Thailand ENVIRONMENT MONITOR 2003

THAILAND ENVIRONMENT MONITOR 2003

JBIC

The World Bank

THAILAND
ENVIRONMENT MONITOR 2003

Table of Contents

The Pollution Control Department (PCD) of Thailand's Ministry of Natural Resources and Environment (MoNRE), the World Bank, the United States-Asia Environmental Partnership (USAEP), and Japan Bank for International Cooperation (JBIC) contributed to the preparation of this document. The World Bank Team consisted of John Morton (Team Leader), Sirinun Maitrawattana, Catalina Marulanda, Nat Pinnoi, Sutthana Vichitrananda, Patchamuthu Illangovan and Anjali Acharya. The team received guidance from Maria Teresa Serra, Sector Director; and Magda Lovei, Sector Manager of the Environment and Social Development Unit of the World Bank. Jack Kneeland and Saengroaj Kraisorn represented USAEP, Norio Saito represented JBIC, and Sopon Tatichotiphan, Paisarn Padungsirikul, Taweeporn Jung, and Suntorn Uppamarn represented the PCD. The municipal benchmarking survey was undertaken under the guidance of Jeff Bowyer (Louis Berger and USAEP) by a consortium of university professors led by Dr. Wanpen Wirojanagud and Dr.Somsak Pitaksanurat (Khon Kaen University) and included Dr. Tares Srisatit (Chulalongkorn University), Dr. Chatchai Ratanachai (Prince of Songkhla University), and Dr. Praphon Kemmadamrong (Chiang Mai University). Pornsri Kictham of the Municipal League of Thailand and Nonthaburi Municipality provided valuable assistance in testing the survey methodology in Nonthaburi. Analysis of landfill gas potential was undertaken in conjunction with Brian Guzzone (USEPA) and Alex Stege (SCS Engineers). The document was peer reviewed by World Bank Staff David Hanrahan, Dan Hoornweg, and Allan Rotman. Jack Fritz from the National Academy of Engineering (US) also peer reviewed the document. The cooperation of Bangkok Metropolitan Administration (BMA), Department of Industrial Works (DIW) of the Ministry of Industry, Municipal League of Thailand (MLT) and the many municipalities surveyed as part of the preparation of the document helped enhance the quality and clarity of the data presented in the report and we gratefully acknowledge their patience and assistance. Sorachai Nuntawatcharaviboon and Kamolnat Nillachad were responsible for the cover design and layout.

PREFACE

The Thailand Environment Monitor series – initiated in 2000 – presents a snapshot of key environmental trends in the country. Its purpose is to engage and inform stakeholders of environmental changes as they occur, in an easy-to-understand format. The first Environment Monitor, published in 2000, benchmarked trends in environmental indicators covering a wide range of issues, including those associated with environmental quality and natural resources conservation. Environmental changes, however, occur over a period of time; therefore annual variations are not easy to measure or assess, unlike economic indicators. Thus, the series is designed to report general environmental trends every five years and in the intervening years, the Monitor focuses on specific themes to highlight critical emerging problems. In 2001, the Monitor focused on water quality and the theme for 2002 was air quality. Solid and hazardous waste management is the focus of the *Thailand Environment Monitor 2003.*

Solid and hazardous waste is a serious problem facing many of the urban and industrial areas of Thailand. Considerable progress has been made in the past decade to improve waste management practices in the country, but the unfinished agenda, including the following issues, remains challenging. In particular, there is a large untapped potential in recycling and waste reduction. Safe and effective municipal waste collection, treatment, and disposal systems are only just beginning to take shape in most areas of the country. Safe hazardous and infectious waste treatment and disposal systems need to be built to keep pace with the growth in waste generation. Sustainable financing for solid waste is still elusive and government agencies are challenged by staffing limitations.

The Thailand Environment Monitor 2003 assesses the status, trends, lessons, and challenges of solid and hazardous waste management in the country. The report is in six sections. Section 1 reviews Waste Generation in the country. Section 2 outlines Waste Reduction and Recycling practices. Sections 3 reviews Municipal Solid Waste, and Section 4 focuses on Industrial and Infectious Waste. Section 5 assesses Environmental Management in relation to the Legal Framework, Institutions, Plans, and current Expenditures. The concluding section of the report outlines the Challenges faced by Thailand.

The report is an outcome of a joint exercise among the Pollution Control Department (PCD) of the Ministry of Natural Resources and Environment (MoNRE), US-Asia Environmental Partnership (USAEP), Japan Bank for International Cooperation (JBIC), and the World Bank. Several surveys were also undertaken to obtain additional data and insights. A disposal practices survey of the 76 provincial capitals was undertaken by PCD and the World Bank and this formed the basis of an analysis of disposal practices. The potential for landfill gas development was also assessed with the help of the US Environmental Protection Agency (USEPA). Additionally, USAEP, in conjunction with a consortium of Thai university professors and with the help of the Municipal League of Thailand, undertook a municipal benchmarking survey of 13 small to medium-sized cities in Thailand. The results of these surveys and analyses are included in the report and are also available separately on the website and attached CD. The other information contained in the Monitor has been compiled from a variety of sources, including published and unpublished data and reports by government agencies, universities, nongovernmental organizations, individuals, the World Bank, and international partners.

H.E. Prapat Panyachatraksa
Minister
Ministry of Natural Resources
and Environment

Ian C. Porter
Country Director
East Asia and Pacific Region
World Bank

Yasushi Negishi
Chief Representative
Japan Bank for International
Cooperation

Winston Bowman
Regional Coordinator
United States - Asia
Environmental Partnership

ABBREVIATION AND ACRONYMS

BMA	Bangkok Metropolitan Administration
BMR	Bangkok Metropolitan Region
DEQP	Department of Environmental Quality Promotion
DIW	Department of Industrial Works
DoH	Department of Health
EIA	Environmental Impact Assessment
ESTs	Environmentally Sound Technologies
EU	European Union
GDP	Gross Domestic Product
GENCO	General Environmental Conservation (Public Company Limited)
IEAT	Industrial Estate Authority of Thailand
ISO	International Organization for Standardization
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
Kg	Kilograms
MoIND	Ministry of Industry
MoInt	Ministry of Interior
MoNRE	Ministry of Natural Resources and Environment
MoPH	Ministry of Public Health
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
MW	Megawatts
NEQA	National Environmental Quality Act
NESDB	National Economic and Social Development Board
NGO	Non Governmental Organization
NIMBY	Not in My Backyard Syndrome
NSO	National Statistical Office
ONEP	Office of Natural Resources and Environmental Policy and Planning
PAO	Provincial Administration Organization
PCD	Pollution Control Department
PoNRE	Provincial Office of Natural Resources and Environment
REO	Regional Environmental Office
TAO	Tambon Administration Organization
TDRI	Thailand Development Research Institute
TECDA	Thai Environmental and Community Development Association
THB	Thai Baht
UNEP	United Nations Environment Program
UNESCAP	United Nations Economics and Social Commission for Asia and the Pacific
USAEP	United States-Asia Environmental Partnership
USEPA	United States Environmental Protection Agency

Thailand currently produces nearly 22 million tons of waste from residences, industries, businesses, and hospitals. This is likely to increase in the coming years as the country is recovering from the financial crisis, and once again returning to a period of high growth, fueled by consumer spending and exports. For example, if current trends hold and recycling rates remain low, it is likely that by the end of the decade municipal waste generation would grow 25 percent and industrial hazardous waste would grow 35 percent. Management of this waste is a huge task that depends upon successful programs for recycling and reuse; providing safe and effective waste collection and disposal; the availability of sustainable financing; and, effective contributions from government, the public, and civil society. Thailand has made great progress in addressing many of these issues and at the same time has further opportunities to make real progress in improving the health and environment for future generations through better waste management.

Solid Waste Management in Thailand At a Glance

Indicator	Value
Municipal solid waste generation (tons/year)	14.4 million
Hazardous waste produced by community activities	0.38 million
Hazardous waste produced by industries (tons/yr)	0.96 million
Non hazardous waste produced by industries (tons/yr)	5.9 million
Hazardous and infectious waste generated by medical facilities (tons/year)	21,300
Share of municipal waste generated that is collected • Bangkok • Medium sized cities-(Muang municipalities)	 >99% 86%
No. of solid waste disposal sites nationwide • Sanitary Landfills • Engineered Landfills and Controlled Dumps • Open dumps	 5 99 >1000
Percentage of infectious waste treated	46%
Percentage of community generated hazardous waste treated or reused	53%
Percentage of industrial hazardous waste treated in centralized treatment facilities (Bangkok and vicinity)	24%
Municipal waste recycling and reuse as a percent of total waste generated • National • Municipal area • Non-municipal area	 11% 16% 5-8%
Recycling by industries as a percent of total waste generated (Bangkok and vicinity) • Hazardous waste • Non-hazardous waste	 18% 78%
Local Government SWM staff having received education above high school (sample of 8)	15%

Data complied from sources cited in Thailand Environment Monitor 2003.

Reducing and Recycling Waste - Untapped Potential!

While industries have effectively harnessed the market for recyclables such as glass, paper, metal and plastic, annually more than 4.5 million tons of recyclables valued at Thai Baht (THB) 16 billion (nearly US$400 million) are thrown away by households and businesses. With improved recycling, a portion of this potential market could be tapped. Despite an active group of approximately 25,000 informal recyclers in the country who profitably collect and trade this waste the limited number of formal recycling programs and low levels of public participation have kept recycling rates low in Thailand. Taking advantage of this opportunity will hinge upon developing effective incentives and awareness of the people to separate and recycle waste in their homes; and developing private sector and community-led recycling programs while protecting the welfare of the informal recyclers who depend upon recycling for a living.

Municipal Solid Waste - Providing Safe and Cost-effective Collection and Disposal!

Much of the efforts in municipal solid waste management in Thailand have focused on establishing the core infrastructure and services to properly collect and dispose waste. These efforts have improved the alarming level of littering found in urban areas in the 1980s and have established modern disposal facilities in many areas. In order to reach the goal of proper collection and safe disposal in urban areas nationwide several key challenges remain.

- ***Building on Gains in Collection.*** The last decade saw significant spending by the national and local governments to upgrade and improve collection systems and today Bangkok Metropolitan Administration (BMA) collects nearly all of the municipal solid waste generated by its population of eight million people and collection in other cities and smaller urban areas averages between 75 and 90 percent. Building on these accomplishments, municipalities will need to strive to improve their services by addressing underserved areas better and ensuring the sustainability of their collection systems through better time and cost efficiency.

- ***Gaining Public Confidence through Safer Disposal,*** Public confidence in disposal facility operation is low with nearly half of the proposed sites in provincial capitals experiencing Not In My Backyard (NIMBY) syndrome, manifested in the outcry from the local people over the health and environmental risks currently posed in existing and future sites. The construction of more than 100 new disposal sites over the last 10 years has introduced many modern disposal practices. However, they comprise less than 10 percent of the estimated 1,000 or more municipal disposal sites in the country, and many lack well functioning environmental controls necessary for sanitary disposal. One of the key challenges is finding a cost-effective way of providing safe disposal facilities to more than 1,100 municipalities nation wide. The development of disposal sites that are shared within or among provinces provides great promise as it could make oversight easier and potentially could save over THB 180 billion (approximately US$ 4 billion) in investments and operation and maintenance costs over the next two decades. Incineration of municipal solid waste is a less attractive option as it is unlikely to be a cost-effective use of resources due to the high investment costs and the technical and operational difficulties this technology poses in Thailand. In addition to providing safe disposal sites, other major challenges include providing incentives for good disposal site operation by establishing an effective system for regulatory oversight and bridging the gap on NIMBY through education, consultation, and demonstrating good disposal.

Industrial Waste-Plugging the Regulatory Gaps!

Thailand has made strides in addressing industrial waste through the establishment of centralized treatment facilities and through the actions of the many Thai exporting firms who have voluntarily improved their environmental practices. However, the regulatory regime and enforcement for industrial waste treatment is not adequate to ensure safe disposal by more than 60,000 industries, and waste treatment and recycling operations. Additionally, cases of open dumping and improper disposal have been reported over the last several years, largely because there is no active oversight and licensing of waste haulers and buyers, and insufficient penalties for open dumping. With the introduction of new waste treatment operators as part of the recent liberalization of the sector, improving upon regulatory oversight will be the key to ensuring that the desired increase in treatment capacity also results in an increased level of safe treatment and disposal. The main challenges are to provide consistent and comprehensive enforcement of disposal regulations on industries and waste treatment operators and reducing the incentives for improper disposal and open dumping through stronger oversight of waste haulers and buyers and tougher penalties.

Infectious and Community Generated Hazardous Waste - Establishing Safe Waste Management Systems!

Currently, 140,000 tons of hazardous waste from households and small commercial establishments and 10,000 tons of infectious waste from hospitals is disposed with municipal solid waste, directly deposited into sewers or dumped indiscriminately. These practices compound the hazards of the many poorly operated landfills in the country. The immediate challenge will be to develop a program to improve existing hospital and municipal treatment practices. In the long term should focus on cost-effective approaches to establishing safer, more sustainable systems.

Paying for Waste Management - Promoting User Fees!

Amounting to THB 22 billion since 1994, capital investments in collection trucks and disposal facilities have been provided primarily through grants to municipalities from the national government budget and the Environmental Fund. The cost of operation and maintenance of these facilities is paid for by municipalities through user fees and municipal budget. While these national and local expenditures have made genuine improvements in solid waste management, neither are supported by a sustainable source of financing. The Environmental Fund has been draining its resources over the past 10 years with no mechanism for replenishment. Additionally, the operation and maintenance costs are not recovered, because fees charged by municipalities for waste collection have only been able to cover a portion of the costs of operating and maintaining the collection and disposal system. A more sustainable financing system needs to be established using a balance of replenishable national government financing and improved local cost recovery. This may include: mechanisms to replenish the Environmental fund such as packaging or other solid waste related taxes; raising fee levels; improving fee collection; exploring other financing mechanisms; improving the cost-effectiveness of solid waste systems; and, building an environment conducive to private sector investment and operation.

Clarifying Roles and Confronting Capacity Constraints!

Since enacting the Decentralization Act the roles for civil society, local governments, and national government have been evolving. It is expected, in the longer term, that public participation will expand, local governments will obtain relative independence in policy making, planning, and providing waste management services, while national government will play a supervisory and supporting role.

- ***National Government- Providing effective outreach and oversight.*** With more than 60,000 industries and 1,000 municipalities, staffing remains a major constraint for national government agencies, which can only provide 1 solid waste officer per 142 municipalities and 1 inspector per 180 industries. The main challenge for these agencies is improving their ability to provide effective outreach and oversight through strong on-the-ground presence, while tar geting their activities in areas with the greatest impact and comparative advantage.

- ***Local Government- Providing local services.*** Local governments have a limited number of staff and on average only 15 percent of the Staff are educated beyond high school. As a result municipalities have, in most cases, only been able to focus on the core tasks of collection and disposal. The major challenge for them will be to improve management and efficiency of their core services while building capacity to address new opportunities such as recycling, planning, and cost recovery.

- ***Civil Society- Catalyzing grassroots initiatives.*** Civil society has been active for years in Thailand with several very successful NGOs playing key roles in encouraging participation in solid waste management. The challenge will be to further catalyze grassroots participation by taking advantage of partnerships with government, civil society, and the private sector.

In summary, the main challenges for solid and hazardous waste management in Thailand are:

CHALLENGES	
Reducing and Recycling Waste	• Getting the incentives right • Taking awareness to the next level • Separating the waste • Harnessing the market for waste • Protecting waste pickers and sa leng
Municipal Solid Waste - Providing Safe and Cost-Effective Collection and Disposal	• Building on gains in waste collection • Expanding and upgrading safe disposal • Regulating solid waste facilities • Coming together on NIMBY
Industrial Waste - Plugging the Regulatory Gaps	• Encouraging safe practices in a liberalized industrial hazardous waste treatment market • Taking on illegal dumping
Infectious and Community Generated Hazardous Waste - Establishing Safe Waste Management Systems	• Improving treatment of infectious waste • Beginning to address community hazardous waste
Paying for Waste Management	• Investing in the future • Recovering operational costs • Improving private sector involvement
Clarifying Roles	• Providing local services • Providing effective outreach and oversight • Catalyzing grassroots initiatives

One of disposal sites in Tambon municipalities

Glass collected by informal recyclers

1 Waste Generation

Millions of tons of waste. Thailand produces nearly 22 million tons of waste annually (Table 1). Municipal solid waste, which is made up of the everyday waste produced by households and businesses, makes up 67 percent of the total waste generation, while non-hazardous waste produced by industries accounts for 27 percent. The remainder of the waste, though produced in lower volumes, is potentially more dangerous due to its hazardous or infectious properties. This includes infectious waste from hospitals and hazardous waste produced by industries and communities, including households and small businesses such as gas stations.

Bangkok Metropolis accounts for bulk of the waste. Bangkok and the surrounding provinces[1], produce 30 percent of the municipal solid waste, 40 percent of the infectious waste, and 43 percent of the industrial waste in the country (Map 1 and Table 1). In the rest of the country, waste generation is more dispersed with larger production in the more populated and industrialized provinces such as Songkhla, Nakhon Ratchasima, Chon Buri and Chiang Mai.

A small group of generators produce a large proportion of the waste. Nearly two-thirds of the industrial hazardous waste comes from metal and electronic industries, while more than half of the community hazardous waste is created by automotive service stations, and nearly all infectious waste comes from hospitals. Municipal solid waste is produced by a combination of residential and other sources, determined by the relative proportion of industrial, commercial, or tourism activity in the area. (Table 2.)

Foam and banana leaves collected from Chao Phraya River during the Loi Krathong Festival

[1] Includes Bangkok, Pathun Thani, Nonthaburi, Samut Sakhon and Samut Prakan.

Table 1: Waste Generation in Thailand in 2002

	Waste Generation ('000th tons/yr)		
	Total	Total minus reuse and recycling	Largest-producing provinces (% of total)
Municipal Solid Waste	14,400	12,800	Bangkok (27%) Nakhon Ratchasima (3.3%) Samut Prakan (2.3%) Khon Kaen (2.1%)
Infectious Waste	21.3	21.3	Bangkok (21%) Chiang Mai (3.9%) Nonthaburi (3.4%) Nakhon Ratchasima (3.0%)
Industrial Hazardous Waste	963	788	Samut Prakan (19%) Bangkok (18%) Pathumthani (11%) Samut Sakhon (7.0%)
Industrial Non-Hazardous Waste	5,890	1,271	Samut Prakan (13%) Bangkok (11%) Samut Sakorn (8.5%) Patumthani (5.2%)
Community Hazardous Waste	372	182	Bangkok (34%), Nakhon Pathom (2.6%) Nonthaburi (1.4%) Pathun Thani (0.8%)

Sources: Based on studies and estimates described in methodology section. Note that an estimated 8.000 tons of infectious waste, 70,000 tons of community-generated hazardous waste, 79,000 tons of industrial hazardous waste, and 160,000 tons of industrial non-hazardous waste are disposed as municipal solid waste and included in the municipal solid waste figure above.

