

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

NATIONAL COMMISSION FOR THE ENVIRONMENT(CONAMA)

THE REPUBLIC OF CHILE

**THE MASTER PLAN STUDY
ON
INDUSTRIAL SOLID WASTE MANAGEMENT
IN
THE METROPOLITAN REGION
OF
THE REPUBLIC OF CHILE**

**FINAL REPORT
VOLUME II
MAIN REPORT**

MARCH 1996

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1126289(6)

**In this report, project cost is estimated at October 1995 price and at an exchange rate of
1 US\$ = 102.4 Japanese yen = 416.2 Chilean pesos.**

PREFACE

In response to a request from the Government of the Republic of Chile, the Government of Japan decided to conduct a master plan study on Industrial Solid Waste Management in the Metropolitan Region of the Republic of Chile and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Chile a study team headed by Mr. Susumu Shimura, KOKUSAI KOGYO Co., Ltd. and composed of members from KOKUSAI KOGYO Co., Ltd. and EX. Corporation three times between January 1995 and December 1995.

The team held discussions with the officials concerned of the Government of Chile, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Chile for their close cooperation extended to the team.

March 1996



Kimio Fujita
President
Japan International Cooperation Agency

March 1996

Mr. Kinio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Mr. Fujita,

LETTER OF TRANSMITTAL

We are pleased to submit to you the study report on the Master Plan Study on Industrial Solid Waste Management in the Metropolitan Region of the Republic of Chile. This study contains the master plan for Industrial and Medical Solid Waste Management (SWM) until 2010.

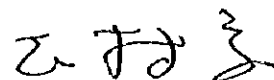
The Industrial/Medical SWM master plan was formulated for the Metropolitan Region based on the field investigation of 200 factories and 90 medical institutions.

The master plan comprises: forecast of future Industrial/Medical SW generation, planning framework with phased goals/targets/strategies, technical systems, institutional systems and estimation of the magnitude of Industrial/Medical SWM business in 2010.

We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs and Ministry of Health and Welfare. And from the Chilean side we also wish to express our deep gratitude to the National Commission for the Environment (CONAMA), CONAMA-Metropolitan Region, the Ministry of Health, the Metropolitan Region Environmental Health Service (SESMA), SESMA-PROCEFF (Stationary Emission Source Control Program), Ministry of Planning-SERPLAC, Superintendent of Sanitary Service (SISS), the Embassy of Japan in the Republic of Chile, and the JICA office in the Republic of Chile.

Finally, we hope that this report will be effectively used for the implementation of the master plan.

Respectfully,



Susumu Shimura
Team Leader
The Master Plan Study on
Industrial Solid Waste
Management in the Metropolitan
Region of the Republic of Chile

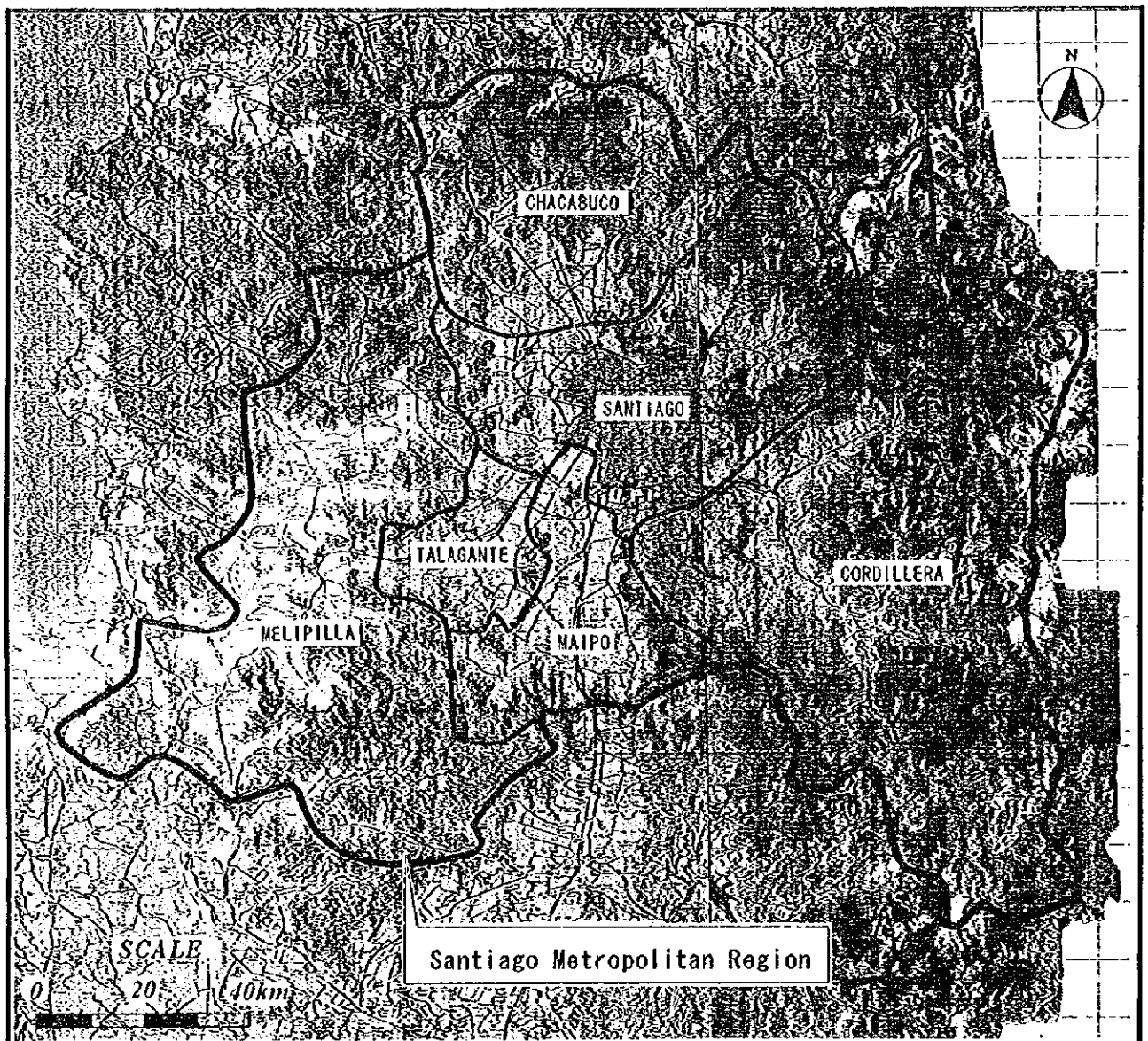
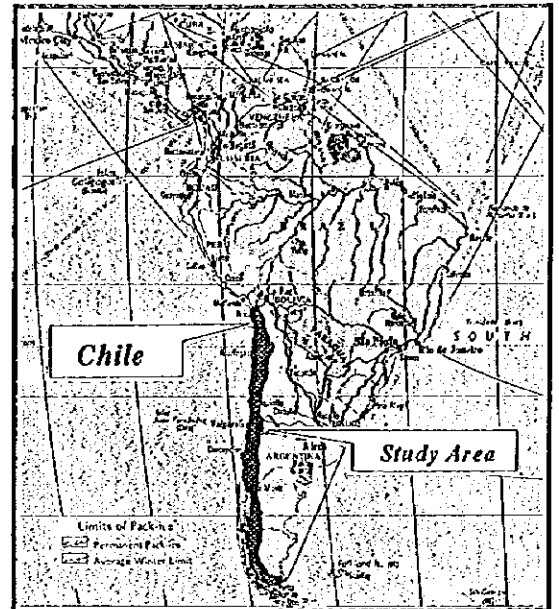
**THE MASTER PLAN STUDY
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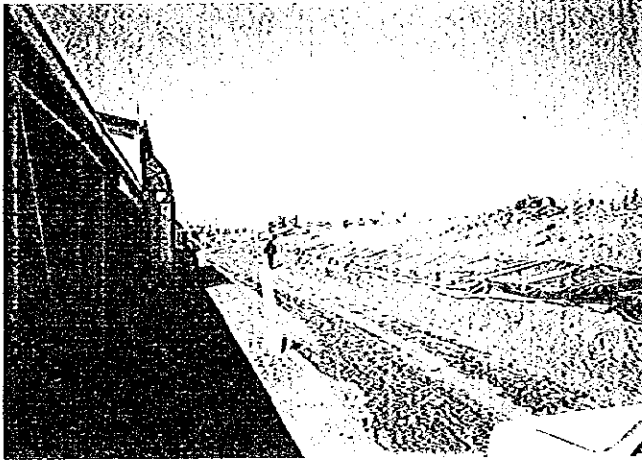
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This is the MAIN REPORT.

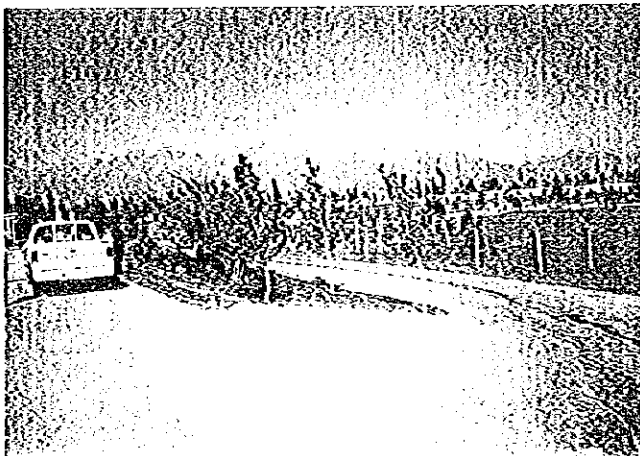
Location Map of The Study Area





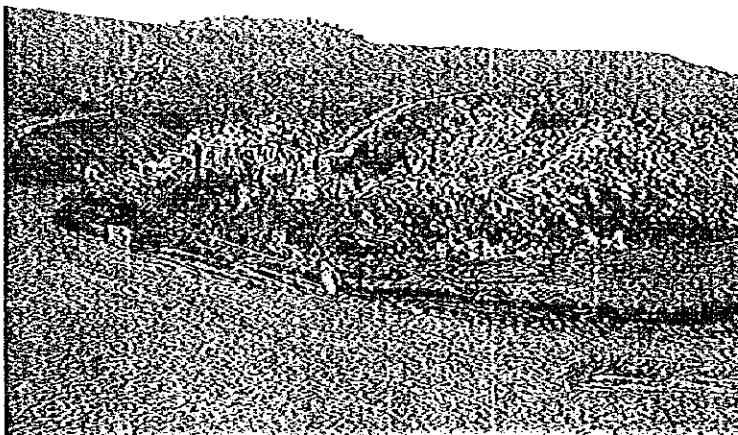
Lo Errazuriz Final Disposal Site (1)

There are 3 authorized municipal SW landfill sites. Lo Errazuriz landfill site, the largest one among them, achieves considerably high level of the landfill management. The line covered by black sheets is leachate collection ditch. Leachate collected are returned to landfilled layers by pumping.



