Republic of the Philippines
Department of Environment and Natural Resources
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METRO MANILA SOLID WASTE MANAGEMENT PROJECT (TA 3848-PHI)

Final Report

REPORT No: 11

Medical Waste Management

September 2003 (Revised)

AEA Technology *In Association With* GlobalWorks • CalRecovery • ENR Consultants

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MEDICAL WASTE MANAGEMENT

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Executive Summary

Worldwide, public concern related to the collection, treatment, and final disposition of health care waste has increased considerably during the past few years. These concerns regarding medical waste are also evident in the Philippines. In addition, there has been concern regarding incineration and a renewed interest in segregation and recycling. As a result, two important pieces of legislation have been passed in the last few years that pertain to solid waste management, including health care wastes:

- the signing of Republic Act No. 8749, an act providing for a comprehensive air pollution control policy and for other purposes (typically known as the Clean Air Act) – prohibits the burning of bio-medical wastes and requires the phase out of existing incinerators by July 2003; and
- the signing of Republic Act No. 9003, an act providing for an ecological solid waste management program and for other purposes (generally known as the Ecological Solid Waste Management Act of 2000 - ESWMA) – requires proper segregation, recycling, and composting of the non-infectious fraction of the waste stream.

This report deals strictly with solid wastes generated in health care facilities. Every facility involved in the provision of care for the maintenance or improvement of the health and well being of either humans or animals produces some type of residue. The quantity, composition, and characteristics of the waste vary depending upon the type of health care facility.

Laws Dealing with Medical Waste

Numerous laws and regulations have been identified as being pertinent to the management of health care wastes in the Philippines. On a national level, 12 key laws and regulations were identified. The two most pertinent ones are RA8749 and RA 9003, as described above.

At the Metro Manila level, the management of health care wastes has been regulated primarily by three regulations:

- *Metro Manila Council MMDA Regulation No. 96-000* -- prohibits littering/throwing of any kind of waste in open or public places, and requires all owners, lessees, occupants of residential, commercial establishments to clean and maintain the cleanliness of their surroundings
- *Ordinance No. 16 Series of 1991* -- regulates the management, collection, and disposal of hospital waste and similar institutions in Metro Manila
- *MMDA Regulation No. 98-008* -- requires that health care facilities provide four types of waste bags.

Types and Number of Health Care Facilities

Based on the Consultant's evaluation, at the present time there are 3,670 health care facilities in Metro Manila. A breakdown by type of facility is presented in Table E-1.

Table E-1. Sources of Medical Waste in Metro Manila

Type of Facility	Government	Private	Totals
Accredited Hospitals	46	151	197
Health Centers	393	8	401
Medical Clinics	2	1288	1290
Dental Clinics	30	950	980
Veterinary Clinics	4	89	93
Pharmaceutical Labs	97	384	481
Blood Banks	3	14	17
Funeral Parlors	0	196	196
Medical Schools	3	8	11
Research Institutions	4	0	4
Totals	582	3088	3670

Quantity and Composition

The Consultants conducted a review of available data and compiled the limited reliable information that is available. The Consultants subsequently conducted a one-week analysis of non-infectious and infectious waste at the East Avenue Medical Center (EAMC) in Quezon City to obtain additional data. A comparison of the results of the study at EAMC with previous studies is presented in Table E-2.

Table E-2. Comparison of Waste Generation by Various Studies

Study (date)	Infectious Waste	Non-infectious Waste	Total
Hospitals (kg/bed-day)			
JICA (1999)	0.31	N/A	N/A
San Lazaro (2002)	0.17	0.39	0.56
EAMC (2002)	0.34	0.19	0.53
All Health Care Facilities (tons/day)			
JICA (1999)	17	N/A	N/A
MMDA (2000)	9	51	60
ADB TA (2003)	27	20	47

N/A: Not available

Based on the results of the study, health care facilities in Metro Manila generate about 47 tons/day of waste. The estimates are based on the highest unit rates from the studies conducted at San Lazaro and at EAMC. Given the present level of segregation, approximately 27 tons/day of the health care waste (about 56% by weight) is considered infectious and/or potentially infectious. The estimated amount of waste generation by type of facility is given in Table E-3.

Based on the results of the waste characterization study and on an expected growth rate of the number of beds of about 2% per year, an estimate has been made on the quantity of health care waste that will be generated in Metro Manila over the next 8 years (see Figure E-1). The estimate shows that the total amount of health care waste will increase to about 55 tons per day by the year 2010. On the other hand, the amount of infectious waste is projected to decline until the year 2008 and after that it will stabilize at approximately 19 tons per day. This decline will only be achieved if comprehensive and continuous training efforts are conducted at all the health care facilities. Furthermore, IEC and other similar activities will also make positive contributions to the reduction of the amount of infectious waste generation.

Table E-3. Estimated Quantities of Health Care Waste Generated in Metro Manila

Type of Facility	No. of Facilities	No. of Beds	Unit Generation Rate (kg/day) Infec.	Non-infec.	Infectious Waste (kg/day)	Non-Infectious Waste (kg/day)	Total (kg/day)
Accredited Hospitals	197						
Government (no. of beds)		17,563	0.34	0.39	5,971	6,850	12,821
Private (no of beds)		11,753	0.34	0.39	3,996	4,584	8,580
Health Centers	401		2	3	802	1,203	2,005
Medical Clinics	1,290		2	3	2,580	3,870	6,450
Dental Clinics	980		6	2	5,880	1,960	7,840
Veterinary Clinics	93		4	1	372	93	465
Pharmaceutical Labs	481		12	3	5,772	1,443	7,215
Blood Banks	17		12	3	204	51	255
Funeral Parlors	196		6	1	1,176	196	1,372
Medical Schools	11		12	3	132	33	165
Research Institutions	4		12	3	48	12	60
Total	3670				26,933	20,294	47,228

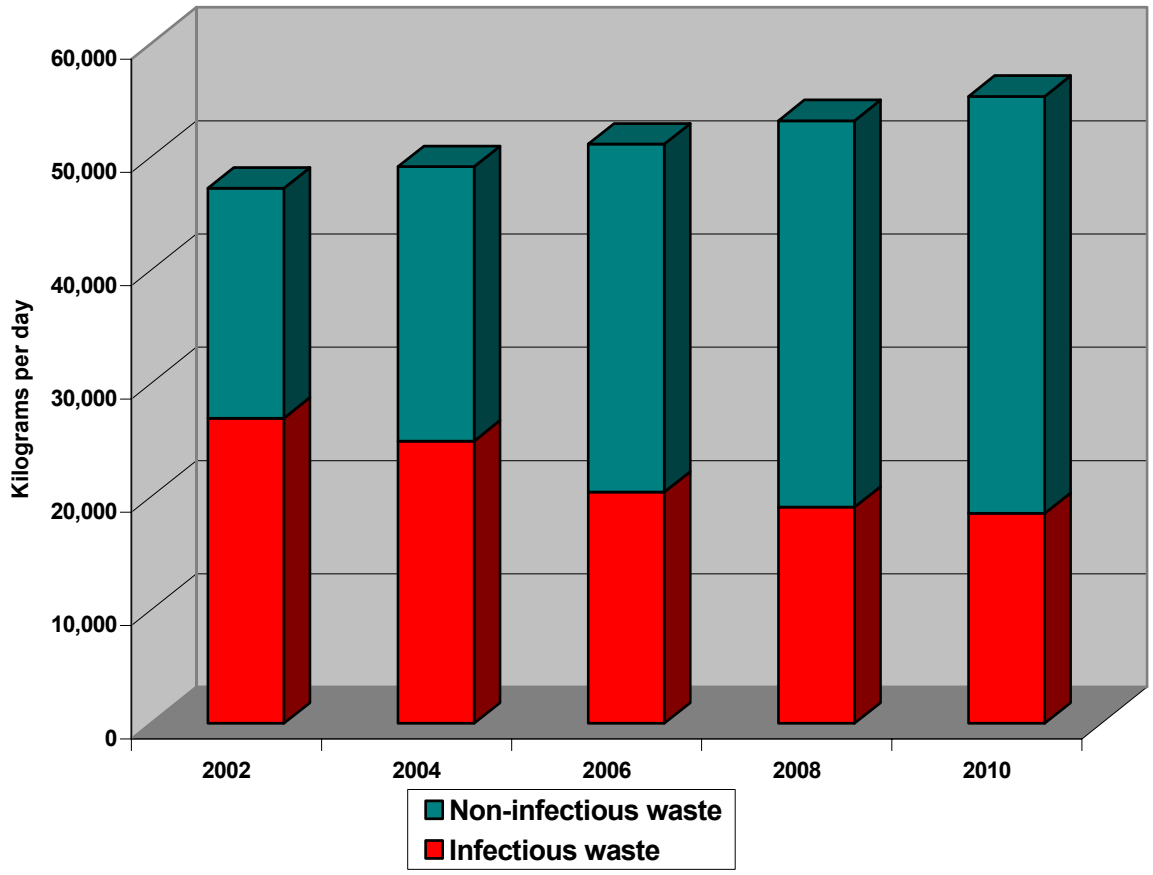


Figure E-1. Estimate of Current and Projected Quantities of HCW Generated in Metro Manila

Current Practices

A key component of the study incorporates an evaluation and suggestions for improvement for the management of health care wastes for both infectious and non-infectious waste. Surveys were conducted of selected health care facilities (hospitals and clinics as well as minor health care facilities) in Metro Manila to determine the status of the waste management system in the sector.

Hospitals and Clinics

Eighteen hospitals and clinics were surveyed; ten owned and operated by the government, and the rest private hospitals. Key results are as follows:

- The majority of the hospitals (90%) indicated that they have established a committee that looks after waste management.
- All of the hospitals surveyed separate sharps such as syringes, scalpels and similar items, from the rest of the wastes. The syringes usually are placed in plastic containers designed to hold sharps (safety boxes) or in other containers such as hard plastic bottles, cans or plastic gallon containers lined with plastic bags.
- Most (65%) of the sharps are given to a private contractor for treatment and disposal. The rest are buried at the site (10%), disposed (5%), incinerated (15%), or burned in improvised combustion units (5%).
- Disinfection of infectious waste is carried out in about 80% of the hospitals surveyed using either steam sterilization or chemical methods.
- All of the hospitals surveyed indicated that they separate medical wastes from general wastes. Ninety percent of the hospitals practice color-coding in storing their wastes while 10% do not follow any type of system.

