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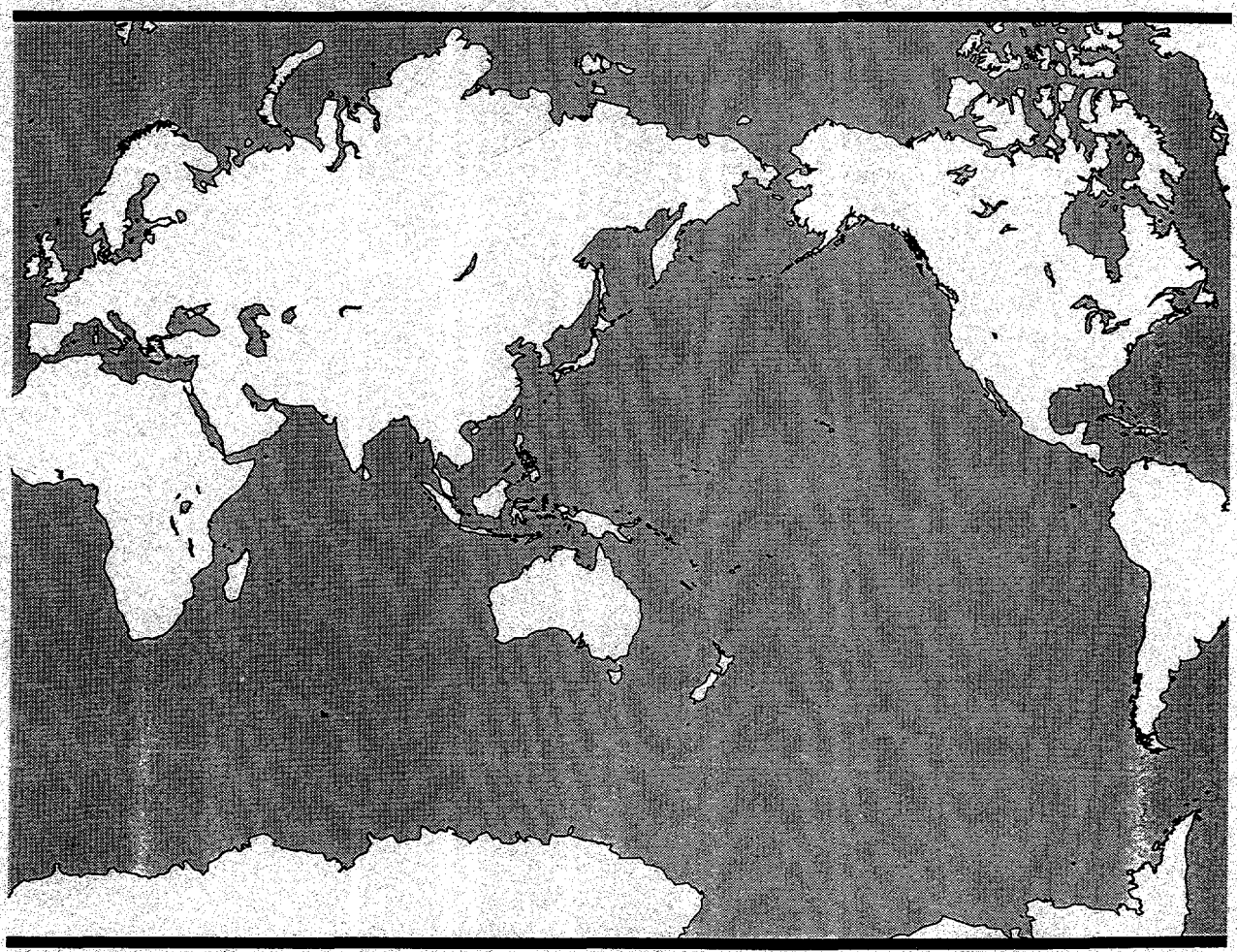
Hazardous Waste Management in the Pacific Basin



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Internal Report

ANL/DIS/RP--85600

Hazardous Waste Management in the Pacific Basin

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ACRONYMS

ADB	Asian Development Bank
ANL	Argonne National Laboratory
APEC	Asia-Pacific Economic Cooperation
ASEAN	Association of Southeast Asian Nations
AWMA	Air and Waste Management Association
BAPEDAL	Environmental Impact Management Agency (Indonesia)
BAPPEDA	Regional Development Planning Board (Indonesia)
BKLH	Bureau of Population and Environment (Indonesia)
BMA	Bangkok Municipal Authority (Thailand)
BMR	Bangkok Metropolitan Region (Thailand)
CETEC	Centre for Environmental Technologies (Malaysia)
CPC	China Petroleum Company (Taiwan)
CWTC	Central Waste Treatment Center (Hong Kong)
DEC	Department of Environment and Conservation (Papua New Guinea)
DIW	Department of Industrial Works (Thailand)
DNR	Department of Environmental and Natural Resources (Philippines)
DOE	U.S. Department of Energy
EAP	Environmental Action Plan
ECNEQA	Enhancement and Conservation of National Environmental Quality Act
EIP	Environmental Improvement Project
EMB	Environmental Management Bureau (Philippines)
ENSEARCH	Environmental Management and Research Association of Malaysia
EPA	Environmental Protection Agency (Taiwan and United States)
EPB	environmental protection bureau
ESCAP	Economic and Social Commission for Asia and the Pacific
ETEC	Environment Technology Export Council
EWC	East-West Center
FMM	Federation of Malaysian Manufacturers
FTI	Federation of Thai Industries
GDP	gross domestic profit
GKS	Gerbangkertosusila (Indonesia)
HKEPD	Hong Kong Environmental Protection Department
HKPC	Hong Kong Productivity Council
IBRD	International Bank for Reconstruction and Development
IDB	Industrial Development Bureau (Taiwan)
IE/PAC	Industry and Environment Program Activity Centre
IEA	Industrial Estates Authority (Thailand)
IEDS	International Environmental and Development Services
IEF	International Environment Forum

IEMP	Industrial Environmental Management Project
IFC	International Finance Corporation
IFCT	Industrial Finance Corporation of Thailand
IPCS	International Program on Chemical Safety
IRPTC	International Register of Potentially Toxic Chemicals
ISWA	International Solid Waste and Public Cleansing Association
ITA	International Trade Administration
ITRI	Industrial Technology Research Institute (Taiwan)
Jabotabek	Jakarta, Bogor, Tangerang, and Bekasi (Indonesia)
KLH	Ministry of Population and Environment (Indonesia)
LLDA	Laguna Lake Development Authority (Philippines)
MDOE	Malaysia Department of Environment
MEIP	Metropolitan Environmental Improvement Program (Philippines)
MNC	multinational corporation
MOE	Ministry of Environment (Indonesia and Korea)
MOEA	Ministry of Economic Affairs (Taiwan)
MOI	Ministry of Industry (Thailand)
NEA	National Energy Administration (Thailand)
NEB	National Environment Board (Thailand)
NEPA	National Environmental Protection Agency (China)
NEPC	National Environmental Protection Council (Philippines)
NHA	National Health Administration (Taiwan)
NPCC	National Pollution Control Commission (Philippines)
OFDA	Office of Foreign Disaster Assistance
OPIC	Overseas Private Investment Corporation
PBCHWR	Pacific Basin Consortium for Hazardous Waste Research
PBEC	Pacific Basin Economic Council
PCB	polychlorinated biphenyl
PCD	Pollution Control Department (Singapore)
PITO	Private Investment Trade Opportunities (Project)
PROKASIH	Clean River Program (Indonesia)
TDA	U.S. Trade and Development Agency
TIP	Technical Information Package
TVE	Town-and-Village Enterprise (China)
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNEP/ROAP	UNEP Regional Office for Asia and the Pacific
UNIDO	United Nations Industrial Development Organization
USAID	U.S. Agency for International Development
USEAP	U.S.-Asia Environmental Partnership
USFCS	U.S. and Foreign Commercial Service

WEC	World Environmental Center
WHO	World Health Organization
WMI	Waste Management International

HAZARDOUS WASTE MANAGEMENT IN THE PACIFIC BASIN

by

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and S.H. Indriyanto

ABSTRACT

Hazardous waste control activities in Asia and the Pacific have been reviewed. The review includes China (mainland, Hong Kong, and Taiwan), Indonesia, Korea, Malaysia, Papua New Guinea, the Philippines, Singapore, and Thailand. It covers the sources of hazardous waste, the government structure for dealing with hazardous waste, and current hazardous waste control activities in each country. In addition, the hazardous waste program activities of U.S. government agencies, U.S. private-sector organizations, and international organizations are reviewed. The objective of these reviews is to provide a comprehensive picture of the current hazardous waste problems and the waste management approaches being used to address them so that new program activities can be designed more efficiently.

1 BACKGROUND

As evidenced by the recent United Nations Conference on Environment and Development, environmental issues are a growing worldwide concern. Such issues are of special importance in developing countries that are trying to balance economic growth with environmental stewardship.

For business organizations from industrialized countries, environmental management in developing countries presents two special situations. First, companies operating in developing countries are being pressed to exercise more careful control of their environmental discharges. Countries that did not have any environmental regulations 5 or 10 years ago are moving toward strict environmental controls. Companies are now required to install pollution control equipment, modify their operational practices, and consider the environmental implications of alternative facility locations. Second, companies engaged in the environmental pollution control business are finding new markets in developing countries. As more stringent requirements are imposed in these countries, environmental companies are finding new customers for air pollution control equipment, wastewater treatment facilities, hazardous waste treatment and disposal operations, environmental quality monitoring equipment, and other technology. The market for consulting services in the environmental area is also increasing.

The U.S. Trade and Development Agency (TDA)[1] has sponsored projects dealing with environmental management in a number of countries. Since 1986, a special effort has been focused on hazardous waste control projects in Asia. In August 1992, Argonne National Laboratory (ANL) and the East-West Center (EWC), both of which are founding members of the Pacific Basin Consortium for Hazardous Waste Research (PBCHWR), were contracted to review TDA's prior hazardous waste projects in Asia and the Pacific, to identify and explain successes and failures in those efforts, and to map out a new set of activities for future work in this area.

The TDA asked ANL and the EWC to carry out the project by a combination of visits to selected countries (7 of the 10), correspondence with in-country personnel, and contacts with other U.S. and international organizations. The intent was to develop both country-specific perspectives and a regional perspective on hazardous waste control.

In this report, Section 2 provides a regional overview of hazardous waste control in the Pacific Basin. In addition to providing some background information on the common issues in the region, it also outlines some of the lessons learned from the country visits, correspondence, and organizational reviews. Section 3 is a series of country profiles that deal with waste control in each of the 10 countries considered. Each country profile contains information on sources of waste, regulations, and government structure for managing waste and identifies possible future activities. Section 4 is a series of organizational profiles. The major U.S. and international organizations working in the hazardous waste field in Asia are included.

It would be inappropriate for this document to be viewed as the final word on hazardous waste in Asia. First, it is limited by the need to review 10 countries, which limits the level of detail that can be presented for any one country. Second, it is limited by the nature of the rapid developments in the region. Decisions on many projects and activities are being made in a very short time frame. Third, it is limited by the amount of insight that can be gained by country visits of short duration. This limitation has been addressed to the extent possible by using PBCHWR in-country contacts with staff intimately involved in the waste control program.

It has not been possible to speak with all the people who might provide insight, interview all the organizations with something to contribute, or review all the relevant literature. This report, however, can be viewed in the same way as all such analytical and evaluation studies; that is, it provides incomplete information but contains sufficient insight to improve the decision process.

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[1] The U.S. Trade and Development Agency, prior to late 1992, was known as the U.S. Trade and Development Program (TDP). For simplicity, the new name, TDA, is used throughout this document.

2 REGIONAL OVERVIEW

The purpose of this section is to provide a general overview of the hazardous waste program activities in the Pacific basin. The regional perspectives presented here have been synthesized from the detailed country-specific evaluations presented in Section 3. While it is not possible to make universal statements that apply to all countries in the region, it has been possible to identify recurrent themes. Certain issues have been raised again and again in different countries. These issues are presented here.

2.1 HAZARDOUS WASTE GENERATION

There is no doubt that the countries of Asia and the Pacific are the fastest growing region of the world. Table 2-1 shows that the annual average gross domestic product (GDP) growth in the region, with some exceptions, is well above both the world average and the industrialized country average. This growth has come through industrialization and urbanization, which have increased the generation of hazardous waste. Table 2-2 gives estimates of hazardous waste generation based on the latest available information. Historical data are not available. In practice, countries define hazardous waste differently. For the purposes of this report, hazardous waste is defined as "wastes other than radioactive wastes which by reason of their chemical reactivity or toxic, explosive, corrosive, or other characteristics cause danger or are likely to cause danger to health or the environment" (Batstone 1989). This working definition was developed by the United Nations Environment Program (UNEP). In the context of this report, hazardous wastes are generated primarily from industrial operations.

Radioactive wastes are specifically excluded from consideration here. Special international agreements and conventions deal with that issue. The International Atomic Energy Agency, an arm of the United Nations, provides primary guidance and support to countries in those matters.

Infectious wastes (e.g., hospital and clinical biological waste) are referred to here but are dealt with separately from the industrial wastes itemized above. Municipal solid waste is also referred to here to the extent that there is a correlation to hazardous waste.

Figure 2-1 gives a schematic diagram of the four major participants in a hazardous waste control program: the government, the industrial sector (waste generators), environmental control companies, and research organizations. Each plays a substantial role in hazardous waste control that must be recognized in developing appropriate projects in the region.

TABLE 2-1 GDP Growth Rates in Asia

	GDP Annual Average Growth Rate (%)	
	1965-1980	1980-1990
China	6.8	9.5
Hong Kong	8.6	7.1
Indonesia	7.0	5.5
Korea	9.9	9.7
Malaysia	7.4	5.2
Papua New Guinea	4.1	1.9
Philippines	5.7	0.9
Singapore	10.0	6.4
Thailand	7.3	7.6
United States	2.7	3.4
OECD Countries	3.7	3.1
World Average	4.0	3.2

Source: World Bank (1992).

TABLE 2-2 Hazardous Waste Generation in Asia

	Hazardous Waste Generation (per year)
China	35,000,000-75,000,000 tons
Hong Kong	105,000 metric tons
Indonesia	4,224,000 cubic meters (Jakarta area) 90,000 metric tons (Surabaya area)
Korea	8,500,000 tons
Malaysia	380,000 cubic meters
Papua New Guinea	Data not available
Philippines	100,000-190,000 cubic meters (Metro Manila)
Singapore	42,000 cubic meters
Taiwan	620,000 metric tons
Thailand	1,200,000 metric tons

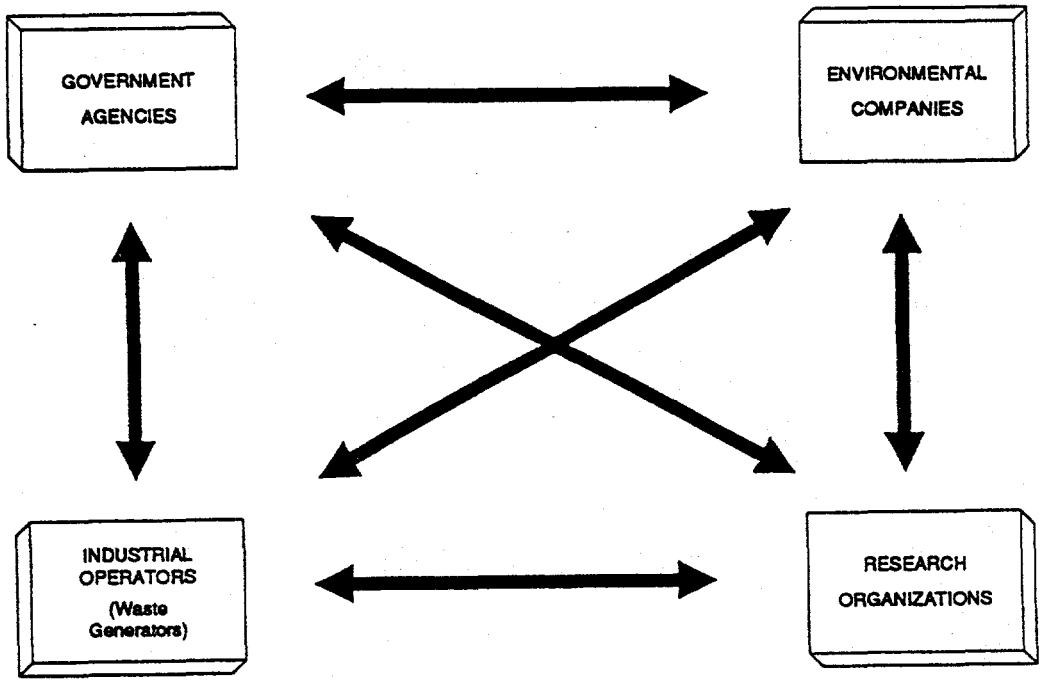

FIGURE 2-1 Major Participants in Hazardous Waste Control

2.2 GOVERNMENT AGENCIES

The government is the primary authority for the control of hazardous waste in each of the countries. A number of common issues surfaced in the review.

2.2.1 Agency Structure and Location in the Government

Each country has a government environmental agency that is responsible for the control of hazardous waste, as well as other environmental pollution issues. Table 2-3 identifies the agency that has hazardous waste control responsibility within each country. In some cases, such as Singapore, Korea, and Indonesia, the agency is at a ministerial level with inputs to the highest levels of government. In other cases, such as Malaysia, the agency is a department of another ministry (such as a ministry of science and technology or a ministry of health), and environmental issues in general and hazardous waste issues in particular are presented to senior government officials through a minister with a broader portfolio. In still other cases, such as Thailand, the responsibility for hazardous waste control is split among several government agencies (e.g., the environmental agency and the ministry of industry).

As is the case with all governments, the vigor with which government hazardous waste control programs are implemented is partially, but substantially, a function of the personality of the chief environmental official and her or his ability to influence the decision-making process in the rest of the government. Experience in the region varies: some countries pursue strong

TABLE 2-3 Government Agency Responsible for Hazardous Waste Control

	Responsible Government Agency
China	National Environmental Protection Agency
Hong Kong	Environmental Protection Department
Indonesia	Ministry of Environment Environmental Impact Management Agency
Korea	Ministry of Environment
Malaysia	Ministry of Science, Technology, and the Environment Department of Environment
Papua New Guinea	Department of Environment and Conservation
Philippines	Department of Environment and Natural Resources Environmental Management Bureau
Singapore	Ministry of the Environment
Taiwan	Environmental Protection Agency
Thailand	National Environment Board and Ministry of Industry Department of Industrial Works

environmental controls, others take a cautious and slow approach, and still others attempt to minimize any constraints that environmental issues place on growth, economic development, and industrialization.

The extent to which there is a strong public and nongovernment organization environmental movement influences the extent to which hazardous waste control is seen as a priority issue by senior government officials. The existence of publicly known hazardous waste problems, such as toxic chemical spills, river pollution, and human health damage, puts extensive pressure on the government to take an aggressive role in hazardous waste control. It is not uncommon to see many daily newspaper articles describing pollution problems in the region.

It is beyond the scope of this review to judge the effectiveness of the government agencies in each of the countries studied. Nevertheless, hazardous waste control projects that are planned for any of these countries must recognize the role and potential effectiveness of the government agencies involved.

2.2.2 Agency Staffing

With few exceptions, the environmental agencies dealing with hazardous waste suffer from moderate to severe shortages of qualified technical staff. Typically, the high-level officials (e.g., department heads) are technically trained and have experience in the environmental field. Many have been educated in the United States, Japan, Australia, or Europe. Many are dedicated civil servants with a strong desire to contribute to the benefit of their country. However, it is also typical that the technical staff members just below the senior levels are relatively few and inexperienced and have a high turnover rate.

A principal reason for this situation is the large disparity between government and private-sector salaries, sometimes as large as a factor of two or three. A young engineer with some environmental training will work for the government for several years, participate in training programs and seminars for government staff sponsored by donor countries, and then leave to join a local or international engineering firm at several times the previous salary. The government agency is then left with few trained and experienced staff members, who are called on to take on more and more responsibility with a minimum of support.

While the issue of inadequate staff is not unique to government environmental agencies, it places a special burden on the development of the relatively new environmental control programs in the region. It is not sufficient just to provide a training course to government staff; long-term, continuing technical support is also necessary. Until environmental agencies are mature enough to attract and retain competent staff, continual support from outside organizations will be needed to move environmental management programs forward. Examples of continuing support are the availability of regular contacts with technical agencies from developed countries (e.g., the U.S. Environmental Protection Agency [EPA]), the provision of contractor (either local or international) support to the environmental agency to assist in developing and implementing programs, and a continuing series of training efforts to upgrade skills and to train newly hired staff members.

2.2.3 Regulations

Most of the countries in this study have in place regulations that govern the handling of hazardous wastes. Some countries have copied regulations almost directly from similar regulations in the industrialized world. Others have developed special regulations to suit their own needs.

Many countries have no comprehensive survey or inventory of hazardous waste generation. In those countries that do have surveys, the information is frequently out of date and unreliable. The TDA-sponsored studies in Thailand, Malaysia, and Indonesia demonstrate the value of estimating the hazardous waste problem before developing regulations.

Countries in the region need to learn from the experience of the United States and other countries in the implementation of hazardous waste regulations. In some cases, the application of regulations has not been tested, and there is little knowledge of how to effectively apply what has been passed into law. Techniques include legal seminars by government agencies, seminars by law firms with international experience, and study programs abroad for country officials on the application of environmental law.

2.2.4 Enforcement

While there is no shortage of hazardous waste control regulations in the region, difficulty with enforcement is almost universal. Part of the problem relates to the staffing problems of government agencies mentioned previously. With low-paid government inspectors, it is difficult to maintain a staff with the expertise necessary to make good judgments on inspection visits.

Another major issue in enforcement is the legal basis for government inspection of industrial operations. Many countries do not have legal mechanisms for government inspectors to gain access to factories. For information on hazardous waste generation and handling, reliance must be placed on what factory operators report themselves. Numerous examples exist of under-reporting of both production levels and waste generated. The under-reporting is driven not only by a desire to conceal the extent of wastes, but also by a desire to avoid revealing information that might increase a factory's tax liability, which is based on its level of production. In several countries, it has been indicated that the latter issue is probably a bigger hindrance to effective enforcement than concern on the part of factory operators about the amount of wastes they generate.

In the development of a centralized hazardous waste treatment plant in Malaysia, the enforcement of hazardous waste control regulations was a major issue. One of the proposed plant contractors wanted some assurance that the government regulations would be enforced and thereby would ensure a profitable amount of waste throughput to the central treatment facility. This issue, along with some others, eventually led to a breakdown of negotiations and the resulting award of the project to another company.

2.2.5 Environmental Monitoring

Monitoring of ambient environmental conditions, such as air quality, water quality, soil contamination, and pollutant concentrations in food, is a major element of a hazardous waste control program. Monitoring is done both by government environmental agencies and by consulting firms as part of routine environmental observation or as part of environmental impact assessments and permit applications for specific industrial and other projects. Environmental monitoring in the region is spotty and sometimes lacking in quality control. In some countries, extensive networks of environmental monitoring equipment with trained staffs are available to collect, reduce, and analyze the data. In other countries, data collection is scattered and done only on a sporadic basis.

Because of the equipment-intensive nature of environmental monitoring efforts, there are ample opportunities for business development.

2.3 INDUSTRIAL COMPANIES AND WASTE GENERATORS

The industrial sector is the second major participant in hazardous waste control, as shown in Figure 2-1. The structure and size of the industrial production sector in a country determines the nature and extent of the hazardous waste problem. It is not possible to develop a coherent hazardous waste control program without an understanding of this sector.

2.3.1 Industrial Sector Structure, Size, and Location

The industrial sector varies significantly throughout the region. Singapore, the smallest of the countries studied, has a major petroleum refining industry but no other heavy manufacturing. In Hong Kong, many of the industries are small (fewer than 10 employees). Korea and Taiwan have large primary metals industries (e.g., steel). Thailand and Malaysia have high concentrations of electronics-based industries. China has a large and diverse industrial sector comprising both state-owned factories and thousands of small town and village enterprises.

Many of the countries have plants built by large, multinational corporations (MNCs). These facilities are located in the region to take advantage of skilled labor forces, low wage rates, and attractive investment incentives. Factories operated by the MNCs are generally viewed by the countries as being able to deal competently with their own waste problems. This view results from the availability of technical expertise and financial resources from the parent company to build and operate control equipment. The only issue is the willingness of the MNCs to invest in and operate hazardous waste control. Even this issue is rapidly disappearing as countries in the region begin to implement environmental control programs and as some of the corporate home offices of the MNCs begin to require their overseas operations to comply with stringent home country environmental regulations.

In terms of hazardous waste control, the most significant portion of the industrial sector in most countries is the large factories run by local companies (not MNCs), which lack expertise and awareness of waste control, and the small- and medium-sized industries, which have neither technical expertise nor financial resources for major environmental control. While each of these facilities contributes only a small portion to the overall hazardous waste problem, the aggregate is substantial and may result in serious environmental degradation even if all the large factories are controlled. Small- and medium-sized industries with significant hazardous waste problems include metal finishing and machining, leather tanning, textiles, and automobile repair shops.

The location of the industrial facilities also influences the hazardous waste control problem in the region. Many countries have industrial areas with a high concentration of manufacturing facilities. Examples are Kaohsiung in Taiwan, the Klang Valley in Malaysia, Surabaya in Indonesia, and Cebu in the Philippines. These areas can generate substantial hazardous waste problems for the local population; however, they also offer a opportunity

to gain an economy of scale in the location of centralized hazardous waste treatment facilities. Having a large number of waste generators relatively close together can reduce waste transport risks and costs, which can be significant when numerous small waste generators are in scattered locations.

In some countries, such as Thailand and Indonesia, the concentration of industrial facilities is even more centralized because of the availability of industrial estates. These estates are areas zoned for manufacturing operations. They offer special opportunities for controlling both hazardous waste and industrial wastewater. Treatment facilities, or in some cases, pretreatment facilities, can be built for factories at an industrial estate. The economy of scale would allow the factories to share the cost of a treatment facility that would be prohibitively expensive for any one of them alone.

In some countries, the location of industries is an element of the overall hazardous waste control program. New factories are restricted to areas that have been set aside for their type of operation. In some cases, existing factories are being forced to relocate to industrial zones in an attempt to gain better control of environmental discharges.

An important point regarding the structure of the industrial sector in Asia is that the rate of change is so rapid that industries that exist now may be dramatically different in as little as five years. For example, a country may now have electronic components assembly factories but may move to electronic components manufacture (with a different hazardous waste generation profile) in a short period of time. From the standpoint of the design of hazardous waste treatment programs, flexibility and adjustment to rapidly changing waste streams is a critical requirement.

The opinion was offered that the availability of centralized hazardous waste treatment facilities in a country may itself have an effect on the development and change of the industrial structure. Companies would have an additional incentive to develop manufacturing operations if it was recognized that their hazardous wastes could be treated economically and safely.

2.3.2 Production Technology

The production technology used in the region varies widely by country and by industry. In places where the industrial base is old and has been oriented to providing products for domestic consumption, the technology is often outdated and poorly maintained. Environmental controls are nonexistent. Many of China's industries, which have long been closed to outside investment, are examples of this situation. In areas of rapid growth, where products are targeted for export, the production systems are newer, use more modern manufacturing techniques, and are in a better state of repair.

One element of hazardous waste control that is only now beginning to appear in the region is the use of cleaner production technology. This technique, sometimes referred to as

pollution prevention, seeks to change the manufacturing process so as to reduce waste generation in the first place. In the United States, Japan, and Europe, environmental control regulations have been a primary motivating factor in the search for cleaner production technology. The U.S. EPA's Pollution Prevention Program is an example. It has been only within the last five years that the search for cleaner production technology for developing countries has been promoted. The UNEP Industry and Environment Program Activity Centre was established with the goal of identifying cleaner production technology and making information available to developing countries.

Pilot studies of cleaner production technology have been conducted in the region. Advanced color dye control in a textile factory in Thailand and a waste minimization effort in a printed circuit board factory in Taiwan are examples. There has not, however, been a major penetration of these systems into the region because the driver of environmental regulation is only now beginning to be felt. In addition, industrial operators are only now becoming aware that cleaner production technology frequently results in a more efficient, higher quality, and more profitable operation (especially if strict waste disposal regulations are enforced).

Clearly, the area of cleaner production technology is a fertile field for new hazardous waste control initiatives. It is an area where business opportunities may grow.

2.3.3 Waste Handling

In the absence of adequate hazardous waste treatment facilities, either on-site or off-site, the prevalent form of waste handling in the region is either to store the material on-site or to dump it somewhere else, including rivers, oceans, and improperly designed landfills. Industrial operators have no other choices.

There is no lack of anecdotal as well as documented evidence of uncontrolled dumping of hazardous waste. In China, it was reported that 1,800 drinking water wells had to be closed because of chromium contamination from metal-finishing operations. In the Philippines, hazardous materials have been discovered leaching from municipal waste landfills where industrial waste has been dumped. In Thailand, the Chao Phraya River and many of the canals in Bangkok are contaminated with industrial chemicals. Even in Papua New Guinea, a relatively unindustrialized area, hazardous chemicals from mining operations have resulted in significant fish kills and water contamination.

The more conscientious industrial operators store hazardous materials on-site in anticipation of a central treatment facility or until government regulations regarding the installation of treatment equipment become formalized. In Malaysia, where plans for a centralized hazardous waste treatment facility are moving along, there is a plan for the early opening of an interim storage facility to accept wastes from factories that are running out of storage space. In Thailand, one relatively simple central treatment facility is operating as a stopgap measure until decisions about a full-fledged treatment operation can be made.

The recovery and recycling of hazardous wastes in the region is only in its infancy because of the state of the environmental control regulations. Newly enacted legislation, combined with weak enforcement, has led to only sporadic attempts to implement recovery, recycling, or waste minimization programs. Where these programs have been implemented, the focus has primarily been on the larger facilities. Small and medium industries have not had much regulatory pressure or economic incentive to undertake these types of activities.

Some interest in waste exchange programs was expressed in some of the countries visited. In this type of operation, companies are matched up such that the waste produced by one company's operation can be used as a feedstock for another's. The Canadian experience with waste exchanges has been cited as a model.

It is reasonable to expect that as hazardous waste control programs and information systems mature, interest in recovery, recycling, exchange, and minimization programs will increase. Certainly, as companies begin to incur the cost of treating and disposing of their wastes, there will be ample incentive to develop these types of programs. This area of technological experience can result in business development.

On-site treatment of hazardous wastes appears to be an option that many industrial operators in the region are willing to consider. Although full-fledged on-site treatment and disposal facilities are within the economic reach of only the largest companies and are practical for treating only particular types and quantities of wastes, there is a measure of interest in this option. Companies will develop on-site treatment facilities if they anticipate government regulations that will require hazardous waste control and if they expect that they will be able to handle the wastes more economically with on-site facilities. As an indication of the potential for on-site treatment (as opposed to off-site, centralized treatment), the government has taken steps to allow for industrial facilities to do their own treatment even in countries where centralized treatment facilities are under development. For example, in Malaysia, where the waste treatment plant operator (a Danish consortium) has been given a 10-year monopoly on centralized hazardous waste treatment facilities, the government has made it clear that on-site treatment by industrial operators is acceptable. That is, factories may choose not to use the central treatment plant if they deal with their own wastes on-site in an approved fashion.

Another factor in the choice of on-site treatment is the clustering of industrial facilities. As mentioned previously, many countries have zones of heavy industrial concentration or industrial estates. There has been some investigation into having factories share hazardous waste treatment facilities. In addition to the economy of scale of this type of sharing, the location of hazardous waste treatment facilities on industrial property gets around public resistance to having centralized hazardous waste treatment facilities located in populated areas. The "Not-In-My-Back-Yard" syndrome is growing in the region.

One caveat regarding on-site treatment voiced in several countries in the region is the reliance on industrial operators to use the equipment properly. Examples were given with respect to wastewater treatment or air pollution control where industrial operators had

installed control equipment to meet government requirements but never operated the equipment. In effect, the equipment was used only as a showcase for visitors or inspectors. Given the relatively weak enforcement that currently exists in many places, it can be expected that hazardous waste control equipment may fall victim to the same situation.

Despite the possible problems, the use of on-site hazardous waste control equipment is another area of potential business development. On-site treatment is not as simple to deal with as a large, centralized waste treatment plant in which the government is the prime customer. Business opportunities must be explored with individual companies and, in some cases, individual factories.

2.3.4 Special Waste Issues: Infectious Waste and Municipal Waste

Infectious waste from hospitals and clinics is sometimes included in the list of hazardous wastes, although it is a special case. The unfortunate spread of the AIDS virus is prompting stricter regulation of infectious waste. All the countries in the region are attempting to deal with infectious waste in one of three ways: on-site incineration, centralized incineration facilities, or landfills. Many countries have small incinerators designed to handle small volumes of material at some hospitals and clinics. In one country, it was noted that much of this equipment was outdated, did not reach high enough temperatures to effectively destroy the material, and was not operated by qualified personnel. There have also been reports that the existing equipment results in high emissions of heavy metals and organics, which come primarily from improper incineration of the highly plasticized waste stream. Options being considered include replacement of the equipment, installation of a central incineration facility, or a combination of both.

Handling of infectious waste is an area for possible business development. It is a simpler issue in that the waste generators are more easily identified and controlled; however, regulatory development is in a state of rapid change.

Municipal solid waste is another special waste issue. Although some studies have indicated that municipal solid waste is frequently contaminated with hazardous materials (e.g., household chemicals, used batteries, or commingled industrial waste), contamination is not the major issue to be addressed. Instead, the issue is the sheer volume of waste and the development of effective waste collection and disposal systems. The oft-cited "Smokey Mountain" municipal waste dump in the Philippines is an example of the extent of the problem. Not only is the site running short of space, but scavengers who make their living picking through recently unloaded piles of waste that contain infectious material, biological pathogens, toxic materials, and injury-producing broken glass and metal are exposed to direct health hazards.

2.4 ENVIRONMENTAL COMPANIES

Environmental companies are the third major participant in hazardous waste control, as shown in Figure 2-1.

2.4.1 Environmental Engineering and Consulting Services

Until recently, environmental engineering and consulting services were virtually nonexistent in the region. Foreign professionals provided by donor agencies and by private companies were the sole source of expertise. While this is still the case with regard to some of the more advanced environmental control issues (e.g., high-temperature hazardous waste incineration), it is no longer a general situation in much of Asia.

As a new generation of engineers and scientists with degrees in environmental engineering, many of whom have trained abroad, has entered the Asian work force, the number of new environmental companies has grown. Some companies build from a base of experience with civil engineering projects and extend their services into the environmental field. Because many countries now require an environmental impact assessment for all new major projects, these companies have expanded their technical staffs to deal with environmental issues.

While the level of environmental experience is not the same as in the United States, Japan, Australia, or Europe, it is growing rapidly. For example, in Thailand, where a centralized hazardous waste treatment plant is under consideration, the general thought is that local companies would deal with most of the conventional parts of the project (e.g., the civil works, the chemical/physical treatment, the landfill) while foreign expertise would be brought in to deal with new areas (e.g., high-temperature incineration). Another example is a joint venture in Indonesia, where a local firm and a Dutch firm have combined to offer integrated services for industrial waste management that include everything from consulting to equipment installation.

The developing environmental service industry in the region requires foreign companies to take a different approach to cooperative projects. It is no longer acceptable to plan a project with full reliance on expatriate staff. Not only is local participation sometimes required by the government, but there is a growing reservoir of local expertise that can and should be tapped. A frequently heard complaint is that most of the funds in donor-funded projects are used for foreign contractors and only token amounts are used for local firms.

Another, more subtle issue has arisen in working with local environmental companies. In a number of countries, some firms have been identified as having close contacts with government decision makers. In several places, it was heard that one foreign contractor or another had won a particular bid because it was teamed up with the best-connected local company. This style of operation is frequently the result of the government having developed confidence in a company and preferring to have important projects sent to

that company. In several cases, the government has actively underwritten the development of a local environmental company in the interest of expanding local expertise. Whatever the motivation, it is necessary for foreign companies to know the idiosyncracies of this type of business operation in the region and respond accordingly.

2.4.2 Off-Site Hazardous Waste Handlers

Off-site hazardous waste companies specialize in the collection, transport, treatment, storage, and disposal of hazardous wastes away from the waste-generating industrial operations. Only a few of these companies now operate in the region. One company operates a simple treatment and disposal facility in Thailand. Local companies, affiliated with foreign companies experienced in waste handling, are beginning operations as part of planned centralized treatment plants in Hong Kong, Taiwan, Malaysia, and Indonesia. In Singapore, waste handlers are licensed by the government, but they deal only with very specialized aspects of the business.

As waste treatment operations expand in the region, there will, no doubt, be more commercial waste handlers. Foreign firms may be partners in some of these operations, but probably under the same terms as were described previously for the environmental engineering service firms. That is, the foreign companies will need to develop partnerships and joint ventures with local companies in order to succeed. All firms currently doing this type of business in the region are set up in this fashion.

A major issue that arose during the review was the operation of waste handling companies by the private sector. Many of the governments in the region have decided to encourage private-sector involvement in this area. They see an opportunity to control environmental problems by using private-sector financing instead of public funds. The waste treatment facilities in Malaysia and Indonesia are to be built and operated by private companies. The government would be involved only in setting operational standards to ensure public health protection or, as in the case of Indonesia, as a part owner providing land and feasibility study costs.

Despite this seemingly pleasant situation for all involved (the government does not have to spend tax money, the private sector has a profitable operation, and the industrial sector has someone else to handle their wastes), problems have arisen. A primary difficulty has been the extent to which waste handling will truly be a private business. In some cases, the government has insisted on retaining the ability to regulate the prices of waste handling services in the interest of not posing too large an environmental cost penalty on local industry. Waste handling companies have responded with requests for throughput guarantees if prices are to be controlled. In some instances, they have explored the possibility of importing wastes from outside the country to ensure a profitable throughput level. This is, of course, an extremely sensitive political issue that raises substantial public reaction. The United Nations Basel Convention on the transboundary movement of hazardous wastes also seeks to control this type of activity.

As a number of countries in the region still operate with a significant degree of centralized control of the economy, it is no surprise that the issue of privately operated hazardous waste handling companies results in a sometimes curious mix of government and private-sector operation.

2.4.3 Site Remediation Services

Companies that specialize in the cleanup of sites contaminated with hazardous materials are common in the United States and Europe. In Asia, however, there is very little local expertise in this area. One reason for this lack of expertise is that very little work has been done even to identify contaminated sites in many countries. Given the current way of handling much of the hazardous waste in the region (i.e., either storage or dumping), there can be little doubt that many contaminated sites will eventually need to be cleaned up. Although the current emphasis is on day-to-day waste generation, within a relatively short period (five years or so), the issue of site cleanup will become a high priority. In some of the more advanced economies, such as Taiwan, the issue is already on the agenda.

2.5 RESEARCH ORGANIZATIONS

Research organizations in the region have become more involved in hazardous waste work control. As shown in Figure 2-1, they are involved with all the other participants in a country's hazardous waste program.

In a number of studies, a local research organization (e.g., a university, government research laboratory, or private research institution) was involved in the work. Although local research organizations may not have the same level of funding, skilled professional staff, and equipment as their foreign counterparts, they have sufficient resources to make them a significant participant in hazardous waste control. Further, many countries are actively working to improve their research establishments and will direct funding to them to enhance their expertise.

