand a treatment facility can be located within the urban area and a disposal site can be outside of the area. Since the Ministry of Agriculture has certain restriction for use of the agriculture land, the proposed site has to clear the restriction. Even if it clears the present regulations, the following aspects shall be carefully checked regarding the location of the facilities because it will be the first facility in the Region:

- impact on water use of a river and/or canal to discharge waste water
- impact on the groundwater

c. Permission for Construction and Operation of the Facilities

The proposed facility plan appear to be carefully examined. However, it is not sure whether the actual facility to be constructed will strictly follow the plan or not.

Therefore it is recommended to separate the permission for construction and it for operation. When it is confirmed that the facilities are constructed in accordance with the proposed plan (especially in view of environmental protection of the surroundings), the operation permit will be given.

d. Operation and Maintenance

As for the operation and maintenance, the following aspects shall be checked:

- factories and their wastes to be treated and disposed of at the proposed facilities;
- manifest system, method of weighing and analyzing wastes, data information system, processes of sorting, storage and treatment;
- staff plan especially capability of technical personnel;
- planned treatment and disposal amount and service area;
- conditions and measures for environmental protection;
- restoration measures and guarantees (to the surrounding land and/or residents) when environmental pollution occurs;
- monitoring method and its disclosure.

e. Consensus of the Comuna and the Surrounding Residents

It is very important for a precedent that the EIA of the project took the procedures to obtain the consensus of the Comuna and the surrounding residents, i.e. public hearing, etc..

f. Conditions for Approval of the Project with Insufficient Regulations for Environmental Protection

Although there is a regulation concerning air pollution control, as for the hazardous wastes management including PCB, etc., standards to be observed for environmental preservation are insufficient at present.

As such situation in mind, environmental norms such as discharge standards of environmental loads to be observed shall be presented for the approval of the project considering future movement of the standards.

g. Construction Schedule of the Proposed Facilities

The proposed scale of the project, i.e. 100,000 ton/year of disposal in total, is quite big considering the present hazardous wastes generation. It is a question how they could collect such amount of the wastes. In addition, it is not clear what is the scale of the facilities for immediate or short term(First Phase improvement). It is, therefore, recommended that the approval should be for only the First Phase and it for the Second Phase will be given after the confirmation of proper and environmentally sound operation of the project. For the information, approval documents are sometimes illegally sold to the third parties in Japan.

h. Items to be Confirmed

The following items on the operation of the project need to be confirmed:

- analysis for the identification of quality of liquid waste and storage and treatment of them which require certain know-how and experiences;
- disposal method of waste water after neutralization; and
- wastes flow for those to be treated and recycled outside the proposed facilities.

i. Tipping Fees

At present a large amount of hazardous wastes and liquid wastes are discharged into rivers and disposal fees at municipal landfills are less than 5 US$/ton. Upon consideration of this situation, it is not clear (doubtful) how the executing body of the project will make two ends meet on the investment. Furthermore, if not profit, it is very doubtful that he could provide himself for the restoration and compensation (to the surrounding land and/or residents) when environmental pollution occurs.

j. Standards for Facilities

The approval of construction may be done while there are no standards regarding proper treatment method of the wastes and structures of the facilities. It is, therefore, necessary to strictly examine contents of the facilities, targets for the environmental protection and its guarantee measures, etc..

k. Basic Standpoints

Although a lot of items to be checked, which seems to be negative, are mentioned in the above, the purpose of the check is not to obstruct the project implementation. Since the project will be the precedent and very large scale, basic standpoints for the approval of the project shall be to carefully examine the project.

G.5.2 Liability Aspects of Private Operation

Provision of basic sanitary conditions for the citizens is considered a public responsibility. Thus, for decades sanitary services like water supply, sewage treatment and waste collection have been performed in public management in public utility departments.

Today, privatization of public services is highlighted and private operation is being common in many countries. The reasons for privatization may be one or several of the following statements:

i. Private operation tends to be more cost effective - obviously because it is possible to implement competitive tendering and thereby obtain the best technical and financial proposals.

ii. Private companies tends to be more efficient than public authorities and public utility companies due to other salary structures (individual pay system) and other employment policies (over-employment is not cost effective).

iii. Private companies has a shorter decision-making process and, thus, tends to respond faster on the market and the needs.

However, privatization highlights new aspects of *reliability and liability*:

i. It is a public duty to assure that the service is conducted - every day and with the expected quality, and

ii. Consequential damage of failure to comply to the demands of operation will often end as a public matter to be resolved - and in the worst cases with excessive costs for the tax payers.

