JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
DEPARTMENT OF INDUSTRIAL WORKS
MINISTRY OF INDUSTRY
THE KINGDOM OF THAILAND

THE STUDY ON MASTER PLAN ON INDUSTRIAL WASTE MANAGEMENT IN THE BANGKOK METROPOLITAN AREA AND ITS VICINITY IN THE KINGDOM OF THAILAND

FINAL REPORT
SUMMARY

NOVEMBER 2002

KOKUSAI KOGYO CO., LTD.
EX CORPORATION

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
DEPARTMENT OF INDUSTRIAL WORKS
MINISTRY OF INDUSTRY
THE KINGDOM OF THAILAND

THE STUDY ON MASTER PLAN ON INDUSTRIAL WASTE MANAGEMENT IN THE BANGKOK METROPOLITAN AREA AND ITS VICINITY IN THE KINGDOM OF THAILAND

FINAL REPORT
SUMMARY

NOVEMBER 2002

KOKUSAI KOGYO CO., LTD.
EX CORPORATION

Preface

In response to a request from the Government of the Kingdom of Thailand, the Government of Japan decided to conduct and entrusted the Study on Master Plan on Industrial Waste Management in the Bangkok Metropolitan Area and its Vicinity to Japan International Cooperation Agency (JICA).

JICA sent a study team led by Mr. Shimura of Kokusai Kogyo Co., Ltd. and organized by Kokusai Kogyo Co., Ltd. and EX Corporation to Thailand six times from March 2001 to September 2002.

The study team held discussions with the officials concerned of the Government of the Kingdom of Thailand and conducted related field surveys. After returning to Japan, the study team carried out further studies and compiled the final results in this report.

I hope this report will contribute to the realization of the sound industrial waste management system and to the promotion of amity between the two countries.

I also express my sincere appreciation to the officials concerned of the Government of the Kingdom of Thailand for their close cooperation throughout the study.

November 2002

川上隆朗

Takao KAWAKAMI
President
Japan International Cooperation Agency

November 2002

Mr. Takao KAWAKAMI
President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

We are pleased to submit you the report of the Study on Master Plan on Industrial Waste Management in the Bangkok Metropolitan Area and its Vicinity in the Kingdom of Thailand.

This study was conducted by the joint venture of Kokusai Kogyo Co., Ltd. and EX Corporation, under a contract to JICA, during the period from February 2001 to November 2002. The major contents of the report are the master plan for non-hazardous industrial waste management and the action plan for hazardous industrial waste management, both of which include the technically and economically feasible and sustainable improvement measures, as a result of the detailed analysis of field survey results.

We believe that the plans proposed in the report contribute to the formulation of sound industrial waste management system, which should be one of the fundamental requirements for the social and economic development of the Kingdom of Thailand. We sincerely hope that its Government gives the highest priority to the realization of the plans.

We would like to take this opportunity to express our truthful gratitude to the officials concerned of JICA, Ministry of Foreign Affairs and Ministry of Economy, Trade and Industry. We also wish to express our gratitude to the officials concerned of Ministry of Industry of Thailand, JICA Thailand Office and Embassy of Japan in Thailand for their cooperation and assistance throughout our field survey.

Susumu SHIMURA
Team Leader
The Study on Master Plan on Industrial Waste Management in the Bangkok Metropolitan Area and its Vicinity in the Kingdom of Thailand

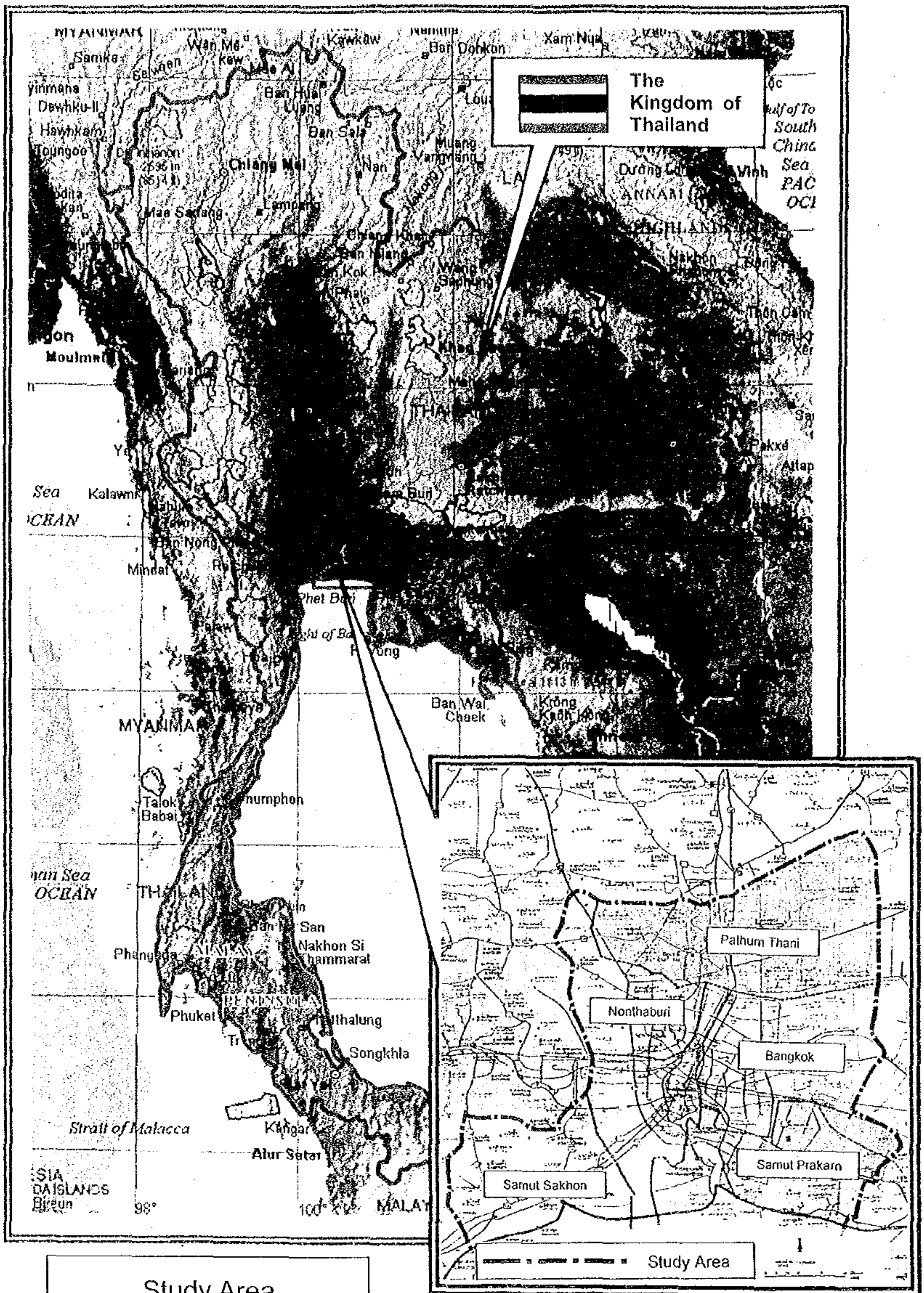
The Study on Master Plan on Industrial Waste Management In the Bangkok Metropolitan Area and its Vicinity In the Kingdom of Thailand

List of Volumes

Volume I	Summary
Volume II	Main Report
Volume III	Annex
Volume IV	Report of the Study on the Use of Waste Blenders in Japan with Particular Attention to Regulations

This is the Summary.

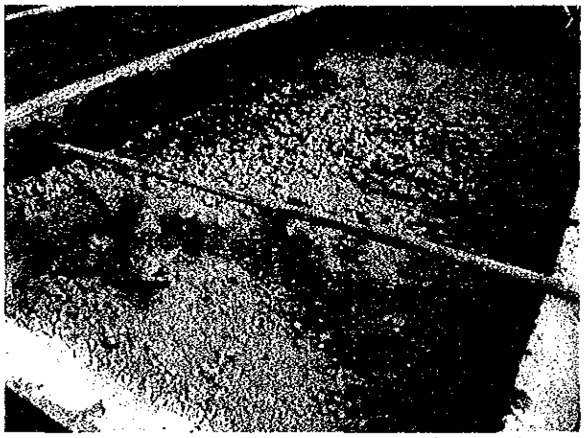
Exchange Rate Used in the Report
US$ 1.0 ＝ 43 Bahts、1 Yen ＝ 0.3 Bahts


The Kingdom of Thailand
Chiang Mai
Phet Buri
MYANMAR
Phuket
Songkhla
Strait of Malacca
Alur Setar
Pathum Thani
Nonthaburi
Bangkok
Samut Sakhon
Samut Prakarn
Study Area

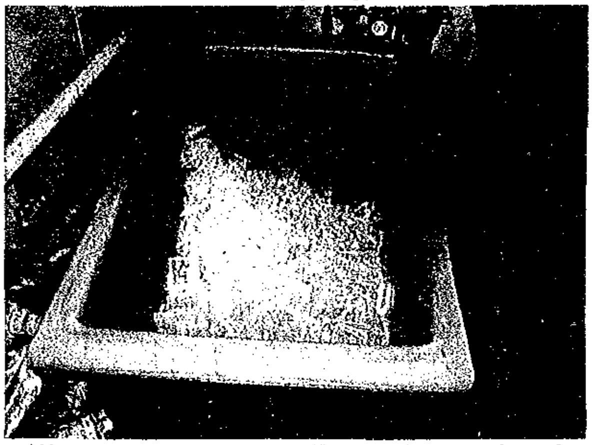
Study Area

Interview at a Factory

Waste Management at a Factory (Storage of Waste for Recycling)



Waste Management at a Factory (Sludge)



Waste Management at a Factory (Separation of Waste Glass)

Waste Management at a Factory (Installation of Bins for Waste Separation)

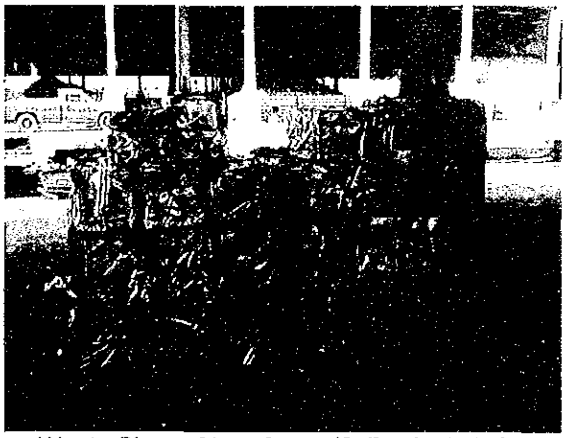
Waste Management at a Factory (Mixed Non-HW Waste)

Plate 1: Factory Survey

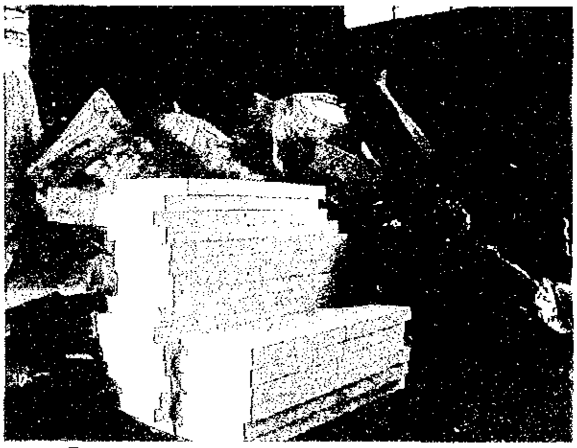
Temporal Waste Storage of Waste Buyers (1)

Temporal Waste Storage of Waste Buyers (2)

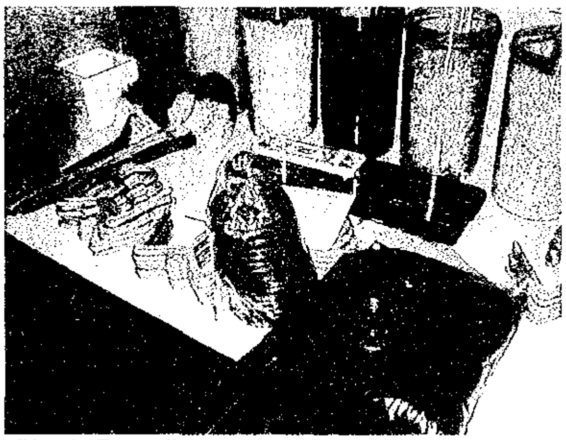
Waste Shop of Iron Scrap (1: Iron Scrap)



Waste Shop of Iron Scrap (2: Products to be Delivered to a Electric Furnace)



Plastic Recycling Factory (1: Material for Recycling)



Plastic Recycling Factory (2: Recycled Products)

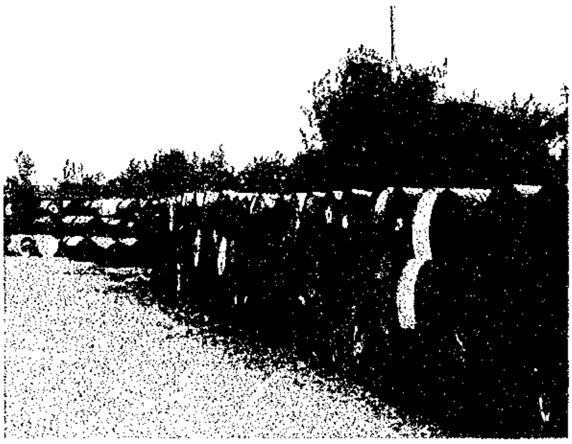
Plate 2: Survey on Waste Collection, Transport, Recycling, Treatment and Final Disposal Companies (1)