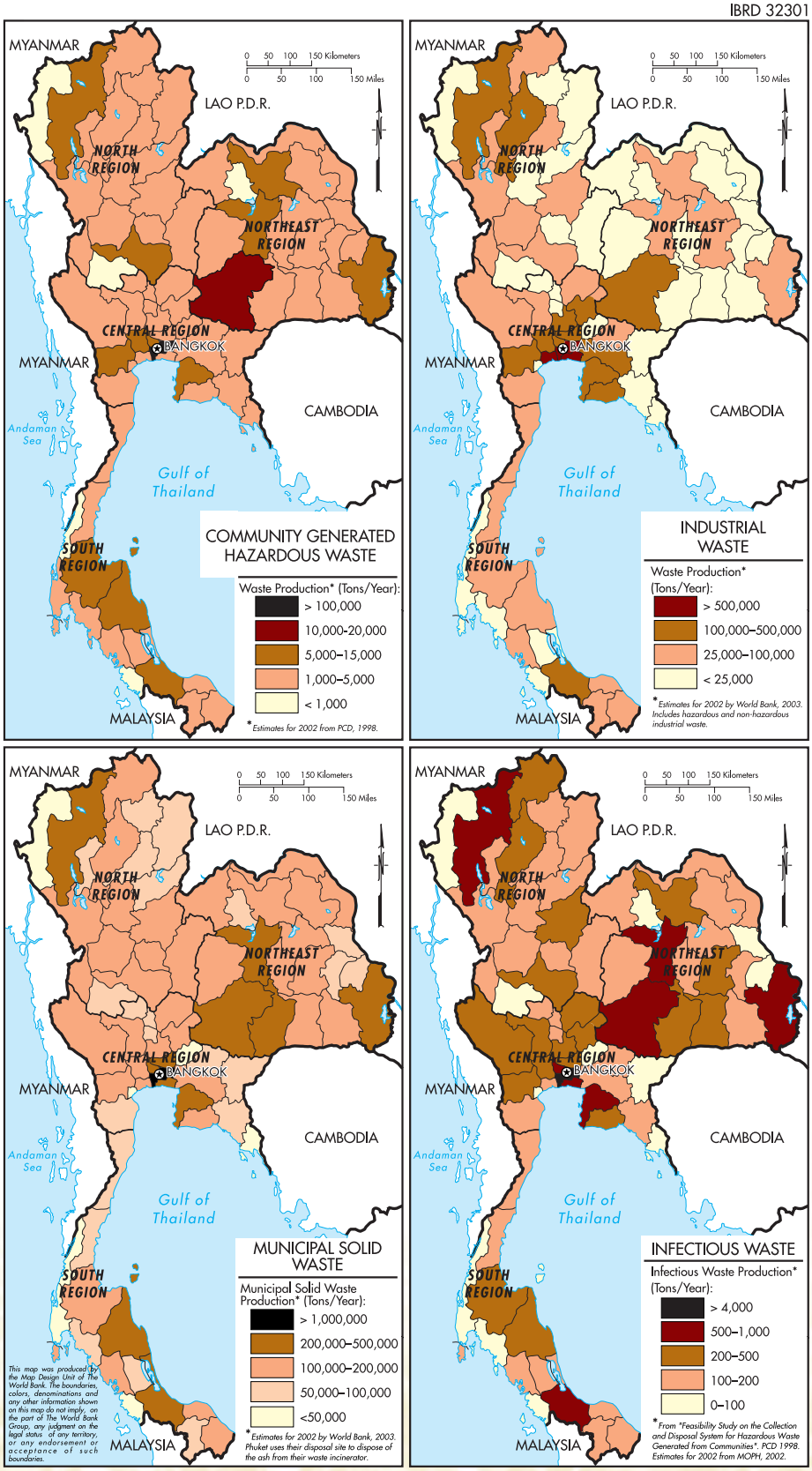
Table 2: Waste Composition in Thailand

Type of Waste	Major Sources	Major Constituents
Municipal Solid Waste	Residential Commercial/Tourism Agriculture	Kitchen waste (51%) Plastic and Foam (22%) Paper (13%) Glass (3%)
Infectious Waste	Hospitals (93%) Educational and labs (7%)	Tissue samples Blood and other liquids Surgical wastes and syringes
Industrial Hazardous Waste	Metals industries (33%) Electronic industries (28%) Plastic industries (8%) Chemicals and Petroleum industries (7%)	Filter materials, waste sludge (35%) Fuel, oil and grease (28%) Liquid organic compounds (8%)
Industrial Non-hazardous Waste	Metals industries (36%) Food industries (13%) Furniture (7%)	Metals and metal alloys (30%) Parts of wood (16%) Animal parts (13%)
Community Hazardous Waste	Automotive stations (54%) Residential (19%) Agricultural (10%) Gas stations (10%	Recyclable waste oils (27%) Lead acid batteries (21%) Other toxic chemicals (8%) Other waste oils (6%)

Sources: Infectious and Community Hazardous Waste : PCD (Community hazardous waste study), 1998. Industrial Hazardous Waste: see methodology section for details; Municipal Solid Waste composition based on 1999 data provided through personal communication with JBIC.

WASTE GENERATION

IBRD 32301



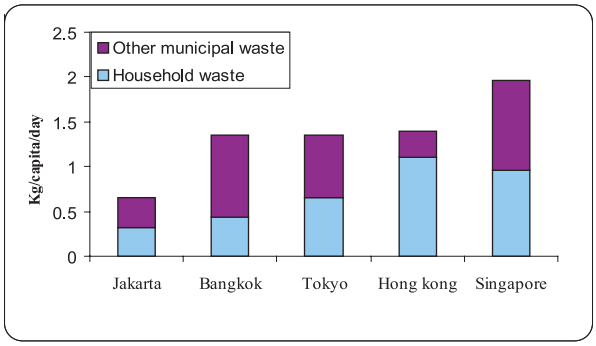
DECEMBER 2003

Each day over a half a kilogram of waste is produced per person. Nationally, the average amount of solid waste produced per person in 2002 was 0.65 kg per day, a number that has grown an estimated 17 percent between 1994 and 2001[2] despite the reduced consumption during and immediately after the 1997 financial crisis (Table 3). On average, urban areas in Thailand produce up to three times more (0.5-1.7 kg/person/day) solid waste per person than in rural areas (0.4-0.6 kg/person/day).[3] This is mostly due to the higher number of businesses and other activities in urban centers. For example, Bangkok has a per capita waste generation rate comparable to Tokyo and Hong Kong (1.3 kg/capita/day), due to the high quantity of waste from non-household sources such as stores, offices, and hotels.

Tourists increase solid waste generation. Tourism areas in Thailand produce some of the highest quantities of solid waste per capita due to the high influx of tourists and supporting businesses. For example, a tourist in Patong Beach, Phuket, produces 2.2 kg/day of solid waste.[4] When the waste from tourism is added to the solid waste produced by the resident population, per capita solid waste generation in Patong Beach is over three times higher than that of Bangkok.

Up to 17 million tons of municipal waste may need to be disposed in 2010. Future growth of solid waste generation will depend upon the population growth, consumption, and recycling and reuse in the country. With the current rate of growth in population and consumption, 17 million tons of waste will be need to be disposed in 2010 (Fig. 2). This could reach as high as 20 million tons if recycling and reuse rates remain constant and consumption levels grow rapidly enough to increase per capita solid waste generation by 50 percent over this period.

Fig. 1: Per Capita Solid Waste Generation for Asian Cities



Sources: Jakarta: Waste production: DKI, 1998. Household waste percentage: Jakarta City Government ,1995; Bangkok: BMA data, 2000; Tokyo: Data provided through personal communication with JBIC, 1998; Singapore, Ibid, 1999; Hong Kong: Environmental Protection Department, 2002.

Table 3: Per capita Solid Waste Generation Rates in Thailand, 2002

	Generation Rate (kg/cap/day)
Thailand average	0.65
Urban Areas	0.4-1.9
Bangkok	1.3
KhonKaen	1.0
Ranong	0.7
ChanthaBuri	0.6
Kanchanaburi	1.3
Rural areas	0.4-0.6
Tourist areas	
Pattaya,ChonBuri	1.6
Patong Beach, Phuket	5.0

Source: PCD, 2001 data. Includes solid waste produced by all sources, normalized to the registered population as nonregisted was not available. Bangkok provided through personal communication with JBIC, 2000 and includes nonregistered population. It should be noted that Bangkok generation would be 1.6 kg/capita/day if normalized to registered population only.

Recycling and Reuse can curb growth in waste generation. If recycling and reuse increased from the current level of 11 percent[5] to 25 percent, future growth in waste generation could be significantly curtailed, which would nearly stabilize or decrease waste generation in the short term (Fig. 2).

[2] Estimated based on PCD per capita waste generation rates and correlated to statistics of consumption of semi-durable and durable goods. Consumption levels of these goods grew an average of 5% in the pre-crisis years (1994-1996), declined an average of 3% annually during the crisis (1997-1998) and grew an average of 2% annually in the post-crisis years (1999-2001).

[3] PCD, 2001 data.

[4] Ban Chang-BFI, 1995.

[5] Estimated based on municipal and non-municipal recycling rate presented in PCD (Recycling Study), 2001.

Industrial Hazardous Waste

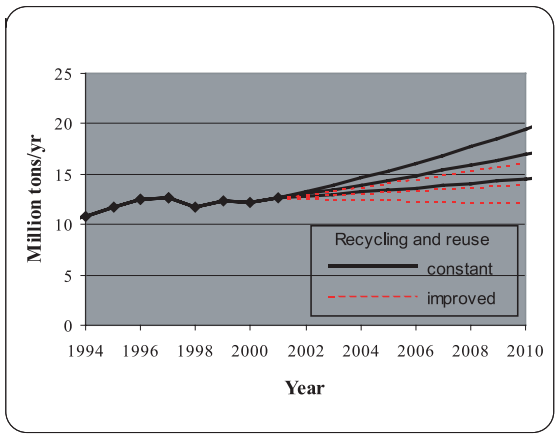
Industrial waste generation is fueled by growth in manufacturing. In the late 1980s and early 1990s industrial waste generation grew dramatically, resulting from an average annual growth in manufacturing of 10 percent. There was a dip in manufacturing production during the financial crisis, yet since then the manufacturing sector has rebounded, growing an average of 4 percent over the last several years.[6]

Industries producing hazardous waste are growing fast. The top four hazardous waste producing industries account for just under 29 percent of the industrial output of Thailand [7] , but include some of the fastest growing sectors. For example, electronics and electrical products, and metal products, account for just under half of the hazardous waste produced in the country. Since 2000, these sectors have grown 2-3 times faster than the manufacturing sector as a whole.[8]

Hazardous waste is likely to grow rapidly with a strong economy. Projections based on current manufacturing composition and waste practices indicate that, in the current decade, hazardous waste generation could grow anywhere from 8 percent with low economic growth (1.5 percent annual GDP growth) to 70 percent with high economic growth (6 percent annual GDP growth) (Fig. 3). Thailand's GDP is expected to grow by 5.6 percent in 2003.

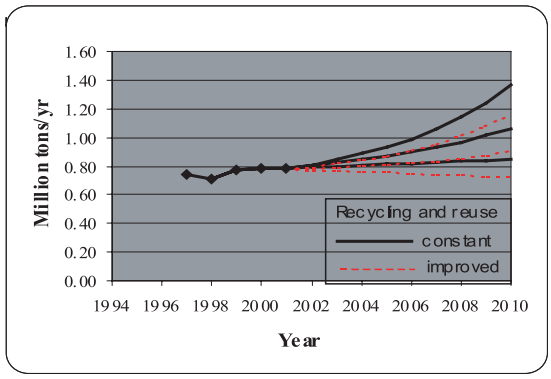
Improved recycling, efficiency, and pollution prevention could reduce industrial hazardous waste generation. While nearly 80 percent of non-hazardous industrial waste is recycled in Bangkok and vicinity, only 18 percent of industrial hazardous waste is reused or recycled.[9] An increase in hazardous waste recycling and reuse from current levels to 30 percent by 2010 could significantly reduce the anticipated growth in hazardous waste, resulting in cost savings both in production and treatment (Fig. 3).

Fig. 2: Municipal Solid Waste Generation



Projection scenarios: High: Growth of per capita waste generation by 50% by 2010; Medium: Current rate of growth in per capita waste generation; Low: Stabilization of per capita waste generation at current levels. Dotted lines indicate the projected waste generation with an increase in reuse and recycling from 11% to 25% by 2010. (See Methodology section for details.)

Fig. 3: Industrial Hazardous Waste Generation



Three economic growth scenarios were used for projections: **High** (6% annual GDP growth), **Moderate** (4%) and **Low** (1.5%). Projections assume the 2001 unit waste generation rates and industrial sector composition and correlation of GDP and sector growth rates using data from 1999-2001. Dotted lines indicate the projected waste production with an increase in reuse and recycling from 18% to 30% by 2010. (See Methodology section for details.)

---

[6] Bank of Thailand figures for growth in manufacturing production index from 1988 to 1996 and 2000 through 2002.

[7] Industrial output from DIW industry database for 2001. The top four hazardous waste producing industries account for 76 percent of the hazardous waste production nationally and are shown on Table 2.

[8] Waste production estimates described in methodology section. Growth from Bank of Thailand data, 2000-2002 annual growth in manufacturing production index.

[9] Kokusai Kogyo and Ex Corp for DIW and JICA, 2002.

Infectious and Community Generated Hazardous Waste

Community hazardous waste produced by households, including such items as batteries, light bulbs, spray cans and cleaning solvents, will roughly follow the increases in solid waste generation. However, the amount is also dependent on changes in particular consumption patterns such as recent increases in the use of cell phones and electronic equipment. Community hazardous waste not produced by households, but produced by gas stations and automotive repair shops, dry cleaners, and photo processing, is largely dependent upon the growth of the economy and to some extent on the inherent technologies and practices. Estimates of growth indicated from 2002 to 2012 community hazardous waste may grow 35 percent (Table 5).

Infectious waste is primarily from hospitals, clinics and primary care units and depends upon the sophistication of the facility, visitation, and types of healthcare provided. Estimates in growth indicate that infectious waste could grow 28 percent from 2002 to 2012 (Table 5).

Table 4: Infectious and Community Hazardous Waste Generation Rates from Different Sources

		Generation rate
Community generated hazardous waste	Residential (kg/person/yr)	1.1
	Commercial (kg/employee/yr)	
	Auto Shops	2,290
	Photo processing	930
	Gas stations	585
	Commercial printing	67
Infectious waste	Central and general hospitals (kg/bed/yr)	127
	Community hospitals (kg/bed/yr)	245

Sources: Infectious waste: Weerachai Chokewinyu, 1996 as reported in MOPH, 2002; Community Hazardous Waste: PCD (Community Waste Study), 1998.

Table 5: Infectious and Community Hazardous Waste Generation (thousand tons)

	1997	2002	2007	2012
Infectious Waste		21.3	24.3	27.2
Community Hazardous Waste	306	372	438	504

Sources: Infectious waste: MOPH, 2002; Community Hazardous Waste: PCD (Community Waste Study), 1998.

Infectious waste in red plastic bag is co-disposed with municipal solid waste

2

Waste Reduction, Reuse and Recycling

Bangkok lags some East Asian cities in recycling. Bangkok recycles 15 percent of its waste, a value just above Beijing and Manila but much lower than cities such as Seoul, Hong Kong, and Singapore (Table 6). Nationally, more than 1.5 million tons of municipal solid waste is recycled each year in Thailand, amounting to 11 percent of the total amount of waste generated[10]. Municipal areas on average recycle 16 percent of their waste while non-municipal areas recycle between 5 and 8 percent[11]. (Fig. 4).

Over one third of municipal waste could be commercially recycled. Roughly 42 percent of Thailand's municipal solid waste is comprised of glass, plastic, paper, and metal, which has the potential to be recycled commercially and then reused in various manufacturing and industrial activities. As a result, almost 4.5 million tons of commercially recyclable materials[12] are discarded each year. The potential market value of these materials is THB 16 billion per year[13]. Metal and paper, in particular, have tremendous recycling potential and approximately two thirds of these recyclables are currently discarded (Fig. 5).

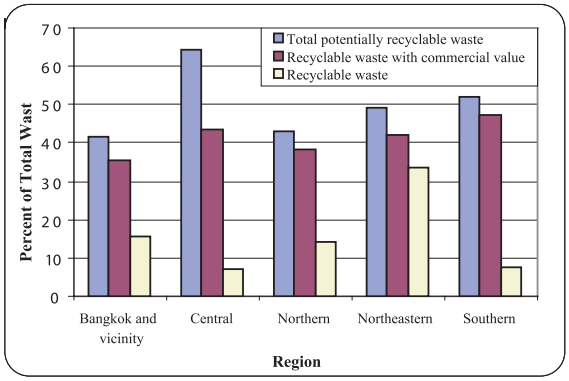
Informal recyclers dominate. Of the recyclable materials that are collected, more than 70 percent is collected informally, by three main groups (Fig. 6). The most prominent are the sa leng, waste collectors who are easily recognized as they commonly use tricycles to collect waste. Additionally, municipal garbage collectors also sort and collect recyclables for sale on an informal basis to supplement their income. Finally, there are several thousand waste pickers or scavengers who collect waste from the landfill and sell it as a livelihood.

Table 6: MSW Recycling Rates in Asian Cities

City	MSW Recycled
Hong Kong	36%
Seoul	45%
Singapore	39%
Manila	13%
Bangkok	15%
Beijing	< 10%

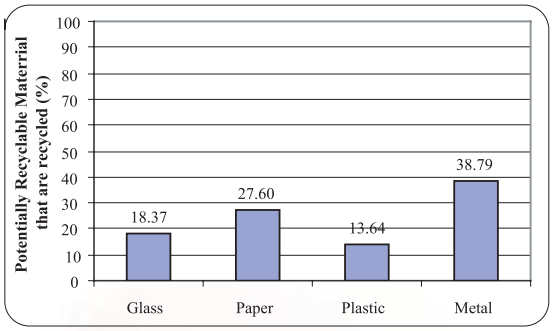
Sources: Hong Kong: Environmental Protection Department, Hong Kong; Seoul;Yoon, 2002; Singapore: UNESCAP; Manila: Philippines Environment Monitor, 2001; Beijing: Institute for Global Environmental Strategies, 2002; Bangkok: PCD (Recycling Study), 2001.

Fig. 4: Percentage of Materials with Recyclable Potential in Municipal Areas of Thailand



Source: PCD (Recycling) Study, 2001.

Fig. 5: Recycling Rates of Selected Recyclable Materials in Urban Areas



Source: PCD (Recycling) Study, 2001.

[10] PCD (Recycling Study), 2001. Out of the 14.4 million tons of solid waste produced nationally, Bangkok and municipal areas recycle 1.28 million tons per yr while non municipal areas recycle between 0.3 and 0.5 million tons per yr.

[11] Municipal areas from PCD (Recycling Study), 2001 and non muinicipal areas from PCD (Recycling Study), 1998 as cited in 2001 study.

[12] Based on percentages from PCD (Recycling Study), 2001 applied to 2001 waste production estimates.

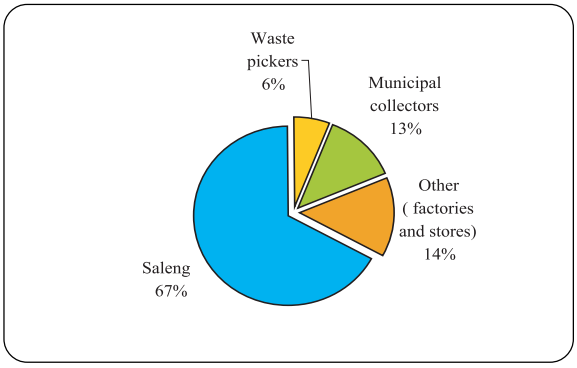
[13] Estimated based on the amount of glass, metal, paper and plastic that is disposed with waste and the sale price of these recyclable materials. See methodology section for more details.

[14] Ibid.

Households do little separation of waste. Separation of recyclables by households is currently limited to that which is encouraged through Garbage Banks and the relatively small quantities of paper and glass that households store for sale or donation to sa leng or recycling shops.

Composting is still not widespread but has a large potential. Composting involves the decomposition of the organic portion of municipal solid waste and using the product as a soil conditioner. There is a large potential use for this material, however, only 2,700 tons of waste per is processed each year in the 113 composting operations found in municipal areas of Thailand[15] and in Bangkok plans were abandoned to develop a composting plant. Studies indicate that the major use for compost in the Bangkok and vicinity is by farmers cultivating tree crops, vegetables, and flowers, and amounts to 1.4 million tons of compost, valued at THB 4.5 billion annually[16]. Additionally, another 150,000 tons of compost could be used by BMA each year in public parks and green areas. Besides reducing the amount of waste for landfills, composting also helps to reduce Thailand's greenhouse gas emissions as envisioned under the United Nations Framework Convention on Climate Change (UNFCCC).