Local research organizations can play an important role in the field of adaptive research, that is, the research needed to modify an existing piece of equipment or a process for local conditions. Such research is needed when technology that was developed for use in the United States, Japan, Australia, or Europe must be made to work under very different climatic conditions (e.g., high temperatures and humidity in the tropics), limited maintenance conditions, or different performance requirements. Local research organizations are particularly well suited for this type of work.

Another area in which local research organizations are working is site assessment, an area typically dominated by engineering and consulting firms. Local groups generally have a better insight into issues of local geography, hydrology, microclimate, ecology, and other aspects that would affect the siting of hazardous waste facilities than would foreign

companies. Because many countries now require environmental impact assessments for all major projects, local research organizations are gaining experience in this type of work.

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3 COUNTRY PROFILES

This section provides reviews of the hazardous waste situations in the following countries:

- China,
- Hong Kong,
- Indonesia,
- Korea,
- Malaysia,
- Papua New Guinea,
- Philippines,
- Singapore,
- Taiwan, and
- Thailand.

Of necessity, the level of detail differs from one country to another. A relatively uniform structure has been attempted in all the country profiles.

CHINA

CONTENTS

FIGURE

TABLE

CHINA

1 BACKGROUND

China is the largest country in the world; it has a population in excess of 1.1 billion people. Economic policy changes have led to significant growth in the country. The gross domestic product (GDP) grew by 6.8% per year from 1965 to 1980 and by 9.5% per year from 1980 to 1990. The industrial portion of the GDP grew from 35% in 1965 to 42% in 1990. Figure CHI-1 is a map of China.

Although Chinese industry is a rapidly growing portion of the economy, much of the industrial infrastructure is old and uses outdated equipment. Some of the newer factories are equipped with modern production machinery, but these are relatively few in number. Extensive environmental control is not widely used in Chinese factories.

2 HAZARDOUS WASTE ISSUES

2.1 HAZARDOUS WASTE PROBLEMS

2.1.1 Sources

No comprehensive, national survey of hazardous waste generation has been done in China. Most of the work done to date has been limited to surveys in specific cities or regions. Extrapolation of the existing hazardous waste generation data to national levels has resulted in estimates of 35-75 million tons per year (Shi and Cheng 1987; Liu and Ke 1992; Liu 1993).

Because of the diversity of the Chinese industrial sector and the lack of comprehensive surveys, it is not possible to detail the rate of hazardous waste generation with any degree of accuracy. On the basis of problems identified, it is safe to say that the largest sources of waste are the chemical, primary metals, metal finishing, textile, and leather processing industries.

One of the major hazardous waste sources is the small industrial operations in the rural areas and small townships of China. These operations, called Town-and-Village Enterprises (TVEs), have been established to promote industrialization in the rural areas. They are primarily labor-intensive operations with minimal capital investment and relatively simple industrial technology. Generally, no environmental control equipment is used in these operations, and the waste discharges, some of which are hazardous, are released untreated into the surrounding watersheds and land areas. No systematic survey of waste generation exists, but it is expected that the aggregate is substantial (Jalal 1990).

FIGURE CHI-1 Map of China

2.1.2 Location

Large industrial operations are concentrated in several major urban areas in China. These areas also have the most significant problems with hazardous waste. The areas with heavy industrial concentrations include Beijing, Shenyang, Jingzhou, Tianjin, Baotou, Shanghai, Chentu, Hunan, and Jiangxi. (See map in Figure CHI-1.)

2.1.3 Problems

Numerous hazardous waste problems at various locations in China have been reported. Specific problems resulting from uncontrolled discharges from individual plants include the following:

- Groundwater contamination
  - levels 900 times greater than the drinking water standard in one area,
  - water supply curtailed for five years in one location, and
  - 1,800 drinking water wells closed in one province.

- Health effects
  - ear and other tissue perforation in workers,
  - chest pain and diarrhea in farmers,
  - multiple poisoning cases, and
  - cancer fatalities near plant.

The anecdotal information indicates a significant problem at many sites in the country. Complete statistical data, however, are not available.

A hazardous waste problem of special significance in China is the treatment of chromium-containing residues. These wastes are generated primarily from metal processing and finishing operations. In addition to the waste generated from ongoing manufacturing operations, piles of solid wastes have been leaching chromium compounds. The issue is significant enough that specific regulations aimed at controlling chromium-containing wastes have been developed.

2.2 GOVERNMENT STRUCTURE FOR DEALING WITH HAZARDOUS WASTE

2.2.1 Agency Structure

The principal agency for dealing with hazardous waste at the national level is the National Environmental Protection Agency (NEPA) (see Table CHI-1). The Solid Waste Management Division has the line responsibility. Although NEPA reports to the State Council,

TABLE CHI-1 Organization of the National Environmental Protection Agency

DEPARTMENT	RESPONSIBILITIES
Law and Policy	Legislation Policy research
Planning	Program planning Information Investment Finance
Science and Technology	Research Standards Equipment
Pollution Control	Air Water Solid waste Noise Marine pollution Urban environment
Development and Monitoring	Development Radioactivity Monitoring Pollution charges
Nature	Nature protection Rural issues
Information and Education	Information dissemination Education programs News
Human Affairs	Personnel issues
Foreign Affairs	International cooperation
Administration	Administrative affairs Finance Secretariat Public security

Source: Adapted from Ma (1993).

the primary ruling body of the country, it is not at the same level as other ministries. The elevation of NEPA to full ministerial status has been discussed, but this has not yet been implemented, and the final resolution of this issue is uncertain.

The Environment Protection Commission of the State Council is a senior advisory group that sets overall environmental policies for China. The Commission has more senior authority than NEPA and provides the general policy guidelines under which NEPA operates.

The NEPA has the responsibility for preparing environmental regulations and legislation to be passed into law by the State Council. Enforcement of the regulations, however, is not within NEPA's general mandate. Instead, enforcement is left to the environmental agencies of the provinces, municipalities, and other local units.

2.2.2 Legislation

The Environmental Protection Law of the People's Republic of China (EPL 1990), adopted in December 1989, provides the basic regulatory framework for environmental control. It outlines the basic policies of environmental protection and adopts a "polluter pays" principle.

The other major legislation relating to hazardous waste is the Regulations on the Safe Management of Hazardous Waste of 1987. These rules cover the production, use, storage, management, transportation, and packaging of hazardous chemicals. Although there is some reference to the management of hazardous waste, the issue is not comprehensively addressed. New regulations relating specifically to the treatment of hazardous waste are under development.

Other laws and regulations relating to hazardous waste are as follows:

- Regulations on the Management of Safe Production for the Medium and Small-Size Chemical Plants,
- Rules on the Management for Storage of Hazardous Chemicals,
- Regulations on the Safe Use of Pesticides,
- Rules on the Prevention of Environmental Pollution by Power Devices Containing Polychlorinated Biphenyls and Their Relevant Wastes,
- Rules on the Prevention and Control of Environmental Pollution in the Production and Construction of Chromium Compounds,
- Management Regulations on the Prevention and Control of Environmental Pollution by Tailings, and

- Circular on the Strict Control of Transboundary Movements of Hazardous Wastes in China.

These regulations are designed to control specific hazardous chemical and waste problems (e.g., polychlorinated biphenyls [PCBs] and chromium compounds).

2.3 CURRENT HAZARDOUS WASTE ACTIVITIES

2.3.1 Shenyang Waste Treatment Facility

In 1989, the U.S. firm Ecology and Environment, sponsored by the U.S. Trade and Development Agency (TDA), carried out a survey of hazardous waste generation for the area surrounding Shenyang, the capital of Liaoning Province (Chelsea 1986; E&E 1989). Shenyang is China's sixth largest industrial center. The study was done in anticipation of the need to protect the city water supply from industrial wastes. The study provided the first systematic survey of hazardous waste generation in China. The waste survey was updated in 1992 and showed generation rates in the range of 160,000 tons per year. Much of the waste is from three industrial operations: a paper mill and two smelters.

Implementation of the recommendations of the project has been slow. A site for a first-stage secure landfill has been selected south of the city. The Shenyang municipal government, which will operate the facility, is making decisions on what types of waste will go into the landfill. A second-stage incinerator is also under consideration.

This project is included in China's Eighth Five-Year Plan. Financing for the first stage of the project includes a $5 million loan from the World Bank. The beginning of construction is awaiting loan approval. Start-up of the landfill is planned for 1995.

2.3.2 Wuxi City Landfill

A secure landfill to serve Wuxi City in Jiangsu Province is also included in the Eighth Five-Year Plan (Liu 1993). The landfill is to be designed to receive 10,000 tons of waste per year. One of the primary factors dictating the need for the landfill is the concern over protecting Lake Taihu, which serves the city. Work is beginning on site selection and landfill design.

2.3.3 Other Projects in the Eighth Five-Year Plan

A number of other hazardous-waste-related projects are included in China's Eighth Five-Year Plan, as follows (Ma 1992):

- Research on the use of chromium residues: This effort is designed to deal with the continuing problem of chromium wastes. It will investigate the use of chromium residues as a fusing agent in smelting, as road construction material, and in other applications.

- Research on the use of electroplating sludge: This project will consider recovery techniques for heavy metals, use of sludge in leather tanning, and use of biological treatment for the sludge.

- Incineration of hazardous waste: Use of cement kilns as waste incinerators and the incineration of PCBs are included in this activity.

As a result of their inclusion in the Five-Year Plan, funds have been designated for these projects.

2.3.4 Beijing Area

The Beijing municipal government is beginning the process of evaluating hazardous waste facilities. The methodologies of the Shenyang study are being used, and some preliminary design is under way. Details are not available.

2.3.5 World Bank Projects

The World Bank program in China involves about $2 billion in next three to four years. Twelve environmental projects are included. About one-third of these involve investment in capital equipment. Some of the projects have hazardous waste management components. Progress toward implementation, however, has been a long, time-consuming process.

Beijing is one of the cities participating in the Metropolitan Environmental Improvement Program of the World Bank. The project is described in Section 4.

2.3.6 China's Agenda 21

In response to the United Nations Conference on Environment and Development held in June 1992, China has been preparing an environmental activity plan (SSTC 1993). A major

topic included in the plan is the control of industrial wastes. Although general in its descriptions, the plan calls for three major activities in hazardous waste control:

- A national survey of waste generation,
- Promotion of cleaner production technology, and
- Formulation of comprehensive hazardous waste legislation.

Other activities specified include the strengthening of research efforts, the use of demonstration projects, and international cooperation.

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HONG KONG

CONTENTS

FIGURE

HONG KONG

1 BACKGROUND

Hong Kong is a heavily industrialized city-state currently operating as a British Crown Colony (see Figure HK-1). The current agreement between the United Kingdom and China calls for the colony to revert to full Chinese control in 1997. The manner in which Hong Kong's thriving economy will function under Chinese authority is somewhat uncertain. The stated position is that the free market system in Hong Kong will be preserved, in contrast to the centrally planned economy on the mainland.

With a per capita gross domestic product (GDP) of $11,490 and a growth rate of 6.2% in the period of 1965-1990, Hong Kong has emerged as one of the high-income countries of the world. With a population only 2.3% of that of the United States, it has achieved a per capita GDP of more than half that of the United States. Services make up 73% of the GDP, and industry accounts for 26%. There is very little agriculture because of the shortage of land.

2 HAZARDOUS WASTE ISSUES

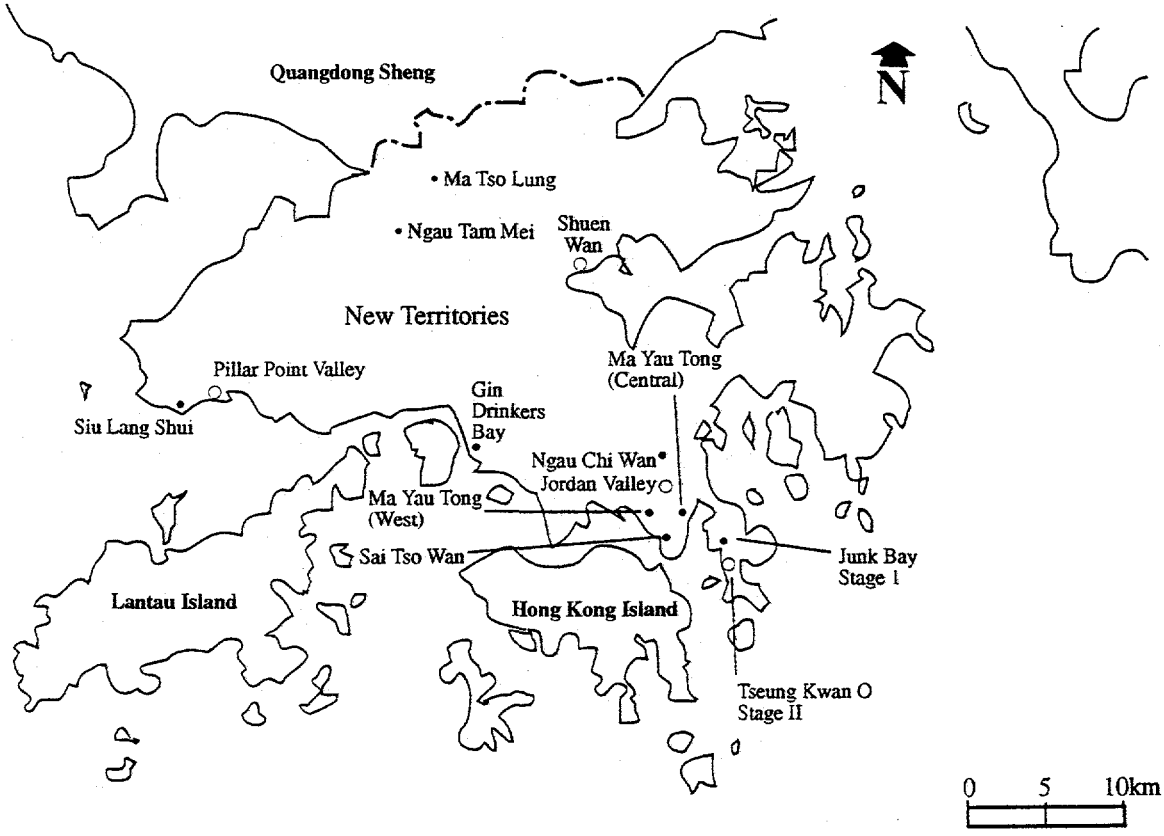
2.1 HAZARDOUS WASTE PROBLEMS

2.1.1 Sources

Light industry is the major component of Hong Kong's industrial base. The largest industrial sectors include textiles, electronics, plastics, metal products, jewelry and watches, optical goods, appliances, and shipyard repairs. About 90% of Hong Kong's manufacturing products are exported (Nash et al. 1989).

There are about 50,000 industrial establishments in Hong Kong. About 11,500 are considered to be potential hazardous waste generators. The quantity of hazardous wastes generated in 1989 was estimated to be 105,000 metric tons per year (HKEPD 1990). Information for 1992 showed an increase to 120,000 metric tons per year (Lei and Yang 1993).

The largest components of the hazardous wastes are in the form of acids and alkalies, copper-containing solutions, and oil/water mixtures. These wastes are typical of the types of industries that are prevalent in Hong Kong.



Legend

Year of Landfill
Closure Site

1975	Ngau Tam Mei	1981	Ma Yau Tong (West)
1977	Ngau Chi Wan	1983	Siu Lang Shui
1979	Ma Tso Lung	1986	Ma Yau Tong (Central)
1979	Gin Drinkers Bay	1989	Junk Bay Stage I
1980	Sai Tso Wan		

○ Operational Landfill
• Completed Landfill

FIGURE HK-1 Map of Hong Kong

A sizable fraction of Hong Kong's industry is in the form of small operations. One analysis showed that about 85% of the industrial establishments employ fewer than 20 workers, and 95% employ fewer than 50 workers (Stokoe 1990).

2.1.2 Location

The majority of Hong Kong's manufacturing establishments are located in multi-story industrial buildings. A typical building could hold up to 680 establishments with floor areas ranging from 25 to 2800 square meters (Stokoe 1990).

Some industrial districts exist in which industrial buildings have been concentrated. However, because of the shortage of land throughout the entire colony, a general mix of industrial, commercial, and residential buildings exists in many areas.

2.1.3 Problems

The most significant hazardous waste problem in Hong Kong is the small-scale nature of the majority of the industrial facilities. The small size severely restricts the use of any on-site hazardous waste treatment equipment because of the high cost relative to the overall expenses of the establishment. Also, because many of these operations come and go in response to rapid fluctuations in the market for the goods produced, their short lifetime works against investment in capital-intensive pollution control equipment.

The lack of available floor space for pollution control equipment exacerbates the problem. Even if industrial operators wish to install control devices, there is no space in which to locate them next to the production equipment. Specially designed equipment must be built to fit within space limitations. This necessity further increases the cost.

The lack of floor space also severely limits the amount of waste material that can be stored on-site. Operators generally dump liquid wastes into the municipal drain and put solid wastes out for disposal with other, nonhazardous material to be dumped at the municipal landfills. No facility is available to receive and process hazardous waste, and operators have had little choice but to dump these materials.

2.2 GOVERNMENT STRUCTURE FOR DEALING WITH HAZARDOUS WASTE

2.2.1 Legislation

The primary piece of legislation that controls waste in Hong Kong is the Waste Disposal Ordinance of 1980 and its subsequent revisions. The Waste Disposal (Chemical Waste) (General) Regulation is the specific part of the ordinance that controls hazardous waste (referred

to as "chemical waste"). These regulations were announced in May 1992 and took effect in November 1992.

The regulations specify a set of chemicals that are considered to be potentially hazardous to health and/or the environment. They also specify a number of waste-producing streams from industrial, service, and general processes and activities. Any facility that generates one or more of the listed chemicals in one of the listed waste streams must register with the Hong Kong Environmental Protection Department (HKEPD).

Pending the opening of a central hazardous waste treatment plant (scheduled for 1993), *only* minimal requirements for the handling of their hazardous wastes are placed on industrial operations. Selected wastes can be sent to a government-operated landfill for codisposal with municipal waste in a controlled fashion, but there is no general requirement that all hazardous waste producers use this facility.

The regulations do set up the process for establishing a "cradle-to-grave" monitoring system for all hazardous wastes. Generators, transporters, and waste treatment operators must all maintain complete records on the movement of hazardous wastes.

2.2.2 Agency Structure

The HKEPD was created as a full-fledged department of the Hong Kong government in 1986. It consolidated a number of environmental policy, regulation, and enforcement functions from its predecessor organization, the Environmental Protection Agency, and a number of other government departments. The HKEPD now has full responsibility for dealing with the implementation of the Waste Disposal Ordinance, its associated regulations, and other legislation that deals with hazardous waste control.

The HKEPD has three major divisions: Waste and Water, Air and Noise, and Administration. It is also expanding its groups in policy and control that cover all media. Environmental planning and assessment groups and an environmental education group are also being developed. The Waste and Water Division has the primary responsibility for hazardous waste programs. The Director of the HKEPD reports to the Secretary for Planning, Environment, and Lands, which is the cabinet-level position in the government with environmental responsibility.

The HKEPD is a well-staffed and well-trained agency. A great deal of technical support has been received from the British government.

2.3 CURRENT HAZARDOUS WASTE ACTIVITIES

2.3.1 Existing Hazardous Waste Management

Pending the opening of a new central hazardous waste treatment plant (described in the next section), the current method of dealing with hazardous waste in Hong Kong is codisposal with municipal waste. Landfills at Tseung Kwan O and Pillar Point Valley (see Figure HK-1) are used for codisposal. Hazardous wastes are mixed with municipal wastes in special cells of the landfills. The cells are segregated from the general sections of the landfill and are monitored for leaching of the hazardous material.

The assumption behind the use of codisposal is that mixing certain hazardous wastes, primarily organic chemicals, with municipal refuse will result in long-term decay and destruction of the material. The bacteria and other chemicals in the municipal refuse will contribute to the breakdown of the hazardous chemicals. Tests run in the United Kingdom and other places support some of these assumptions. There is, however, a great deal of dispute over the efficacy of this practice because of the wide variability in the composition of municipal refuse and its reactions with many different types of hazardous waste. Certain wastes, such as those containing heavy metals, are not good candidates for codisposal because they will not be broken down by natural processes. The Hong Kong landfill sites screen incoming wastes in an attempt to prevent these noncompatible waste materials from being codisposed.

One unique feature of the current system in Hong Kong is that there is no charge to waste generators for using the codisposal sites. Industrial operators can even request technical assistance from the HKEPD to evaluate their waste streams and to assist in the codisposal operation. The philosophy behind this approach is twofold. First, the Hong Kong government wants to avoid placing any undue burdens on industrial operators, which are a major contributor to the economic growth of the colony. Because many of the operators are small, any significant charge for waste disposal could become a major cost item. Second, lacking any other reasonable alternatives, the waste generators would be more likely to simply dump their wastes into municipal drains rather than pay any substantial disposal fees. The nature of the industrial operations in Hong Kong would make the policing of this activity virtually impossible.

Selected hazardous wastes are handled in special ways in Hong Kong. Polychlorinated biphenyls (PCBs) are shipped to the United Kingdom for incineration. When the new central treatment plant becomes operational, they will be handled locally. Asbestos is disposed of in the landfills in specially isolated cells.

2.3.2 New Central Waste Treatment Facilities

Hong Kong is now slated to have the first fully integrated hazardous waste treatment facility in Asia. Referred to as the Central Waste Treatment Centre (CWTC), the plant is located on Tsing Yi Island. The contract for the facility was signed in 1990 with Enviropace,

Ltd., which is affiliated with a U.S. firm, Waste Management International. The plant went on-line in April 1993. By August, it had reached 30% of operating capacity. Full-capacity operation is expected in about two years (Lai 1993). The CWTC contains physical and chemical treatment processes, oil/water separation equipment, a rotary kiln incinerator for organic wastes, and chemical stabilization processes for residues.

The bidding process for the facility was more detailed than usual for a Hong Kong government project. The design and performance specifications for the facility were developed by the HKEPD over about a five-year period. The potential contractors were asked to provide increasing levels of detail and commitment to performance specifications as the bidding process progressed. Out of initial responses from 13 bidders (including consortia that represented 50 individual companies), 9 were invited to submit tenders. Six bids were received. In the end, the U.S. firm won the bid as it was the only contractor willing to meet the performance requirements set by the HKEPD. Because of the strong technical input to the design requirements by the HKEPD, it appears that superior technology was the deciding factor in the choice of the company.

The contractual terms for the CWTC represent an interesting and somewhat unusual approach for this type of operation. The agreement calls for the contractor to finance, build, and operate the facility for 15 years. During that time, the Hong Kong government will pay the company a fee designed to amortize the capital cost and provide operating revenue. The fee will be based on a complex formula that depends on the quantity and type of waste to be treated. The government will guarantee the contractor a minimum annual fee for operating the facility. In addition to operating the CWTC, the contractor is to provide pickup and transport services for hazardous waste and chemical spill emergency response capability.

The approach taken in Hong Kong means that the waste generators do not pay directly for the waste collection, treatment, and disposal services. These services are provided by the government at no direct cost to the industrial operators. The reason for this approach again relates back to the generally small size of Hong Kong's industries. The feeling was that imposing a user charge for hazardous waste treatment would only discourage use of the CWTC, encourage illegal and uncontrolled dumping of wastes, and impose undue economic burdens on the small-business operators. As a means of raising the necessary revenue to operate the CWTC, the government is considering a wide range of taxes and fees, such as a registration fee for waste generators, taxes on chemicals either imported or produced locally, and general industrial taxes.

From the perspective of a private company building and operating a central hazardous waste treatment plant, this type of contractual arrangement is attractive because it minimizes the business risk. From the standpoint of environmental control, it can be argued that this approach does not provide any incentives for minimizing waste generation. This argument must, however, be viewed in light of the nature of Hong Kong's rather unique industrial structure (i.e., primarily small businesses). In either case, the Hong Kong approach will provide an interesting case study as compared with the direct charge approach being taken elsewhere in the region.

2.3.3 Site Cleanup

Little work has been done on identifying and cleaning up sites contaminated with hazardous waste in Hong Kong. Because most of the uncontrolled dumping goes into municipal drains (which eventually dump into the ocean) and into municipal landfills, the landfills themselves may be the largest potential problems. Contamination of the Hong Kong harbor and surrounding near-shore areas of the ocean by hazardous wastes is another potential problem.

2.3.4 Cleaner Production Technology

No structured programmatic effort exists in the HKEPD to promote the use of cleaner production technology. The work of the Hong Kong Productivity Council (HKPC) comes closest to dealing with these issues.

2.3.5 Infectious Waste

In Hong Kong, infectious waste is currently disposed of in hospital incinerators (25%), municipal incinerators (35%), and landfills (40%) (HKEPD 1991). The latter two methods are considered unacceptable. A feasibility study for the development of a dedicated infectious waste incinerator was begun in 1991. The proposed site for the facility is to the west of Tuen Mun. Results of the study are expected early in 1993.

2.4 OTHER RELATED ACTIVITIES

The HKPC was established in 1967 to provide technical support, research and development, and training to Hong Kong's industries. Its staff now numbers more than 400. It is funded partially by the Hong Kong government and partially by its consultancy work.

One of the major activities of the HKPC has been in the area of environmental protection. Its role has been to identify solutions to environmental problems for Hong Kong businesses. In some cases, this has involved identifying environmental problems and assisting in the selection and implementation of pollution control equipment. In other cases, this has involved the research and design of special equipment to meet specific needs. Equipment that fits into very tight space restrictions has been one of the major areas of effort. The HKPC also conducts training courses for industrial operators on environmental control and compliance with environmental laws and regulations.

One of the areas in which the HKPC has had some success is the identification and implementation of environmental control equipment and process changes that improve overall productivity. Industrial operators are more likely to accept this type of environmental control because it simultaneously improves profitability.

The HKPC has collaborated with a number of international organizations, particularly in its research and development activities.

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INDONESIA

CONTENTS

FIGURES

TABLE

INDONESIA

1 BACKGROUND

The Republic of Indonesia consists of a group of about 13,700 islands lying between the mainland of Southeast Asia and Australia. The archipelago is the largest in the world, and it stretches from the Malay peninsula to New Guinea. The principal islands are Java, Sumatra, Kalimantan (Borneo), Sulawesi (Celebes), Irian Jaya (West New Guinea), the Moluccas, and Timor (see Figure INDO-1). Indonesia's land area is approximately 735,000 square miles, and its 1991 population was about 193 million. The climate is tropical, with an annual average temperature of 79°F and heavy rainfall during most seasons.

In the early stage of industrialization in Indonesia, the government promoted the construction of industrial facilities, such as fertilizer plants and oil refinery complexes. These plants were built on a turnkey basis and equipped with industrial waste treatment facilities. However, environmental problems began to emerge in the early to mid-1980s, when the government started to reduce its role as the agent of development and the private sector began to participate in industrial development, particularly in manufacturing industries. As the pace of industrialization accelerated during the latter part of the 1980s, environmental problems, including those of hazardous wastes, became more serious.

2 HAZARDOUS WASTE ISSUES

2.1 HAZARDOUS WASTE PROBLEMS

2.1.1 Sources

Environmental problems caused by industrial waste discharges have been identified through several environmental protection programs launched by the government of Indonesia. Hazardous waste problems in Indonesia have not been well documented, however, because an accurate definition of hazardous waste has been lacking. An inventory of hazardous waste generation for major cities in Indonesia was initially prepared by the former Ministry of Population and Environment (KLH is the Indonesian acronym) in 1983-1984 and updated annually; however, its reliability is questioned. Detailed inventories of hazardous waste for nine metropolitan/industrial locations in the country are currently in progress and scheduled for completion in 1993-1994.

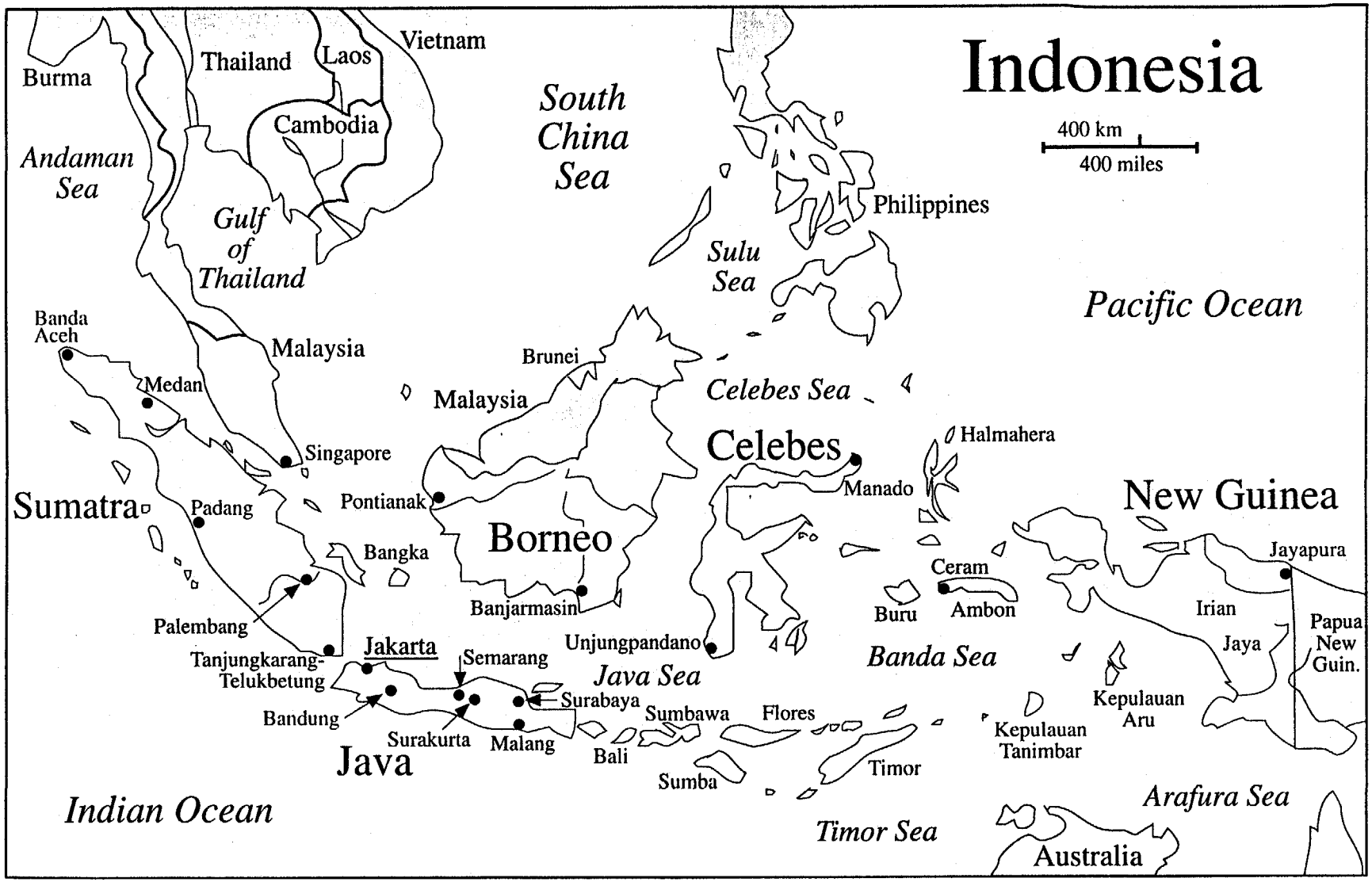

FIGURE INDO-1 Map of Indonesia

Several other environmental studies to estimate the quantities and pollutant contents of wastes were also conducted in the past. However, the only reliable data are those for the Jabotabek[1] and GKS[2] regions (see Table INDO-1). The total estimated hazardous waste generation rates are approximately 352,000 cubic meters per month and 7,500 tons per month for the Jabotabek and GKS regions, respectively. The major source categories of these wastes are fabricated metal products, machinery and equipment, and food, beverages, and tobacco for the Jakarta area, and chemicals, petroleum, coal, rubber and plastic products, and basic metal industries, including iron and steel industries, for the GKS region (Indriyanto, undated).

2.1.2 Location

Industrial activity is concentrated in nine areas in Indonesia: (1) Cibinong, Jabotabek region in West Java; (2) Cerme, GKS region in East Java; (3) East Kalimantan; (4) Lhokseumawe, Aceh region in North Sumatra; (5) Batam, Riau region in Central Sumatra; (6) Palembang in South Sumatra; (7) Medan in North Sumatra; (8) Central Java; and (9) Cilegon in West Java.

The textile, metal, and metal finishing industries are concentrated in Java and Sumatra. The leather tanning industry is located mostly in Java; the pulp and paper industries are located mostly in Java and Sulawesi. More widely spread industries include the cement and food industries. Cement facilities are located in Java, Sumatra, Sulawesi, and Timor, and food processing facilities are scattered throughout the country with medium- and large-scale plants located near large cities (Indriyanto, undated).

2.1.3 Problems

The Indonesian government has taken the initiative in recent years to regulate industrial waste discharges. However, environmental management in Indonesia has been hampered by numerous constraints, such as overlapping regulatory authorities among government agencies and a lack of clear definition of those authorities; lack of detailed regulations, including discharge permit programs; insufficient financial resources for the government agencies, which result in a shortage of qualified environmental staff and inadequate monitoring programs and enforcement; and a low level of public awareness. Public concern about potential health problems associated with hazardous wastes is increasing, however, and citizens are beginning to report apparent pollution problems to the authorities.

No systematic studies on potential environmental or health problems related to hazardous wastes in Indonesia have been conducted to date. However, a study is being planned

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[1] Jabotabek is the acronym for Jakarta, Bogor, Tangerang, and Bekasi.

[2] GKS is the acronym for Gerbangkertosusila, which in turn is an abbreviation for Gresik, Bangkalan, Mojokerto, Surabaya, Sidoarjo, and Lamongan.

TABLE INDO-1 Hazardous Waste in the Jabotabek and GKS Regions

Industry	Hazardous Waste Generated			
	Jabotabek Region		GKS Region	
	Number of Plants	Cubic meters per month	Number of Plants	Tons per month
Food, beverages, tobacco	10	59,265	25	63
Textile, wearing apparel, leather tanning	9	8,436	10	382
Wood and wood products	5	2,251	10	29
Paper, paper products, pulp	1	1,110	9	13
Printing and publishing	11	9,179	5	5
Petroleum refining	-	-	5	359
Chemicals	23	24,081	64	4,238
Plastics	4	45	-	-
Glass and ceramics	6	37,980	21	67
Iron and steel	7	36,681	18	1,663
Auto components, electroplating, electronics	34	166,035	47	641
Others	7	7,061	9	37
Total	117	352,124	223	7,490

Source: Adapted from Dames & Moore (1990), CH2M Hill (1990), and Makarim (1990).

that will investigate potential health effects on workers engaged in recycling of imported, used batteries.

2.2 GOVERNMENT STRUCTURE FOR DEALING WITH HAZARDOUS WASTE

2.2.1 Legislation

Three types of environmental regulations are currently in place in Indonesia: government regulations, presidential decrees, and ministerial decrees. Although government regulations for hazardous substances do exist, those proposed for hazardous waste management have been reviewed by related ministries and are in the Office of the Cabinet Secretary awaiting endorsement by the President. The regulations are expected to include a list of industries generating hazardous wastes, a definition of the constituents of hazardous wastes, and technologies and procedures for hazardous waste treatment. They will also require segregation of hazardous waste from other general wastes, which is recommended by the current guidelines; use of central hazardous waste treatment, storage, and disposal facilities, which are under

development, by industries generating hazardous wastes; and reporting by generators and transporters of hazardous waste and by hazardous waste treatment plant operators.

In addition, guidelines have been established for hazardous waste minimization, classification, listing, labeling, pretreatment, storage, solidification, and cleanup. An ongoing program funded by the U.S. Agency for International Development (USAID) deals with source minimization, recycling, and process changes for waste minimization.

2.2.2 Agency Structure

Indonesia has two government institutions that directly deal with environmental issues: the Ministry of Environment (MOE) and the Environmental Impact Management Agency (the Indonesian acronym is BAPEDAL). The MOE was created in April 1993 from the former KLH.

The MOE sets Indonesia's environmental policies and coordinates environmental management among various government agencies. It deals with demographic information, including population statistics and projections; natural resource management, including adoption of ambient air and water standards, spatial and land-use planning, geographical information systems, resource conservation, and biodiversity; policy making and strategy development for rehabilitating damaged environment; and other functions, such as staff training, computer center operation, and liaison with nongovernment organizations. At the provincial level, its duty is implemented by the Bureau of Population and Environment (BKLH), which cooperates with the Regional Development Planning Board (BAPPEDA) and other regional and district agencies. The organizational structure of the MOE is shown in Figure INDO-2.

The government's policies on hazardous waste management include (1) control of hazardous waste from cradle to grave; (2) development of centralized facilities and private financing of hazardous waste treatment, storage, and disposal facilities; and (3) the location of one centralized hazardous waste treatment facility in each region, with no monopoly on the ownership of all the facilities. The program plan is to develop one centralized hazardous waste treatment facility in each of the Jabotabek, GKS, and East Kalimantan regions. These three facilities are expected to handle the nation's hazardous waste problem in the near future. Lhokseumawe region in northern Sumatra could become a candidate site for another hazardous waste treatment, storage, and disposal facility.

The BAPEDAL was created in 1990 from the former KLH with the mandate to implement environmental pollution control, hazardous waste management, environmental monitoring, environmental information development, and the establishment of a reference laboratory. The BAPEDAL consists of central, provincial, and regency level organizations. The organizational structure of the Central BAPEDAL is shown in Figure INDO-3.

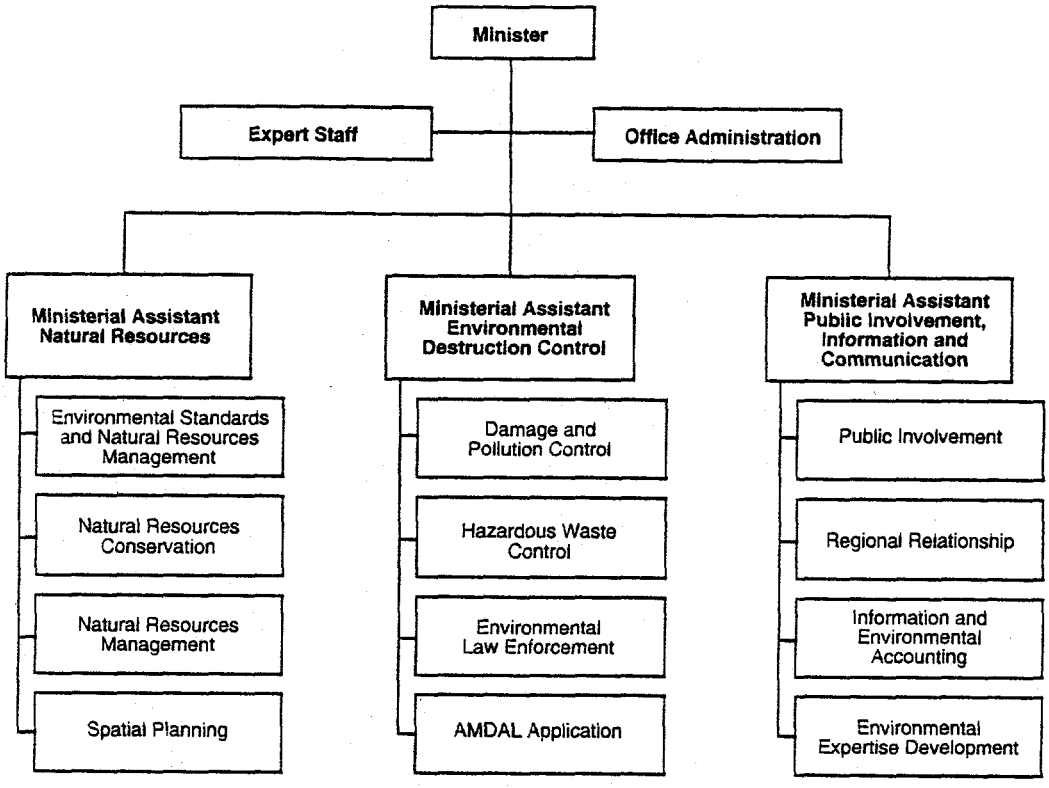

FIGURE INDO-2 Organization of KLH

The long-term objective of BAPEDAL is to maintain sustainability of natural resources and the environment supported by a high level of environmental awareness and community participation in environmental impact management. To attain this objective, BAPEDAL employs bottom-up development concepts, such as establishment of environmental management systems; development of institutions, regulations, and education and training programs; implementation of strategic programs; creation of market mechanisms; and development and education of effective nongovernment organizations that can function as an external force for environmental protection.