In waste management the aspects of reliability and liability are relatively easy to resolve with the private operator. However, in landfilling of waste the aspects are different as landfilling includes costs and long-term risks exceeding the time of primary operation (e.g. leachate collection, gas protection and monitoring). Thus, there will remain considerable costs after the time where income from disposal of waste has stopped. Thus, it is necessary to consider the following two aspects related to privatization of a landfill:

i. How can we assure that there is funding available for proper closing down and rehabilitation of the site when waste disposal is terminated and the income flow stopped?

ii. How can we assure that long term consequences of improper design and operation will not be a later public headache?

Both aspects concern the existence of the private operator and his ability to pay at the time the costs occur.

These aspects have been considered in the proposal for the new landfill directive for the European Union and it is proposed that the private operator must provide a bank guarantee (or deposit the funding) for the costs of rehabilitation of the site at the end of operation.

The long-term risk may be handled in same manner (bank guarantee), but it is necessary to consider a time limit for the guarantee. Such guarantee ('protection fee') could be collected on the top of the disposal fee and kept as deposit for 5, 8 or 10 years after closing down the site. Such fee will provide funding for necessary actions and it could at the same time be an important motivation for the contractor to operate the site well as such guarantee should be paid to him after the specified guarantee period is successfully terminated.

ANNEX H

PRESENT INDUSTRIAL, MEDICAL AND MUNICIPAL SWM

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ANNEX H PRESENT INDUSTRIAL, MEDICAL AND MUNICIPAL SWM

H.1 Review of Previous Studies

H.1.1 *Previous Studies*

An important number of studies regarding medical and industrial SW have been carried out in the Metropolitan Region during the last three years. Their main objectives have been:

- to understand the management of waste from its storage within the site until its final disposal whether in a sanitary landfill or in an illegal dumping site.
- to understand the quantitative and qualitative characteristics of such solid waste.
- to analyze present legislation on the subject, both national and international, pointing out the legal loopholes and shortcomings existing on a national level.
- to propose steps for improving solid waste management in all its aspects.

Most studies have been ordered by the Comisión Especial de Descontaminación de la Región Metropolitana (CEDRM), which since 1995 has become the COREMA of the Metropolitan Region. The most relevant studies are:

i. Household and Industrial (Toxic and Hazardous) Solid Waste Management Plan; Design and Implementation of a Hazardous Solid Waste Management Control System in the Metropolitan Region.
DAMES AND MOORE CHILE LTDA. (1992-1994) for CEDRM
(hereinafter referred to as D&M's RISPEL study)

ii. Action Plan Proposal for the Elimination of Illegal Dumping Sites and the Recovery of Affected Areas in the Metropolitan Region.
ELECTROWATT INGENIEROS CONSULTORES (CHILE) S.A. (EWI) (1994) for CEDRM (hereinafter referred to as EWI's VIRS study)

iii. Study on Medical Solid Waste Management in the Metropolitan Region.
EWI (1994) for CEDRM (hereinafter referred to as EWI's RESHOS study)

iv. Diagnosis and Identification of Technologies and Strategies for Non Hazardous Solid Waste Management in the Metropolitan Region. EWI for CEDRM (hereinafter referred to as EWI's RISNOR study)

II.1.2 Review of Main Studies

a. D&M's RISPEL Study

This study designs a control system for ISW management through the monitoring of waste from generation to final disposal. The designed system provides for the use of a declaration document which must accompany the waste at all times, from its generation until its final destination. The system was made applicable through Act 5081/93 of the SESMA.

It proposes an organizational structure for the operation and maintenance of the system that takes advantage of the existing institutional arrangement. Also, appropriate training for the personnel that will be operating the system is conceived. The Act brings the system into operation for a period of six months.

Furthermore, the study proposes classification criteria as well as requirements for the storage, collection, transportation and final disposal of waste.

Apparently, the study has become very important and it has made available, in a short period of time, a system for controlling industrial waste in the Metropolitan Region. The study has also provided a data base management system that allows to obtain, at all times, quantitative and qualitative characteristics of the waste as well as information regarding its destination.

The contents and objectives of the study are presented in the latter part of this section.