Minor Health Care Facilities

An assessment was conducted of the following types of facilities: dental clinics, veterinary clinics, diagnostic and laboratory clinics, and mortuaries/funeral parlors. Waste management practices were similar among the facilities surveyed. The following sections of this report describe the results of the survey.

- General wastes typically are stored in plastic bags, are disposed through open burning or are collected by a municipal waste collector. In some cases, the wastes are burned.
- Sharps are separated from other medical waste and are placed in plastic containers, and eventually are taken to the municipality's dumpsite.
- Infectious or potentially infectious wastes generally are not disinfected prior to disposal.
- Pharmaceutical wastes typically are flushed into the sewer or disposed at the disposal site.
- Most medical wastes currently are separated from the general wastes, but often are mixed with other wastes during disposal.
- At mortuaries/funeral parlors, placenta and fetuses were collected by family members or buried in a cemetery.

Waste Treatment Systems and Equipment

A separate survey was carried out to supplement the information related to the different practices associated with the management of health care wastes. A total of 36 hospitals participated in the survey. According to the respondents, the quantity of regulated waste (infectious, toxic and hazardous) generated each day by the facilities ranges from 3 to 700 kg. At the time of the study (early 2003), most regulated wastes were treated by incineration or through microwave.

Treatment of Medical Wastes at DOH Hospitals

Approximately five years ago, the DOH completed the acquisition of various types of equipment (including 25 incinerators and 36 small microwave units) for DOH hospitals, financed through a Soft Loan by the Austrian Government. The capacity of the incinerators varies from 300 to 500 kg/day and that for microwaves from 84 to 144 kg/shift. The DOH reported that 13 microwave units were installed in Metro Manila, only one of which is operational.

Private Sector Participation

At the time of the study (early 2003), there are two privately owned facilities, the operating companies of which provide collection, treatment, and disposal services to both private and public health care facilities in Metro Manila (IWMI and CESI). IWMI uses incineration (2000 kg/day), and has reported that they have acquired a new pyrolysis unit that will be capable of treating 10 tons per day. CESI uses a large-scale microwave (250-400 kg/hr). Collection schedules vary for each hospital from daily to once or thrice per week.

St. Luke's Medical Center installed an autoclave for the treatment of its residues. The unit is capable of processing about 330 kg/hr and it is for the exclusive use of the hospital.

Alternative (Non-burn) Technologies

The Consultants conducted an analysis of technologies that could treat infectious wastes and meet the requirements of the Clean Air Act. The following technologies were evaluated: mechanical (size reduction and compaction); thermal (autoclave, microwave, pyrolysis/gasification); chemical (chlorination, ozonation); radiative (electron beam, Cobalt-60); and biological (enzymatic processes, composting).

The following criteria were used to evaluate the technologies:

- Prevailing regulations
- Available options in the region
- Quantities of generated waste categories
- Availability of qualified personnel
- Technologies available on the market
- Capital and operating and maintenance cost

Based on the results of the evaluation, the Consultants concluded that infectious and some hazardous wastes generated in health care facilities in Metro Manila could be treated by a combination of physical and thermal technologies. Given the degree of development of some of the technologies and the current conditions in the country, the most appropriate technologies for the Philippines seems to be disinfection by means of autoclaves or microwaves.

Capacity Building and Stakeholder Participation

Seminars, workshops, and meetings were organized throughout this TA. In addition, a technical working group was established to discuss issues and obtain feedback on several initiatives. Additionally, the project team supported the process to update the DOH's *Manual on Hospital Waste Management.*

Strategy for the Treatment of Medical Wastes Generated in Metro Manila

The results of the surveys and evaluations were used by the project team to develop a strategy for collecting, treating, and disposing of the wastes. The strategy utilizes a combination of microwave and autoclaves providing service to either one or a combination of users. The system also relies on a waste collection system provided by dedicated, specialized vehicles to transport the waste from the generators to the treatment facilities using a reliable "chain of custody" system. The service providers can be a combination of public and

private sector (taking advantage of the two existing private sector contractors). Finally, the strategy relies on the use of one or more sanitary landfills equipped with the appropriate features to accept the treated materials.

The strategy has been designed such that:

- currently estimated quantities of waste generated can be properly managed; and
- maximum use of existing appropriate facilities can be accomplished.

The strategy also relies on the development and implementation of an education and training program aimed at all of the staff and patients of health care facilities. The education and training program should emphasize waste minimization and proper and efficient segregation of the wastes.

The strategy consists of two options (Option 1 and Option 2) to treat the estimated 26,930 kg/day of infectious wastes generated in Metro Manila. The alternatives are based on the viability of repairing and operating existing microwaves that have been installed in several DOH facilities in Metro Manila. In both options it is assumed that the private sector would play a critical role. Treatment facilities could be established through strictly private sector initiatives or in partnership with the public sector. The strategy also provides the opportunity for the establishment of special lending programs aimed at encouraging the development of additional private sector participation in the management of health care wastes. A summary of the proposed options is provided in Table E-4.

Table E-4. Proposed Options for Treatment of Infectious Medical Waste*

	Option 1		Option 2	
	Technology	kg/day, 2 shifts	Technology	kg/day, 2 shifts
Quantity Generated				
Department of Health		3,230		3,230
All other facilities		23,700		23,700
Total		26,930		26,930
Service Provider				
DOH	Microwave	3,230	Autoclave	3,230
IWMI	Pyrolysis	10,000	Pyrolysis	10,000
Chevalier	Microwave	4,800	Microwave	4,800
St. Luke's Medical Center	Autoclave	900	Autoclave	900
New individual units at facilities**	Autoclave/Other	1,600	Autoclave/Other	400
New cluster units at facilities**	Autoclave/Other	3,200	Autoclave/Other	1,600
New private sector operation**	Autoclave/Other	3,200	Autoclave/Other	6,000
Total		26,930		26,930

*Large body parts and cadavers would be cremated.
**Other – implies the use of any technology that would meet the requirements of the Clean Air Act.

Option 1

As shown in Table E-4, Option 1 is based on the use of microwave and autoclave units to sterilize infectious waste, and assumes the repair and use of the 13 existing DOH microwave units that are installed in various health care facilities in Metro Manila. The private facilities (IWMI, Chevalier, and St. Luke's) would be utilized. The rest of the waste would be treated in 6 autoclaves, each with a capacity of 150 kg/hr. To maximize the investment, all units (microwaves and autoclaves) would be operated for two shifts per day (8 hr/shift). The third shift would be used for maintenance.

The estimated capital costs and O&M costs are subdivided by public and private sectors. The total capital cost for the public sector is US$885,000 and that for the private sector is US$2,065,000. Similarly, the O&M cost for the public sector would be US$1,063,464 and that for the private sector US$1,179,320. These costs include amortization.

Option 2

This option essentially is the same as Option 1 with the major difference that we assume that the DOH decides not to use the 13 microwave units in Metro Manila. In Option 2, the waste that would have been treated by the microwave units would be treated by autoclaves. The waste would be treated in 9 autoclaves (3 pubic and 6 private). The capacity of 8 autoclaves would 150 kg/hr and one would be 80 kg/hr. St. Luke's, CESI and IWMI would process wastes as suggested in Option 1. All units would be operated for two 8-hr shifts per day. The third shift would be used for maintenance.

The estimated capital costs and O&M costs are subdivided by public and private sectors. The total capital cost for the public sector is US$1,235,000 and that for the private sector is US$4,829,000. Similarly, the O&M cost for the public sector would be US$705,592 and that for the private sector US$2,327,672. These costs include amortization.

Public Education and Outreach

An outreach strategy related to medical waste was developed based on the results of the evaluation of health care facilities. The strategy is summarized below; further information is presented in the report on Community Awareness Strategy. Two key issues related to medical waste management were identified, which demonstrate the need for additional IEC activities: (1) problems associated with improper segregation; and (2) an increase in public awareness and concern. Recommended activities are outlined in Table E-5. Posters and fact sheets were prepared and will be made available to health care facilities.

Table E-5. Recommended IEC Strategies Related to Medical Waste Management

Target Audience	Purpose	Strategy/Method
Hospital Personnel	Training	▪ Guidance document ▪ Trainer training ▪ Personnel training ▪ Interactive training guide
	Reminder	▪ Posters ▪ Fact sheets
Non-hospital Personnel	Instruction, motivation	▪ Posters

Consultation with Key Entities

The Consultants conducted a series of meetings with key Government and Non-Government organizations including the Secretary of the DENR (Secretary Gozun), Undersecretary of the DOH (U. Sec. Lopez), other representatives from the DENR (Director of EMB), representatives from the DOH, the BOT Center, and the Philippine Medical Association on May 28, 2003. In addition, the Consultants presented the proposed strategy to representatives of the DENR, DOH, BOT Center, MMDA, Philippine Hospital Association, Philippine Medical Association, the Heart Center, and others on June 9, 2003. The participants in these meetings reached consensus and offered strong support for the strategies.

Conclusions

- Two important pieces of legislation have been passed in the last few years (the Clean Air Act and the Ecological Solid Waste Management Act) that impact the management of health care wastes. Nevertheless, few changes have taken place in the actual management of health care wastes in Metro Manila during the last two years. Two of the most notable changes include: an increased reliance on the private sector for the collection and treatment of health care wastes and the decision by the MMDA to stop its participation in the management of health care wastes.

- Those responsible for the management of health care wastes have a number of concerns including: complying with the requirements of recent legislation (the Clean Air Act and the Ecological Solid Waste Management Act), and the reassignment of responsibilities that were once under the purview of MMDA.

- Until recently, incineration has played a major role in the treatment of health care wastes. Technically viable and affordable alternatives are needed to treat wastes that have in the past been treated by incineration. A secure and reliable final disposal site is not available for accepting health care wastes treated by non-burn technologies.

- The DOH acquired 25 incinerators and 36 disinfection units from the Austrian Government for installation in some of its hospitals. Only four of the microwave units currently are in operation, the others either are defective or not used.

- Health care facilities in Metro Manila generate on the order of 47 tons of medical waste. Approximately 27 tons are considered infectious or potentially infectious. Based on the information collected during this evaluation, it is estimated that about 5 tons per day of infectious waste (or about 18.5% by weight) were disposed properly (i.e., through autoclave, microwave or incineration) and approximately 22 tons per day (or about 81.5% by weight) were disposed on the land (either buried on-site or discarded along with the rest of the waste collected by the municipal waste collection service).