Recycling Factory: Storage of Unrecyclable Material

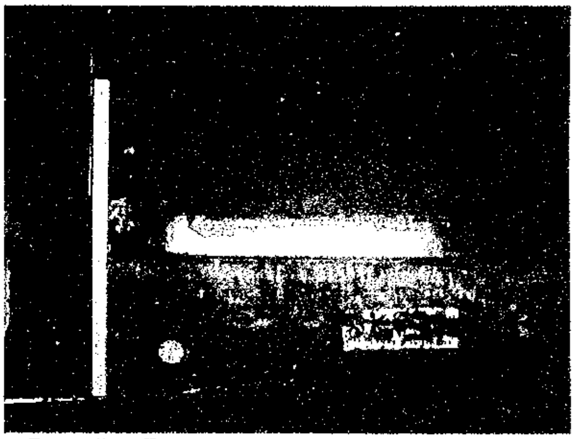
Recycling Factory: Separation of Glass Cullet

Recycling Factory: Separation of Metals from Electronic Parts

Recycling Factory: Variety of Recyclable Non-HW



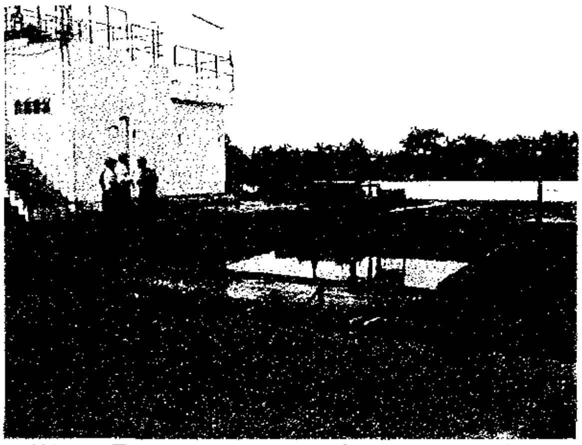
Recycling Factory: Storage of Drums of Solvent for Recycling



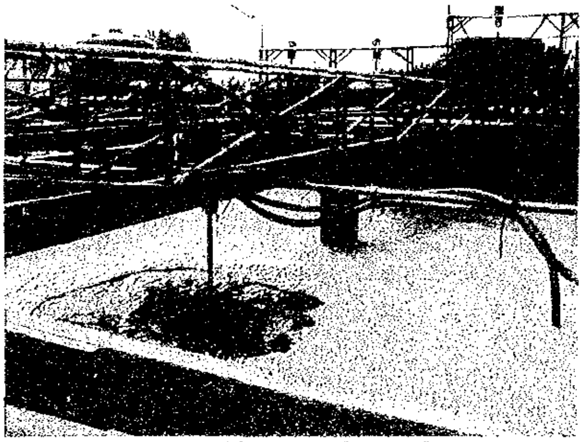
Recycling Factory: Furnace for Alminum Scrap

Plate 3: Survey on Waste Collection, Transport, Recycling, Treatment and Final Disposal Companies (2)

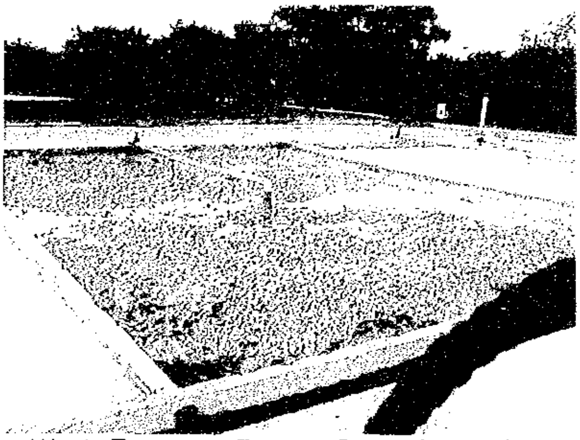
Waste Treatment Factory: Genco Samaedam Center (1: Wastewater Reception)



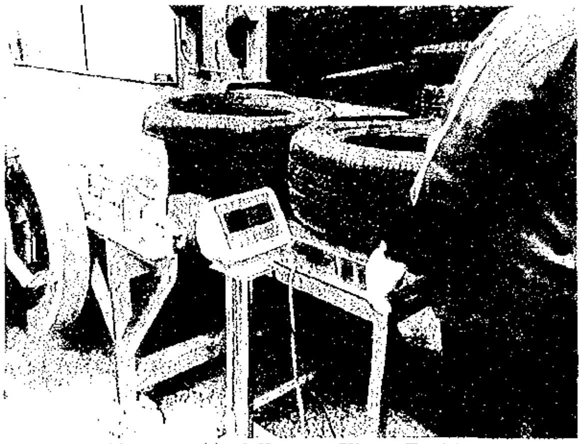
Waste Treatment Factory: Genco Samaedam Center (2: Wastewater Reception Tank)



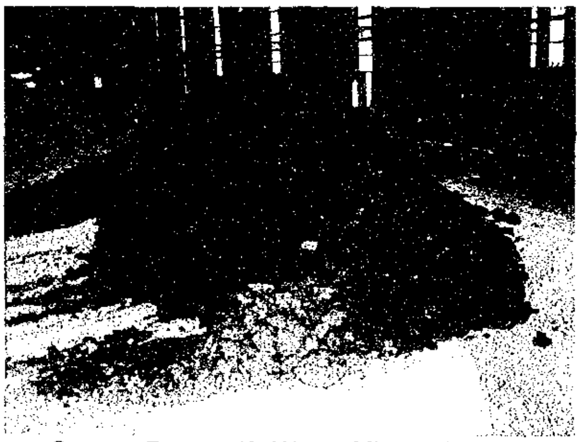
Waste Treatment Factory: Genco Samaedam Center (3: Treatment of Wastewater from Dying)



Waste Treatment Factory: Genco Samaedam Center (4: Sludge Drying Bed)

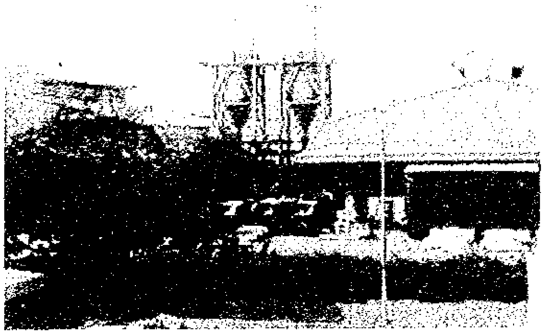


Cement Factory (1: Off-spec Tires Fed to Cement Kiln)



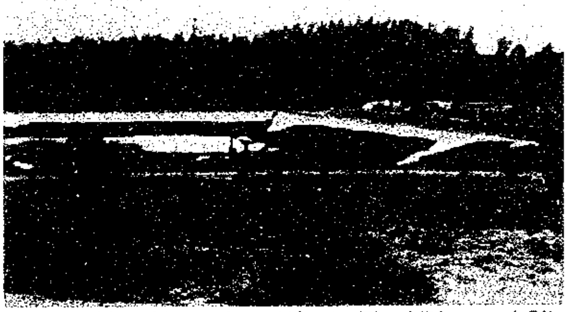
Cement Factory (2: Waste Mixed with Raw Material)

Plate 4: Survey on Waste Collection, Transport, Recycling, Treatment and Final Disposal Companies (3)



Waste Treatment Plant: GENCO Map Ta Phut
(Sludge Stabilization Facility)

Waste Final Disposal Site: GENCO Map Ta Phut
(New Landfill Under Construction)



Private Non-Hazardous Waste Final Disposal Site
(Landfill Cell)

Private Non-Hazardous Waste Final Disposal Site
(Leachate Treatment Facility)

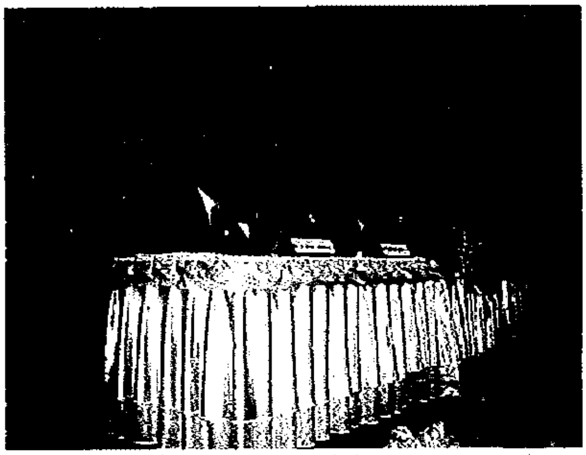
Private Hazardous Waste Final Disposal Site

Plate 5: Survey on Waste Collection, Transport, Recycling, Treatment and Final Disposal Companies (4)


Instruction given to Interviewers of POS


Interview with Local Residents

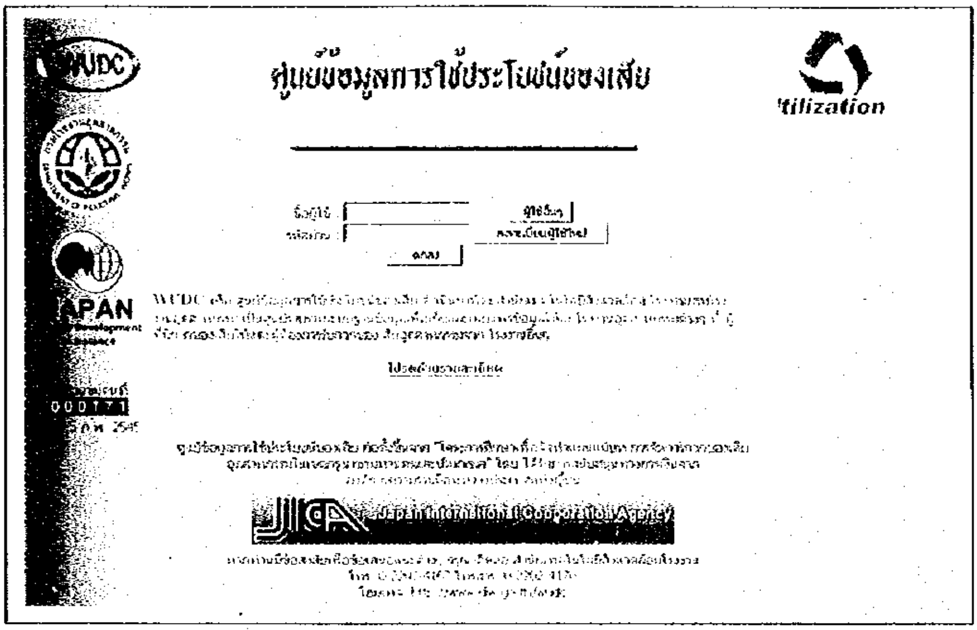

Seminar (1)


Seminar (2)

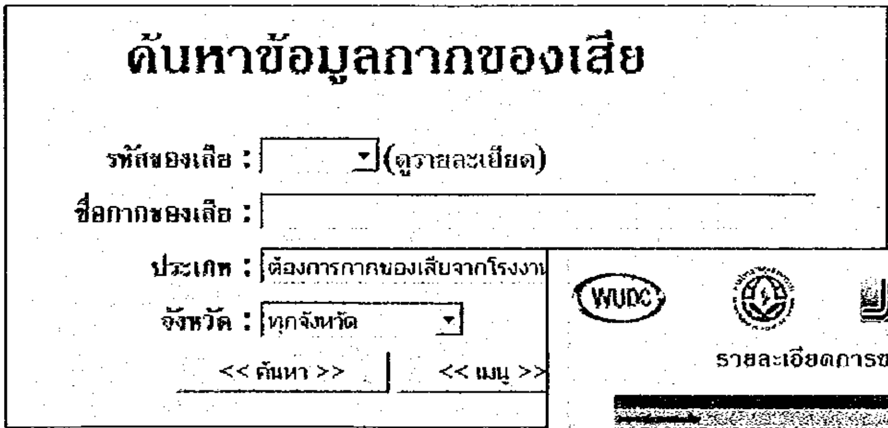

Workshop (1)


Workshop (2)

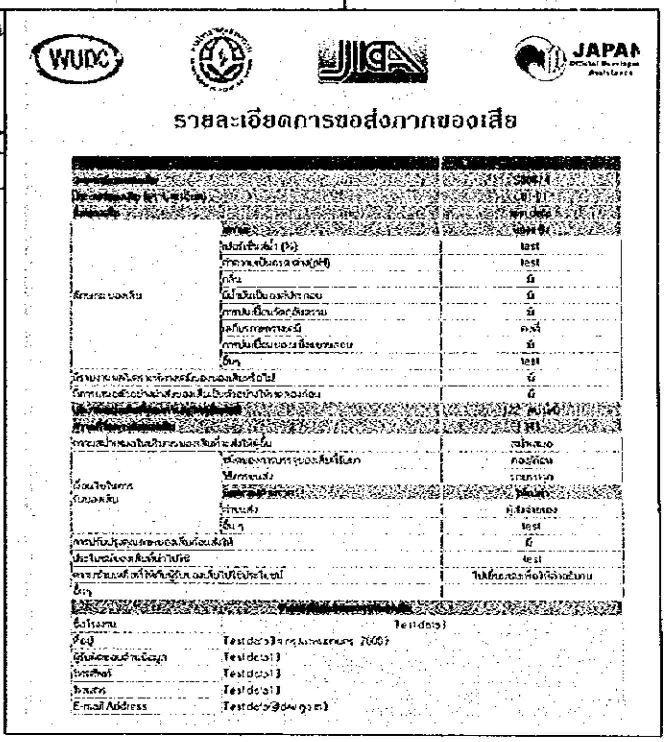
Plate 6: Public Opinion Survey (POS)/Seminars/Workshops



WUDC Website (Homepage)