The Study was performed in three stages. Stage 1 was completed in 6 months, Stage 2 in 3 months and Stage 3 in 9 months.

aa. Objectives of the Study

The main objective of the Study was to develop a control system for all hazardous solid waste of industrial origin that is managed in the Metropolitan Region.

ab. Specific Objectives

The Study intended the achievement of the following objectives in each one of its three stages:

aba. Stage 1

- To design a control system for hazardous solid waste management through the monitoring of different types of residues, from their production until their final disposal, with the purpose of preventing the deterioration of the environment and potential harm to the population's health.
- To present criteria for classification according to the levels of hazard that can be assigned to hazardous waste and to define, for each category, the technical requirements for its storage in the generation source, collection, transportation, processing and/or final disposal.
- To design and specify a procedure for the monitoring of hazardous solid waste, including the production, storage in the place of origin, collection, transportation, processing and/or final disposal.
- To propose an organizational structure for the operation and maintenance of the system, taking advantage of the existing institutional configuration and entrepreneurial capability in the Metropolitan Region.
- To design, and to operate along with the Environmental Sanitation Service of the Metropolitan Region (from here on referred to as SESMA), a preliminary control system for the production, transportation and destination of industrial solid waste, making use of the structure and information of the SESMA and of the existing legal dispositions.

abb. Stage 2

- To evaluate and to specify the human and material resources required to operate and maintain the system, including investment, operating and maintenance costs.
- To design the necessary professional profiles and, based on those, to develop a training schedule for the public and private personnel that will participate in the operation of the system (Stage 3 of the Study).

abc. Stage 3

- In coordination with the SESMA, to implement and operate during a trial period the hazardous solid waste control and monitoring system in the

Metropolitan Region which was developed during the Study.

ac. Activities Completed

The activities performed by Dames & Moore during the Study were categorized into the following.

aca. Issue 1: Management System

- Conceptual design
  - . Declaration Form
  - . Supervision Form
  - . Data Base
  - . Characteristics of Hazard
  - . Criteria of Hazard
  - . Quantifying Procedures and Techniques
  - . Criteria for Waste Management.
- Preliminary control system
  - . Gathering and Analysis of Existing Information
  - . Design of the Preliminary Control System
  - . Analysis and Processing of Preliminary Information.

acb. Issue 2: Organizational Structure

- Definition of the structure
  - . Definition of Functions
  - . Identification of the Existing Institutions and Legislation
  - . Operating Structure of the Control System.
- Operation and transfer of the proposed system
  - . Resources for the Operation of the Control System
  - . Financing Alternatives.

acc. Issue 3: Training

- Human resources department
  - . Definition of Professional Profiles
  - . Preparation of Handbooks.
- Training plan
  - . Design of the Plan
  - . Outcome of the Training.

b. EWI's VIRS Study

ba. General Objective

The general objective of the study is to submit an action plan that allows to locate and terminate the present illegal solid waste dumping sites in the Metropolitan Region, as well as to prevent their future re-appearance.

The issues of present situation, the way these problems are faced in foreign countries and the plan for eliminating illegal dumping sites and recovering the degraded areas are developed throughout the study.

bb. Observations

As a result of the study 101 illegal solid waste dumps were detected, 78 of them inside the urban area and 23 in rural places. Also, 270 potential areas for becoming illegal solid waste dumps were identified.

Other aspects from the observations are:

- It is estimated that the illegal dumps reach 713 hectares and a total volume of 10.2 million m^3. It is observed that 71 of these dumps could continue to expand.
- The majority of illegal dumps are located in comunas with less resources.
- The origin of illegal dumps is related to the existence of unfenced areas without clear use and without an owner or keeper that looks after the land.
- These illegal dumps are characterized by the disposal of different types of solid waste, integrated without any established pattern and without any kind of management. For this reason some physical and chemical reactions which are difficult to foresee may take place.
- From a social point of view, illegal dumps are a potential hazard for the surrounding towns as many of them constitute a focus for crime and drug addiction.
- Dwellings are erected in 38 of the dumps and the extraction of "valuable" objects (under extremely insanitary conditions) has been detected in 23 of those dumps.
- The presence of pets and farm animals was detected in 78 dumps and birds were seen in 23 dumping sites.
- 58% of the volume disposed in these dumps corresponds to construction waste and 13% are plastics. Papers, cardboard, metals and woods are observed with an estimated volume that ranges between 5 and 8%; organic

matter constitutes 4%.