- According to the survey results, most health care facilities that generate cytotoxic wastes pay private contractors to collect and dispose of the materials. Most of the other water-soluble pharmaceutical wastes are discharged into the sewer system. Radioactive wastes are carefully collected from the point of generation and appropriately stored until the radioactivity has decayed to safe levels and the materials can be safely disposed along with the general waste.

- Hospitals generate on the order of 0.73 kg/bed-day of solid wastes. Approximately 0.34 kg/bed-day are considered infectious or potentially infectious. Most hospitals practice some segregation. Most (about 78%) of the accredited hospitals dispose of their infectious waste properly (either through incineration or microwave), 66% of which is conducted off-site. The remaining hospitals (22%) relied on land disposal or open burning.

- Many of the other health care facilities (dental clinics, veterinary clinics, diagnostic and laboratory clinics, and mortuaries/funeral parlors) practice some segregation; in particular sharps are placed in rigid containers. In general, all wastes (including untreated infectious waste and sharps) are mixed and collected as municipal solid waste.

- The results of the waste characterization survey conducted in the course of this TA demonstrated that improper segregation still takes place in some facilities. Little if any inspection of segregation of wastes at health care facilities is conducted.

- Estimates indicate that the total amount of health care waste will increase in Metro Manila to about 55 tons per day by 2010. At the same time, our estimates show that thorough training programs and other activities will lead to proper segregation and therefore the amount of infectious waste will decrease to 18.5 tons by 2010.

- Information obtained in course of this study shows that the health care sector is not prepared to comply with the provisions set forth by the Clean Air Act. Recently, the DOH and the DENR have held a series of meetings in an attempt to address the Clean Air Act. Based on the discussions held with representatives from the public and private sectors, the majority of the entities seemed to be waiting for the Government to provide solutions.

1 Background

Worldwide, public concern related to the collection, treatment, and final disposition of health care waste has increased considerably during the past few years. This concern is partly due to several incidents associated with the illegal or improper disposal of some of these wastes. For instance, used hypodermic needles and syringes were found on beaches along the Eastern Coast of the United States, and the sale of used disposable syringes has been reported in some cities in India.

The public's concern seems to be related to the potential risks associated with the transmission of human immunodeficiency virus (HIV), hepatitis B virus (HBV), and other agents associated with blood-borne diseases. Furthermore, the public in several countries has reacted negatively to emissions from incinerators that are used to treat health care waste, and is concerned that these emissions may contain high concentrations of toxic compounds and viable microorganisms. More recently, people's concerns have been heightened by the SARS epidemic across most of Asia and Canada.

A serious lack of understanding of the modes of transmission of agents related to blood-borne disease (particularly, fatal diseases) has prompted intense public pressure to regulate health care wastes.

These concerns regarding medical waste are also evident in the Philippines. In addition, there has been concern regarding incineration and a renewed interest in segregation and recycling. As a result, two important pieces of legislation have been passed in the last few years that pertain to solid waste management, including health care wastes:

- the signing of Republic Act No. 8749, an act providing for a comprehensive air pollution control policy and for other purposes (typically known as the Clean Air Act) – prohibits the burning of bio-medical wastes and requires the phase out of existing incinerators by July 2003; and

- the signing of Republic Act No. 9003, an act providing for an ecological solid waste management program and for other purposes (generally known as the Ecological Solid Waste Management Act of 2000 - ESWMA) – requires proper segregation, recycling, and composting of the non-infectious fraction of the waste stream.

This report deals strictly with solid wastes generated in health care facilities. Every facility involved in the provision of care for the maintenance or improvement of the health and well being of either humans or animals produces some type of residue. The quantity, composition, and characteristics of the waste vary depending upon the type of health care facility. A modern hospital in an industrialized area generally is a complex, multidisciplinary unit that produces a variety of residues. On the other hand, a medical post located in a rural area in a developing country would produce an entirely different type of solid waste. Each of these facilities would require a different approach to managing their wastes.

2 Definitions

Unfortunately, wastes generated in health care facilities do not have standard definitions that have been universally accepted. Currently, there seem to be as many definitions as there are institutions involved in the management or regulation of these wastes. This situation, of course, leads to confusion and misinterpretation of findings from research and other work. Given the present situation, a few definitions have been selected from various sources that seem to be the most commonly used and the most logical to the Consultants.

Health care waste is produced in all conventional facilities dedicated to the treatment of patients such as hospitals, clinics, medical posts, and others. Other facilities or establishments that generate health care wastes include: veterinary hospitals, dental and medical offices where treatment is provided, analytical laboratories, dialysis facilities, blood banks, university laboratories and similar facilities, tattooing and body piercing facilities, mortuaries, and others. Health care waste refers to all materials, biological or non-

biological, that are discarded in any health care facility and are not intended for any other use. In the most global definition, health care waste would include solid, liquid, and gaseous residues. However, for the purpose of this report we will limit the definitions to the solid medium. A modern, large facility would generate waste such as paper and similar materials from administrative offices, residues from food preparation from kitchen facilities, grass clippings and prunings from maintenance of the grounds, as well as a variety of other materials that would be generated as the result of treatment of patients.

Medical waste refers to that fraction of health care waste that is produced as the result of diagnosis, treatment, or immunization of human beings or animals.

Infectious waste means that fraction of medical waste that can potentially transmit an infectious disease. In some countries, this is referred to as "regulated medical waste" or "RMW."

Radioactive waste means all materials contaminated with radionuclides (radionuclides are used in health care facilities for treatment, diagnosis, and research), which spontaneously emit particles and/or rays by the disintegration of the nuclei of their atoms.

Pharmaceutical waste means all products, drugs, drug residuals, and therapeutic chemicals that have been returned from wards, have been spilled, are outdated or contaminated, or have to be disposed of because they are no longer required.

Hazardous waste means all materials that can cause harm to human beings or animals or to the environment due to their physical or chemical characteristics (sharpness, flammability, corrosivity, and others).

Work conducted in several countries indicates that only a relatively small fraction of health care wastes (between 10% and 20% by weight) is hazardous and contain materials or compounds that may be infectious, toxic, or radioactive.[1]

In general, wastes generated in health care facilities in economically developing countries have raised serious concerns due to inadequate treatment and final disposal practices. In addition, hazardous health care wastes, when inappropriately managed, may compromise the quality of patient care (lead to intra-hospital infections) and pose occupational health risks to those who care for the patients as well as to those that manage the wastes.

Every year, relatively large quantities of potentially infectious and hazardous wastes are generated in health care facilities throughout the world. Unfortunately, most economically developing countries suffer financial and other constraints to adequately manage these wastes. Generally in developing countries, few individuals in the staff of the health care facility are familiar with the procedures required for an effective and efficient waste management program. In many developing countries, the management of wastes is delegated to poorly educated laborers who perform most activities without proper guidance and insufficient protection.

An effective and efficient program for the management of health care wastes is a critical component of the facility's infection control program and consequently has a severe impact on the quality of care, as well as on the occupational health of the entire staff of the facility.

[1] Pruess, A. *et al*, *Safe Management of Wastes from Health-Care Activities*, World Health Organization, Geneva, 1999.

3 Laws Dealing with Medical Waste

Laws and regulations that have been identified as pertinent to the management of health care wastes in the Philippines are set out in TA report no. 6, *Laws and Regulations*. The laws most relevant to the management of medical wastes are briefly presented as follows:

3.1 National Level

Common Wealth Act 383 – provides for penalties for disposing of refuse, wastewater, and other materials into rivers (5 September 1938).

Republic Act 3931 – an act creating the national water and air pollution control commission (18 June 1964).

R.A. 4226 Hospital Licensing Law, series of 1965 -- The Implementing Rules and Regulations (Administrative Order No. 68-A, series of 1989) provide guidelines to protect and promote public health by ensuring quality hospital services appropriate to its level of health care. The Bureau of Licensing and Regulation of the Department of Health enforce this law.

Presidential Decree No. 825 – provides for penalties for improper disposal of waste and for other purposes (7 November 1975).

Presidential Decree No. 856, Code on Sanitation of the Philippines -- deals with refuse disposal, nuisances and offensive trades and occupations, and disposal of dead persons. President F. Marcos promulgated the Code on Sanitation (P.D. 856) on December 23, 1975. The primary objective of the Code was to improve the quality of life of the Filipinos through protection and promotion of public health. P.D. 856 was a consolidation, compilation, and integration of all health sanitation laws from the 75 years prior to the code's enactment, which, up to that time, were scattered in various statute books. Approximately, twenty years prior to its enactment, the committee on codification prepared the first draft of the code. Unfortunately, due to political reasons, this draft did not gain acceptance. The first draft was followed by two other efforts; these efforts did not prosper in Congress either. The fourth draft of the code was expedited and was given the force of Law when President Marcos signed it as Presidential Decree No. 856. The Code on Sanitation contains 22 Chapters but does not deal specifically with solid wastes produced in health care facilities. However, some of the chapters that are relevant to medical wastes are: Chapters 4, 6, 17, 18, 19, 20, and 21. The implementing rules and regulations (IRR) for Chapter 18 were promulgated in 1998 (over 20 years after PD 856 was signed into law).

Memorandum Circular No. 30, November 2, 1987 issued by the Office of the President -- established a Task Force on Waste Management. The Task Force prepared a solid waste management plan for Metro Manila (1988-1992). The President of the Philippines approved the plan for implementation. The plan identified the need to perform a special study on hospital wastes. The DOH, in coordination with the Environmental Management Bureau of the DENR, conducted a study and survey of 64 selected government and private hospitals in Metro Manila from May to August 1988. In view of the hazards created by the unsatisfactory methods of collection and disposal of hospital solid waste covered by the study, the Environmental Health Service of the DOH, in consultation with the private sector and academe, developed Manual *on Hospital Waste Management* in 1992. The manual was prepared to serve as a guide to hospital administrators and managers of health programs who must assume the responsibility for disposal of hospital wastes. The standards and guidelines contained in the manual are made part of the implementing rules and regulations of Refuse Disposal chapter of the P.D. 856. The manual was also used in a series of orientation training for Administrators of DOH Hospitals, some provincial hospitals, and private hospitals in Metro Manila in 1994 and 1995.

Republic Act 6969 – an act to control Toxic Substances and Hazardous and Nuclear Wastes, covers management of all unregulated chemical substances (October 26, 1990).