The strategic programs adopted by BAPEDAL include (1) Clean River Program (PROKASIH); (2) Blue Sky Program, focusing on mobile sources; (3) Sanitation and Municipal Waste Control in Urban Areas; (4) Coastal Water/Sea Water Pollution Control; (5) Control of Environmental Destruction; (6) Application of Environmental Impact Analysis; (7) Hazardous Waste Management; (8) Small-Scale Activities; and (9) Enforcement and Compliance.

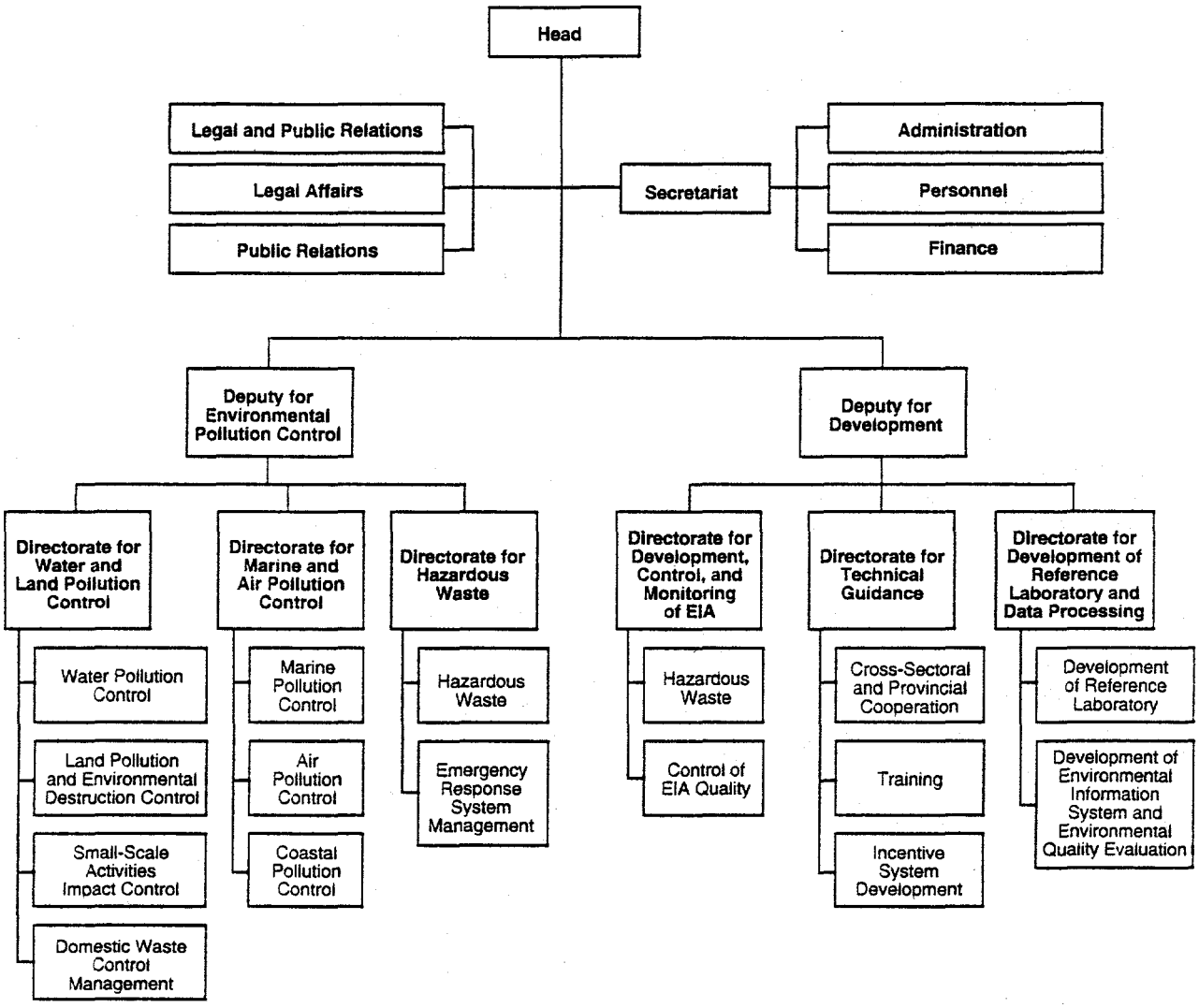

FIGURE INDO-3 Organization of BAPEDAL

2.3 CURRENT HAZARDOUS WASTE ACTIVITIES

2.3.1 Jabotabek Hazardous Waste Treatment Facility

A feasibility study for the treatment facility in the Jabotabek region (Jakarta and its vicinity) was completed under a program sponsored by the U.S. Trade and Development Agency (TDA) in 1990 (Dames & Moore 1990). After the study was completed, KLH selected an Indonesian firm, P.T. Bimantara Citra, and asked it to find an experienced foreign partner for the project. P.T. Bimantara Citra had a long list of potential partners, which included U.S., German, and Canadian firms, such as Waste Management International (WMI), Bechtel Environmental, IT International, Lurgi (German), and Alberta Special Waste Management (Canadian).

The major criteria used in selecting the foreign partner were expertise in hazardous waste business management, financial strength, and willingness to take the financial risk of the project. Firms were eliminated because they demanded too many conditions and did not wish to take the necessary financial risks, had no direct hazardous waste management experience, were interested in selling incinerator equipment only, or were interested in construction only, or they withdrew after getting more details on the project. WMI was the only firm that met all criteria and remained in the bidding.

In May 1992, WMI and P.T. Bimantara Citra entered a joint venture to construct a hazardous waste treatment center at the site identified in the feasibility study. An environmental impact study for the project was completed as a part of the feasibility study. A study to develop the regulatory program to meet the BAPEDAL requirements is being conducted by Dames & Moore, another U.S. firm, and was scheduled for completion in March 1993. Currently, WMI is preparing a detailed design for the facility. The first-stage design calls for a stabilization and landfill process, an analytical laboratory, and a blending facility to prepare a waste-derived fuel for burning in a cement kiln at a nearby cement plant. An MOE license for the discharges from the Jabotabek facility was issued in February 1993. Construction of the facility was expected to begin in April 1993, with initial operation in late 1993.

WMI will own 70% of the joint venture company, and P.T. Bimantara Citra will hold the remaining 30%. The facility is designed for a throughput of 85,000 metric tons per year at an investment cost of $100 million to $150 million. The fee to be imposed on the users of the facility will be determined by the Indonesian government and the company running the facility. The facility is expected to receive hazardous wastes from West Java province, including the Jabotabek region, which currently produces about 65,000 metric tons per year. In the future, the government will acquire shares of the facility as part of its involvement in providing the site (50 hectares) and some of the feasibility study costs (about $1 million).

2.3.2 GKS Hazardous Waste Treatment Facility

The feasibility study for a hazardous waste treatment facility in the region surrounding Surabaya (known as GKS) was also carried out as part of a TDA-sponsored program. It was completed in 1990 (CH2M Hill 1990).

The progress of the GKS project has been slower than that of the Jabotabek project. In the summer of 1992, in response to a government advertisement in a local newspaper, 44 Indonesian firms showed interest in the GKS project. Eight of the 44 firms that submitted their qualifications to the government and their foreign partners were invited to a briefing in September 1992 for a question-and-answer session. The foreign companies were four German firms, two U.S. companies (Waste Science & Technology Corporation and SHN Consulting Engineering), one Japanese firm, and one Canadian firm. After the briefing, only one team, the one including Lurgi of Germany, has shown serious interest. The Indonesian government has decided to repeat the bidding process for the project in the near future.

Because of concerns about the reliability of the waste quantities estimated in the feasibility study, an Australian team was tasked to determine whether there is enough waste to make the facility economic. To ensure adequate throughput, the Indonesian government appears to be considering the import of waste, at least for the early years of operation.

Indonesia expected to have the regulatory environment in place by early 1993. The issue of requiring industry to use the facility is expected to be addressed in the regulations. The hazardous waste content would determine the fee imposed on the users of the facility.

2.3.3 East Kalimantan Hazardous Waste Treatment Facility

A preliminary feasibility study for a hazardous waste treatment facility in East Kalimantan was completed in March 1991 by an Indonesian firm, P.T. Asproes Binareka. Initial results showed that the project might not be economically feasible because there was insufficient industrial waste in the region. The major source of waste is the wood processing industry, in which plywood is manufactured.

After discussions with local government officials, additional studies are being proposed that will consider sites other than the one originally evaluated. Details on the timing of this new study are not available.

2.3.4 Infectious Waste

The Minister of the then-KLH announced in October 1990 that wastes from hospitals and clinical laboratories in Indonesia would be included in the PROKASIH program. However, recent inspections in a number of regencies revealed that hospitals and clinical laboratories were dumping infectious wastes and hazardous wastes into nearby bodies of water without any treatment. At some of these facilities, septic tanks were operated to treat these wastes, but infectious wastes were sent to the septic tanks mixed with domestic wastes. Considering these problems, MOE, in cooperation with the Department of Health, has determined that hospitals and clinical laboratories would be required to prepare environmental impact assessment reports (Kompas 1992).

Of the 1,500 public and private hospitals in Indonesia, only 18 have installed infectious waste treatment facilities. Three have relatively sophisticated treatment facilities consisting of mechanical, biological, and chemical processes. Others are equipped with incinerators and other modest treatment facilities. The primary problem faced by hospitals is lack of capital investment for such treatment facilities. The Department of Health announced that funds were allocated in 1992 for infectious waste treatment facilities at 17 hospitals in North Sumatra, although specific treatment processes for such facilities were not identified (Tempo 1992).

2.3.5 Site Cleanup

Documentation of sites that had been contaminated by hazardous wastes and that had been reported by citizens began in 1991. The assembly of a site inventory was started in 1992 by BAPEDAL. Although such sites are not considered a very serious problem on a national scale, industrial dumping of hazardous waste is becoming a major problem in West Java. Plans are being drawn up for developing guidelines for cleaning up sites. Site cleanup regulations have yet to be developed.

2.3.6 USAID Activities

In July 1991, the Government of Indonesia, the World Environmental Center (WEC), and the USAID developed a two-year program of pilot activities in the area of industrial waste minimization and pollution reduction in Indonesia. A cooperative agreement to implement the program was signed in July 1992. The program includes a variety of activities, such as (1) waste minimization audits, sector-specific waste minimization workshops, and train-the-trainer courses for three types of industries (pulp and paper, metal finishing, and textile); (2) a cross-sectoral waste minimization workshop for plant managers; (3) an assessment of air pollution from mobile sources; (4) a waste exchange forum; (5) identification of mercury pollution sources; (6) industrial estate environmental management courses; (7) hazardous waste management training; and (8) environmental management internships (USAID 1992).

In recent visits to pulp and paper plants and metal finishing factories in Java and Sumatra, a team of WEC industry experts identified a number of low-cost and no-cost methods to improve operating efficiencies and reduce industrial waste generation. WEC will submit a final report to USAID after the waste minimization audits are completed. A decision on how to follow up these audits will be made then; possible actions include making sure that recommendations are implemented, conducting additional audits at different factories, and disseminating audit reports to different firms. It is expected that the same WEC team will visit the factories already audited to see what recommendations have and have not been implemented and to learn the basis for the implementation decisions. On the basis of the finding from the second visit, the experts will offer recommendations on what new technologies (both in the production and waste treatment lines) these industries should purchase to improve their environmental performance.

2.3.7 Other Activities

The Institute for Hazardous and Toxic Waste Management, located at the New Jersey Institute of Technology, has recently received funding from USAID through the National Science Foundation to establish an industry/university cooperative research center at one of the universities in Indonesia. The center will deal with hazardous waste issues and carry out research programs in the area of waste management, including hazardous wastes. The University of Indonesia agreed to locate the research center at its campus. The university is

currently in the process of securing funds to establish an Indonesian technical education infrastructure. This will support and facilitate the Industrial Efficiency and Pollution Abatement Project, which is sponsored by Japan, as well as the center. An academic training element will also be included.

Other activities of the government's hazardous waste management program include the development of guidelines for hazardous waste treatment, the development of procedures for sludge solidification, analysis of site cleanup procedures, and the implementation of a waste exchange information system.

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KOREA

CONTENTS

FIGURES

KOREA

1 BACKGROUND

The Republic of Korea (South Korea, hereafter called Korea) forms the southern part of the Korean peninsula, in eastern Asia. To the north, separated by a demilitarized zone that roughly follows the 38th parallel, is the Democratic People's Republic of Korea (North Korea). To the west is the Yellow Sea, to the south is the East China Sea, and to the east is the East Sea or Sea of Japan (see Figure KOR-1). Korea's land area is approximately 38,000 square miles, and its 1992 population was about 43.5 million.

Through the implementation of seven economic development plans since 1962, Korea has been transformed from an essentially agricultural economy into a newly industrialized country. The rapid pace of development and industrialization has caused increasing environmental problems.

2 SOLID AND HAZARDOUS WASTE ISSUES

2.1 WASTE PROBLEMS

2.1.1 Sources

According to Korea's Waste Management Act, revised in 1991 (MOE 1991a), waste materials are classified into two categories: (1) general wastes that include municipal waste and nonhazardous industrial waste and (2) specified hazardous wastes[1] that consist of industrial wastes that present relatively high health and environmental risks because of their corrosivity, flammability, bioaccumulation, acute and chronic toxicity, low biodegradability, and putridity.

The amount of waste generated in Korea in 1991 was estimated at about 59 million metric tons per year: 34 million tons per year of municipal waste and 25 million tons per year of industrial waste. Although accurate information is not available, approximately 34% of industrial waste is assumed to belong to the newly defined specified hazardous waste category. The per capita generation rate was estimated to be 4.0 kg per person per day (2.3 kg per person

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[1] Specified wastes include waste acids, waste alkalies, waste organic solvents, waste synthetic polymers, waste insecticides and pesticides, wastes containing polychlorinated biphenyls (PCBs), residues of animal origin, waste asbestos, waste gypsum, waste lime, mineral wastes, waste dusts, waste foundry sands and waste blast sands, refractory and ceramic wastes, incineration residues, stabilized and solidified wastes, waste catalysts, waste absorbents and adsorbents, sludge, and other wastes designated by the Minister of Environment.

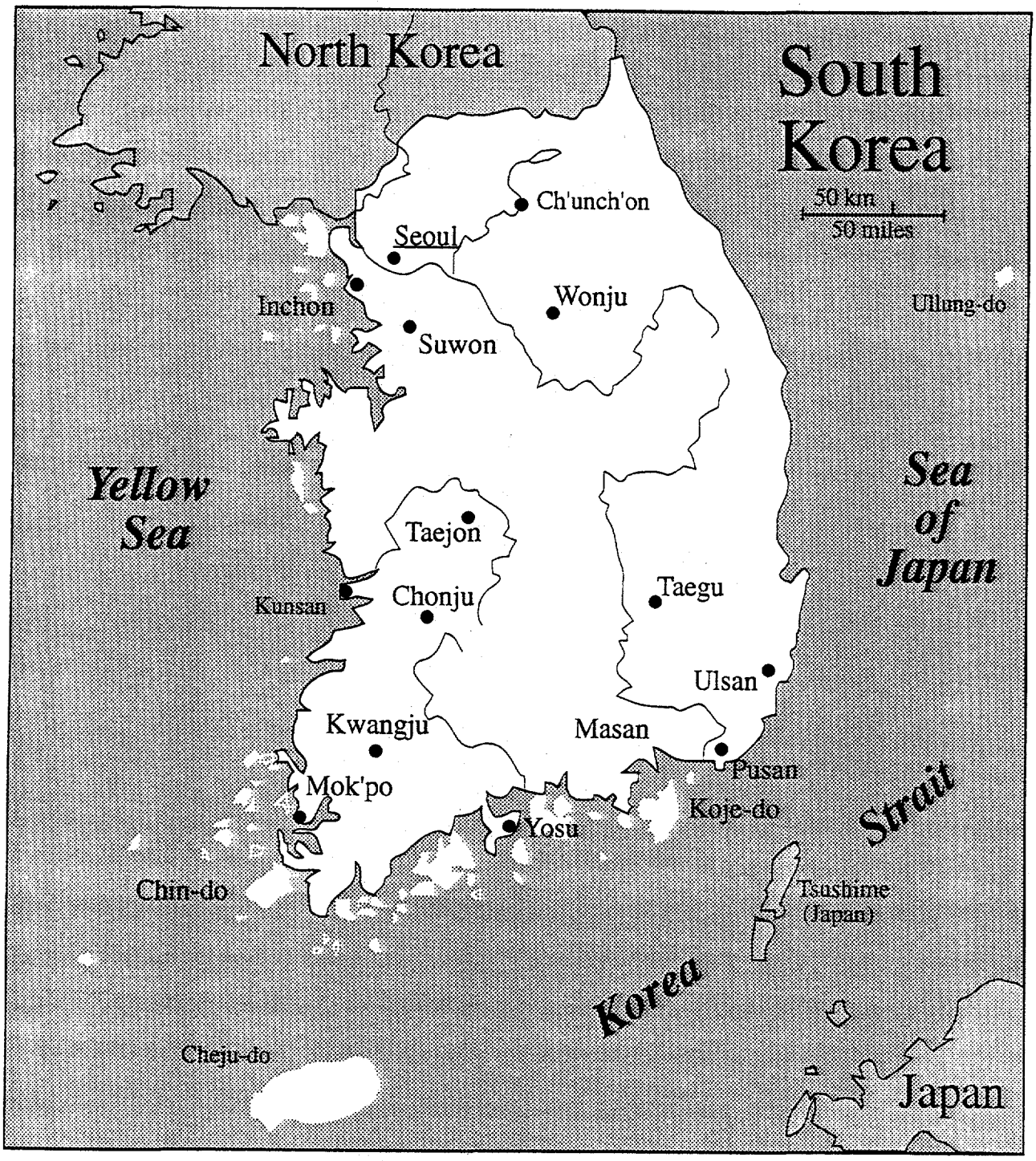

FIGURE KOR-1 Map of Korea

per day of municipal waste and 1.7 kg per person per day of industrial waste). The average rates of annual increase in waste generation during 1991 were 10% for municipal waste and 13% for industrial waste (MOE 1991b,c). The rate of increase in generation of specified hazardous waste is estimated to be even greater than that for industrial waste as a whole.

Major contributors to the municipal waste inventory in 1991 included food residue (29%), briquette ash (28%), paper waste (15%), and metals and glass (5%). Contributors to the industrial waste inventory were mineral residue (47%), organic sludge (22%), ash (8%), and scrap metals (5%). National statistics indicate that the recycling rates for municipal and industrial wastes were approximately 5% and 54%, respectively (MOE 1991b,c).

2.1.2 Location

The largest fraction of the municipal waste generated in the country in 1991 (35%) came from Seoul City, where about 25% of the nation's population is concentrated. Other areas that generate large amounts of municipal waste are Kyonggi Province (15%), Pusan City (10%), and Kyongnam Province (7%). Major areas of industrial waste generation include the provinces and cities located in the southeast (49% from Kyongpuk and Kyongnam Provinces and Pusan and Taegu Cities) and those in the southwest (26% from Chonpuk and Chonnam Provinces and Kwangju City). Generation of hazardous industrial waste was highest in the provinces and cities located in the southeast (56%) and those surrounding Seoul City (30% from Kyonggi Province and Seoul and Inchon Cities) (MOE 1992a).

2.1.3 Problems

Although more than one-half of the industrial waste generated in Korea is being recycled and reused, separation of hazardous wastes from nonhazardous wastes for disposal purposes has not been widely practiced.

The first large-scale, modern sanitary landfill site in Korea was opened in 1990 to serve the Seoul metropolitan area. However, most of the landfill sites in Korea today are operated by the open dumping method, which has caused public sanitation problems for nearby residents and contamination of surface and ground water due to untreated leachates.

Although the organizational structure of the Waste Management Bureau of the Ministry of Environment (MOE) is well established and the waste management regulations have been in force for more than a year, enforcement activities are still in their infancy because of a shortage of funds and trained staff.

2.2 GOVERNMENT STRUCTURE FOR DEALING WITH WASTE

2.2.1 Legislation

Korea's Environmental Policy Act, which presents the nation's basic ideas and directions for environmental conservation policies and defines the nation's responsibilities and duties to attain the environmental rights of the people, was established in 1990 and was further expanded through a revision in 1992. Municipal and industrial wastes, including specified hazardous waste, are controlled by the Waste Management Act revised in March 1991 (MOE 1991a) and the waste management regulations promulgated in December 1991. Under the Waste Management Act, general waste, which includes municipal waste and nonhazardous industrial waste, is to be managed by municipalities. The specified hazardous waste is to be managed by the industry itself or by the central government. The December 1991 waste management regulations require rigorous tracking of transport, treatment, disposal, and reuse of wastes containing hazardous components.

Currently, a draft Waste Recycling and Reuse Promotion Act is being prepared on the basis of draft legislation submitted by several different ministries for introduction to the Parliament for the purpose of resource and energy conservation.

2.2.2 Agency Structure

The Office of Environment, a sub-cabinet-level agency established in 1980 within the Ministry of Health and Social Affairs, was the first governmental agency for the protection of the environment in Korea. As the pace of Korea's industrialization accelerated and environmental pollution problems became very serious, six Regional Offices of Environment were established in 1986. The Office of Environment was elevated in 1990 to a cabinet-level agency as the MOE. The Specified Waste Section under the Waste Management Bureau within MOE is responsible for the management and enforcement of hazardous waste related issues and regulations. The organizational structures of the Korean MOE and Waste Management Bureau are shown in Figure KOR-2.

2.3 CURRENT WASTE ACTIVITIES

2.3.1 Landfills

The bulk of the nation's general waste is disposed of in landfill sites. Only a very small fraction (about 2%) is incinerated. There are 675 landfill sites operating throughout the country, with a total land area of about 5.0 square miles. Most of these landfill sites are small and operated by the open dumping method (MOE 1992b).

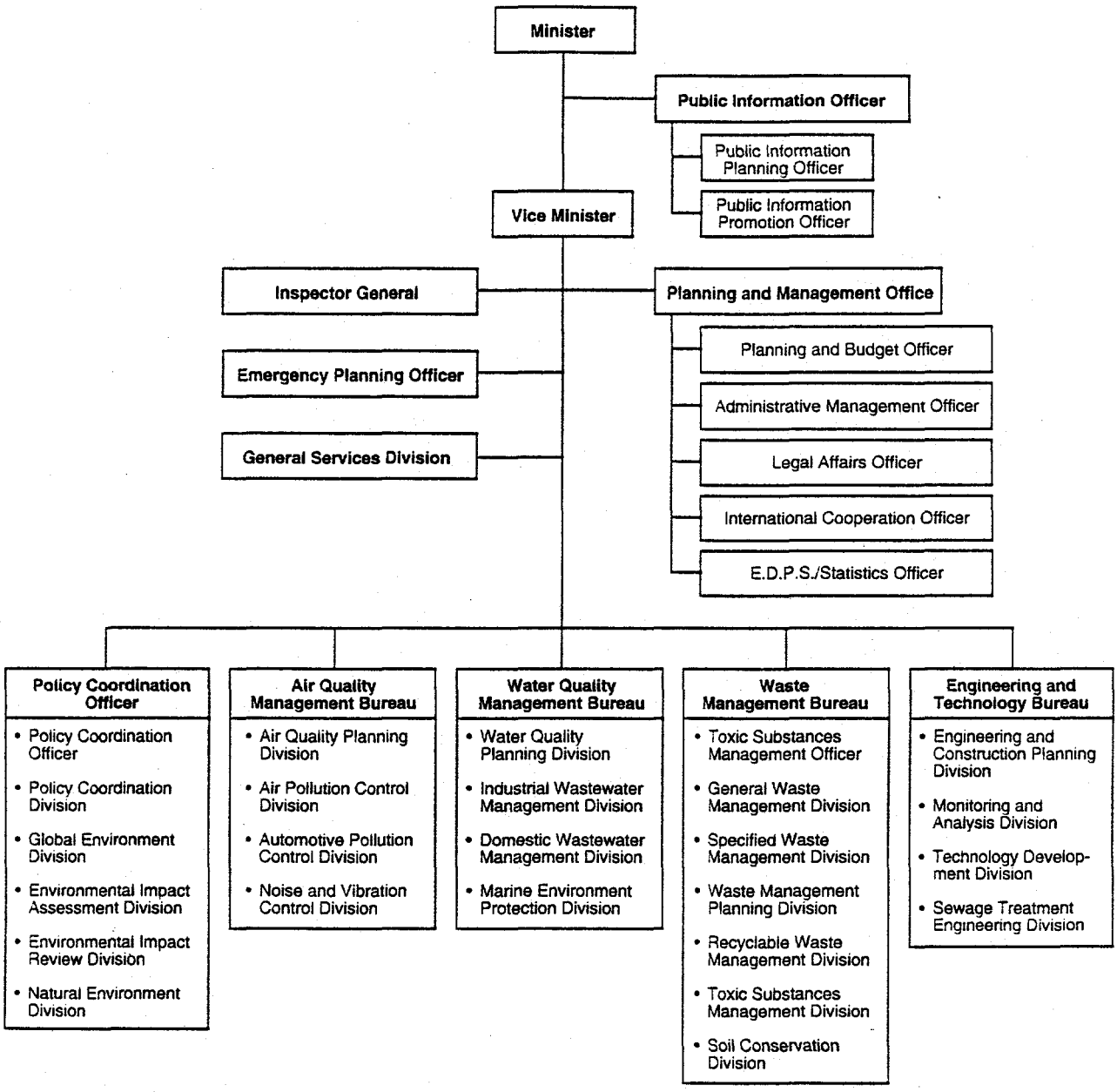

FIGURE KOR-2 Organization of the Ministry of Environment

The only exception is the Seoul Metropolitan Area Sanitary Landfill Facility, the first phase of which was opened in December 1990. Facility construction will be completed in five phases by 2014 with a total budget of $240 million (MOE 1992a). This regionwide sanitary landfill facility, which is to be operated by the MOE, is to receive general wastes from Seoul and Inchon Cities and 22 counties and small cities in Kyonggi Province. The current plan is to build a total of 34 regionwide sanitary landfill facilities throughout the country by 1996 to handle general wastes from 112 counties and provincial cities for the next 10 years and longer (MOE 1992c).

2.3.2 Incinerators

Only two small municipal solid waste incinerators are currently operating in Korea: one in Seoul (150 metric tons per day) and the other in Eijongbu, Kyonggi Province (50 metric tons per day) (MOE 1992a). These facilities were designed and constructed by domestic firms with technical support from Japanese companies. To handle the nation's mounting waste problems, the central and local governments are planning to build a number of incinerators in parallel with construction of regionwide sanitary landfill facilities.

Two incinerators are under construction and targeted for completion by the end of 1992: one with a capacity of 200 metric tons per day in Taegu City and the other with a capacity of 100 metric tons per day in Sungnam City. These two facilities were also designed and constructed by domestic firms with technical support from Japanese companies. Two contracts for incinerator construction have been awarded recently: one for a 200 metric tons per day facility for Pyungchon City and the other for a 1,600 metric tons per day facility in Seoul City. The foreign firms involved in these projects as technical partners to domestic firms are Germany's Stein Mueller and Babcox, respectively.

The nation's incineration capacity is to be expanded to 29,250 metric tons per day by the year 2001 to dispose of about 28% of the municipal solid waste generated nationwide, which will require a total budget of about $3 billion from the central and local governments (MOE 1992c).

2.3.3 Industrial Waste

Industrial wastes that are not recycled are primarily disposed of in landfill facilities. There are 46 industrial waste landfill facilities in operation throughout the nation: 29 facilities operated by waste generators, 15 by commercial waste disposal service companies, and 2 by public agencies (MOE 1992a). One of the waste-generator-owned facilities also operates an incinerator. It cannot be denied that commercial waste disposal service companies have inadequately treated or illegally dumped specified hazardous wastes in the past. The new waste management regulations strengthen the functions and requirements of these private companies and attempt to eliminate the factors that lead to inadequate waste treatment through

subdivision of activities into collection, transport, intermediate treatment, and final treatment operations.

Most specified hazardous wastes that are not recycled are incinerated. Two public hazardous waste disposal facilities are currently operating: one with a capacity of 60 metric tons per day located in the Seoul metropolitan region and one with a capacity of 100 metric tons per day located in the southeastern region. The latter facility is to be expanded to 150 metric tons per day in 1993. These facilities were designed and constructed by domestic firms and use physical/chemical treatment, solidification, and incineration processes. A third public hazardous waste treatment facility, with a capacity of 35 metric tons per day, is planned in the southwestern region during 1991-1996 (MOE 1992a). Because of intensified opposition from nearby residents, it has become difficult for private firms to establish waste disposal facilities. To handle the wastes that are difficult for the private firms to treat, sufficient public capacity for hazardous waste disposal will be installed in six different regions by 1996 (MOE 1992c).

To avoid the difficulty in disposing of large volumes of wastes from an industrial estate, the law requires plans for waste treatment facilities to be made during the initial planning stage. In addition, an industrial estate with a total area greater than 245 acres or an annual waste generation greater than 30,000 metric tons is required to install its own waste treatment and disposal facility. It is also the government's policy to actively encourage existing industrial estates to install their own waste treatment and disposal facilities (MOE 1992c).

Almost all major corporations in Korea are either planning or constructing waste treatment and disposal facilities (especially incinerators) to handle the wastes generated by their own manufacturing facilities. Eight to ten such in-house incinerator projects are currently active. Eleven corporations have already signed contracts with foreign technical partners to acquire up-to-date technical know-how in the area of incinerator design, construction, and operation, and three more are expected to do so very soon (EIN 1992). Such a technical cooperation agreement with a qualified foreign partner is one of the prerequisites to qualify as a bidder for incinerator projects. The U.S. firms active in Korea in this respect include Foster Wheeler, Waste Management International, and Morse Boulger.

Some of Korea's major corporations are also aiming at exporting incinerator business overseas on the basis of the expertise and experience acquired from construction and operation of incinerators within Korea. To speed up its entry into the overseas incinerator market, one Korean corporation is known to have underbid for an incinerator facility project at one-third the estimated cost.

Insofar as waste-related hardware is concerned, it is believed that all types and sizes of waste collection and transport equipment and about 90% of all incinerator components are domestically manufactured. High-temperature incinerator grate and air pollution control equipment are probably the only exceptions.

2.3.4 Waste Minimization, Recycling, and Reutilization

The government's policy is to actively support expansion of new technology development for reducing hazardous waste generation. National and other public research institutions are involved, and their results are expected to find wide application throughout the industrial sector. Development of such new technologies will be promoted by preferentially providing financial support for installation and operation of waste treatment facilities that use such new technologies (MOE 1992c).

Recycling and reuse of waste materials are also very important in Korea, where natural resources are scarce. To collect, treat, and reuse plastic wastes that are not easily biodegradable, the Plastics Waste Treatment Enterprise Act was promulgated in December 1979, and the Korea Resource Regeneration Corporation was established. The semi-government corporation has expanded its mission over the years to collecting empty pesticide and herbicide bottles. Since waste segregation and collection practices were introduced in 1991, the corporation has become involved in the collection and reuse of other materials (MOE 1992c).

2.3.5 Infectious Waste

Although regulations for regulating medical wastes have been established in Korea (MOHSA 1981), separate collection, treatment, and disposal of these infectious wastes are not well practiced. It is not uncommon for these wastes to be disposed in landfills together with general wastes. Some large hospitals have installed and operate their own incinerators. However, most of these wastes are being handled by private consignment companies. The annual rate of medical waste generation in Korea was estimated to be approximately 53 tons per day in 1992 on the basis of the total number of hospital beds (144,140 at about 23,000 hospitals and clinics) and a generation rate of 0.37 kg per bed per day. About 23% of the waste was disposed of by incineration in the hospitals. A recent study showed that a single centralized incineration facility would be the most economical way to deal with hospital wastes (Koo et al. 1993).

The treatment of laundry from medical facilities is regulated by other rules (MOHSA 1990; Park 1991).

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MALAYSIA

CONTENTS

FIGURES

MALAYSIA

1 BACKGROUND

With the encouragement of government policies, Malaysia has changed its economic structure from a primary reliance on agriculture (particularly rubber and palm oil) to a stronger reliance on manufacturing. In 1988, the manufacturing component of the gross domestic product was 24% compared with 11% in 1966 (Bin Shafii 1992). Continued growth in this sector is expected, along with increases in hazardous waste generation. Figure MAL-1 is a map of the country.

2 HAZARDOUS WASTE ISSUES

2.1 HAZARDOUS WASTE PROBLEMS

2.1.1 Sources

The largest generators of hazardous waste in Malaysia are the metal finishing and electroplating operations, which make up about 30% of the waste. Textile, industrial gas, foundry, and asbestos facilities each contribute 9-15% of the total. Total waste generation has been estimated to be 380,000 cubic meters per year (TDA 1987). Work is currently under way to revise these data, and preliminary results show the amounts to be slightly less than the original estimates. It is projected that the total hazardous waste generation will grow by about 35% by the year 2000 (Idris and Jaafar 1993; Singh and bin Mahmood 1993).

Acids and sludges are the largest components of the hazardous waste stream. Alkalies, asbestos, slag and clinker ash, oils, and paint wastes are the next largest contributors. Also, a large number of containers and drums (more than 600,000) have been contaminated with hazardous materials and require disposal.

The determination of waste generation rates and types was begun in 1981 when the Malaysian Department of the Environment (MDOE) conducted a survey of waste generators with help from Australian consultants. In 1985, this information was updated by a Danish consultant. In 1987, the work was further revised by a U.S. Trade and Development Agency (TDA) sponsored study (TDA 1985, 1987, 1988). Two U.S. contractors, Dames & Moore and Waste Management International, used the previous work, coupled with site visits to 79 plants, to develop the new information. Although the data are now considered to be somewhat dated because of changes in the industrial structure (particularly the growth in the electronics and petroleum industries) and are being updated again, the basic information for planning hazardous waste treatment programs is considered to be sound.

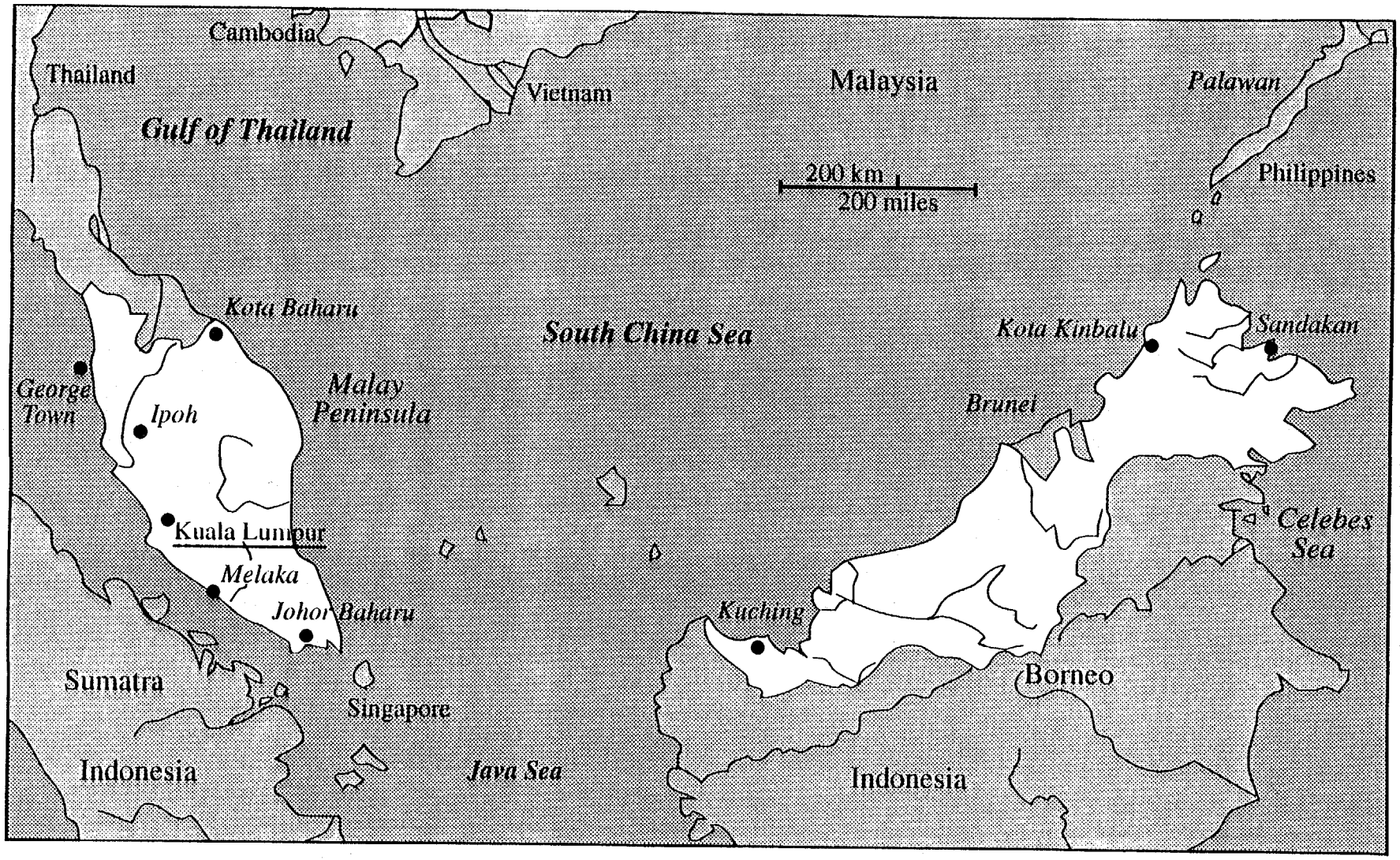

FIGURE MAL-1 Map of Malaysia

There are some indications that household waste contains material that could be classified as hazardous (e.g., nickel and cadmium in batteries). The full extent of the problem, however, is not known at this time.

2.1.2 Location

The largest concentration of industrial operations, and hazardous waste generators, is along the west coast of peninsular Malaysia, including the Klang Valley, Penang, Ipoh, and Johor Baharu (see Figure MAL-2).

Lack of land use controls in the past has led to the location of many industrial operations in residential areas. These plants generally have no environmental controls suited to their wastes. Industrial solid waste and wastewater, some of which is hazardous, are disposed of with household wastes. Malaysia has started to develop industrial estates on which manufacturing facilities are concentrated. However, this development is still in the early stages of implementation.