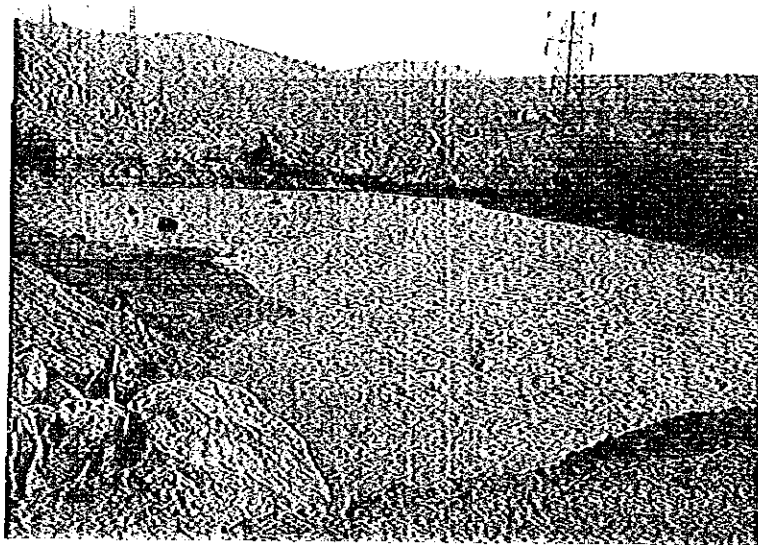
Lo Errazuriz Final Disposal Site (2)

Lo Errazuriz landfill site, covering total 40 hectare, is planned to be closed in December 1995. The picture shows an area where landfill operation was completed and vegetation for park was prepared. The park serves as a public recreational area for the surrounding communities.



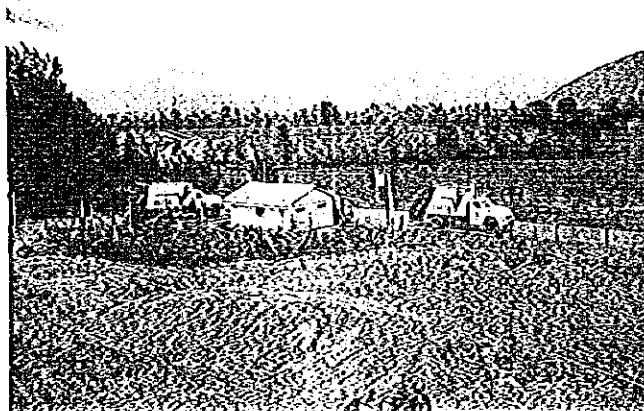
Cerros de Renca Final Disposal Site (1)

Cerros de Renca landfill site, second largest among 3 landfill sites, is located in the north of Santiago urban area. Although they also employ measures of daily coverage of waste disposed and biogas recovery, their quality of landfill management is inferior to that of Lo Errazuriz.



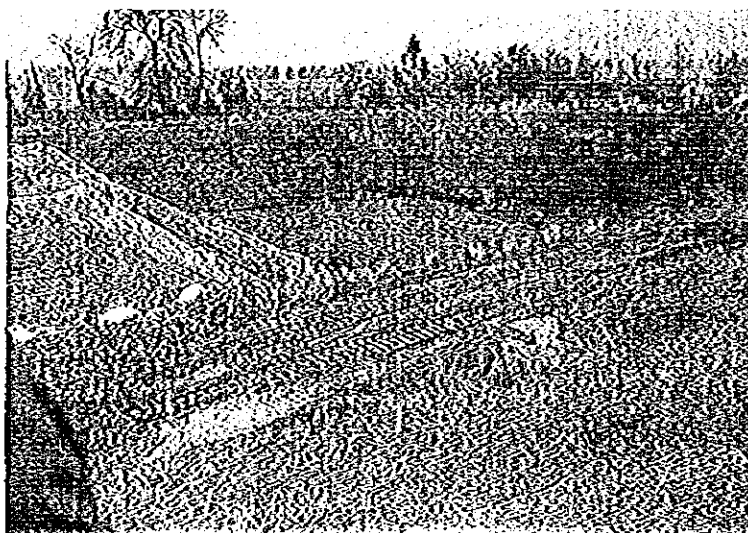
Cerros de Renca Final Disposal Site (2)

Neither intermediate treatment facilities nor final disposal sites for industrial solid waste (exclusively) do exist in the Metropolitan Region. Dumps of industrial liquid waste are found in a corner of Cerros de Renca site.



Lepanto Final Disposal Site (1)

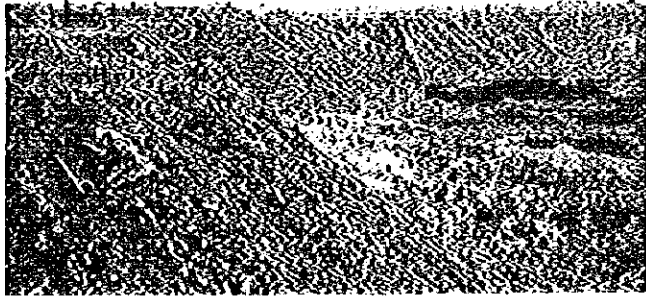
Lepanto site, the smallest among them, is located in the south of Santiago urban area. Although the landfill management of Lepanto is inferior to other 2 sites, daily coverage of waste disposed and biogas recovery are maintained in their practice.



Lepanto Final Disposal Site (2)

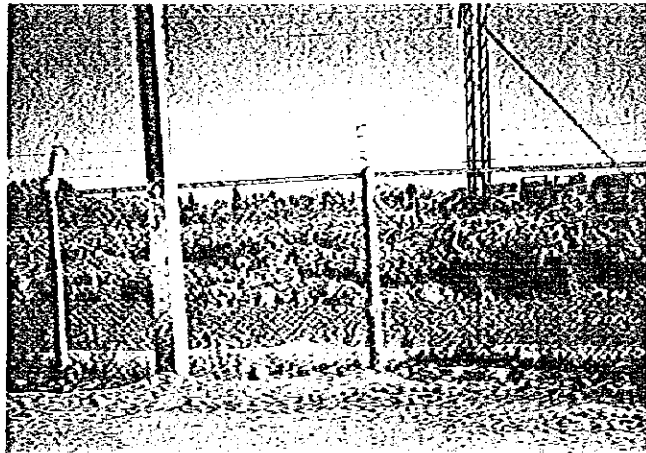
Tipping fee at Lepanto is comparatively cheap and various industrial solid wastes are received there.

Unauthorized Destinations (1)



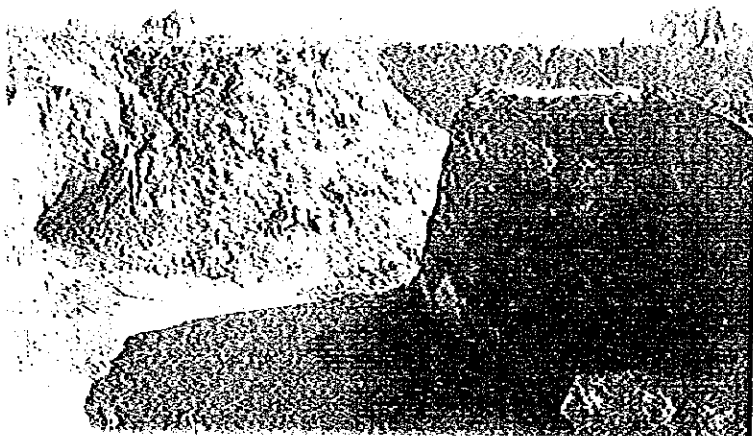
Apart from the 3 authorized landfills, there are several unauthorized landfill sites and many illegal dumps in the Metropolitan Region. The picture shows the largest illegal dump next to Lo Errazuriz site. Various types of solid waste are illegally dumped at ex-gravel/sand extraction pits. Great majority dumped are construction solid waste.

Unauthorized Destinations (2)



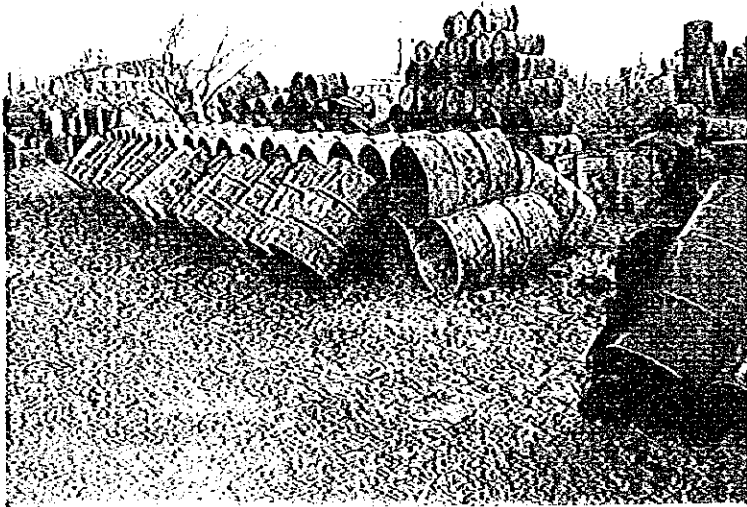
Quite a few scavengers are found in the illegal dump next to Lo Errazuriz site, although scavenging is not allowed in the Lo Errazuriz site.

Unauthorized Destinations (3)



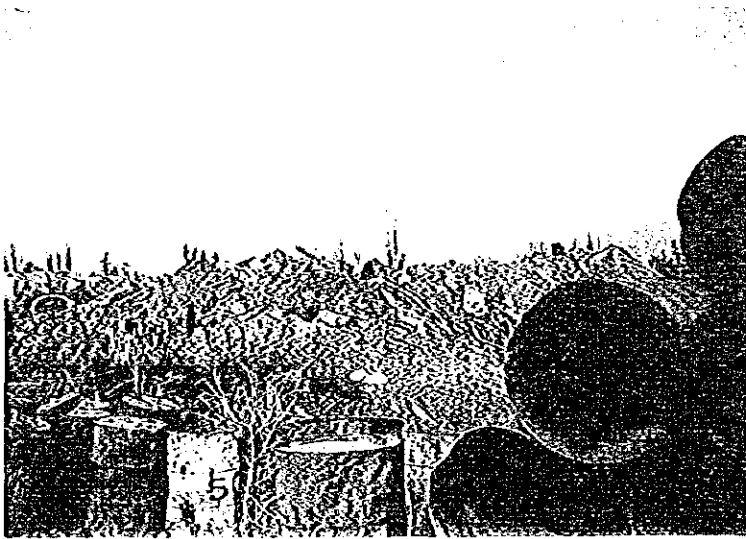
There are many ex-gravel/sand/clay extraction pits in the Metropolitan Region and many of them are subject to illegal dumping. The picture shows an existing extraction pit, which welcomes construction waste disposal. The pit is registered as an unauthorized landfills in the CDSI system of SESMA-PROCEFF.