Waste Search Page

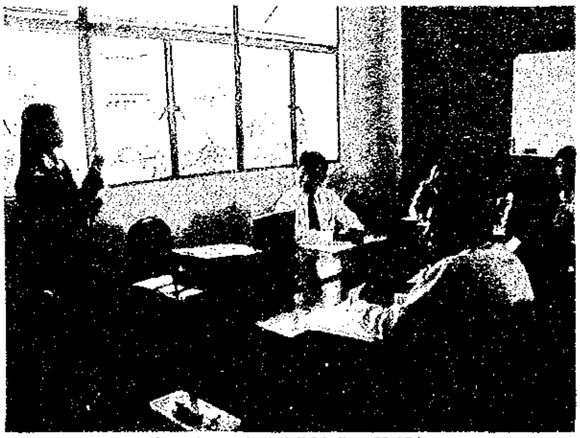


Search Result (Full Report)

Plate 7: Pilot Project (Development of Waste Utilization Data Center Website)


Lecture by DIW Staff (1)


Lecture by DIW Staff (2)


Lecture by DIW Staff (3)


Internet Execise (1)

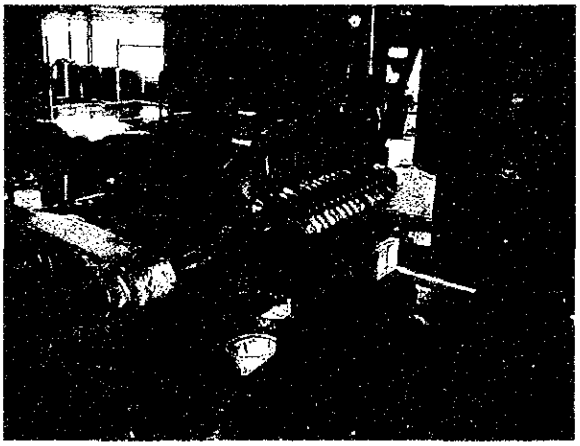

Internet Execise (2)


Internet Execise (3)

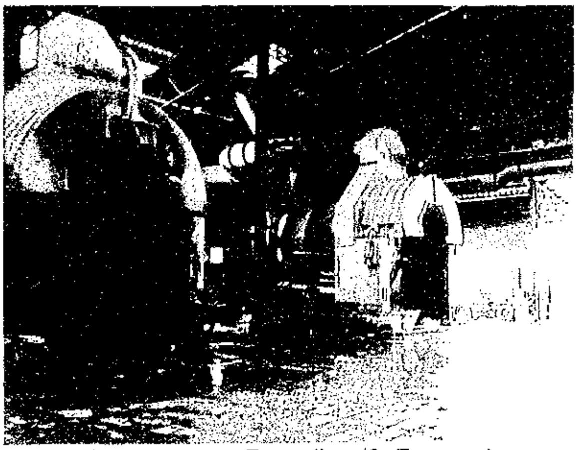
Plate 8: Pilot Project (WUDC Dissemination Seminar)


Waste Oil Recycling (1: Reception Facility)


Waste Oil Recycling (2: Recycling by Sulfuric Acid/Activated Clay Process)


Waste Oil Recycling (3: Reformed Oil Production Process)


Waste Battery Recycling (1: Reception of Waste Batteries)


Waste Battery Recycling (2: Furnace)

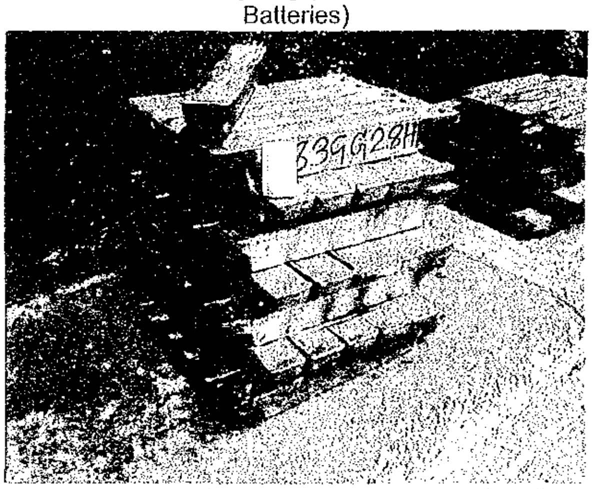

Waste Battery Recycling (3: Recovered Lead)

Plate 9: Survey on Waste Oil and Waste Battery Recycling Industry

CONTENTS

List of Tables

Page:

List of Figures

LIST OF ABBREVIATIONS

A/P	Action plan
BMA	Bangkok metropolitan administration
C/P	Counterpart
DB	Database
DF/R	Draft final report
DIW	Department of industrial works
FIRR	Financial internal rate of return
F/R	Final report
FTI	The Federation of Thai industries
GIS	Geographic information systems
HW	Hazardous waste
IC/R	Inception report
IEAT	Industrial estate authority of Thailand
ISIC	International standard industrial classification
IT/R	Interim report
IW	Industrial waste
IWM	Industrial waste management
JICA	Japan international cooperation agency
LC	Local consultant
M/M	Minutes of meetings
M/P	Master plan
MOI	Ministry of industry
MOPH	Ministry of public health
MOSTE	Ministry of science, technology and environment
MW	Municipal waste
MWM	Municipal waste management
NSEDP	National Social and Economic Development Plan
NGO	Non-Governmental organization
Non-HW	Non-hazardous waste
NPV	Net present value
OEPP	Office of Environmental Policy and Planning
O&M	Operation and maintenance
P/P	Pilot project
P/R	Progress report
PCD	Pollution control department
POS	Public opinion survey
S/W	Scope of work
TEI	Thai Environment Institute
TSIC	Thailand standard industrial classification
WUDC	Waste Utilization Data Center

Code for Industrial Sectors

Study Code	MOI Code	Description of Industries
G01	001 – 002, 004 – 009	Food (agricultural product, non-aquatic animals, aquatic animals etc.)
G02	010 – 015	Food (flour, sugar, tea, ice etc.)
G03	016 – 021	Drink, Beverage
G04	022	Textile, Thread, Fibre
G05	023 – 027	Textile product (Clothes, mats etc.)
G06	028	Wearing Apparel
G07	029 – 033	Hide, Fur, Footwear
G08	034	Woodwork (any or many items)
G09	035 – 036	Woodwork (bamboo, rattan, straw, cork etc.)
G10	037	Furniture
G11	038 – 040	Paper, Cardboard
G12	041	Printed matter
G13	042 – 050	Chemical matter, Petroleum
G14	051 – 052	Rubber
G15	053	Plastic product
G16	054 – 058	Glassware, Ceramics, Non-Metallic Matter
G17	059 – 060	Steel basic industries, Non-ferrous metal basic industries
G18	061 – 062	Metal product (tools, appliances, household furniture, building interior etc.)
G19	063	Metal product (construction, installation)
G20	064	Metal product (others)
G21	065 – 066	Machines (Engines, Turbines, Machinery)
G22	067	Machines (for producing metal or wood products)
G23	068	Machines (for paper, chemical, food, textile etc.)
G24	069 – 070	Machines (calculating machines, Accounting machines, Water pumps, air or gas compressors etc.)
G25	071 – 073	Electric product (Machines or Product under No.70, Radio set, Electric instruments or appliances etc.)
G26	074	Electric product (Electric Equipment)
G27	075 – 077	Transportation machines (Ship, Trains, Streetcars, Cars or Trailers)
G28	078 – 080	Transportation machines (Motorcycles, Tricycles, Bicycles, Aircraft, Wheeled vehicles etc.)
G29	081 – 084	Precision machinery
G30	085 – 087	Others (Musical instruments, Sport, Toys etc.)
G31	088 – 094	Others (Electric power, Gas, Packaging, Cold storage etc.)
G32	095	Others (Engine-driven for vehicles or motorcycles etc.
G33	003, 096 – 104	Others (Stone, Watches or Clocks, Central waste treatment plant, Generating steam, salt etc.)

Central waste treatment plant is MOI code 101.
MOI code 105 "waste sorting and landfilling" and code 106 "waste reuse/recycling" were newly added in December 2001.

Non-Hazardous Industrial Waste

Type of Non-Hazardous Waste	Non-Hazardous Waste Code
Parts of plants such as roots, barks and leave	C01-01
Parts of animals such as bones, skins, hair and excreta	C01-02
Parts of wood	C02
Paper wastes	C03
Plastics or synthetic rubbers	C04
Cloth, thread and fabric	C05
Animal's fat and oil and vegetable oil	C06
Natural rubbers	C07
Metals and metal alloys (not in salt form)	C08
Ceramics	C09-01
Glasses	C09-02
Stone, cement, sand or materials consisting of clay, sand or stone e.g. tile, brick gypsum and concrete	C10
Mixed waste	C11
Others	C12

Hazardous Industrial Waste

HW Code for the Study	Description	Detail Description
W01-01	Inorganic acid	Sulfuric acid (H_2SO_4), Hydrochloric acid (HCl), Nitric acid (HNO_3), Phosphoric acid (H_3PO_4), Other inorganic acids
W01-02	Organic acid	Acetic acid (CH_3COOH), Formic acid (HCOOH), Other organic acids
W02	Alkalis	Caustic soda (NaOH), Ammonia (NH_3), Sodium carbonate (Na_2CO_3), Other alkaline materials
W03-01	Heavy Metal Compounds	Salts
W03-02		Toxic salts (Hg, As, Cd, Pb, Cr)
W03-03		Heavy metal other than the above
W04-01	Liquid Inorganic Compounds	Plating wastes, Cyanides
W04-02		Liquid inorganic compounds other than the above
W05	Solid Inorganic Compounds	Asbestos, Slag, Silt
W06-01	Organic Compounds	Reactive chemical wastes (Oxidizing agents, Reducing agents, etc)
W06-02		Solvents
W06-03		Organic compounds other than the above
W07-01	Polymer Materials	Epoxy resin, Chelate resin, Polyurethan resin
W07-02		Latex rubber
W07-03		Polymer materials other than the above
W08-01	Fuel, Oil and Grease	Lubricating oil (Engine oil, Grease, etc)
W08-02		Chlorinated solvents (Trichloroethylene, Methyl chloride, etc)
W08-03		Oil waste other than the above
W09	Fine Chemicals and Biocides	Pesticide, Medicine
W10	Pickling Waste	---
W11-01	Filter Materials, Treatment Sludge	Inorganic sludge
W11-02		Organic sludge
W12-01	Other Toxic substance (besides W01-W11)	Non-HW mixed or contaminated with HW according to MOI Notification No. 6 (Year 1997) pursuant to the Factory Act.
W12-02		Waste from specific industrial processes
W12-03		Chemical dust, Chemical container etc.

1 Introduction

1.1 Background

Due to the excessive concentration of socio-economic activities into the Bangkok metropolitan area and its neighboring provinces, waste issues have become a growing concern.

Solid waste has two categories: municipal waste (MW) and industrial waste (IW). Bangkok Metropolitan Administration (BMA) and provincial governments deal with the former to a certain extent, although not fully satisfactorily because of the difficulties of finding a future waste disposal site. The management system for the latter, which is under the control of Department of Industrial Works (DIW) of Ministry of Industry (MOI), is, however, still immature in spite of its efforts.

IW is further divided into two: non-hazardous waste (non-HW) and hazardous waste (HW). Enough attention has not been paid to non-HW and how and how much it is actually generated, discharged, collected, transported, treated and disposed of is not well known. Without such information, DIW does not have an effective control measure over waste sources, i.e. industries.

On the other hand, a number of studies on HW have been carried out. "Preparation of register on hazardous waste generation and GIS application for the province Samutprakarn" is coming to its final stage with an assistance of the German government, and the master plan of HW management is being prepared by DIW. The progress of actual waste management projects is, however, very little because of a lack of concrete action plans and strong oppositions of local residents against the projects.

Given these conditions, the Government of Thailand requested to the Government of Japan a study on a master plan (M/P) of industrial waste management (IWM) in the Bangkok Metropolitan Area and its vicinity to be made. In response, the Japan International Cooperation Agency (JICA), Japan's technical assistance implementing agency, discussed the details of the study with the Thai side and the both parties signed a Scope of Work (S/W) to implement the study.

After the competitive tender, JICA appointed a joint venture of Kokusai Kogyo Co., Ltd. and Ex Corporation as the consultant of the study.

1.2 Scope of the Study

1.2.1 Objectives of the Study

The objectives of the study were as below as defined in the S/W.

1) To formulate a master plan (M/P) for the proper management of non-hazardous waste (Non-HW) in the Bangkok Metropolitan Area and its vicinity with the target year 2010 as well as an action plan for immediate improvement, taking integrated environmental protection and waste minimization/recycling into consideration.

2) To set up proper standard and regulations for non-hazardous waste management (Non-HWM).

3) To formulate an action plan (A/P) on hazardous waste management (HWM) concentrating in the area of waste reuse/recycling, industrial cluster and zero emission concepts.

1.2.2 Study Wastes

The study covered industrial waste (IW) that generates at factories regulated by the Factory Act, B.E. 2535 (1992). The industrial waste has two categories: HW and Non-HW. The former one is stipulated in the MOI Notification No.6, B.E. 2540 (1997) and the latter in the MOI Notification No.1, B.E. 2541 (1998).

1.2.3 Study Area

The study covered the Bangkok Metropolitan Area (or simply referred as Bangkok in the report which corresponds to the area administered by the Bangkok Metropolitan Authority (BMA)), Samut Prakarn, Nonthaburi, Pathum Thani and Samut Sakhon Provinces (See Figure 1-1).

1.3 Policies of the Study

The team set up four core policies for working on industrial waste management plans (IWMP, either M/P or A/P) in this study.

1. Practicability

Any plans will be in vain unless they are implemented. The team attempts to formulate a practical IWM M/P and A/P not replicating the systems running in other countries but reflecting the real conditions in Thailand.

2. Sustainability

The team attempts to formulate a IWM M/P and A/P which aim at the establishment of sustainable IWM not passing environmental burden on to the next generation.

3. Social acceptance

Problems of IWM should not be left with only industries but must be tackled by the society. In order to involve the society, plans for IWM should be accepted by the society.