2.1.3 Problems

The Malaysian industrial structure is composed of both large, multinational companies and small- to medium-sized operations. The smaller industries make up a relatively large portion of the total waste generation. These operations are difficult to monitor and create special concerns in the collection of hazardous waste for treatment.

The absolute size of the Malaysian industrial base is relatively modest by regional comparison. It is only half the size of those of Thailand and Indonesia and about equal to that of Singapore on an absolute measure. This small scale means that an insufficient volume of waste is generated to support more than one centralized, integrated hazardous waste treatment facility. This situation has affected the economics of system design and implementation. Recent discussions have focused on whether regional waste treatment plants could economically be built to service the needs of local industries. The impact of such a move on the economics of the planned central treatment plant is being considered.

A number of the industries that are currently storing waste on-site to comply with government regulations are running out of space. Some companies are hiring private contractors to collect and store their wastes until treatment facilities are available. Others simply dump the material illegally. The situation is such that an early stage of the implementation of the planned centralized hazardous waste treatment plant is to open temporary storage facilities. These facilities would enable waste generators to move the wastes off their premises and alleviate the space shortage. The material would be kept in storage until the treatment equipment becomes operational.

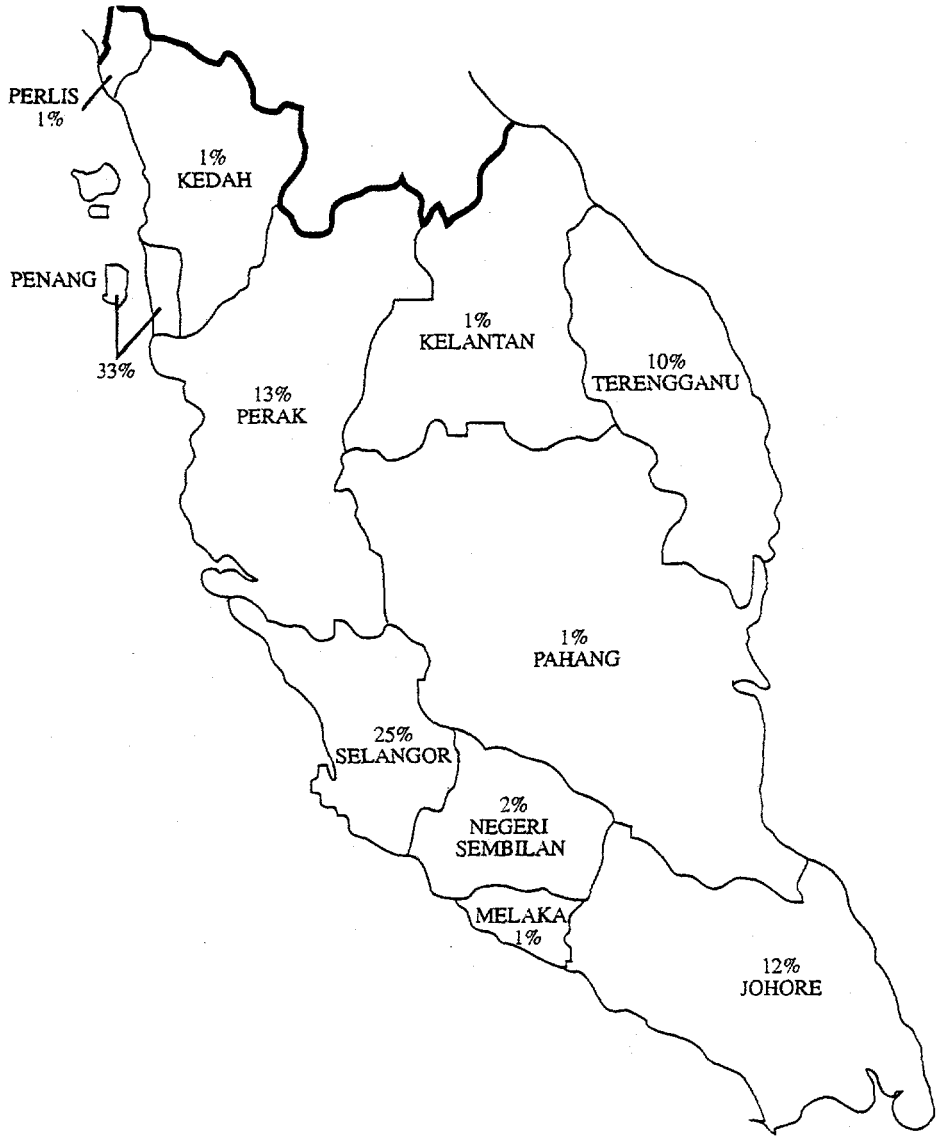

FIGURE MAL-2 Distribution of Sources of Hazardous Waste in Malaysia

There is a general assessment that the large multinational corporations operating in Malaysia are well equipped to deal with their own environmental problems. Many are required by their home country to follow either home-country environmental regulations or Malaysian regulations, whichever are more stringent. The small- and medium-sized companies, however, have neither the technical expertise nor the resources to effectively manage their own waste problems. It is these facilities that need assistance from government waste control programs.

One problem that has surfaced with respect to industrial wastewater treatment systems is the lack of industry commitment to maintain and operate the equipment. It has been reported that some companies will purchase the equipment to satisfy government requirements,

but will not maintain it and frequently will not operate the units. This attitude may carry over into on-site hazardous waste control.

2.2 GOVERNMENT STRUCTURE FOR DEALING WITH HAZARDOUS WASTE

2.2.1 Legislation

The legislation controlling the handling of hazardous waste is the Environmental Quality Act of 1974 along with its subsequent amendments (EQA 1974). Specific amendments were made in 1989 to deal with hazardous waste. Among other things, these amendments identified 28 waste categories under nonspecific sources, 30 under specific sources, and 107 waste streams that would be referred to as "scheduled wastes" and must be treated in a specified manner. The amendments also identified "prescribed premises" as the only acceptable locations for the treatment, storage, and disposal of scheduled wastes. Prescribed premises must have an operating license. In 1991, 64 applications for licenses to operate a prescribed premise were received; only 24 were approved (MDOE 1992a).

The regulations do not require the waste to be processed at a centralized waste treatment plant. The generator may process the material entirely on-site. However, treatment facilities and final disposal must be certified and licensed.

To comply with the regulations, waste generators must notify the MDOE of the quantity of any scheduled waste generated, on at least a quarterly basis. Any transport of scheduled wastes off the premises must be done with a manifest tracking system. Spot checks are made to verify a company's reported data. In 1991, a total of 19 summonses were issued to companies for violations of the hazardous waste regulations. In 1992, the number had risen to 197 summonses (New Sunday Times 1992).

2.2.2 Agency Structure

The Ministry of Science, Technology, and the Environment is the organization with responsibility for environmental control. Within the Ministry, the MDOE is the unit charged with actual development and operation of the environmental control programs. Figure MAL-3 shows the organizational structure.

The MDOE staff numbers about 500; about 200 persons are classified in the professional and subprofessional (technician) categories (MDOE, undated). Staffing of hazardous waste control programs with trained professionals is a continuing problem. As with other countries in the region, salary differences between government agencies and the private sector discourage many trained professionals from remaining in government service.

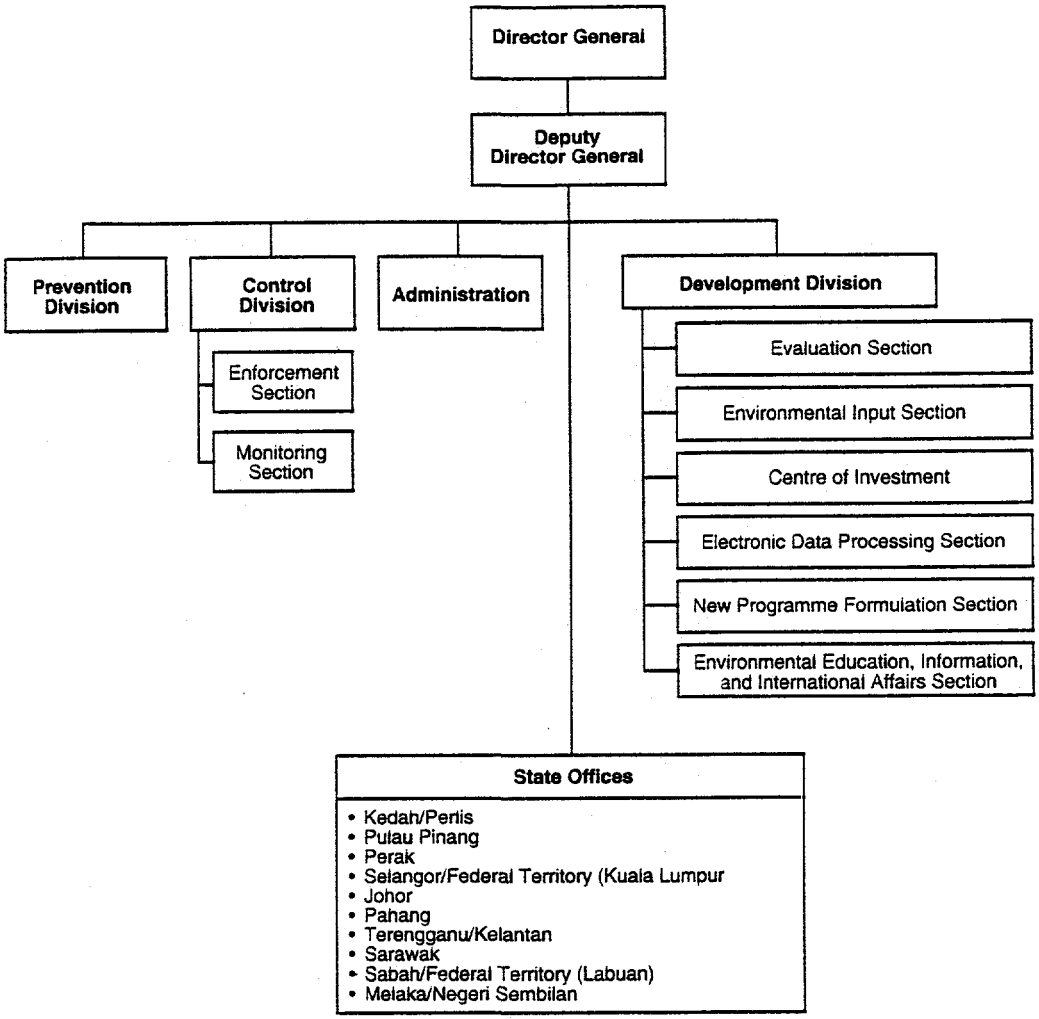

FIGURE MAL-3 Organization of the Malaysian Department of Environment

Enforcement of the regulations is a continuing problem. Despite the increase in summonses for violations, many of the small- and medium-sized factories are not registered and do not comply with the requirements of the legislation. The small MDOE staff is not able to keep track of all these facilities.

The MDOE has 10 state offices that deal with local problems. Each has an enforcement officer, but these people are not devoted only to hazardous waste issues; they must cope with the full spectrum of environmental compliance.

In addition to the MDOE, there is a National Council for the Environment. This body is made up of selected cabinet ministers and is responsible for developing environmental policy for the country. The Council is chaired by the Prime Minister or Deputy Prime Minister.

The Environmental Quality Council also provides input into the environmental control process. This council is made up of selected ministers and representatives from the private

sector. Its role is to provide the government with additional input on environmental policies and regulations. It also serves to promote environmental awareness to the public.

2.3 CURRENT HAZARDOUS WASTE ACTIVITIES

2.3.1 New Central Hazardous Waste Treatment Plant

A new hazardous waste treatment facility is currently planned for construction at Bukit Nenas, Port Dickson District, Negri Sembilan (Idris and Jaafar 1993). The facility will be built by a consortium that involves a Danish firm, I. Krüger A/S, and a Malaysian firm, United Engineers of Malaysia. The Danish firm is providing about 60% of the financing, and the balance is from the Arab Malaysian Development Bank.

The site of the facility is currently undergoing an environmental impact assessment prior to the start of construction. There have been some public protests about the site, especially from local pig farmers. If the environmental impact assessment is approved, the site can begin receiving hazardous waste on a temporary storage basis to relieve space shortages at a number of industrial plants.

The treatment facility will consist of incineration units with a capacity of 20,000-30,000 tons per year, a physical/chemical treatment line with a capacity of 10,000-15,000 tons per year, and a solidification plant with a capacity of 100,000-150,000 tons per year. A secure landfill is also included. The capital cost for the facility will be 500 million Danish kroner (about 200 million Malaysian Ringgit or $81 million), of which 40% will be spent on equipment to be produced in Denmark. There have been some preliminary inquiries about the purchase of some U.S.-built equipment for use in the facility.

Three transfer stations are also part of the system. These will be in the northern, eastern, and southern parts of the country. I. Krüger will operate the waste pickup and transport system and implement a manifest system to provide cradle-to-grave tracking of wastes.

The terms of the agreement between the government of Malaysia and the I. Krüger consortium reflect experience gained in the long and difficult negotiations between the MDOE and Waste Management International of the United States (MDOE 1992b). I. Krüger does not have any guarantees of waste throughput to the facility, and factories are not required to use the facility. Both issues were sticking points in the earlier discussions. The MDOE has indicated that it is prepared to enforce its hazardous waste regulations vigorously and thus provide an incentive for industry to handle its wastes properly. Shipping waste to the I. Krüger plant is one option; on-site treatment is another. I. Krüger does have a monopoly on off-site treatment facilities for a period of 10 years. The MDOE has indicated that it will not license another off-site hazardous waste treatment plant during that time.

Certain wastes are to be excluded from the facility: infectious, radioactive, and explosive waste. Any waste that is to be recycled is not covered under the monopoly agreement. In addition, any factory may develop its own facilities for treating and disposing of hazardous wastes on-site, subject to licensing by MDOE. Hazardous wastes from the Malaysian states of Sabah and Sarawak are also not included in the plan for the treatment facility. Some other arrangements will need to be made for these. Marine pollution wastes covered under the MarPol Agreement will, however, be accepted at the facility.

The potential for importing hazardous wastes from other countries is an issue. The official government position is that it will not be allowed. Some have speculated, however, that after the initial stockpile of hazardous waste is disposed of, the only way for the facility to remain profitable is for additional wastes to be imported and run through the system. The government has maintained that it will abide by the United Nations Basel Convention covering the transnational movement of hazardous wastes. This would require prior informed consent before any waste is moved across national borders.

The price that will be charged for waste treatment is still under negotiation. The MDOE must approve the final pricing scheme. Rates in the range of 5-10 Malaysian Ringitt ($2-4) per kilogram have been mentioned. Of special concern is a pricing scheme that can be levied on small industries without placing too large a burden on their operations. Some discussions have been held regarding government subsidies for small factories that send their wastes to the facility or a subsidy of on-site or pretreatment equipment for these factories.

2.3.2 National Conservation Study

Under the sponsorship of the World Wildlife Fund, a national conservation study is being conducted for Malaysia. About 20 different components are covered in the study, including hazardous waste control. The hazardous waste work was done by the national university, Universiti Kebangsaan Malaysia.

The report has not yet been released to the public as it is undergoing review and integration. One of the principal recommendations that will probably come from the work is the need for a national hazardous waste management strategy. The point is made that the current approach, focusing on the central treatment plant, is limited and does not consider the full spectrum of hazardous waste needs in the country. Among the other recommendations that are likely to be made are the development of specialized waste treatment facilities for factories located in industrial estates, the relocation of factories to common areas where waste treatment facilities can be designed and implemented more efficiently, emphasis on waste minimization and cleaner production technology, and changes to the Malaysian regulations. It is not clear at this time what effect this report will have on the decision-making process.

2.3.3 Site Cleanup

To date, there have been only scattered reports of contamination of soil and water from improper handling of hazardous waste. It is expected that this situation is more the result of a lack of investigation than the lack of a problem. A shortage of staff and money has been cited as the reason for the MDOE's limited efforts to investigate the problem.

The most frequently reported problem is leaking underground storage tanks, mostly containing petroleum products. The MDOE has asked companies to conduct tests on such tanks but has not pursued a vigorous program in this regard.

Municipal landfills are thought to be another source of contamination. Because some industrial operations send their wastes to these sites and some household waste contains hazardous materials, some contamination problems are expected. Again, there has been no extensive or systematic investigation of these problems.

A major reason for the lack of work on site contamination is the relatively small reliance Malaysia places on groundwater. Most of the water supply is surface water, which is monitored for conventional, as well as hazardous, contaminants. As more reliance is placed on groundwater supplies, the site contamination issue may become a significant problem requiring remediation.

2.3.4 Cleaner Production Technology

The use of cleaner production technology or waste minimization is gaining more attention in Malaysia, but has not yet seen any large-scale implementation effort. The MDOE does not have any structured waste minimization program. In fact, many incentives exist that encourage investment in pollution control equipment rather than cleaner production technology. For example, a factory may receive an investment tax credit, an import duty exemption, an accelerated depreciation allowance, or a reduced-interest loan for purchasing end-of-pipe environmental control equipment. The same credits are not available for purchases of cleaner production equipment.

The Federation of Malaysian Manufacturers (FMM) has expressed an interest in developing waste minimization information programs for its members. It has also suggested that tax laws be modified to allow credits for cleaner production technology.

It has been suggested that waste minimization efforts in Malaysia are reasonable only with respect to new factories. The cleaner production equipment can be chosen for new facilities, but there is little hope of convincing factory operators to retrofit existing plants unless there are clear production advantages.

An ironic point has been made with respect to waste minimization efforts in Malaysia. Given the relatively small size of the Malaysian industrial sector, in absolute terms, and the fact

that the centralized hazardous waste treatment plant is already on the small end of the scale for a commercially viable enterprise, any major waste minimization effort is likely to have an impact on the economic profitability of the plant. It has been suggested that the plant will have ample feed for its start-up period, when much of the waste to be processed will come from stockpiled material. However, in later years, sufficient throughput may not be available, particularly if there is a concerted effort to implement waste minimization and pollution prevention programs. Others argue that growth in the Malaysian industrial sector will more than make up the difference and provide a regular stream of waste to keep the plant economic.

2.3.5 Infectious Waste

Infectious waste is currently handled by small incinerators at individual hospitals. No central incinerator is available. The centralized hazardous waste treatment plant will not accept infectious waste for processing.

A few individual companies have proposed infectious waste incineration facilities, but none has been approved yet. The Ministry of Health has a Memorandum of Understanding with British firms for the use of their equipment. It was recently proposed that the general hospital in each Malaysian state be equipped with an infectious waste incinerator. This idea is still under discussion.

2.4 OTHER RELATED ACTIVITIES

Some activities in Malaysia are not exclusively devoted to hazardous waste but are related in some way. These activities are described in the following sections.

2.4.1 Environmental Management and Research Association of Malaysia

The Environmental Management and Research Association of Malaysia (ENSEARCH) is a professional organization made up of about 500 individual members and 75 institutional members (ENSEARCH 1992a). Formed in 1984, ENSEARCH represents a substantial element in the environmental field in Malaysia. The Director General of the MDOE is an ex-officio member of the ENSEARCH Council. ENSEARCH has conducted workshops, training courses, and limited research on hazardous waste treatment. The organization seeks to be a forum for the exchange of technical ideas and information in the environmental field.

A new concept being proposed by ENSEARCH (1992b) is the establishment of the Centre for Environmental Technologies (CETEC). This new organization would serve to promote and conduct research in environmental areas, including hazardous waste. It is being conceived along the same lines as the Rubber Research Institute of Malaysia and the Palm Oil Research Institute of Malaysia.

The CETEC would be designed to conduct research projects for government and private-sector clients. It would use its own staff and contracted temporary technical staff to carry out projects. The CETEC would be involved in laboratory and applied research designed to demonstrate environmental technologies. In addition to research, CETEC would organize symposia and conferences, conduct workshops, and be a focal point for environmental data and information.

The CETEC currently has a 6-acre plot of land in Seredah, Selangor (a new growth center), which was donated. It is seeking to raise funds for a building. In the interim, CETEC will operate out of the ENSEARCH offices.

2.4.2 Federation of Malaysian Manufacturers

The FMM is an industry group made up of about 1,200 member organizations, most of which are individual industrial companies (FMM undated, 1992). About 60% of the members are small- and medium-sized industries. The FMM provides a range of services to its members, including representing member concerns to the government and providing technical advice and assistance.

Environmental issues are one area of FMM activity. It has sponsored workshops and technical seminars on environmental control. Control of waste in electroplating, reduction of waste in the packaging industry, and finding replacements for chlorinated fluorocarbons in the refrigeration and air conditioning industries are examples of the types of technical support FMM has provided to its members. Some of this work has been carried out by outside technical experts. The FMM has had some interaction with the Private Investment Trade Opportunities (PITO) Project in the environmental area. The feeling was expressed that this is a good interaction but is of a short-term nature. Longer term involvement is more desirable.

Of special interest to FMM is the concept of waste minimization and recycling. It has been working to develop programs on these subjects for its members. Several outside groups have conducted seminars and workshops.

2.4.3 USAID/ASEAN Projects

Malaysia is not a U.S. Agency for International Development (USAID) country. However, two programs operated by USAID/Association of Southeast Asian Nations (ASEAN) in Malaysia are related to hazardous waste: the PITO Project and the Environmental Improvement Project (EIP). The general structure of each is described in Section 4.

The PITO Project, which seeks to bring together U.S. and Asian business representatives to establish commercial ties, has sponsored some work in Malaysia. During the visit, some representatives from FMM discussed the need for hazardous waste control in the electroplating industry in Malaysia.

The EIP seeks to conduct a series of projects in the ASEAN countries that contribute to environmental improvement. No hazardous waste projects have yet begun in Malaysia.

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PAPUA NEW GUINEA

CONTENTS

PAPUA NEW GUINEA

1 BACKGROUND

Papua New Guinea is located on the eastern half of the island of New Guinea, which it shares with Indonesia. The islands of the North Solomons, New Britain, New Ireland, Manus, and others are also part of Papua New Guinea. The current population is about 4 million. Agriculture and mining are the largest elements of the economy. Papua New Guinea is one of the largest gold and copper producers in the world. Papua New Guinea gained independence from Australia in 1975. Close ties between the two countries are still maintained.

2 HAZARDOUS WASTE ISSUES

2.1 HAZARDOUS WASTE PROBLEMS

2.1.1 Sources

The major sources of hazardous waste are the mining operations (PBCHWR 1988). Gold, copper, and petroleum extraction are the largest activities. In gold mining, cyanide compounds are used to extract the gold from the ore. There have been previous problems with the large Ok Tedi mine, which is a major gold producer. The Bougainville copper mine in the North Solomons is also a large source of wastes, mostly acids and copper-containing compounds. Petroleum extraction generates drilling mud wastes and oily wastes.

The only other sources of hazardous wastes are small-scale industrial operations. Timber sawmills generate wastes from wood preservatives. The building and construction industry and the automobile servicing industry also generate some wastes. Agricultural operations have caused problems with pesticide wastes.

No systematic inventory of hazardous waste generation in the country has been done. Data on waste generation type and quantity are not available.

2.1.2 Location

Unlike the major mining operations, the small industrial operations are scattered throughout the country.

2.1.3 Problems

A number of highly publicized spills of hazardous materials from mining operations have occurred. Wastes from mining have also caused fish kills in nearby streams and lakes. The Jaba River in the North Solomons has suffered serious impacts from the copper mining operations. The Ok Tedi River, the Fly River, and the Gulf of Papua have all seen increased pollutant concentrations from the gold mining operation.

2.2 GOVERNMENT STRUCTURE FOR DEALING WITH HAZARDOUS WASTE

2.2.1 Legislation

The controlling legislation is the Environmental Contaminants Act (Hazardous Chemical Substances Guidelines and Regulations) (DEC 1993). The legislation prescribes a list of chemicals that are to be considered hazardous. It calls for permits to be obtained before a hazardous material can be imported. This requirement is especially significant for Papua New Guinea because virtually all hazardous materials come from imports.

The act also establishes the Hazardous Chemical Substances Working Party. This group is made up of government, university, and industry representatives and is chartered to provide advice on policy matters related to hazardous materials to the Minister for Environment and Conservation. The working party is an attempt to secure expert advice on the handling of hazardous materials on a case-by-case basis.

The legislation contains no requirements regarding treatment, storage, and disposal of hazardous wastes. Health inspectors enforce health-related regulations that sometimes affect hazardous materials handling, but this effort is minimal.

Waste treatment requirements are sometimes built into the operating permit for mining operations. These are handled on a case-by-case basis.

2.2.2 Agency Structure

The Department of Environment and Conservation (DEC) is the government agency with responsibility for environmental control. Some city authorities and town councils also have a measure of responsibility.

The DEC is a very small organization with limited resources. It relies primarily on following the approaches used in other countries by reviewing published literature. It provides a limited advisory service to the cities and towns on specific hazardous waste problems, but this is done on an ad hoc basis. Foreign consultants are sometimes called in to provide specific information. Australian experts are frequently used.

2.3 CURRENT HAZARDOUS WASTE ACTIVITIES

No hazardous waste treatment facilities are currently in operation in Papua New Guinea. All waste is handled through the municipal wastewater treatment system, disposed of in municipal landfills, or dumped without any control. No plans for treatment, storage, and disposal facilities have been announced.

2.4 OTHER RELATED ACTIVITIES

Papua New Guinea has been working to increase its overall environmental control effort. The Environmental Management for Sustainable Development Program has been in operation since 1990. Its objective is to raise awareness of the need for environmental control activities in the country. It is attempting to develop greater participation from various government and nongovernment agencies.

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THE PHILIPPINES

CONTENTS

FIGURE

TABLE

THE PHILIPPINES

1 BACKGROUND

More than 15,000 industrial and manufacturing plants currently operate in the Philippines. These plants are diverse in terms of both the size of the business establishments and the activities undertaken. The Philippine industrial sector can be described by the following structural characteristics:

- The presence of a very broad spectrum of industries from the large-scale petroleum refining operations to the food industry, which varies in size from very large to very small;
- Many industrial firms dealing with highly toxic materials, such as chlorinated hydrocarbons, mercury compounds, cyanide, arsenic, etc.;
- A large concentration of manufacturing activities in Metro Manila and surrounding core regions;
- An increasing share of "nontraditional" manufactured exports as a portion of total exports, with concentration in three products: garments, electrical and electronic components, and handicrafts; and
- A large number of small cottage industries, which are sometimes unregistered, make up the Philippines' informal industrial subsector, and contribute about 40% of the gross national product.

From 1985 to 1990, large increases in production and employment occurred in the transportation equipment industry. In addition, the basic metal, nonmetallic mineral products, paper and paper products, furniture and fixtures, and wearing apparel industrial sectors all doubled their value of production. From a survey conducted by the Department of Trade and Industry, the major sectors that exhibited substantial growth rates in sales during the first quarter of 1990 were the plastic industry, with sales growth of 58%; consumer durables, 49%; garments, 46%; cement, 41%, and agro-based industries, 39%.

The Philippines' chemical industry is relatively small. The country has imported more than $1.5 billion of chemicals; major items include petrochemicals and such inorganic chemicals as ammonia and soda ash. Most of the local chemical industries concentrate on downstream processing operations, such as plastics fabrication, pharmaceutical formulation, cosmetics manufacture, and other compounding operations (Uriarte 1992). Table PHIL-1 lists the number of large industrial firms in 1987 in the Philippines by industry classification (Fuentes 1991).

TABLE PHIL-1 List of Large Manufacturing Firms in the Philippines

Industry Classification	Number of Firms
Textile	297
Leather and leather products	39
Wood and wood products	254
Industrial chemicals	89
Other chemical products	206
Plastic products	162
Iron and steel	99
Nonferrous metal	22

Source: Fuentes (1991).

2 HAZARDOUS WASTE ISSUES

2.1 HAZARDOUS WASTE PROBLEMS

2.1.1 Sources

Currently, there is no national inventory of hazardous wastes in the Philippines; however, several studies have resulted in data on hazardous waste characteristics for specific regions of the country.

The Laguna Lake Toxic and Hazardous Waste Management Feasibility Study, sponsored by the Laguna Lake Development Authority (LLDA) and the U.S. Trade and Development Agency (TDA) (URS 1989), indicated that the Laguna de Bay in Metro Manila produced more than 10% of the nation's manufacturing output. There were 1,155 industrial establishments within the watershed. About 65% of the industries operating in the urbanized northwestern region and in the agro-industrial southwestern region contributed significantly to the pollution loading of the lake. These industries generated a variety of hazardous waste discharges, which resulted from operations including, among others, the manufacture of basic industrial chemicals or chemical products (synthetic resins, plastics, paints, and rubber tires); machine and equipment assembly; tanning and leather finishing; iron and steel milling; and livestock and poultry raising. The most commonly discharged hazardous contaminants were identified as metals (copper, zinc, chromium, lead, and nickel) and organics (bis-2-ethylhexyl, phthalate, chloroform, methyl chloride, toluene, benzene, and phenol). Sediments from the lake and selected tributary streams were found to have low concentrations of hazardous contaminants. The same was found in the tissue-cumulative metal analysis carried out in macro-invertebrates and fish food species. However, the concentration of hazardous contaminants in lake water exceeded criteria in several locations near the main inflow points.

The Industrial Technology Development Institute, using information from a study sponsored by the Economic and Social Commission for Asia and the Pacific, reported that the gold and copper mining industries were the major hazardous waste generators in the Cordillera Autonomous Region. These industries generated mine tailings and metal-containing wastewater. The survey also provided preliminary estimates of hazardous waste generation for the Metro Manila area. The results indicated that there were 20 to 40 million liters per year of concentrates with a predominance of acid and metal wastes and smaller volumes of toxic washing and alkalies; 80 to 150 million liters per year in the form of dilute aqueous solutions; and imported chemicals, which could result in hazardous waste. These imported chemicals included, among others, 20 metric tons per year of organo-mercury, 10 metric tons per year of organic arsenic compounds, and 2,000-3,000 metric tons of fluids containing polychlorinated biphenyls (PCBs) in transformers and capacitors.

A national hazardous waste inventory workshop, jointly sponsored by the Department of Environment and Natural Resources and the U.S. Agency for International Development, was held in September 1992 in Tagaytay City, with more than 40 participants representing government agencies, industries, consulting firms, and advisory groups. On the basis of current industry statistics, the workshop participants identified the following wastes as priority hazardous wastes in the country: plating wastes, organic solvents, and acids and alkalis. Some wastes were considered to be of little consequence, including reactive wastes, waste containers, putrescible waste, and oily organic waste. Little waste was generated from the pesticide and pharmaceutical industries, as these industries are mainly formulation and packaging operations in the Philippines. Wastes from the petroleum refining industries were limited to a small number of plants. Few hazardous wastes are generated from the textile industry, but in view of the importance of textile and cloth exports, the waste generation from the textile industry was considered to require independent investigation (Barnes 1992).

A recent study of the Metro Manila Area (Brabante 1993) indicated that 25 million cubic meters of acid and alkaline liquid wastes, 2,000 cubic meters of solvent wastes, and 22,000 tons of other hazardous wastes are disposed of on land or in waterways.

2.1.2 Location

Although industrial plants are distributed throughout the country, most of the waste-generating industries are found in Metro Manila and its nearby provinces. Several major industries operate in Bulacan, a province bordering Metro Manila to the north. In addition, a number of large industrial plants, such as cement plants and steel mills, are located in Mindanao, the southern portion of the country. Two major export processing zones with semiconductor production plants are located in Baguio City and Cebu City. Most sugar industries are found in Negros Occidental. Gold and copper mining industries are located in the Cordillera Autonomous Region. Large hospitals that generate infectious waste abound in the extended metropolitan areas, while such hospitals can be found only in urban areas of the provinces.

A map of the Philippines is provided in Figure PHIL-1.

2.2 GOVERNMENT STRUCTURE FOR DEALING WITH HAZARDOUS WASTE

2.2.1 Agency Structure

The National Water and Air Pollution Control Commission was established in 1964. This commission later became the National Pollution Control Commission (NPCC). The National Environmental Protection Council (NEPC) was established in 1977. In 1987, NEPC and NPCC were merged into the Environmental Management Bureau (EMB) of the Department of Environment and Natural Resources (DENR). The EMB is the leading agency responsible for formulating and implementing environmental policies, laws, plans, and programs, including those related to hazardous waste management. The DENR has 13 field offices, one for each of the 13 regions of the country. These field offices enforce the policies, laws, plans, and programs.

In addition to DENR/EMB, several other government agencies are involved in the control and management of environmental pollution, including hazardous waste. These agencies and their responsibilities are as follows:

- Department of Trade and Industry: Responsible for planning and implementing commercial and industrial development programs, this agency is concerned with the availability of adequate pollution control capacity, including that of hazardous waste treatment and disposal facilities.

- Department of Transportation and Communication (Land Transportation Office): This office is concerned with the transportation of hazardous waste and the response capability for spills and other accidents.

- Department of Public Works and Highways: The primary responsibility of this national government agency is development of the nation's infrastructure, such as highways, public buildings, and flood control systems. At the direction of the Presidential Task Force on Solid Waste Management, it has been charged with responsibility for design and construction of solid waste transfer stations and sanitary landfills for Metro Manila.

- The Department of Health: This agency is responsible for public sanitation and inspection of foods and crops. It has also been charged with responsibility for developing and implementing a plan for management of waste from hospitals.

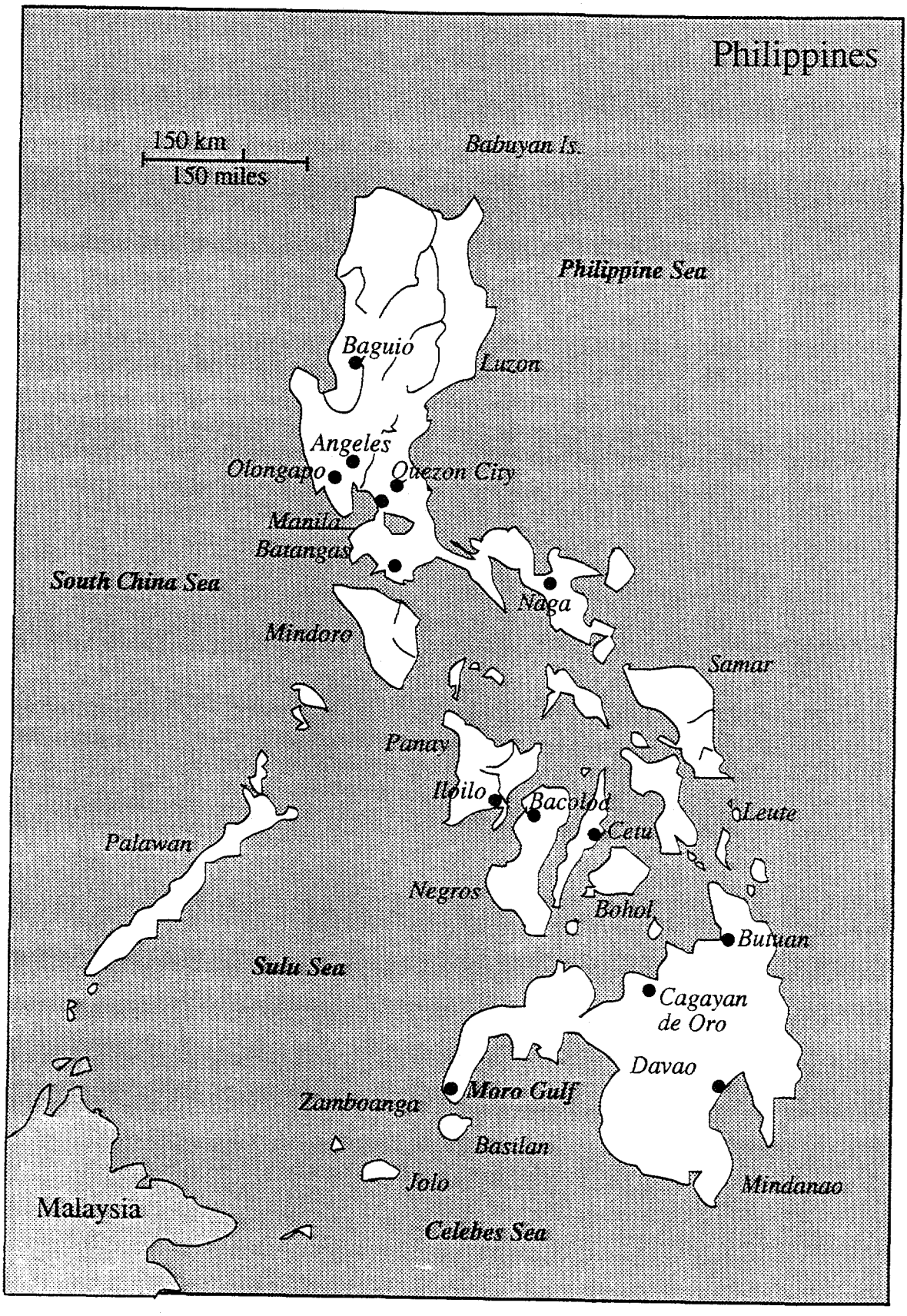

FIGURE PHIL-1 Map of the Philippines

- Central Bank: The importation of hazardous chemicals is currently regulated through an ad hoc arrangement between the Central Bank and other pertinent government agencies.

- Metropolitan Manila Authority: This agency is responsible for collection and disposal of municipal solid waste from 4 cities and 13 towns in Metro Manila.

- Lake Laguna Development Authority: This agency has been authorized under its charter to "carry out the development of the Laguna Region with due regard and adequate provisions for environmental management and control, preservation of the quality of human life and ecological systems, and the prevention of undue ecological disturbance, deterioration and pollution." It is also charged with setting water quality standards for waste discharges, enforcing these standards, and pursuing violators under penal or civil actions (Montgomery Consulting 1990).

- Other agencies: The Philippine Coast Guard has primary responsibility for enforcement of marine pollution regulations, including oil spill response and contingency planning, in conjunction with EMB. Several government agencies are involved in the licensing, permitting, and monitoring of toxic chemicals and hazardous wastes. The Fertilizer and Pesticide Authority controls registration, labeling, and use of pesticides and licenses handler and pest control operators. The Bureau of Food and Drugs controls chemical content of food and drugs.

2.2.2 Legislation

The pressure from rapid population growth, combined with high population density and inadequate (sometimes unavailable) environmental sanitation facilities, has resulted in the generation of severe negative environmental impacts in the Philippines. Several environmental laws were established in the late 1970s and early 1980s to deal with the problems. The framework for the national environmental policy is Presidential Decree 1151, the Philippine Environmental Policy. This legislation was complemented by Presidential Decree 1152, the Philippine Environmental Code. Additional laws and regulations dealing with the environment have been enacted and amended. These statutes include assorted environmental legislation, regulations, decrees, etc.

The legislation pertinent to hazardous waste control was signed into law only recently. On July 23, 1990, the two highest legislative bodies of the country proposed Senate Bill No. 225 and House Bill No. 25194, which were subsequently passed and consolidated on September 6, 1990. The law was approved by the President of the Philippines on October 26, 1990, as Republic Act 6969, known as the Toxic Substances and Hazardous and Nuclear Waste Control Act of 1990. The act covers regulation and control of toxic chemicals, hazardous wastes, and

nuclear wastes. The types of regulatory controls included in Republic Act 6969 are the following:

- Definition and listing of wastes,
- Transport and storage control,
- Pretreatment requirements,
- Treatment and disposal requirements,
- Reporting requirements,
- Waste minimization requirements,
- Regulations on waste import and export,
- Policy on sustained development and clean technology, and
- Policy on multimedia control.