Plate 3 Present ISWM: Unauthorized Destinations (1)



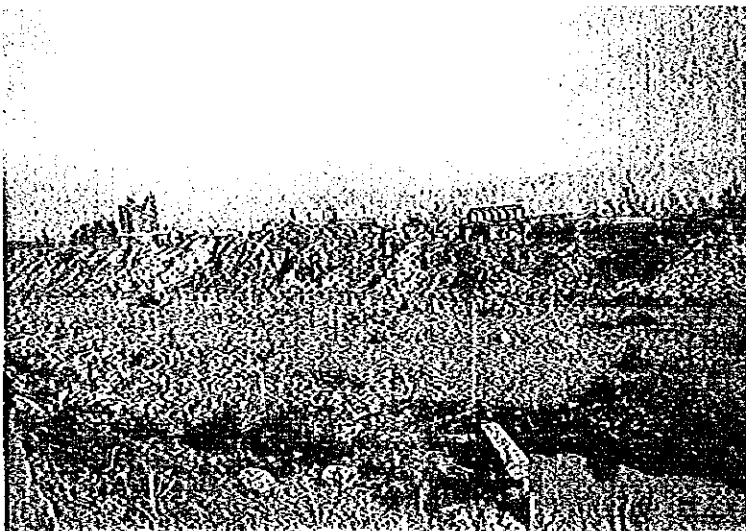
Unauthorized Destinations (4)

It is estimated that more than 50% of industrial solid waste is currently recycled in the region. However, inappropriate practices of recycling are observed in many occasions. The picture shows open burning of discarded drums with extraneous matters for recycling of drums.



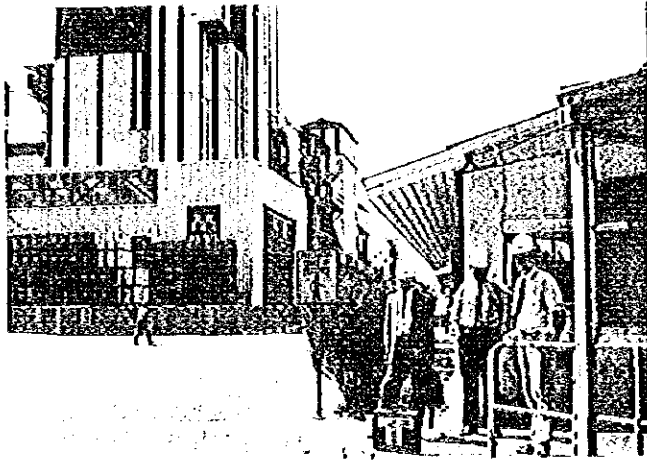
Unauthorized Destinations (5)

Many of inappropriate recycling sites are located adjacent to unauthorized landfills. Residues from recycling are finally disposed of at those unauthorized landfills.



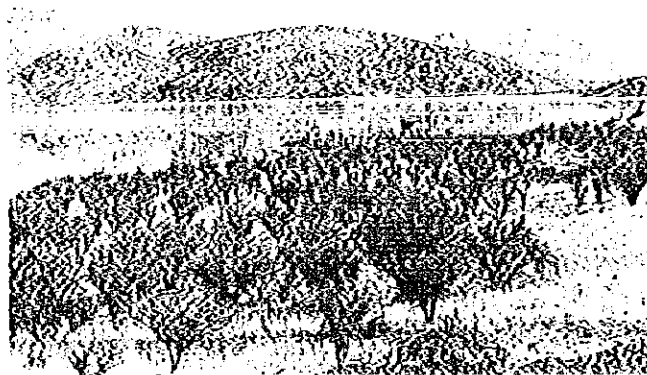
Unauthorized Destinations (6)

Small- or micro-scale recyclers recover valuable materials from solid waste they collected. Majority of residues from solid waste after the material recovery are illegally dumped. The picture shows illegal dumping of residues from recycling activities at Rio Mapocho.



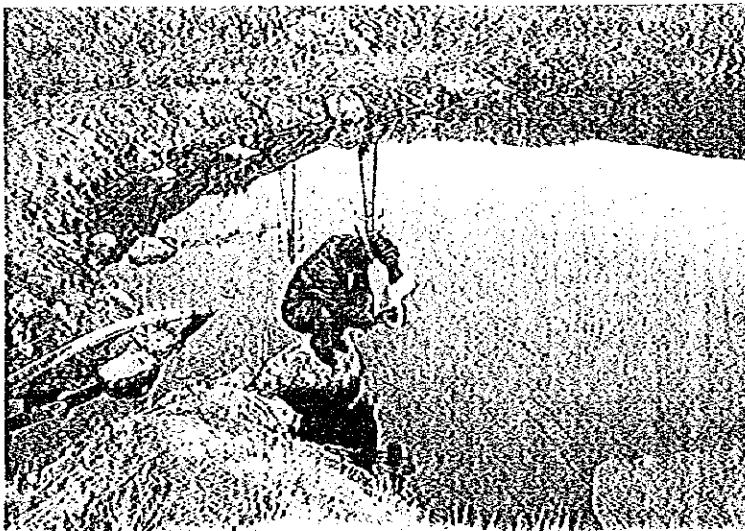
Factory Survey (1)

It was observed in the Team's survey that working environment in factories in general are well put in order and kept clean. However, it was found that on-site management of industrial solid waste are not well established in factories.



Factory Survey (2)

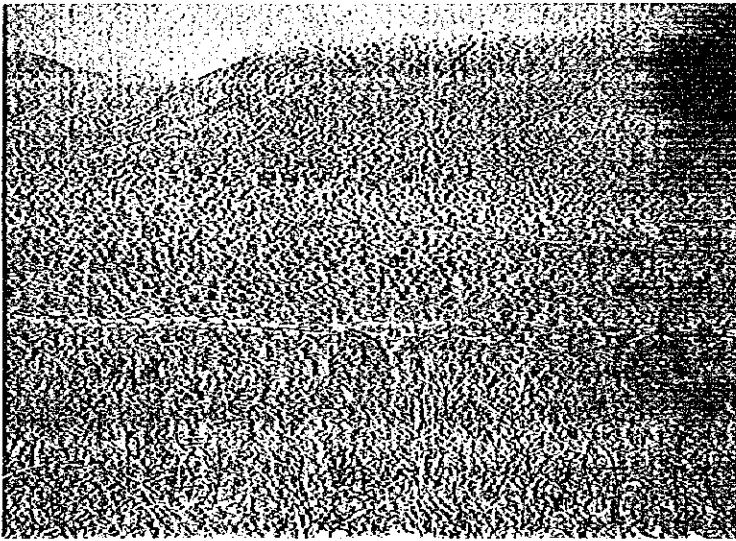
As for the mining industries, there are several ore-dressing in the MR and they produce considerable amount of tailings. However, all of tailings generated in the mining industries are disposed of at their own landfills at present and in future (i.e. closed system). The picture shows tailings disposal site whose capacity is for 100 years of tailings to be generated.



Leachate Quality Survey

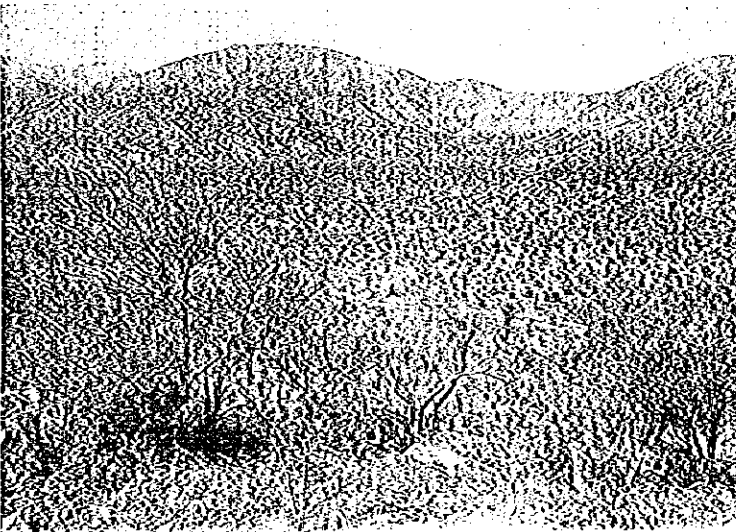
The Study carried out the leachate quality survey for 3 authorized landfills. The picture shows sampling of leachate at Cerros de Renca site.

Plate 5 Field Survey (1)



Candidate Site of HW Landfill (1)

The Study carried out comparative environmental evaluation for 11 candidate sites (selected by the counterpart) for hazardous waste disposal. The picture shows the candidate site at Cerro Carneros.



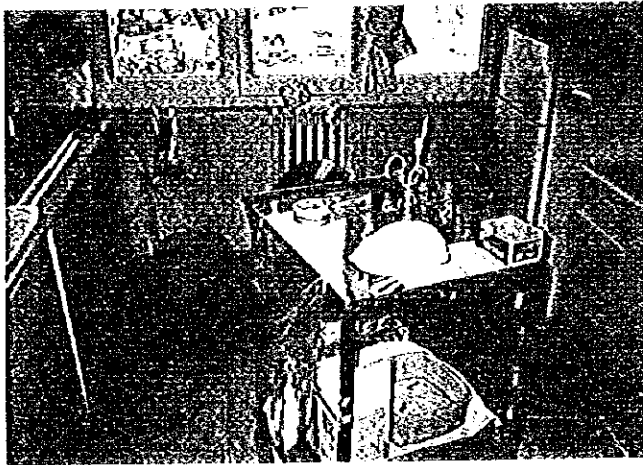
Candidate Site of HW Landfill (2)

The picture shows the candidate site at Quilapilún.



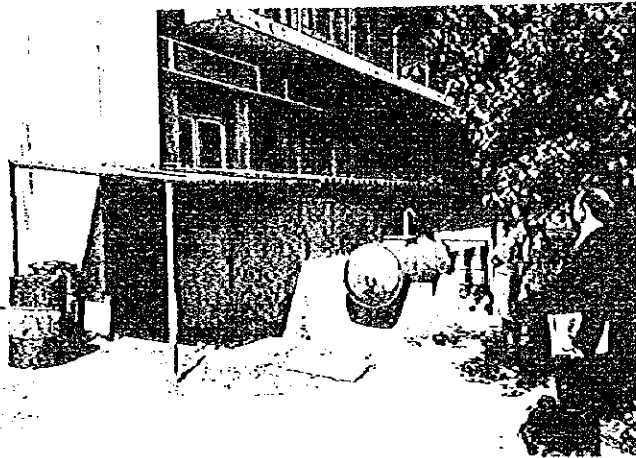
Field Survey on Industrial/Medical Solid Waste Management in Brazil

In order to refer the Brazilian industrial/medical solid waste management for the study, Team investigated actual situation of said management in Brazil. The picture shows the hazardous industrial solid waste final disposal site at São Jose des Campos in São Paulo state.