Fig. 6: Collection of Solid Waste for Recycling



Source: PCD (Recycling Study); 1998

Box 1: Encouraging Recycling Through Garbage Banks

Garbage banks were conceived as initiatives to encourage recycling activities at the community level, through which participants receive goods or money in exchange for their recyclable waste. Following the success of the first garbage bank in Dan Khun Tod, these types of banks have been replicated around the country. As of 2001 there were 87 of them in the municipal areas of Thailand that process a total of 2,500 tons of recyclables a year.

School garbage banks are typically set up in local schools, where students can bring recyclable waste for collection. Students receive either cash or a certain number of reward points in exchange for their waste, depending on the volume and the type of material presented. Reward points can be redeemed to procure sports equipment, stationary, and other goods, the purchase of which is funded with profits from the sale of the recyclable materials. Garbage banks are typically managed by students, with support from teachers and parents.

Community garbage banks are variations of the school banks, run by communities and municipalities. In Phitsanulok, a community garbage bank is profitably managed by local youth, with the support of the municipality and of a private waste trading firm. In Phicit, profits generated from a garbage bank were used to set up a communal convenience store, where goods are sold to members at a lower price. In Udon Thani province, members of the garbage bank receive shares of proceeds from the sale of all the collected recyclable waste

The "garbage-for-eggs" project was instituted in one of Bangkok's poorest residential areas by Klong Toey Environmental Protection Group. The primary objective of the project was to solve yearly flooding problems faced by the community, due to the blocking of canals and sewerage systems by improperly discarded waste. Residents were encouraged to collect recyclable materials and to exchange them for eggs. Within six months of the program's start-date, the amount of waste in the community was reduced by 161 tons. The project is now operating in 23 communities within Bangkok and other provinces.

Note: Data on number of Banks and garbage for eggs projects from PCD (Recycling Study), 2001.

[15] PCD (Recycling Study), 2001.

[16] Data provided through personal communication with JBIC.

Box 2: Improving the Lives of Informal Recyclers

It is common for the informal sector to participate in solid waste management activities in developing countries. This is due primarily to inadequate municipal services, which create a large need for informal waste collection, and the consequent opportunity it provides for income among the poor. The size of the informal recycling sector varies significantly from country to country. It has been estimated, for instance, that around 2 percent of Mexico's population live off recycling-related activities, including 30,000 people in the metropolitan area of Mexico City alone. In Colombia, 300,000 people, roughly 1 percent of the country's population, are involved in scavenging activities.

The informal waste collection sector in Thailand is considerably smaller, with an estimated 25,000 people involved in informal recycling. This includes more than 15,000 sa leng waste collectors, 2,000 waste agents, and just under 4,000 scavengers who collect waste from disposal sites and transfer stations. In addition, over 3,000 municipal collectors in the country supplement their income by selling recyclables on an informal basis. Moreover, in Thailand, the income gap between formal and informal sectors is not as significant as in other countries. For example, at the On-nuch transfer station in Bangkok, scavengers earn between 150 and 400 baht per day while municipal collection workers earn an average of 700 baht per day. At the same time, informal recyclers, especially scavengers, are truly marginalized groups in Thailand that are subject to dangerous and unsanitary working conditions. The majority have no benefits such as medical insurance and pension plans; they have limited job stability and few educational and other job opportunities. The following initiatives, implemented in Colombia and the Philippines, may provide some innovative ideas to help these people:

Colombia, various cities - The support of government agencies and local NGOs has greatly contributed to the improvement of working conditions for waste pickers throughout Colombia. Recycling organizations started to emerge during the early 1990s, and progressively became small-scale enterprises and regional cooperatives. These cooperatives have gradually given their members employment benefits that are typical in the formal sector, such as subsidized health care, paid vacations, and pensions. Membership improves overall behavioral traits because recyclers have access to training, and they participate in meetings, social activities, and community life. Working conditions of recyclers typically improve after joining cooperatives because they are provided stable access to sources of recyclable materials (away from the landfills), as well as equipment and uniforms.

The Philippines, Quezon City - In 1993, the community of scavengers that lives in Metro Manila's Payatas dumpsite established the Payatas Scavengers Association. This initiative has considerably improved the living standards of its members by filling some of the typical voids found in the informal sector. The Association has promoted programs, among others, that aim at stabilizing the monthly incomes of scavengers through: 1) the establishment of home-based solid waste microenterprises, where recyclable materials are processed and subsequently resold at a profit, on a steady basis; and 2) the creation of a communal savings fund that provides access to loans for members of limited and uncertain monthly incomes.

Sources: Hoyos, E., 2000; International Source Book on Environmentally Sound Technologies (ESTs) for Municipal Solid Waste Management (MSWM); The Philippines Environment Monitor 2001, The World Bank; PCD (Recycling Study), 1998; TDRI, The State of the Environment in Thailand, 2000; Data on earnings at On-nuch provided through personal communication with JBIC; Earnings of municipal workers at On-nuch include their base salary, income from selling recyclables, and other income from holiday work and collection fees from households..

Incentives for Waste Reduction in Municipalities and Industries

Municipalities are encouraging participation in recycling. Bangkok, as well as most small to medium-sized regional cities, is undertaking some public awareness campaigns for recycling and waste separation[17]. While participation in recycling is crucial, only modest success has been reported in most of these programs. For example, a recent program by BMA resulted in an increase the amount of recyclables collected but still only accounts for 0.3 percent of the total waste recycled in Bangkok and vicinity[18].

Incentives for waste reduction and recycling could save money on disposal. The introduction of packaging taxes and other economic incentives for reducing waste and encouraging recycling in many countries have had a larger impact on recycling and waste reduction in these countries than just public awareness and organized recycling programs alone. Implementing such measures in Thailand could have a significant impact both on waste generation and disposal costs. For example, with a modest 25 percent reduction in paper and plastic waste, garbage production could be reduced by over 1 million tons annually, resulting in an estimated savings of THB 500 million per year on collection and disposal[19].

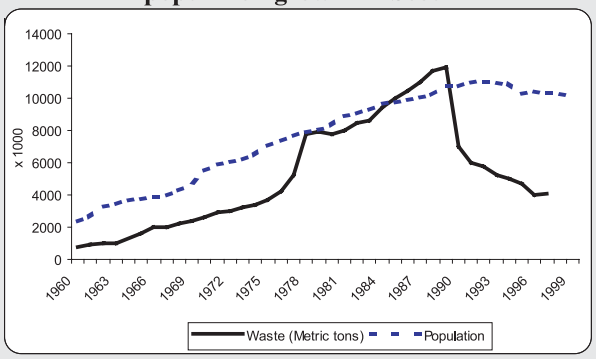
Reduced packaging waste could improve export competitiveness. Packaging laws in the EU and other countries, including Japan, can reduce the competitiveness of Thai exports. These countries charge fees on excess packaging of products, including those imported from Thailand. As many Thai companies have not adapted their packaging to these laws and are commonly not aware of the fees, the price of using Thai products is higher than for companies that have adapted to packaging laws. By reducing packaging waste in Thai products, Thai manufacturers can increase their competitiveness through reduced import fees and in many cases also through reduced production costs[20].

Box 3: Successful Waste Reduction and Recycling in Asian Cities

Yokosuka City: The Potential of Participation
Yokosuka City, a city with a population of 380,000 people located about 50 km from Tokyo, was able to increase waste recycling drastically through an intensive public awareness and consultation program. Before the introduction of the new waste separation program in 2000, the city held 1,200 small public meetings during six months and through this was able to reach 40 percent of all households in the city. As a result of the awareness and ownership gained in these efforts, by 2001 there was a 77 percent reduction in the amount of waste disposed in landfills; a 26 percent reduction in the amount of waste incinerated; and an improvement in the recycling rate from 13 to 31 percent.

Seoul: The Potential of Economic Incentives
From 1962 to 1991, Seoul's population increased about 3.5 times, yet its municipal solid waste generation increased approximately 15 times. In the 1990s the government introduced programs that effectively reversed this drastic increase in waste generation. These initiatives included campaigns to: discourage the use of disposable goods; reduce the excessive packaging of products; and increase the use of reusable shopping bags. In addition, legislative initiatives were introduced, such as the revision of *Waste Management Act* to promote recycling (1991) and the *Volume-based Waste Collection Fee* (1995), by which all waste generators must pay for the generation of non-recyclable materials. As a result, by 1999 Seoul generated 1.06 kg/person/day of MSW, a 64 percent reduction in per capita generation relative to 1991. In addition, recycling rates increased from 6 percent in 1991 to 45 percent in 2000.

Fig. A: Municipal solid waste generation and population growth in Seoul



Sources: Personal communication with JBIC. Yoon and Jo, Proceedings of Workshop of IGES/APN Mega-City Project, 2002.

[17] 12 of the 13 cities surveyed in the municipal benchmarking survey, 2003 were undertaking these programs. Other municipalities are undoubtedly undertaking similar programs also, however, the data was not available.

[18] Department of Public Cleansing, BMA, 2000.

[19] World Bank estimates based on typical operation and maintenance and personnel costs for collection and disposal costs as reported by a sample of 8 municipalities.

[20] From PCD, Research and Development on Waste Minimization and Utilization Technology.

Recycling of Industrial and Community Waste

The majority of industrial non-hazardous waste is recycled. According to a survey of industries in Bangkok and its vicinity, 78 percent of non-hazardous industrial waste is recycled (Table 7), mostly offsite by waste buyers and private companies. Annually, this amounts to 590,000 tons of metals; 140,000 tons of plastics; 90,000 tons of paper; and 65,000 tons of glass.

Industrial hazardous waste recycling is being encouraged. In Bangkok and vicinity less than 20 percent of industrial hazardous waste is recycled or reused[21] (Table 7). Fuel oil and grease, along with organic compounds account for 30 percent of the total recyclables. Waste exchange programs are currently being piloted in Thailand to further encourage industrial recycling. In these programs, companies match their waste disposal and raw material needs through a computerized database and subsequently exchange wastes. These types of transactions avoid disposal costs for the waste supplier, while the user can purchase used raw materials at lower prices than new materials.

Some generators of community hazardous waste undertake extensive recycling. Approximately 51 percent of community generated hazardous waste is recycled or re-used. The largest generators are auto-repair shops and gas stations, which recycle 80 percent and 68 percent of their hazardous waste respectively. Households are the next largest generators, however, they only recycle or reuse approximately 2 percent of their waste[22] .

Table 7: Recycling of Industrial Waste

Type of Waste	% Recycled	Materials with Highest Recycling Rates (% recycled)
Hazardous Waste	18.2%	Alkalis (83%) Heavy Metals (46 %) Pickling Waste (40%) Organic Compounds (32%)
Non-Hazardous Waste	78.4%	Plant material (100%) Animal parts (99.9%) Wood and paper waste (98%) Natural rubbers (93%)

Source: Kokusai Kogyo Co., Ltd and Ex Corporation for DIW and JICA, 2002.

Informal recyclers play a major role in recycling in Thailand

Various decorating products made from garbage by school kids in Pattani

[21] Kokusai Kogyo Co., Ltd and Ex Corporation for DIW and JICA, 2002.

[22] PCD (Community Waste Study), 1998.

3

Municipal Solid Waste

Collection and Transport

Solid waste collection is generally better in urban areas. Bangkok collects almost 100 percent of its municipal solid waste (Box 4). Outside Bangkok collection efforts are more variable, with larger cities (Muang municipalities) typically having more efficient collection than smaller towns (Tambon municipalities). Collection rates in rural areas are estimated to be between 20 and 30 percent[23] (Table 8).

Effective use of collection trucks is a challenge. While investments made in collection trucks are sufficient for most municipalities, many report maintenance problems; complain of spillage of garbage and leachate from trucks; and have problems accessing congested, narrow, or disorganized roads[24]. Some municipalities have begun to address these issues. For example, specially adapted collection trucks can access all areas and night collection can avoid traffic congestion.

Collection truck modified from a "Tuk-Tuk" in order to be access narrow roads

Table 8: Solid Waste Collection in Municipalities

	Range	Average
Tambon Municipalities	64-93%	75%
Muang Municipalities	59-100%	86%
Bangkok	> 99%	

Source: Compiled from data in each region as reported in: PCD studies (1997, 2000). Bangkok has a reported rate of 100%, however, it is acknowledged that self disposal and open dumping occurs, although the quantity is not known.

Box 4: Taking the Trash Away: Waste Collection in Bangkok

Through large investments in trucks in the early 1990s and improved management through district offices, Bangkok is now able to collect nearly 100 percent of its waste. A two-step system is used:

Primary collection: Collection at households is undertaken by the BMA through the Public Cleansing Division of the district offices. Collection is done at night to avoid traffic and uses approximately 2,200 vehicles that collect approximately 8,800 tons of waste per day. The collected waste is transported to one of three transfer stations.

Secondary transport: At the transfer stations, BMA places the waste into large hauling trucks, which are weighed in order to determine the amount of waste processed. Private sector firms then haul the waste a distance of between 10 and 110 km to one of two landfills.

Table A: Transfer Stations in BMA

	Waste Transferred (ton/dy)	Hauling Distance (km)	Final Disposal Site
On-nuch	3,554	10	Rachathewa
Tharaeng	2,362	110	Kampangsaen
Nongkhaem	2,865	80	Kampangsaen

Source: Information provided through personal communication with JBIC. Quantities of waste transferred are 1999 values.

Over 100 new disposal facilities have been constructed. Of the estimated 1,000 or more disposal sites nationwide, only 104 have been constructed to appropriate standards through national government funding. Many of these new disposal facilities are located in the 76 provincial capitals and as a result 57 percent of these municipalities have engineered or sanitary landfills (Fig. 7). In contrast, only 4 percent of the more than 1,000 smaller, Tambon municipalities have landfills, with the remainder relying on dumps that are often located in abandoned or disused land where garbage is indiscriminately tossed (Fig. 8).

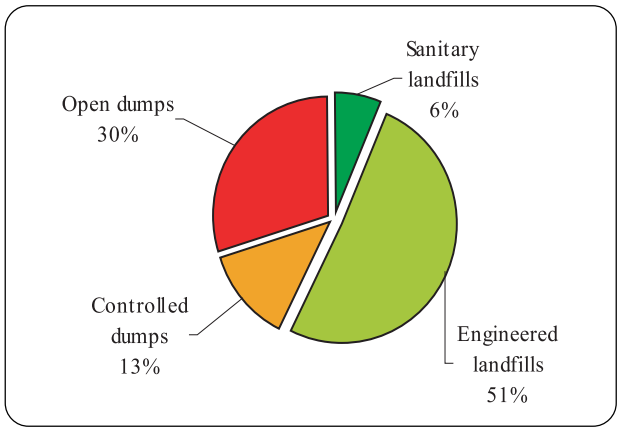
Disposal sites commonly lack environmental controls. Only 5 provincial capital sites, truly operate with all the operational practices and environmental controls and conditions expected of a sanitary landfill[25] (Table 9 and Map 2). The remaining sites incorporate some but not all of these practices and most commonly lack environmental controls. In particular, only 21 percent of the sites have leachate treatment, monitoring wells, and gas ventilation systems, and only 14 percent of the sites operate with effective environmental controls (see Fig. 9)

Box 5: Protecting Natural Treasures- The Challenge of Solid Waste Disposal in National Parks

Tourists commonly produce more than twice the amount of waste of households and managing this waste is crucial to maintaining the natural beauty of tourist attractions such as National Parks and beaches. National Parks, unlike municipalities, are not well positioned to manage solid waste as they have limited expertise and budget resources. For National Parks in Thailand, this problem is leading to the accumulation of waste due to poor waste collection and the existence of open dump sites in what should be a natural protected areas. Through a JBIC funded program, the National Park, Wildlife and Plant Conservation Department is currently addressing this issue by encouraging waste reduction and recycling in National Parks and developing cooperative waste management arrangements among the Park and the adjacent local governments.

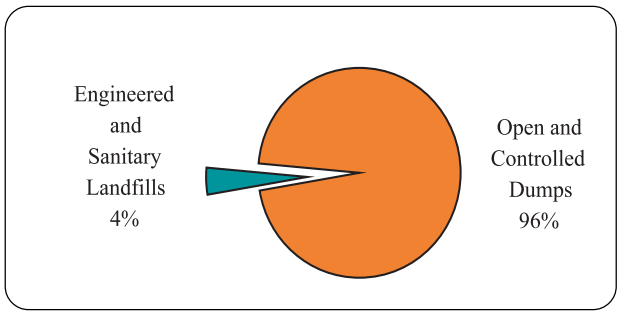
Source: Personal communication with JBIC.

Fig. 7: Disposal Practices in Provincial Capitals



Source: Survey of landfills in Amphur Muangs, 2003. See Table 8 for description of types of disposal sites.

Fig 8: Disposal Practices in Tambon Municipalities



Open and controlled dumps are the predominant disposal practice in Tambon Municipalities

[25] These include Songkhla, Rayong, Si Sa Ket, Bangkok- Ratchathewa, and Mukdahan.

Fig. 9: Sanitary Landfill Practices in Provincial Capital Disposal Sites

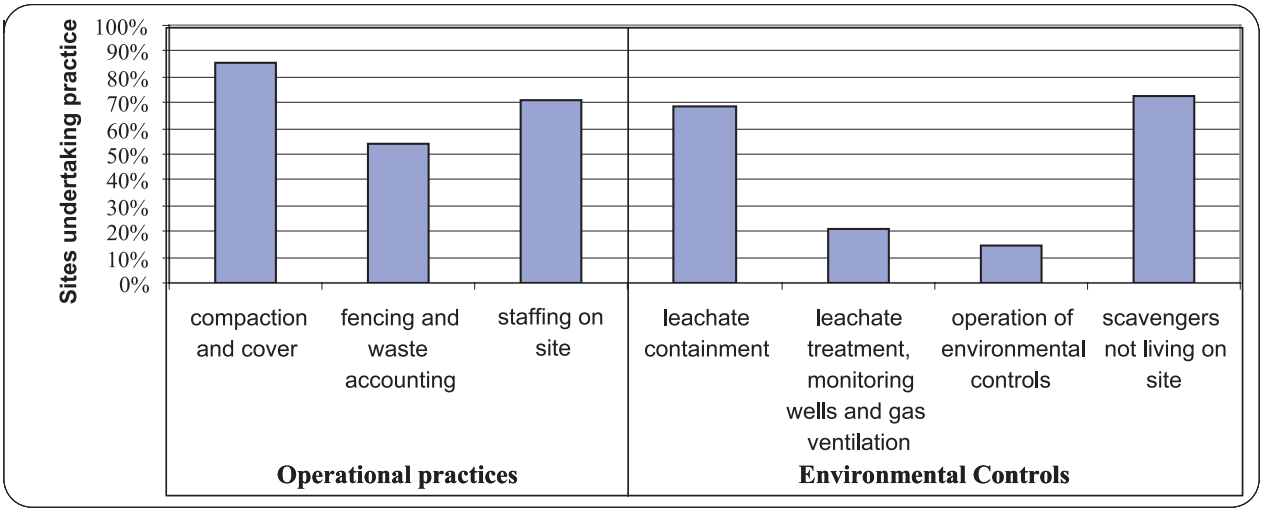
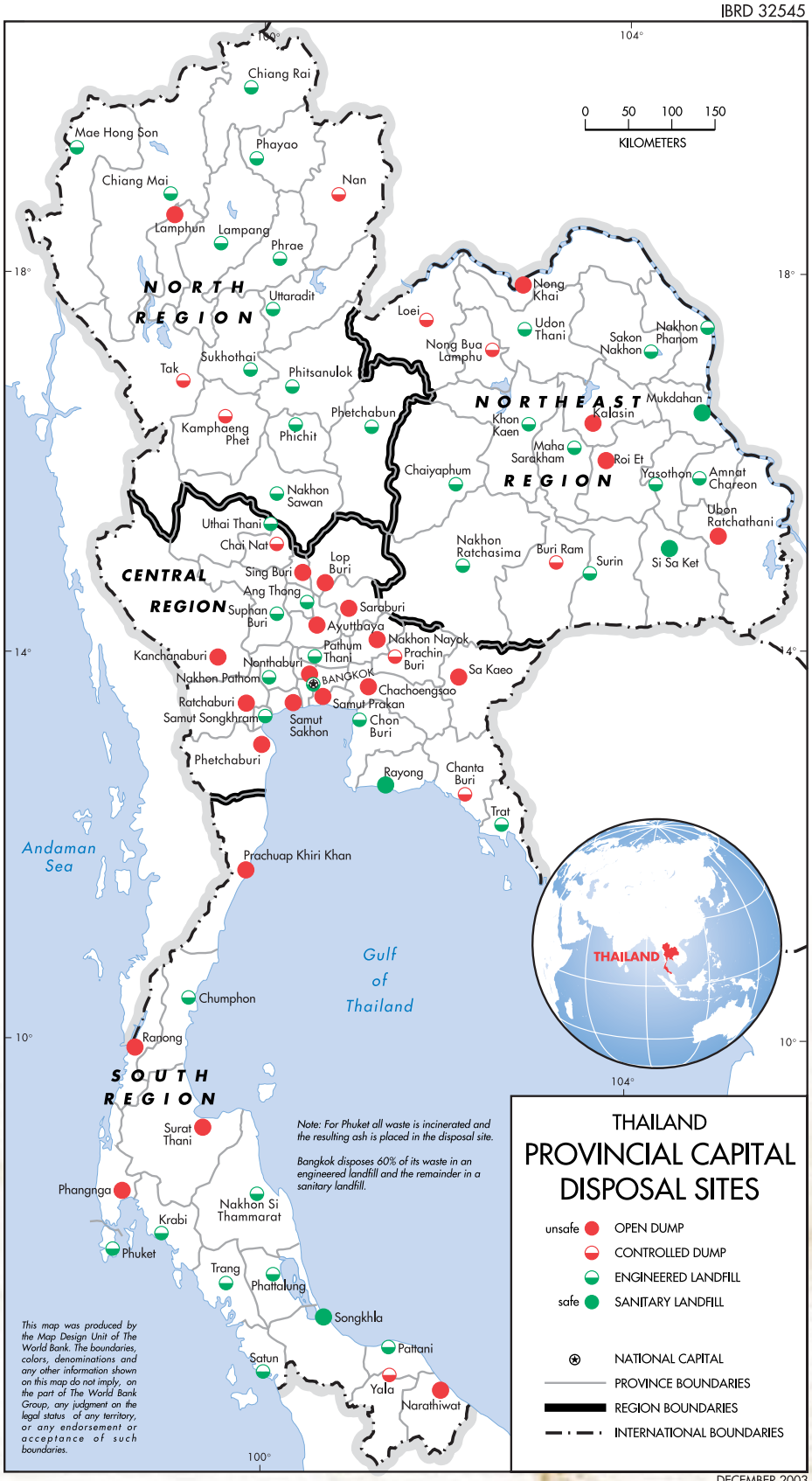