4. Thai initiative

The Thai side should take the initiative in carrying out the study, so that it can smoothly bring the output of the study, i.e. M/P and A/P, into effect and apply the experience in other occasions.

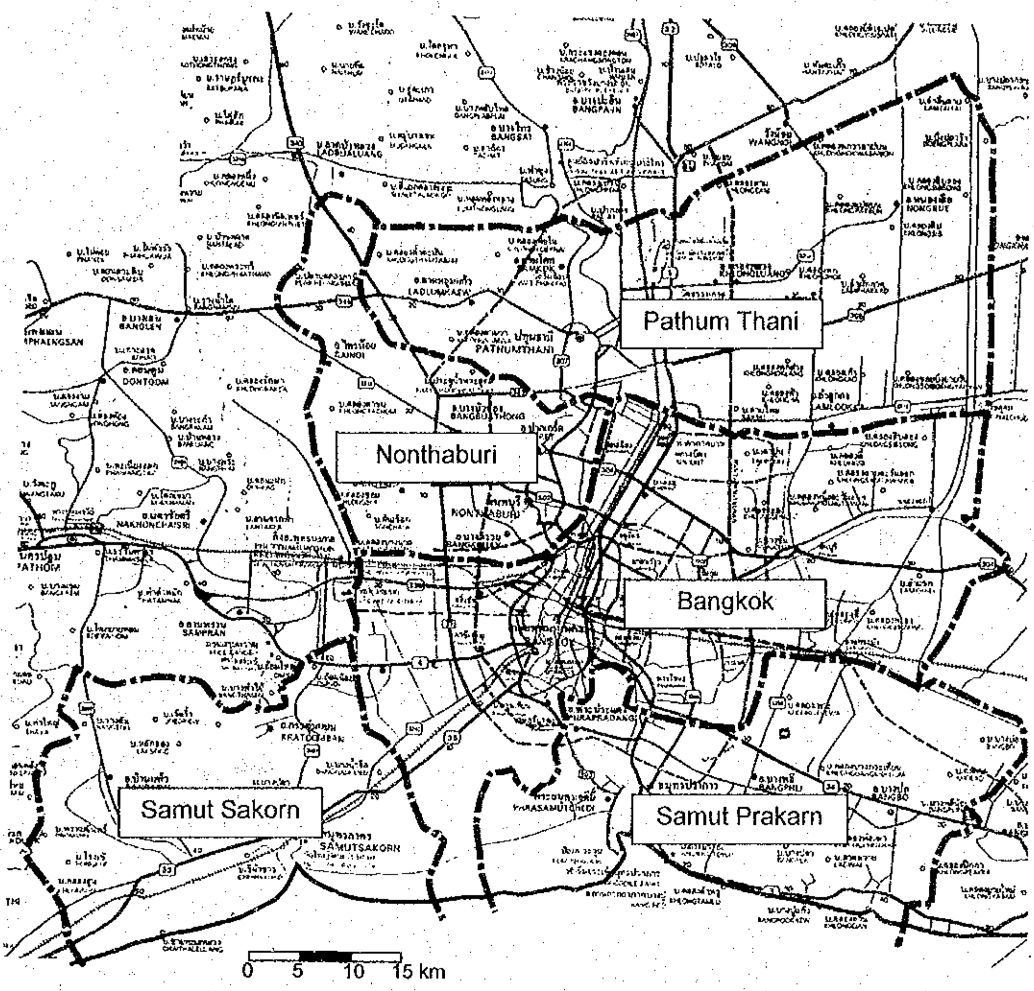


Figure 1-1: Study Area

1.4 Work Schedule

The work schedule is shown in Figure 1-2 and Figure 1-3.

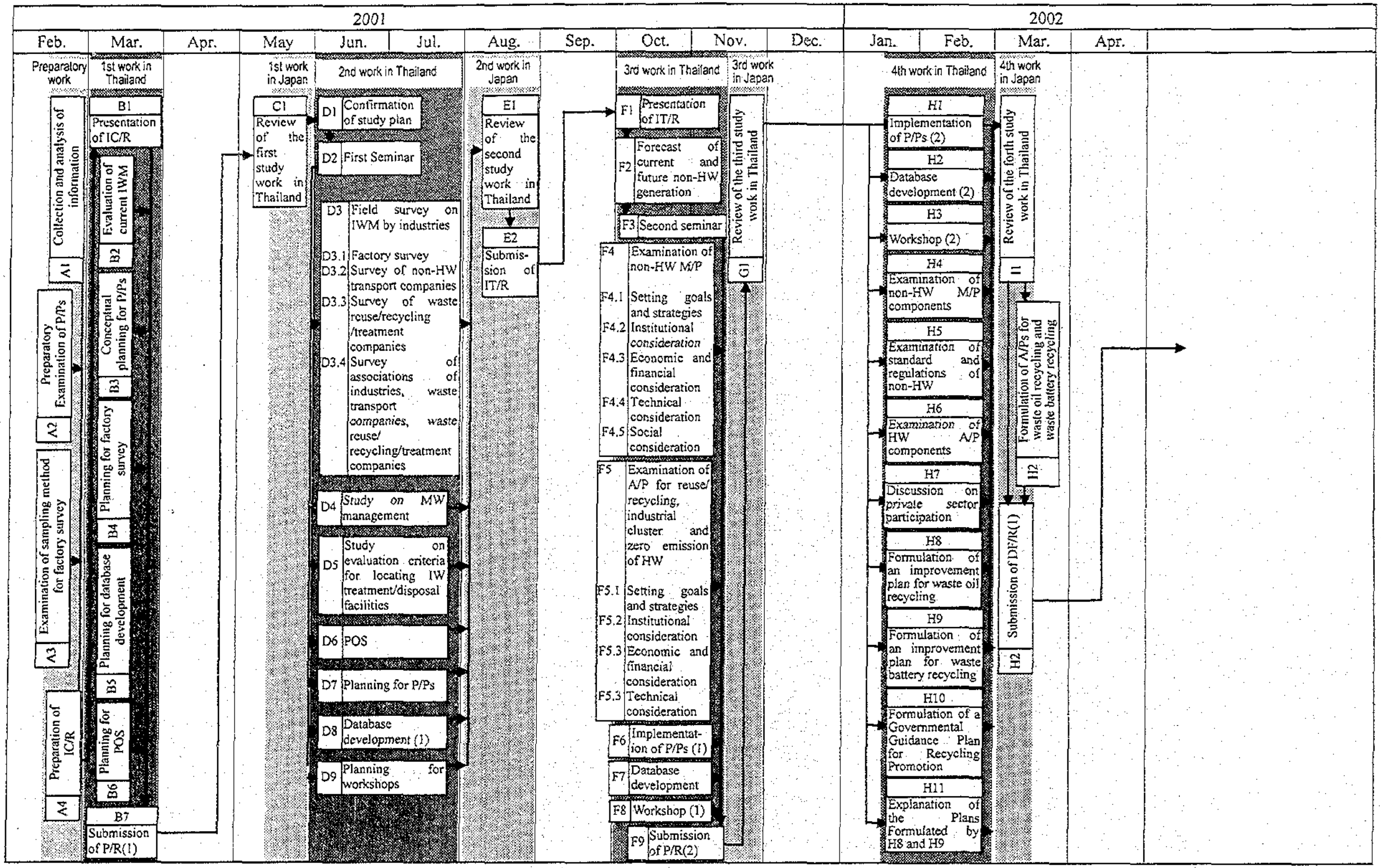


Figure 1-2: Work Schedule (1)

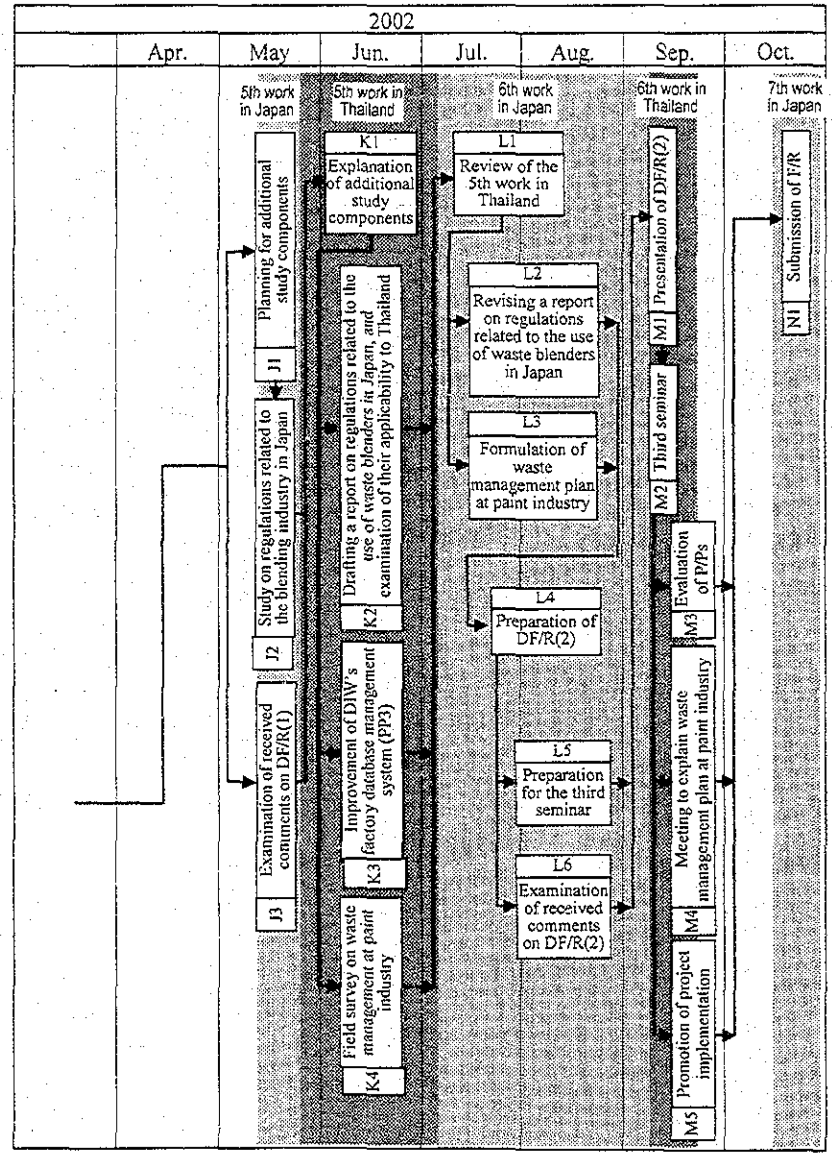


Figure 1-3: Work Schedule (2)

1.5 Persons Involved

a. Study Team Members

The JICA study team consisted of the following members.

Table 1-1: Team Members

Field in Charge	Name	Nationality
Team leader / Industrial waste management planning	Susumu Shimura	Japanese
Institution building	Anek Hirunraks / Sakchai Suriyajantratong	Thai
Industrial waste management	Tamotsu Suzuki	Japanese
Waste recycling and minimization	Shoji Nakamura	Japanese
Public sector participation	Takeshi Kojima	Japanese
Industrial waste treatment facility planning / site evaluation	Ichiro Kono	Japanese
Economic and financial analysis	Satoshi Sugimoto	Japanese
Data management	Kunito Ishibashi	Paraguayan
Social and environmental consideration	Keiko Kani	Japanese
Pilot project (tannery industry)	Tomizo Ogawa	Japanese
Pilot project	Noriko Otsuki	Japanese
Governmental guidance for recycling promotion	Zensuke Inoue	Japanese
Waste oil recycling	Eiichi Yasuoka	Japanese
Waste battery recycling	Kenji Kunogi	Japanese
Hazardous waste survey	Takeshi Higo	Japanese
Paint industry waste survey	Toshihei Masuda	Japanese
Waste blender/Administrative coordinator 2	Kaoru Tsuda	Japanese
Administrative coordinator 1	Precha Chuntakorn	Thai

b. Counterpart Members

The following DIW officers worked with the JICA team as counterpart.

Ms. Kanya Sinsakul/ Mr. Virah Mavichak	Director General
Mr. Veerachat Bunnag/ Mr. Kosol Jairungsee	Director, Bureau of Industrial Environment Technology
Dr. Jullapong Thaveesri	Head, Waste Management Division, Bureau of Industrial Environment Technology
Mr. Supap Sansook	Scientist 8, Bureau of Industrial Environmental Technology
Mr. Supap Sansook	Scientist 8, Bureau of Industrial Environmental Technology
Mr. Sudsakorn Pudtho	Contract and International Cooperation Advisor
Ms. Kanokpan Supatanasinkasem	Scientist 7, Bureau of Industrial Environmental Technology
Mr. Naratip Lauhatiranada	Scientist 7, Bureau of Industrial Environmental Technology
Ms. Nuchanat Suphansri	Scientist 6, Bureau of Industrial Environmental Technology
Mr. Kajornpong Sirivisoot	Engineer 3, Bureau of Industrial Environmental Technology

2 Current Industrial Waste Management

2.1 Profile of the Study Area Natural Conditions

2.1.1 Natural Condition

The study area extends along the lower basin of the Chao Praya River and the Tha Chin River in the Central region of Thailand. It covers the area of 5,593 square kilometers, and most part of the area is a low flat land. Bangkok, located in the center of the study area, is the most urbanized and industrialized area in Thailand, and agriculture and rice farms can be seen only in the sub-urban area. In the other 4 provinces, the areas bordering Bangkok are now changing into residential or industrial areas from an agricultural area.

The climate of the central plain of Thailand is categorized as tropical savannah (Aw), and weather is divided into three seasons, winter, summer and rainy season. An average rainfall was about 1,351.2 mm with an average of 117.8 rainy days according to the meteorological data of this region in 1998 by the Meteorological Department.