DOH Department Circular No. 152-C, series of 1993 -- directs all Directors and Chiefs of hospitals, clinics, laboratories, and research offices to promote a healthy environment by following the guidelines set in this circular associated with waste segregation, collection, treatment, and disposal.

On October 19, 1993, the President of the Republic issued a memorandum to the Secretary of the DOH directing the Department of Health to implement guidelines on hospital waste management, and put into practice a solid waste management plan for all hospitals.

Republic Act No. 8749, June 23, 1999 - an act providing for a comprehensive air pollution control policy and for other purposes (Clean Air Act). In addition to other aspects, this act bans the incineration of municipal, bio-medical, and hazardous wastes, which process emits poisonous and toxic fumes. Furthermore, the Act requires that existing incinerators dealing with bio-medical wastes be phased out by July 2003. This act has had a major impact in the management of medical wastes in the country since many health care facilities have relied on incineration for the treatment of their infectious wastes.

Republic Act No. 9003, Ecological Solid Waste Management Act of 2000 - an act providing for an ecological solid waste management program and for other purposes. This act addresses some of the wastes generated in health care facilities.

DENR, Memorandum Circular No. 05, July 12, 2002 - clarification of the incinerator ban in the Philippine Clean Air Act of 1999. This memorandum was issued based on a decision of the Supreme Court in the case of MMDA versus Jancom Environmental Corporation. The decision by the Supreme Court held in agreement with the ruling of the Court of Appeals that RA 8749 does not prohibit incineration of wastes except those burning process that emit “poisonous” fumes. The memorandum circular clarifies that any thermal treatment technology, whether burn or non-burn as defined in DAO 2000-81, that meets the emission standards of stationary sources as listed in Section 19 of RA 8749 and complies with all other relevant provisions of RA 8749 and other applicable laws of the Republic is allowed to be operated in the country.

3.2 Regional Level - Metro Manila Area

At the Metro Manila level, the management of health care wastes has been regulated primarily by three regulations.

Metro Manila Council MMDA Regulation No. 96-000 -- This regulation prohibits littering/throwing of waste, rubbish or any kind of waste in open or public places, and requiring all owners, lessees, occupants of residential, commercial establishments, whether private or public to clean and maintain the cleanliness of their frontage and immediate surroundings and providing penalties for violation thereof.

Ordinance No. 16 Series of 1991 -- This ordinance regulates the management, collection, and disposal of hospital waste and similar institutions in Metro Manila. Ordinance No. 16 was enacted by the Metro Manila Council pursuant to Section 2, Executive Order No. 392. Section 2 of the ordinance applies to all government hospitals, all private hospitals, research institutions, dental and medical clinics, laboratories, and blood banks in Metro Manila. According to Ordinance No. 16, a minimum monthly fee of Php300 will be charged plus Php50 per additional cubic meter generated in excess of five cubic meters. All hospitals are to be charged with usual waste fees related to general waste depending on their bed capacity or volume of waste produced, based on existing taxation. Revenues collected are to accrue to the fund of the MMDA to be used for operating expenses for the collection and disposal of hospital waste and for other improvements thereof. This monthly fee has not been changed and it is apparent that the implementation of the Clean Air Act will lead to an increase in the costs associated with the treatment of the hazardous wastes. Consequently, the monthly fee will also require an increase.

MMDA Regulation No. 98-008 – MMDA was enforcing this regulation in health care facilities until recently. The regulation specifies that health care facilities use four types of bags for the storage of their wastes. The bags were divided by color as follows:

Bag Color	Purpose/Use
Black	Storage and collection of dry (non-pathological and non-infectious) waste
Orange (identified by means of the internationally accepted trefoil sign)	Specifically utilized for the storage and collection of radioactive waste, to be kept in special storage areas in the health care facility until sufficiently decayed such that the material was no longer hazardous (the alternative was to dispose of the waste following procedures set out by the Philippine Nuclear Research Institute)
Green	Storage and collection of biodegradable (compostable) waste
Yellow	Storage and collection of either dry or wet infectious waste and any other type of waste that was potentially infectious

Sharps had to be placed in containers specifically designed for storing these materials and covered with a solution of lime. Similarly, pathological waste and chemical waste had to be covered with solutions of lime.

The regulation further required that the hospitals be responsible for proper disposal.

Until July 2002, the Health Operations Center, Environmental Sanitation Enforcement Unit, of the MMDA was responsible for the monitoring of compliance with the Code of Sanitation and MMDA 98-008. It has been reported that in 2003 the Health Operations Center relinquished its monitoring duties to the Department of Health, NCR. Currently, the DOH, the MMDA, the DENR, and the LGUs are in the process of drafting a Memorandum of Understanding to determine which entity will ultimately be responsible for the monitoring of the proper management of health care wastes. Solid wastes generated in DOH hospitals will be monitored by the DOH's National Center for Health Facility Development. The DOH National Center will also be responsible for monitoring the proper management of solid wastes generated in "specialty" hospitals in Metro Manila such as the Heart Center, the Kidney Center, and others.

4 Previous Studies

A limited number of studies have been conducted on the management of health care wastes in Metro Manila. Following is a description of the studies reviewed by the Consultants.

4.1 1997 JICA Survey

In 1997, the Japanese International Cooperation Agency (JICA) assisted the DOH in the conduct of a survey to obtain baseline information on the quantity of infectious and hazardous waste as well as on the practices for the management of the wastes generated in Metro Manila. The study was conducted in March 1997 by the Environmental Health Service (EHS) of the DOH. The study was designed to evaluate waste management practices of all hospitals in Metro Manila and covered about 158 facilities. The majority of the information on waste management practices was collected during interviews with personnel in charge of waste management in the specific facility. The study covered primary, secondary and tertiary hospitals as defined in the DOH's Administrative Order No. 68-A, series of 1989.

4.1.1 Infectious and Hazardous Waste Sampling

This particular portion of the study covered 52 health care facilities or about 30% of all hospitals in Metro Manila at that time. These included a combination of primary, secondary, and tertiary hospitals.

Primary data were obtained by weighing and measuring the solid waste generated in the hospitals. Weighing of infectious and hazardous waste and measurement of general waste was carried out for a period of seven consecutive days. In addition, the data were verified by conducting interviews of key personnel in the hospitals and by ocular inspection of wards and temporary storage areas.

4.1.2 Segregation

Waste segregation practices observed in hospitals involved separation of various types of wastes according to category and through coding-coding schemes. Plastic bags or containers were used as follows:

Black – non-infectious dry waste
Green – non-infectious wet waste
Yellow – infectious, pathological, and hazardous waste
Red – sharps

The results of the survey indicated that the majority of the facilities practiced segregation, and about 87% of the hospitals surveyed at that time practiced color coding.

4.1.3 Storage and Collection

The results of the survey demonstrated that some of the health care facilities had satisfactory installations for the temporary storage of health care waste. The majority of the storage locations were sited away from wards, laboratories and any other important department of the facility to control intra-hospital infections and contamination.

4.1.4 Storage Facility

The evaluation demonstrated that hospitals use various types of containers for the temporary storage of waste. The survey indicated that about 56% of the hospitals have their own storage facilities within the hospital premises, while the rest stored their waste elsewhere.

4.1.5 On-site Collection System

According to the results of the surveys conducted by JICA, non-infectious waste was collected from room to room. The process of collection was performed by hand or with the assistance of pushcarts. The waste collected in this manner was transported to a specific area for temporary storage. On the other hand, infectious and pathological wastes were collected using different containers. The containers used for the collection of these residues were lined with plastic. Some of the health care facilities used safety boxes for the storage of sharps.

The results of the survey indicated that 43.7% of the hospitals used pushcarts and about 20% used mobile collection bins for waste collection.

As suggested by the DOH, room-to-room collection of hospital waste was carried out at the beginning of every shift by the majority of the hospitals. Only about 26% of the hospitals conduct room-to-room collection once per day.

4.1.6 Off-site Collection System

The results of the survey also indicated that of 74 hospitals, 60 were serviced by a private contractor that collected waste using its own collection vehicles. The remaining 14 facilities used collection vehicles and incinerators of other hospitals.

The private service provider used some type of manifest. The manifest contained data on the origin, type, and amount of waste to be disposed. The quantity of waste shown in the manifest also was used as the basis for billing for charges associated with collection and treatment of the wastes.

4.1.7 Pre-Treatment

The results of the survey dealing with pre-treatment of infectious and hazardous waste in hospitals showed that 95, or about 60%, of the facilities sampled treated their wastes before final disposal. However, 53

establishments (about 33.5%) did not pre-treat their wastes. The remainder of the hospitals did not have any records on the conduct of any type of pre-treatment.

The health care facilities were found to practice the following pre-treatment measures: chemical disinfection, autoclaving, delay to decay (for radioactive wastes), dilution, and ozonation.

4.1.8 Final Disposal

Final disposition of non-infectious waste was conducted by the municipality or city where the hospital was located. At that time, about 128 (about 81%) of the hospitals received municipal or city collection and disposal services.

At the time of the survey, 74 hospitals, or about 47%, disposed of their waste through incineration. Sixty of the 74 hospitals relied on the services of a private contractor.

4.2 1999 Waste Generation Survey

JICA carried out a hospital waste generation survey in 1999 as part of a comprehensive solid waste management study for Metro Manila. The survey was designed to determine the type, volume, and mass of solid waste generated in hospitals. The survey targeted 52 facilities, of which 49 responded positively. Six of the hospitals were monitored for less than the seven-day study period.

A total of 16,830 kg of hazardous and infectious waste and about 1,184 cu m of general waste were identified and measured during the study period. A summary of the results obtained in the survey is presented in Table 1. As shown in the table, the quantity of hazardous and infectious waste generated is as follows: primary hospitals about 0.152 kg/bed-day; secondary hospitals about 0.213 kg/bed-day; and tertiary hospitals about 0.305 kg/day-bed.

Table 1. Quantities of Hazardous and Infectious Waste Estimated by JICA

Hospital Category	General Waste		Hazardous Waste	
	Total (m^3)	Generation Rate (m^3/bed-day)	Total (kg)	Generation Rate (kg/bed-day)
Tertiary	1009.46	0.02	15,528.10	0.305
Secondary	130.45	0.02	1,014.11	0.213
Primary	37.97	0.04	288.40	0.152

Source: JICA, 1999[2]

4.3 1997 DOH Survey of Waste Management Practices of Private and Government Hospitals in MM

A survey of all public and private hospitals in Metro Manila was also conducted by DOH in 1997. A total of 145 facilities were surveyed. Details on the methodology of the survey were not available. The results of the survey presented in an Executive Summary show that:

- Only 58, or about 40%, of the hospitals had a committee on waste management.
- Only 56 of the hospitals surveyed (about 38%) had a separate budget for hospital waste management. Of these, 40% had an annual budget of less than P 50,000.