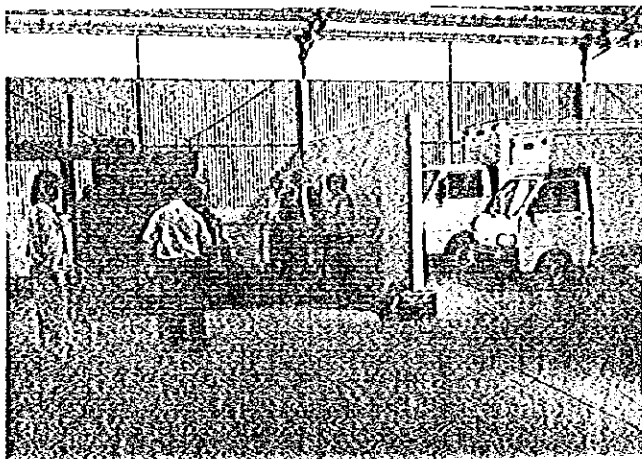
Infectious Solid Waste Separation at Source

Infectious solid waste are to be separated at source as shown in the picture. Some of said waste are incinerated at individual incinerator at medical institutions.



Individual Incinerator at a Hospital

There are 42 hospitals in the Metropolitan Region. 12 hospitals have individual incinerator for infectious solid waste in their premises.



A Medical Solid Waste Handling Agent

A company extends the service of collection and incineration of infectious medical waste in the Metropolitan Region since end of 1994.



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ABBREVIATIONS

AGCI	:	Agencia de Cooperación Internacional
APC	:	Air Pollution Control
APVIRS	:	Areas Potenciales de Vertidos Ilegales de Residuos Sólidos (Potential Areas for Illegal Dumping of Solid Waste)
BOD	:	Biochemical Oxygen Demand
CA	:	Competent Authority
CDSI	:	Control de Desechos Sólidos Industriales (Industrial Solid Waste Control)
CEDRM	:	Comisión Especial de Descontaminación de la Región Metropolitana
CENMA	:	National Environmental Center Project
CETESB	:	Campanhia de Tecnologia de Saneamento Ambiental of Sao Paulo Metropolitan Area
CIU	:	Clasificación Internacional Industrial Unificada (International Standard Industrial Classification)
CIREN	:	Centro de Información de Recursos Naturales (Natural Resources Information Center)
CIW	:	Centers of Industrial Waste
CL	:	Controlled Landfill
CMP	:	Maximum Permissible Concentration
COENNU	:	Comisión Chilena de Energía Nuclear
CONAMA	:	Comisión Nacional del Medio Ambiente
CONAMA-RM	:	Comisión Nacional del Medio Ambiente - Dirección Región Metropolitana
CORFO	:	Corporación de Fomento de la Producción
CP	:	Cleaner Production
CPT	:	Cleaner Production Technologies
DF/R	:	Draft Final Report
DIA	:	Declaración de Impacto Ambiental
DS	:	Decreto Supremo (Supreme Decree)
D&M's RISPEL Study	:	Diseño e Implementación de un Sistema de Control para el Manejo de Residuos Sólidos Peligrosos en la Región Metropolitana (Design and Implementation of a Control System of Hazardous Solid Waste Management)
EC	:	European Community
EIA	:	Estudio de Impacto Ambiental (Environmental Impact As- sessment)

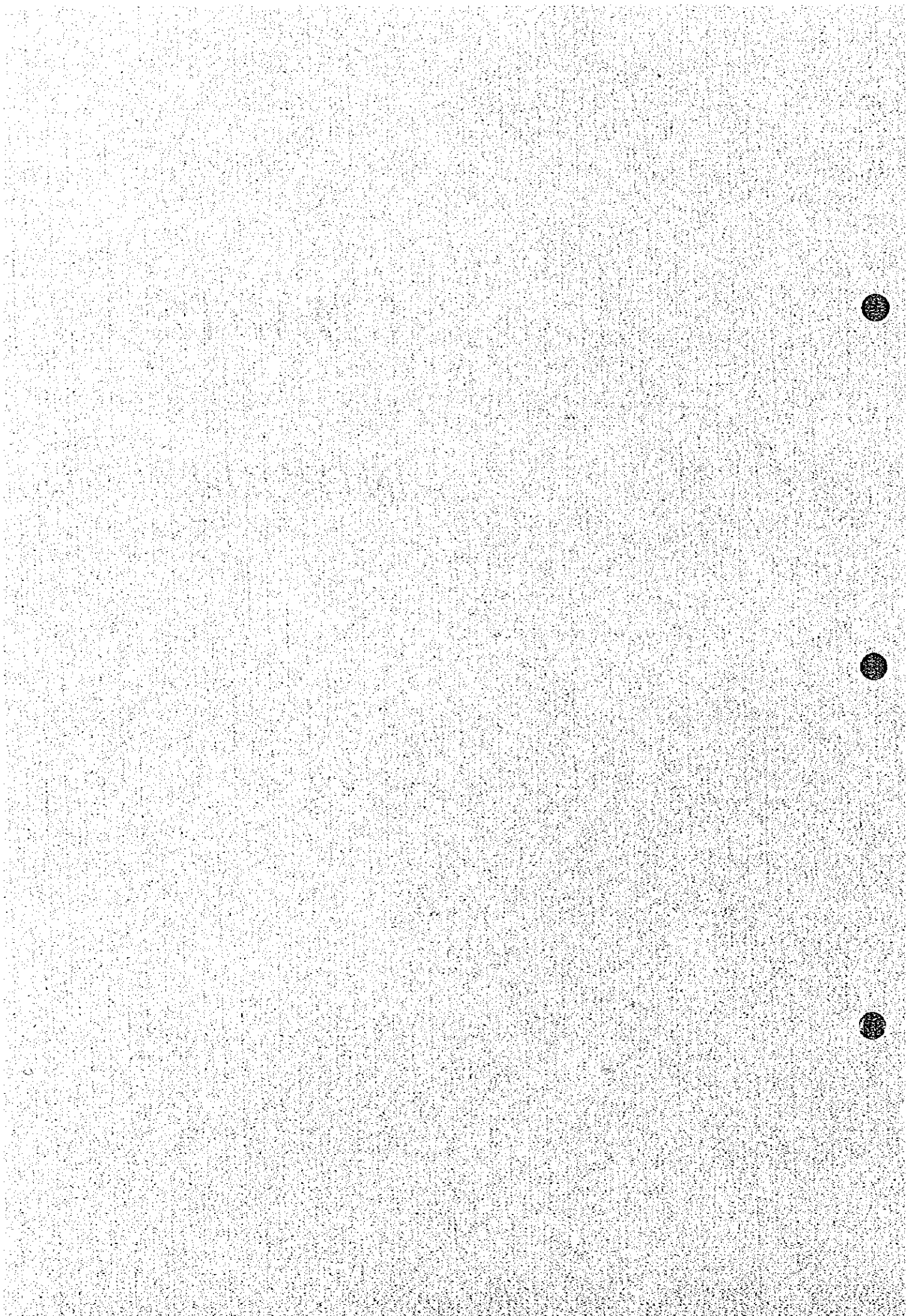
EMOS S.A.	:	Empresa Metropolitana de Obras Sanitarias, S.A.
EOP	:	End of Pipe
EU	:	European Union
EWI	:	Electrowatt Ingenieros Consultores (Chile) S.A.
EWI's RESHOS Study	:	Estudio de Manejo de Residuos Sólidos de Establecimientos Hospitalarios en la Región Metropolitana (Study on Medical Solid Waste Management in the Metropolitan Region)
EWI's RISNOR Study	:	Diagnóstico e Identificación de Tecnologías y Estrategias para el Manejo de Residuos Sólidos No Riesgosos en la Región Metropolitana (Diagnosis and Identification of Technologies and Strategies for the Management of Solid Industrial Non-Hazardous Waste in the Metropolitan Region)
EWI's VIRS Study	:	Proposición de un Plan de Acción para la Eliminación de Vertederos Ilegales y Recuperación de Areas Afectadas en la Región Metropolitana (Action Plan Proposal for the Elimination of Illegal Dumping Sites and the Recovery of Affected Areas)
FGT	:	Flue Gas Treatment
FONASA	:	Fondo Nacional de Salud
F/R	:	Final Report
GDP	:	Gross National Product
GNP	:	Gross Domestic Product
HCP	:	Heat Charge Processes
HPI	:	Highly Potential Industries
HIW	:	Hazardous Industrial Waste
HW	:	Hazardous Waste
IC/R	:	Inception Report
IL	:	Inert Landfill
IEE	:	Initial Environmental Evaluation
INE	:	Instituto Nacional de Estadística
INN	:	Instituto Nacional de Normalización
ISIC	:	International Standard Industrial Classification
ISO	:	International Standardization Organization
ISW	:	Industrial Solid Waste
ISWM	:	Industrial Solid Waste Management
IT/R	:	Interim Report
JICA	:	Japan International Cooperation Agency
LA-CA	:	Legal Acts of the Competent Authority
LA-MC	:	Legal Acts of Multi-ministerial Characteristics

LNG	:	Liquefied Natural Gas
LPG	:	Liquefied Petroleum Gas
LPI	:	Less Potential Industries
LW	:	Liquid Waste
MACAM	:	Sistema de Medición Automatizada de Contaminantes Atmosféricos y Variables Meteorológicas
MIDEPLAN	:	Ministerio de Planificación y Coordinación
M/M	:	Minutes of Meeting
MOP	:	Ministerio de Obras Publicas
MR	:	Metropolitan Region
MS	:	Ministerio de Salud
NGO	:	Non-governmental Organization
O & M	:	Operation and Maintenance
PI	:	Potential Industries
PPP	:	Polluter Pays Principle
P/R	:	Progress Report
PROCEFF	:	Program de Control de Emisión de Fuentes Fijas (Stationary Emission Source Control Program)
PROGRESI	:	Industrial Waste Management Program
RESHOS	:	Residuos Hospitalarios (Medical Waste)
RILES	:	Residuos Industriales Líquidos (Industrial Liquid Waste)
RISNOR	:	Residuos Sólidos Industriales No Riesgosos (Non Hazardous Industrial Solid Waste)
RISPEL	:	Residuos Industriales Peligrosos (Hazardous Industrial Waste)
SCL	:	Strictly Controlled Landfill
SEREMI	:	Secretaría Regional Ministerial
SERNAGEOMIN	:	Servicio Nacional de Geología y Minería
SERPLAC	:	Secretaría Regional Ministerial de Planificación y Coordinación
SESMA	:	Servicio de Salud del Ambiente Región Metropolitana (Metropolitan Region Environmental Health Service)
SNSS	:	Servicio Nacional de Servicios de Salud
SOFOFA	:	Sociedad de Fomento Fabril
SS	:	Servicio de Salud/Suspendid Solids
SISS	:	Superintendencia de Servicios Sanitarios
SW	:	Solid Waste
S/W	:	Scope of Work
SWM	:	Solid Waste Management

TA-CA : Technical-normative Act of the Competent Authority
TIS : Technical Information System
US-EPA : Environmental Protection Agency of United States of
America
VIRS : Vertidos Ilegales de Residuos Sólidos (Illegal Dumping of
Solid Waste)
WP : Watering Processes
WHO : World Health Organization
WWT : Waste Water Treatment

CHAPTER 1

INTRODUCTION



CHAPTER 1 INTRODUCTION

This chapter describes the outline of the Study, i.e. background, objective, policy, key assumptions, work process and organization of the study. Readers may understand the general feature of the study in this chapter.