Recently, Administrative Order 29, Implementing Rules and Regulations for Republic Act 6969, was issued (Brabante 1993). These rules cover the following areas:

- Waste generator requirements: Generators are required to identify their hazardous wastes and maintain a continuing registration and reporting of them. They must also assume responsibility for proper treatment on-site or delivery to a treatment or disposal facility.
- Manifest system: A cradle-to-grave tracking of hazardous wastes is instituted.
- Treatment, storage, and disposal requirements: Initially, treatment, storage, and disposal requirements must be met as part of the environmental impact assessment for a facility. Special standards for these facilities are to be developed over a two-year period.

2.3 CURRENT SOLID AND HAZARDOUS WASTE ACTIVITIES

2.3.1 Current Waste Management Practices

2.3.1.1 Waste Collection

A separate system for the collection and transportation of hazardous waste has not been implemented in the Philippines. Solid and semisolid hazardous wastes are apparently collected by the municipal solid waste system.

2.3.1.2 Treatment and Disposal

Available information indicates that there are few facilities specifically designed to treat hazardous waste in the Philippines. The only treatment for liquid hazardous waste is that provided by conventional wastewater treatment plants in some industrial complexes. These plants, however, generally lack the ability to treat and dispose of the concentrates and sludges produced. On the basis of the results of a waste survey conducted in 1985 (Uriate 1992), the present disposal methods for hazardous wastes (including toxic and hazardous concentrates and sludges) from industrial sources are as follows:

- Discharge to drains and rivers without treatment: This practice contributes to severe organic pollution and constitutes the main source of heavy metal pollution of several river systems. It was also found to cause heavy metal contamination of Manila Bay.

- Dumping at municipal landfills: Codisposal of industrial hazardous waste with municipal solid waste in open dumps, practiced in most cities in the country, creates a health hazard to scavengers and contributes to the contamination of land, surface water, and groundwater.

- On-site storage, treatment, and disposal: This practice may be employed in industries, but little information on the extent of its use is available.

- Private landfills operated by a single industry or a haulage contractor: Little information is available about their location or operation, but the presence of such landfills was confirmed.

- Ocean dumping: Some mining wastes as well as caustic and fly ash are dumped in the ocean.

2.3.1.3 Emergency Planning and Response

The Philippines has an emergency plan known as the Calamities and Disaster Preparedness Plan. The plan was developed by the Office of Civil Defense and serves as the foundation for all contingency and operation plans. In the Philippines, contingency plans at the national and local levels are carried out by an interagency group coordinated by the Disaster Coordinating Council. Among such plans are the contingency plans for active volcanoes and for unusual water releases from major dams in Central Luzon.

Emergency planning and response actions for industrial accidents is relatively undeveloped. It is reported that only a few industries have developed contingency plans for industrial accidents (Diaz 1991).

2.3.1.4 Industrial Waste Exchange

The Industrial Waste Exchange Philippines Project was initiated in 1987. The main objective of the project is to reduce negative environmental impacts due to industrial wastes through the promotion of waste exchange and recycling among industries. The project is partially funded by the Canadian International Development Research Centre and is administered by the EMB (Diaz 1991).

2.3.1.5 Hospital Waste

The results of a study conducted in October 1988 to assess the status of hospital waste management in Metro Manila indicated that most of the hospitals surveyed disposed of all their wastes (including infectious wastes) in the municipal waste collection and disposal system. The study also indicated that only 6 of the 64 hospitals surveyed have incinerators and that some of the hospitals practice unsatisfactory disposal methods, such as burning and burying waste within the hospital compound and discharging contaminated fluids into drains (Diaz 1991).

2.3.2 Philippine Government Activities in Hazardous Waste Control

Current hazardous waste activities by the Government of the Philippines focus on development and enforcement of regulations and standards under Republic Act 6969. A national workshop for the safety and control of toxic chemicals and hazardous wastes, jointly sponsored by EMB, the World Health Organization, and the United Nations Development Program (UNDP), was held in Manila on November 13-15, 1991. Workshop participants discussed overall chemical safety program planning and implementation, the preliminary assessment of the country-level situation, potential approaches and projects for resolving identified problems, and program coordination issues. The workshop was attended by 82 participants from various government departments, nongovernmental organizations, and private industry. Following the workshop, a framework for the preparation of a national strategy for the control and

management of toxic chemicals and hazardous wastes was developed. A series of 15 projects was identified for immediate implementation (Moss 1992).

Currently, EMB is in the process of preparing an inventory of hazardous waste generation, which was to be completed in April 1993. It is also developing rules and regulations applicable to hazardous waste generators and owners and operators of hazardous waste storage, treatment, and disposal facilities. Other EMB efforts in the hazardous waste area include providing training for both government and industry to prepare for the eventual implementation of the regulations and identifying the need for hazardous waste treatment and disposal facilities (Fuentes 1991).

2.3.3 Philippine Government Activities in Municipal Solid Waste Control

The strategy for municipal solid waste management in the Philippines varies from place to place and is unique to the local culture and other activities in the area. One thing common to all is the use of open dumps as the final waste depository.

About 4,000 tons of municipal solid waste is generated daily in Metro Manila (TRD 1991). Management of the waste is weak. There are currently no facilities that can be classified as sanitary landfills. Previous attempts to maintain sanitary landfills have been abandoned, and the sites have turned into open dumps. After the recyclable and reusable materials have been removed by household and neighborhood scavengers, only 60% of the solid by-product and residue is actually transported to dumps; the remaining 40% remains uncollected. The uncollected fraction remains along streets and alleys or ends up in the estuaries and canals that cut through the city. During the rainy seasons, these materials, along with the septic tank leachate, are washed out to Manila Bay or dumped into Laguna de Bay. Even after the material reaches an open dump, material sloughs into the water or contributes to air pollution as a result of smoldering fires in the dumps. Some open dumps are adjacent to bodies of water, and waste material sloughs into the water on a regular basis, contributing to organic pollution of surface water and groundwater resources.

The municipal solid waste collection and disposal system of Metro Manila has reached critical proportions after decades of neglect. Much pressure has been mounted on the Metro Manila Authority, the lead implementing agency for this problem, to come up with an efficient, practical, yet economic solution.

The Metro Manila Solid Waste Management Feasibility Study, funded by the TDA (Consoer, Townsend, and Associates 1990), proposed a series of integrated solid waste management activities: (1) development of two environmentally secure landfills, including gas recovery, material recovery, and composting; (2) provision of communal containers for collection of waste in those communities that are inaccessible to collection vehicles; (3) establishment of five transfer stations for transfer of waste to larger, more efficient long-haul vehicles; (4) construction of a refuse pit at each transfer station for temporary storage when needed; (5) a resettlement and livelihood support program (including job training and job placement) for the

squatters and scavengers who would be affected by closure of the open dump sites; (6) closure of all existing open dump sites, covering them with dirt, and providing for removal of gases; and (7) a solid waste management training program and groundwater monitoring around landfill sites.

Some of these activities are currently being implemented. The construction of the first transfer station in Metro Manila has been completed. At the new San Mateo landfill site, pilot landfill cells and a leachate collection system have been installed and are being tested. They are funded by local agencies and built by local firms. The project is also being appraised by interested funding agencies. The Metro Manila Authority is reportedly negotiating with the World Bank for a $100 million loan to implement the projects suggested by the feasibility study (Cayton 1992; also Section 2.3.5 of this report).

2.3.4 Contaminated Site Remediation Activities

There are likely many yet uncharacterized sites in the Philippines that have been contaminated with hazardous wastes. These sites include a number of open dumps, industrial plants, and creeks and rivers. There are no data (at least in the public domain) on the location and nature of the contaminated sites, no established technical standards for cleanup, and no guidelines pertaining to the liabilities of responsible parties. At present, however, limited activities are being conducted or planned by the government and foreign agencies, aimed at rehabilitating selected polluted or "dead" rivers by dredging bottom sediments. Priority for river rehabilitation has been given to the following waterways: (1) Navotas-Malabou-Tullahau-Tinajeros River, (2) Pasig River, (3) Laguna Lake, (4) Manila Bay, and (5) Calancan Bay (Carpenter 1992).

The Danish government has provided $1.6 million in funding to DENR through the Danish International Development Agency to assist in the Pasig River Rehabilitation Project. A feasibility study to develop a long-term strategy for reduction of pollutant loading to the river was scheduled to be completed by the end of 1992. Additional funding for implementation has been requested.

The many existing open dump sites in the country are becoming major sources of environmental and health problems. In Manila alone, at least seven large open dump sites should be closed. Many of these sites are located in shallow waterways or rice paddies. Closing existing dump sites is a priority project in the Philippines. Currently, however, there is no specific ongoing closure or cleanup program. Several developments must be set in motion in order to allow the government to begin the closure process: (1) at least one of the new sanitary landfills should be in operation, (2) cost-effective transport of refuse to the new landfill should be developed, and (3) a closure plan should be developed for each site. In addition to these prerequisites, closing dump sites will require a considerable amount of money and time to adequately address the environmental issues at each site.

2.3.5 Multilateral and Bilateral Activities

In addition to the Philippine government activities, several hazardous waste and municipal solid waste activities are funded by bilateral or multilateral organizations.

2.3.5.1 World Bank

The World Bank has funded the following projects aimed at improving environmental management in the Philippines:

- Metropolitan Environmental Improvement Program (MEIP): A regional program funded by the UNDP and executed by the World Bank to assist governments, industries, nongovernment organizations, and communities arrest and reverse environmental degradation in rapidly growing Asian urban centers (including Metro Manila). The MEIP is involved in the formulation of an environmental management strategy and action plan and the conduct of studies on industrial efficiency and pollution control, public sanitation facilities, and community-based recycling and resource recovery programs. It also supports nongovernment organizations involved in solid waste management and information dissemination campaigns on urban environmental issues.

- Environmental Sector Study: To be performed from July 1992 to March 1993, this study is intended to provide the Philippine government with a comprehensive holistic framework and action plan to strengthen the environmental management process for infrastructure and industry, especially in light of the imminent changes arising from the implementation of the Local Government Code. The study will formulate a definition of the government's objectives and role in managing environmental processes, map out an appropriate strategy for meeting such objectives, and estimate the resources needed to implement the strategy.

- Industrial Efficiency and Pollution Control: This project (being planned) is intended to strengthen the framework, incentives, planning, and enforcement mechanisms dealing with industrial pollution in Metro Manila and Cebu. This proposed project will also establish financial arrangements for firm-level investment in pollution control and waste management identified in the MEIP study.

- Metro Manila Solid Waste Management: This project is intended to improve environmental conditions in Metro Manila through the introduction of sanitary landfill methods and closure of existing open dump sites. This project (being planned) will comprise the development of two sanitary landfill sites, construction of four refuse transfer stations,

procurement of transfer trucks and equipment for landfill site operations, rehabilitation of maintenance shops, and technical assistance. A grant ($576,000) has been obtained from the Japan Environmental Fund for the design and initial assessment of the feasibility of the project.

2.3.5.2 Asian Development Bank

The Asian Development Bank has been assisting the Metro Manila Environmental Improvement Project and various projects for water and wastewater treatment. An environmental sector assistant loan of $300,000 began in 1992. The bank is planning to provide a technical assistance grant of $100,000 for developing hospital services (USAID 1991). This work will have a component that includes medical waste as part of the environmental impact assessment process.

2.3.5.3 U.S. Agency for International Development

The U.S. Agency for International Development (USAID) has previously sponsored environmental initiatives and studies on the Philippine tannery and semiconductor industries. The agency is currently sponsoring the Industrial Environmental Management Project (IEMP) with a goal of encouraging sustained economic growth in the industrial sector in the Philippines along with corresponding improvements in the control of industrial pollution. With DENR as the lead implementation agency, the project will spend a total of $12 million over five years from 1991 to 1996. The IEMP is expected to achieve a measurable reduction in the generation of industrial emissions, effluents, and wastes at a number of industrial sites in the Philippines. Among its expected accomplishments are improved efficiency and management of energy, raw materials, and waste recovery and recycling; increased investments in pollution control technologies by targeted firms; strengthened Philippine capacity to conduct pollution management appraisal, environmental risk assessments, environmental impact assessments, and compliance audits; advances in the policy and regulatory framework regarding pollution management in the Philippines; and expanded public participation in the development of policies and projects to prevent, reduce, and manage the country's industrial pollution (USAID 1991).

These objectives will be accomplished through a series of activities, including pollution reduction initiatives; policy studies and public/private dialogues; and training and technology transfer:

- Completion of an environmental risk assessment that identifies the five industry sectors that pose the highest social costs from industrial pollution;

- Completion of pollution management appraisals at up to 150 industrial sites;

- Completion of about 10 policy analyses to support advances in regulatory, fiscal, and administrative dimensions of pollution issues; and

- Training of a substantial number of Filipinos in pollution management appraisal (200), environmental risk assessments (60), environmental impact assessments (700), compliance audits (200), compliance monitoring (200), and data collection and analysis (300).

2.3.5.4 Germany

A German international aid agency, GTZ, has funded the Philippines-German Project at $1 million per year in an attempt to improve the hazardous waste management situation in the City of Cebu (Faensen-Thiebes 1992). The project elements include (1) providing training courses for the DENR staff, aimed at improving its knowledge and skills concerning the recognition of hazardous waste and methods for their proper treatment; (2) establishing a data inventory on type, quantities, and chemical characterization of industrial wastewater and hazardous wastes from local industries and databases on regional surface and groundwater water quality, hydrology, and ecology; (3) providing technical assistance through the Cebu Chamber of Commerce and Industry to bridge the information gap on industrial waste management and hazardous waste treatment technologies; (4) upgrading, by supplying analytical equipment, an existing water laboratory of the University of San Carlos so that it will be able to analyze a wide range of toxic substances; (5) disseminating information on hazardous waste to the general public through newspaper articles and local radio and television to raise public awareness of hazardous waste issues; and (6) construction of a central waste treatment facility for the metal finishing industry. GTZ will pay for the capital cost of the treatment unit, and the operating costs will be obtained from user fees. (A secure landfill for Cebu may not be needed in the near future as hazardous waste generation is still limited. Temporary storage may be needed for the next 10 years [Faensen-Thiebes 1992].)

2.3.5.5 Canada

Funding of $3 million was provided by the Canadian government through the International Development Research Centre for the establishment of a waste exchange program in the Philippines and for providing assistance in environmental planning and management.

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SINGAPORE

CONTENTS

FIGURES

SINGAPORE

1 BACKGROUND

Although Singapore is one of the smallest countries in the world (area of 620 square kilometers, population of 3 million), it has achieved a level of economic success that classifies it as a high-income economy. In absolute terms, Singapore's economy is small at $35 billion, but its per capita gross national product grew at an annual average of 6.5% per year from 1965 to 1990, ranking it third in a list of 125 countries kept by the World Bank.

The industrial sector makes up slightly more than one-third of Singapore's economy. The service sector accounts for the other two-thirds. Manufacturing is about 29% of the total gross domestic product.

2 HAZARDOUS WASTE ISSUES

2.1 HAZARDOUS WASTE PROBLEMS

2.1.1 Sources

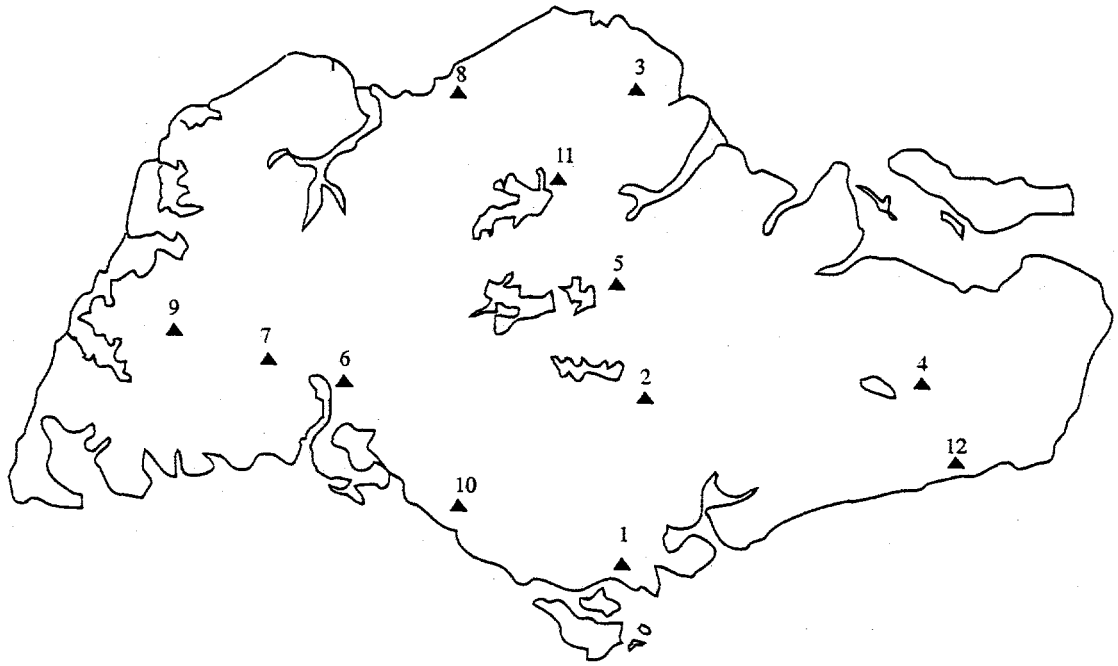
Singapore has major petroleum refining operations and is a center for international shipping. Both activities are major contributors to hazardous waste generation. Other sources include electronics and metal finishing operations.

In 1991, a total of 42,000 cubic meters of hazardous waste was collected by licensed operators. It was estimated that 80% was recycled. The remainder was treated before final disposal (MOE 1992a). No detailed data on sources or types of waste were available.

International shipping, which transports crude oil and petroleum products to and from Singapore, is estimated to generate about 10,000 tons of sludge per year.

2.1.2 Location

Most of the heavy industries in Singapore are located in the western part of the country, including some offshore islands (see Figure SING-1.) Smaller industries are distributed throughout the rest of the country. Some industrial estates exist that concentrate factories into areas where common services can be provided.



URBAN	INDUSTRIAL	RURAL
1 URA Building	6 Jurong Town Hall	11 Yishun SBMT Camp
2 Toa Payoh Library	7 Boon Lay Sec School	12 PA Campsite
3 Chong Fu Primary School	8 Woodlands Sec School	
4 Yumin Primary School	9 Nanyang Technological Institute	
5 Serangoon Depot (P&R)	10 Civil Service Institute	

FIGURE SING-1 Map of Singapore

One concept being considered is the development of a "chemical island" in the western part of the country. The idea is to use some of the offshore islands to expand Singapore's chemical industry. The islands would be linked by causeways. Development over a 20- to 30-year period is planned; a number of projects are slated for the next 10 years. If pursued, this development will require special hazardous waste treatment facilities to service the plants located there. Land has already been set aside in the area for industrial waste treatment facilities, although the scope and design of these facilities has not yet been determined.

2.1.3 Problems

The primary hazardous waste problem in Singapore is the lack of facilities to deal with the waste. The tanker sludge is shipped offshore (i.e., to other countries) for incineration, but

the feeling is that this measure is not adequate to meet continued sludge generation from increased shipping.

Industrial hazardous waste either is sent offshore or is stored in the country. Some is dumped with municipal waste. Although leaching of these materials has not yet been observed, there is concern that it may become a problem in the future.

2.2 GOVERNMENT STRUCTURE FOR DEALING WITH HAZARDOUS WASTE

2.2.1 Legislation

There are no specific requirements for the treatment and disposal of hazardous waste other than a generic requirement that this must be done so as not to threaten public health or the environment. The primary legislation that covers the control of hazardous waste in Singapore is the Environmental Public Health (Toxic Industrial Waste) Regulations (EPHA 1988). The regulations require waste generators to give notification when the total quantity of specified wastes exceeds prescribed limits. Twenty-five general waste categories are identified. These are further subdivided into more specific types of wastes. Waste generators must also keep records of all hazardous wastes, including documentation of their final disposition.

The regulations specify requirements for toxic waste collectors. Licensing requirements, record keeping, and transport limitations are included. A manifest system is used to keep track of the wastes. Waste collectors are limited to specified routes in moving toxic waste.

2.2.2 Agency Structure

The Ministry of the Environment is the organization responsible for dealing with all environmental matters in Singapore. Within the Ministry, the Environmental Policy and Management Division has responsibility for implementing environmental control programs. This division has three departments: the Pollution Control Department (PCD), the Strategic Planning and Research Department, and the International Environment and Policy Department. The PCD is responsible for dealing with hazardous waste. Figure SING-2 gives an organization chart for the PCD.

It was reported that environmental control was viewed, even within the Ministry, as an added cost to local businesses. The government was reluctant to enforce any strict environmental requirements unless it was evident that control techniques were available in Singapore and that they would not impose an undue competitive burden on local industry. Once regulations were passed, however, it was reported that enforcement was strict.

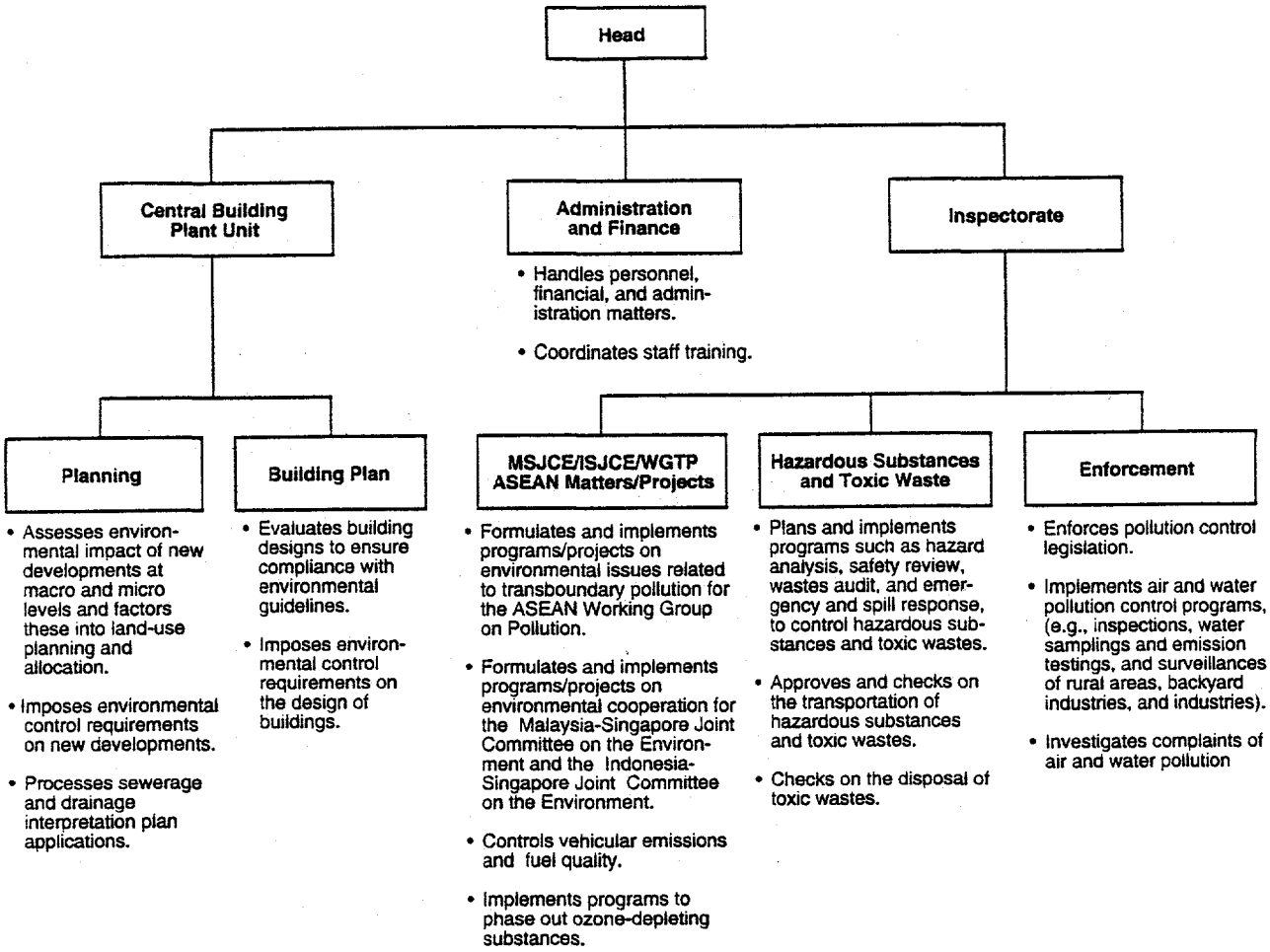


FIGURE SING-2 Organization of the Pollution Control Department

2.3 CURRENT HAZARDOUS WASTE ACTIVITIES

2.3.1 Existing Hazardous Waste Management

The stated policy in Singapore is to avoid industrial development that generates hazardous waste. During the process of screening applications for industrial development, the Economic Development Board reportedly determines whether any hazardous wastes generated can be handled by existing waste handling companies or by the proposed operation on-site. If not, the development project is not approved. An example of wastes that cannot be dealt with in Singapore is halogenated chemicals. These have been banned from industrial use in the country. In practice, however, few applications are rejected by the Board on the basis of hazardous waste generation.

Singapore has no integrated hazardous waste treatment facilities. Major companies handle their own hazardous wastes. Waste is either stored and treated on-site or is collected by licensed hazardous waste transporters and handlers. There are currently 94 licensed

handlers, each certified to handle only specific wastes (EPHA 1992). The handlers do some treatment of wastes and ship the residue to designated sections in sanitary landfills. It has been estimated that these landfills have a six- to seven-year capacity remaining. These landfills are not secure. The next landfill is expected to be built on an offshore island. Plans call for a liner and leachate collection system.

Sludge from electroplating operations has been identified as a special problem. Only two companies are licensed to handle this waste. Much of the plating waste is dumped in the sanitary landfills.

The oil tanker sludge problem is also of significant concern. The rate of generation is about 10,000 tons per year. Current storage capacity is 30,000 to 40,000 tons. The sludge is currently shipped offshore for incineration, but this is felt to be an inadequate approach. A tender for an incinerator with capacity in the range of 20,000 tons per year is close to being let.

2.3.2 New Hazardous Waste Treatment Facilities

Little work has been done on evaluating new integrated hazardous waste treatment plants for Singapore. Part of the reason for this situation is that the relatively small amount of hazardous waste generated does not lend itself to an economically viable central treatment plant. The other part of the reason is a government philosophy that relies on the private sector to deal with its own waste management with a minimum of regulation. The combination of these factors has led to no priority being given to the development of a centralized treatment plant.

The situation may change, however, if the chemical island becomes a reality. In this case, the concentration of industry in that area would require hazardous waste treatment facilities. It may then be economic to build a central treatment plant to service both the chemical industries and other industrial operations.

Although little detailed work has gone into analyzing the economic viability of a central treatment plant for the chemical island complex, some companies have done preliminary market studies of the concept. Most have come to the conclusion that there will only be sufficient waste to support one central plant. The government considers that this estimate may be low for the long term and that the need for such a facility will become significant within the next five years.

The current feeling is that if such a facility were to be built, the preferred method would be a purely private-sector operation. The use of monopoly agreements to allow the builder to have the sole centralized, off-site treatment facility would be acceptable. Factories could, however, elect to do their own on-site treatment. The government would not control the prices charged for treatment services; it would become involved only if the proposed pricing schemes would place an undue economic burden on industrial operations.

A feasibility study to evaluate the central treatment plant concept has been proposed. It is not universally considered to be a worthwhile exercise because the basic principle is that a private-sector company will do its own evaluation and make its own decision without any government support.

2.3.3 Site Cleanup

No work has been done on cleanup of contaminated sites in Singapore. The only sites that currently cause concern are the sanitary landfills used to dump treated industrial waste. Illegal dumping is not acknowledged as a widespread problem. The small area of the country limits the number of places where material can be dumped without its being noticed and reported in a matter of days.

2.3.4 Cleaner Production Technology

The use of cleaner production technology and waste minimization techniques is not widespread in Singapore. The Ministry of Environment has a new waste minimization department, but its initial focus is on consumer waste, not industrial waste.

The PCD has tried to promote recycling of wastes and the use of waste exchanges, but it has not made these practices regulatory requirements. Requiring factories to conduct environmental audits has been discussed, but this idea has not yet been implemented.

One factor that works against waste minimization is the system of credits for end-of-pipe pollution control equipment. Companies are allowed to take accelerated depreciation allowances on this type of equipment. In some cases, the equipment is required by law. While it works to control environmental discharges, this approach does not allow for any credits for cleaner production technology. There is a strong desire not to impose any burdens on companies that would jeopardize their competitive position.

2.3.5 Infectious Waste

Infectious waste is handled at two central incinerators that service the whole country. There is currently sufficient capacity to meet the demand.

2.4 OTHER RELATED ACTIVITIES

2.4.1 Green Plan

Singapore has prepared a master plan that outlines basic policy goals and steps to be taken to develop a "model Green City" (MOE 1992b). The Green Plan provides general guidelines but no specific actions or projects to be undertaken.

In the area of hazardous waste, the plan indicates that Singapore intends to upgrade its hazardous waste treatment facilities and require the use of safety audits. It also indicates that slop reception and treatment facilities to cope with waste oil and tanker sludge from the increasing international shipping activities will be upgraded.

A element of the Green Plan that is of special interest is the desire to develop Singapore into a regional center for environmental management by the year 2000. The establishment of the Institute of Environmental Technology in Singapore in 1993 is a step toward this goal. Although few specific details are given, it appears that the intent is to have environmental companies use Singapore as a base of operations for their activities in the region. This would be consistent with the way Singapore has developed other such "home base" operations.

2.4.2 USAID/ASEAN Projects

Singapore is not a U.S. Agency for International Development (USAID) country. However, two programs operated by USAID/Association of Southeast Asian Nations (ASEAN) in Singapore are related to hazardous waste: the Private Investment Trade Opportunities Project and the Environmental Improvement Project. The general structure of each is described in Section 4. There have not been any specific hazardous waste activities in Singapore under these two programs.

3 REFERENCES

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TAIWAN

CONTENTS

FIGURE

TABLES

TABLES (Cont.)

TAIWAN

1 BACKGROUND

Taiwan is an island nation with a population of over 22 million in an area about the size of Connecticut and New Hampshire combined. It has one of the highest population densities in the world. A map of Taiwan is provided in Figure TAIW-1.

Over the last three decades, Taiwan has changed from an agricultural economy into a newly industrialized and prosperous economy. The environmental damage from urbanization and industrialization has been very serious.

As Taiwan's economy is very dependent on foreign trade, most major manufacturing industries are export oriented or they supply export industries. In the early stage of industrialization, development focused on labor-intensive industries, such as the garment, textile, shoe, toy, and sundry good industries. The chemical industry also grew at a fast rate. In the 30 years from 1952 to 1982, the number of chemical plants in Taiwan increased more than tenfold from 5,622 to 62,474 (Chiang 1989). Amid concerns that increasing labor costs and an appreciated local currency are making Taiwan less competitive in lower quality and more labor-intensive products, companies are moving into higher quality and value-added products, including those in the high-technology sector.

The output of various industrial products in Taiwan is outlined in Table TAIW-1 (Price Waterhouse 1991). Industrial sector output, including mining, energy, manufacturing, and construction activities, dramatically rose by 107%, from $35.9 billion to $74.3 billion, from 1986 to 1991.

2 HAZARDOUS WASTE ISSUES

2.1 HAZARDOUS WASTE PROBLEMS

2.1.1 Sources

In 1985, the Bureau of Environmental Protection completed the first nationwide survey on the generation of industrial waste in Taiwan. The industries covered included manufacturing in both the private and public sectors (i.e., government-owned corporations). Agriculture, forestry, fishery, and construction industries were not included. Some of the data were obtained from analysis of samples; some were estimated by using hazardous waste generation figures obtained from Japan. The survey indicated that the manufacturing industry generated

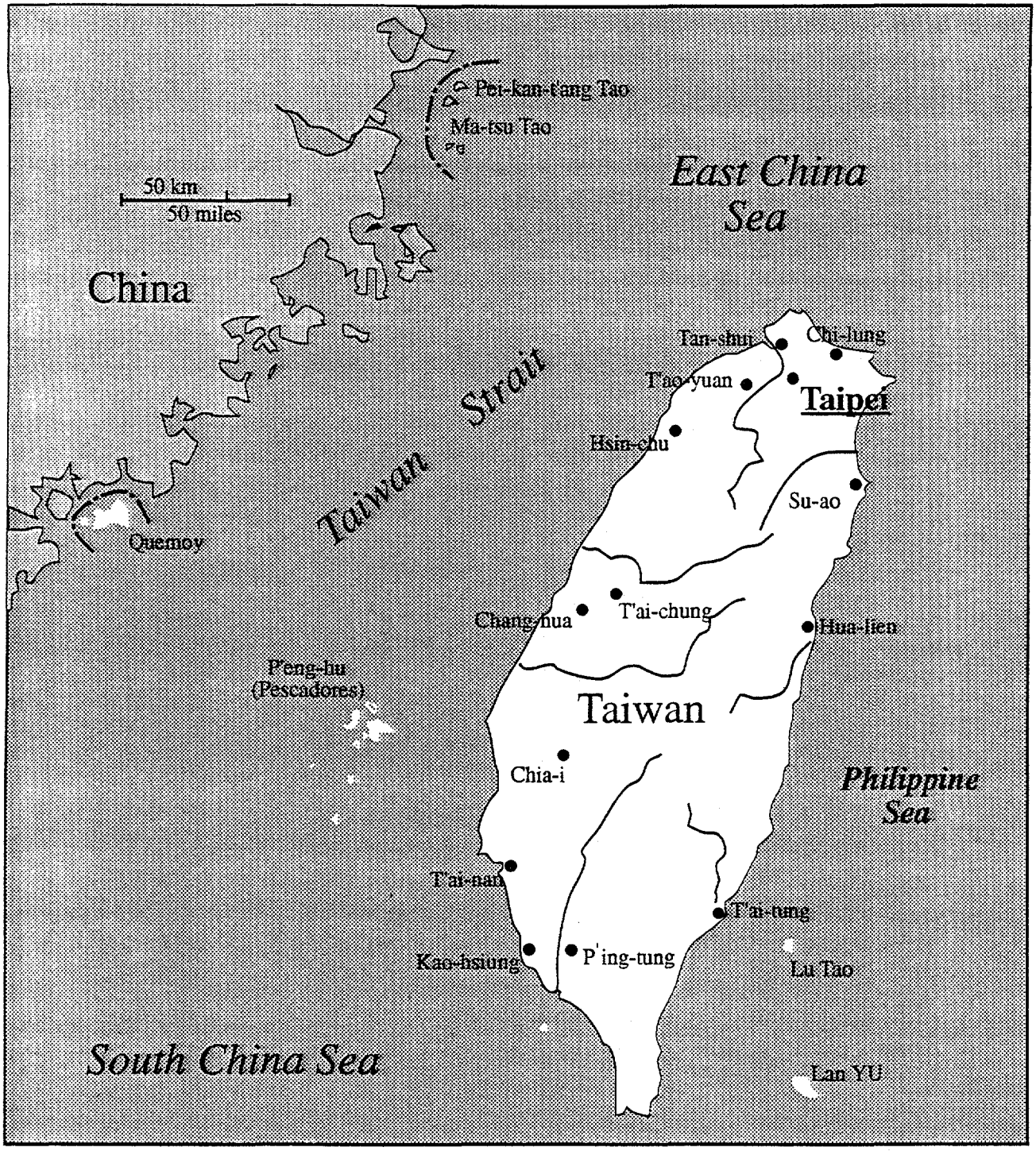

FIGURE TAIW-1 Map of Taiwan

TABLE TAIW-1 Output of Various Industrial Products

Products (Units)	1990	1989	1988	1987	1986
Garments (million dozen)	66	80	83	107	103
Artificial fabrics (1,000 metric tons)	2,565	2,382	2,039	1,975	1,798
Paper (1,000 metric tons)	3,311	3,018	2,955	2,700	2,493
Polyvinyl chloride (100 metric tons)	938	805	779	773	724
Shoes (million pairs)	416	598	811	877	862
Cement (million metric tons)	19	18	17	16	13
Screws (1,000 metric tons)	318	321	318	308	284
Iron plates (1,000 metric tons)	7,391	6,535	5,748	5,415	5,132
Color TV sets (1,000 sets)	2,089	3,713	3,743	4,448	3,988
Integrated circuits (million pieces)	2,488	2,289	2,073	1,910	1,651
Computers (1,000 sets)	3,394	3,198	3,068	2,032	1,218
Motor vehicles (1,000 sets)	358	323	276	253	175
Bicycles (1,000 sets)	7,088	7,213	7,350	10,227	9,768

Source: Price Waterhouse (1991).

30 million metric tons per year of solid and hazardous waste, of which 10% or 3 million metric tons was hazardous. Additionally, Taiwan kept 1,000 metric tons of polychlorinated biphenyl (PCB)-containing dielectric fluids and about 110,000 metric tons of mercury-contaminated sludge in impoundments (Yang 1989).

The most recent survey of solid and hazardous wastes from all industrial sectors was conducted in 1990. Data for manufacturing operations are presented in Tables TAIW-2 and TAIW-3 (Chung-Hsing Consultants 1992). Total industrial waste generation on the island was estimated to be 12 million metric tons per year (i.e., 60% less than the 1985 estimate), including 5.2% or 620,000 metric tons per year of hazardous waste. The industrial waste generation is projected to increase by 6% per year, to 21 million metric tons per year by the year 2000. On the basis of the quantity of solid and hazardous waste generated, the food processing and basic metal industries are the largest generators. Chemical materials and basic metal industries are the largest generators of hazardous wastes.

2.1.2 Location

Urbanization and industrialization in Taiwan has concentrated on the plain along the western coast of the island. Kaohsiung City and Kaohsiung County in the southern portion of the island, Taichung County in the center, and Taipei County in the north generate larger quantities of industrial waste than other areas. Waste from industrial parks represent 53.5% of total generation (Chung-Hsing Consultants 1992).

2.2 GOVERNMENT STRUCTURE FOR DEALING WITH HAZARDOUS WASTE

2.2.1 Agency Structure

The Taiwan Environmental Protection Agency (EPA), which was upgraded to cabinet level from the Bureau of Environmental Protection in 1987, has the overall responsibility for proposing and promulgating environmental laws and regulations and for planning and implementing environmental programs in the country. With a few exceptions, the responsibility for enforcement of environmental regulations lies with the local environmental protection bureaus (EPBs) of city and county governments. The environmental regulations require all factories or plants to implement control actions to meet the standards or be subject to fines or suspension of production activities.