[2] Japan International Cooperation Agency, The Study on Solid Waste Management for Metro Manila in the Republic of the Philippines, Final Report, Main Report I, March 1999

- Of the hospitals surveyed, about 87% practiced segregation, 77% practiced color-coding, and 42% practiced labeling of wastes into wet and dry general wastes.

- Among the 127 hospitals that practiced segregation, the most common containers were made out of plastic. On the other hand, those hospitals that practiced color coding (113 facilities) relied on the use of plastic bags.

- Approximately 62% of the facilities pre-treated their infectious and pathological waste prior to final disposal. The most common pre-treatment method was chemical disinfection.

- About 46% of the facilities generated less than 5,000 kg of general waste per month and about 55% of the hospitals generated less than 1,000 kg of infectious waste per month.

- Sixty-six hospitals reported that they relied on pushcarts for in-house collection of solid waste.

- About 87% of the facilities had temporary storage facilities, and 56% of the facilities practiced some type of recycling.

- The collection frequency for the wastes to their treatment or final disposal facility was three per week.

- With respect to treatment/disposal, 31% buried on-site, 27% practiced burning, 12% used an in-house incinerator, and 5% practiced composting of their biodegradable residues.

- At the time of the survey, 38% of the facilities made use of a private contractor for the collection of their solid wastes. About 86% of the entities reported that their wastes were being collected by the municipal service. On these, 48% reported that they did not know the final destination of their wastes, 39% indicated that the wastes were being disposed in a landfill, while 44% reported that the wastes were being disposed in an open dumpsite.

- The results of the survey also indicated that 49% of the facilities had not trained their personnel on hospital waste management. Among the trained personnel, the results of the survey showed that 67% originated from two or more sections of the hospital.

- Finally, the survey indicated that the most common IEC strategies used by the hospitals were: posters (28%), manuals (22%), and handbills (18%).

4.4 2001 Hospital Waste Management Study

During the first quarter of 2001, the Western Pacific Regional Office of the World Health Organization requested Dr. L.F. Diaz to provide technical assistance to the Department of Health of the Philippines in the area of health care wastes [3]. The primary objectives of the work included:

- To conduct an evaluation of the waste management practices utilized by health care facilities (both public and private);

- To propose recommendations for improvement of the waste management systems used by the facilities;

[3] Diaz, Luis F., Mission Report on Hospital Waste Management, Prepared for the World Health Organization, 2001

- To categorize suitable options for the management of infectious and pathological wastes in general and specifically for the health care facilities owned and operated by the DOH due to the enactment of the Clean Air Act of 1999; and

- To prepare an action plan for management of health care wastes in the Philippines.

Some of the most important conclusions obtained in the study include:

- A comprehensive record of all health care facilities (both public and private) operating in the country was not available;

- Reliable data on the quantity and characteristics of the solid wastes generated in the health care facilities had not been collected;

- The majority of the institutions visited in Metro Manila and in other parts of the country segregate their wastes into containers of different colors;

- Most of the facilities visited used incineration for the treatment of their infectious wastes;

- Some of the hospitals relied on the private sector for the collection and treatment of their infectious wastes;

- Some of the incinerators were old and did not have any equipment for air pollution control;

- Some of the health care facilities sold food residues as animal feed;

- Some of the facilities practiced recycling and sold the recycled materials;

- The Department of Health entered into a loan with the Austrian government to purchase 25 incinerators and 36 microwaves for installation in its hospitals. Of the four units visited, only two were operational.

- The majority of the health care facilities had established a waste management committee. The consultant was informed that the committee did not meet on a regular basis.

- Radioactive waste materials are collected appropriately and stored until the material is decayed.

- Cytotoxic materials were discharged in the wastewater system.

- Health care facilities in the public sector were experiencing some budget cuts.

4.5 2002 Technical Assistance Biomedical Waste Treatment and Disposal Options in the Philippines

The U.S. Trade and Development Agency (TDA), an agency of the United States Government that promotes the export of equipment and services from the US, funded this TA. The work was carried out at the request of the Environmental Management Bureau (EMB) of the DENR. The main focus of the analysis was to provide EMB with information regarding technologies that would treat health care wastes properly and at the same time comply with the Clean Air Act.

Some of the key information provided in the report includes: a general description of available biomedical waste treatment systems (chemical/mechanical, irradiation, and thermal); information about available systems in the US and their costs (a list of 56 vendors is included); and information on the number of hospitals as well as the number of beds in the Philippines by region. In addition, the analysis included an estimation of the

amount of health care waste generated by hospitals in the Philippines, and a projection to the year 2050. The generation of health care waste is assumed to be 2.0 kg per bed per day, with approximately 15% of that waste considered biomedical waste. Consequently, the amount of waste to be treated was estimated at 0.3 kg per bed per day. Based on these assumptions, it was estimated that the amount of biomedical waste generated in the Philippines by hospitals only was on the order of 10,290 tons per year in 2001. Using the same assumption, the authors estimate that the hospitals in the National Capital Region (NCR) would produce about 8.8 tons of biomedical waste per day.

The study also points out that the ADB has established a US$ 25 million Air Pollution Control Credit Facility (APCCF) managed by the Land Bank of the Philippines. This credit facility was established to purchase equipment and services needed to meet the requirements of the Clean Air Act (including the acquisition of non-burn technologies to replace existing incinerators).

5 Types and Number of Health Care Facilities

To be able to determine the quantity of waste generated on a unit basis, an assessment of the number of the various categories of health care facilities was conducted. The assessment was based on a compilation of data from various entities, which were updated to the extent possible based on the surveys conducted by the Consultants, as discussed later in the report.

Based on the Consultant's evaluation, at the present time there are approximately 2,068 health care facilities in the Philippines, with a total of about 93,976 beds. A listing of the number of facilities (by region), as well as the number of beds in the facilities, is presented in Table 2.

A summary of the number of government and private hospitals located in Metro Manila is presented in Table 3, divided by municipality. As shown in the table, Metro Manila has 197 hospitals, with a total of 29,316 beds.

A listing of the medical establishments in Metro Manila is presented in Annex 1.

Table 2. Number of Hospitals and Hospital Beds in the Philippines

Region	Number of Facilities	Number of Beds	Average Number of Beds per Hospital
I	129	4,119	32
II	99	2,905	29
III	214	7,451	35
IV	321	10,685	33
V	152	4,405	29
VI	89	4,916	55
VII	102	5,321	52
VIII	76	2,851	38
IX	83	2,968	36
X	120	3,588	30
XI	201	6,564	33
XII	103	2,727	26
CAR	68	2384	35
NCR (Metro Manila)	197	29,316	149
ARMM	37	1,635	44
Caraga	74	2,127	29
Totals	**2,068**	**93,976**	**45**

Sources: Philippine Hospital Association, September 2001, ADB Project Office. Allen Engineering & Sciences,[4]

[4] Allen Engineering & Sciences, *Technical Assistance for Biomedical Waste Treatment and Disposal*, TDA Activity No. 2001-30075B, Prepared for US Trade and Development Agency, May 2002.

Table 3. Number of Hospitals and Hospital Beds in Metro Manila (2002)

Location	No. of Government Hospitals	No. of Private Hospitals	Total No. of Hospitals	Total No. of Beds
Caloocan	3	13	16	2,714
Las Pinas	1	9	10	498
Makati	2	5	7	1,137
Malabon	1	3	4	54
Mandaluyong	1	3	4	4,854
Manila	10	26	36	7,757
Marikina	1	9	10	353
Muntinlupa	2	9	11	819
Navotas	1	0	1	6
Paranaque	1	7	8	328
Pasay	2	6	8	619
Pasig	2	12	14	750
Quezon City	16	34	50	8,327
San Juan	1	2	3	495
Taguig	1	4	5	137
Valenzuela	1	9	10	468
Totals	**46**	**151**	**197**	**29,316**

Information collected by the Consultants regarding the various generators of medical waste in Metro Manila is presented in Table 4. Some of the data in the table were collected in 1998 and the Consultants have updated some data. The information in the table show that there are approximately 582 government and 3,088 private facilities, for a total of 3,670 facilities in Metro Manila that would generate some type of health care waste that would require special treatment and final disposition. This compares well with data from MMDA, which indicates that there are approximately 3,730 health care facilities in the Metro Manila area (of which 1,509 are hospitals and clinics, the rest are dental offices, laboratories, funeral parlors and others).

Table 4. Sources of Medical Waste in Metro Manila

Type of Facility	Government	Private	Totals
Accredited Hospitals	46	151	197
Health Centers	393	8	401
Medical Clinics	2	1288	1290
Dental Clinics	30	950	980
Veterinary Clinics	4	89	93
Pharmaceutical Labs	97	384	481
Blood Banks	3	14	17
Funeral Parlors	0	196	196
Medical Schools	3	8	11
Research Institutions	4	0	4
Totals	**582**	**3088**	**3670**

6 Quantity and Composition

Before any kind of plan can be developed, it is necessary to have a good understanding of the quantity and composition of the waste. The Consultants conducted a review of available data and compiled the limited reliable information that is available. The Consultants subsequently conducted a one-week analysis of non-infectious and infectious waste to obtain additional data.

6.1 Assessment of Previous Studies

The JICA study conducted in 1999 reports that 17 tons/day of infectious waste are generated by primary, secondary and tertiary hospitals in Metro Manila (see Section 4). MMDA currently estimates that health care facilities in Metro Manila generate a total of 60 tons of waste each day, of which approximately 9 tons would be considered infectious.

The staff at San Lazaro Hospital conducted a waste characterization study at the hospital in 2002. Specific methodologies on the conduct of the study are not readily available. However, a summary of the findings is presented in Table 5.

As shown in the table, the total amount of waste generated at San Lazaro Hospital was about 283 kg/day of which 85.9 kg was considered infectious (30.4%) and 197.1 kg was considered general or non-infectious (69.6%). Based on the number of beds, these quantities are equivalent to a waste generation of 0.17 kg/bed-day of infectious waste and 0.39 kg/bed-day of non-infectious waste.