1.1 Background

As a result of successful application of free market policies since the mid 1980s, the republic of Chile has been enjoying high levels of economic growth. However, rapid growth of economic and industrial activities also brought about serious environmental pollution problems such as air and water pollution and solid wastes, especially in the Metropolitan Regions of Santiago.

The present government, which took over the former one in 1990, keeps macroeconomic policies basically unchanged on the one hand and increases its attention to environmental pollution issues on the other. In 1990, CONAMA and CEDRM were established in order to develop national and local programs for the improvement of the environment, the basis of administrative consolidation of environmental management in Chile was founded. Succeedingly the Environment Basic Law (*Ley de Bases del Medio Ambiente*) was published in March 1994, the integrated deployment of environmental management was initiated both region-wide and nation-wide.

Whereas among environmental problems in the Santiago Metropolitan Region air and water pollution predominate which are mainly derived from rapid urbanization and intensified socio-economic activities, countermeasures including legislative regulations, are rapidly put in force to cope with them.

In view of the municipal SWM (Solid Waste Management), collection services are realized for most citizens. Although some problems remain such that the final disposal sites have shorter life to serve, sanitary landfill operations are satisfactorily executed in 3 sites. On the other hand, for ISWM (Industrial Solid Waste Management), the declaration (manifest) system of solid waste generators is completed. Based on that declaration system administrative guidance to each generator has been executed since May 1993 and preliminary researches including estimation work of generated amount of ISW carried out. However, no substantial measures are planned nor executed regarding treatment and/or disposal of the ISW. Hence, ISW including hazardous

waste are transported into the municipal SW disposal sites and illegal dumping is brought about. Consequently this process immensely aggravates the urban environment. As for medical SW, incineration at hospitals or sanitary landfill disposal are partially carried out. No clear legislative criteria are established for treatment and/or disposal of medical SW. Appropriate management is not done for the whole medical SW.

Related with the more stringent enforcement of the environmental regulations over air and water pollution in the future, polluting substances, which are currently dispersed into the atmospheric and aquatic environment, are dust and sludge through treatment and will eminently emerge as mass waste. Furthermore, in accordance with further industrialization and urbanization, issues of treatment and disposal of industrial/medical SW will have to be dealt with the first priority to the solution.

In this regard, integrated industrial/medical SWM including waste minimization at the production stages and consistent management from waste generation to final disposal need to be programmed and actualized.

The Government of Chile, which aims to be a small government, has a principle that vitality and creativity of private sectors should be optimized in the business of treatment and disposal of industrial/medical SW, and selection of the treatment and disposal sites, acquisition of neighborhood consensus, O&M of the facilities could be endorsed to the responsibility of the private sectors. Consequently, the Government of Chile requested the Government of Japan for assistance in planning appropriate industrial/medical SWM and in examining prerequisites for providing institutional and organizational arrangement.

Under such circumstances in December 1993, the Government of Chile officially requested the Government of Japan to implement the Master Plan Study of Industrial Solid Waste Management in the Metropolitan Region in the Republic of Chile.

1.2 Scope of the Study

a. Objective of the Study

The objectives of the Study are:

- to formulate a master plan for the proper management of industrial and medical waste in the Metropolitan Region with the target year of 2010 as

well as an action plan for aspects that need immediate improvement, taking integrated environmental protection and waste minimization into consideration; and

- to identify priority projects for feasibility studies.

b. Study area

The study area shall cover the Metropolitan Region as in Figure 1.2a.

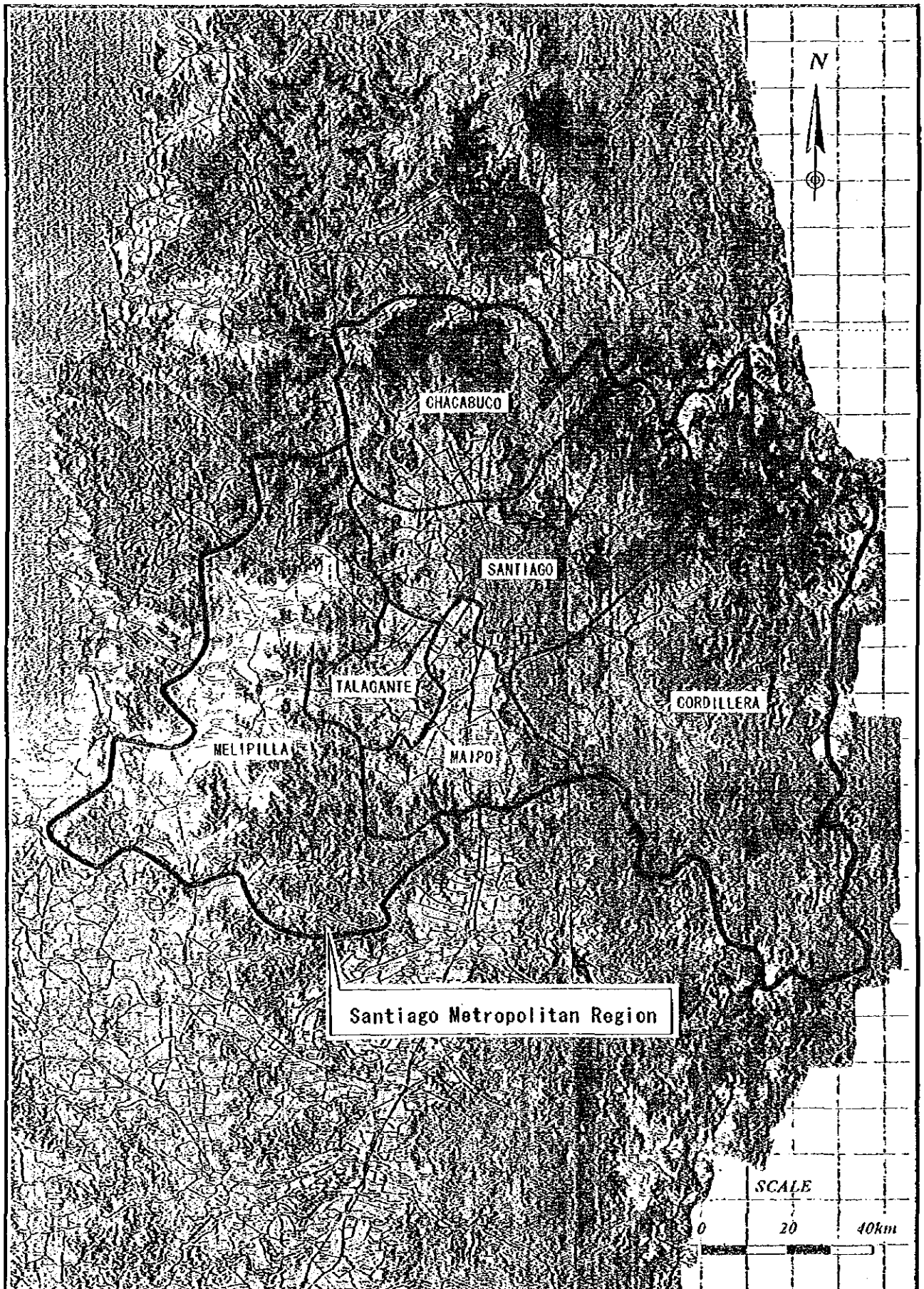


Figure 1.2a Study Area

c. Study wastes

The wastes to be studied in this study shall cover industrial and medical solid wastes. Construction and agricultural wastes are excluded from the study.

1.3 Basic Policy of the Study

For the successful execution of the Study, the Study Team established the basic policy regarding the following points:

a. Joint study

Due to the rapid change of the socio-economic situation in Chile as well as her policies on environment, it would be very important to identify the present situation and future change of the institutional system on industrial/medical SWM and to make an appropriate institutional development plan. This task, however, is not an easy task for foreign professionals without the appropriate support from Chilean counterpart and professionals.

With this reason, the Study Team proposed that the Study should be implemented as a joint study and asked for cooperation and active participation of the Chilean side, specially regarding the following works;

- sample survey of actual industrial/medical waste generation;
- public opinion survey;
- survey on private contractors of municipal waste collection and disposal;
- interview survey with NGOs (Non-governmental Organizations);
- survey of recycling system and market for reusable materials;
- environmental policy planning;
- organization and institution planning;
- financial planning; and
- prompt decision making regarding important matters which require the decision of the Chilean side.

b. Workable plan and appropriate technology

Upon careful consideration of the characteristics of the Study, the most workable and

implementable industrial/medical SWM master plan shall be formulated for the Metropolitan Region in close cooperation with the Chilean counterpart. Furthermore, the Study Team should develop the most appropriate technology both for technical and institutional systems for industrial/medical SWM in the area. Especially, the proposed plan should present and support a self-sustainable industrial/medical SWM for the Metropolitan Region.

In order to formulate the above-mentioned master plan, the Study Team pursued the Study carefully taking the following aspects into account:

- For the projection of trends in industrial/medical solid waste generation, the framework of the socio-economic conditions is to be determined based on industrial and urban development policies of Chilean Government.
- In view of the importance of institutional aspects which make the proposed technical system implementable, both technical and institutional aspects are to be dealt in the study with the same gravity.
- In order to obtain the best result within a limited period, previous information and studies should be examined and utilized to the maximum including information collected through the declaration system.
- As for the technical standards for treatment and final disposal of industrial solid waste, a step-wise application of proposed standards should be examined. For instance, it would be recommended that the scope of legislative enforcement by the Chilean Government should be limited to hazardous industrial and medical wastes for the time being.
- In the examination of institutional aspects for industrial/medical SWM, the Chilean Government's policy, which stresses the role of private sector for the construction and operation of industrial/medical SWM facilities, should be taken into account.
- In view of the importance of proper acquisition of sites for industrial/medical SWM facilities, a practical procedure to obtain neighborhood consensus should be formulated jointly by the Study Team and the counterpart.
- In parallel with the Study, the National Environmental Center Project is conducted as a technical cooperation programme of JICA. Since an integrated environmental management is the key to successful implementation of the Master Plan proposed by the Study, it should be conducted in cooperation with the National Environment Center Project.

c. Multi-media approach

An ISWM Master Plan is formulated based on future waste generation. The future ISW generation is expected to increase according to the reinforcement of air and water pollution control. At the same time, it is also important to consider the degree of waste minimization including source reduction, separation and recycling which depend on legislation and its enforcement, environmental policy, promotion system for environmental protection facilities, consciousness of enterprises and citizens, etc.. It was, therefore, necessary to take a **Multi-media approach** on environment (integrated environmental management) in the process of the master plan formulation.