Table 9: Safe and Unsafe Disposal Practices

		Operational Procedures	Environmental Controls
UN SAFE	Open Dump	No formal operational procedures.	No environmental controls. Scavengers are commonly living on site.
	Controlled Dump	Some basic waste accounting, placement and compaction procedures, limited facilities such as fencing and staff on site.	Limited or no environmental controls. Waste pickers are commonly living on landfill.
SAFE	Engineered Landfill	Some basic waste accounting, placement, cover, and compaction procedures, fencing and staff on site. Waste pickers may be living on landfill.	Some environmental monitoring and environmental controls such as liner, drainage, leachate treatment, and gas ventilation. Controls may be dysfunctional or not operated.
	Sanitary Landfill	Waste accounting, placement, cover and compaction procedures, fencing and staff on site. No scavengers living on landfill.	Regular environmental monitoring. Environmental controls, including liner, drainage, leachate treatment, and gas ventilation that are able to maintain sanitary environmental conditions.

Note: Also see methodology section.

IBRD 32545


THAILAND
PROVINCIAL CAPITAL DISPOSAL SITES
unsafe
OPEN DUMP
CONTROLLED DUMP
ENGINEERED LANDFILL
safe
SANITARY LANDFILL
NATIONAL CAPITAL
PROVINCE BOUNDARIES
REGION BOUNDARIES
INTERNATIONAL BOUNDARIES
0 50 100 150
KILOMETERS
NORTH REGION
NORTHEAST REGION
CENTRAL REGION
SOUTH REGION
Andaman Sea
Gulf of Thailand
BANGKOK
Chiang Rai
Mae Hong Son
Phayao
Chiang Mai
Nan
Lamphun
Lampang
Phrae
Uttaradit
Sukhothai
Tak
Phitsanulok
Kamphaeng Phet
Phichit
Phetchabun
Loei
Nong Khai
Udon Thani
Nakhon Phanom
Sakon Nakhon
Nong Bua Lamphu
Khon Kaen
Kalasin
Mukdahan
Maha Sarakham
Roi Et
Yasothon
Amnat Charoen
Chaiyaphum
Ubon Ratchathani
Nakhon Ratchasima
Buri Ram
Surin
Si Sa Ket
Nakhon Sawan
Uthai Thani
Chai Nat
Lop Buri
Sing Buri
Ang Thong
Suphan Buri
Saraburi
Ayutthaya
Nakhon Nayok
Pathum Thani
Prachin Buri
Sa Kaeo
Kanchanaburi
Nonthaburi
Nakhon Pathom
Chachoengsao
Samut Prakan
Ratchaburi
Samut Songkhram
Samut Sakhon
Chon Buri
Phetchaburi
Rayong
Chanta Buri
Trat
Prachuap Khiri Khan
Chumphon
Ranong
Surat Thani
Phangnga
Nakhon Si Thammarat
Krabi
Phuket
Trang
Phattalung
Songkhla
Pattani
Satun
Yala
Narathiwat
Note: For Phuket all waste is incinerated and the resulting ash is placed in the disposal site.
Bangkok disposes 60% of its waste in an engineered landfill and the remainder in a sanitary landfill.
This map was produced by the Map Design Unit of The World Bank. The boundaries, colors, denominations and any other information shown on this map do not imply, on the part of The World Bank Group, any judgment on the legal status of any territory, or any endorsement or acceptance of such boundaries.
DECEMBER 2003

Unsafe disposal practices are putting communities and waste pickers at risk. Currently, many of the provincial capital disposal sites are experiencing environmental problems that pose health risks to people in the surrounding area. Disease can be spread through insect and rodent vectors and through drinking and bath water that has been polluted by solid waste. The health risks are compounded by the fact that each year an estimated 70,000 tons of community generated hazardous waste and 8,000 tons of infectious wastes are disposed in combination with municipal wastes[26].

Table 10: Provincial Capital Disposal Sites Reporting Environmental Problems

Issue	# sites	% of sites
Leachate contamination	26	34%
Fires	12	13%
Rodents and birds	26	34%

Source: Survey of disposal sites in provincial capitals, 2003

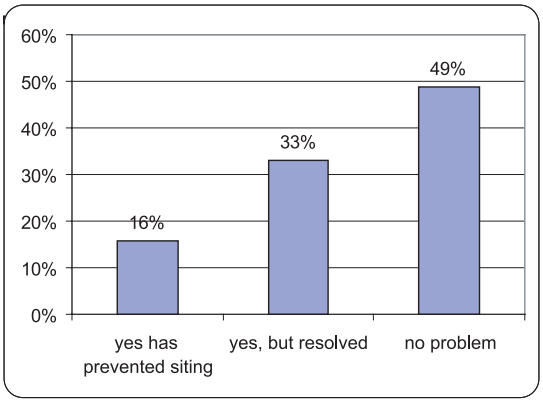
Public pressure is mounting. A poor record of safe disposal practices is contributing to low public confidence in the disposal facilities. Half of the provincial capital municipalities reported that there was public opposition to landfill siting. Of those, a third had to abandon or postpone plans to establish a new landfill due to the strong resistance from people living near the proposed site (Fig. 10).

Table 11: Informal Waste Pickers Living or Working on Provincial Capital Disposal Sites

Type of Waste Pickers	Sites		Total # of people
	#	%	
Living on disposal site	19	25%	719
Living outside disposal site but working on site	44	58%	1064

Source: Survey of diposal sites in provincial capitals, 2003

Fig. 10 : Public Opposition to Landfill Siting in Provincial Capitals



Source: Survey of disposal sites in provincial capitals, 2003

Box 6: NIMBY - Bridging the Gap Between Communities and Waste Managers

What the Residents Want. A recent survey of residents of Bangkok and vicinity revealed that only 15% of the people would not allow a municipal or industrial waste facility to be built in their district. Additionally, when asked what conditions would have to be met in order for them to accept a plan to construct a municipal or industrial waste treatment and disposal facility in their district, the most common answers were that they would require that they participate in the planning process and that the location be based on environmental and health considerations.

Demonstrating Safe Disposal: In response to public opposition to siting a landfill in Bak Praek, the municipality has constructed a demonstration landfill that is designed to educate the people on how a landfill operates and that it can be done safely. The landfill, which is designed to last only a few years, is intended to accommodate tours to educate the public.

Sources:: Kokusai Kogyo Co., Ltd., EX Corporation for DIW and JICA, 2002. Based on survey of 410 residents of BMA, Pathun Thani, Nonthaburi, Samut Prakan, and Samut Sakhon.. Personal communication, Bak Praek Municipality. 2001.

Requirements for a Plan for Construction of a Waste Facility in their District	% residents
1. Participation in planning process	46%
2. Site location selected based on health and environmental concerns	45%
3. Government promotes reduction and recycling programs	31%
4. Thorough Environmental Impact Assessment	29%
5. Measures taken to prevent emission of toxic pollution	29%
6. Proper government monitoring and inspection	27%
7. Factories and businesses make effort to reduce waste	25%
8. Government constructs public facilities (park or community center).	24%
9. Government compensates residents	18%
10. Third party monitoring including local residents	12%

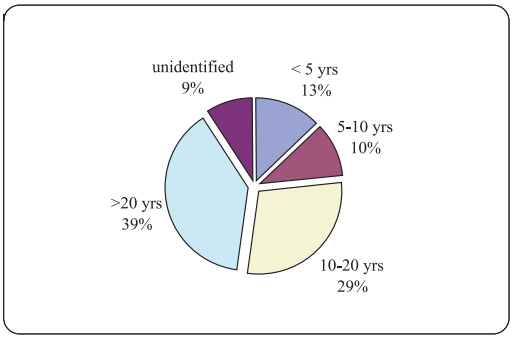
[26] PCD (Community Waste Study), 1998 and MOPH, 2002

Most sites in provincial capitals have enough disposal capacity for more than a decade. Almost 70 percent of the disposal sites used by provincial capitals have an expected lifetime of greater than 10 years and just under 40 percent are expected to last 20 years or more (Fig. 11). With investments in upgrading, these sites could provide safe, long-term disposal for these areas.

Shared facilities could reduce the costs of disposal site improvement. The costs of upgrading the 1,000 dumps and landfills is high. Instead of upgrading the individual sites to sanitary landfills, it would be less costly to send all the waste from a province or portion of a province to a single facility (Table 12). Nationwide, shared facilities would result in a savings of over THB 20 billion in investments, and, over 20 years there would be a savings of THB 160 billion in operations and maintenance
(Also see Box 17).

Incinerators are not likely to be cost-effective at this time in Thailand. Incineration of municipal solid waste is a costly and operationally complex alternative to landfills (Table 13). It is often considered where land is scarce, such as congested urban centers and islands, due to the ability to reduce waste volume by approximately 80 percent. In these

Fig. 11: Expected Remaining Lifetime of Provincial capital Disposal Sites



Source: Survey of disposal sites in provincial capitals, 2003

Table 12: Provincial Capital disposal sites that could serve the entire Province or half Province

	Province	Half province
Number of sites	9	12
Average size (rai)	270	97
Average remaining capacity (million tons)	2.9	0.8

Source: Survey of disposal practices in provincial capitals, 2003.

Table 13: Is Bangkok Ready for Incineration?

Minimum prerequisite for incineration	Status
There is a mature well-functioning waste management system in place for a number of years	Functioning collection and disposal system. No effective household segregation, recycling, or composting and fee collection system.
Disposal of solid waste is done at controlled and well-operated landfills.	Ratchathewa landfill has the operational and environmental practices in place. Kampangsean landfill has a history of environmental complaints but is upgrading practices and controls.
There is a stable supply of combustible waste amounting to at least 50,000 metric tons/yr.	Bangkok produces 3.6 million tons of waste a year.
Waste composition allows combustion without supplementary fuel (average> 7 MJ/kg; never below 6 MJ/kg in any season).	Average: 6.9 MJ/kg Minimum: 4.9 MJ/kg.
Community is willing to absorb increased treatment cost through management charges, tipping fees, and tax-based subsidies	Fees have just increased from THB 4 to 40 per 20 litres. To cover the costs of incineration, Bangkok residents would have to pay an equivalent of THB 150-200 per 20L or THB 300-400 per /household per month through fees, taxes, or other mechanisms.
Skilled staff can be recruited and maintained.	Local skills for environmental monitoring and operation of incinerators are limited.
The Planning environment is stable enough to allow a planning horizon of 15 years or more.	BMA uses a 5 year Development Plan that functions as an action plan and suffers from frequent changes and political interference.

Prerequisites from Municipal Solid Waste Incineration, A Decision Makers Guide, World Bank, 1998. Calorific values represent 13 samples taken from transfer stations in Bangkok in 1996 and 1999 (Fichtner, 1996 and Collection Improvement Plan, 1999) but do not represent a systematic assessment of the seasonal fluctuations. A preliminary assessment based on the ash, moisture, and volatile solids content of these samples indicate that many of the samples taken are out of the range that can be combusted without supplementary fuel (personal communication, JBIC). Costs based on current collection costs and capital and operations and maintenance cost for incineration of 10,000 tons/day using numbers from World Bank, 1998.; BMA planning assessment based on COWI-EP&T Associates, 2000.

areas, a decision on whether to pursue incineration should first consider the following issues: the composition of the waste; performance record of the municipality; and availability of staff and equipment for operation, oversight, and environmental monitoring. All of these pose barriers in Thailand. Additionally, Thai municipalities currently only recover a portion of operation and maintenance costs of landfill-based systems. Consequently, municipalities would not be able to recover the additional costs of incinerators. Given this potential and the option for transporting waste to landfills outside of land-limited urban areas and islands, it is likely that investments in recycling and landfill-based disposal systems will be a more cost effective investment than incurring the large cost of incineration.

Technology to produce electricity from garbage is being introduced to Thailand. Both landfills in Bangkok are currently developing systems to produce energy by using "landfill gas," the flammable gas produced by garbage when it degrades in landfills (Box 6). Work by Kasesart University at the Kampangsean landfill has been successful at adapting the technology to the high moisture found in Thai landfills, which would otherwise inhibit collection of the gas. After piloting the new design, they have recently begun producing electricity for use by the Kasesart University Campus. Using the lessons of this project, a facility is also under development at the Ratchathewa Landfill.

BOX 7: LANDFILL GAS: A UNIQUE WAY OF BENEFITING FROM SOLID WASTE MANAGEMENT

Landfill gas is produced by the degradation of organic matter in garbage and is made up of approximately 50% of the flammable gas methane. Through networks of tubes in the landfill, it can be collected and provided as fuel gas for electricity generation, industrial processes and running leachate treatment systems. It also reduces nuisance odors, air pollution and the risk of explosion in and around the landfill. These systems have been successfully developed in countries throughout the world and in Thailand pilot systems are being developed in the Bangkok landfills.

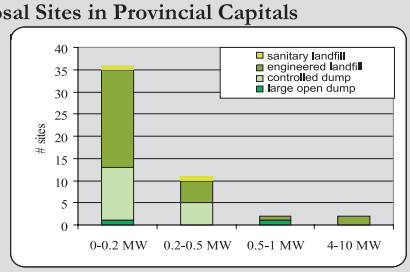
Thailand's landfills lend themselves predominantly to small-scale systems: The amount of gas produced is dependent on the amount of garbage disposed in a given site. With the exception of the 2 large sites (4-10 MW) for Bangkok, each of which could provide enough power to supply thousands of households, most of the potential landfill gas facilities are relatively small scale, providing enough power for up to several hundred households (0-1 MW) These sites would require specialized small-scale technologies in order to enhance the financial viability. The advent of large shared disposal facilities provides an additional future opportunity for larger scale systems.

Improvement of operational practices and landfill conditions would improve potential: The amount and quality of gas and the efficiency of facility operation is enhanced significantly by good operational practices at landfills. The current operational practices and conditions of many of Thailand's landfills may prevent or limit the use of these sites for landfill gas. In particular, disposal sites operating as sanitary landfills would be the best prospects for development of a facility while the many open dumps in the country would likely not be viable for landfill gas collection and use. The many sites that are of intermediate quality (controlled dumps and engineered landfills) could potentially be good sites especially if practices are improved.

Table A: Effects of Landfill Practices on Landfill Gas Utilization

Enhancements	Impediments
Good compaction	Poor compaction.
Daily cover	Frequent fires.
Effective leachate drainage	High leachate levels.
Capping filled landfill	Shallow landfills.
Deep landfills (> 10 m preferable)	Co-disposal of hazardous waste.

Fig.A: Power Generating Potential of Solid Waste Disposal Sites in Provincial Capitals



Note: Based on estimates of landfill gas production using USEPA Land GEM model and waste filling data based on survey of disposal sites in provincial capitals, 2003. Represents capacity that could be supported by gas in the next 5 years and be sustained for 10 years or more. Does not include small open dumps due to their limited potential.

4 Hazardous Waste

Factories opt for less regulated and lower cost alternatives to centralized treatment. Only 24 percent of the hazardous waste produced in Bangkok and vicinity is treated by licensed centralized treatment facilities and as a result only a portion of the capacity of these facilities are being utilized. The remainder is managed using a combination of lower cost and often times less regulated practices. Approximately 14 percent of the waste is managed off-site through disposal by other unlicensed treatment and disposal operators, waste buyers and private recycling firms. In addition, 56 percent of hazardous waste is managed on the factory site which, due to the large numbers of factories, is difficult to regularly monitor.

Non-hazardous waste is often disposed on site. While most of the non-hazardous industrial waste produced in the country is recycled, a large quantity, almost 1.3 million tons of waste, still needs to be disposed each year. Of that, an estimated 940,000 tons is stored or disposed on the factory site, while 160,000 tons is disposed off-site in municipal landfills and 150,000 tons by private operators[27].

Will more operators mean safer disposal? With the recent liberalization of the waste treatment industry in Thailand, more firms are entering the waste treatment market and as a result capacity for centralized treatment is expanding. It is not clear this will result in an increase in safe disposal. There is a risk that unlicensed operators and unsafe on-site practices will force licensed firms to go out of business or to make sacrifices in disposal safety standards in order to provide a lower treatment price.

Table 14: Licensed Centralized Waste Treatment and Disposal Facilities

	Capacity (tons/year)	Actual Treatment 2001 (tons/year)
Hazardous and non hazardous waste facilities		
GENCO Samae Dam	90,000	87,547
GENCO Map Tha Phud	160,000	42,131
Landfill disposal facilities (three operators)	NA	NA
Cement manufacturers	3,272,480	NA
Fuel blending operators	25,000	NA
Dedicated non-hazardous waste facilities		
Four operators	103,000	NA

Source: Personal communication with DIW, 2003 and Kokusai Kogyo and Ex Corp for DIW and JICA, 2002. Note: Cement manufacturers are licensed to use their cement kilns to treat waste and are currently using a small portion of their capacity to treat waste oils and solvents and are recycling some materials such as calcium for use as raw materials in manufacturing cement.

Box 8: Opening Up or Closing Down? The Growing Pains of Industrial Waste Market Liberalization

General Environmental Conservation (GENCO) was created ten years ago and has provided treatment of hazardous and non-hazardous industrial waste in its two locations in Samae Dam and Map Tha Phud. It was the only centralized industrial hazardous waste treatment service in the country up until 2002, when the Department of Industrial Works began issuing licenses to other waste treatment companies. The liberalization has led to a 30 to 40 percent decrease in the level of the waste treatment fees charged to industries. Not able to keep up with the price changes, GENCO is now reporting losses for 2003, forcing it to undergo a drastic restructuring plan, including a reduction in personnel and other cost saving measures.