Table 5. Quantity of Waste Generated by San Lazaro Hospital, 2002

Type of Waste	Quantity (kg/day)	Percent	Type of Waste Quantity (kg/day-bed)
Yellow bag			
Pathological	27.90		0.06
Infectious	29.79		0.06
Sharps	28.24		0.06
Total yellow bag	**85.93**	**30.37%**	**0.17**
Black bag			
Domestic	158.85		0.32
Paper	38.21		0.08
Total black bag	**197.06**	**69.63%**	**0.39**
Total	**282.99**	**100.00%**	**0.56**
No. of beds	500		

Source San Lazaro Hospital 2002

6.2 Waste characterization analysis at EAMC

Based on the amount of available data, the Consultants determined that additional information was required. Therefore, the Consultants planned and carried out a waste characterization study to determine the quantities and characteristics of the wastes generated in large health care facilities. In keeping with the level of resources available, the study was conducted during a five-day period at the East Avenue Medical Center (EAMC) in Quezon City. This hospital was selected in coordination with representatives from the DOH and was considered to be representative of several others in the Metro Manila area.

The objectives of the study were to determine:

- the quantity of wastes generated by the various wards in the hospital,
- the bulk density of the various types of solid wastes generated in the facility, and
- the physical composition of non-infectious wastes.

The results of the study, as shown in Table 6, indicate that the facility generated a total of 0.53 kg of waste per bed-day. Approximately 0.34 kg/bed-day were considered infectious. Figure 1 presents a comparison of the quantity of infectious waste generated by the entire hospital with the non-infectious waste generated by the four departments analyzed.

The results also indicated that the average bulk density of non-infectious waste was about 151kg/cu m and that of infectious wastes was 262 kg/cu m. The results of the determinations for each of the departments (non-infectious waste) and for the infectious waste are presented in Figure 2.

An analysis of the composition of non-infectious waste generated by the four departments was also conducted. The composition analysis indicated that about 36% (by weight) was food and yard waste and about 30% was plastics. The analyses also indicated that the non-infectious waste contained a certain amount (1.86%) of special wastes (batteries, syringes, and needles). The results of the composition analysis for each of the departments are presented graphically in Figures 3 through 6. Additional information on the waste characterization analysis is presented in Annex 2.

Table 6. Average Medical Waste Generation at EAMC (kg)

Source of Waste	Day 1	Day 2	Day 3	Day 4	Day 5	Total (kg)	Average (kg/day)
Infectious							
Total Infectious	257	219	180	205	155	1016	203
Non-infectious							
PICU	21	25	17	33	10	106	21
Ward	73	75	70	34	22	274	55
OPD		9.2	20.1	16	23	68.3	17
ER-Surgery	29	32	30	27	20	138	28
Total Non-infectious	123	141.2	137.1	110	75	586.3	117
Total	380	360.2	317.1	315	230	1602.3	320
Waste Generation (kg/bed)							
Infectious	0.43	0.37	0.30	0.34	0.26		0.34
Totals	**0.63**	**0.60**	**0.53**	**0.53**	**0.38**		**0.53**

Number of beds: 600 (100 % occupancy)

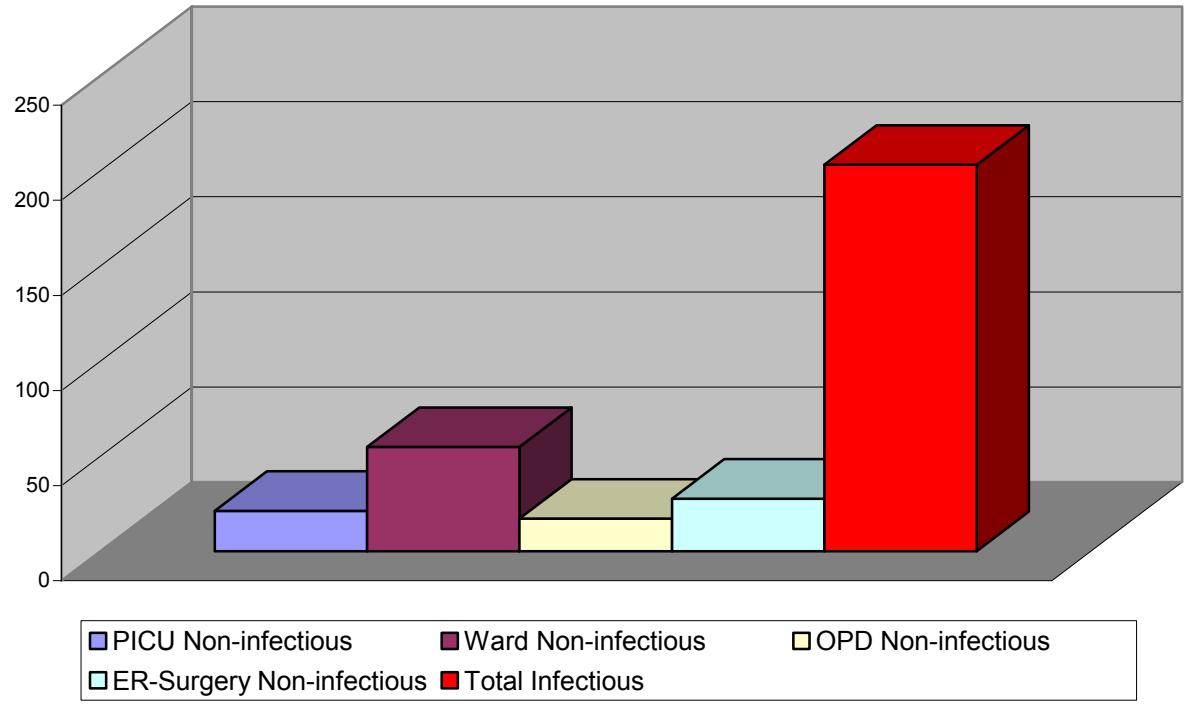


Figure 1. Average Rate of Generation of Medical Waste by Source (kg/day)

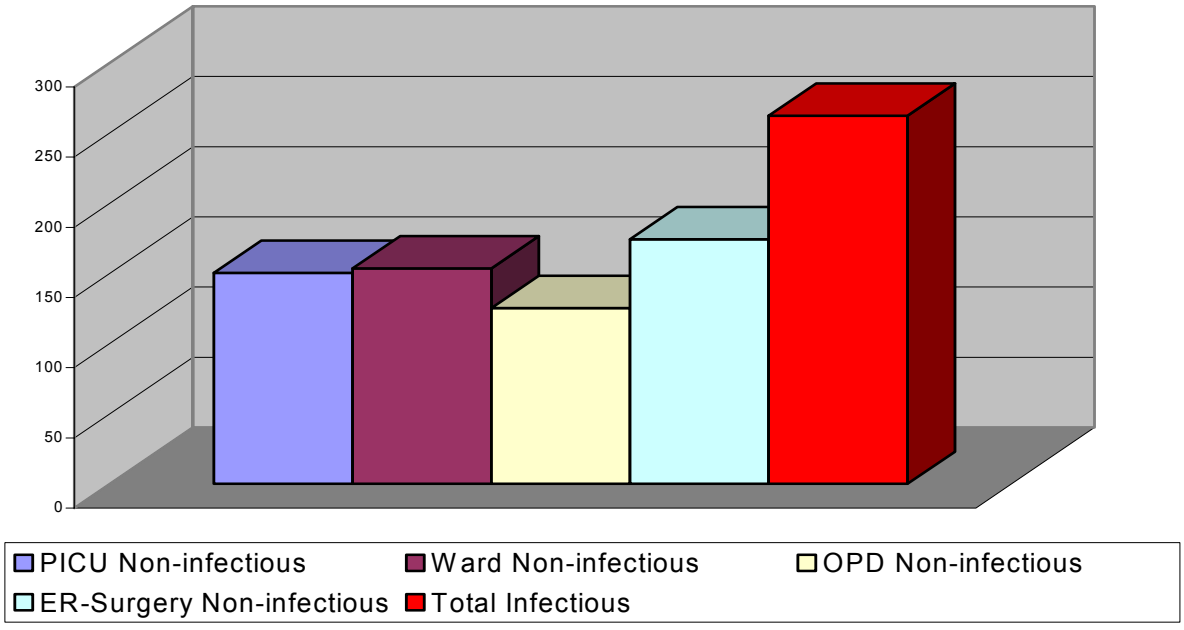


Figure 2. Average Bulk Density of Medical Waste (kg/cu m)