Until recently, Taiwan did not have a system of permits or licenses specifically related to environmental protection. Many factory owners preferred to pay fines in lieu of investing in pollution control equipment, or to wait until they received a warning before making necessary improvements. To remedy the situation, the Taiwan EPA began in 1989 to promote a system

TABLE TAIW-2 Industrial Waste Generation by Industry

Industry	Waste Generation (metric tons per day) Total Waste	Hazardous Waste	Portion Hazardous (%)
Food	9,525.2	13.6	0.14
Beverage and Tobacco	241.9	0	0
Textile	719.9	2.9	0.41
Garment	46.7	0.1	0.21
Tannery	189.9	54.6	28.7
Furniture	1,476.6	1.8	0.12
Paper and Printing	1,160.5	8	0.69
Chemical Material	1,185.0	45.3	25
Chemical Products	147.9	15.8	10.7
Oil and Coal Refining	7.2	1.4	19.31
Rubber	375.5	0.03	0.01
Plastics	978.8	2.6	0.27
Non-metal Mining	1,395.7	1.7	0.12
Basic Metals	9,338.9	447.6	4.79
Metal Products	1,678.3	351.2	20.93
Machinery	814.9	54.1	6.65
Electric/Electronic Equipment	1,334.2	202.4	15.17
Transportation Equipment	751.9	74.5	9.91
Instrument Manufacturing	36.9	3.5	9.38
Other Manufacturers	591.8	3.4	0.57
Nonmanufacturing	34.4	0.6	1.73
Total	32,032.10	1,285.13	4.01 (Average)

Source: Adapted from Chung-Hsing Consultants (1992). Based on hazardous waste identification criteria being considered by the Taiwan EPA.

of reports, registration, and licensing for pollution sources, which would require factories to report, at regular intervals, to their environmental protection authority on the state of their pollution emissions. This project is still in the preparatory stage, although the Taiwan EPA has invested considerable resources in personnel training. The Taiwan EPA is also preparing the legal basis for requiring such reporting and licensing by promulgating new laws or amending existing laws.

On the basis of 1990 statistics, the total amount of professional staff in the environmental agencies, including those at the central, state, and local levels, was estimated to be about 1,900, as shown in Table TAIW-4. The Taiwan EPA is staffed with about 450 employees. About 55 of these employees are in a branch that manages municipal solid waste and industrial waste.

TABLE TAIW-3 Industrial Waste Generation by Waste Type

Waste Type	Waste Generation (metric tons per day) Total Waste	Hazardous Waste	Portion Hazardous (%)
Tank bottom	41.2	38.8	94.05
Organic sludge	2,133.2	46.0	2.16
Biological sludge	276.8	0.0	0.0
Inorganic sludge	4,286.4	130.4	3.04
Spent solvents	146.8	146.8	100.00
Waste oils	261.7	57.5	21.97
Waste liquors	294.6	63.6	21.57
Waste acids	392.8	270.3	68.81
Waste alkali	313.5	277.0	88.37
Fly ash	1,228.6	92.0	7.49
Combustion residues	893.6	11.3	1.27
Mining residues	6,395.4	295.8	4.63
Spent catalysts	5.6	2.9	51.56
Asbestos	14.7	14.0	95.73
Unused chemicals	17.8	12.4	69.43
Waste plastics	848.2	0.5	0.06
Waste rubber	525.7	0.0	0.00
Glass/pottery/porcelain	421.9	0.06	0.02
Construction waste	451.5	0.0	0.00
Waste metal	4,043.4	232.0	5.74
Waste paper	879.1	1.9	0.22
Waste wood	1,467.7	0.0	0.00
Waste fiber	25,340.2	0.0	0.00
Plant/animal residues	0.0	0.0	0.00
Other industrial waste	1,822.3	0.0	0.00
Total	326,621.1	1,693.3	5.18 (Average)

Source: Adapted from Chung-Hsing Consultants (1992). Based on hazardous waste identification criteria being considered by the Taiwan EPA.

TABLE TAIW-4 Professional Staff in Environmental Agencies

Agency	Total Staff	Staff Responsibility					
		Municipal Solid Waste and Hazardous Waste	Water	Air and Noise	Toxics R&D and Control	Monitoring	Other
Taiwan EPA	438	55	29	27	31	90	206
Taipei City EPB	447	189	13	14	13	11	207
Kaohsiung City EPB	209	78	8	24	9	12	78
Taiwan Province EPA	293	37	9	11	6	159	71
Counties and Cities EPB[a]	500	60	58	86	47	18	231
Total	1,887	419	117	162	106	290	793

[a] Including 16 counties and 5 cities under the Taiwan Provincial Government.

Source: Taiwan EPA (1991).

The EPBs of most cities and counties were created only recently in response to the need for environmental protection on the local level, where the priority programs are in municipal solid waste and waste water management. On the basis of the information collected during the study, the staffs of industrial waste management programs in city and county governments are generally small (no more than four persons in most cases), and their experience in dealing with hazardous waste issues is limited.

To be prepared for increased environmental activities on the local level, the Taiwan EPA had recruited and trained a total of 520 auditors and inspectors by the end of March 1991. They are currently assigned to work at local government units to strengthen their capability for enforcement and review of pollution sources (Young 1992).

Besides the Taiwan EPA, several other government agencies are designated to carry out specific responsibilities of environmental management. The Industrial Development Bureau (IDB) of the Ministry of Economic Affairs (MOEA) is responsible for managing environmental controls in industrial parks and for providing technical assistance and financial incentives to industries for pollution control and waste reduction. The National Health Administration (NHA) is responsible for planning and implementing hospital waste management.

2.2.2 Legislation and Enforcement

The specific legislation regulating hazardous waste disposal is the Waste Disposal Act, which was enacted in 1975, mainly to regulate municipal solid waste. The act was amended in 1985 and 1989 to include laws and regulations to regulate industrial waste.

Under the 1989 amendment of the Waste Disposal Act, waste is classified into two categories: general solid waste (i.e., municipal solid waste) and industrial waste. Hazardous waste is included as a part of industrial waste. The Taiwan EPA defined hazardous waste as "a solid waste generated from the industry, which has characteristics of being toxic and dangerous, and its quantity and concentration may pose a potential threat to human health and to the environment" (Chung-Hsing Consultants 1992).

The cradle-to-grave approach was adopted for managing hazardous waste in Taiwan under the Waste Disposal Act, which includes the following important features:

- Establishment of hazardous waste identification criteria;
- Formulation of a waste management plan;
- Establishment of the design and operating criteria for treatment, storage, and disposal facilities;
- Requirements for regulatory permits to install and operate treatment, storage, and disposal facilities;
- Implementation of a uniform manifest system; and
- Promotion of industrial waste minimization through recycle and reuse.

As stipulated under the Waste Disposal Act, a company is fined up to NT$150,000 (equivalent to US$6,000) on a daily basis if it violates rules dealing with the storage, treatment, or disposal of industrial and solid waste. When an enterprise seriously and persistently violates the criteria or rules regarding the management and handling of industrial waste, the government agency may stop its operations or suspend its business license.

Another rule, entitled Method for Storage, Treatment, Disposal of Industrial Waste and Facility Standards, was promulgated in 1989. This rule stipulates that companies in special industries designated by the authorities, at the time of establishment or alteration of scope of operations, must "submit industrial waste disposal plans to obtain operation permits" (Young 1992).

Enforcement of environmental regulations in Taiwan has generally been lax. As an example, even though hazardous waste control regulations were promulgated and became effective in May 1991, enforcement of these regulations is still not fully in place because of the

lack of a manifest system and off-site treatment and disposal facilities. The public, however, is becoming more concerned with environmental quality. Protestors have blockaded many polluting firms, and some factories have been forced to cease operation.

The Taiwan EPA has been given the task of providing more orderly environmental control. The agency is now close to completing a legislative framework with 19 laws and 53 regulations for the control of pollutants in all media. Law enforcement is becoming more rigorous as the enforcement infrastructure needed for monitoring, testing, and inspection improves. The Taiwan EPA has mapped out a five-year (July 1992-December 1996) medium-range plan to strengthen environmental management (Wang 1992b). The Taiwan EPA has listed a total of 16,000 factories as major water polluters and 15,000 plants as air pollution offenders. Although not specifically identified, most of these factories are also generators of solid and hazardous waste. These factories, under the supervision of the environmental protection agencies, will be required to install proper control equipment and to manage their waste properly within the next four-year period. Failure to comply will result in monetary penalties; continuing violators will be forced to close.

2.3 CURRENT SOLID AND HAZARDOUS WASTE ACTIVITIES

2.3.1 Current Hazardous Waste Handling Practices

On the basis of the information collected from various sources in Taiwan, the present disposal methods for solid and hazardous wastes from industrial sources include the following:

- Off-site treatment and disposal: There are few off-site facilities specifically designed to treat or dispose of hazardous waste in Taiwan. Some off-site treatment facilities involving stabilization and solidification processes have been built and licensed to operate.

- On-site storage, treatment, and disposal: On-site treatment of hazardous waste exists in some large refining or chemical manufacturing facilities. Most of these facilities use incineration. Some industrial complexes have wastewater treatment plants, but these plants generally cannot treat and dispose of the concentrates and sludges produced.

- Discharge to drains and rivers without treatment: This practice may be employed in industries, especially small- and medium-sized firms, but little information on the extent of its use is available.

- Dumping at municipal landfills: Codisposal of industrial hazardous waste with municipal solid waste in sanitary landfills and open dumps has been common in Taiwan.

- Illegal dumping by industry or haulage contractors: This situation is often mentioned, but little verifiable information is available.

- Ocean dumping: This procedure is used for some wastes from food processing and slag from steel mills.

No specific system for the collection and transportation of hazardous waste has been implemented in Taiwan. In many cases, solid and semisolid hazardous waste, especially from small- and medium-sized firms, is collected by the same system that is used for municipal waste.

2.3.2 Industrial Waste Management Facility Needs

A hazardous waste management plan for Taiwan was developed for the Taiwan EPA in 1992 by Chung-Hsing Consultants. In that study, a survey was conducted to determine industrial waste generation in the country, and regulatory control requirements were assessed (Chung-Hsing Consultants 1992). Under the Six-Year Development Plan,[1] the Taiwan EPA and IDB will jointly administer a program to further refine the plan, focusing on development of a policy for the collection and disposal of hazardous industrial waste. The program budget is estimated to be $41 million (Reinfeld & Associates 1992).

The investment needs for pollution control in private industry in Taiwan were estimated by the Industrial Technology Research Institute (ITRI) (Chen 1991). Table TAIW-5 lists these needs. For the period from 1991 to 1997, a total of $1.7 billion is needed for investment in the control of air and water pollution, management of solid and hazardous waste, and environmental monitoring for manufacturing industries in the private sector. Investment for solid and hazardous waste management was estimated to require about $470 million, or 28% of the total estimated investment need.

In addition to privately owned plants, many facilities are owned by national corporations that are planning to invest in environmental controls. These corporations include Taiwan Power (Taipower), China Petroleum Corporation (CPC), China Steel, and Taiwan Sugar (Taisugar). According to ITRI, these firms will invest more than $11.2 billion, of which $6 billion is for equipment, $3.9 billion for engineering services, $840 million for consulting, and $500 million for environmental monitoring (Chen 1991). On the basis of the information given in Taiwan's Six-Year Development Plan (Reinfeld & Associates 1992), the investment for environment-related infrastructure being planned by these corporations before 1997 is estimated to be $1.53 billion: $222 million by China Steel, $39.3 million by Taisugar, $408 million by CPC, and $858 million by Taipower.

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[1] Taiwan's six-year national development plan, announced in 1991, includes 775 specific projects to be performed from 1990 to 1996 to modernize and expand Taiwan's communications and transportation systems, upgrade traditional industries, clean up the island's environment, and develop 10 new industries. Total cost of the plan is estimated at $303 billion, including $15 billion for environmental programs (Reinfeld & Associates 1992).

TABLE TAIW-5 Investment Needs for Industrial Pollution Control from 1991 to 1996

Industry	Anticipated Investment in Environmental Control (US$ millions)				
	Air	Water	Waste	Monitoring	Total
Food, Beverage, Tobacco	0.0	73.2	26.4	5.2	104.8
Textile	0.0	120.8	34.4	17.2	172.4
Tannery	2.5	15.2	4.8	2.4	24.9
Paper and Printing	10.2	50.8	22.8	9.2	93.0
Chemical Materials/Products	144.0	324.0	180.0	72.0	720.0
Rubber	1.3	0.0	3.2	0.4	4.9
Plastics	25.2	0.0	54.8	4.0	84.0
Nonmetal Mining	72.8	6.8	39.6	13.2	132.4
Basic Metals	35.2	20.8	30.0	15.2	101.2
Metal Material and Products	4.4	7.2	3.2	1.2	16.0
Machinery	0.0	2.8	3.2	1.2	7.2
Electric/Electronic Equipment	16.0	36.8	16.0	4.0	72.8
Transportation Equipment	28.8	23.2	46.0	17.2	115.2
Instruments and Other	3.0	7.2	5.2	1.6	17.0
Total	343.00	688.8	469.6	164.0	1665.4

Source: Adapted from Chen (1991b).

A large portion of small- and medium-sized firms cannot afford their own solid and hazardous waste treatment and disposal equipment, although a number have their own wastewater treatment units. Many firms located in industrial parks use the wastewater treatment plants at the parks, which are generally owned and operated by MOEA/IDB. At present, there is a pressing need for centralized facilities for treatment and disposal of solid and hazardous wastes to serve these firms. The central industrial waste treatment and disposal facilities that are being designed or planned in Taiwan are discussed in the following sections (Reinfeld & Associates 1992).

2.3.2.1 Tafa Hazardous Waste Treatment/Disposal Center

The Tafa Hazardous Waste Treatment/Disposal Center will be located in Tafa Industrial Park, Kaohsiung County (southern Taiwan). It is designed for storage, treatment, and disposal of industrial hazardous wastes generated from industrial parks in southern Taiwan. The facility will consist of incinerators, physical and chemical treatment, stabilization and solidification, sanitary landfills, and secured landfills. The design is basically that proposed in the feasibility study performed by Bechtel Environmental, Inc. (Bechtel 1988).

The facility is currently under preliminary design by ICF Kaiser, a U.S. firm, which received the general design consultancy. The budget for this project is $125.2 million. It is to be jointly administrated by the Taiwan EPA and IDB with Ret-Ser, a state-owned engineering agency. Ret-Ser, the prime contractor, is investing its own funds and seeking a foreign equity partner for the project. Ret-Ser has also received a significant loan from the IDB. Ret-Ser and its partner are to own and operate the facility. The facility is scheduled to begin operation in 1995. However, the project is facing delays due to contract negotiations and inconsistent or unclear funding mechanisms. The project's implementation is also complicated by protests from neighbors who do not want the facility located near them.

2.3.2.2 Tafa Special Industrial Waste Treatment/Disposal Center

The Tafa Special Industrial Waste Treatment/Disposal Center is to be located next to the Hazardous Waste Treatment/Disposal Center in Tafa Industrial Park. It will receive and incinerate scrap metal wastes that are currently scattered throughout various parts of southern Taiwan. Its budget is $65 million. The Taiwan EPA is overseeing this project. ICF Kaiser is the general design consultant, and Ret-Ser has been given the contract to operate this facility in tandem with the hazardous waste facility. A detailed incinerator design has been prepared by WTE Technologies, a U.S. firm. This project is facing delays similar to those confronting the hazardous waste facility.

2.3.2.3 Other Central Hazardous Waste Treatment and Disposal Facilities

Under the current Industrial Waste Management Plan, one or two additional central hazardous waste treatment facilities are required in Taiwan. The amount of $83 million has been budgeted for a treatment center under the Six-Year Development Plan. The size, location, and scope of the project, however, has not been defined. It is expected, however, that Ret-Ser and other state-owned engineering firms will play a major role in the project. A recent paper identified the need for a total of 16 hazardous waste incinerators in the next decade (Li 1993).

2.3.3 Municipal Solid Waste Management Facility Plan

Approximately 7.9 million metric tons per year of municipal solid waste is currently collected in Taiwan. The Taiwan EPA estimates that municipal solid waste generation will increase by 6% annually, to 10 million metric tons per year by 2000. Although 61.4% of municipal solid waste is now properly disposed of in sanitary landfills (60%) or incinerators (1.4%), the existing sanitary landfills are expected to be full within one to two years. Because of difficulties in acquiring land, sanitary landfills will be de-emphasized in urban areas. Incinerators will be employed in the near future, with preference given to large plants. Under the current Taiwan EPA municipal solid waste management strategy, 85% of municipal solid waste collected in 1996 and 100% of that in 2000 will be disposed of properly. By 2000, after all the planned incinerators are built, 60% of the collected municipal solid waste will be incinerated.

In addition, it is expected that a waste recovery of 9,500 metric tons per day will be achieved, leading to the reduction of the municipal solid waste annual growth rate from 6% to 5% (Chen 1991).

Under Taiwan's Six-Year Development Plan, 84 municipal solid waste facilities will be installed by 1997. These facilities include 23 incinerators, 60 landfills, and a compost plant. Accessory equipment, including 469 garbage trucks, 148 drain-cleaning vehicles, and 105 street-sweeping cars, is also needed (Wang 1992a). The budget required for these landfills, incinerators, and equipment is estimated to be approximately $3.8 billion (Chen 1992).

The planned incineration projects are listed in Table TAIW-6. With the exception of the Neihu incinerator, which was scheduled to be completed in late 1992, all the units are being designed or planned. On the basis of the 16 incinerators that have been budgeted, the required funds total $2.76 billion.

To promote waste reduction, the Taiwan EPA has launched an aggressive "Hsi-Fu" recycling project for collecting, treating, and recycling selected used consumer products. Items that have been targeted for recycling include plastic bottles, old tires, paper, lubricant oils, aluminum cans, glass, cars, motorcycles, fluorescent light tubes, and mercury cell batteries. The current Taiwan EPA target is to recover 50% of recyclable waste, which accounts for 40% of the island's total waste. Under the Six-Year Development Program, a budget of $226 million has been allocated for establishing recycling plants (Reinfeld & Associates 1992).

2.3.4 Hospital Waste Management Facility Needs

According to the 1990 statistics, Taiwan has a total of 827 hospitals and 12,075 clinics (NHA 1991). These institutions together have 89,151 beds and generate approximately 112 metric tons per day of medical waste, including 39 metric tons per day of infectious waste (Chung-Hsing Consultants 1992). Table TAIW-7 shows the amount of waste generated.

The NHA is the leading agency for planning and administering hospital waste management programs under the general regulatory guidance provided by the Taiwan EPA. As the majority of health institutions are small- to medium-sized hospitals and clinics, NHA plans to build a number of central treatment and disposal facilities for medical wastes.

The existing medical waste incinerators in Taiwan are capable of treating 20% of the waste generated on the island (NHA 1992). Additional medical waste incinerator needs in Taiwan include 3 large units (100 metric tons per day each) and 30 small units (ranging from 2 to 3 metric tons per day each) (Tsai 1992). Total investment for these facilities is estimated to be approximately $150 million.

TABLE TAIW-6 Municipal Solid Waste Incinerator Projects

Incinerator	Supervisory Organization	Capacity (metric tons per day)	Budget (millions of dollars)	Completion Date
Chiayi	EPA	300	54	12/94
Taipei County Shulin Regional	EPA	1,350	204	06/94
Taipei County Hsintien Regional	EPA	900	158	01/94
Taichung City Nantuan Regional	EPA	900	167	06/95
Hsinchu City Nanliao Regional	EPA	900	144	06/96
Taipei County Pali Regional	EPA	1,350	216	01/96
Keelung City Tien-Wai-Tien Regional	EPA	900	145	12/97
Hsinchu County Hsinfen Regional	EPA	N/A	N/A	12/96
Taichung County Houli Regional	EPA	N/A	N/A	12/96
Changhwa County Hsinchow Regional	EPA	900	N/A	12/97
Pingtung Kangting Regional	EPA	900	150	06/96
Tainan County Regional	EPA	900	168	12/97
Tainan City Regional	EPA	900	168	06/95
Kaohsiung County, Jenwu Regional	EPA	1,350	113	06/96
Taoyuan County South District Regional	EPA	1,350	202	12/97
Taichung County Regional	EPA	900	202	06/96
Ilan County Regional	EPA	600	N/A	12/97
Taipei City Nei-Hu Regional	Taipei EPB	900	100	1992
Taipei City Shilin	Taipei EPB	1,800	296	12/95
Taipei City Mucha	Taipei EPB	1,500	175	12/94
Kaohsiung City Southern	Kaohsiung EPB	N/A	34	12/97
Kaohsiung City Central	Kaohsiung EPB	N/A	34	12/97
Kaohsiung City Northern	Kaohsiung EPB	N/A	34	12/97

Sources: Reinfeld & Associates (1992) and Wang (1992a).

TABLE TAIW-7 Hospital Waste Generation

	Waste Generation (metric tons per day)					
	Hospitals		Other Institutions[a]		Sum	
Year	Total Waste	Infectious Waste	Total Waste	Infectious Waste	Total Waste	Infectious Waste
1989	59.09	19.91	6.04	2.66	65.11	22.57
1990	104.8	35.29	7.79	3.7	112.5	38.99

[a] Including community clinics, private clinics, medical laboratories, midwives, and animal hospitals.

Source: Adapted from Chung-Hsing Consultants (1992).

2.3.5 Emergency Response Programs

Emergency and response action planning for industrial accidents is relatively undeveloped in Taiwan. Under the Six-Year Development Plan, $17 million was budgeted to establish chemical disaster prevention systems. An additional $17 million was allocated for toxic chemical projects. The full scope of these projects has not yet been defined (Reinfeld & Associates 1992).

2.3.6 Industrial Waste Exchange

An industrial waste exchange program has been in operation since 1987 at the ITRI, with the support of MOEA/IDB. A bimonthly newsletter informs industrial customers about available and requested waste material. Through 1990, more than 140,000 metric tons of waste material was exchanged through the program. The materials most frequently exchanged included waste alkali, mine residues, organic chemicals, food processing wastes, and used solvents (Huang and Chen 1991).

2.3.7 Industrial Waste Minimization

Under the present environmental protection program in Taiwan, steps are being taken to promote industrial waste minimization. Formulated in 1991, the industrial waste minimization promotion plan includes voluntary actions to be implemented in a phased approach within the six-year period from 1991 to 1996. The goal is to reduce hazardous waste generation by 50% in the 11 years from 1990 to 2001. Government agencies and contractors are providing information to the general public on the importance, benefits, and limitations of

waste minimization technologies and practices. They are also acting as a clearinghouse for information on waste minimization technologies and as a source of technical assistance to industry for identifying and implementing waste minimization practices. Government agencies and banking institutions are acting as the financial sources for research, development, and demonstration of new technologies and for providing subsidies and other economic incentives to adopt waste minimization practices. Mandatory regulatory measures, such as plant pollution audits, may be imposed in the years to come, depending on the results and effectiveness of voluntary compliance measures (Lin 1991; Tseng 1992).

2.3.8 Uncontrolled Contaminated Site Remediation

Lack of environmental control over several decades has resulted in many, yet uncharacterized, contaminated sites in Taiwan. These sites include open dumps, industrial plants, croplands (contaminated from irrigation with industrial effluents), and creeks and rivers.

With the present emphasis on dealing with problems associated with ongoing pollutant generators, the Taiwan government does not appear to be ready to commence an all-out effort to clean up contaminated sites. No information is available (at least in the public domain) on the location and nature of these contaminated sites. Nor are there any established technical standards for cleanup or guidelines pertaining to the liabilities of responsible parties. In the interim, limited activities are being planned by the government, aimed at collecting background information and formulating plans and strategies for dealing with the problem eventually.

Under the Six-Year Development Plan, a project will be carried out by the Taiwan Provincial Government, at a cost of $1.9 million, to study heavy metal contamination of farm lands by industrial wastewater pollution. Another project, with a budget of $148 million to be funded through the Taiwan EPA, will assess the status, technologies, and practices that prevent groundwater contamination. Still another project, to be funded by the Taiwan EPA at a budget of $35 million, is to develop methods to reduce soil pollution by agricultural activities. In addition, two projects are to be performed for the Kaohsiung City Government to rehabilitate polluted segments of the Houching River (at a cost of $13 million) and the Chiencheng River (at a cost of $19 million) in the southern part of Taiwan (Reinfeld & Associates 1992).

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THAILAND

CONTENTS

FIGURES

THAILAND

1 BACKGROUND

Thailand is a rapidly industrializing country. Industry accounted for 25% of the gross domestic product in 1970 and 36% in 1990. The number of government-registered factories, excluding rice mills, grew from 631 in 1969 to 51,500 in 1989. Rice mills amounted to about 50,000 factories in 1989 (ESCAP 1992). The largest components of the Thai industrial sector are food processing, transport equipment, fabricated products, and machinery parts. In the 1980s, high growth was seen in machinery production, leather goods, electronics, plastic products, rubber products, toys, transport equipment, paper products, and chemicals. The seventh five-year national economic and social development plan, covering 1991-1996, emphasizes the continued development of six industries: agro-industry, textiles, clothing, electronics, petrochemicals, and basic metals (EWC 1992). These industries all generate hazardous waste that must be dealt with.

2 HAZARDOUS WASTE ISSUES

2.1 HAZARDOUS WASTE PROBLEMS

2.1.1 Sources

Currently, the largest hazardous waste generators in Thailand are metal smelting and manufacturing, which account for 47% and 33%, respectively, of the hazardous waste projections for 1991. Other significant generators are the commercial/service sector, marine and harbor pollution, and hospitals and laboratories, each of which is responsible for about 6% of the total. Heavy metals and sludges make up 57% of the hazardous wastes; oils, 17%; and acid wastes, 10%. Other major wastes include solvents, inorganic sludges and solids, and photo wastes. Municipal waste is estimated to account for 0.9% of the hazardous waste total (special problems with discarded fluorescent lamps and batteries were cited) and infectious waste, about 6% (U.S. Trade and Development Agency [TDA] 1989b).

A great deal of uncertainty exists regarding the quantities of hazardous waste actually generated in Thailand. A study sponsored by the TDA (1989a,b) is still considered to be the best inventory of waste generation; however, the responsible Thai agencies consider the estimates to be high. The TDA study used employment-based coefficients to estimate waste generation rates; factory visits were not used extensively. As a result, it is felt that some of the data may be as much as a factor of two too high. Illustrative of this problem is a comparison of data published in Lohwongwatana (1990) and ESCAP (1992) to the data of the TDA work. The

original TDA work estimated total hazardous waste generation to be almost 2 million metric tons in 1991. Later data published by Thai organizations have reduced this to 1.2 million metric tons, with the bulk of the change coming in the heavy metal sludges.

The manner in which many industries handle their wastes is poorly understood. Some appear to be storing hazardous wastes in anticipation of the opening of a centralized waste treatment facility to which they can send it. Some are dumping the material on their own land or having it hauled away illegally. Experience with other environmental controls implemented by industries leads to the belief that even those industries that have purchased and installed some control equipment do not operate it but use it only to show compliance with legal requirements.

One of the primary needs in Thailand is the development of a more reliable estimate of hazardous waste generation. Reliance on factory visits and sampling of actual waste streams is the preferred method. The development of a computerized database to manage the information is an identified need.

2.1.2 Location

Much of Thailand's industry is located in the Bangkok Metropolitan Region (BMR). More than 50% of registered factories are in the BMR. About 17% are in the Central Region, which includes the eastern seaboard (EWC 1992).

Many of the older, smaller factories in the BMR are interspersed with residential and commercial areas. These facilities were built prior to the implementation and enforcement of zoning control. The current government policy is to encourage factories to locate away from the BMR and to concentrate them in industrial estates. These estates are designated for industrial development and provide factories with common facilities such as roads, water and electricity supplies, and waste handling.

There are currently 22 industrial estates in Thailand, ranging in size from 200 to 7,250 rai (80 to 2,900 acres). Although most are in the BMR, the Industrial Estates Authority (IEA) is actively promoting the development of new estates away from Bangkok. Figure THAI-1 shows the proposed locations of new industrial development zones as promoted by IEA.

Very little information about the handling of hazardous waste in the industrial estates is available. The IEA is responsible for the administration of these facilities and operates independently of the other Thai government environmental organizations.

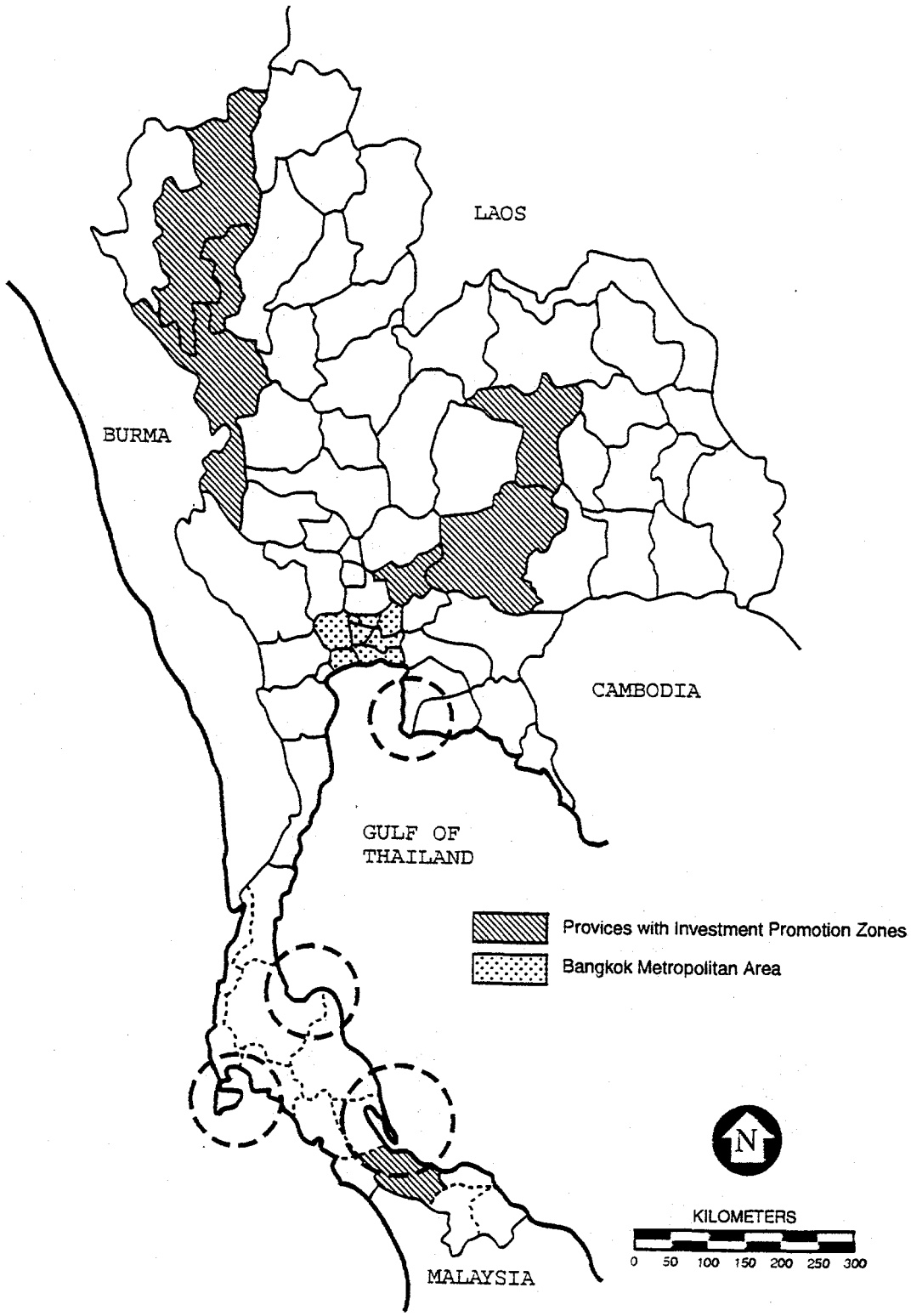

FIGURE THAI-1 Proposed Industrial Estate Locations

2.1.3 Problems

With the exception of the large multinational companies, which have some waste treatment equipment of their own, most industrial operations have no access to controlled hazardous waste treatment facilities. Because only one small facility handles hazardous waste, most factories either store their wastes on-site or dump them illegally. In some cases, hazardous waste is simply included with a factory's solid waste or wastewater and is discharged in an uncontrolled fashion. In other cases, particularly with sludges, the material is carted away to be dumped in vacant land. It is not uncommon to see discarded chemicals in open dumps. Some of the larger industries pretreat their hazardous wastes before discharging it with other wastes, but this is not done in any regulated fashion. Factories that store their wastes have reported that they are running out of room to stockpile the material. They are pressing for some form of government action to handle the overflow.

2.2 GOVERNMENT STRUCTURE FOR DEALING WITH HAZARDOUS WASTE

2.2.1 Legislation and Agency Structure

The primary piece of legislation that covers environmental protection in Thailand is the Enhancement and Conservation of National Environmental Quality Act (ECNEQA 1992), which took effect in June 1992. This act assigns basic responsibility for environmental control to the National Environment Board (NEB), which was set up under earlier legislation but now has an expanded role. The NEB is chaired by the Prime Minister and has 13 cabinet ministers and other senior government officials as members. Eight additional members are drawn from the private sector.

The NEB has broad responsibility to develop and submit policies to the cabinet, plan for environmental protection, prescribe environmental quality standards, propose amendments to environmental laws, and supervise the enactment of environmental laws. Although NEB has been in existence since 1975, the new act gives NEB a much broader role in policy formulation and in enforcement. The enforcement powers of the NEB under the new law are comparable to those that are available to the Police Department. It has been reported, however, that extensive enforcement of environmental laws has not yet been carried out by NEB because of severe staff shortages. Also, the traditional Thai reluctance to impose on another's activities has slowed enforcement efforts.

The staff work for the NEB is carried out by three departments, all of which are administratively attached to the Ministry of Science, Technology, and Environment. The three departments are the Office of Environmental Policy and Planning, the Pollution Control Department, and the Environmental Quality Promotion Department. In the area of hazardous waste control, the Pollution Control Department has the most significant role.

In addition to the NEB, the other Thai government agency that is a principal participant in hazardous waste control is the Ministry of Industry (MOI). The Department of Industrial Works (DIW) of the MOI is the group charged with the responsibility of, among other things, monitoring industrial compliance with environmental regulations and providing for selected environmental control services to industry. The DIW is the key organization attempting to develop and implement an industrial hazardous waste control system. Figure THAI-2 is an organization chart of the DIW.

Two pieces of legislation give the DIW responsibility for industrial pollution control: the Factory Act (1992) and the Hazardous Substance Act (1992). The Factory Act is an enhanced version of a law originally passed in 1969. It gives the DIW authority to regulate industrial activities by the licensing of factories. The DIW must issue a permit for a factory to be built. An operating permit is also required and must be renewed on a regular basis. As part of the process of issuing a permit, the DIW has the authority to request information about the factory's operation, including compliance with environmental requirements. A registered engineer must approve the layout of a factory as well as the environmental control. The DIW is considering licensing third-party companies to serve as inspectors to review environmental controls on its behalf.

As a companion rule to the Factory Act, Ministerial Decree No. 25, which was issued in 1988, has specific provisions that apply to the handling of hazardous waste.[1] This decree identifies what is to be considered a hazardous waste. It also requires a factory either to treat and dispose of the waste on-site according to specified requirements or to comply with DIW procedures to move the waste off-site for treatment and disposal.

Enforcement of the provisions of the decree depends on accurate reporting of the quantity of hazardous waste generated and its disposition by the factory owner. The DIW staff conducts spot checks, but only infrequently because of staff shortages. There are many anecdotal stories of gross under-reporting of waste generation (by a factor of 10 in one case) and falsified reporting.

The DIW, through its Factory Control Division, has recently formed a committee to consider strategies to locate factories that generate hazardous waste in special zones. The Bangkok and Samutprakarn areas are of primary concern. The committee will also consider incentives to move existing factories into appropriate industrial parks.

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[1] Ministerial Decree 25 was issued under the original Factory Act and its subsequent amendments. It is still applicable under the new Factory Act.

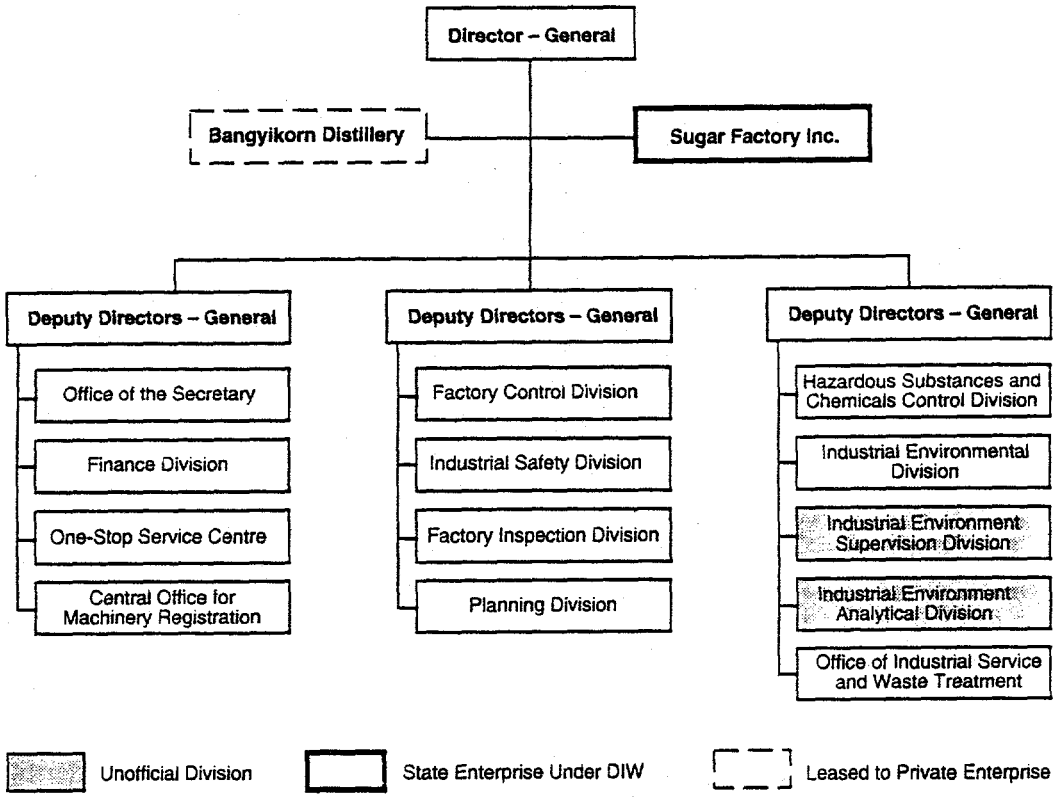

FIGURE THAI-2 Organization of the Department of Industrial Works

The Hazardous Substance Act sets up a Committee on Hazardous Substances, which is chaired by the Permanent Secretary of the MOI. An important feature of this group is the required membership of three representatives of nongovernment organizations. The committee has the responsibility for developing recommendations for the control of hazardous substances. These recommendations are implemented by cabinet decision if there are key issues or a conflict among committee members. The ministry that is affected by a specific regulation implements the recommendations. This act provides the broad legal basis for controlling hazardous wastes (as well as other toxic substances) in Thailand.

2.2.2 Inter-Agency Cooperation

Thai law divides the responsibility for hazardous waste control between the NEB and the DIW. As is typical in all governments, there is frequently a lack of coordination and cooperation across agency lines. In the past, the DIW has had the principal line responsibility for dealing with industrial hazardous waste because it is the organization with direct permitting control over factories. The new environment law puts more responsibility on the NEB. The implications of this added authority have not yet been worked out in practice.

The DIW has, at times, been questioned on whether it can successfully manage industrial pollution while it is administratively located in a ministry that has primary

responsibility for industrial growth and development. Such apparent conflicts of interest have not stopped the DIW from moving ahead with hazardous waste control efforts; however, its effectiveness has sometimes been questioned.

2.3 CURRENT HAZARDOUS WASTE ACTIVITIES

Thailand is actively pursuing several activities in hazardous waste control. The need for a decision by the government in several critical areas is the primary issue to be resolved before substantive progress toward implementation of waste control efforts can be made.