Source: Data from Bangkok Post, June-July, 2003

[27] Based on national production estimates in methodology section and disposal practices for Bangkok and vicinity. from Kokusai Kogyo and Ex Corp for DIW and JICA, 2002.

Cases of improper disposal and open dumping have been reported. Although surveys of industries typically indicate all waste is treated or disposed, 12 cases of dumping were reported to PCD in 2000[28] and more have been reported in the media in the past several years (Table 15). Some have endangered the health of local residents, including schools and local villages[29] , while others have been contained with no apparent harm. More than 80 percent of the respondents in a recent survey were aware that illegal dumping causes serious problems and more than half of the same respondents demanded better controls, including imposition of higher penalties by the government (Box 9).

Open dumping can be done without knowledge and little punishment. With limited regulatory oversight and licensing for waste haulers and buyers, these groups are not held accountable for any improper disposal or dumping. Although rarely imposed, the largest fine for illegal dumping is THB 2,000 on the transporter, while factories are not fined[30].

Table 15: Examples of Improper Waste Disposal

Location	Date	Type of waste
Bangkhen, Bangkok	April, 2000	Solvent and paint sludge
Lam Look Ka Pathum Thani	April, 2000	Solvent and paint sludge
Sukhapiban, Samut Prakan	May, 2000	Copper powder
Bang Bon district, Bangkok	May, 2000	Yellow solvent or glue
Suan Luang, Bangkok	September, 2000	Chemical waste mixed with aluminum waste
Rama 8 Bridge, Bangkok	October, 2000	Pesticides
Muang Suphan Buri	January, 2001	Used solvents

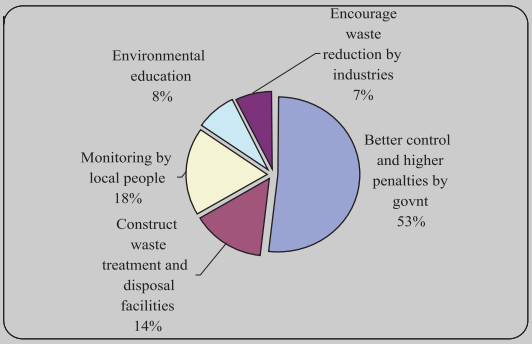
Source: Kokusai Kogyo and Ex Corp for DIW and JICA, 2002

Box 9: What People Think of Industrial Waste Disposal

A survey in 2002 of 410 residents of Bangkok and vicinity revealed that people are aware of the problems of poor disposal of industrial waste. Additionally, the majority believe that better control and higher penalties on industries by government is the most effective solution to control the illegal dumping of industrial waste.

Fig. A: Public Opinion of Industrial Hazardous Waste

Fig. B: Public Opinion on the Most Effective Solution to Illegal Dumping of Industrial Waste



Source: Kokusai Kogyo Co., Ltd., Ex Corporation for DIW and JICA, 2002. Based on survey of 410 residents of Bangkok, Pathun Thani, Nonthaburi, Samut Prakan, and Samut Sakhon.

28 Over a period between April 2000 and March 2001.

29 Examples include the Bampen Nua School near Ban Chang Industrial Estate and the Mab Tha Phud Phan Pittyakhan School in Rayong.

30 Open dumping activities can be enforced through several laws, how ever the largest fine of THB 2,000 is under the Public Order and Cleanliness Act.

Large amount of operations makes regulation difficult. There are over 60,000 industries, central treatment operators, and recycling enterprises whose waste management practices are regulated under the Factory Act. Regulatory oversight of these groups is handled by the Department of Industrial Works (DIW) by only 332 inspectors. Similarly, oversight of nearly an additional 1,800 industries in 28 industrial estates is performed by 17 staff of Industrial Estate Authority of Thailand (IEAT).

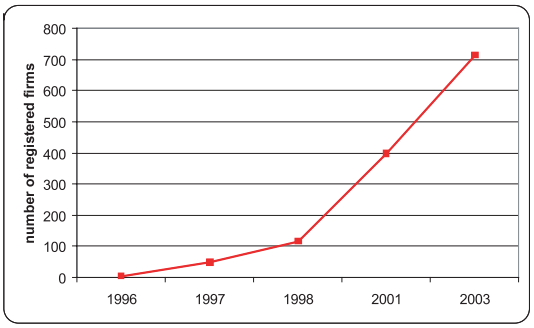
Non-regulatory incentives provide additional motivation for exporting firms. Concerns about corporate image and environmental expectations placed on export industries have motivated more and more companies in Thailand to improve their environmental management systems (Fig. 12). For example, certification of Thai firms under the International Organization for Standardization 14001 (ISO14001) environmental management standard has risen seven fold to 700 firms since 1998. Approximately 60 percent of the certified firms surveyed reported that the amount of hazardous waste pollution was reduced as a result of the certification process[31].

Providing secure drums is important to providing safe industrial hazardous waste disposal

Table 16: Environmental Regulatory Concerns for Industrial Hazardous Waste Management Practices

Practice	Main Environmental Concerns	Main Regulators
Waste haulers	Safe transport Accounting for waste	Local Government; Ministry of Transport
Recyclers and waste buyers	Safe recycling Accounting for waste	DIW IEAT
Centralized treatment operators	Safe operation Safe disposal	DIW IEAT
Use of waste solvents as fuel for cement kilns	Safe operation (correct waste type, temperature, and emissions treatment)	DIW IEAT
Waste treatment and disposal by private contractors	Safe treatment and disposal Accounting for waste	DIW IEAT
On-site treatment and disposal	Safe storage Safe on-site disposal Accounting for waste	DIW IEAT

Fig. 12: Number of ISO 14001 Certified Firms in Thailand



Source: TEI, 1999; Ministry of Industry.

[31] Survey from TEI, 1999.

Box 10: Improving Export Competitiveness Through Better Waste Management

With increasing integration of international trade, exporting industries in Thailand have been positioning themselves to be competitive in response to the evolving rules and trade environment. Described here are opportunities for Thai industries to increase their competitiveness through improved industrial waste management.

Certifying Environmental Management

Eco-labeling is an environmental performance certification that is practiced in more than 30 countries around the world. It allows ecologically concerned consumers to recognize environmentally friendly products and reward them through their purchasing habits. Many countries have developed their own ecolabel including Japan (Ecomark), US (Green Seal), and Germany (Blue Angel). The certification is typically undertaken by an independent third party based on criteria that commonly relate to life-cycle assessment of the product's environmental impact. Thailand initiated its own ecolabel known as Green Label, which was launched in 1994, and now awards over 30 product categories. Efforts to harmonize ecolabels, particularly among the North American and European countries, are likely to further increase the role of the labels in international trade.

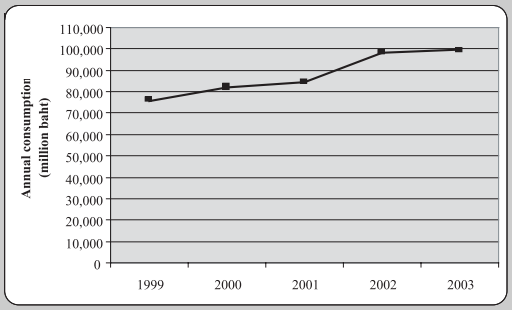
ISO 14000 refers to a series of voluntary environmental standards developed by the International Standards Organization (ISO), which serves as a tool to help organizations demonstrate good environmental management. It also can enhance corporate image, improve the working environment, and increase efficiency which leads to cost savings. ISO 14000 certifications are becoming a prerequisite to do business in many markets because certified corporations commonly require their suppliers to be certified. In Thailand, the largest representation of the 712 certified companies is from the large exporting industries, including electronics and motor vehicles.

Producer Responsibility For Electronic Waste

EU Directives on Electronic Waste: The European Commission has recently issued two new directives: *Waste Electrical and Electronic Equipment (WEEE)* and *Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (ROHS).* They aim to provide incentives for producers to take environmental and waste management aspects into account when designing electrical and electronic equipment. Both apply to all electrical and electronic equipment available in the EU, including those from Thailand. Electronics is Thailand's leading export, accounting for 20 percent of all manufacturing exports from the Kingdom. These manufacturers will be expected to design more environmentally friendly electronic equipment, both to reduce fees associated with their product and to comply with restrictions on use of hazardous substances in electronic equipment.

Electronic Waste in Thailand: Consumption of electronic goods has grown steadily since the financial crisis. These products and their waste (e.g., batteries, etc) often include toxic substances that, when recycled by informal recyclers or improperly disposed, can increase health risks. Recently there has been interest in introducing laws similar to the EU. This effort could increase competitiveness of Thai industries and prevent dumping of used electronics in Thailand from countries with more stringent electronic waste laws. Some of the major obstacles to implementation include proper separation of these products and the establishment of recycling facilities specifically for electronic waste, including the technology appropriate to Thailand.

Fig. A: Electronics Consumption in Thailand



Source: Bank of Thailand, 2003 using 2003 prices. 2003 consumption based on projection of year to date consumption. Personal communication with FTI provided insight into the challenges of establishing facilities for electronic waste recycling in Thailand based on their discussions with interested companies.

Community Generated Hazardous Waste

A management system for most community generated hazardous waste does not exist. While over half of the waste generated from community sources such as households, gas stations, and dry cleaners is recycled, only 1 percent of the remainder is treated. As a result, each year an estimated 140,000 tons of this waste is either co-disposed with municipal solid waste or discharged to the sewer or directly to the environment[32]. These practices increase the risk of exposure to the general public, collection workers, and scavengers, and can contribute to groundwater contamination.

Household hazardous waste is a major problem. Households produce less than one quarter of the community generated hazardous waste in the country, but account for half of the community hazardous waste disposed in landfills[33]. Although there have been attempts in Bangkok to improve household waste management, there is currently limited segregation at the source; limited awareness among the public and collection workers; and limited systematized disposal practices.

Infectious Waste

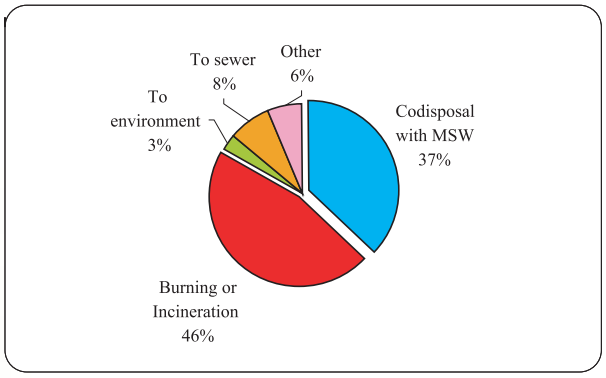
Waste management practices are dependent upon the type of medical facility. There are over 1,400 hospitals in Thailand. Approximately 75 percent of hospitals treat and dispose of their infectious waste on site, primarily via incineration, while only 17 percent rely on the local government. For more than 24,000 clinics in the country, infectious waste is primarily disposed with the general waste and thus ends up co-disposed with municipal solid waste. Primary care units dispose of their infectious waste typically by open burning or using small incinerators[34].

Nationwide, almost half of infectious waste is incinerated. Nearly half of all infectious waste in the country is incinerated or burned using predominantly small hospital and municipal-run incinerators, while over a third is co-disposed with municipal solid waste (Fig. 13). The remainder of the waste is mostly disposed with municipal sewer or released to the environment[35].

Conditions of incinerators vary. Incinerators in hospitals and primary care units are commonly either broken, operated improperly, and/or lack pollution control equipment. The condition of the eight municipal infectious waste incinerators in the country depends on the municipality. In the largest municipalities (Nakorn and Muang) most of the incinerators are in good condition, while in smaller Tambon municipalities most are broken or otherwise not in use[36].

Current practices present health and environmental threats. The approximately 10,000 tons per year of infectious waste disposed in the environment, sewer or with municipal solid waste presents significant health risks, especially to municipal waste workers and scavengers who are in direct contact with the waste on a daily basis. Additionally, operating the incinerators at insufficient temperature and without air pollution control equipment can result in the emission of dioxins and other air pollutants, increasing the likelihood of respiratory illness and cancer in people living in the vicinity.

Fig.13: Infectious Waste Disposal Methods



Source: PCD (Community Waste Study), 1998.

[32] PCD (Community Waste Study), 1998.
[33] Ibid.
[34] MOPH, 2002.
[35] Ibid.
[36] Based on a survey by MOPH, 2002.

Exploring other potential practices. There are many other alternative treatment and disposal options that may be effective for certain types of wastes and facilities (Box 11). In addition to exploring these options, waste reduction and proper separation can result in improvements in the safety and effectiveness of collection and disposal of infectious waste.

Box 11: Treatment and Disposal Options for Infectious Waste

Incineration: Waste is burned under controlled conditions. To be effective and safe, it must be operated at specific temperatures and conditions. Advantages include its ability to eliminate the health risks associated with all types of infectious wastes, and reduce the volume of the waste. Its disadvantages include high costs, sophisticated operation, and production of air pollution, including dioxins, that become more severe if operated at an insufficient temperature. The capital costs range from THB 5 to 10 million for each ton/day of capacity.

Autoclaving: Waste is heated by steam in an enclosed container at high pressure. The output is non-hazardous material that can normally be safely placed in a landfill with municipal waste. Advantages include the ease and familiarity of its operation. Its disadvantages include the high cost of operation, production of air emissions and wastewater, and its inability to treat special medical waste such as tissues and body parts. The capital costs range from THB 2 to 6 million for each ton/day of capacity.

Microwave and radiowave irradiation: Waste is disinfected using a high-energy electromagnetic field that causes high frequency oscillation of the liquid portions of the cell material. The output is considered non-hazardous and can be disposed in a landfill with municipal waste. Its main advantages are the reduction in volume and its minimal production of toxic pollutants. Its disadvantages include cost and sophistication and its ineffectiveness in treating special medical waste such as tissues and body parts. The capital costs range from THB 5 to 10 million for each ton/day of capacity.

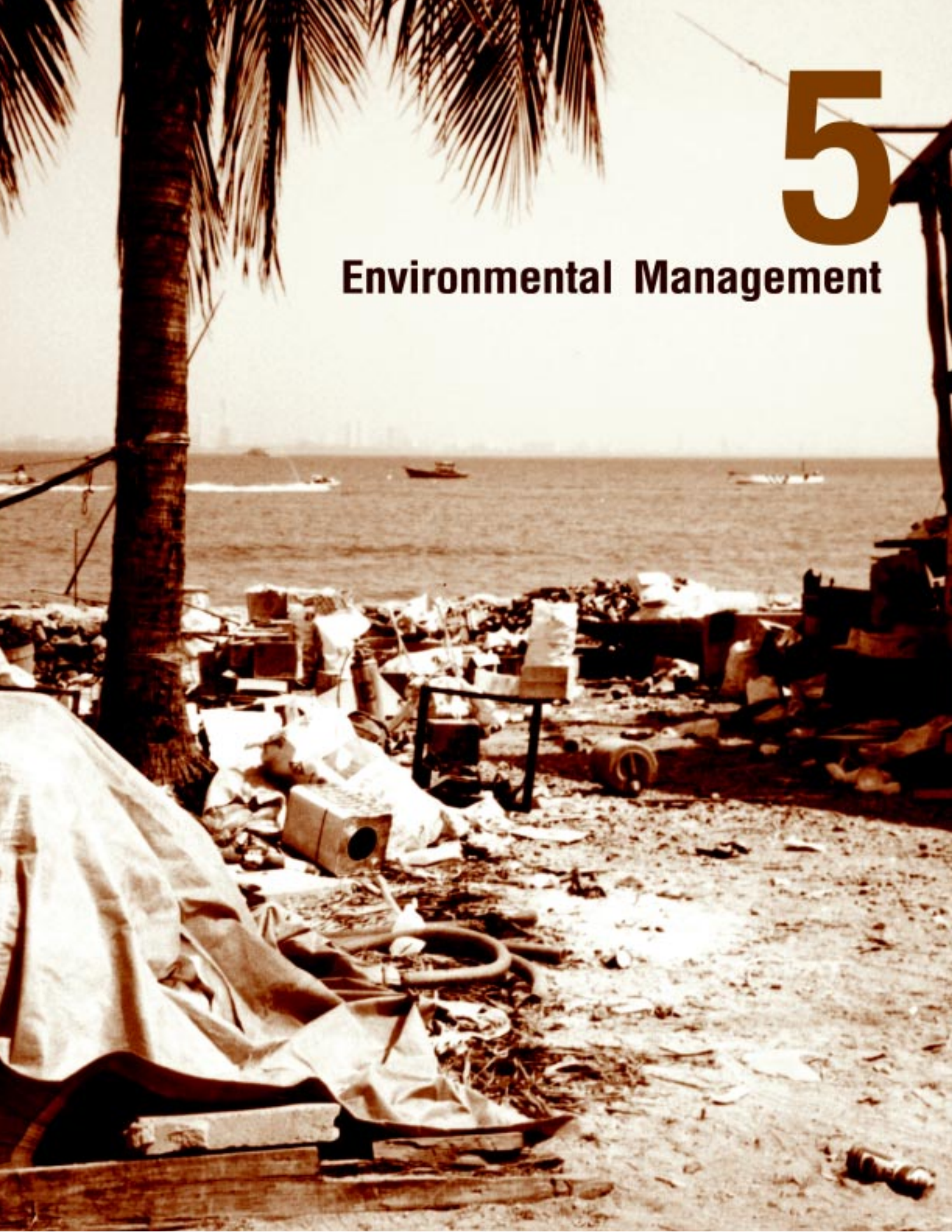
Chemical disinfection: Waste is shredded and chemicals are added to kill or inactivate pathogens. The output needs to be disposed using techniques such as safe landfilling. The advantage of this process is the reduction of waste volume resulting from shredding. However, the disadvantage of chemical disinfection includes cost and sophistication of operation, its inability to treat wastes such as tissues and body parts, and its production of a toxic waste stream.

Safe landfilling: Waste is placed in a pit excavated in mature municipal waste or in a special area constructed in the landfill and covered immediately with soil or fresh municipal waste. For added health protection and odor suppression, lime can be spread over the waste. The area should also be fenced off to prevent access by waste pickers or scavenging animals. The capital costs are low as it uses an existing municipal landfill. The advantages of these methods are simplicity and low cost. This is a next best alternative to incineration for the effective management of body parts and tissues. However, unlike incineration, a major disadvantage is that the waste remains infectious, and therefore can be very dangerous if not managed extremely carefully.

Source: Adapted from Johannessen, et al., Healthcare Waste Management Guidance Note, The World Bank, 2000.

Signboard to educate kids on solid waste reduction and management

Municipal solid waste incinerator on Ko Si Chang, Chonburi



5

Environmental Management

Over THB 22 billion has been invested in solid waste management. Local governments have relied on national government investments in solid waste management through both the Environmental Fund and the national budget. Since 1994, THB 22 billion has been spent predominantly on landfills and trucks[37]. In 2003, the budget allocation for solid waste management amounted to THB 1.6 billion or 37 percent of the annual budget for environmental quality management (Fig. 14), and 0.2 percent of the total national budget allocation. Most of these investments are directed towards the populous provinces in the central region.

Municipalities allocate less than 25 percent of their budget. Each municipality is expected to operate and maintain their own solid waste systems. Based on reported expenditures from a sample of 8 municipalities, budgets for solid waste collection, disposal and street sweeping typically account for between 5 and 25 percent of the total municipal budget and amount to between THB 100 and 500 per capita per year[38].

Private sector involvement is limited. In a few municipalities, collection or disposal of waste is undertaken by private companies (Table 17). In these cases, municipalities normally contract the company to operate the collection and/or disposal systems. However, the funding for the major infrastructure, such as disposal sites or transfer stations, has been funded by government.

Revenues are limited to solid waste collection fees. The Public Health Act provides the basis for charging fees on solid waste collection, but does not include other activities such as disposal. In addition to the need to cover these other costs, other revenue generating mechanisms, such as surcharges on electricity bills, levies on excessive packaging, and tourist taxes, represent unexplored opportunities in Thailand to improve cost recovery (Table 18).