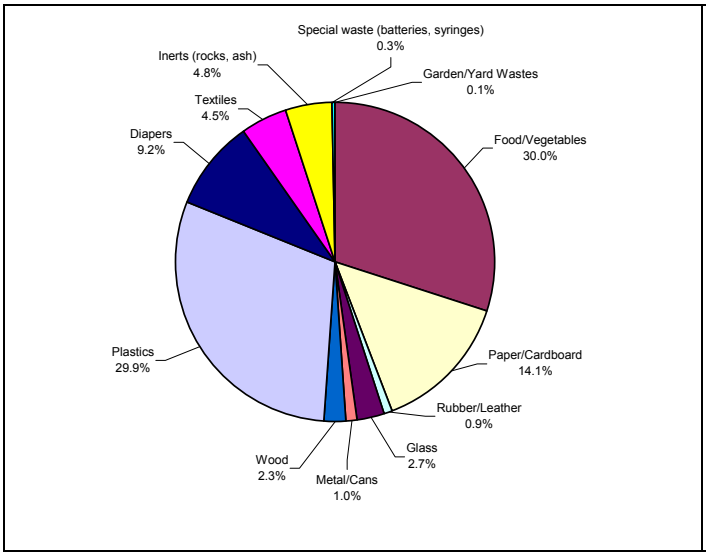


Figure 3. Average Composition of PICU Waste

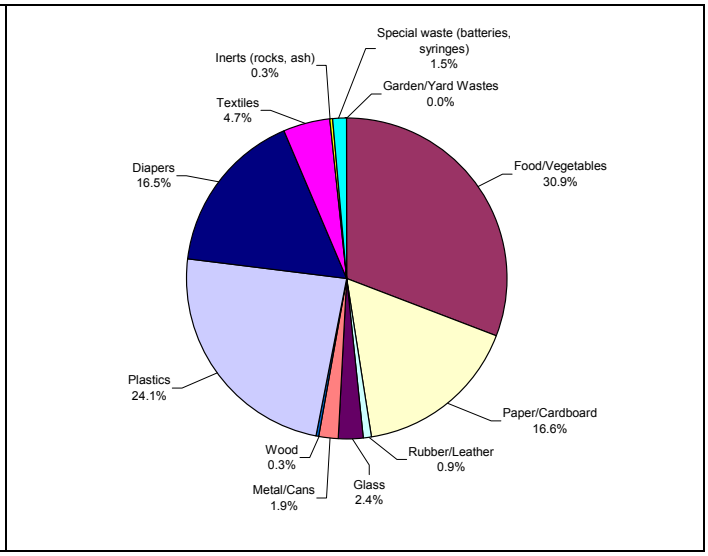


Figure 4. Average Composition of Ward Waste

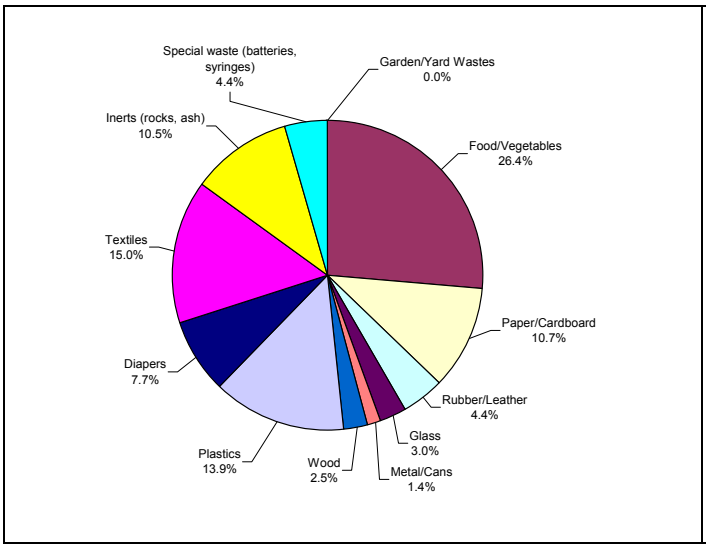


Figure 5. Average Composition of OPD Waste

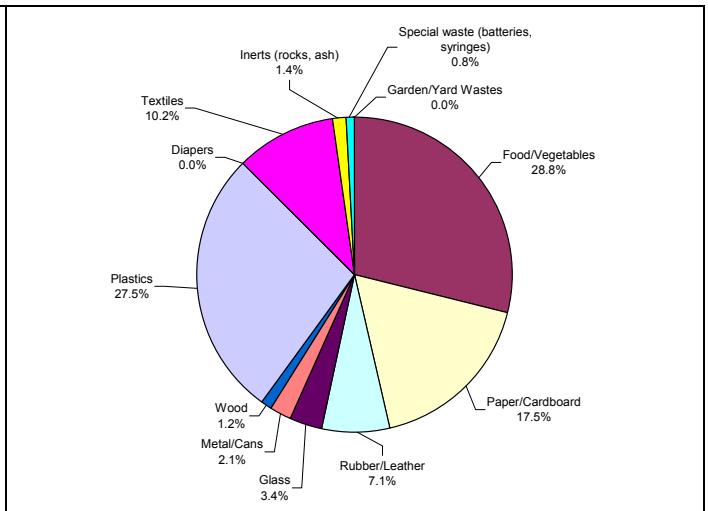


Figure 6. Average Composition of ER-Surgery Waste

A summary of the key results of the waste analysis at EAMC is presented in Table 7.

Table 7. Summary of Results of Analysis Conducted at EAMC, 2002

Type of Waste	Waste Generation (kg/bed-day)	Bulk Density (kg/cu m)
Non-infectious	0.34	151
Infectious	0.19	262

6.3 Results and Estimation

The results of the present study show that EAMC generates about 0.34 kg of infectious wastes/bed-day, the results of the study conducted by JICA in 1999 indicated that tertiary hospitals generated on the order of 0.31 kg of infectious wastes/bed-day, and the results of the work carried out at San Lazaro in 2002 showed that the hospital produced about 0.17 kg of infectious wastes/bed-day. A compilation of the data from the various sources is provided in Table 8.

Table 8. Comparison of Waste Generation by Various Studies

Study (date)	Infectious Waste	Non-infectious Waste	Total
Hospitals (kg/bed-day)			
JICA (1999)	0.31	N/A	N/A
San Lazaro (2002)	0.17	0.39	0.56
EAMC (2002)	0.34	0.19	0.53
All Health Care Facilities (tons/day)			
JICA (1999)	17	N/A	N/A
MMDA (2000)	9	51	60
ADB TA (2003)	27	20	47

N/A: Not available

Based on the results of the waste characterization analysis and the surveys of health care facilities (described in another section of this report), the Consultants estimated that health care facilities in Metro Manila generate about 47 tons of waste per day. The estimates for waste generation at hospitals are based on the highest unit rates from the studies conducted at San Lazaro and at EAMC. This approach was considered the most prudent in order to ensure adequate capacity in the strategic plan and to address the demands of the health care facilities.

Given the present level of segregation, approximately 27 tons per day of the health care waste (about 56% by weight) is considered infectious and/or potentially infectious. The estimated amount of waste generation by type of facility is given in Table 9.

Table 9. Estimated Quantities of Health Care Waste Generated in Metro Manila in 2002

Type of Facility	No. of Facilities	No. of Beds	Unit Generation Rate (kg/day) Infec.	Non-infec.	Infectious Waste (kg/day)	Non-Infectious Waste (kg/day)	Total (kg/day)
Accredited Hospitals	**197**						
Government (no. of beds)		**17,563**	**0.34**	**0.39**	**5,971**	**6,850**	**12,821**
Private (no of beds)		**11,753**	**0.34**	**0.39**	**3,996**	**4,584**	**8,580**
Health Centers	**401**		**2**	**3**	**802**	**1,203**	**2,005**
Medical Clinics	**1,290**		**2**	**3**	**2,580**	**3,870**	**6,450**
Dental Clinics	**980**		**6**	**2**	**5,880**	**1,960**	**7,840**
Veterinary Clinics	**93**		**4**	**1**	**372**	**93**	**465**
Pharmaceutical Labs	**481**		**12**	**3**	**5,772**	**1,443**	**7,215**
Blood Banks	**17**		**12**	**3**	**204**	**51**	**255**
Funeral Parlors	**196**		**6**	**1**	**1,176**	**196**	**1,372**
Medical Schools	**11**		**12**	**3**	**132**	**33**	**165**
Research Institutions	**4**		**12**	**3**	**48**	**12**	**60**
Total	**3670**				**26,933**	**20,294**	**47,228**

Based on the results of the waste characterization study and on an expected growth rate of the number of beds of about 2% per year, an estimate has been made on the quantity of health care waste that will be generated in Metro Manila over the next 8 years. As shown in Figure 7, the total amount of health care waste is projected to increase to about 55 tons per day by the year 2010. On the other hand, the amount of infectious waste is projected to decline until the year 2008 and after that it will stabilize at approximately 19 tons per day. This decline will only be achieved if comprehensive and continuous training efforts are conducted at all the health care facilities. Furthermore IEC and other similar activities will also make positive contributions to the reduction of the amount of infectious waste generation.

7 Current Practices

A key component of the study incorporates an evaluation and suggestions for improvement for the management of health care wastes for both infectious (also known as regulated) and non-infectious waste.

Before a sound solid waste management strategy can be developed for Metro Manila, it is important to understand the current management practices followed by existing facilities. Consequently, surveys were conducted of selected health care facilities in Metro Manila to determine the status of the waste management system in the sector. Specifically, the surveys aimed to:

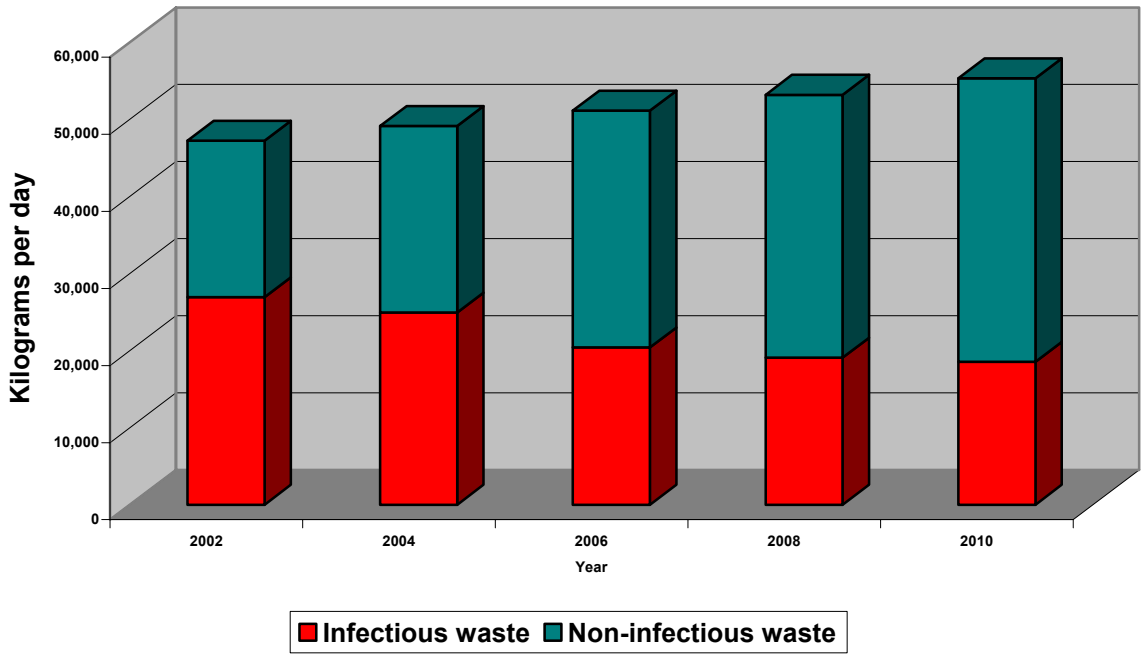


Figure 7. Estimate of Current and Projected Quantities of HCW Generated in Metro Manila

- Outline the different waste management practices in health care facilities in Metro Manila from generation, storage, collection, treatment and disposal.
- Determine the flow of wastes from the facility through intermediate handlers, treatment and to final disposal sites.
- Identify key players in health care waste management in Metro Manila.