2.1.2 Social Conditions

a. Administration

According to the National Public Administration Act B.E. 2534 (1991), the nation public administration of Thailand has 3 types, Central Administration, Provincial Administration, and Local Administration, as shown in Figure 2-1.

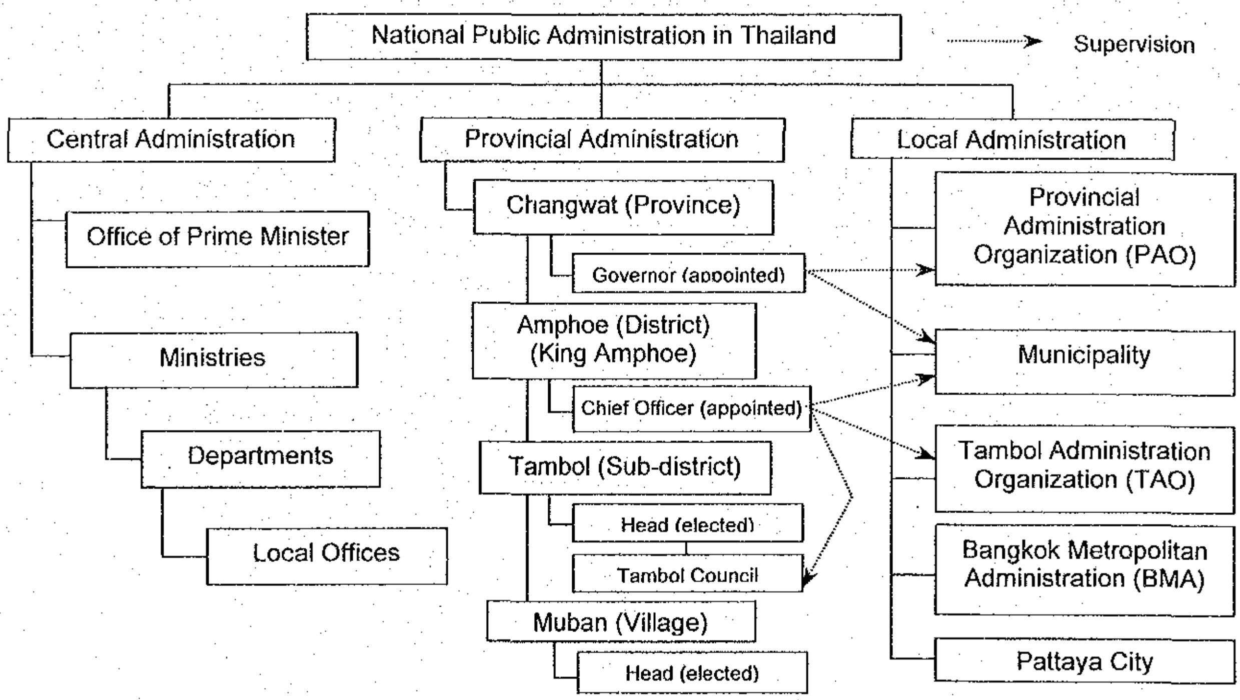


Figure 2-1: Structure of National Public Administration in Thailand

a.1 Central Administration

The central administration is under the concept of centralization by the government aiming at the application of national policies over the country and smooth implementation for policy accomplishment.

The central administration consists of the Office of Prime Minister and 13 Ministries. The Ministries have departments which act nearly independently and often have local offices.

a.2 Provincial Administration

The provincial administration, under the basic concept of decentralization, is responsible for taking policies from the central administration to perform and to be representative of the central government agencies. It has a hierarchical structure as in Figure 2-1.

a.3 Local Administration

The local administration is based on the concept of decentralization according to the National Public Administration Act B.E. 2534 (1991) which stipulates that any area is ready for people participation in the local administration. There are 5 types of the local administration in Thailand today, as shown in Figure 2-1.

a.4 Structure of Public Administration and Population in Bangkok and its Vicinity

Province	Population	*Provincial administration*			*Local administration*		
		Amphoes	Tambols	Mubans	PAO	Municipalities	TAOs
Nonthaburi	879,029	6	52	421	1	9	37
Pathum Thani	633,994	7	60	494	1	13	52
Samut Prakarn	977,388	5 + 1 King Amphoe	50	406	1	16	32
Samut Sakhon	421,738	3	40	288	1	7	31
Bangkok	5,662,499	50 districts and 154 sub-districts					

Source of population: Population statistics B.E. 2542 (1999) prepared by the Department of Local Administration

b. Population

Population statistics B.E. 2542 (1999) prepared by the Department of Local Administration indicates that Bangkok is the most crowed city where 5,662,499 people live. Population in Nonthaburi, Pathum Thani, Samut Prakarn, and Samut Sakhon is 879,029, 633,994, 977,388 and 421,738 respectively. The proportion of population in these areas to the whole population is 9.3%, 1.4%, 1.0%, 1.6%, and 0.7% in the order as above, which sum up to 14.0%.

c. Public Utilities

c.1 Electricity

Electricity supply in Bangkok is under the responsibility of Metropolitan Electricity Authority, which also supplies electricity to part of Nonthaburi and Samut Prakarn. Most of other area in the study area is supplied electricity by the Provincial

Electricity Authority, with an exception of part of Nonthaburi, where the Electric Generation Authority of Thailand (EGAT) is the supplier.

c.2 Water Supply

Water in Bangkok is provided by Metropolitan Waterworks Authority, which also provides water some part of Nonthaburi and Samut Prakarn. Its water sources are the Chao Praya River, the Tha Chin River and groundwater.

In the other provinces, the Provincial Waterworks Authority (PWA) is the water supplier, but supply is limited to large communities: small communities and villages outside the PWA service area mostly draw up groundwater by themselves.

c.3 Wastewater Management

There are a number of wastewater treatment plants constructed and operated in the study area including Bangkok, Nonthaburi and Pathum Thani. The plants in the Bangkok mostly employ the activated sludge system. In Samut Prakarn, a plant is under construction in tambol Khlong Dan, being expected to complete by 2004. There is no wastewater management project in Samut Sakhon.

2.1.3 Economic Conditions

a. National Economy

Thai economy has been keeping its high growth for a long term since 1960s. Rapid industrialization due to a large inflow of direct capital investment and increase in export in 1980s changed the agriculture-oriented economy to industry and service oriented.

In the case of Thai economy, the trend of export and import has a high correlation with the growth of national economy because the total of export and import value covers more than 50% of the gross domestic product (GDP). However, while the increase in export accelerated the imports of raw materials as well as the production of relevant industries, its positive impacts on domestic economy were limited.

Another important characteristic of Thai economy is the disparity in income among the regions, especially between the Bangkok metropolis including its vicinity and other regions. Large-scale industries including foreign firms dealing with export and import businesses are mostly located in the vicinity of Bangkok, while agriculture and small and medium size enterprises (SMEs) are the main industries in other regions. It implies that poverty alleviation and reduction of income disparity will be a more important policy issue to be addressed in Thailand.

a.1 History and Present Status of Thai Economy

Figure 2-2 shows the trend of actual economic growth rate in Thailand between 1970 and 1999. Even though the first and second oil crises slowed the pace of economic growth, the Thai economy grew steadily as a whole until the latter half of the 1990s. In particular, from 1988 to 1990, it recorded the growth rate of over 10% for the consecutive three years, mainly due to the increased inflow of direct investment influenced by the trend of a strong yen and a weak dollar, as well as to the increase in the exports of diversified products. The unprecedented financial crisis in the second half of 1990s hit the Thai economy, ending with the negative economic growth for two years (1997 and 1998), but the average annual growth rate during 1970-1999 was

6.5% and it can be said that Thailand is one of the most successful countries in Asia in its economic development.

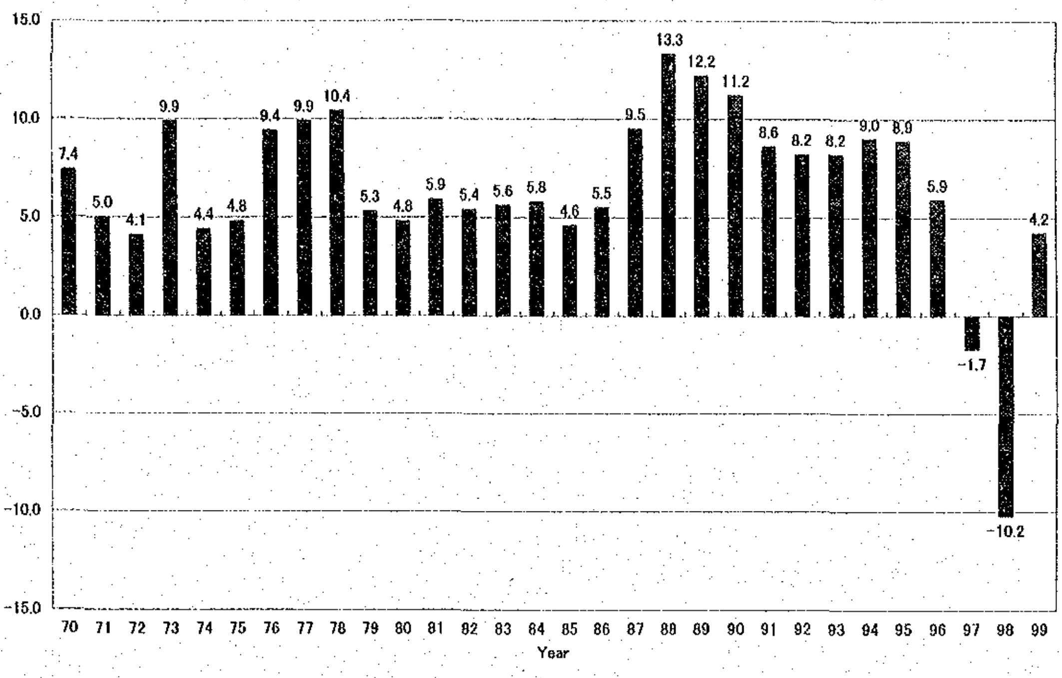


Figure 2-2: Trend of Actual Economic Growth Rate in Thailand (1970-1999)

Source: NESDB (National Economic and Social Development Board)

Currently in 2000, the GDP in Thailand reached around 122 billion US dollars, which was the second largest after Indonesia among the ASEAN countries. Thailand is also taking the leading role in the development of Indochina economic zone.

a.2 Structure of Thai Economy

Thai economy drastically changed its structure with rapid industrialization in the late 1980s. Comparing the structure of Thai economy between 1980 and 1990, the ratio of agriculture to the GDP decreased from 23.2% to 9.3% while the ratio of manufacturing industry increased from 21.5% to 35.5%.

Regarding the ratio of employed persons by sector, the percentage of agriculture sector decreased from 64.0% to 48.4% between 1990 and 2000 while manufacturing, commerce, and services sectors increased their percentage of employed persons during the same period. However, agricultural sector still takes the biggest role in the employment of potential labor force.

a.3 Per Capita GDP and its Regional Disparities

Per capita GDP has also increased with the growth of national economy in Thailand. Per capita GDP of 2,173 bahts in 1960 had doubled to 4,077 bahts in 1970 and increased 3.5 times more to 14,180 bahts in 1980. Just before outbreak of the economic crisis in 1996, per capita GDP recorded 77,043 bahts or 3,100 dollars US. Since the outbreak of economic crisis, per capita GDP drastically decreased with the depreciation of Thai bahts against US dollars and other foreign currencies, ending up with 74,675 bahts or 1,976 dollars US in 1999.

Comparing the level of per capita GDP among ASEAN countries, Thailand is the third biggest after Singapore and Malaysia.

An important issue to be addressed in Thailand is the disparity in wealth among regions. Bangkok and its vicinity produced 48.4% of the total GDP in 1998. Per capita GDP in Bangkok and its vicinity is 4,990 dollars US annually while the average in the Northeastern Region only reached 638 dollars US. Solution to this disparity in wealth among regions will be a key to the further development of the national economy in Thailand.

b. Regional Economy (the study area)

In terms of GDP, the study area produces 48.4% of the national total. Bangkok covers 79% of the GRP in the study area. In terms of GDP in Thailand, the percentage covered by Bangkok reached around 37% in 1998.

On the other hand, comparison of per capita GRP in 1998 at current market prices by provinces in the study area shows that Bangkok recorded the largest per capita GRP of approximately 231 thousand Bahts, which was followed by Samut Sakhon's 222 thousand and Pathun Thani's 211 thousand bahts. Nontaburi showed the lowest per capita GRP, 110 thousand and these figures indicate the difference in the scale of economy among the provinces in the study area.

c. Industries

c.1 General

Manufacturing industry is the second largest after service industry in terms of GDP in Thailand, accounting for 35.5% in 1999. According to the industrial statistics in 1998 provided in the Statistical Yearbook of Thailand 2000, Bangkok and its vicinity, the study area, covers about 63 % in terms of the number of manufacturing establishments. The study area can be defined as the center of manufacturing industry in Thailand.

Although the number of establishments is larger in Bangkok, the number of employees and gross output value of manufacturing industry is much larger in the vicinity. This is mainly due to the concentration of large-scale industries in the vicinity resulting from the active development of industrial estate and parks.

c.2 Number of Registered Factories

Industrial Statistic 1999 indicates that the highest number of registered factories of 21,309 is found in Bangkok, while it is 5,589 and 2,710 in Samut Prakarn and Samut Sakorn respectively. Comparing with the number in the year 1991, the highest increasing rate is recorded by Samut Sakorn, followed by Pathum Thani and Nonthaburi.

c.3 Characteristics of Manufacturing Industries in the Study Area

In terms of number of establishments and employees, sub-sector of textiles and wearing apparels is the largest among the sub-sectors of manufacturing industry in Bangkok and its Vicinity. Sub-sector of metals and their products is the second largest in the number of establishments while food and beverage sub-sector is the second largest in the number of employees.