Fig. 14: Budget Allocation for Solid Waste Management in Provincial Plans for 2003

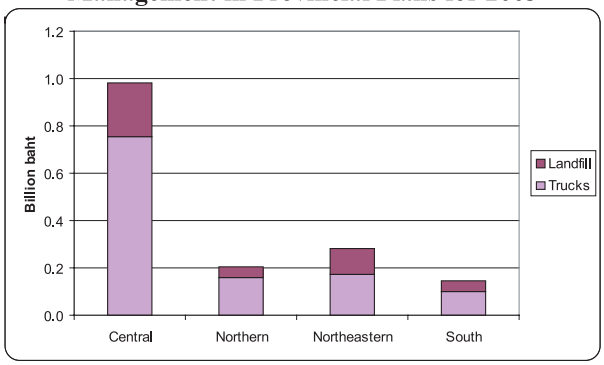


Table 17: Examples of Private Sector Participation in Solid Waste Management

City or Municipality	Private Sector Role
Lampang	Collection and disposal of waste
Chiang Mai	Collection of waste
Phuket	Collection of 50% of waste, incinerator operation and fee collection
Pattaya	Collection and transfer of waste
Bangkok	Transfer and disposal

Source: municipal benchmarking survey, Personal communication with JBIC.

Thailand has made large investments in landfills and trucks

[37] From Draft National Solid Waste Strategy, 2003.

[38] Based on operation and maintenance and personnel costs reported by 8 small to medium sized municipalities.

User fees are not providing adequate revenues. Municipalities typically charge fees for collection of solid waste based on the amount of waste produced. While the fees generate revenue, they typically can only cover between 2 and 50 percent of the operations and maintenance costs of collection and disposal in major cities in Thailand[39]. This is due to a combination of low fee levels and inefficient fee collection, especially in residential areas.

Bangkok raises fees ten-fold. Bangkok currently recovers only 3 percent of its solid waste expenditures through user fees and has only been able to collect fees from approximately 20 percent of their customers[40]. The monthly fee of THB 4 per 20 L/day was recently increased to THB 40, a level that, if collected from 70-80 percent of customers, could recover the costs of operation and maintenance of solid waste in Bangkok.

More efficient waste collection could reduce costs. Cost recovery could be improved by improving the efficiency of collection. Common problems that could be improved in Thai municipalities include better route selection and improving upon slow collection, which occurs as a result of informal sorting of recyclables by the municipal collection crews.

Better route selection could improve the efficiency of collection

Table 18: Commonly Used Mechanisms to Fund Solid Waste Management Worldwide

Type	Description
User fees	Direct: Paid by waste generators according to waste amount or service. Indirect: Flat rate fee.
Surcharge	Incremental fee on property tax or water or electricity bills.
Haulage and Tipping Fees	Haulage fee: Fee collected by waste hauler from local government. Tipping fee: Disposal fee collected by landfill operator from waste hauler or local government.
Levies	Fees paid on high waste-producing products or activities such as excessive packaging and tourism.

Table 19: Solid Waste Collection Fees Charged in Selected Municipalities

	Collection fees (Baht/month)		
	Small producers (<20 L/day)	Medium producers (20-500 L/day)	Large waste producers (>500 L/day)
Chiang Mai	40	40-2,000	2,000+
Phuket	30	30-1,500	1,500+
Nonthaburi	20	20-500	1,500+
Pattaya	20	20-40	1500+
Nakhon Ratchasima	20	50-1,000	1,500+
Rayong	10	40-500	2,000+
Kanchanaburi	20	40-500	1,000-2,000
Hat Yai	20	40-1,000	1,000+
Surat Thani	20	30-720	2,000+

Source: Municipal benchmarking survey, 2003.

[39] Estimated range from 8 medium sized municipalities and Bangkok based on reported fee revenues and operation and maintenance and personnel costs for solid waste collection and disposal.

[40] Collection rate is from 1998 data provided through personal commu nication with JBIC.

Multiple Laws: The legal framework for solid waste management is based on a series of laws designed primarily for other purposes but include provisions governing solid and hazardous waste management. The most important of these laws are summarized in Tables 20 and 21. These laws are supported by enabling regulations, guidelines, and standards issued by the relevant line agencies and municipalities, listed in Box 11.

Table 20: Major Laws Governing Municipal Solid Waste Management

Key Legislation	Relevance
Enhancement and Conservation of National Environment Quality Act (NEQA), 1992	This act is the basic environmental protection law for the country and establishes the role of MoNRE in environmental planning, standard setting, and monitoring. It specifies the role of the municipality in: managing solid waste management, contracting out solid waste management services to the private sector where needed, and charging fees in accordance with ministerial regulations. It also establishes the Environmental fund, which can be used to finance solid waste investments proposed by local governments.
Public Health Act, 1992	This is the most comprehensive of the laws dealing with solid waste management. It reiterates the roles of the municipality in solid waste management described in NEQA. In addition, it specifies the role of the municipality in licensing private solid waste operators and in creating local by-laws that define methods of collection, transport, and disposal, as well as hygiene standards and requirements for buildings.
Public Order and Cleanliness Act, 1992	Among other things, this act specifies how households should store solid waste and place it for collection. The act is one of several that prohibit dumping of solid waste and littering.
Building Control Act, 1992	This act specifies the method by which large buildings should store and place refuse for collection.

Table 21: Major Laws Governing Industrial and Infectious Waste Management

Key Legislation	Relevance
Enhancement and Conservation of National Environment Quality Act (NEQA) 1992	Generally applies to industrial and infectious waste management through environmental planning and environmental quality standards and monitoring. Also establishes EIA system, which applies to industrial waste disposal sites.
Factory Act, 1992	Authorizes the Department of Industrial Works (DIW) to issue standards and specify methods for the control, handling, and disposal of waste by a factory and to license, permit, and inspect factory operations, including waste management. It also governs the licensing, permitting, and inspection of waste treatment, disposal, and recycling facilities.
Hazardous Substance Act, 1992	Governs a broad range of hazardous materials, including hazardous and infectious waste. Allows the handling, storage, transport, and disposal of hazardous waste to be specified in a ministerial decree.
Industrial Estate Act, 1979	Governs the powers of the Industrial Estate Authority of Thailand, including enforcement of regulations and taking action on hazardous waste practices within industrial estates.
Public Health Act, 1992	Specifies that local government must provide disposal facilities for infectious and industrial non-hazardous waste and that health-care facilities can treat and dispose of infectious waste with approval from the local government.

All levels of governments are involved. The responsible national-level ministries are the Ministry of Natural Resources and Environment (MoNRE), the Ministry of Public Health (MoPH), Ministry of Industry (MoIND), and Ministry of Interior (MoInt). They primarily set the national policy and the departments and agencies under the ministries are responsible for implementing the provisions of the law through regulations and technical guidelines. These agencies include the PCD, DIW, Industrial Estate Authority of Thailand (IEAT), Office of Natural Resources and Environmental Policy and Planning (ONEP), and the Local Administration Office.

The local governments - provincial administrative organizations (PAO), municipalities (Nakorn, Muang, and Tambon), and Tambon Administrative Organization (TAO) - are primarily responsible for waste collection, transport, treatment, and disposal. These local governments can contract the private sector to undertake some of the services. Civil society groups and non-government organizations are active in awareness raising and recycling programs. The roles of key institutions are outlined in Box 13.

Decentralization will increase the role of local governments and regional and provincial offices. The Decentralization Action Plan details the ongoing process of transferring functions, budget, and personnel from the central government to nearly 8,000 local governments. Through this plan it is envisioned that local governments will obtain relative independence in setting policies and managing public services in response to the needs of the local people. The central government's role will evolve into providing support, advice, and supervision to the local governments. In addition to giving local governments a larger role in waste management, the importance of MoNREs regional (REOs) and provincial offices (PoNRE), as well as the provincial offices of other agencies, is increasing with more staffing and responsibilities for outreach and monitoring.

Box 12: How is Decentralization Expected to Change Waste Management?

- More budget available to local governments that could be used for waste management.
- Improved skills and capability for local governments to raise revenues including user fees, taxes, and other mechanisms to fund solid waste management.
- New local government functions including:
  - Licensing, supervision, and monitoring of factories with local impacts.
  - Receipt of complaints of factory violations and problems.
  - Monitoring, compliance, and enforcement of environmental standards.
  - Issuing waste-related fines.
  - Provincial authorities taking the lead in developing shared disposal facilities.
- Increased public participation in solid and hazardous waste management.
- Enhanced national government supervision, standards, and outreach.
- Greater local government mandate and ability to undertake planning.

Source: Adapted from Decentralization Action Plan, 2002.

Civil society will be needed to help increase public participation. Both the Decentralization Action Plan and the 1997 Constitution mandate greater public participation in environmental planning and implementation of environmental services. Effective waste management will rely upon active involvement of the public in activities such as reporting open dumping of industrial waste, disposal site planning as well as recycling and composting. Civil society organizations will continue to play a key role in bringing about this involvement through awareness building and encouraging grass root initiatives.

Box 13: Role of Key Institutions in Waste Management

	MoNRE	MoPH	MoIND	IEAT	Local Government	Private Sector	Civil Society
Municipal Solid Waste 	PCD ONEP DEQP	DoH			PAO TAO Municipality	Private collection and disposal operators	
	• Planning nationally, provincially, and in pollution control zones. • Issuing environmental standards and waste management guidelines. • Provision of funds to local governments via Environmental fund. • Environmental monitoring.	Oversight of Public Health Act including setting maximum fee levels.			• Provincial environmental planning. • Collection and management of municipal waste. • Issuing fees, and standards.	Construction, operations, and maintenance under contract by local governments.	• Provincial environmental planning • Conducting awareness programs. • Promoting recycling efforts. • Training of local government officials. • Assessing performance.
Infectious Waste 	PCD	DoH			PAO TAO Municipality	Hospitals and private disposal operators	
	• Issuing environmental standards and waste management guidelines. • Environmental monitoring.	• National planning. • Oversight Public Health Act.			• Collection and management of infectious waste. • Approval of hospital and private disposal.	Construction, operations, and maintenance.	
Industrial Waste 	PCD ONEP		DIW	Development Department	PAO TAO Municipality	Private (or public-private) collection and disposal operators	
	• Planning nationally, provincially, and in pollution control zones. • Issuing environmental standards and waste management guidelines. • Reviewing EIAs for centralized waste treatment facilities. • Environmental monitoring.		• Setting standards. • Licensing, permitting and inspection of factory waste handling practices. • Monitoring contamination. • Licensing of disposal sites and recycling operations. • Joint venture with private sector in hazardous waste disposal facilities.	• Safety and environmental regulation within industrial estates. • Applies DIW regulations to industrial waste management.	• Provincial environmental planning. • Collection and management of non-hazardous industrial waste.	Construction, operations, and maintenance.	- Raising awareness. - Reporting events of illegal dumping.

Table 22: Capacity Indicators of National Agencies
Staffing in Selected National Agencies

	Function	Staffing	Indicator	Unit
Solid Waste Management	Solid Waste Management	8 PCD officers	142	municipalities per officer
Industries, central treatment and disposal facilities, and recycling operations.	Control, supervision, and inspection of industries.	332 DIW officers	180	industries per officer
	Planning, outreach, and environmental monitoring	79 DIW officers	770	industries per officer
	Issuing permits to transport waste out of the factory	10 DIW officers	6,064	industries per officer
	Control, supervision, and inspection and issuing permits for transport of waste for industries in industrial estates.	17 IEAT officers	105	industries per officer

National agencies are overwhelmed and extended. Monitoring and outreach by national government agencies is limited by the low number of staff relative to the industries, municipalities, and disposal sites they need to cover (Table 22). These agencies have adapted their programs to focus on the most important issues and industries and have developed some local presence through regional and provincial offices. However, a lack of human resources and on-the-ground presence in many regions is a major barrier to effectively fulfilling their national supervisory and outreach role.

Site visit by PCD staff

Box 14: Building Successful Outreach Programs in Solid Waste

MoNRE has just begun to take a more active role in outreach to municipalities by providing them help in improving solid waste skills, planning, and operations. The two programs below represent examples of programs that have been implemented:

Planning in Si Sa Ket municipality: Led by an active mayor, Si Sa Ket municipality has successfully operated one of the only sanitary landfills in the country and has taken actions such as establishing garbage banks in schools and "No Waste Bin" roads to keep the main commercial area clean and to reduce littering. Building on these initiatives, ONEP and the regional and provincial offices of MoNRE, together with experts brought in by JBIC, were able to provide assistance to the municipality in developing a strategic plan that includes targets for reduction of solid waste generation by 20 percent, setting up more garbage banks, and improving fee collection efficiency to 50 percent.

Certification program for landfill operators: The Pollution Control Department is in the process of developing a solid waste certification program. The program aims to improve solid waste management and practices by developing a series of training and certification programs for landfill operators and managers in the country. Through assistance from USAEP, a network of trainers, primarily in universities, is being established throughout the country in order to provide municipal staff with the opportunity to learn the necessary skills for certification as landfill operators.

Sources: Personal communication with JBIC; USAEP website.

Municipalities focus on delivery of core services. Currently, municipalities have allocated their staff primarily to provide the core services of collection and street sweeping. Staffing for disposal varies depending on the municipality and the category of the disposal facility. Only a few municipalities have allocated significant staff to public outreach and there are no staff dedicated to recycling. Autonomous planning by local governments is still limited; most planning activities that revolve around the provincial action plans are undertaken with the direct support of the national agencies. Industrial licensing and oversight is handled by DIW officials residing in the provincial government offices.

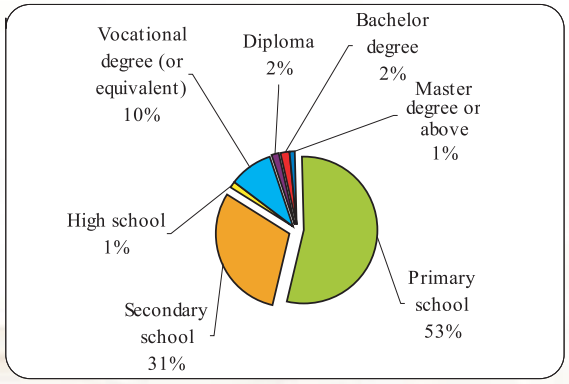
Many local governments are beginning to reach out to the public. In order to encourage general public awareness on solid waste issues, as well as increase involvement in activities such as recycling and litter removal, many local governments have undertaken active public outreach programs. Additionally, to be responsive to the needs of the people, many municipalities have set up service complaint systems and undertaken consultation with the public on issues such as landfill siting.

Staff skills need strengthening. There are few staff with advanced education and training programs are limited (Table 23). As local governments begin to take on further responsibilities, providing training and hiring new staff will be a major challenge (also see Box 14).

Table 23: Capacity Indicators of Municipalities

Average Staffing in Selected Municipalities

Function	Staffing (persons)	Indicator	Unit
Collection	134 (range 35-530)	1 (range 0.5-2.0)	Staff/ton/day
Street Sweeping	117 (range46-235)	1 (range 0.6-2.0)	Staff/km
Disposal	17 (range 1-44)	0.1 (range 0.02-0.4)	Staff/ton/day
Public Awareness	14 (range 2-49)	1 (range 0.2-2.7)	Staff/10,000 population
Planning	7 (range 5-10)	1 (range 0.4-1.8)	Staff/10,000 population
Recycling	0	0	Staff/ton recycled



Indicator	Unit
34 percent (range 1.5-100)	Staff trained per year
3 days (range 1-8)	Days of training for staff undergoing training
20,000	Annual national government budget for training, seminars and workshops per municipality (THB)
3 (range 0-17)	Number of national government training, seminars and workshops in each province per year.

Source: Municipal Benchmarking Survey, 2003. Covers 8 municipalities. National data on training events from 2003 provincial action plans from MoNRE, 2003.

Using the National Economic and Social Development Plan (2002-2006) and National Environmental Quality Policy and Plan (1997-2016), general goals have been arrived at for waste management including targets for solid and hazardous waste reduction, collection, planning, and construction of treatment and disposal facilities. From this basic framework, national waste management plans are currently under development for municipal solid waste and industrial waste. The draft contents of the plans are shown below:

Municipal Solid Waste Management

The National Solid Waste Management Strategy is in the process of finalization and the strategy focuses on practical approaches to increase the efficiency of solid waste management with the involvement and responsibility of the local governments, and the public and private sectors. It envisions management of solid waste at all stages, including: production and sale; consumption and at-source recycling and reuse; collection and second-stage recycling; and disposal and treatment. The strategy, which focuses on the reduction and management of waste, covers such issues as public awareness, investment, taxes, legal issues, and capacity building programs.

Production and sale: Includes the establishment of laws and a system for manufacturer responsibility for recovery of recyclable products and packaging; encourages reduction of packaging waste during production and sale through tax incentives; encourages the reuse of raw materials in the production process through tax incentives for reuse of materials and avoiding the underpricing of raw materials through strict conditions on concessions for extractive industries; and encourages cleaner production through investment in research and development for technologies and introducing a waste exchange program.

Consumption and at-source reuse and recycling: Includes increasing public awareness of current rising consumption patterns and ways to reduce, reuse, and recycle waste; regulates informal waste buyers and sorters; encourages waste buying and sorting enterprises through tax incentives; and encourages capacity building in waste sorting for local governments.

Collection and second-stage recycling: Includes government investment and encourages private sector involvement in collection and sorting systems; encourages increased local government involvement in collection and sorting; develops guidelines for transfer stations; and outlines adjustment of fees to be more consistent with costs of collection, transfer, and sorting.

Treatment and disposal: Includes support in the development along with government and private sector investment in provincial disposal and treatment centers; establishes regulations for disposal sites; establishes disposal fees; encourages increased public participation in siting of treatment and disposal facilities; and encourages the development of composting, waste reuse, and landfill gas utilization systems through awareness and capacity building, research and development, and incentives for private sector investment.

Source: Draft National Solid Waste Management Strategy

Industrial Waste Management

The Department of Industrial Works is in the process of developing an industrial hazardous waste and non-hazardous waste master plan for BMA and vicinity. The draft contents of the plan includes:

Hazardous waste

Reuse and Recycling Promotion: Includes promotion of reuse and recycling methods for hazardous waste, including use of cement kilns in recycling, and supports waste analysis and blending industries.

Waste Exchange: This ongoing program aimed to match factories that can use certain types of waste as raw materials with factories that produce that waste would be promoted further through broader dissemination and programs to get industries together to arrange exchanges.

Waste Minimization: Includes implementation of a waste manifest system to track the amount of waste produced and its destination; undertakes waste audits to promote better management of waste and segregation of recyclables; encourages zero emissions in industrial estates ; and formulates industrial waste management for individual industrial sectors.

Non-Hazardous Waste

The proposed goal of this plan is to promote waste reduction by factories; improve the quality of recycling and maintenance of the current recycling level; and encourage a shift from on-site final disposal to safer off-site disposal facilities. Proposed initiatives promote: the establishment of industrial waste management systems in factories; improved waste reduction and recycling; improved regulation of on-site waste management in recycling industries; establishment of treatment facilities; improvement of regulation of treatment facilities, buyers, and transporters; and improvement of monitoring and data control.

Source: Kokusai Kogyo Co., Ltd., Ex Corporation for DIW and JICA, 2002.

Effective waste management cannot be successfully accomplished through the efforts of the public sector alone. In fact, each citizen has an important role. The following examples demonstrate the growing efforts of Thai civil society in successful environmental management through citizen participation.

Motivating Citizen Responsibility - Magic Eyes

".Ah! Ah! Don't Litter! The Magic Eyes see you." - This famous quote was popularized by the Thai Environmental and Community Development Association (TECDA), or better known to Thai citizen as the 'Magic Eyes,' which worked magic by reducing prolific littering in Bangkok in the early 1980s and pioneering citizen responsibility in taking care of the environment. Established in 1984, TECDA brings together 23 prominent corporate partners that put their social responsibility into action, employing innovative social marketing and community-based participatory approaches. The group works with government agencies, private corporations, schools, media, communities, and NGOs, to build environmental awareness and responsibility, conveying a clear message that the individual citizen can make a difference. Today, the Magic Eyes logo - two will-powered eyes in a bright green circle - is widely recognized in Thailand as the eyes that are watching the environmental behavior of the people. The program has evolved over time to be responsive to the changing lifestyle of Thai citizens, and the changing face of waste problems. From the initial anti-littering campaign, Magic Eyes has expanded its scope to cover general environment conservation, solid waste reduction and recycling, Chao Phraya River conservation, and energy conservation. Magic Eyes program offers practicable green alternatives and places the responsibility to adapt and sustain these practices on the individual citizen.