- The study proposes an action plan and institutional strategy for the elimination of illegal dumping sites and the recovery of degraded areas. It contemplates:
  - Regulatory actions
  - Actions over generators
  - Actions over transporters
  - Actions over sites (VIRS, Illegal Solid Waste Dumping)
  - Actions over solid waste management infrastructure
  - Monitoring and penalizing actions
  - Action over citizens
- Finally, the following data and results of the study is presented in appendices:
  - Compiled national and foreign legal regulations
  - Identification files for dumps, with aerial photographs
  - Files for characterizing and quantifying VIRS and APVIRS (Potential Areas for VIRS)
  - Bibliography

bc. Study Contents:

Executive Summary

1. Introduction
2. Identification of VIRS and APVIRS
3. Data Base
4. Solid Waste Management in Switzerland
5. Diagnosis of illegal dumping sites in the Metropolitan Region
6. Priorities for the recovery of illegal SW dumping sites
7. Technologies for the recovery of illegal SW dumping sites
8. Recommendations regarding recovery methods for degraded areas of each illegal dumping site in the MR
9. Study of 5 cases
10. Action plan and institutional strategy for the elimination of illegal dumping sites and the recovery of degraded areas

c. EWI's RESHOS Study

This study characterizes the quantity and quality of solid waste generated in an important number of hospitals and makes a diagnosis of the present situation regarding the integrated management of such types of waste, submitting proposals for its

improvement. The main conclusions and proposals are summarized in the following points:

- The sanitary legislation and regulation presently in force regarding medical SW is scarce and faces the issue in a very general manner.
- The infrastructure for treatment and disposal of medical SW is lacking. This shortage is greater in public hospitals than in private ones.
- In most hospitals there is no trained personnel dedicated exclusively to the management of solid waste. In general, the integrated management of this kind of waste is deficient, with very few exceptions.
- A large number of incinerators from hospitals are in a damaged state due to lack of appropriate maintenance. The incineration must be restricted, whenever possible, to waste that can in fact be reduced to ashes and to waste with a pathogenic agent that can be eliminated. The autoclave (steam treatment) is an economically and technically feasible alternative for the sterilization of hazardous medical SW.
- Some fractions of medical waste have a high content of pathogenic agents. For this reason the generation, treatment, transportation and final disposal of such waste must be regulated within the framework of a global policy on this matter, involving and coordinating all related agents.

The objectives and the content of the study are presented below.

ca. General Objective

The general objective is to characterize the quantity and quality of waste generated in hospitals of the Metropolitan Region. The wastes that appear in the different hospital areas are analyzed and those signifying a potential harm and requiring special treatment before final disposal are identified. Based on this, the technical options and the most appropriate management procedures are analyzed.

cb. Specific Objectives

- Qualitative and quantitative characterization of solid waste produced by hospitals in the Metropolitan Region and elaboration of a diagnosis regarding the present management situation.
- To define technical options and procedures for the management (internal and external) of solid waste produced in the Metropolitan Region's hospitals, on the basis of magnitude, characteristics and complexity of treatment required for the different types of waste.
- To evaluate the capacity and the present status of existing equipment for

solid waste treatment in hospitals, as well as the possibility for recovering damaged equipment.

- Taking into account the results of the previous objective regarding the capacity and status of existing equipment, to evaluate from technical, sanitary and economic points of view the propriety of establishing: I) a centralized treatment system, ii) solutions for groups of hospitals, iii) individual solutions.
- Location of suitable places for the final disposal of such wastes.
- To propose a policy regarding the roles of waste generators, public sector and private sector within the recommended solution.
- To propose a regulation scheme in accordance with the solution recommended, including the following aspects: sanitary/environmental matters, safety in the operation and continuity of the service, fees system, and surveillance and monitoring mechanism.
- To establish the human and financial resources for implementing the proposed regulations.

cc. Study Content

The study is structured into 8 chapters.

- Chapter 1 is the executive summary and Chapter 2 corresponds to the Introduction.
- Chapters 3 and 4 correspond to the diagnosis stage. First, the Medical Solid Waste Classification scheme to be used is presented and the several medical wastes identified through the field studies are qualitatively characterized. The present legal schemes are also analyzed. Next, a qualitative analysis of the present management situation is completed. Chapter 5 includes a quantitative analysis and a projection on waste generation.
- Chapter 6 presents the global medical waste management policies.
- Medical waste management is separated into Chapter 7 (Internal Management) and Chapter 8 (External Management and Final Disposal). The latter includes an analysis regarding the problems of final disposal sites.
- A group of appendices are presented which submit the methodology used, bibliography, glossary, cartography, the Data Base Manual and an individual report about the hospitals that were surveyed.

d. EWI's RISNOR Study

This study analyzes the ISW declaration system established by Act 5081, indicating it is not appropriate to obtain a qualitative characterization, since the format of the document forces to declare combinations of waste, which results in loss of detail. In order to bridge this difficulty, the study proposes a closed list of wastes that allows to describe non hazardous solid waste (RISNOR) with a consistent terminology.

Based on the information included in the CDSI (ISW Control) data base, located at PROCEFF, a survey was designed and carried out. The results are then extrapolated to industries in the Metropolitan Region, obtained from the INE (National Institute of Statistics) data base.