Regarding the gross output value, electronic machinery and equipment manufacturing is the largest, accounting for 20% of the total of manufacturing industry in the Study

Area. Food and beverage manufacturing industry is the next largest and followed by textiles/wearing apparels and transport machinery and equipment sub-sectors.

Looking into the value-added of each sub-sector of manufacturing industry, food and beverage sub-sector is the biggest, accounting for 23% of the total value-added produced by the manufacturing industry in the study area. Next biggest is the motor vehicles manufacturing sub-sector, covering about 17%.

c.4 Development of Industrial Estates/Parks

According to the 'Y2K Factory Directory & Map, there are 11 industrial estates and parks in the study area. Bangkok and its vicinity area is designated by the Board of Investment (BOI) as Zone 1, in which investment is strongly promoted by providing special economic incentives to the investors as shown in Table 2-1 below.

Table 2-1: Investment Incentives in Zone 1

	Investment outside industrial estate/park	Investment inside industrial estate/park
Zone 1	- 50% reduction of import duty on machinery. - One-year exemptions of import duty on raw materials for the products to be exported.	- 50% reduction of import duty on machinery. - One-year exemptions of import duty on raw materials for the products to be exported. - Exemption of corporate income tax for 3 (three) years.

Source: Chamber of Commerce, Japan, Thailand Office, 2001

In Thailand, there are three types of industrial estates in terms of their developers, i.e. direct development and operation by the Industrial Estate Authority of Thailand (IEAT), joint development and operation between IEAT and private sector, and development and operation solely by private sector. Investment in the IEAT affiliated industrial estates can obtain such incentives as freely acquisition of land, employment of foreign experts, and remittance of capital or dividend to abroad.

In terms of the levels of incentives, BOI categorizes the industrial estate into three types, namely, General Industrial Zone (GIZ), Export Processing Zone (EPZ), and Free Trade Zone (FTZ). Although there is no FTZ realized, evolved EPZ, named EPZ-plus, is established with additional incentives. In the case of EPZ, the above incentives are permanently provided to the enterprises without any specified duration.

In the context of above encouraging incentives, industrial estates and parks were actively developed and operated in Thailand. Bangkok and its vicinity area are among the most actively developed areas of industrial estates and parks.

d. Further Progress of Industrialization and Industrial Waste

With the recent recovery of economy in Thailand, its industries will also restart their further growth and technological development. Particularly the high-tech industries are expected to increase with the growth of foreign capital investment in Thailand.

The high-tech industries manufacture high value-added products by utilizing advanced technologies and processes, while they generate the industrial wastes that require specific treatment processes for their detoxification. Generation of these types of waste is expected to increase with the technological advancement of industries in Thailand.

Therefore, it is the key of sustainable economic and industrial development in Thailand to establish proper industrial waste management system, starting from legal and regulatory mechanism to the development of industrial waste recycling, treatment and landfill facilities.

Furthermore, considering the importance of export processing industries in Thai economy, implementation of proper industrial environment management in these industries will be the key of sustaining their presence in the international market in the current trend of standardization of environmental management system under ISO 14001 as well as the environmental compliance under the multi-national free trade agreement. In this respect, industrial waste management in Thailand is the policy issue of primary importance that may determine the future success or failure of its economy.

2.2 Important Findings in Field Investigations

In order to understand the current industrial waste management (IWM) in the study area the following interview surveys are carried out.

- Factory survey;
- Questionnaire survey on needs of waste exchange;
- Survey of non-HW collection/transport organizations;
- Survey of waste reuse/recycling/treatment companies;
- Survey of associations of industries, waste collection/transport companies, and waste reuse/recycling/treatment companies.

Objectives, procedures and other details are in the Main report. Only particularly important findings are presented below.

2.2.1 Factory Survey

- 17.2 % (37) of factories discharge mixed wastes of HW and non-HW.
- 206 factories (96%) that gave valid answers about waste generation annually generate 118,904 ton of non-HW and 27,349 ton of HW.
- 14.9 % (32) of factories have on-site treatment of IW and 23.3 % (50) of factories conduct on-site reuse or recycling of IW.
- The most common collection service provider is private company contracted by factories (54%), followed by Pho Kha Khong Gao (waste buyers) (50%) and the municipalities (21%).
- Almost all (96.3 % (207)) of the factories answered they know off-site treatment/disposal of their IW, i.e. method used and name of the treatment/disposal companies or names of the persons in charge.
- Figures below present non-HW flow and HW flow of 206 factories surveyed that gave valid answers about waste generation. In addition waste flows of each category of non-HW and HW are presented in Annex 3.3.

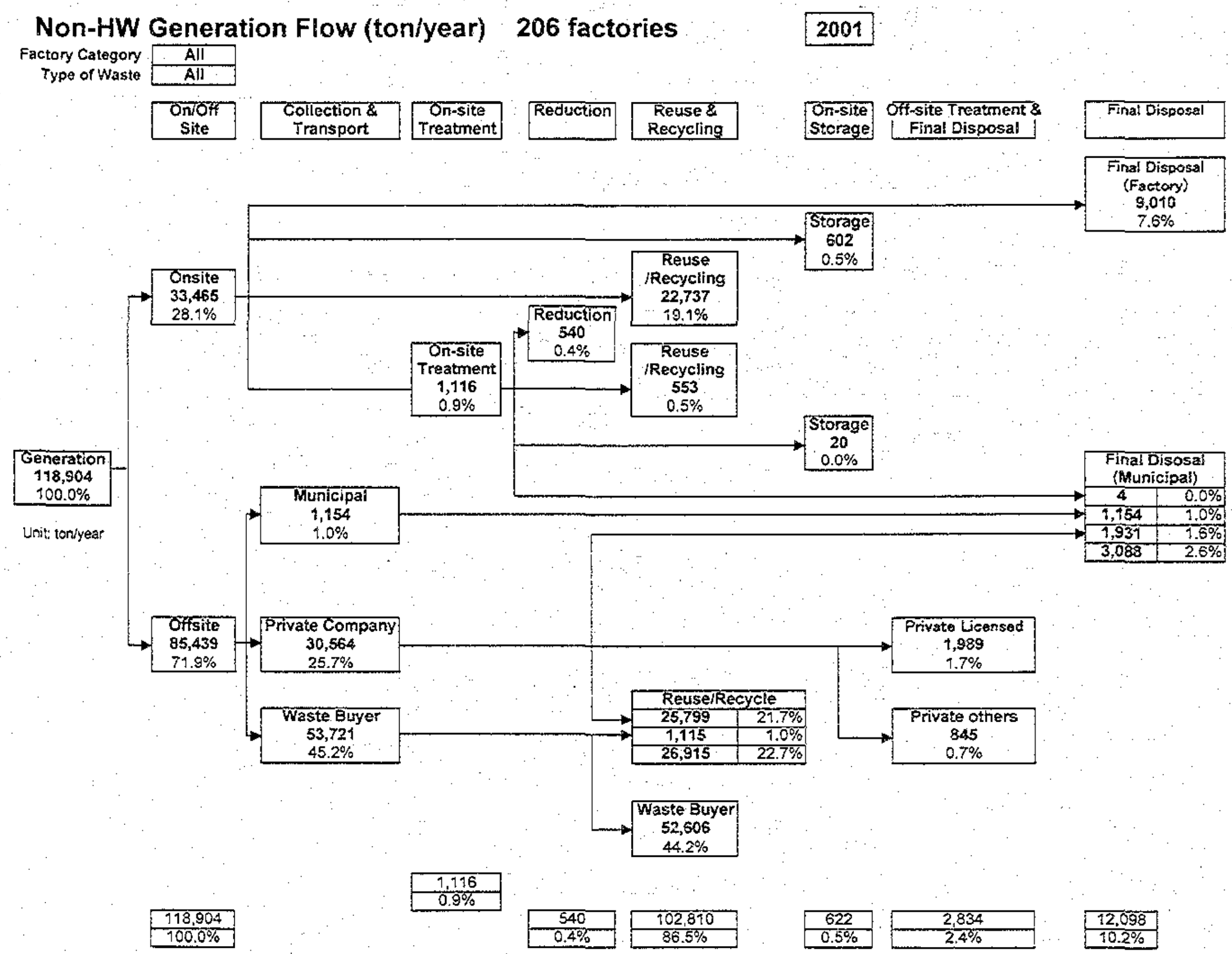


Figure 2-3: Non-HW Flow of 206 Factories Surveyed

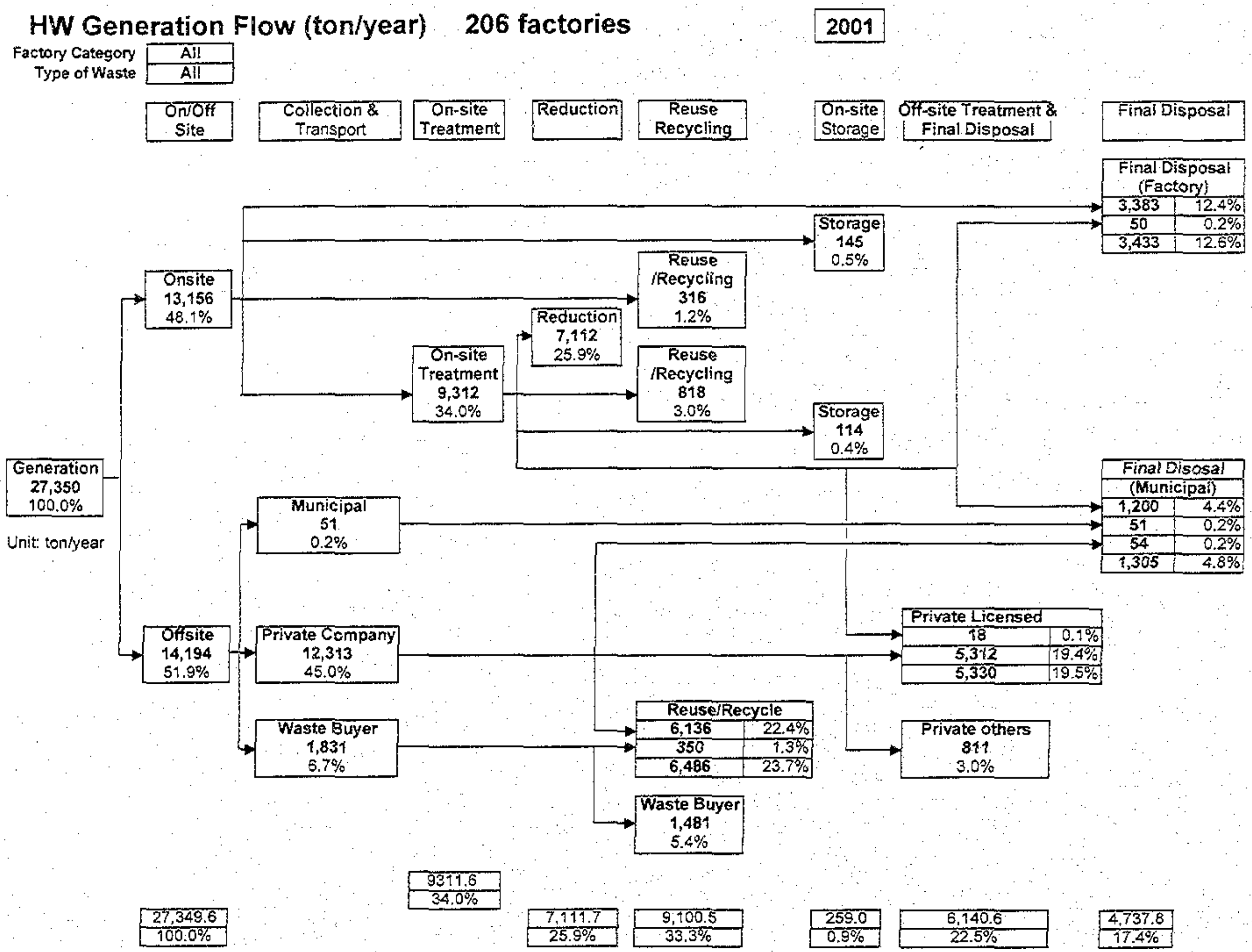


Figure 2-4: HW Flow of 206 Factories Surveyed

- About half (47.9 % (103)) of factories answered IW will not increase so much, but factories that have a plan of waste management improvement were few except for large-scale factories.
- Most factories, 81 %, expressed their interests in a waste exchange program and about half of factories (47.4 % (102)) have wastes that would be possible IW for the program.
- It is difficult to draw general findings about financial matters of collection, on-site disposal and final disposal because the valid replies were diverse and not many enough. Annex 3.2 is to be referred.
- According to the evaluation of 215 factories on the current IWM about half (47.4 % (102)) of factories have some problems on it. The most significant problem 102 factories face now on IWM is "High IW treatment cost" (29% of 102 factories), followed by "No or limited services available for treatment" (27%) and "Lack or limited reuse and recycling of IW" (14%).

2.2.2 Survey on Non-HW Collection and Transportation Organizations

Factory waste is collected by the following three parties.

a. Local administration (districts in Bangkok and municipality offices in its surrounding provinces)

The district offices collect waste from factories according to the Agreement made on 22 January 1997 between the BMA and the DIW which stipulates that the BMA should tentatively collect waste from factories except for hazardous waste. In municipalities, there is no legal stipulation, but waste from factories is collected by the municipality offices as a customary practice.

The quantity of waste collected by the municipality is estimated at 211,357 ton/year, while 34,975 ton/year according to the Factory Survey. The difference may be caused by the overestimated answers of persons in charge at the districts and municipalities. Also, the figure may include un-recyclable portion of industrial waste that comes not from factories but waste buyers but is regarded as factory waste.

b. Private company of waste collection and transportation

Two companies, BYL and SITA-THAI, collect and transport waste to cement plants by subcontracting out the work to Nature Trans. The former deals 7,000 tons/year of liquid waste and the latter 20,000 tons/year of oil and solvent. The comparison of these figures with the data obtained from the transport permit suggests there should be more other waste collection/transportation companies, although the team could not identify them.

c. Waste buyer

"Waste buyers" buy waste directly from the factories and sell it to the recyclers or to the secondary waste buyers. Thus, waste may be carried into the recyclers via several steps. From the factory survey, the team understood that the role played by waste buyers is substantially large in IWM of the study area, but it was difficult to know the details of their activities and even their addresses.