Protecting the Island of Phuket. One of Thailand's most attractive tourist destinations faces an overwhelming amount of solid waste, generated by tourism as well as its own residents. In response to the serious environmental pressures on Phuket, as well as the increased energy usage associated with the development of an incinerator to manage solid waste, the 'Beautiful Phuket through Recycling' initiative was launched. The partnership was led by the NGO TECDA, or 'Magic Eyes,' with financial support from the National Energy Policy Office (NEPO). Forty-three schools, 26 hotels, the Provincial Governor's Office, and 19 Tambon Administration Offices and municipalities joined this effort to reduce waste and separate waste for recycling. It included a program in which Phuket's major superstore 'Big C' partnered with local waste dealers to set up a 'recycling marketplace' to encourage residents to separate waste and sell their recyclables. Over a two-year period, the program reduced over 9,000 tons of garbage, resulting in an energy savings of over THB 50 million. The program brought about other benefits, including income generation, which helped fuel replication and scaling up of other project activities.

Sources: Personal communication with TECDA, TEI and MCDF.

Promoting Waste Recycling in Industries and Businesses

Material Exchange Center. From their extensive experience in working closely with private sector, government, and local communities, Thailand Environment Institute (TEI) has recognized the high potential of industrial waste recycling. However growth in recycling is very much constrained by economic, informational, technological, regulatory, attitudinal, and physical barriers. Lack of information is the most significant barrier. In response to this, the Material Exchange Center (MEC) has been established within TEI to serve as a neutral body linking organizations that have recyclable materials to those that are in need of such materials. It also acts as an information center to provide knowledge resources and transfer waste recycling technologies to industrial factories and other interested parties. Their focus on dissemination of information is making a positive difference in industrial recycling.

Encouraging Office Paper Recycling. Big brown boxes with a green tree logo are making their way into corporate offices as part of the effort of Media Center for Development Foundation (MCDF) to encourage paper recycling. Through their 'Recycling Paper for Trees Project,' MCDF is reaching out to offices to introduce a more economical way to use paper based on the principle of Reuse, Reduce, and Recycle. Offices are encouraged to donate recyclable paper by placing it in the provided brown boxes, which are collected regularly by the MCDF staff for transport to recycling centers. Revenue generated from this activity will be put into a fund set up for environmental conservation purposes. Reports of the fund activities are regularly provided to donors to show that their contribution makes a difference in saving the environment.

Waste for eggs program in Pattani

6 Challenges

Over the past decade, Thailand has made impressive strides in addressing the massive task of managing the 22 million tons of waste it produces each year. The country has established solid and hazardous waste disposal facilities, improved municipal management of waste nationwide, and cleaned up a littered Bangkok. These successes and the current interest among government, the general public and the private sector, positions Thailand to take decisive steps to address the unfinished agenda by focusing on: reducing and recycling waste; improving treatment and safe disposal of solid and hazardous wastes; enhancing the supporting institutional, regulatory, and financing framework; and expanding public and civil society participation.

1. Reducing and recycling waste.

With only 11 percent of the municipal solid waste in the country being recycled, there is a huge untapped potential in recycling that could both reduce disposal costs and provide revenues for recycling operators. Taking the first steps toward reaching Thailand's goal of tapping this potential by achieving municipal solid waste recycling rates of 30 percent will require a concerted effort to address the following key gaps in the system.

Getting the incentives right: The effective introduction of economic and other incentives for waste recycling and reduction has the potential to cause dramatic reduction in the amount of waste disposed. Choosing the taxes, fees, or other incentives that can be implemented in Thailand, and effectively encouraging recycling and waste reduction will be of paramount importance. Among the approaches with the most promise is the development of incentives to reduce packaging waste, both in production and in the many department stores and shops in the country. The main challenge of the program is to ensure that the monetary incentives are large enough and enforceable. Additionally, by first focusing on the "low hanging fruit," such as the major sectors or stores that can be effectively regulated and those that could benefit from improved export competitiveness, the impact and lessons can be defined immediately.

Taking awareness to the next level: Changing consumption and waste generation patterns among the general population is a long-term process that requires a steady but aggressive effort. Much progress has already been made through ongoing programs in Thailand such as the awareness developed through Magic Eyes and government campaigns. The key priority will be to expand the size and public profile of these programs with the goal of raising the issues of wasteful consumption and recycling to a major priority in the national conscience.

Box 15: Solid Waste Management Strategy

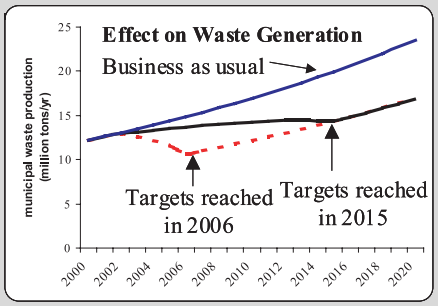
REDUCTION AND RECYCLING TARGETS (FOR 2006)

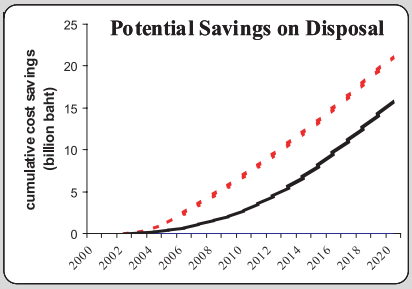
	Production rates (kg/cap/dy)		Total amount (million tons/yr)		Recycling rate (% of total waste)	
	Current Estimate	Target	Current Estimate	Target	Current Estimate	Target
National					11%	30%
Bangkok	1.3	< 1	3.7	5 % reduction		
Nakorn Municipalities & Pattaya	0.6-1.6 (1.1 ave)	< 1		5 % reduction		
Muang Municipalities	0.5-4.3 (1.3ave)	< 0.8	4.3			
Tambon Municipalities	0.4-5.0 (0.6ave)	< 0.6				
Tambon Admin. Organizations	0.4-0.6	< 0.4	6.5	10% reduction		

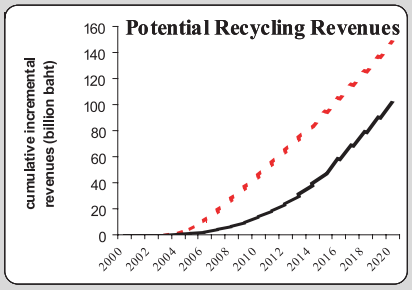
Source: (i) production rates: Bangkok, personal communication with JBIC; Other derived from PCD 2001 data. Note: high value under Tambon Muncipality is Tourist area Patong Beach, Phuket and similarly under Muang municipalities the high value is the industrial area of Pra Pradang, Samut Prakan; (ii) total amount: World Bank estimates based on PCD and NSO data; (iii) recycling rate: Based on numbers reported in PCD, 2001 (Recycling study).

Box 16: Potential For Waste Reduction and Recycling

Reaching the national waste reduction and recycling targets could have significant benefits by both reducing the quantity of waste disposed and allowing more recyclables such as glass, paper, metal and plastic to be recovered from municipal solid waste and sold.







Source: See Methodology Section

Separating the waste: Participation of households in separating recyclables and non-recyclables will be necessary to achieve the desired recycling rates. Currently, only some households separate a portion of their recyclable and non-recyclable waste for the purposes of selling to sa leng or to lesser extent garbage banks. Additionally, in areas outside of Bangkok, programs to encourage household segregation of recyclables are commonly either non-existent or under-resourced. The challenge will be to establish convenient systems, the right incentives, and a strong marketing program. Effective training, support, and increased staffing at the municipal level may also be necessary to fill the gaps in recycling activities found in many areas of the country.

Harnessing the market for waste: Each year, more than 4.5 million tons of commercially usable materials valued at THB 16 billion are thrown out with municipal solid waste.. With improved recycling programs a portion of this potential market could be tapped. In particular, if recycling rates increase such that the government's targets for 30 percent recycling is reached by 2015, almost 100 billion baht in revenues from recyclables that were previously thrown out could be collected by 2020 (Box 16). Currently, solid waste recycling is run predominantly through a private market composed of a relatively small group of informal waste scavengers, collectors, and agents. Additionally, there are some formal recycling programs run by the private sector and community-based garbage banks. Considering the large potential for private and community-led recycling and the danger of over-investing in government run facilities, the role of the government should in the short-term to provide proper incentives to support recycling operations run by private, community, and NGO-led initiatives.

Protecting waste pickers and saleng: Informal collection and recycling not only accounts for most of the recycling in the country but provides a source of income for approximately 25,000 poor Thais. Increased regulation of the market and the introduction of larger players may further marginalize this group, potentially forcing them further into poverty. As the recycling market expands and undergoes increased regulation, it should explore ways to build on the role played by this group and improve their working conditions, income, and opportunities.

2. Municipal solid waste - providing safe and cost-effective collection and disposal.

While collection and disposal systems have improved significantly over the last 10 years, most of the solid waste in the country is disposed without adequate environmental controls. These poor disposal practices are putting local communities at risk to disease and pollution and increasing NIMBY by reducing the confidence of the people in safe disposal.

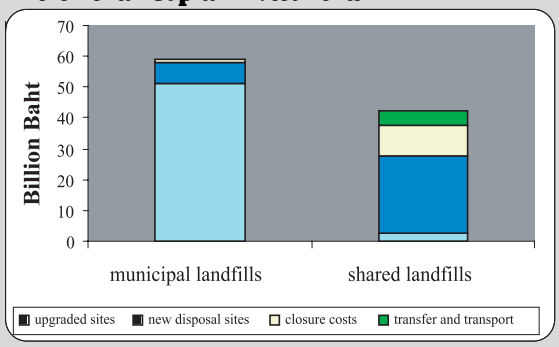
Building on gains in waste collection:
As a result of investments in collection infrastructure and services, Bangkok Metropolitan Administration is currently able to collect nearly all of the municipal solid waste generated by its population and waste collection in other cities and smaller urban areas averages between 75 and 90 percent. With most of the major collection infrastructure in place, the challenge ahead is to expand to underserved areas and improve the quality of collection services through improved cost efficiency and waste collection rates.

Expanding and upgrading safe disposal: There are more than 1,000 sites nationwide, with just over 100 of them properly designed and even fewer operating with proper environmental controls. Ensuring safe disposal using this large quantity of small disposal sites would not be cost-effective relative to establishing facilities shared by a province or portion of a province (Box 17). Development of large shared landfills as envisioned under the Solid Waste Management Strategy may be possible, in the short term in up to 21 provinces, by upgrading existing large sites and establishing correspondingly good institutional and financial mechanisms for financing, operation, collection, and transfer. In other provinces it may be more practical to consolidate disposal to a group of the better operated and larger landfills in the short term and develop plans for a provincial or multi-provincial site in the future.

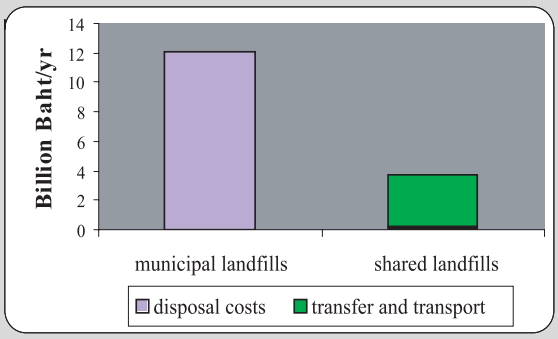
Box 17: Ensuring Safe Disposal Nationwide: The Potential of Shared Facilities

Ensuring safe disposal in the over 1,000 small, dispersed sites currently found nationwide will be costly and will frustrate oversight and outreach. In contrast, plans to ensure safe disposal nationwide by developing larger facilities shared by a portion or an entire province could save THB billions in disposal facility construction and operation.

Incremental Capital Investments



Incremental Operational Maintenance



	INVESTMENTS NECESSARY FOR NATIONWIDE SAFE DISPOSAL			
	New Sanitary Landfill Construction	Upgrading Sanitary Landfills	Safe Closure of Other Sites	Collection, Transfer and Transport
Municipal landfills	348 Tambon and Muang sites and 14 provincial capital sites would be constructed to replace expired sites.	891 Tambon and Muang sites and 63 provincial capital sites would need to be upgraded.	348 Tambon and Muang sites and 14 provincial capital sites would be closed.	Existing collection system would be used.
Shared landfills	Construction of shared landfills (55 provincial sites).	21 provincial capital sites could be upgraded as shared landfills.	55 provincial capital sites and 1049 Tambon and Muang sites would be closed.	Existing collection system would be used along with new transfer and transport facilities.

Notes: Shows the incremental capital and operation and maintenance costs relative to today and covers only greater municipal areas. See methodology for details

Regulating solid waste facilities: Currently there is no regulatory oversight of municipal landfills because landfills are not considered a pollution source under NEQA. Bringing landfills under the purview of NEQA would provide the mandate to PCD for oversight for environmental control, and with active enforcement would significantly increase the incentives for better disposal practices. Beyond this regulatory reform, the challenge would be to provide the properly targeted regulatory oversight complemented by training. For example, large municipalities with engineered landfills may need more intense oversight complemented by capacity building. However, smaller municipalities with open dumps might be better served by developing simple practices to improve the management of the dump while at the same time planning for its closure, with the goal of disposing waste in a provincial landfill in the future.

Coming together on NIMBY: This is now a common barrier to siting new landfills in Thailand and has prevented the development of regional landfills. The challenge is to explore ways to find common ground on this issue. Waste operators will need to build trust with the local people through assurances of proper waste management, allowing local people to participate in the siting of the landfill, and exploring ways the facility revenues can provide benefits to the local population. At the same time, information and education would be helpful in allowing the local people to make informed decisions and participate meaningfully in plans and decisions on solid waste disposal.

3. Industrial waste -plugging the regulatory gaps.

While Thailand has successfully developed centralized treatment facilities and many exporting firms are taking proactive measures to address environmental issues, cases of open dumping of industrial waste have been reported in the last several years and its safe treatment cannot be ensured with the current level of treatment capacity, regulatory oversight, and enforcement.

Encouraging safe practices in a liberalized industrial hazardous waste treatment market: In 2001, licensed centralized industrial hazardous waste treatment facilities only treated 24 percent of the industrial hazardous waste in Bangkok and vicinity. Further, due to gaps in regulatory oversight, lower cost and unsafe options are likely practiced by some licensed and unlicensed operators. To ensure the development of a market for hazardous waste treatment that is both safe and cost-effective, consistent and enforced standards for treatment facility operation, environmental controls, and accounting for waste need to be ensured.

Taking on illegal dumping: Complaints of open dumping of hazardous waste have been reported in Thailand over the past several years. Currently, there is no licensing and no oversight of waste haulers and buyers, and the fines for illegal dumping are insufficient. A licensing system and tough penalties for illegal dumping need to be implemented. The authority for licensing is already provided to the local governments through the Public Health Act and to the Ministry of Transport under the Land Transport Act. Implementation of a licensing system, with adequate penalties, through local governments with support from the Ministry of Transport could be an effective approach. Similarly, the authority for charging fees for illegal dumping lies with local governments under a variety of acts, while PCD has the mandate to respond to complaints and prepare a clean-up plan. By charging large fines for dumping and enforcing this through local governments with support from PCD, the incentive for illegal dumping could be decreased significantly.

4. Infectious and community generated hazardous waste - establishingsafe waste management systems.

Improving treatment of infectious waste: Much of the infectious waste produced in the country is disposed with municipal solid waste under unsanitary conditions that pose health risks. Additionally, the condition and operation of many of the hospital and municipal incinerators used to treat infectious waste is poor, increasing the risk of air pollution and ineffective treatment. As the government moves forward on developing a long-term plan for establishing the necessary treatment capacity, the major challenge will be to improve practices in the short term. Potentially effective approaches include training of hospital personnel in segre-

gation, pollution prevention and if cost-effective, use of alternative approaches such as autoclaving for certain types of waste. Additionally, training and regulatory oversight for incinerator operation should be more aggressively pursued along with simple procedures to reduce exposure through separate "safe landfilling" in municipal landfills.

Beginning to address community hazardous waste: Outside of the program in Bangkok, there are no formal collection and disposal arrangements for community generated hazardous waste including waste oils from gas stations and household waste such as light bulbs and batteries. The first and most difficult challenge will be to develop a program for household and commercial hazardous waste segregation that includes the proper awareness building and relies on effective incentives. At the same time, disposal can be improved through integration of disposal with industrial hazardous waste treatment facilities and improving landfill disposal practices of hazardous waste (e.g. using separate secure areas).

5. Paying for waste management.

To meet Thailand's goal of establishing sanitary landfills in all provinces by 2011, over THB 40 billion will need to be spent on landfill upgrading and construction and the costs of operation and maintenance will increase by THB 4 billion per year as a result of the new facilities. The long-term improvement of the solid waste sector will depend on finding a more sustainable source of financing both for investments and operational costs.

Investing in the future: Establishing sanitary landfills to cover each province would require an increase in annual expenditures on landfill construction from THB 1.1 billion in 2003 to an average of THB 5 billion over the next 8 years. In addition, other priority investments such as recycling centers and capacity building of municipalities will be needed. Currently, the investments are almost entirely financed through grants from a combination of the Environmental fund and the national budget. With the large future investment requirements, the major challenge will be to sustain this source of financing over the long term. The introduction of cost-recovery mechanisms, such as earmarking revenues from packaging and other taxes for solid waste investments, may provide answers to this.

Recovering operational costs: Currently, the fees charged by municipalities for solid waste collection and disposal are too low to cover the costs of operation and maintenance of collection and disposal. Funding therefore comes from the municipal budget, yet often times it is inadequate to properly maintain and monitor the environmental controls. The challenge will be to explore options for increasing fees or imposing new financing and collection mechanisms to ensure costs can be recovered in a fair, transparent manner. Also a major related challenge will be the necessity to provide visible improvements in solid waste service combined with public awareness to convince people that higher fees are in their interest.

Improving private sector involvement: Under the right conditions, the private sector can provide a supplemental source of financing for solid waste investments. While there has been some success in the provision of hazardous waste treatment facilities, involvement in solid waste has been most commonly limited to contracts for collection and disposal. The main challenges for developing effective private sector involvement include streamlined regulatory procedures that are enforced consistently; adequate and collectable fees or other cost recovery mechanisms; and strong contractual arrangements. The potential financial attractiveness of the planned establishment of provincial landfills provides an excellent opportunity for private sector involvement.

6. Clarifying roles

Under the Decentralization Plan, public participation will increase, the national government will provide outreach and oversight to over 1,000 municipalities and 60,000 industries, and local governments will assume many more responsibilities with limited staff and skills. In order to play their respective roles effectively, capacity and skills need to be built for:

Providing local services: Currently, local governments primarily focus on providing the core waste services of street sweeping, collection, and disposal, with little or no staffing for recycling activities or public awareness. Planning is predominantly handled through national agencies. The challenge for municipalities will be to build on their experience to improve management and service delivery while beginning to address new opportunities like recycling and cost recovery. Addressing the capacity constraints of the large number of municipalities will necessitate a long-term national program for training that is comprehensive enough to reach even the smallest municipalities. A core element of the strategy should be highlighting emerging best practices in municipalities in order to provide incentives for good performance while disseminating successful practices.

Onnuch transfer station in Bangkok

Garbage Bank Program on Ko Lan, Chonburi

Providing effective outreach and oversight: Currently, there is only one solid waste officer for every 142 municipalities and one inspector for every 180 industries. As national agencies will increasingly be expected to play a supervisory and support role at the local level, they will need to increase their staffing and presence by strengthening the regional and provincial offices. The challenge will not only be to provide effective on-the ground presence but also to target their activities in areas with the greatest impact and comparative advantage.