1.4 Key Assumptions

Key assumptions used in this study area are as follows:

a. Socio-economic conditions

Items	Unit	Descriptions		
1. Population				
- Projected Population of the Study Area	persons	1995 5,642	2000 6,100	2010 6,930
- Annual Growth Rate	%/year	1.5		
2. Economy				
- GDP	bill. US\$	62.5 114.9	in 1995 in 2010	
- Annual Increase Rate of GDP in Real Term	%	5.1		
- Currency Exchange Rate		1 USD = 416.2 Peso = 102.4 Yen		

b. Waste generation

Items	Descriptions									
1. Classification of Industry	CIU (International Standard Industrial Classification)									
2. Targeted Industries	CIU code: - Manufacturing Industries (CIU code 31111 - 39099) - Generation, transmission and distribution of electric energy (CIU code 41011) - Gasoline filling stations (CIU code 62536) - Laundries and cleaners (CIU code 95201) Scale of Industries: Industries with 10 or more employees									
3. Classification of ISW	24 Categories compatible with SESMA-PROCEFF 333 ISW categories									
4. Data used for the calculation of present generation	ISW generation data: - 236 factories surveyed by EWI's RISNOR Study - 189 factories surveyed by JICA Study Team Data source on industries: INE									
5. Forecast of ISW Generation 5.1 Method applied 5.2 Population figure for the forecast 5.3 Forecast of the number of employees 5.4 Installation rate of PCF (Pollution Control Facilities)	Standard Unit Method Number of employees Linear Regression by Least Square Method combined with some variation factors Air PCF: 100% in 2010 On-site Water PCF: 100% in 2010									
6. Generation Rate 6.1 Dust and APC products 6.2 Inorganic and organic sludge 6.3 Water content	Generation ratio of similar categories of industries obtained by the Team's survey are applied to dust generation in 2010. "BOD/SS concentration data for respective group-wise industries of Japan" minus "maximum limits of BOD/SS concentration defined in Nch2280". The sludge generated from the removal of dissolved inorganic substances through physical-chemical treatment is not projected. <table border="1" data-bbox="612 1473 1219 1572"> <thead> <tr> <th>Category</th> <th>Inorganic Sludge</th> <th>Organic Sludge</th> </tr> </thead> <tbody> <tr> <td>Before Dehydration</td> <td>90%</td> <td>99%</td> </tr> <tr> <td>After Dehydration</td> <td>85%</td> <td>85%</td> </tr> </tbody> </table>	Category	Inorganic Sludge	Organic Sludge	Before Dehydration	90%	99%	After Dehydration	85%	85%
Category	Inorganic Sludge	Organic Sludge								
Before Dehydration	90%	99%								
After Dehydration	85%	85%								

c. Cost Estimation

Items	Descriptions
1. Principle	For the estimation of the magnitude of ISWM business in 2010, outline of technical system (storage, collection, transportation, treatment and disposal) in 2010 are assumed. Amount of ISW and unit costs of treatment/disposal in the system are set up based on the system.
2. Storage 2.1 On-site 2.2 At Treatment Facilities	Excluded from the estimation. Included in the tipping fees of treatment facilities.
3. Collection and Transportation	Prepared by referring current collection/transportation costs for municipal SW.
4. Intermediate Treatment 4.1 Service life of facilities 4.2 Loan conditions 4.3 Tipping fees	15 years 15 years of payback period and 6% interest rate in real term. Including profits and insurance costs for accidents.
5. Recycling	Recycling ratios of ISW in 2010 are estimated, with reference to empirical data in Japan and results of the Team's factories survey.
6. Final Disposal	Tipping fee including profit, insurance cost, etc. of SCL and CL for ISW are estimated referring to the present tipping fee of municipal landfills in the MR and the fees employed in said landfills in Brazil

1.5 Work Processes of the Study

The study commenced in January 1995 based on the Scope of Work signed between the Chilean Government and JICA in August 1994, and will end in February 1996.

The study consisted of the following three phases;

- Phase 1 : Evaluation of the Present Industrial/Medical Solid Waste Management
- Phase 2 : Establishment of a Planning Framework
- Phase 3 : Formulation of a Master Plan

The work processes of the Study are described below.

- a. **Phase 1 : Evaluation of the Present Industrial/Medical SWM (January - April, 1995)**
 - aa. **Preparation Work in Japan (January, 1995)**
 - ab. **1st Study Work in Chile (January - April, 1995)**
 - 1) Submission and Discussion of Inception Report
 - 2) Data Collection and Analysis
 - 3) Field Survey on Present Status of Industrial/Medical SWM
 - 4) Public Opinion Survey
 - 5) Examination of Policy on ISWM
 - 6) Evaluation of the Present Industrial/Medical SWM
 - 7) Preparation and Submission of Progress Report
 - 8) Field Survey on Industrial/Medical SWM in Brazil
- b. **Phase 2 : Establishment of a Planning Framework (May - June, 1995)**
 - ba. **2nd Study Work in Chile (1) (May - June, 1995)**
 - 1) Forecast of Future Socio-economic Conditions
 - 2) Forecast of Future Generation of Industrial/Medical Solid Waste
 - 3) Establishment of a Planning Framework
- c. **Phase 3: Formulation of a Master Plan (June, 1995 - February, 1996)**
 - ca. **2nd Study Work in Chile (2) (June - August, 1995)**
 - 1) Establishment of Goal, Targets and Strategy
 - 2) Definition of Industrial/Medical Solid Waste
 - 3) Investigation of Option Areas for Intermediate Treatment and Final Disposal Facilities
 - 4) Examination of Measures for Waste Minimization
 - 5) Examination of an Optimum Technical System
 - 6) Examination of Technical Standards for the Technical System
 - 7) Estimation of Costs and Examination of Executing Bodies
 - 8) Examination of an Optimum Institutional System
 - 9) Planning of an Industrial/Medical SWM Seminar

10) Submission and Discussion of Interim Report

cb. 1st Study Work in Japan (October - November, 1995)

- 1) Preparation of the Master Plan
- 2) Identification of Priority Project(s)
- 3) Implementation of Initial Environmental Examination (IEE) for the Priority Project(s)
- 4) Primary Estimation of Project Cost
- 5) Overall Evaluation
- 6) Examination of Cooperation Program with the National Environmental Center Project
- 7) Compilation of Draft Final Report

cc. 3rd Study Work in Chile (December, 1995)

- 1) Submission and Discussion of the Draft Final Report
- 2) Industrial/Medical SWM Seminar

cd. 2nd Study Work in Japan (January, 1996)

- 1) Compilation of Final Report

ce. Submission of Final Report (February, 1996)

1.6 Study Organization and People Involved

a. Study Organization

The CONAMA (Comisión Nacional del Medio Ambiente) was the Team's counterpart agency and acted as an overall coordinating body with regard to the implementation of the Study and as a focal point of communication regarding general affairs of this JICA Study. CONAMA took necessary steps regarding the assignment of the Chilean counterpart personnel for respective fields in the Study.

The Advisory Committee, which was organized by JICA, gave necessary advice to the Study Team.

The Steering Committee, which was organized by the Chilean side, was responsible for

overall supervision of the Study and decision making on matters related to it.

The study organization was shown below:

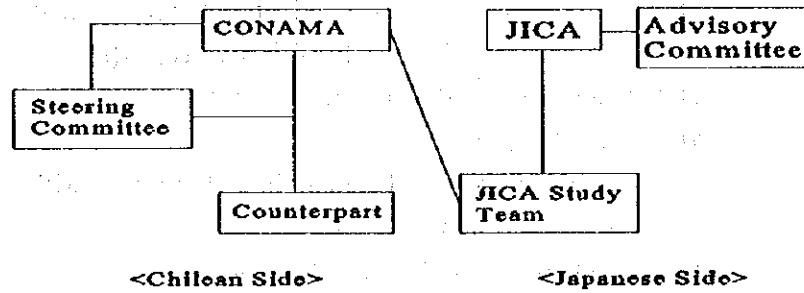


Figure 1.6a Study Organization

b. People Involved

ba. Member of Chilean Steering Committee

Name	Post
Javier Vergara	Regional Director, CONAMA R.M.
Alejandro Cofré	Technical Director, CONAMA
Julio Monreal	Chief of Environmental Programs Department, Ministry of Health
Mauricio Ilabaca	Chief, SESMA
Marta Zamudio	Chief, SESMA-PROCEFF

bb. Members of Chilean Counterpart

Name	Post
Joost Meijer	Coordination Engineer, CONAMA R.M.
Gonzalo Velásquez	Engineer, Solid Waste Unit, CONAMA R.M.
Gustavo Maldonado	Engineer, Solid Waste Unit, CONAMA R.M.
Luis Herman	Engineer, CONAMA
Yolanda Acevedo	Architect, CONAMA
Gonzalo Aguilar	Engineer, Department for Environmental Programs, Ministry of Health
Cecilia Godoy	Engineer, SESMA
Fernando Sepúlveda	Engineer, Solid Waste Unit, SESMA-PROCEFF
Antonio Saldías	Engineer, Solid Waste Unit, SESMA-PROCEFF
Fabian Solís	Geographer, SERPLAC R.M.
Miguel Carrasco	Engineer, SISS

bc. Members of the JICA Advisory Committee

Name	Title	Post
Dr. Kunitoshi SAKURAI	Chief of the Committee	Professor, Department of Urban Engineering, University of Tokyo
Mr. Shigeo ISHIDA	Industrial Policy	Development Specialist, Institute for International Cooperation, JICA
Mr. Jiro EIHO	Industrial Waste Administration	Section Chief of Industrial Waste, Environmental Improvement Division, HYOGO Prefectural Government Office
Dr. Yuzo INOUE	Industrial Waste Treatment	Senior Research Officer, Department of Water Supply Engineering/ Department of Waste Management Engineering, The Institute of Public Health, Ministry of Health & Welfare

bd. Members of the Study Team

Name	Title
Susumu SHIMURA	Team Leader/ ISWM Plan
José Felicio HADDAD	Organization and Institution Plan (1)
Satoshi SUGIMOTO	Economic Policy/ Financial Plan
Koichi HIRAMATSU	Waste Minimization Plan
Hiroshi KATO	Intermediate Treatment/ Final Disposal Plan
Shunsuke AOYAMA	Environmental Policy (1)
José ARELLANO V.	Organization and Institution Plan (2)/ Environmental Policy (2)
Nils CRISTENSEN	Medical/ Hazardous Waste Disposal Plan
Tadaya YAMAMOTO	Environmental Study (Social Aspects)/ Cost Estimation
Jens Kjems TOUDAL	Environmental Study (Technical Aspects)
Ferran MACIPE C.	Administrative Coordinator

PART I

PRESENT INDUSTRIAL AND MEDICAL SWM

CHAPTER 2

PROFILE OF THE STUDY AREA

CHAPTER 2 PROFILE OF THE STUDY AREA

Natural conditions, environment, land use, socio-economic conditions, industries, which are deemed as key elements for the examination of the Master Plan of ISWM in the MR, are summarized in this chapter.