2.2.3 Survey on Waste Reuse/Recycling/Treatment Companies

a. Factories with DIW Authorization as Waste Business Enterprises

Factories that treat and/or dispose of industrial waste have been registered with DIW as the Code 101 factories until December 2001. DIW introduced the new factory registration codes, Code 105 and 106 on December 2001.

- Code 105: Waste sorting and/or landfilling factory
- Code 106: Waste reuse/recycling factory

Except for a few factories with Code 101, a large number of factories doing waste reuse/recycling have been categorized in a particular code depending on what they produce. By introducing the new codes 105 and 106, DIW intends to clearly distinguish factories dealing with waste from others. The factory registration process of these codes has just started, and DIW announced "the list of factories engaged in waste treatment, recycling, or final disposal" under the Factory Act on April 24, 2002. The list includes all factories categorized in Code 101, and newly introduced Code 105 and Code 106. The number of factories of codes 101, 105 and 106 has been gradually increasing as shown in the table below, which compares the number of factories as of November 2001 (as reported in DF/R(1)), April 24, 2002 (as in the aforementioned list), and August 6, 2002 (as in the latest list available for the team during the final field study work in Thailand). The study on waste business enterprises carried out by the team was based on the list of April 24.

Table 2-2: Number of Factories with DIW Authorization as Waste Business Enterprises

Type of Waste Dealt With and MOI Code	August 6, 2002	April 24, 2002	Nov. 2001
HW, 101	10*1	8*1	5
HW, 105	1	1	-
HW, 106	3	2	-
HW total	14	11	5
Non-HW, 101	6	6	7
Non-HW, 105	5	2	-
Non-HW, 106	1	1	-
Non-HW total	12	9	7
Total	**26**	**20**	**12**

Note *1: The Rachaburi Landfill, which is considered as a facility attached to the DIW's Samae Dum Center and does not have its own factory registration number, was not included in the list on April 24, but regarded as one facility in this table.

As the table above shows, the number of factories with DIW authorization as waste business enterprises has been increased since November 2001. At present, DIW is receiving many applications for the registration of codes 101, 105 and 106, and the number of authorized factories will further increase.

b. Reuse/Recycling Activities

- There seems to be enough facilities to receive most types of non-hazardous reusable/recyclable waste for reuse/recycle purposes.

- However, the amount of some types of recyclable waste which is collected to such reuse/recycling facilities within the country is not enough. Nearly 70% of aluminium scrap is imported and substantial portion of PET bottles are exported to China for recycling.

- As for the reuse/recycling of HW, it seems to be limited to such waste as waste oil, waste solvent and waste solder (for lead recovery).

- The use of cement factories as a reuse/recycling facility is effective to promote HW reuse/recycling, but it is still at the starting point. It first started at Siam Cement Kaeng Koi plant in April 2001 followed by another, Siam city cement plc. As of February 2002, there are these two factories with code 101 registrations.

- There are many stakeholders in a reuse/recycling process. The real situation of their activities is not yet well known.

- New factory codes 105 for waste sorting and landfilling and 106 for waste reuse/recycling were created in December 2001, but a system to control reuse/recycling industry including waste buyers is not yet adequately developed.

2.2.4 Study on Associations

The following findings were obtained from the interviews with 8 associations that received the team's visit.

- Generally, the industrial associations are not so much aware to IWM or pollution control. They are rather interested in the promotion of cleaner production (CP) technology.

- The following opinions were raised.
  - Since there are only a few companies which have an official permission to collect and treat waste, the market of waste treatment services is not competitive and monopolized.
  - Therefore the waste disposal cost has been increasing.

- 5 associations have been promoting the better management of industrial waste and also help the member companies to solve the problems due to industrial waste. 5 associations give technical support to the members concerning IWM by providing information on technology.

- 3 expect the government to give information, advices, and solutions on IWM. All of 8 associations declared that they are willing to promote waste recycling. The member companies are trying to reduce the industrial waste and need the information on waste treatment technology.

2.2.5 Study on Municipal Waste Management

a. Unclear Responsibility for Collection of Industrial Waste

Before the MOI Notification No.1 B.E.2541 (1998) was issued, the local administration was responsible for even industrial waste except for the hazardous one. The issue of this notification means that DIW is responsible for the management of industrial waste either non-hazardous or hazardous one, but in fact, the local administrations still collect non-hazardous industrial waste. In case of the BMA, the district offices collect non-HW from factories according to the said memorandum. When the agreement was made, it was expected that private companies would appear soon which collect non-HW from the factory as their business, but yet no companies appear. Therefore, the district offices are still forced to collect non-HW and it goes to the municipal landfill sites, while DIW cannot promote the participation of the private sector in the non-HW management business.

The problem is that the local administrations collect industrial waste without bearing the responsibility of non-HW management, which is retained by DIW. It may discourage the municipality's effort. It is much better to entrust responsibility to the local administration in order to encourage their collection services.

b. Illegal Dumping

It is reported that there are illegal dumping sites in some of the districts and municipalities. It is said that most of them are waste discharged by the residents in the area nearby. This might indicate that waste collection frequency for the residents is insufficient. District and municipality offices should clarify the reason why illegal dumping occurs and should take necessary measures to improve the service quality for the residents.

2.2.6 Public Opinion Survey

a. General issues

The result of cross sectional analysis by sex, age, monthly household income and educational background revealed that the educational background is a decisive factor in many questions of the questionnaire. In this report, the result of survey was analyzed paying more attention to the educational factor.

People with higher educational background tend to be more interested in environmental issues, evaluate the current environmental situations stricter, and be more critical about government policies and measures. Since the ratio of people who go on to university is expected to continue to increase and people in general are expected to be more aware of environment issues in Thailand, it can be said that the opinion of the group with bachelor degree or higher can be used to expect future trend of public opinion about industrial waste and its management.

b. Environmental awareness

- Environment is not a primary issue, but people keep a great interest in environment issues. The main sources of information on environment are TV news and newspaper.
- Air pollution and deforestation are the top issues among environment concerns.
- Since the financial crises in 1997, people tend to give more priority to economic development rather than environment conservation.
- To improve environment, people think that tightening control on pollution by the government is the most needed countermeasure.

c. Industrial Waste and Its Management

- People are interested in IW issues, but the level of knowledge is not high in general.
- Illegal dumping is regarded as a major problem and a cause of pollution, and people want the government to tighten control on illegal dumping.
- More than 60% of respondents agreed that it is urgent to construct new IW treatment/disposal facilities, but higher educated group tend to agree with the construction plan conditionally; to tighten control on illegal dumping; to reveal information; and to tighten control on the operation of facilities.
- As conditions to accept the construction plan of IW treatment/disposal facilities, participation in the decision-making process and careful site selection were top 2 demands.

2.3 Database Development

2.3.1 Current Database

a. Current Database (DB) of DIW

DIW has two important DB: one is the factory registration DB and the other is the GIS industrial location DB.

a.1 Factory Registration DB

a.1.1 DB Structure

The Factory Registration DB contains the data of all the registered 121,231 factories in the whole country. Database has such basic data items as factory registration number, factory name, address, horsepower, expired date of operation licence, number of workers, and industrial type. Some of these data can be seen at the DIW's website.

a.1.2 Problem of DB Update

The analysis of the Factory registration DB has detected a serious problem of data update. DIW should take an urgent action to solve the problem of not updated DB, otherwise this DB will not be useful even as a reference of the general and principal information of the factory. The information of this DB is essential because it is the starting point for any study, analysis and control of the factories and therefore it should be updated and to have truthful information.

Database update is expected in such occasions as:

- When the factory pays the annual fee.
- When the factory wants to enlarge their production and requests a new permission.
- When the factory is inspected by the DIW inspectors.

But latest information is not always available in these occasions because some factories do not cooperate DIW and refuse information disclosure. It is usually DIW regional offices that acquire latest information, but even if they can do so, data is sent to the DIW headquarters not in a digital form but in a written from because the database system used at the regional offices is different from that of the headquarters and data can not be transferred from one to the other. Consequently, documents put together from 74 regional offices over the country to the headquarters have been left untouched and piled up.

With regard to hardware, DIW has enough capacity. The 4 Factory and Inspection Bureaus have approximately 100 workstations and 400 employees that are designated for the control of the industries, and at least one terminal workstation in each provincial office.

a.2 GIS Industrial Location DB

The GIS Industrial Location DB contains the location data of 121,231 factories in the whole country, on which the exact location of the factories can be shown.

b. Current Database on IWM

At present the DIW has one DB related to IWM. This DB contains the registration record of factories that generate HW only in Samut Prakarn province. The DB is developed under the project promoted by Thai-German Technical Cooperation Program, "Preparation of Register on Hazardous Waste Generation & GIS Application for the Province Samut Prakarn" in the year 1999.

At the beginning, the database management system (DBMS) of this DB and the DBMS of the main server of IT Center had an inconvenience to be interconnected due to different operating systems. After the development of a computer program, at present the databases are interconnected and the HWDB of GIS Data Center can draw the general information of factories from the main factory registration DB.

But here also exists a problem that has to be solved as soon as possible by DIW. The factory registration DB is not updated periodically and in this situation many types of report will be emitted with false data.

2.3.2 Development Plan

a. Development Plan for New Database

At the end of the first study work in Thailand, DIW and the team signed minutes of meetings on the progress report (2) and agreed that the team would develop the following three databases and applications to manage them.

- Non-Hazardous Waste Database (Non-HW DB)
- Manifest System Database (MS DB)
- Waste Utilization Database

Waste Utilization Database will be described in Chapter 4.3.1.

For DB management, three personal computers, two printers and accessories have been installed in the Environmental Section, Bureau of Industrial Environment Technology, of DIW.

b. Development of Non-HW Database

b.1 Background

Since there was no database of non-HW, it was decided to establish its basis. Data on non-HW obtained by the factory survey were entered to the database.

b.2 Database Fields

Database fields are as below.

Name	Description	Fields
1.Waste type	Type of classification of waste	(1) Waste_Type_ID
		(2) Description
2. Waste Category	Category of classification of waste	(1) Waste_Category_ID
		(2) Waste_Type_ID
		(3) Description
3. Waste Sub	Sub-category of classification of waste	(1) Waste_Sub_ID
		(2) Waste_Type_ID
		(3) Waste_Category_ID
		(4) Description
4. NonHW	General detail of generation of waste from factories	(1) NonHW_ID
		(2) Facreg
		(3) Waste_sub_ID
		(4) NonHW_Description
		(5) Process_Description
		(6) Generated_Amount
		(7) Amount_unit
5. NonHW_Sub	Detail of treatment/recycling/disposal of each waste of NonHW table	(1) NonHW_Sub_ID
		(2) NonHW_ID
		(3) OnOffSite
		(4) Amount
		(5) Treatment_Amount
		(6) Treatment_Method
		(7) After_Treatment_Amount
		(8) Recycle_Amount
		(9) Recycle_Method
		(10) Disposal_Amount
		(11) Disposal_Method

b.3 Outcome of the Non-HW DB and Future Usage

The establishment of the database enabled the team to check, integrate and analyze the data. As a result, the team could calculate the waste generation rate of each type of waste and of each category of industry, by which the team further could estimate the total waste generation amount in the whole study area in 2001 and 2010. Moreover, the analysis of the database could produce the waste flow. The waste flow explains the reality of IWM by describing how much waste is reused/recycled, treated, or disposed of on-site or off-site.

In this manner, this database is useful to investigate the non-HW management system and identify the issues to be improved.

b.4 Future Use and Institutional System of Non-HW DB

For the continuous use of this database, it is necessary to repeat the factory survey, as done by the team in the present project, every a few years and to update the data. It is recommended to have a legislative measure to obligate factories to disclose data of their waste management to DIW.

If the data is updated, the total non-HW generation amount and waste flow can be estimated periodically, and it is also possible to monitor non-HW management with the progress of the M/P, and to review the non-HW management policies.

Because the non-HW DB is a new database, DIW does not have an institutional system to operate or maintain it. The daily O&M work is, however, minimal and data updating will be well done using human resources outside as it is an event only once in a few years.

To facilitate the O&M of non-HW DB, the team prepared an operational manual (in English and Thai), as shown in Annex 6.1.

b.5 Improvement of Non-HW DB

The problem of update of the factory registration DB should be sorted out in order for the non-HW DB to be useful. The team arranged the non-HW DB so that its data can be exported to the DIW factory registration DB. In this manner, data from factory surveys that are recommended to be carried out periodically, should be utilized not only for the non-HW DB but also for the factory registration DB.

c. Development of Manifest System Database

c.1 Background

At present, DIW intends to enforce the manifest system shown in Figure 2-5, but it is not fully operated. The form has six copies, but only Copy 1, which comes from the Samae Dam Treatment Center, is available at DIW, but the copies are simply filed without being digitised. Consequently, the team and C/P agreed to develop a Manifest System DB (MS DB) to which the data of Copy 1 would be entered.

DIW obtained the manifest data from Samae Dam Treatment Center in digital format and provided them to the team.