2.3.1 Hazardous Waste Management Planning

Following the completion of the TDA-sponsored study, a series of workshops led by NEB resulted in the development of a 15-point plan for the control of hazardous waste in Thailand. The elements of the plan (HWMP 1992) are as follows:

- Development of a definition of hazardous wastes,
- Planning for on-site segregation and storage of hazardous waste,
- Development of a hazardous waste transportation plan,
- Development of a waste minimization plan,
- Setup of centralized treatment facilities,
- Construction of a final waste disposal facility,
- Development of a hazardous waste inventory system,
- Handling of accidental spills,
- Control of heavy metal contamination from mining operations,
- Control of polychlorinated biphenyls (PCBs),
- Encouragement of private sector involvement in hazardous waste management,
- Revision of hazardous waste laws,
- Conduct of training and public education,

- Development of a monitoring and control plan, and
- Development of a financial plan.

Despite the comprehensive nature of this planning effort, it has not yet been submitted to the cabinet for review and approval. Also, the plan must be revised in light of the new environmental laws.

Even though this plan has not received full government review and authorization, it still serves as an informal guide to the steps that need to be taken. A number of items are actively being pursued and developed. A major problem in the implementation of these activities is the limited amount of NEB staff with training and experience in hazardous waste control. Few have had any direct exposure to training courses or actual field experience in planning a comprehensive hazardous waste control program. There is a pressing need for technical support and training in this area.

2.3.2 Existing Centralized Hazardous Waste Treatment Facilities

There is currently only one centralized hazardous waste treatment facility in Thailand. It is at Samea Dam, Banghuntien District, a western suburb of Bangkok (Figure THAI-3). It has been operating since 1988. The facility is capable of physical and chemical treatment, with an emphasis on the wastes from electroplating and textile dyeing factories. There is currently no secure landfill for the permanent disposal of the Banghuntien facility's processed wastes. Plans are being made for a secure landfill in Ratchaburi province, about 100 km away.

The Banghuntien facility was built at a cost of about 32 million baht ($1.3 million). The capital cost, including land, buildings, and equipment, was paid by the Thai government. The facility is leased to a private Swiss company, SGS Environmental Services, for a small royalty fee of 50,000 baht ($2,000) per month. The company charges industries a waste treatment fee to cover its operating costs.

The facility processes just over 10,000 cubic meters of hazardous waste per month. Sludge accounts for about 5% of the total; the rest is wastewater. The facility is running at about 85% capacity.

In the first three years of operation, there was substantial difficulty in getting wastes sent to the plant. This problem, combined with a low government-controlled user fee, led to serious financial deficits in the operation of the facility. Now, with better enforcement of regulations, the plant is approaching a breakeven operation. Another factor that is encouraging

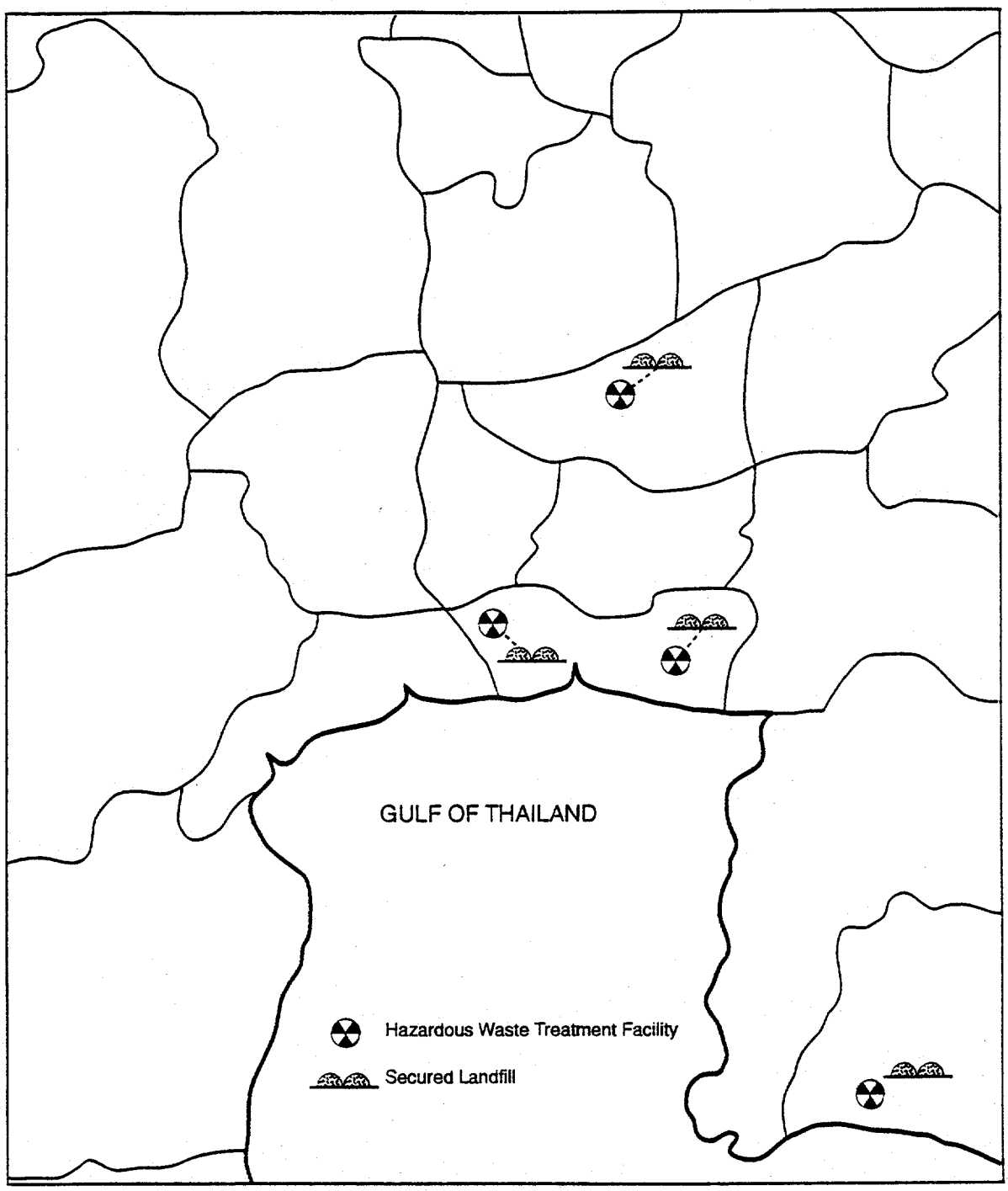

FIGURE THAI-3 Location of Existing and Proposed Hazardous Waste Treatment Facilities

factories to use the facility is the transfer of legal liability. Once hazardous waste leaves the generator's site, the factory is no longer liable for any damages caused by the waste. Since the law prohibits factories from transporting hazardous waste, the SGS pickup and transport of wastes, combined with the transfer of liability, is an attractive situation.

Although this facility is available, some factories still substantially under-report the quantity of waste they generate and its hazardous characteristics. The government has been reluctant to penalize these companies because they are at least using the treatment facility.

The price charged to waste generators is substantially below the full cost recovery of the Banghuntien facility. By one estimate, the recovery of the capital as well as the operating costs would require a price that is four to five times higher than what is currently charged. One opinion has been offered that a price even higher than the full cost recovery would be acceptable to many industries because of the transfer of liability.

2.3.3 New Centralized Hazardous Waste Treatment Facilities

Discussions for up to five new centralized hazardous waste treatment facilities are currently under way (Figure THAI-3). The discussions on these facilities were begun following the completion of the TDA-sponsored study. Initial plans called for one of the new facilities to be open in 1993 and two others in 1995. Implementation is far behind schedule.

Three sites are designated to serve the Bangkok area: Chonburi, Ratchaburi, and Saraburi. The Chonburi site can also serve the heavily industrialized eastern seaboard (the eastern shore of the Gulf of Siam). The fourth site is at Rayong, at the southernmost end of the eastern seaboard. A fifth site to service the petrochemical industry on the eastern seaboard has recently been proposed and will be discussed separately.

Site evaluations have been completed or are in process at Chonburi and Ratchaburi. Work on Rayong has just begun. All the sites are planned to have the full spectrum of hazardous waste treatment, including physical and chemical treatment, incineration, solidification and stabilization, and secure landfill disposal.

The DIW considers Ratchaburi to be the highest priority. The secure landfill will be the first element completed and put into operation. Its initial use will be to provide final disposal for material processed at the Banghuntien treatment center. The initial cells in the landfill will use a 50-cm clay liner with a leachate collection system. Subsequent cells will use a single-layer high-density polyethylene liner and then a double layer. Suppliers are being sought for the liners.

An incinerator is planned for the Ratchaburi facility, but there has been some public opposition to its location near populated areas. It is believed that it may take another two years to get an incinerator approved even though the funds have already been approved in the Thai government's budget.

Public acceptance is also a problem for the facility at Chonburi. The local government has joined public opposition to the facility on the basis of its being too near to a populated area. The current approach at Chonburi is to slow down the implementation process to allow for more public input and exchange of ideas and information. Also, it may be desirable to have industry in that area concentrate more on on-site waste handling. To date, there has been no economic analysis of the relative merits of on-site compared with centralized hazardous waste treatment in the area. One opinion was that the Chonburi facility may never be implemented because of the public opposition.

In developing tender documents for hazardous waste incinerators, the DIW called on the United Nations Industrial Development Organization (UNIDO) to provide expert services. The DIW sought an objective viewpoint that did not reflect a particular country's commercial interests. The UNIDO representative who arrived in April 1992 provided some initial information for the development of bidding documents for small rotary kiln incinerators (8,000-14,000 tons per year). The UNIDO expert did not return to complete the work because of medical problems. A replacement consultant has recently arrived and is preparing a specification report. Preliminary design specifications call for rotary or rocking kilns with a capacity of 2 tons per hour at a cost of about $10 million. Bid documents are expected in mid-1993, and completion is scheduled for 1994.

Two major issues appear to be influencing the implementation of the new hazardous waste treatment centers: the economics of the operation and the role of the government in the projects. The economics of the new hazardous waste treatment centers is a subject of much debate and uncertainty within the DIW, NEB, and other Thai organizations. Because there is a great deal of uncertainty in the waste generation data and the economic feasibility evaluations developed under the TDA-sponsored study, there is considerable uncertainty about whether the treatment centers can be operated profitably and at a cost acceptable to the waste generators. It is not sure whether an adequate volume of waste will be shipped to the centers or whether the rates can be high enough to recover both operating costs and capital investments. The DIW is especially concerned about moving ahead with one or more large treatment centers and then finding that there is insufficient waste volume. Lack of adequate waste quantities might lead to pressure to import waste from outside the country or to ship waste long distances across the country, both of which are considered to be unacceptable options.

An indication of the extent of this problem is the discussions that were held with an Australian group on the construction of a centralized hazardous waste treatment facility. The DIW was willing to grant the group a permit to operate in accordance with the Factory Act's requirements. The Australian group wanted the authority to import wastes and tax incentives to ensure a profitable operation. The Thai government was unwilling to agree to these issues and terminated discussions. Again, the lack of a clear economic feasibility evaluation based on a reliable characterization of waste generation led to a decision not to move forward.

A more reliable evaluation of the economics of each of the planned hazardous waste treatment centers is clearly a critical need. As currently structured, the MOI has the final decision on the implementation of any new central treatment facility.

The roles of the government and the private sector in hazardous waste treatment plants are another issue influencing the implementation of these projects. The existing treatment facility at Banghuntien was built with government funds and is leased to a private company for operation. There is uncertainty about whether this will be the preferred approach for the other facilities. The DIW appears to prefer this approach, at least for the next facilities to be built (at Chonburi, Ratchaburi, and either Saraburi or Rayong). This approach would allow relatively low fees to be charged to users of the plants. The NEB, on the other hand, seems to prefer more private-sector involvement in both construction and operation. The point is made that the new environment law encourages private-sector activities.

One aspect of this issue, however, seems to generate much confusion and debate. When discussions regarding private-sector involvement in hazardous waste treatment facilities are held, there is often wide variation in the definitions of what constitutes a private-sector operation. One viewpoint is the traditional, fully private configuration. A private company would obtain its own financing to build the facility and charge users a fee sufficient to recover its capital and operating costs along with a profit. Another viewpoint is that the private sector would obtain the financing, but the fees would be government controlled to avoid imposing too high a cost burden on users. A third alternative is a private-sector facility in which the government is a shareholder. At this point, the discussions include issues of whether, in return for controlling the fees or having a measure of involvement in the project, the government will require factories to use the treatment plant, give guarantees of throughput to the treatment center operator to ensure profitability, provide some type of monopoly agreement to exclude competing waste treatment facilities, and so on. It is evident that a privatized hazardous waste treatment facility means different things to different people. This is a major issue to be resolved before progress toward implementing new facilities can be made.

2.3.4 Proposed Eastern Seaboard Facility

One of the results of the lack of definitive progress on the implementation of new hazardous waste treatment facilities has been inquiries regarding treatment facilities focused on the needs of specific industries. U.S. Agency for International Development (USAID)/ Thailand has been asked to consider the development of a hazardous waste treatment plant to service the needs of the oil refining and petrochemical industries on the eastern seaboard of the Gulf of Siam (USAID undated, 1992a) (see Figure THAI-3). The premises behind this facility are that these industries are large generators of hazardous waste and have land available for siting a treatment facility that would not be subject to the same degree of public opposition as the other facilities and that there would be sufficient volume and economies of scale to make the project fully private (perhaps a Thai/U.S. joint venture) and profitable. Project cost is expected to be in the range of $100 million. The first step to be taken in developing the project is the conduct of a detailed waste characterization of the region and a commercial feasibility study.

USAID/Thailand has expressed an interest in supporting this concept and has issued a request for support from several U.S. contractors to conduct the study (USAID 1993). There will be cost sharing on the part of several Thai organizations to get the work done. Only firms

that have an interest in the design, construction, and operation of such a facility have been invited to bid. In addition, USAID/Thailand has prompted and supported the Thai government in the convening of a task force to study the concept. The task force includes representatives from the DIW, the NEB, the IEA, the Petroleum Authority of Thailand, the Federation of Thai Industries (FTI), and USAID/Thailand. Discussions with some of these representatives indicate a very positive response to the idea and a willingness to evaluate the concept. The waste characterization and commercial feasibility study was scheduled to be completed in the first half of 1993.

Despite a generally positive view of the effort, several reservations were identified by some of the Thai staff. One such reservation is the question of whether a sufficient quantity of hazardous waste is generated by the oil refining and petrochemical industries to support a profitable treatment facility for them alone. One viewpoint was that these industries would have a significant incentive to reclaim and recycle many of their wastes, which have economic value. Another issue is whether this facility would accept hazardous wastes from other industries in the region. Its operation would likely have an effect on whether or not the other two treatment facilities proposed for the general area (at Chonburi and at Rayong) would be economically viable if some of their customer base were being served by this facility. The proposed study will need to resolve these issues.

2.3.5 Site Cleanup

The cleanup of sites (or site remediation) where hazardous waste has been dumped or spilled has not yet received much attention, but it is acknowledged to be a potential problem. Investigations are needed to identify and characterize the sites. The primary candidates are the areas where industrial operations have been dumping their wastes. Arsenic and PCB contamination of soil has been identified in several places. The municipal landfills in Bangkok have heavy metals in their leachates and are also candidates for investigation. The location of some of the dump sites in flood zones exacerbates the problem.

The current approach to site cleanup is to have local authorities take the responsibility. It is not clear whether this option will be viable when more detailed investigations of sites are done and as more sophisticated control and cleanup measures are required. One step toward a more detailed evaluation of site cleanup is a small project initiated by the National Science and Technology Development Agency. A small Thai firm is being contracted to study the use of bioremediation (the use of bacteria to destroy soil contaminated with hazardous waste). The effort has just begun.

2.3.6 Cleaner Production Technology

The use of cleaner production technology (pollution prevention or waste minimization) to reduce the amount of hazardous waste generated is just beginning to attract attention in Thailand. Some preliminary discussions between various Thai agencies (e.g., the NEB and the

FTI) have been held, but there is only limited practical experience with this approach to waste management.

Several opinions have indicated that while pollution prevention is conceptually a good idea, Thai industries may not yet be ready to pursue this activity with any vigor. The relatively weak regulatory and enforcement environment does not provide any incentive to invest in cleaner production technology. It was expressed that the concept of cleaner production technology must be introduced to Thai industries slowly and put in the context of improving production efficiency as well as controlling environmental pollution. Low-cost options must be identified first. Exposing industrial plant managers to efficient and cleaner production techniques is a useful step. Without a concerted effort to train industrial operators, there is little hope of promoting changes to current practices or equipment.

2.3.7 Hazardous Material Emergencies

The Chulaborn Research Institute has recently set up a committee to address the handling of chemical disasters. The first meeting was to be held in May 1993 to develop a plan of action.

2.3.8 Infectious Waste

Infectious waste from hospitals and clinics is treated differently from industrial hazardous waste. The controlling agency is the Ministry of Public Health, although the NEB provides some policy guidance and recommendations. In the Bangkok area, the Bangkok Municipal Authority (BMA) has responsibility for the implementation of infectious waste control. As in the case of industrial hazardous waste, the split responsibility among different Thai agencies leads to difficulties in effective and efficient implementation of control programs.

More than 500 hospitals serve the Bangkok area. Some have small infectious waste incinerators in the capacity range of 0.1 ton per day. Most are old units with no air pollution control equipment. Many do not operate at temperatures high enough to effectively destroy the waste. Most are located in high-density populated areas. Many hospitals do not have a staff that is adequately trained in the safe operation of incineration equipment.

The NEB has been urging the BMA to focus on central incineration units that can service many hospitals. The NEB feels that two large units with capacities in the range of 10-20 tons per day would be adequate to serve the whole city. It is felt that the actual approach will be a combination of central incineration and small, hospital-based incineration units. One estimate was that 30-35 small incinerators for individual hospitals would be procured in the current fiscal year at a cost of 1-2 million baht ($40,000 to $80,000) each.

The BMA recently solicited bids on a central infectious waste incinerator. The Ministry of Public Health had set aside a budget of 40 million baht ($1.6 million) for the project. The bids

came in at significantly higher levels (50-75 million baht [$2-3 million]). Discussions are under way to either increase the available budget or modify the specifications to reduce costs. One factor contributing to the higher costs is the air pollution control equipment needed for the units to be located in the metropolitan area. A more remote site might relieve some of these needs, according to some estimates.

2.4 OTHER RELATED ACTIVITIES

Several other activities are not entirely focused on hazardous waste, but are closely related.

2.4.1 Environment Fund

Under the terms of the ECNEQA, the environment fund has been established. The fund is to be used to finance grants to local governments, loans to state enterprises, or loans to private companies for the construction of pollution control facilities. The intent is to use the fund as a source of low-interest capital for private-sector projects and to provide 60-70% of the cost of municipal waste treatment facilities (primarily for wastewater).

The fund was initially capitalized at 500 million baht ($20 million). It is to be augmented by revenue from the Fuel Oil Fund, allocations from the government budget, fines collected for violations of environmental laws, and interest collected on loans made through the fund. In addition, the fund may receive additional money from donor countries. Initial discussions have been held with Japanese organizations. Because of the relatively new status of the fund, no significant hazardous waste control projects have yet been initiated.

2.4.2 Industrial Finance Corporation of Thailand

The Industrial Finance Corporation of Thailand (IFCT) is a private organization that has been involved in the financing of pollution control projects in small- and medium-sized businesses since before the Environment Fund was created. To date, its activities have focused on air and water pollution. It has provided 1.2 billion baht ($48 million) to 28 air and water pollution control projects in the pulp and paper, construction, textile, and metal products industries.

The IFCT operates as a lending institution. It accepts applications for loans, employs evaluation teams to determine the viability of the applications, and provides funds for companies to procure their own equipment. Loans have been in the range of 1.5-70 million baht ($60,000-$2.8 million).

To date, the IFCT has not financed any work in hazardous waste control or in cleaner production technology, but it has begun to explore the possibilities. Preliminary discussions

regarding the formation of Thai companies to handle hazardous waste for the small- and medium-sized operations were held. Little interest has been shown thus far. Thai companies are unsure whether a treatment facility serving small industries would be utilized in the absence of strict regulatory enforcement. The IFCT has been looking for outside funding to conduct feasibility studies of the concept.

The IFCT's experience with financing pollution control, other than hazardous waste, in small- and medium-sized industries provides some insight into what may happen with hazardous waste control. The IFCT has found that small companies are very reluctant to invest in pollution control equipment. In addition to the unwillingness to spend money on non-production-related equipment, many factories are limited in the space they have available for environmental control systems. This is particularly true of facilities in the Bangkok area, where land is at a premium. Some of the industries that do purchase pollution control equipment do not use it; they retain it only to satisfy DIW requirements.

The IFCT considers concentrating small- and medium-sized factories in industrial estates and providing centralized waste treatment to be an effective means of dealing with the hazardous waste problem, as well as other environmental controls. There has not been, however, any systematic evaluation of the economics and desirability of this approach.

One factor that has limited the IFCT's ability to become more involved in pollution control activities is its status as a private lending institution. It has not been easy for the IFCT to obtain funding from international or bilateral development assistance agencies because it is private and because Thailand has been deemed too far up the development ladder to receive grants or concessionary loans in this area. The IFCT has been able to get some funding from Japan, the United Kingdom, and Nordic countries, but it has been tied to the purchase of equipment from these countries.

2.4.3 USAID/Thailand Activities

2.4.3.1 Industrial Environment Management Program

USAID/Thailand, along with the FTI, has implemented the Industrial Environment Management Program (IEMP). The FTI is an industry association made up of about 2,000 members. It is subdivided into a series of Industry Clubs and Provincial Clubs, which focus on specific industrial sectors and geographic areas, respectively. Although membership in FTI is open to all Thai industries, it is heavily dominated by larger industrial companies. The FTI's primary role is to serve as an intermediary between Thai industry and the government. It also provides technical support to its members and represents Thai industry in international meetings and organizations.

The IEMP is one of the activities of the FTI. Its elements include the following:

- Environmental awareness: promoting better awareness on the part of industry, government, and the public on the need for and the alternative approaches to environmental control;

- Cooperative technical assistance: providing technical support to Thai industries on environmental control, including the establishment of contacts with U.S. industries and environmental control organizations; and

- Industrial environmental information: maintaining a database of industrial environmental control both in Thailand and worldwide.

The FTI has, in past activities, tried to bridge the gap between industry and government in the area of environmental control. It has, for example, brought the two sides together on disputes on several environmental regulations and contributed to the identification and acceptance of a compromise position.

The FTI attempted to begin work in hazardous waste control several years ago, but found the climate unfavorable because of the absence of government regulations and industry interest. In the latest work plan for the IEMP (FTI 1992), the FTI has proposed a significant activity to provide technical assistance to the DIW in the hazardous waste area, including the evaluation of hazardous waste incineration plans, solvent recycling, siting of hazardous waste facilities, development of a waste exchange program, improvement of the hazardous waste generation inventory, establishment of a hazardous waste manifest system, establishment of an emergency response program, and training.

One notable example of the contributions FTI can make is a project that involved the textile industry (Chayovan 1992). The FTI was asked to assist the textile industry in responding to new environmental standards issued by the MOI. The FTI solicited the assistance of USAID and the World Environment Center (WEC). Following discussions, industry workshops, and a study tour to the United States, new regulations were proposed and agreed to by all parties. A significant component of the process was the identification of technology for better control of the textile dyeing process that significantly reduced waste generation and resulted in improved production efficiency. The technology was brought to Thailand and successfully tested. It is now being promoted for more widespread use in the industry. The result was a combination of pollution prevention and modified regulations. This small example is a good model for the type of serendipitous benefits that can be gained by a program such as the IEMP.

2.4.3.2 U.S.-Thailand Development Partnership

USAID/Thailand has been moving to redefine its development assistance to Thailand in light of the country's rapid growth and development. A document (USAID 1992b) describes

some of the general approaches to be taken. The basic premise is to develop new USAID activities more in the vein of a partnership that benefits both Thailand and the United States. USAID/Thailand will no longer fund and manage major development projects in Thailand (Gurley 1992). USAID will consider involvement in research, feasibility studies, and master plans to the extent that these efforts contribute to long-term solutions to development projects. The Thai government is considered to have sufficient resources to do much of the implementation themselves. Private-sector investment is also considered to be attractive enough in Thailand to handle many capital projects.

The partnership approach uses a three-step methodology: (1) provide U.S. technical assistance to define problems, (2) structure a solution that involves U.S. expertise and technology transfer, and (3) develop a transaction that brings resources, including private-sector ones, to bear on the implementation of the solutions. USAID/Thailand will fund some of the peripheral or "up-front" costs of a transaction, but will not be the major source of funds for the activity.

Environment has been identified as one of the top priority areas for new activities under the partnership. The USAID/Thailand involvement in the proposed eastern seaboard hazardous waste treatment facility is an example of this new approach to projects.

2.4.4 USAID/ASEAN Projects

Two programs operated by USAID/Association of Southeast Asian Nations (ASEAN) (as distinguished from USAID/Thailand) are related to hazardous waste: the Private Investment Trade Opportunities (PITO) Project and the Environmental Improvement Project (EIP). The general structure of each is described in Section 4.

The PITO Project, which seeks to bring together U.S. and Asian business representatives to establish commercial ties, has sponsored some work in Thailand. In mid-1992, several U.S. companies involved in hazardous waste control stopped in Thailand on a multicountry tour. The visit, which involved about 10 U.S. companies and a number of U.S. government agencies, was both applauded and criticized. Comments were made that the group had too many large companies and too many government representatives. Comments were also made that the tour reflected a good government-business cooperation that is not usual for the United States.

The PITO Project has also prepared material for use by U.S. businesses seeking to begin marketing in Thailand (EWC 1992).

The EIP seeks to conduct a series of projects that contribute to environmental improvement in the ASEAN countries. Because the project's prime contractor began full-scale operation only in September 1992, no projects have been implemented yet.

3 MUNICIPAL WASTE

The population of Thailand is currently about 56 million. Bangkok's population is about 6 million people; the next largest city, Korat, has a population of only about 200,000. The rate of waste generation is increasing as the country becomes more industrialized and affluent. A TDA-sponsored study of municipal waste options in Bangkok (Baker 1988) identified a number of possibilities.

3.1 MUNICIPAL WASTE PROBLEMS

In Bangkok, the rate of municipal waste generation is about 5,000 metric tons per day (TDA 1989c). This is an increase of 67% since 1983. The per capita waste generation rate is about 0.9 kg per person per day on a citywide average.

Residential refuse is about 37% garbage (i.e., food wastes), 15% wood and grass, 12% plastic, 12% paper, 8% noncombustible metal and stone; the rest is miscellaneous items. A significant aspect of the waste is that it has a moisture content of about 60%, an ash content of 12%, and a combustible material content of only about 28%. Wastes from commercial and industrial sources have somewhat different compositions, but all share the same high-moisture and low-combustible-material characteristics.

A growing problem with municipal refuse is the increasing plastics content. The use of small plastic bags to wrap virtually all items (food, dry goods, department store purchases, etc.) is putting an increasing burden on the already stressed waste disposal system.

Waste disposal in Bangkok is limited to three sites: Nong Haem, On-Nooch, and Ram Intra. There are composting facilities in Nong Haem and On-Nooch, but the facilities at On-Nooch are old and beyond their economic lifetime. Small incinerators are in operation at these two sites, but they are limited in capacity and handle only material rejected from the composting plants. At these sites, more than 90% of the waste is sent directly to open landfills. At Ram Intra, all the waste has been landfilled, and the site was recently closed. The remaining lifetime at the other landfills is estimated to be less than five years (TDA 1989c).

3.2 GOVERNMENT STRUCTURE FOR DEALING WITH MUNICIPAL WASTE

In Thailand, the responsibility for handling municipal waste lies with the local municipal jurisdiction. In Bangkok, the BMA is the controlling agency. The BMA has final decision authority on the development and operation of any municipal waste facilities, although some project funding is received from the central government.

One issue under consideration for any new municipal waste facilities is the role of the private sector. The BMA would like to see the private sector play a major role in municipal

waste handling. Initially, the private sector's responsibility may be limited to operating a facility. Later, more involvement in providing collection services and even building and operating disposal facilities on privately owned land are possibilities.

The National Energy Administration (NEA), Department of Energy Development and Promotion (formerly the Department of Energy Affairs), was heavily involved in the TDA-sponsored study. The NEA wanted to consider the possibility of incinerating municipal waste to generate electricity. The study concluded that this concept was not feasible because of the high moisture content and poor combustion characteristics of the waste and the resulting high cost of generated electricity. After accepting this conclusion, the NEA has not actively participated in further studies of the municipal waste issue in Bangkok.

3.3 CURRENT MUNICIPAL WASTE ACTIVITIES

The BMA has recently solicited bids for the opening of new sanitary landfill operations. Four new operations are being considered. Two are expansions of existing facilities at Nong Haem and On-Nooch. These facilities will all be sanitary landfills only and will have neither composting nor incineration capability.

The BMA has set aside 900 million baht ($36 million) for new waste handling facilities. The largest problem is the availability of large tracts of land that are close enough to Bangkok to keep transport costs reasonable.

The land shortage is prompting a continued interest in incineration facilities. The BMA would like to have a unit with a capacity of 600-1,000 tons per day. The Japanese International Cooperation Agency was asked to study the possibilities and recommended a 600 ton per day unit. The BMA began the process of requesting bids for a detailed design study and set aside 60 million baht ($2.4 million) for the work. It was then approached by a U.S. firm offering to do the design work at no cost in exchange for a 50- to 100-year commitment on the land for the facility if it proved to be feasible. The BMA is considering the offer but has questions about its fairness. It is considering other proposals as well.

The BMA believes that an expenditure of about 3,000 million baht ($120 million) will be necessary for incineration facilities. The current desire is to consider the 600 ton per day unit in three 200 ton per day increments. The BMA would finance the first unit, underwrite part of the second unit, and have the third unit privately financed. The desire is to hold incineration costs below 350 baht ($14) per ton.

3.4 OTHER RELATED ACTIVITIES

Although the NEA has not been involved in recent municipal waste projects in the Bangkok area, it has maintained an interest in incineration in other parts of Thailand. In December 1990, the NEA submitted a request to TDA (through the U.S. Embassy in Bangkok)

for a project to consider municipal waste projects in other parts of the country, including four pilot projects in regions to be selected. The NEA's interest stems from the possibility that other areas may have waste with characteristics that are more amenable to use in electricity-producing incinerators or that these incinerators could provide steam to nearby commercial or industrial facilities. The use of other local biomass fuels (bagasse, rice straw, etc.) to co-fire with the municipal waste is another possibility.

The project was accepted by TDA on February 20, 1991, and a grant of $250,000 was approved. The political crisis in Thailand that began with the coup on February 23, 1991, halted the project. The NEA has not yet received any additional word on the status of the previously approved project. In the absence of TDA funding, the NEA funded the first stage of the proposed project. The result was a document that characterized the municipal waste in a large number of cities around the country.

In March 1992, a U.S. contractor financed directly by TDA did a more extensive review of the waste problems in two other cities, Pattaya and Phitsanaulok. Because this review was done outside the Thai government, the NEA has not yet seen the report.

One other project has recently been suggested. A U.S. firm has proposed the use of coal imported from Alaska to co-fire with the municipal waste in Bangkok. It was stated that this would overcome the high moisture problem and provide electricity at a rate competitive enough to be sold to the Electricity Generating Authority of Thailand. No details on this proposed project were available.

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4 ORGANIZATION PROFILES

The following sections provide information on a number of organizations that have activities in Asia dealing with hazardous waste control. The organizations reviewed include U.S. government, U.S. private-sector, and international institutions. Because of resource limitations, organizations from countries other than the United States were not included in the review. The profiles presented here are not intended to be a comprehensive picture of the operation of each of these organizations. Rather, they are intended to present the segment of the organization's activities that are involved with hazardous waste. Table 4-1 summarizes the activities of each organization as they relate to hazardous waste.

4.1 U.S. GOVERNMENT ORGANIZATIONS

4.1.1 U.S. Agency for International Development

The U.S. Agency for International Development (USAID) is the U.S. government organization most involved in providing development assistance to developing countries. The USAID, along with the U.S. Trade and Development Agency (TDA) and the Overseas Private Investment Corporation (OPIC), are elements of the International Development Cooperation Agency.

Five main organizational units within USAID are relevant to hazardous waste control programs in Asia. The Bureau for Asia is the headquarters unit that coordinates all USAID programs in Asia. The field missions within the Bureau for Asia are permanently located in-country. The Association of Southeast Asian Nations (ASEAN) Program, operating out of the field mission in Bangkok, Thailand, is responsible for interaction with the ASEAN countries. The Office of Environment and Natural Resources provides technical services to the regional bureaus and field missions. The Office of Foreign Disaster Assistance (OFDA) is responsible for responding to natural and manmade disasters and for assisting in disaster planning.

4.1.1.1 Bureau for Asia

The Bureau for Asia is responsible for all USAID activities in the region. Bureau staff with environmental expertise provide general guidance and support in project development and evaluation.

The headquarters staff occasionally formulates and implements projects in the various USAID countries. Currently, no hazardous-waste-related projects are being run from headquarters; all are being carried out by the field missions.

TABLE 4-1 Summary of Organization Activities

Organization	Function and Activities
U.S. GOVERNMENT ORGANIZATIONS	
U.S. Agency for International Development	• Development assistance
U.S. Asia Environmental Partnership	• Coordinator of U.S. government environmental activities in Asia
U.S. Environmental Protection Agency	• Regulation development and implementation • Technical analysis and research
U.S. Trade and Development Agency	• Trade promotion for development projects
Department of Commerce	• Trade promotion
Overseas Private Investment Corporation	• Business risk insurance
Export-Import Bank	• Export financing
Department of Energy	• Research on site remediation
U.S. PRIVATE SECTOR ORGANIZATIONS	
World Environment Center	• Expert consultation to industry
U.S. ASEAN Council for Business and Technology	• Business networking
Environmental Technology Export Council	• Trade group to promote exports
INTERNATIONAL ORGANIZATIONS	
World Bank	• Project loans • Technical assistance
Asian Development Bank	• Regional development • Project loans • Technical assistance
United Nations Environment Program	• Technical assistance • Training
World Health Organization	• Technical assistance • Training
Economic and Social Commission for Asia and the Pacific	• Regional development • Technical assistance • Training
United Nations Industrial Development Organization	• Industrial development • Technical advice to industry
International Solid Waste and Public Cleansing Association	• Technical information exchange
Asia-Pacific Economic Cooperation	• Ministerial level cooperative organization • Collaborative programs
Pacific Basin Economic Council	• Private-sector business leader organization • Business interactions
International Environmental Bureau	• Expert consultation to industry
OTHER ORGANIZATIONS	
Air and Waste Management Association	• Professional organization
U.S. Environmental Training Institute	• Training institution
Pacific Basin Consortium for Hazardous Waste Research	• Technical organizations • Information exchange • Collaborative research

4.1.1.2 Field Missions

Four USAID field missions are located in Asia. USAID/Thailand, USAID/Indonesia, and USAID/Philippines are country-specific missions that operate projects in their respective countries. USAID/ASEAN is a regional office serving the six ASEAN countries. Its activities are discussed in Section 4.1.1.3.

USAID/Thailand has been involved with the development of hazardous waste projects in Thailand. In one project, a contractor consortium evaluated the proposed hazardous waste incineration facilities at two sites. In another, contractor support is being solicited for a study of the development of a waste treatment facility to serve the eastern seaboard petrochemical industries.

USAID/Thailand is revising its operating procedures in Thailand. In a prototype activity for USAID operations in the more advanced developing countries, a U.S.-Thailand Partnership is being developed. Its focus is to provide long-term, sustainable solutions to Thailand's development process through U.S. technology and expertise. It is based on the premise that countries like Thailand have the financial resources to apply to their own development problems. An initial point of emphasis in the partnership will be environmental protection.

USAID/Indonesia is conducting a waste minimization project with the World Environment Center (WEC). The two-year program includes a variety of pollution prevention activities, some of which relate to hazardous waste.

USAID/Philippines operates a large Industrial Environmental Management Project (IEMP) in the Philippines with a budget of $12 million over five years. The project is projected to demonstrate pollutant emission reductions in a number of industrial facilities.

Details on these projects are given in the respective country profiles in Section 3.

4.1.1.3 ASEAN Program

The ASEAN comprises Brunei Darussalam, Indonesia, Malaysia, Philippines, Singapore, and Thailand. Only Indonesia, Philippines, and Thailand are recipients of direct USAID support and have USAID field missions. USAID/ASEAN is the unit within the USAID that deals with the other ASEAN countries and with ASEAN as an integrated unit. USAID/ASEAN is collocated with the USAID mission in Bangkok, Thailand.

USAID/ASEAN has two major activities related to environmental issues in the region: the Private Investment and Trade Opportunities (PITO) Project and the Environmental Improvement Project (EIP).

4.1.1.3.1 Private Investment and Trade Opportunities Project. The PITO Project was established in August 1989 (USAID 1989). It was budgeted at $13 million over the period of fiscal year (FY) 1989 to FY 1995. The current expectation is that the project will be extended beyond FY 1995. The purpose of the project is to contribute to sustained growth and development in the ASEAN region and to promote an expansion of business ties between private U.S. and ASEAN companies. The project has three main components: trade and investment promotion, policy analysis and problem resolution, and capital markets.

The trade and investment promotion component is designed to provide information on trade and investment opportunities to U.S. and ASEAN businesses. It includes the collection and dissemination of information on market opportunities, market seminars on new developments and on methods of conducting business, and missions to both the United States and ASEAN countries for company representatives. As part of this activity, PITO offices have been established in each of the ASEAN countries to serve as the point of contact. The U.S. point of contact is the ASEAN-U.S. Council for Business and Technology, located in Washington, D.C. The Council has sponsored two environmental missions to Indonesia, Malaysia, Thailand, and Singapore.

One element of the trade and investment promotion component is the technology promotion and assistance services. This activity is designed to deal with specific issues of technology transfer, quality assurance, standards development, and new packaging and materials development. This element is run by Technonet Asia, a nonprofit, nongovernmental development agency headquartered in Singapore. Included in this effort are the development of a database on technical expertise in various areas of interest around the region, technology workshops and conferences, technical referral services, and a standards development program. Technonet Asia has conducted a two-week seminar and workshop on appropriate technology for pollution control in the textile industry in Indonesia and a two-week seminar on pollution control and wastewater treatment in the textile industries in Thailand.

The policy analysis and problem resolution component of PITO is designed to link a U.S. research institute with ASEAN research institutes to address specific issues and problems in trade promotion. The East-West Center in Honolulu, Hawaii, is the U.S. institution involved in this activity. Counterpart agencies in the ASEAN countries are also involved. A recent paper addressed environmental issues (EWC 1992).

The capital markets component of PITO provides support to OPIC in the establishment of the ASEAN Growth Fund. The fund will be designed to provide equity capital to small and medium businesses in ASEAN countries. The focus will be on joint ventures between U.S. and Asian companies. The total capitalization of the fund is $75 million. The PITO Project will provide the services of underwriters and finance specialists to help organize the fund and evaluate projects. To date, no environmental activities have been carried out under this element.

Some of the activities of the PITO Project match up with country-specific projects identified in Section 3, particularly the missions to the United States and Asia.

4.1.1.3.2 Environmental Improvement Project. The EIP was initiated in January 1992 (USAID 1991, 1992). It is funded at $17.5 million over a six-year period from FY 1992 through FY 1997. USAID/ASEAN is providing $12.5 million; the balance comes from the USAID Bureau of Research and Development. The project's objective is to promote environmentally compatible development activities. The use of private-sector initiatives to carry out these activities is a major goal. The project has three components: policy and institutional development, technical assistance and training, and technology commercialization and investment promotion.