2.1 Natural Conditions

The Metropolitan Region of Santiago covers an area of approximately 15,300 km², which counts for 2% of the total land surface of the Republic of Chile. Most of the MR falls in the Rio Maipo basin, which flows to the Pacific Ocean. Rio Mapocho and Zanjón de la Aguada respectively run in the northern and southern part of the urbanized area of Santiago and join to the Rio Maipo. (see Figure 2.1a)

The MR area is in a large valley basin and has small precipitation (i.e. 300mm to 600 mm annual). Meanwhile Rio Maipo has its origin in melt snow in mountains and has such affluent flows that it reaches 150m³/sec in summer and 500m³/sec in winter. Wide and fertile agricultural land extends in down stream of the said three rivers and receives significant amount of the river water by irrigation. The river water is used for municipal water downstream as well, whereas domestic and industrial waste water in the MR are discharged into the rivers through sewage lines.

2.2 Environment

The MR forms a valley basin surrounded by mountains, thus air pollution attributed to exhaust gas from automobiles and factories is aggravated. Consequently respiratory problems and illnesses (attributable to air pollution) are increasing and it creates serious problems (especially in winter).

As for aquatic contamination in the region, since measures of waste water treatment are not substantiated in most factories, these are discharged together with domestic sewage directly into the Rio Maipo and its major tributary Rio Mapocho which runs across the urbanized area of the MR. However, water pollution by industrial waste water discharge does not become tangible.

The reasons could be:

- major water polluting industries such as ore dressing, marine product processes, pulp mill are not located many in the MR. Some factories of ore dressing exist, however, all of them have their waste water treatment facilities and landfills for tailings;
- affluent flow in the rivers where waste water are discharged; and
- rapid flow in the rivers do not make its water contamination visible and sensible.

Furthermore, Rio Maipo directly flows into the Pacific Ocean and rapid ocean current disperses contaminants and consequently contamination in the coastal area does not take place either.

Whereas, there are such problems that, since irrigation water receives untreated domestic waste water, green vegetables (such as cabbage and lettuce) are not edible uncooked. In periods of drought, the wasters of the basin in some zones are about 100% sewage waters.

2.3 Land use

The MR of Santiago comprising 6 provinces covers 15,349 km². More than 90% of its population and industrial/commercial activities is concentrated in Santiago Province; its area is about 2,000 km².

INE estimated that urban migration and population growth of the MR will continue and its population of about 5.3 million in 1992 will expand to 6.9 million by the year 2010. The "Tertiary Circle Area", which is within an approximate area of 10-15 km radius of the city center, absorbs about 70% of the population growth from 1982 to 1992. Furthermore, industrial areas are increasingly formulated along the "Ring Road" which is located at about 10 km radius of the urban center.

According to the Metropolitan Regulatory Plan of Santiago, Santiago and Cordillera Provinces (see Figure 2.3a) mainly comprises:

- commercial and old residential areas in the urban district,
- industrial areas in its circumference,
- new residential area expanding in the outer area,
- agricultural land use (mainly arable) is predominant along the major two rivers i.e. Rio Maipo and Rio Mapocho, and
- area of restriction (by geographical risk and environmental protection) to the urban expansion.

2.4 Socio-economic and Industrial Situation

The national economy in the Republic of Chile is making fairly steady growth in comparison with all other worldwide economies. Especially the MR is continuously achieving its GDP growth of approximately 10% higher than the Republic's average growth for the past decade. It counts for about 47% of the GDP in Chile.

Large number of ISW generators comprising manufacturing industries (in 3,000's in CIU code in 4 digits), mining, power station, gas stations and laundries, etc. are found in the MR. The manufacturing industries among others as principal ISW producers in the MR mainly comprise:

- factories newly located in the west of the urbanized area along the Pan American North (No.5), and
- small and medium industries situated in old residential areas in the south-east of the urban area (see Figure 2.4a).

According to INE data, industries with 10 or more employees counts for approximately 3,400 companies in the MR, and about 3,000 companies are located in the Santiago Province, whose total employees counts for about 280,000 people.

Industries in the MR mainly comprise:

- food and beverage production (20% of factories with 10 or more employees) which are commonly found in urban area in all countries;
- textile and clothing industries (27%; as above);
- chemicals, fertilizers, pharmaceuticals production (15%; as above); and
- metal and mechanic manufacturing (19%; as above).

Whereas material industries such as mining, pulp, steel makers are found less frequent in the MR.

In view of ISW generation, large-scale ISW waste generators (e.g. material industries such as copper smelting refinery, blast furnace, petroleum refinery or pulp digesting and bleaching) are not found in the MR. Constituents of current industries in the MR indicate that ISW, in wide variety, are generated including LW (Liquid Waste) and HW (Hazardous Waste). Since further localization of process industries and high-tech industries are expected, ISWM corresponding to this trend of industrialization is required.

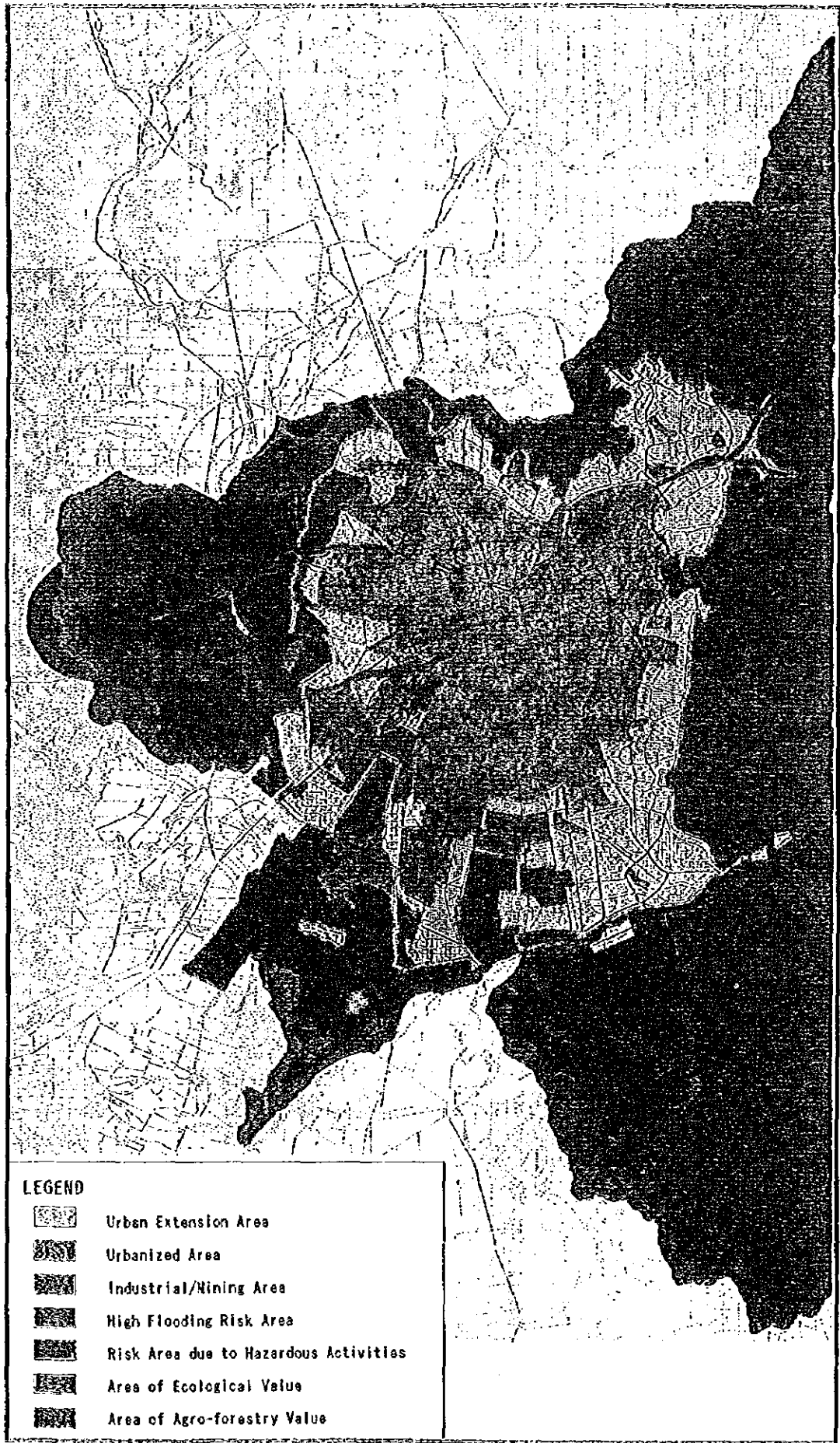


Figure 2.4a Land Use Plan for Santiago and Cordillera Provinces (Metropolitan Regulatory Plan of Santiago)