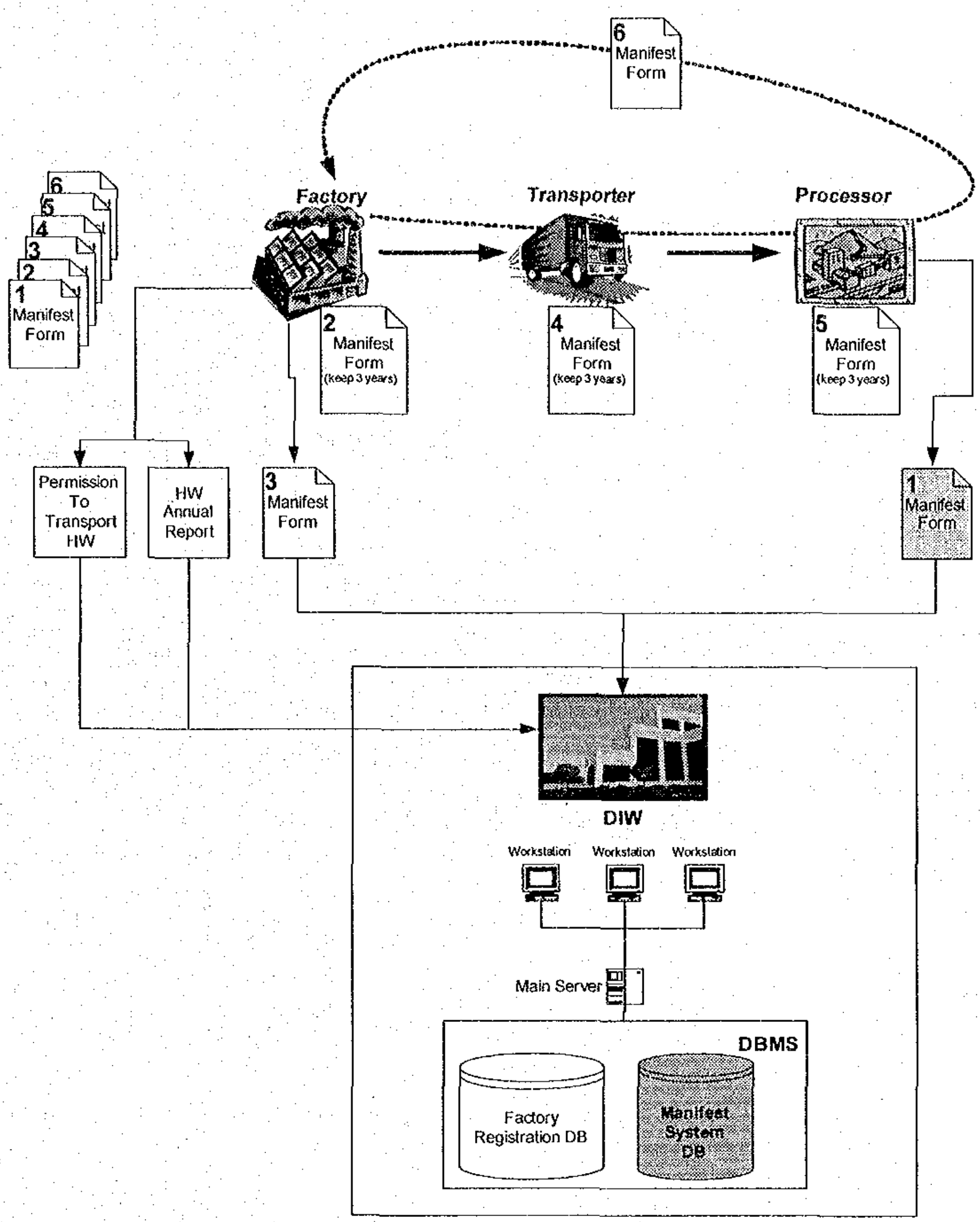


Figure 2-5: Manifest System Scheme

c.2 Data Fields

Fields of data in tables are as shown below.

Name	Description / Fields	
1. MSFactorySheet	Details of Manifest data came from factory	
	(1) Manifest_ID	(19) Transporter_ID
	(2) Facreg	(20) TransporterTruckType
	(3) FactoryEmergencyContactNo	(21) TransporterTruckRegistrationNo
	(4) FactoryEmergencyContactName	(22) TransporterEmergencyResponse

	(5) FactoryCertificateName	(23) TransporterEmergencyPhoneNo
	(6) FactoryCertificateTitle	(24) TransporterCertificateName
	(7) FactoryDate	(25) TransporterCertificateTitle
	(8) FactoryTime	(26) TransporterDate
	(9) Waste_Sub_ID	(27) Processor_ID
	(10) WasteDescription	(28) ProcessorWasteQtyReceived
	(11) WasteContainerType	(29) ProcessorWasteQtyUnit
	(12) WasteContainerNo	(30) ProcessorArrivalCertifName
	(13) WasteTotalQty	(31) ProcessorArrivalCertifTitle
	(14) WasteTotalQtyUnit	(32) ProcessorArrivalCertifDate
	(15) ContractNo	(33) ProcessorArrivalCertifTime
	(16) PurchaseOrderNo	(34) ProcessorAcceptanceName
	(17) WasteProfileNo	(35) ProcessorAcceptanceTitle
	(18) AdditionalDescriptionWaste	(36) ProcessorAcceptanceDate
2. MSProcessorSheet	Detail of Manifest data came from processors	
	(1) Manifest_ID	(11) Waste_sub_ID
	(2) Facreg	(12) Processor_WasteQtyReceived
	(3) Transporter_ID	(13) Processor_WasteQtyUnit
	(4) Transp_TruckType	(14) Processor_ArrivalCertifName
	(5) Transp_Truck_ID	(15) Processor_ArrivalCertifTitle
	(6) Transp_Emergency_Response	(16) Processor_ArrivalCertifDate
	(7) Transp_Emergency_PhoneNo	(17) Processor_ArrivalCertifTime
	(8) Transp_Certificate_Name	(18) Processor_AcceptanceName
	(9) Transp_Certificate_Title	(19) Processor_AcceptanceTitle
	(10) Processor_ID	(20) Processor_AcceptanceDate
3. MSProcesor	General Information of Processor	
	(1) ProcessorID	(4) PhoneNo
	(2) Name	(5) FaxNo
	(3) Address	(6) email
4. MSTransporter	General information of transporter	
	(1) Transporter_ID	(4) PhoneNo
	(2) Name	(5) FaxNo
	(3) Address	(6) email

c.3 Outcome of the MS DB and Future Usage

From the work of this database development, the following was revealed.

- In total, 18,812 of manifest form copy 1 from 549 factories in 2000 and 6,689 from 413 factories in 2001 (from January to June) were submitted to DIW. The unit to express the amount of waste is not unified and tons and cubic meters are used. If the figures are simply summed up regardless the unit, it comes to 131,752 in 2000 and 47,631 in 2001.

Table 2-3: Manifest Data from Samae Dam Center (Number of Factories, Number of Manifest Sheets and Waste Amount)

Year	2000	2001 (Jan.-June)
Number of Factories	549	413
Number of Manifest Sheets	18,812	6,689
Waste Amount (ton and/or m3)	131,752	47,631

- Factories which send waste to the center are controlled by their names and DIW factory registration codes are not used.
- It was found not easy to sum the amount of each type of waste. This is because the center categorizes waste for the purpose of price setting, and different code numbers are assigned to even the same type of waste if it comes from different factories.
- The treatment capacity of the center is 1,000 ton/day. If ton is used as the unit and the center operates 300 days in a year, the operation rate of the center is about 44%.

DIW specifies the submission of Copy 1 of the manifest form as a condition of the Code 101 license. The present study only dealt with the manifest data from the Samae Dam Center, which were already digitised by the center. If DIW makes sure that all the code 101 factories submit Copy 1 and data is transferred to the MS DB, the total amount of waste that is properly treated of disposed of can be obtained and useful to verify the waste flow.

If DIW is to introduce the electric manifest system, this database will serve as a base.

c.4 Institutional System of the MS DB

The MS DB is the new database as well as non-HW DB, and the DIW currently does not have an institutional system to operate and maintain the MS DB as a regular work.

However, the Samae Dam Center has been digitising its data. If DIW standardizes a rule of data format (see the next section, c.5.), enforces the rule at the Samae Dam Center, and has the digitised data sent to DIW together with Copy 1, it should not be a trouble to update the data of Samae Dam Center. The similar procedure should be applied to the other code 101 factories.

To facilitate the O&M of MS DB, the team prepared an operational manual (in English and Thai) as shown in Annex 6.2.

c.5 Improvement of MS DB

At present, the bill of hazardous waste manifest system of PCD/MOSTE described in Section 5.4.2 of the Main Report is under discussion. DIW/MOI should be prepared to modify or improve the MS DB to adjust it to the manifest system.

It is essential to standardize the digital data format for the improvement of the MS DB. Specifically, the following issues should be sorted out.

- *In the manifest, the DIW registration number is not written.* Without the code, it is not possible to make a full link between the Manifest DB and the main factory registration DB of DIW it is difficult to really utilize this DB to control waste management at factories. The team recommends DIW to use the DIW registration number to identify all the factories which send waste to Samae Dam. Otherwise it will be hard to know which factories registered at DIW send how much waste to this treatment center.

	(5) FactoryCertificateName	(23) TransporterEmergencyPhoneNo
	(6) FactoryCertificateTitle	(24) TransporterCertificateName
	(7) FactoryDate	(25) TransporterCertificateTitle
	(8) FactoryTime	(26) TransporterDate
	(9) Waste_Sub_ID	(27) Processor_ID
	(10) WasteDescription	(28) ProcessorWasteQtyReceived
	(11) WasteContainerType	(29) ProcessorWasteQtyUnit
	(12) WasteContainerNo	(30) ProcessorArrivalCertifName
	(13) WasteTotalQty	(31) ProcessorArrivalCertifTitle
	(14) WasteTotalQtyUnit	(32) ProcessorArrivalCertifDate
	(15) ContractNo	(33) ProcessorArrivalCertifTime
	(16) PurchaseOrderNo	(34) ProcessorAcceptanceName
	(17) WasteProfileNo	(35) ProcessorAcceptanceTitle
	(18) AdditionalDescriptionWaste	(36) ProcessorAcceptanceDate
2. MSProcessorSheet	Detail of Manifest data came from processors	
	(1) Manifest_ID	(11) Waste_sub_ID
	(2) Facreg	(12) Processor_WasteQtyReceived
	(3) Transporter_ID	(13) Processor_WasteQtyUnit
	(4) Transp_TruckType	(14) Processor_ArrivalCertifName
	(5) Transp_Truck_ID	(15) Processor_ArrivalCertifTitle
	(6) Transp_Emergency_Response	(16) Processor_ArrivalCertifDate
	(7) Transp_Emergency_PhoneNo	(17) Processor_ArrivalCertifTime
	(8) Transp_Certificate_Name	(18) Processor_AcceptanceName
	(9) Transp_Certificate_Title	(19) Processor_AcceptanceTitle
	(10) Processor_ID	(20) Processor_AcceptanceDate
3. MSProcesor	General Information of Processor	
	(1) ProcessorID	(4) PhoneNo
	(2) Name	(5) FaxNo
	(3) Address	(6) email
4. MSTransporter	General information of transporter	
	(1) Transporter_ID	(4) PhoneNo
	(2) Name	(5) FaxNo
	(3) Address	(6) email

c.3 Outcome of the MS DB and Future Usage

From the work of this database development, the following was revealed.

- In total, 18,812 of manifest form copy 1 from 549 factories in 2000 and 6,689 from 413 factories in 2001 (from January to June) were submitted to DIW. The unit to express the amount of waste is not unified and tons and cubic meters are used. If the figures are simply summed up regardless the unit, it comes to 131,752 in 2000 and 47,631 in 2001.

Table 2-3: Manifest Data from Samae Dam Center (Number of Factories, Number of Manifest Sheets and Waste Amount)

Year	2000	2001 (Jan.-June)
Number of Factories	549	413
Number of Manifest Sheets	18,812	6,689
Waste Amount (ton and/or m3)	131,752	47,631

- Factories which send waste to the center are controlled by their names and DIW factory registration codes are not used.
- It was found not easy to sum the amount of each type of waste. This is because the center categorizes waste for the purpose of price setting, and different code numbers are assigned to even the same type of waste if it comes from different factories.
- The treatment capacity of the center is 1,000 ton/day. If ton is used as the unit and the center operates 300 days in a year, the operation rate of the center is about 44%.

DIW specifies the submission of Copy 1 of the manifest form as a condition of the Code 101 license. The present study only dealt with the manifest data from the Samae Dam Center, which were already digitised by the center. If DIW makes sure that all the code 101 factories submit Copy 1 and data is transferred to the MS DB, the total amount of waste that is properly treated of disposed of can be obtained and useful to verify the waste flow.

If DIW is to introduce the electric manifest system, this database will serve as a base.

c.4 Institutional System of the MS DB

The MS DB is the new database as well as non-HW DB, and the DIW currently does not have an institutional system to operate and maintain the MS DB as a regular work.

However, the Samae Dam Center has been digitising its data. If DIW standardizes a rule of data format (see the next section, c.5.), enforces the rule at the Samae Dam Center, and has the digitised data sent to DIW together with Copy 1, it should not be a trouble to update the data of Samae Dam Center. The similar procedure should be applied to the other code 101 factories.

To facilitate the O&M of MS DB, the team prepared an operational manual (in English and Thai) as shown in Annex 6.2.

c.5 Improvement of MS DB

At present, the bill of hazardous waste manifest system of PCD/MOSTE described in Section 5.4.2 of the Main Report is under discussion. DIW/MOI should be prepared to modify or improve the MS DB to adjust it to the manifest system.

It is essential to standardize the digital data format for the improvement of the MS DB. Specifically, the following issues should be sorted out.

- *In the manifest, the DIW registration number is not written.* Without the code, it is not possible to make a full link between the Manifest DB and the main factory registration DB of DIW it is difficult to really utilize this DB to control waste management at factories. The team recommends DIW to use the DIW registration number to identify all the factories which send waste to Samae Dam. Otherwise it will be hard to know which factories registered at DIW send how much waste to this treatment center.