The policy and institutional development component deals with the development of environmental policies and programs. It works with government organizations, private-sector organizations, and nongovernment organizations. Some of the specific regional activities to be undertaken in this component are as follows:

- Preparation of a comparative summary of environmental regulations,
- Evaluation of regional approaches to hazardous waste control,
- Comparison of pollution control loan policies of national development banks,
- Evaluation of "command and control" compared with market-based environmental control policies,
- Evaluation of regional policy research needs,
- Development of regional environmental certification for testing laboratories,
- Conduct of conferences and workshops, and
- Promotion of public information.

Some of the country-specific activities to be undertaken in the project are as follows:

- Assistance in the development of regulations,
- Assistance in the evaluation of environmental impact assessments, and
- Development of environmental baseline information.

The second component of the EIP is technical assistance and training. It is focused on skill development in government and private organizations. Four types of activities make up this component:

- Environmental assessments by environmental specialists who will visit factories in ASEAN countries; a total of 15 per year are expected;
- Short courses of one to four weeks duration, covering a variety of environmental issues;
- Seminars, workshops, and conferences;
- Environmental databases oriented toward the dissemination of environmental information.

The third component of the EIP is technology commercialization and investment promotion. This part is designed to promote environmental technology transfer and commercialization between private ASEAN and U.S. companies. Typical activities under this component are as follows:

- Identification of business opportunities,
- Co-funding of feasibility studies and demonstrations, and
- Identification of project financing assistance.

The budget of the EIP, while significant in aggregate, is relatively small in terms of the amount that can be applied in any one country. The total budget available for the six ASEAN countries is on the order of $3 million per year.

4.1.1.4 Office of Environment and Natural Resources

The Office of Environment and Natural Resources provides environmental support to the USAID field missions around the world. The office conducts some of its own studies and programs where there are advantages to be gained by multicountry efforts.

4.1.1.5 Office of Foreign Disaster Assistance

The OFDA has the responsibility for dealing with natural disasters (floods, storms, earthquakes, etc.) and with man-made disasters (industrial accidents, urban problems, etc.). As part of a relatively new effort, OFDA has begun to address disaster planning in addition to disaster response. The planning for industrial accidents, including spills of toxic chemicals, is part of this activity.

In an earlier project, OFDA sponsored a test program to study the incineration of spent pesticides by using a cement plant rotary kiln. The study was carried out in Pakistan, and the published results were encouraging (Huden 1991). This effort is typical of the type of advance planning effort needed to avoid hazardous waste problems.

4.1.2 U.S.-Asia Environmental Partnership

The U.S.-Asia Environmental Partnership (USAEP) was formed in early 1992. Its function is to enhance environmental protection and promote sustainable development in Asia and the Pacific by mobilizing U.S. environmental technology, expertise, and financial resources. The USAEP is administratively attached to the USAID Bureau for Asia. It has developed a coalition of U.S. government organizations as partners in its activities. It operates by providing additional funding resources for its partner organizations to conduct additional work that USAEP has identified as needed in the region and by conducting some of its own projects.

The USAEP program has four major elements: human and organizational resources development, technology cooperation, environmental and energy infrastructure, and biodiversity conservation. In the human and organizational resources development component, the USAEP works with other agencies to strengthen environmental organizations in Asian countries and to conduct training programs. The following cooperative activities have been initiated:

- Staff exchanges of U.S. and Asian professionals in cooperation with the Asia Foundation;
- Training courses with the U.S. Environmental Training Institute, four of which have been held in the hazardous waste field;
- Expert consulting services from U.S. industry through the WEC;
- Expert teams for short-term problem solving from the U.S. Environmental Protection Agency (EPA); and
- Collaboration on commercial studies.

In the technology cooperation component, USAEP seeks to stimulate U.S. firms' interest in Asia and provide information on environmental business opportunities to U.S. companies. The element has initiated the following projects:

- Hiring of local professionals in Indonesia, Korea, the Philippines, Thailand, Hong Kong, Malaysia, Singapore, and Taiwan to identify business opportunities and develop relationships;

- Establishment of an Asian Environmental Business Information Service, a computerized database of business leads that can be accessed by subscribers; and

- Establishment of the Environmental/Energy Technology Fund, in cooperation with the National Association of State Development Agencies, to provide support to state-level trade promotion agencies.

The environmental and energy infrastructure component is designed to identify and track infrastructure projects in Asia and to work with U.S. government and private-sector organizations to enhance the ability of U.S. firms to compete successfully on these projects. Activities in energy, municipal waste, and hazardous waste have been identified as initial priorities. To date, no hazardous waste activities have been undertaken. The activities that have been undertaken are as follows:

- Establishment of the Infrastructure Finance Advisory Service to assist U.S. companies in identifying projects and locating financing,

- Start (by mid-1993) of a program to support public and private proposals to increase the participation of U.S. companies in Asian infrastructure projects, and

- Provide support to the development of new capital markets for U.S. businesses to access in infrastructure project implementation.

The biodiversity conservation component focuses on evaluating the impact of development on a country's forest and marine resources.

4.1.3 U.S. Environmental Protection Agency

The Office of International Activities of the U.S. EPA is responsible for dealing with international environmental policy. The office has no program that deals with hazardous waste in an integrated fashion in a specific country or region of the world because the agency's mandate is primarily domestic in nature and lacks resources for this type of effort.

Because the U.S. EPA is recognized worldwide as the repository of unmatched environmental control expertise, it receives frequent requests for assistance in a variety of environmental matters. The agency attempts to deal with these on a case-by-case basis and often in collaboration with USAID, TDA, and other U.S. government agencies. The U.S. EPA also collaborates with international organizations such as the World Bank and the United Nations Environment Program (UNEP). Staff members are occasionally assigned as technical experts to missions conducted by these organizations that deal with a variety of development issues. These assignments last from a week to several months.

The type of assistance that is most frequently requested from the U.S. EPA by developing countries is advice on the development of environmental control programs, including regulations, monitoring, and enforcement. The U.S. EPA is also called upon to provide technical expertise on environmental issues ranging from health effects of environmental pollution to the cost and effectiveness of various control technologies. The U.S. EPA is generally viewed by developing countries as a source of technical expertise that is free from commercial biases.

Several U.S. EPA activities are related to hazardous waste control in Asia. The first is information dissemination. The U.S. EPA makes virtually all of its technical reports available to any requestor from any country. The problems requestors experience in getting these publications are based on a lack of awareness that the material is available, unfocused requests for general information that make it difficult to determine what is needed, and a lack of resources to purchase the documents from the National Technical Information Service. The U.S. EPA has prepared Technical Information Packages (TIPS) that cover a variety of environmental issues. The TIPs are intended for worldwide distribution. The TIPs and other U.S. EPA documents are not only a source of technical information, but also serve to introduce country staff to U.S. technology, which can lead to the development of exports.

In China, the U.S. EPA has a general Memorandum of Understanding for collaboration in environmental areas. The activities under this agreement have covered a wide range of environmental issues over a 13-year period. The U.S. EPA has also detailed a staff person to the World Bank to assist in the writing of environmental regulations in China.

Indonesia has requested the U.S. EPA to assign five long-term advisors to BAPEDAL, the environmental control agency. One of the advisors would assist in the development of a hazardous waste generator permitting program. Another would assist in the development of hazardous waste site remediation and emergency response programs. The cost of the five advisors would be paid either by the U.S. EPA with funds from the USAEP or by the Indonesian government with funds from a World Bank loan.

In Taiwan, the U.S. EPA signed a Memorandum of Agreement for technical cooperation in environmental protection. Included under the agreement are activities such as technical meetings, training, information exchange, and consultation on environmental infrastructure.

Recently, the U.S. EPA has received funding from USAID to begin an Environmental Pollution Prevention Program worldwide. The program will include the following elements:

- Pollution prevention audits: Assistance will be provided to factories in developing countries on cleaner production opportunities.

- National cleaner production and pollution prevention programs: Assistance in identifying and designing national cleaner production programs will be provided.

- International cooperation: The program will work with donor agencies on industrial pollution prevention.

- Technology cooperation and investment promotion: Support for new technology development will be provided.

- Environmental support services: Experts in pollution prevention will be made available to developing countries.

- Environmental policy: Assistance in revising and/or establishing regulations that promote pollution prevention will be provided.

- Pollution prevention training: Workshops and study tours on pollution prevention will be held.

- Pollution prevention awareness: Information on pollution prevention will be disseminated.

Another area in which the U.S. EPA is active in Asia is in the tracking of transnational movements of hazardous materials, particularly from the United States to Asian countries. The U.S. EPA has the responsibility to ensure that such movements comply with U.S. law and are in accordance with the Basel Convention, which prescribes strict requirements on such movements (UNEP 1989). Because the U.S. Congress has not yet ratified the Basel Convention, no specific U.S. laws force compliance. On some occasions, the U.S. EPA has been able to prevent a shipment of hazardous wastes from the United States to other countries. However, this effort is frequently hampered by the lack of awareness of or interest in the problem in the receiving country. In some cases, such movement is characterized as a material recycling effort rather than disposal of U.S. hazardous wastes abroad. Without objections from the receiving country and specific U.S. laws under the Basel Convention, there is little the U.S. EPA can do.

4.1.4 U.S. Department of Commerce

The organization within the U.S. Department of Commerce that deals with the promotion of exports of U.S. goods and services is the International Trade Administration (ITA). Within ITA, three organizations have relevant activities: the U.S. and Foreign Commercial Service (USFCS), the Trade Development Office, and the International Economic Policy Office.

4.1.4.1 U.S. and Foreign Commercial Service

The USFCS operates both domestically and in-country. Domestically, USFCS seeks to assist in the expansion of existing trade activities of U.S. companies as well as encourage companies to begin export efforts by sponsoring trade fairs and trade missions, providing export counseling services to companies, and identifying export opportunities.

In selected countries, the USFCS maintains a resident staff of both U.S. nationals and local personnel. These offices have the responsibility to gather information on possible export opportunities, relay material to U.S. companies with possible interest, and serve as a liaison between U.S. and country business people. In practice, many of the USFCS offices in Asia have staff shortages. They do not have sufficient personnel to cover all the possible business leads that arise. In addition, many staff members are responsible for handling business contacts from a wide range of fields. Few of the country offices have a single person with responsibility only for environmental issues.

4.1.4.2 Trade Development

The Trade Development Office in ITA is organized primarily along industry lines. A relatively recent addition is the Office of Energy, Environment, and Infrastructure. This office is charged with identifying opportunities for U.S. businesses to participate in major infrastructure development projects. The Trade Development Office carries out its efforts through analyses of each of the basic industries, development of export policies, and promotional activities.

4.1.4.3 International Economic Policy

The International Economic Policy Office concentrates on the formulation and implementation of trade policies. It is organized along regional lines, with one group focusing on East Asia and the Pacific.

4.1.5 U.S. Trade and Development Agency

The TDA has two main missions: contributing to the development of a country and promoting the export of U.S. goods and services. Its operations bridge the gap between the development assistance efforts of organizations such as USAID and the trade promotion efforts of organizations such as the U.S. Department of Commerce.

The efforts of the TDA have a very specific focus. It works primarily on activities that are close to implementation in a country, dealing with projects that have already been determined to be of high priority by a country. By providing funding for things such as feasibility studies for projects that are beginning the basic design effort or training for projects that are soon to be implemented, the TDA seeks to promote the involvement of U.S. firms in the final project selection.

The TDA is involved in projects in a wide variety of areas, including environmental control. Recent projects in Asia are as follows:

- Hazardous waste treatment facility feasibility studies in China, Indonesia, Malaysia, Taiwan, and Thailand; and

- Water pollution and waste management studies in China, Korea, the Philippines, and Thailand.

Details of these projects are given in the various country profiles in Section 3.

4.1.6 Overseas Private Investment Corporation

The OPIC began operations in 1971 when it took over some responsibilities that had originally been assigned to USAID. The OPIC undertakes two basic activities: provision of political risk insurance and project financing, both with a concentration in developing countries. The OPIC's assets are in excess of $1 billion. Apart from the initial capitalization, the OPIC has not received funds from the U.S. government and is self-sustaining.

The OPIC provides risk insurance to companies doing business in developing countries. It insures against inconvertibility (the inability to convert local currency to U.S. dollars), expropriation of assets by a country, and war and civil unrest. The intent is to provide U.S. businesses with insurance that would not be available from commercial insurers.

In the area of financing, the OPIC provides direct loans for projects to small businesses. The loans are generally modest (less than $10 million). The OPIC also provides loan guarantees to businesses of all sizes.

In addition to these two main areas, the OPIC has several special programs. The OPIC provides specialized insurance to contractors and exporters, energy exploration and development activities, and leasing services. It also provides pre-investment services in the form of investment missions, the Opportunity Bank of information on specific projects in developing countries, and the Investor Information Service containing data on specific countries.

A new OPIC program, funded by USAEP, is just beginning. The Environmental Enterprises Development Initiative is designed to provide funding assistance to U.S. companies establishing or expanding environmental operations in Asia. Activities eligible for funding include market-entry assessments, business plan preparation, technology reviews, investor reviews, and prototype or pilot project implementation. Funds are limited to $100,000 per project with 50% matching funds required from the project sponsor. As this is a new activity, no projects have yet been implemented.

4.1.7 Export-Import Bank

The Export-Import Bank of the United States is an independent agency. It seeks to supplement, not replace, commercial lending activities for exporters. Its primary goal is to provide funds in such a way as to compete with subsidized financing from other countries. The Export-Import Bank provides both direct loans and loan guarantees to exporters. Total financing capability is in the range of $10-15 billion.

4.1.8 U.S. Department of Energy

The U.S. Department of Energy (DOE) has a major program, entitled Environmental Restoration and Waste Management, which is designed to deal with hazardous and radioactive wastes at its facilities (DOE 1991). Although focused on the specific needs of the DOE sites, the program has incorporated an international element. As part of the effort, DOE will be seeking collaboration with other countries in the identification, development, and implementation of existing and new technologies for site cleanup. It is intended that opportunities for the export of U.S.-developed site remediation technology and services be an element of the program. The DOE program is currently funded at about $5.5 billion.

4.2 U.S. PRIVATE-SECTOR ORGANIZATIONS

A large number of private U.S. organizations have been involved or are beginning to be involved in international hazardous waste activities. All deal with a broader spectrum of environmental issues, beyond hazardous waste, and some deal with even broader business issues. A selected set of these organizations is described in the following sections.

4.2.1 World Environment Center

The WEC was founded in 1974 under a grant from the UNEP. It has grown to include support from U.S. and other government agencies, as well as its member private-sector companies. The WEC has three major activities: the International Environment and Development Services (IEDS), the International Environment Forum (IEF), and the WEC Gold Medal for International Corporate Environmental Achievement.

Under the IEDS, the WEC provides the services of environmental experts from its member companies to address specific environmental problems in developing countries. Typical of such activities are the following:

- Industrial environmental reviews, including specific plant surveys;
- Support to country environmental institutions;

- Workshops and training programs; and
- Study tours.

Typical activities involve employees of WEC member companies providing their time at company expense to participate in these efforts. The WEC uses its funding to cover travel and in-country costs. The IEF, for example, is designed to bring together industrial officials, typically from multinational companies, and country government officials to share information on environmental and resource management issues; meetings are held quarterly. In addition, the WEC Gold Medal is awarded annually to a multinational company that has an outstanding, well-implemented environmental policy.

The WEC also has several funded environmental projects related to hazardous waste control. The USAEP has provided a grant of $3.4 million to WEC to carry out efforts in Asia. Activities under this project include the traditional WEC efforts to provide expert consultants from U.S. companies to businesses in Asia, training programs, conferences, and attaching Asian staff to U.S. companies for on-the-job training. A broad spectrum of environmental issues, not just hazardous waste, will be covered.

In Indonesia, the WEC is conducting a project on waste minimization for USAID/Indonesia. In the Philippines, the WEC has conducted a series of workshops on hazardous waste control. These workshops were designed for government staff at both the national and regional level and for industry representatives. The WEC is also undertaking a project with the USAID OFDA in disaster planning for industrial estates. Initial work will be carried out in Mexico, India, Thailand, and Indonesia.

The WEC does not view its primary mission as the promotion of U.S. trade opportunities. The mission is more in line with development assistance in the environmental area. Trade and export opportunities that develop as a result of WEC projects are considered to be a side benefit rather than the primary focus.

4.2.2 U.S. ASEAN Council for Business and Technology

The U.S. ASEAN Council for Business and Technology is a consortium of private companies. Its objective is to promote business ties between U.S. and Asian companies, with an emphasis on the ASEAN countries. The council covers a number of different commercial areas. Environmental control and hazardous waste are in their field of interest. Working with the USAEP, the U.S. Department of Commerce, and USAID, the council organized a tour of U.S. company officials to Thailand, Indonesia, and Singapore in late 1992.

4.2.3 Environmental Technology Export Council

The Environmental Technology Export Council (ETEC) was formed in April 1992 as a consortium of U.S. environmental technology companies and trade associations. The primary objective of ETEC is to promote the export of U.S. environmental control goods and services. Membership in the organization includes equipment manufacturers, consulting firms, engineering firms, U.S. government laboratories, and professional associations. Member organizations pay a fee of $2,500 to $5,000 per year, which is used to finance the operation of the organization.

As initial projects, ETEC has plans for the following:

- A study of U.S. competitiveness in world markets for environmental technology;
- An analysis of financing and insurance mechanisms available;
- Establishment of an electronic information system, available to ETEC members, on environmental project opportunities;
- Training programs for country decision-makers at ETEC member facilities; and
- Translation service for country environmental laws.

A recently completed survey of ETEC members on their experiences with exporting goods and services showed several trends (ETEC 1992). Of the 19 respondents, all earned less than 10% of their revenue from exports in 1991, yet almost all expressed a moderate-to-strong interest in developing new export markets in the next five to ten years. Pacific rim countries were second to Mexico among the respondents' interests in market development. Only a relatively small fraction (about one-third) had participated in any U.S. government program on export promotion. Most of that participation was simply in trade missions. There was not any other extensive involvement with U.S. government trade promotion efforts. While the survey sample was small and may not be entirely representative of U.S. environmental businesses, it does illustrate that, at least for these firms, there has not been a strong government-business collaboration in the environmental technology export area.

4.3 INTERNATIONAL ORGANIZATIONS

A number of international organizations are involved in the area of hazardous waste control in Asia. Their missions, operational styles, and resources vary considerably but all may be considered as potential participants in future projects.

4.3.1 The World Bank

The World Bank is actually a group of affiliated organizations including the International Bank for Reconstruction and Development (IBRD), the International Development Association, the Multilateral Investment Guarantee Agency, and the International Finance Corporation (IFC). The IBRD is the organization usually thought of when reference is made to the "World Bank." In the context of hazardous waste control, both the IBRD and the IFC must be considered.

4.3.1.1 International Bank for Reconstruction and Development

The IBRD deals with environmental issues in four distinct ways (World Bank 1992):

- The IBRD assists borrowing countries in the development of their environmental institutions and their environmental control infrastructure;
- The IBRD requires an environmental assessment of any project that is considered to have a significant potential for environmental impact;
- The IBRD works with borrowers to reduce poverty and link this effort to overall environmental improvement; and
- The IBRD works with member countries on the global environmental issues of climate change, ozone depletion, loss of biodiversity, pollution of international waters, and land degradation and deforestation through the Global Environment Facility.

The first item is of the greatest concern in hazardous waste control efforts. The second item relates to hazardous waste control in the sense that it involves the review of any IBRD-financed project for its hazardous waste generation potential and control strategy. The last two items do not relate directly to the issue of hazardous waste control.

The IBRD operates in two ways to assist borrowers in the development of their environmental institutions and infrastructure. The primary mode of IBRD activities is to provide loans to countries to build environmental control facilities (e.g., water supply systems, or sewage treatment facilities) or to add environmental control equipment to a project (e.g., wastewater treatment equipment for an industrial plant or air pollution control for a power station). In addition to paying for equipment and construction, IBRD loan funds can be used for training, institutional development, and other such supportive activities. These funds must, however, be repaid by the borrowing country.

The secondary mode of IBRD activities is to provide grant funds to a country to assist in environmental activities. These grants are used for technical assistance from foreign experts, purchase of small amounts of equipment, participation in training programs, and the like. The

IBRD has limited resources for such grants. Most frequently, the IBRD solicits funds from donor countries to finance these grant activities. Donor country funds are sometimes tied to the use of donor country personnel or equipment. It is important to recognize the distinction between these two modes of IBRD operation. The loan program is, by far, the largest portion of the IBRD's activities. Grants are small by comparison and are difficult for the IBRD to obtain and distribute. Nevertheless, it is through this grant activity that a number of developed countries attempt to introduce developing countries to their technology and expertise.

The IBRD's lending activities in East Asia (including all of Southeast Asia and the Pacific) are expected to increase. Environmental components in urban lending (including water supply, sewage treatment, solid waste management, and other activities) are projected to be about $485 million per year in 1993-1996. Industry and energy-related environmental projects are projected to be funded at about $115 million per year; agriculture and natural resources environmental projects are projected to be funded at $410 million per year. Among the projects identified are the following:

- Industrial efficiency and pollution control in the Philippines,
- Industrial pollution control in Thailand,
- Air quality enhancement in Thailand,
- Zhejiang multi-cities project in China,
- Zhejiang environment project in China,
- Tianjin urban development and environment project in China,
- Shanghai environment project in China,
- Liaoning environment project in China,
- Jiangsu chemical project in China,
- Shenyang engineering project in China,
- Environmental technical assistance in China,
- Industrial efficiency and pollution control in Indonesia,
- Urban environment in Indonesia,
- Beijing environment project in China,

- Southern Tiangsu environment project in China, and
- Environment management loan in Papua New Guinea.

In addition to these free-standing environmental projects, other IBRD-financed projects will have significant environmental components. Also, the following activities are related efforts.

4.3.1.1.1 Environmental Action Plans. Environmental Action Plans (EAPs) are documents prepared by borrower countries by using IBRD grant funds. An EAP is designed to give an overview of the environmental situation in the country and to outline major directions for environmental improvement. These documents are to serve as a basis for the discussion and evaluation of a country's loan requests that have environmental implications. To date, EAPs have been prepared in only a few countries. Drafts are being prepared in China, Indonesia, the Philippines, and Thailand.

4.3.1.1.2 Metropolitan Environmental Improvement Program. The Metropolitan Environmental Improvement Program (MEIP) was established as a regional program in 1989 with basic funding provided by the United Nations Development Program (UNDP). Other funding has been received from donor countries. The objective of the MEIP is to deal with the environmental problems of major metropolitan areas in Asia. The cities included in the first phase of the program are Beijing, Bombay, Colombo, Jakarta, and Manila.

The program involves the following elements:

- Preparation of an environmental management strategy that outlines the current environmental issues and identifies actions to be taken,
- Strengthening the environmental management skills of the control agencies,
- Conducting feasibility studies for high-priority environmental control projects that will eventually lead to loan applications,
- Intercountry collaboration and research on common problems, and
- Study visits and workshops.

One of the proposed new elements of the MEIP is an emphasis on clean technology. This approach would supplement the use of traditional end-of-pipe control solutions with considerations of cleaner production, waste-minimizing technology. It is an attempt to include pollution prevention in the environmental management process. It has been suggested that if this approach proves successful, future IBRD projects would not only have a traditional

environmental assessment, but would also include a cleaner production assessment that would determine whether the project was making optimal use of pollution prevention techniques.

4.3.1.1.3 Global Environment Facility. The Global Environment Facility is a special program of the IBRD, the UNEP, and the UNDP. It focuses on projects that have particular global significance. Four specific areas have been identified: global warming, pollution of international waters, destruction of biodiversity, and depletion of stratospheric ozone.

The pollution of international waters is the area most related to hazardous waste. Only a few projects in this area have been implemented in Asia. The most significant is a project to control ship wastes in China, which is funded at $30 million (GEF 1993).

4.3.1.2 International Finance Corporation

The IFC differs from the IBRD in that it conducts its activities with private-sector companies rather than with government organizations (IFC 1992a,b). The IFC makes loans for business ventures and is able to assume equity positions in some operations.

In the environmental field, the IFC has two types of effort. First, it seeks to identify commercially viable environmental projects. With the increasing emphasis on privatization in developing countries, particularly in Asia, more opportunities exist for private-sector firms to take on environmental projects, such as water supply, municipal waste handling, and hazardous waste treatment. The IFC seeks to identify and nurture these projects. The IFC recently completed a nine-country study (IFC 1992b) that identified some private-sector investment opportunities in environmental areas. This study is the IFC's first attempt to become involved in this type of activity.

The second type of environmental effort the IFC undertakes is to review all its projects for potential environmental impacts. It uses guidelines similar to those used by IBRD in conducting these reviews.

4.3.2 Asian Development Bank

The Asian Development Bank (ADB) is a regional lending institution that operates along the same principles as the World Bank. The ADB is headquartered in Manila.

The ADB has a longer history of environmental analysis of its projects than the other international lending institutions. It has incorporated environmental impact assessments in its project review cycle for a number of years. It has also provided loans and grants for environmental projects in the region.

In a project begun in 1993, the ADB initiated the Environmental Rehabilitation Project in Thailand. The objective of the project is to provide technical assistance to the Thai government in developing an investment program to improve water and air quality in priority areas.

4.3.3 United Nations Environment Program

The headquarters of the UNEP is located in Nairobi, Kenya. Two units of UNEP have special relevance to hazardous waste control in Asia: the Regional Office for Asia and the Pacific (ROAP) and the Industry and Environment Program Activity Centre (IE/PAC).

4.3.3.1 Regional Office for Asia and the Pacific

The UNEP/ROAP is located in Bangkok, Thailand. It serves as the coordinator for UNEP activities in the region. It deals with all environmental issues, including hazardous waste.

The UNEP/ROAP is currently emphasizing two major efforts in the hazardous waste control area. The first is the implementation of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (UNEP 1989). Since the convention was agreed upon in 1989, UNEP/ROAP has been working with individual countries to ratify and implement the terms of the agreement. In addition, UNEP/ROAP is attempting to monitor the movement of hazardous wastes in the region.

The second major effort is the promotion of cleaner production technology in industrial operations in developing countries. The UNEP/ROAP works with the IE/PAC, which is described in Section 4.3.3.2. The UNEP/ROAP is trying to identify possible candidates for demonstrations of cleaner production in Asia. Although its budget is small, it is seeking to serve as leverage to get good demonstration projects identified and implemented.

In supporting the cleaner production program, UNEP/ROAP has organized a network of institutions in the region to exchange information on technological approaches. The first focus of this group is the pulp and paper industry in Asia, which has unique characteristics that differentiate it from operations in Western countries. The network is seeking ways to recover chemicals from the processing operations and to find better ways to deal with spent liquors from the mills.

Also in the cleaner production area, the Chinese National Environmental Protection Agency and the City of Shaoxing (about 150 miles from Shanghai) have submitted a proposal to UNEP/ROAP to conduct a cleaner production technology demonstration (CEN 1992). The approach is to use Shaoxing to demonstrate the application of cleaner production technology. Initial efforts will focus on a textile mill, a steel works, a zinc plant, a chemical plant, and a

flashlight manufacturing plant. The UNEP/ROAP is providing technical experts to advise the Chinese plant operators on available alternatives.

In addition to these main efforts in the hazardous waste area, the UNEP/ROAP arranges for training courses, workshops, and symposia on hazardous waste control. It has been seeking to develop a set of training materials and a program of "training the trainers" to more effectively disseminate hazardous waste control information into developing countries.

4.3.3.2 Industry and Environment Program Activity Centre

The IE/PAC, headquartered in Paris, was established in 1975 as the UNEP Industry and Environment Office. Its purpose is to bring together representatives from industry, government, and nongovernmental organizations to focus on the environmental implications of industrial development.

The major IE/PAC activity dealing with hazardous waste is the Cleaner Production Program, which was established in 1989. This program is designed to promote the use of cleaner production techniques in the industrial sector. These techniques produce less waste, use less raw material (especially materials that are toxic), and produce waste products that are less toxic to human health and the environment. The scope of these techniques focuses on the entire production cycle from raw material extraction through transport, processing, production, and waste handling.

A main component of the program is the International Cleaner Production Information Clearinghouse. This computerized system provides information on cleaner production technologies, case studies, contacts for more information, and a calendar of related events. It was set up with support from the U.S. EPA.

Another main activity of the program is the establishment of working groups to focus on cleaner production case studies. Working groups have been established in the leather tanning, textiles, metal finishing, pulp and paper, biotechnology, and petroleum industries. The working groups are made up of representatives of industries in countries where cleaner production techniques have been applied and in countries where there is interest in adapting and using some of the approaches. The program also provides training courses, publications, and technical assistance in the use of cleaner production technology.

A related IE/PAC effort is Awareness and Preparedness for Emergencies at the Local Level. This program provides communities with training and guidance in the establishment of emergency preparedness programs. Preparedness for industrial accidents such as toxic chemical spills is included.

4.3.4 World Health Organization

The World Health Organization (WHO) is a specialized agency of the United Nations that deals with issues of human health. Several units and activities within the WHO deal with hazardous waste issues.

4.3.4.1 International Program on Chemical Safety

The International Program on Chemical Safety (IPCS) is a joint effort of the WHO, the International Labor Organization, and the UNEP. It is designed to disseminate information about the risks of various chemicals and proper means of handling and disposal.

One of the activities of the IPCS is the development and maintenance of the International Register of Potentially Toxic Chemicals (IRPTC). This extensive database contains information about the characteristics of a wide variety of chemicals. The database is accessible in all member countries of the United Nations system. Because of the extensive nature of the information and the large number of chemicals in general use (estimated by some to be in the range of 50,000-60,000), the IRPTC is limited in the scope of its coverage.

The IPCS focuses is on toxic chemicals in general. It goes beyond hazardous waste considerations. The program is primarily an information source and does not focus on specific industrial projects.

4.3.4.2 Regional Office for the Western Pacific

The WHO Western Pacific Regional Office (WPRO), which is located in Manila, Philippines, has responsibility for activities covering all of the western Pacific, including the small island states. One operation from this office is the Regional Environmental Health Centre, located in Kuala Lumpur, Malaysia.

In 1989, the WHO/Western Pacific Regional Office initiated a project entitled Safety and Control of Toxic Chemicals and Hazardous Wastes, funded by the UNDP at about $500,000 (UNDP 1989). The project had activities in China, Malaysia, the Philippines, Korea, and Singapore. The two-year project had the following objectives:

- To delineate national priorities for chemical safety;
- To enable participating governments to optimize their existing legislative and regulatory frameworks for controlling toxic chemicals and hazardous wastes;
- To improve technical, planning, and managerial skills through training; and

- To promote public awareness of the need for toxic and hazardous chemical control.

To meet these objectives, a number of activities were carried out, such as a series of national workshops, technical studies on specific problems, review of national legislation and proposal of modifications to increase toxic chemical control, training courses, fellowships, and educational materials for community health workers and the public.

The project was carried out from 1990 to 1992. A regional workshop was held in Kuala Lumpur in October 1991 so that the participating countries could share their experiences and insights (WHO 1991). The following are some of the findings and recommendations of the project, as quoted from the final report (WHO 1992):

> (1) The project produced proposals for activities to improve various aspects of chemical safety Programs. Common areas of concern included: (a) the development of chemical safety information/databases and information services; (b) the training of professionals; and (c) the preparation of pragmatic chemical safety guidelines and manuals. These proposals should be further developed and implemented by governments, with the support of UNDP [the United Nations Development Program], WHO and others where appropriate.
>
> (2) Although substantial development of chemical safety legislation has been achieved, further work is needed in most countries. Legislation must be underpinned by detailed regulatory guidelines and must include/address import, export and international trade issues.
>
> (3) The training of professionals to deal with chemical safety problems is crucial to the further development of national capabilities. Systematic training Programs should be developed to include: (a) on-the-job-training for today's workers; (b) university-level training for tomorrow's professionals; and (c) awareness training for the general public.
>
> (4) Although all countries involved in the project recognize the need for emergency response, few have an adequate capability. Governments should give priority to establishing appropriate means of responding to chemical emergencies.

4.3.5 Economic and Social Commission for Asia and the Pacific

The Economic and Social Commission for Asia and the Pacific (ESCAP) is a specialized arm of the United Nations. It is headquartered in Bangkok, Thailand. Its purpose is to promote economic and social development in the nations of Asia and the Pacific.

The ESCAP has sponsored several activities related to hazardous waste. Most have centered on the identification of the role of industrial development in the generation of hazardous wastes (ESCAP 1987, 1992a). ESCAP provides information on industrialization impacts to its member countries. Several guidance documents have been prepared (ESCAP undated, 1992b).

Three hazardous-waste-related projects are currently under way:

- Preparation of a guidance manual on hazardous waste management for developing countries,
- Development of a database on hazardous waste in the region, and
- Assistance to developing countries in implementing the Basel Convention on transboundary movement of hazardous waste.

4.3.6 United Nations Industrial Development Organization

The United Nations Industrial Development Organization (UNIDO) is located in Vienna, Austria. The primary mission of this group is to assist developing countries with the growth and development of the industrial sector.

One specific UNIDO activity that relates to hazardous waste control is the establishment of National Cleaner Production Centers. These centers would be located in about 20 countries around the world and funded for a five-year period. The objective of these centers would be to demonstrate cleaner production technology under host country conditions. Local staff members would participate in the demonstrations and contribute to the adaptation of these technologies to local situations. UNIDO is collaborating with UNEP on this project.

The UNIDO also provides technical experts in various environmental areas to developing countries. An example is the expert detailed to Thailand to help with the preparation of the bid specifications for hazardous waste incinerators. Although UNIDO does not have all the necessary technical expertise on its own staff and frequently relies on independent consultants from United Nations member countries, it has a reputation for providing information that is not commercially biased.

4.3.7 International Solid Waste and Public Cleansing Association

The International Solid Waste and Public Cleansing Association (ISWA) is a multinational group with representatives from countries in North America, Europe, Asia, Africa, and Latin America. The purpose of the group is to provide a forum for the exchange of information and collaborative activities among members in the area of waste control. The ISWA

is a source of contacts with technical experts, particularly in Europe. The U.S. EPA is the U.S. member in ISWA.

One ISWA activity is the Working Group on Hazardous Wastes, which focuses on these special issues. This group has dealt with hazardous waste issues in developing countries. It has held several conferences and workshops that address the hazardous waste problems in developing countries. It has also prepared some training materials (ISWA 1991).

4.3.8 Asia-Pacific Economic Cooperation

The Asia-Pacific Economic Cooperation (APEC) was formed as a cabinet- or ministerial-level organization in 1989. The group now has 15 member countries: Australia, Brunei, Canada, China, Hong Kong, Indonesia, Japan, Korea, Malaysia, New Zealand, the Philippines, Singapore, Taiwan, Thailand, and the United States. The objective of the organization is to promote cooperative activities, including trade, among the member countries. In part, the group was a response to some concern over the development of the European community as a potent trading bloc.

In addition to regular meetings among the APEC ministers, a series of cooperative work programs has been identified as initial efforts. The six areas of cooperation are as follows:

- Trade and investment data,
- Trade promotion,
- Expansion of investment and technology transfer,
- Human resource development,
- Marine resource conservation, and
- Regional energy cooperation.

The typical manner in which a cooperative work program would be implemented is to begin with one country agreeing to serve as the coordinator for that area. A series of working level meetings are held to identify the needs in the area and to map out a particular strategy for conducting the cooperative work. Included in such a program would be activities such as conferences, training courses, exchange of information and data, and collaborative research projects. The intent of the activities is to provide a forum for cooperation and collaboration. There are no direct commercial promotion efforts as part of APEC activities.

Although no APEC activity currently deals directly with industrial pollution in general and hazardous waste in specific, the topics for cooperative projects are constantly under review and revision.

4.3.9 Pacific Basin Economic Council

The Pacific Basin Economic Council (PBEC), a private-sector organization, provides a forum for business leaders to meet and exchange ideas. The PBEC was formed in 1967 and is headquartered in Honolulu, Hawaii. Among PBEC activities is the arrangement of meetings between senior business leaders and senior government officials to discuss business development issues. Several publications provide information to members on trends in the region. The PBEC also facilitates contacts among member companies seeking to establish new business ties.

The PBEC has about 900 member companies. Each is represented in one of 14 Member Committees. The countries that have Member Committees are Australia, Canada, Chile, Fiji, Hong Kong, Japan, Korea, Malaysia, Mexico, New Zealand, Peru, the Philippines, Taiwan, and the United States. The U.S. Member Committee is headquartered in Washington, D.C.

The U.S. membership in PBEC comprises about 35 companies from different industrial and service areas. Most are large firms with significant multinational experience. The U.S. Committee of PBEC has issued a policy paper (PBEC undated) calling for the following:

- An expansion of trade but the consideration of a "Pacific Basin Code of Conduct" that would spell out guidelines to make for more even-handed trading practices,
- Expansion of open or two-way investment in international business,
- Good corporate citizenship,
- Changes in U.S. economic policy to emphasize an export orientation, and
- New mechanisms for intergovernmental cooperation on trade.

The U.S. Committee has formed the Environmental Business Committee to help U.S. firms seeking to do environmental business in the region.

4.3.10 International Environmental Bureau

The International Environmental Bureau was established in 1984 under the International Chamber of Commerce. It comprises about 35 industrial organizations around the world, and it is headquartered in Norway. Its objective is to make the environmental expertise of its members available to companies in developing countries. The IEB's recent activities have included the following:

- Supporting corporate environmental management through workshops and briefings to company officials,

- Promoting energy and resource efficiency through joint projects among companies in developed and developing countries,
- Promoting environmental auditing,
- Facilitating access to environmental technology, and
- Promoting environmental education.

4.4 OTHER ORGANIZATIONS

Several other organizations are not conveniently grouped with those previously mentioned but are notable with respect to hazardous waste.

4.4.1 Air and Waste Management Association

The Air and Waste Management Association (AWMA) is an organization and network for professionals in the air pollution and waste management fields. It includes most U.S. companies involved in hazardous waste management. The AWMA conducts an annual technical meeting and a number of specialty conferences throughout the year. Training courses are part of the AWMA technical program. The AWMA has recently cooperated with the USAEP in environmental training programs for Asia. The AWMA is headquartered in Pittsburgh, Pennsylvania, and its membership is greater than 14,000 in 50 countries.

4.4.2 U.S. Environmental Training Institute

The U.S. Environmental Training Institute is a nonprofit organization set up to conduct environmental training for developing country professionals. The Institute is headquartered in Washington, D.C. Training courses are conducted there and at the facilities of member industrial organizations. Funding is received from various U.S. government and private company sources.

Participants in training courses at the Institute do not pay tuition fees. Travel costs are borne by their home organizations, development assistance agency grants, or a limited number of scholarships from the Institute. Institute courses cover a wide range of environmental topics, including hazardous waste.

4.4.3 Pacific Basin Consortium for Hazardous Waste Research

The Pacific Basin Consortium for Hazardous Waste Research was formed in 1987 by the joint efforts of Argonne National Laboratory, the East-West Center, and the Industrial

Technology Research Institute in Taiwan. The Consortium's objectives are to promote collaborative research, serve as a network of professionals in the hazardous waste field, and promote information exchange. The Consortium has 85 member organizations from 16 countries. The Secretariat is located at the East-West Center in Honolulu, Hawaii.

The Consortium hosts a regular technical meeting and prepares occasional reports on hazardous waste topics of interest in Asia. The Consortium's network of contacts has been used frequently to provide information on hazardous waste technical issues.

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