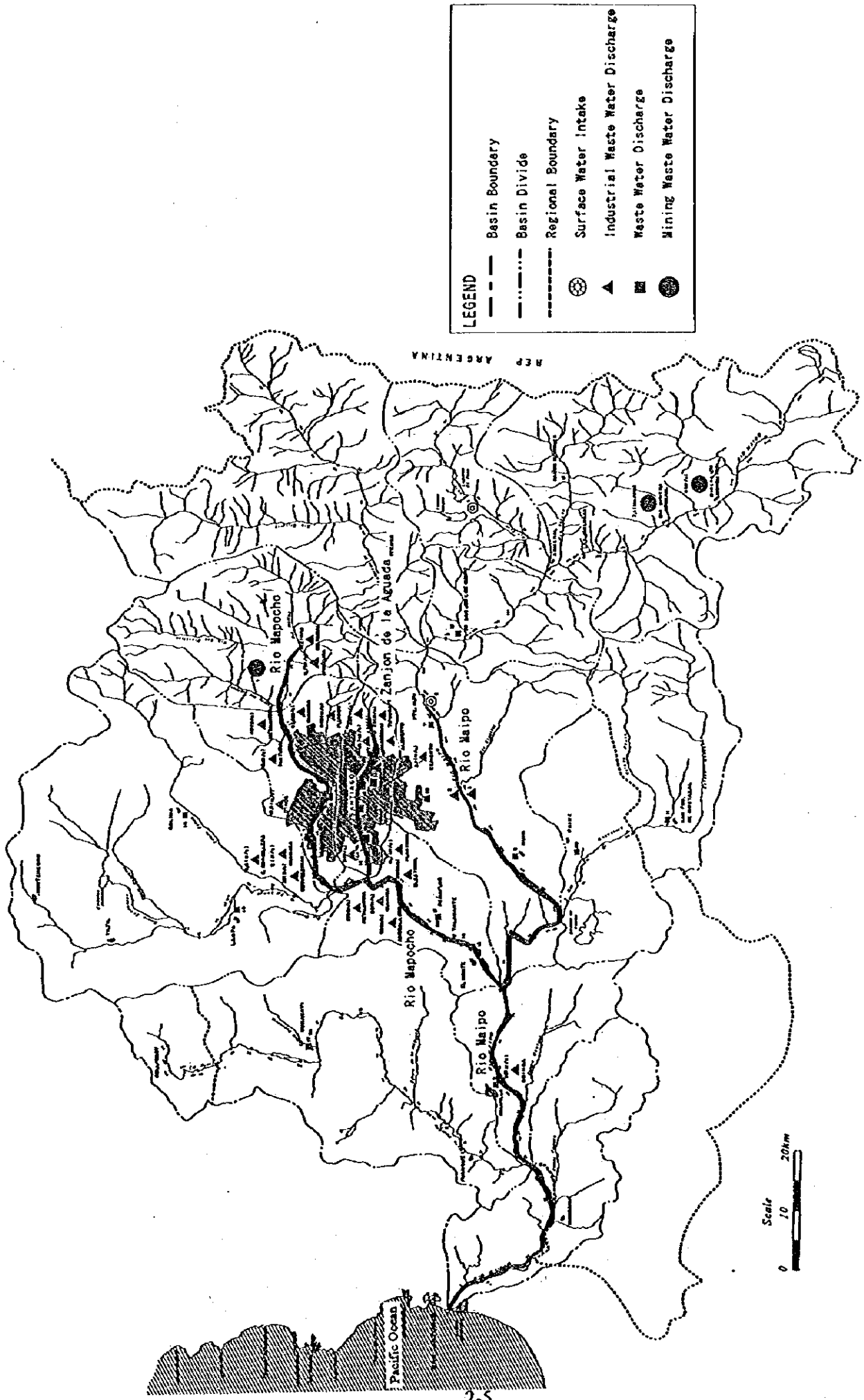


Figure 2.4b Maipo River Basin

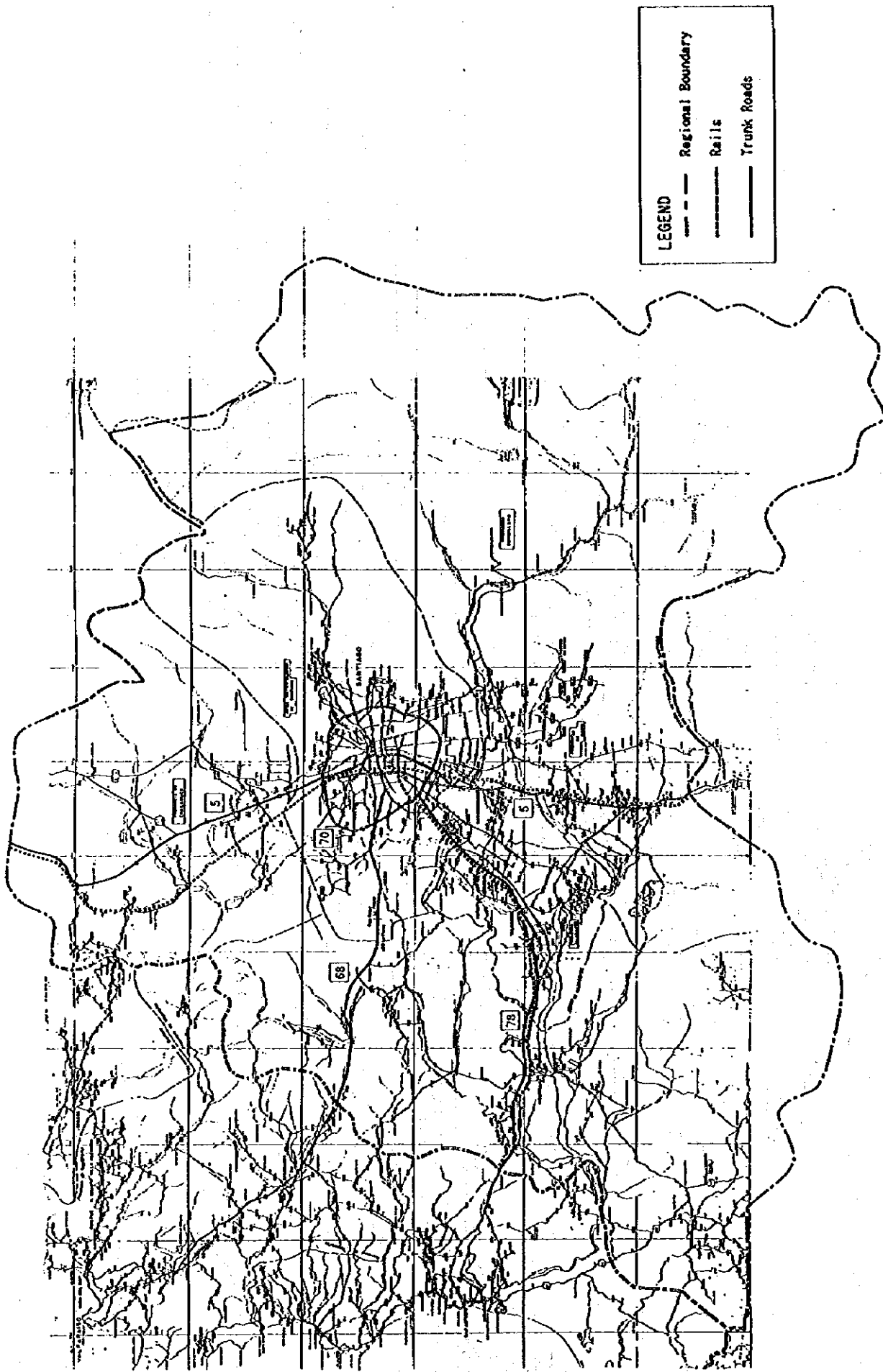


Figure 2.4c Transportation Network

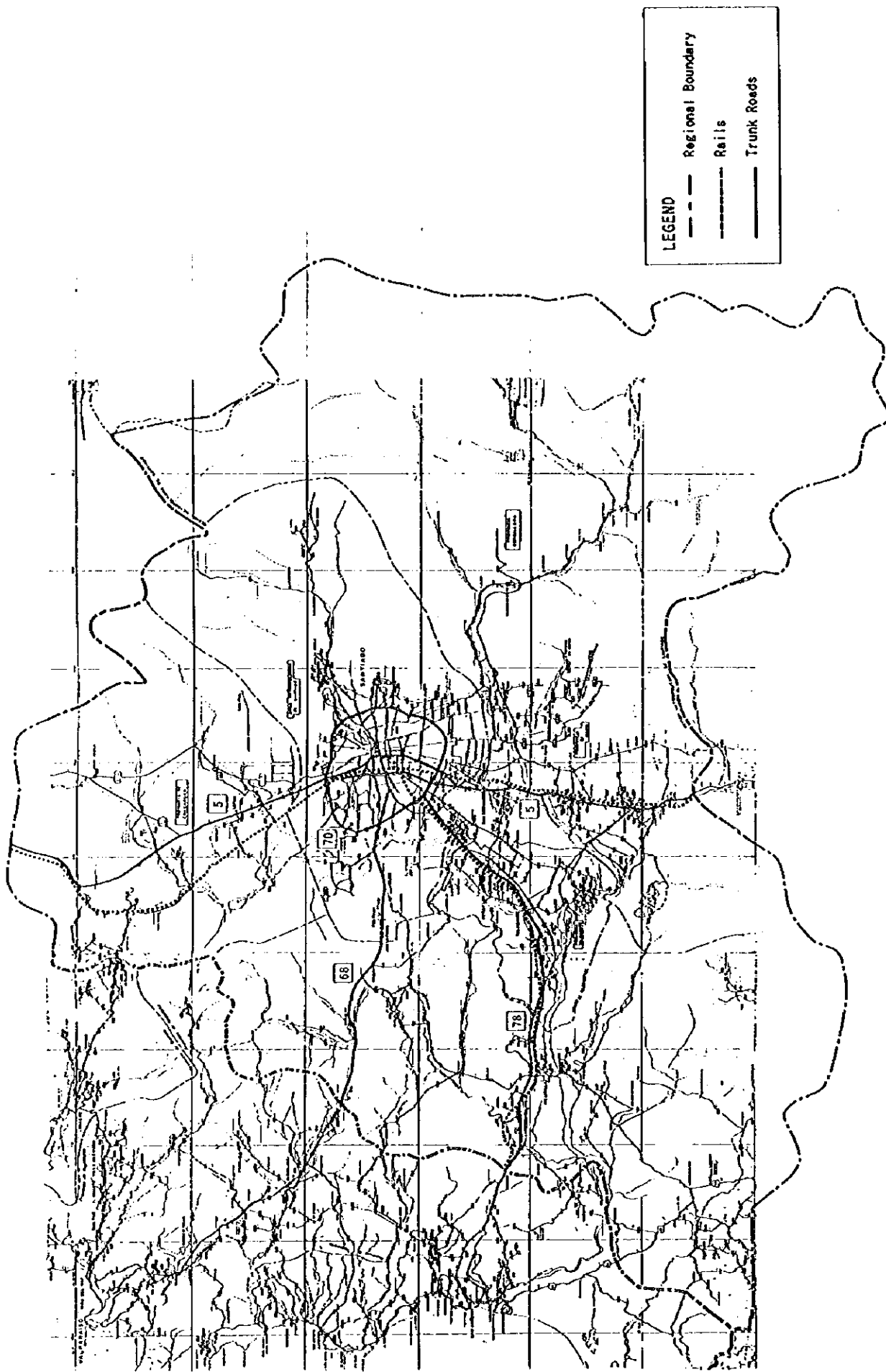


Figure 2.4c Transportation Network