The survey submits information concerning: reused/not reused RISNOR generation, in situ storage, transportation, percentage of waste considered hazardous, percentage of industries submitting information under the declaration system of Act 5081. Also, a projection of RISNOR generation for the year 2004 is completed.

The study analyzes the ISW generation models, such as the Winvent model and the model on rapid evaluation of Environmental Pollution Generation Sources.

The study proposes a RISNOR classification that allows to identify reusable and non reusable waste. It also defines criteria for the evaluation of location of dumping sites, indicating construction and operation norms.

The study outlines policy for Solid Waste Management in general, and, stemming from it, a specific policy for RISNOR. It analyzes the existing legal framework with regard to the management of such waste, and it proposes a strategy for promulgating and/or improving the relevant guidelines.

da. General Objective

The general objective of the study is to obtain information on the characteristics, volume and origins of Solid Industrial Non-Hazardous Waste, and to outline a policy proposal for their environmentally adequate management.

A proposal for a management policy for Solid Industrial Non-Hazardous Waste must encompass all aspects of the waste's life-cycle; that is, it must necessarily tackle their generation, collection, transportation, storage, and final destination, meaning by the latter reutilization of waste, possible treatments and final disposal.

db. Specific Objectives

In order to outline a management policy for Solid Industrial Non-Hazardous Waste, it is necessary to obtain information and to clarify certain concepts. The specific objectives of the study are, therefore:

- To diagnose the present situation concerning the origin, storage, collection, transportation, and final destination of Solid Industrial Non-Hazardous Waste;
- To identify and quantify the Solid Industrial Non-Hazardous Waste;
- To analyze the relevant national and international legislation, and to propose norms that would encourage adequate management of waste;
- To revise the institutional structure now in force for controlling the management of waste, and to propose institutional options.

dc. Scope of the Study

The scope of the study includes:

- Analysis of the operation of the Declaration System of Act 5081 by the Metropolitan Health Service of the Environment ("SESMA"), which is run by the Program of Fixed Source Emissions Control ("PROCEFF"), dependent of the SESMA;
- Analysis of the information stored in the database on the Control of Solid Industrial Waste ("CDSI"), which is run by PROCEFF through the Declaration System;
- Adaptation of the system so that it operates with the information to be generated on Solid Industrial Non-Hazardous Waste ("RISNOR");
- Comparison with the information of the World Bank's "Winvent" and the WHO's "Rapid Evaluation of Sources of Air, Water and Soil Pollution" models;
- Classification of RISNOR, to allow for the implementation of this classification as part of the management policy outlines for RISNOR.

The criteria used for classification are:

- incinerability (incinerable/ non-incinerable/ mixtures);
- feasibility of being used (recyclable/ reusable/ non-recyclable or non reusable);
- need for previous treatment (needs/ does not need treatment prior to disposal);

- type of disposal facility appropriate for the residue.
- Conceptualization of the treatment and final disposal of RISNOR according to the proposed classification.
- Application of a survey on a sample of industries in the Metropolitan Region, including the design of the sample and of the survey, a description of the survey's results, and their validation;
- Analysis of the results, as part of a Diagnosis of the Present Management of RISNOR.
- Extrapolation of the survey results to the Metropolitan Region;
- Forecast of RISNOR production within ten years;
- Identification of the criteria to be employed for the evaluation of a disposal facility location, the norms for the installation and operation of the facility;
- Indication of the requirements for building disposal facilities;
- Description and proposal of possible sites for industrial disposal facilities in the Metropolitan Region.
- Proposal of a "General Plan for the management of solid industrial waste" which is compatible with the studies that are a part of the "Diagnosis and Identification of Technologies and Strategies for Solid Waste Management in the Metropolitan Region" project.
- Proposal of a "Specific Plan for RISNOR management" which rests on:
  - an analysis of the agencies that hold direct responsibility over the management of RISNOR, for which the constitutional laws and regulations relevant to each one of them have been reviewed.
  - a perception of the participatory role that public and private agencies should play. This analysis is based on answers obtained through interviews with officials of these agencies.
- Analysis of the legal framework of RISNOR management in the Metropolitan Region, which sustains the whole development of the proposal for an institutional structure and short, medium and long term norm proposals.

dd. Study Contents

Chapter 1	Introduction
Chapter 2	Comments and Conclusions
Chapter 3	Declaration System of Act 5.081
Chapter 4	International Generation of Waste
Chapter 5	Survey of Metropolitan Region Industries
Chapter 6	Feasibility of RISNOR Re-Utilization, Treatment and Final Destination
Chapter 7	Generation of RISNOR in the Metropolitan Region