Catalyzing grassroots initiatives: Effective solid waste management needs the involvement of people at all levels. Community-led initiatives and community work led by operational NGOs and civil society organizations should be encouraged and supported. By providing support and developing partnerships with civil society for initiatives such as garbage banks, community clean-ups, and grassroots advocacy campaigns, solid waste management could be improved in ways government cannot do alone.

Landfill survey and categorization: A survey was developed on landfill practices and sent to the local governments in charge of disposal of solid waste from Thailand's 76 provincial capitals. The survey contained questions about the disposal site facilities, operational practices, environmental controls and conditions, and size and filling history. After receiving the surveys, follow-up phone calls were made to a portion of the municipalities to clarify and verify the survey responses. Cross checks of some of the data were also made using existing reports and data provided by PCD. The results were collated and the categorization of the disposal sites was done based on the following criteria:

Table 24. Minimum Characteristics for Different Types of Disposal Sites

	Basic practices		Staffing	Environmental Controls		Operation of environmental controls.	Environmental Conditions
	Compaction and cover.	Fencing and waste accounting	On-site staff	Leachate liner	Leachate Drainage,leachate treatment, gas ventilation, and monitoring wells	Leachate treatment system and regular monitoring.	Leachate contamination, fires, more than occasional rodents and birds, and scavengers living on site.
Open dump	-	-	-	-	-	-	-
Controlled dump	Both	one or both	Yes	-	-	-	-
Engineered landfill	Both	one or both	Yes	Clay or plastic	one or more	-	-
Sanitary landfills	Both	Both	Yes	Clay or plastic	all	both functional.	None of the conditions exist.

The survey also provided a basis for estimating the remaining lifetime of the landfill This was done based on estimates of filling history from either municipal estimates of waste volume in landfill (area and depth) combined with number of years open or municipal estimates of filling rates.

Municipal benchmarking survey: Through USAID grant executed by USAEP, a survey of 13 municipalities was undertaken to better understand the current status of collection, disposal, recycling practices; financial performance; human resource and infrastructure capacity and public participation and outreach in these municipalities. The survey was undertaken between December 2002 and April 2003 by a team led by Dr. Wanpen Wirojanagud of Khon Kaen University and comprised of well-known environmental specialists from four leading universities in different regions of Thailand: Khon Kaen (Northeastern), Chulalongkorn (Central), Chiang Mai (Northern), and Prince of Songkhla (Southern). The surveys were carefully designed in cooperation with the Municipal League of Thailand and were conducted in a collaborative process with the survey team undertaking multiple visits to the municipalities to help clarify data questions and collect the necessary data. Special attention was made to ensure consistency in the types of data collected in the different municipalities. After all the data was collated and analysis was undertaken, extensive additional quality assurance and quality control was undertaken, including verification of the data with the municipalities, published reports and data from national agencies. The outcome is presented in the Monitor and data is available in the accompanying CD.

Estimates of waste production: The estimates of waste production presented in this report included some estimates made by the World Bank using existing data and other estimates made in recent studies and reports.

Table 25. Basis for Waste Generation Estimates

	Waste Sources	Generation rates	Historical production	Future production	Recycling	Comparison with other estimates
Municipal Solid Waste	Population based on NSO provincial-level data and growth rates for 2000.	PCD, 2001 data consisting of data provided by municipalities and estimates based on size of municipality.	Historical population data and generation rates correlated to consumption of durable and non-durable goods in 2001 prices.	Scenarios based on: stable generation rates (low); current rate of growth of generation rates (medium); linear 50% growth of generation rates by 2010 (high)	Recycling rate of 11 percent based on PCD (Recycling study), 2001 which indicates each year 1.28 million tons of waste is recycled in municipal areas and 0.3-0.5 million tons is recycled in other areas.	Estimates for 2001 are consistent with PCD data. Estimates for the 1990s are also comparable to available data.
Industrial Waste	DIW database of all industries (including those in industrial estates).	2001 survey of 215 industries in BMA and vicinity[41].	DIW industry data (1997-2001) and unit generation rates from survey of 215 industries in BMA and vicinity[42]. Not done for non-hazardous waste	Scenarios (1.5%, 3% and 6% GDP growth) based on correlation of sector growth rates with economic growth rates using 1999-2001 data. Not done for non-hazardous waste.	An 18 percent recycling rate for hazardous waste and 80 percent recycling rate for non-hazardous was used based on a survey of 215 industries in BMA in vicinity.	The estimates for 2001 are within 25 percent of DIW and PCD estimates. Considering the likely error in the data, these numbers are basically the same.
Infectious waste	Taken from surveys and estimates made in MOPH, 2002.					
Community Generated Hazardous Waste	Taken from surveys and estimates made in PCD (Community Waste Study), 1998 subtracting the infectious waste generation estimates.					

Costs of shared waste facilities:

Using the data from the landfill survey, estimates were made of the costs of sanitary disposal nationwide under 2 scenarios: (i) shared, provincial or half provincial facilities; (ii) existing municipal level disposal sites. The shared landfill scenario assumed that all existing landfills that could support the waste from the greater municipal population of at least half the province would be converted to sanitary landfills, while the remainder would be closed and provincial sanitary landfills will be constructed in its place. The municipal landfill scenario assumed that all landfills with a lifetime greater than 5 years would be upgraded to a sanitary landfill while the remainder would be closed and replaced by sanitary landfills of comparable size. The lifetime of the disposal site was estimated using the waste filling history based on either physical measurements of waste volume in landfill or reported filling rates. Costs of upgrading were done for each disposal site in provincial capitals based on its existing infrastruc-

[41] Kokusai Kogyo and Ex Corp for DIW and JICA, 2002.

[42] Ibid

ture and unit costs for infrastructure obtained from feasibility studies and upgrading studies for Thai landfills. For other disposal sites, four percent are known to be engineered landfills and assumed to have the associated infrastructure. For the remainder it was assumed two thirds had the infrastructure of an open dump and remainder controlled dumps. Unit costs for each infrastructure item, for the construction of a new sanitary landfill and for disposal site closure were based on numbers from PCD studies (Regional Landfill Study and Disposal Site Rehabilitation Studies). Transport costs for each of the scenarios was based on the assumption that the same local collection system would be used but the shared facility would utilize transfer stations including the associated hauling costs. The costs for hauling were estimated using a correlation between population density and the cost difference between shared and individual hauling costs from PCD (Landfills in pollution control zones) developed for the 7 provinces in BMA and vicinity. Capital and operation and maintenance costs for the transfer stations were also based on estimates from this study.

Benefits of waste reduction and recycling:

The benefits of waste reduction and recycling in terms of revenues from recycling sales and savings on disposal costs were estimated assuming the government targets were reached by 2006 as proposed in the Ninth National Economic and Social Development Plan and alternatively in 2015. Savings on disposal costs are based on average annualized capital costs for disposal based on PCD studies and typical operation and maintenance costs reported by municipalities. Recycling revenues were based on the amount of glass, paper, plastic and metal in Thailand's waste that is commercially recyclable (PCD Recycling Study, 2001) which amounts to 42 percent of the total municipal waste generation. Future waste production was taken from the medium growth scenario (see waste production estimates) and prices for different types of recyclables are based on current market values (Wongpanit Co. Ltd.). The recyclables were assumed to maintain the same relative composition over time and the overall recycling rate waste was assumed to increase linearly until the government target was reached. Data was not available for the composition of metal in waste and therefore did not delineate the more valuable aluminum from other metals. The sale price for metal used assumes a large non-aluminum content and therefore likely represents a conservative estimate. Estimates of the total market value of recycled waste that is thrown away was estimated similarly. Based on the total recyclable content of 42 percent and the current recycling rate of 11 percent, approximately 31 percent of the total municipal solid waste generation or just over 4.5 million tons annually consist of recyclable materials that are thrown away. The composition of these recyclables was estimated using recycling rates and waste compositions data provided in PCD (Recycling Study), 2001. This amounted to an annual total of 1.5 million tons of paper; 1.9 million tons of plastic; 0.4 million tons of metal ; and, 0.75 million tons of glass. The potential market value of these recyclables (THB 16 billion annually) was estimated by multiplying these production numbers by the above mentioned prices for these materials.

Foam to be recycled at Wongpanit Co. Ltd recycling company.

Paper mache made from recycled paper

GLOSSARY OF TERMS

Biodegradable: Capable of decomposing rapidly by microorganisms under natural conditions. Most organic materials, such as food scraps and paper, are biodegradable.

Collection: The process of picking up wastes from residences, businesses, or a collection point, loading them into the vehicle, and transporting them to a processing site, transfer station, or landfill.

Commercial waste: All municipal solid waste emanating from business establishment such as stores, markets, office buildings, restaurants, shopping centers, and entertainment centers.

Community Generated Hazardous Waste: Hazardous waste produced by households and commercial establishments such as hotels, airports, gas stations, photo processors, universities and dry cleaners. For the purposes of the analysis in this document, infectious medical waste from hospitals is categorized separately.

Composting: The controlled biological decomposition of putrescible fraction of MSW in the presence of air to form a humus-like material.

Controlled dump: A waste disposal site that has no environmental controls but undertakes basic waste management practices such as correct placement of the waste in thin layers and compaction and cover.

Decomposition: The breakdown of matter by bacteria and fungi changing the chemical makeup and physical appearance of MSW.

Disposal: The final placement of waste that is not salvaged or recycled.

Engineered landfill: A disposal site that has been designed with at least some controls to minimize environmental and health hazards including water pollution from runoff and leaching. MSW is spread in thin layers, compacted, and covered with a fresh layer of soil each day. These environmental control systems are not necessary complete or operating properly.

Generation rate: The amount of waste that is generated over a given period of time

Groundwater: The supply of freshwater that is found beneath the Earth's surface, usually in aquifers, which supplies wells and springs. Because groundwater is a major source of drinking water, there is growing concern about contamination from disposal sites.

Hazardous waste: Waste generated during production and other activities by society that can pose a substantial or potential hazard to human health or the environment when improperly managed.

Household waste (domestic waste): MSW composed of garbage and rubbish, which is generated as a consequence of household activities. In developing countries, up to two-thirds of this category consist of putrescible wastes.

Incineration: A treatment technology involving destruction of MSW by controlled burning at high temperatures. The main objective of this process is to reduce volume of MSW so that landfill life span can be extended.

Industrial waste: Hazardous and non-hazardous materials generated during an industrial operation.

Infectious waste: Hazardous waste with infectious characteristics, including contaminated animal waste, human blood, and blood products, isolation waste, pathological waste, and discarded needles and medical instruments.

Landfill gas (LFG): A gas produced by the degradation of organic matter in waste disposed in landfills. It is made up of approximately 50% of the flammable gas methane and is commonly collected from landfills for use as a fuel gas or for the production of electricity.

Leachate: Wastewater that collects contaminants as it trickles through MSW disposed in a landfill. Leaching may result in hazardous substances entering surface water, ground water, or soil.

Materials recovery facility: Facility that processes residentially collected mixed recyclables into new products.

Moisture content: The fraction or percentage of a substance that is water.

Municipal solid waste (MSW): Includes non-hazardous waste generated in households, commercial and business establishments, institutions, agricultural wastes, and sewage sludge. In Thailand portion of other types of waste (infectious, industrial and community hazardous waste) are also collected and disposed with municipal solid waste.

NIMBY: Acronym for "Not In My Backyard"; an expression of resident opposition to the siting of a municipal solid waste management facility based on the particular location proposed.

Open dump: A site used to dispose of waste without any management and/or environmental controls.

Recycling: Separation physical/mechanical process by which secondary raw materials (paper, metal, glass, plastics) are obtained from MSW. The process could be accomplished manually, or by simple and /or sophisticated equipment.

Resource recovery: The process of obtaining matter or energy from MSW

Sanitary landfill: Waste disposal site that is designed and operated to minimize environmental and health hazards including water pollution from runoff and leaching. MSW is spread in thin layers, compacted, and covered with a fresh layer of soil each day.

Transfer station: A facility at which municipal solid waste from collection vehicles is consolidated into loads that are transported in larger trucks or other means to more distant disposal sites.

Waste picking: A process of extraction of recyclables and reusable materials from a mixed MSW for further use and /or processing.

Source : Adapted from "Planning Guide for Strategic Municipal Solid Waste Management in Major Cities in Low-income Countries," Draft Planning Guide, February 1998, Environment Resources Management, London.

ORGANIZATION	WEBSITE ADDRESS	Description & Contents
Pollution Control Department	www.pcd.go.th	Provides comprehensive information on solid, hazardous, and infectious waste management in Thailand, including related laws, regulations, and conventions. Also provides list of PCD projects, publications, and useful links. However, most information is available in Thai only.
Thailand Environment Institute	www.tei.or.th	Provides information on TEI programs, lists on-going and accomplished projects from 1993 until present. Details of Thai Green Label, ISO 14000, and Cleaner Technology are also provided.
Material Exchange Center	www.tei.or.th/mec	Provides service on waste exchange between industries. Promotes and presents information on waste reduction and recycling technology to industries.
Computer Recycling Center (CRC)	www.crc.org	Presents its activities on how to promote the re-use of computer and electronic equipment, and recycle unusable items.
General Environmental Conservation Public Company Limited (GENCO)	www.genco.co.th	Provides details of its treatment and disposal systems. Presents industrial waste regulations and useful links to other waste related websites.
The Environmental Engineering Association of Thailand	www.eeat.or.th	Presents news and events on environment. Updated information on environment is also available through EEAT electronic journal, i.e. ISO 14000 and green industry.
Office of Natural Resources and Environmental Policy and Planning	www.onep.go.th	Provides overview of state of Thai environment, environmental plans, policies, and multilateral agreements.
Department of Environmental Quality Promotion	www.deqp.go.th	Presents information on environment, including environmental standards, laws, interesting articles, projects, and also a list of environmental NGOs.
Department of Industrial Works	www.diw.go.th	Provides industrial information, statistics, and laws. Also provides links to related websites such as waste utilization data center, and the study of potential area for industrial waste landfill site selection.
Thai Environment and Community Development Association (Magic Eyes)	www.magiceyes.or.th	Presents its activities on how to save the environment, and provides useful links to other related websites.
Thailand Network of Eco-efficiency and Cleaner Production	www.tnec.info	Provides information on environmental trainings and seminars. Presents articles on plan and policy and also ecology and cleaner production articles.

ENVIRONMENT / GEOGRAPHY

Environment

Forest:
forest cover: 172,050 sq km (2001) or 33.5 percent of land area

Protected areas:
protected areas: 90,506 sq km (2001) or 17.64 percent of land area
number of protected areas: 341 units (2001)

Water quality:
Percentage of river basins with water quality:
good: 40 percent (2002)
moderate: 25 percent (2002)
poor: 32 percent (2002)
very poor: 3 percent (2002)

Air quality:
Ambient - Bangkok
TSP (24 hrs): 0.1 mg/m3 (2002)
PM_{10} (24 hrs): 49.4 ug/m3 (2002)
CO (8 hrs): 0.9 ppm (2002)
Ozone (1 hr): 13.7 ppb (2002)
SO_2 (24 hrs): 5.2 ppb (2002)
NO_2 (1hr): 23.9 ppb (2002)

Solid and hazardous waste:
solid waste: 14.4 million tons (2002)
industrial hazardous waste: 0.96 million tons (2002)
industrial non-hazardous waste: 5.9 million tons (2002)
community hazardous waste: 0.38 million tons (2002)
infectious waste: 21,300 tons (2002)

Natural disaster:
Flood:
number of occurrences: 14 (2001)
value of assets loss: 3,666.3 million baht (2001)
Typhoon:
number of occurrences: 1,061 (2001)
value of assets loss: 501 million baht (2001)
Drought:
population affected: 18.9 million persons (2001)
value of assets loss: 72 million baht (2001)
Forest fire:
Total forest fire area: 933.3 sq km (2000)

Geography

Area: 515,113.6 sq.km

Land boundaries:
total: 4,863 km
border countries: Myanmar 1,800 km, Cambodia 803 km, Laos 1,754 km, Malaysia 506 km

Coastline: 3,219 km

Maritime claims:
continental shelf: 200-m or to depth of exploitation
exclusive economic zone: 200 nm
territorial sea: 12 nm

Climate: tropical; rainy, warm, cloudy southwest monsoon (mid-May to September); dry, cool northeast monsoon (November to mid-March); southern isthmus always hot and humid.

ECONOMY/SOCIETY

Geography (CONT.)

Terrain: central plain; Khorat Plateau in the east; mountains elsewhere

Elevation extremes:
lowest point: Gulf of Thailand 0 m
highest point: Doi Inthanon 2,576 m

Mineral resources:
tin, natural gas, tungsten, tantalum, timber, lead, fish, gypsum, lignite, fluorite.

Environment-international agreements:
party to: Climate Change, Endangered Species, Hazardous Wastes, Marine Life Conservation, Nuclear Test Ban, Ozone Layer Protection, Tropical Timber 83, Tropical Timber 94 and Biodiversity.

Economy

GDP: 5,433 billion baht (2002)

GDP growth rate: 5.2 percent (2002)

GDP-composition by sector:
agriculture: 9.9 percent
industry: 45.2 percent
services: 44.9percent (2002)

Inflation rate-consumer price index: 0.7 (2002)

Unemployment rate: 2.2 percent (2002)

Exports of good and services/GDP: 64.7 (2002)

Industrial production growth rate: 7.5 percent (2002)

Agricultural production growth rate: 0.5 percent (2002)

Agriculture-products: rice, cassava (tapioca), rubber, corn, sugarcane, coconuts, soybeans.

Exports: total value: 2,955.7 billion baht (2002)

Imports: total value: 2,778 billion baht (2002)

Gross Domestic Investment/GDP: 23.9 (2001)

Gross national savings/GDP: 29.3 (2001)

Society

Population: 63.4 million (2002)

Population growth rate: 0.82 percent (2002)

Labour force: 34.2 million (2002)

Birth rate: 14 births/1,000 population (2002)

Death rate: 6 deaths/1,000 population (2002)

Infant mortality: 20 deaths/1,000 live births (2002)

Access to safe water (percent of population): 92.6 (2000)

Access to sanitation (percent of population): 97.8 (2000)

Life expectancy at birth: Male 69.9 years, Female 74.9 years (2002)

Literacy: 95.5 percent (2002)

National capital: Bangkok

Administrative divisions: 76 provinces (changwat)

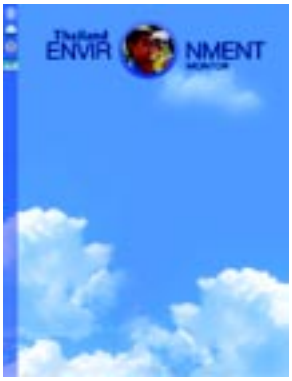
Independence: 1238 (traditional founding date; never colonized)

Source: PCD, DIW, MoPH, NSO, NESDB, Royal Forest Department, and Ministry of Education

December 2003

Thailand Environment Monitor 2000
presented a snapshot of general environmental trends in the country

Thailand Environment Monitor 2001
Assessed the status of water quality management in the country



Thailand Environment Monitor 2002
Assessed the status of air quality management in the country

Thailand Environment Monitors are available in both English and Thai online at :
http://www.worldbank.or.th/monitor

Pollution Control Department

92 Soi Phahon Yothin 7
Phahon Yothin Road
Sam Sen Nai
Phayathai District
Bangkok 10400
Thailand
Tel (66 2) 298-2000
Fax (66 2) 298-2002
www.pcd.go.th

U.S. Agency for International Development (USAID)
United States - Asia Environmental Partnership (US-AEP)

10th Floor, Tower A
Diethelm Tower
93/1 Wireless Road
Bangkok 10330
Thailand
Tel (66 2) 263-7465
Fax (66 2) 254-2838
www.usaep.org

Japan Bank for International Cooperation (JBIC)

14th Floor, Nantawan Building
161 Rajdamri Road, Pathumwan
Bangkok 10330
Thailand
Tel (66 2) 252-5050
Fax (66 2) 252-5514
www.jbic.go.jp

World Bank Office, Bangkok

14th Floor, Tower A
Diethelm Tower
93/1 Wireless Road
Bangkok 10330
Thailand
Tel (66 2) 256-7792
Fax (66 2) 256-7794
www.worldbank.or.th