7.1 Methodology

7.1.1 Hospitals and Clinics

To meet the objectives of the study, a survey was conducted in selected health care facilities in Metro Manila. A sample of the questionnaire used is given in Annex 3a.

The survey included a few general questions about the facility; the committee responsible for managing hospital wastes; and segregation, storage, collection, treatment and disposal practices for the different types of medical wastes, kitchen and non-infectious wastes.

The study involved actual site visits, interviews and completing survey forms by the respondents. Data gaps were obtained through follow-up telephone interviews.

Secondary data were obtained from government agencies such as the Department of Health, which supervise or monitor these hospitals. Past research and studies on hospital waste management were reviewed to provide additional information.

7.1.2 Minor Health Care Facilities

The evaluation of current practices at these facilities was conducted by means of a written survey. In order to maintain some type of standardization, this evaluation used the same form used for the assessment of solid waste management practices in hospitals in Metro Manila. A copy of the survey instrument used in the evaluation is presented in Annex 3a.

In the survey, clinics and other health care establishments were chosen randomly from a list provided by the DOH and by relevant professional associations. The randomly selected establishments were contacted and asked if they would be willing to participate in the survey. Questionnaires were either hand delivered or sent via fax to representatives of those institutions who indicated some level of interest for participating in the survey. Follow up visits and interviews were conducted to those facilities and to individuals who asked for assistance in completing the survey form. Data gaps and questions were resolved by contacting the respondents on the telephone.

7.1.3 Waste Treatment Systems and Equipment

A two-page survey form was sent thru fax to the selected hospitals. A copy of the survey form is given in Annex 3b. The completed survey form was returned via fax by the participating hospitals.

The results of the surveys are discussed in the following sections.

7.2 Hospitals and Clinics

The following sections discuss the waste management system in hospitals and in clinics, waste flow and the different entities that participate in hospital waste management.

Hospital waste management system includes the identification of responsible hospital units or departments in charge of solid waste management, the different practices observed in waste segregation and storage, mode of collection, treatment and disposal arrangements. Whenever applicable, treatment or disposal facility is also discussed.

Hospital waste flow discusses the various stages of waste management from the hospital to intermediate handlers to final disposal. This section also covers the different forms of waste diversion being practiced in the hospitals surveyed.

The third section identifies the different agencies, private companies or individuals that play key roles in the management of hospital waste in Metro Manila.

Copies of all the completed survey instruments are filed and available for review in the office of the NSWMC.

7.2.1 Hospital Waste Management System

Eighteen health care facilities were selected for the survey. The list of facilities is presented in Table 10. Ten of the facilities are owned and operated by the government while the rest are private hospitals. Three are classified as specialty hospitals, two are university hospitals or clinics and the rest are categorized as general hospitals. Among the hospital surveyed, six are located in residential areas, nine in commercial areas, one in an industrial zone and one in a poor area. The hospitals surveyed have been in operation as early as 1908 and as recently as 2002.

Table 10. List of Hospitals Surveyed in Metro Manila

Name of Hospital	Classification of Hospital	Number of Beds (avg no. occupied per daily basis)	No. of Staff	Age of Facility
Government				
1. PNP General Hospital	General	350 (206)	304	--
2. Dr. Jose N. Rodriguez Memorial Hospital	Special Hospital	191 (164)	412	--
3. Research Institute for Tropical Medicine	Specialty Hospital	50 (--)	426	--
4. Valenzuela General Hospital	General	106 (95)	186	--
5. Quirino Memorial Medical Center	General	328 (328)	516	50
6. Philippine General Hospital	General	1334(1334)	3704	95
7. San Lazaro Hospital	Special	514 (510)	853	42.5
8. East Avenue Medical Center	General Hospital	646 (1000)	1014	33
9. University Health Service, UP Diliman	Primary Hospital	54(25-30)	100	50
10. Amang Rodriguez Medical Center	General	133 (171)	345	38
Private				
11. St.Clare's Medical Center		-	-	30
12. Fairview General Hospital	General	30 (19)	100	10
13. St Jude Hospital and Medical Center	General	70 (36)	132	40
14. Manila Doctors Hospital	General	300 (240)	1400	46
15. Asian Hospital and Medical Center	General	258 (--)	--	0.5
16. St. Martin de Porres Charity Hospital	General	144 (70 – 86)	226	43
17. University of Perpetual Help Medical Center	Teaching Hospital	215 (188)	856	27
18. National Children's Hospital	Special Training Hospital	352(171)	435	45

The key results of this portion of the survey indicated that:

- The majority of the hospitals surveyed (90%) indicated that they have established a committee that looks after waste management. A specially appointed individual usually takes overall responsibility for the different areas such as chemical/microbiological safety; radiological safety; infection control; and the disposal of medical, radioactive and non-medical solid wastes for these hospitals. In general, the nominated individual was found to be qualified, capable and had an understanding of the responsibilities attached to that appointment.

- One of the facilities visited seemed to be grossly over crowded (East Avenue Medical Center). This was especially the case in the obstetric and gynaecology department. This situation seems to be common in government and charitable hospitals.

7.2.1.1 Sharps

All of the hospitals surveyed separate sharps such as syringes, scalpels and similar items, from the rest of the wastes. The number of syringes that are disposed by the hospitals surveyed ranges from 15 to 30 per day. The syringes usually are placed in plastic containers designed to hold sharps (safety boxes) or in other containers such as hard plastic bottles, cans or plastic gallon containers lined with plastic bags.

Based on the number of responses, management of these wastes is conducted either through:

- burial in hospital grounds (10%),
- disposal to landfill (5%),
- incineration (15%),
- burning in improvised combustion units (5%) or
- given to a private contractor for treatment and final disposal (65%).

7.2.1.2 Infectious Wastes

Some of the infectious wastes are first disinfected. Disinfection is carried out in about 80% of the hospitals surveyed. Disinfection is conducted either by steam sterilization or through chemical methods. The respondents estimated that the infectious waste streams include:

- discarded syringes and needles (65%),
- Petri dishes (40%),
- human biopsy materials (30%),
- human or animal tissue (35%), and
- other microbiological wastes (50%).

The wastes generally are stored in yellow plastic bags or in containers that are properly labeled. Private contractors collect and treat the wastes. After treatment, the wastes are disposed at a municipal disposal facility.

Family members generally collect the placentas and fetuses. In some cases, the placentas and fetuses are incinerated or are disposed through private contractors. There is not much difference between non-Muslim and Muslim families regarding practices in these types of wastes.

Based on the number of health care facilities surveyed, it can be estimated that the final method of disposal for this type of waste consists of:

- burial on hospital grounds (15%),
- disposal to landfill (15%),
- disposal to sewer (10%),
- incineration on-site (15%) and
- through the use of private contractors (45%).

7.2.1.3 Pharmaceutical Wastes

Pharmaceutical wastes originate from the different wards and departments of the health care facilities. The segregated pharmaceutical wastes are either:

- discharged into the sewer via toilets or via disposal units placed in the sinks (15%),
- returned to the manufacturer (20%),
- disposed at a landfill (5%),
- incineration (15%) or
- collected and treated by private contractors (45%).

Approximately 60% of the hospitals disposed of water-soluble chemicals through the sink and flushing it with large volumes of running water. Some respondents (30%) indicated that these wastes are also collected and being treated off-site by private companies.

Forty percent of the hospitals surveyed generate cytotoxic wastes. Cytotoxic wastes are separated from the rest of the waste except for one hospital. Disposal of these wastes are by:

- landfilling (20%),
- incineration (20%) and
- the rest (about 60%) are collected and disposed by private contractors.

Waste solvents and other hazardous chemicals are flushed down the sink by about 50% of the hospitals surveyed, while one hospital incinerates them and the rest indicate that the wastes are treated by private contractors.

In 85% of the hospitals surveyed, effluents from automated equipment and general wastewater are discharged directly into the sewerage system.

7.2.1.4 Radioactive and Other Wastes

Only three of the hospitals surveyed generate radioactive wastes coming from radioimmunoassay, research activities (66%) and the rest from radiotherapy and radiological practices.

Low-level radioactive solid wastes typically are properly stored in a designated area allowing radiation to dissipate before collection and disposal. None of the hospitals surveyed generate solid wastes of higher radioactivity.

Forty-five percent of the hospitals dispose pressurized containers through the municipal disposal facility, while the rest are being contracted out.

7.2.1.5 General (Non-Medical) Solid Waste

All of the hospitals surveyed indicated that they separate medical wastes from general wastes. Ninety percent of the hospitals practice color-coding in storing their wastes while 10% does not follow any type of system; however, the wastes are properly stored in designated areas prior to collection.

Kitchen wastes are segregated in all of the facilities surveyed. Thirty percent of the hospitals disposed their kitchen wastes by flushing them into the sewer system, 5% by open burning and the rest, through the collection and disposal services provided by the city or municipality.

7.2.1.6 Medical Waste Incinerators

Only three of the hospitals surveyed have access to incineration, either on-site or off-site. One waste incinerator is not primarily dedicated for treating regulated hospital wastes and does not belong to the municipality or city. Two hospitals identified bad odor as the major difficulty in operating an incinerator.

7.2.2 Key Players in Hospital Waste Management in Metro Manila

7.2.2.1 Government

A disposal facility by the local government unit is solely dedicated for municipal solid wastes specifically domestic in nature. Regulated wastes should not be accepted in the disposal area; these wastes should be properly treated and disposed of. The Department of Health regulates this aspect in both major and minor health care facilities.

7.2.2.2 Waste Management Committee in Hospitals

The waste management committee in hospitals has the responsibility to plan for waste management strategies. The committee is in charge of monitoring the practices of the hospital staff regarding proper storage of the waste. The committee also is responsible for supervising the collection of the different types of wastes within the hospital premises, prior to the collection by the municipality or by private contractors.

The committee, composed of staff from the different departments or units of the hospital should meet regularly and should address waste management concerns. The committee sometimes issues hospital memoranda and circulars for the improvement of waste management.

7.2.2.3 Private Contractors

Private contractors provide collection, treatment and disposal services for health care facilities that are willing to avail of such services. At the present time, there are only two companies providing these services in Metro Manila: Integrated Waste Management, Inc. (IWMI) and Chevalier Enviro Services, Inc. (CESI). At the time of the study (early 2003), Integrated Waste Management used incineration while Chevalier used microwave technology.

7.3 Minor Health Care Facilities

The results of this study have shown that large hospitals are the major generators of medical wastes compared to minor health care establishments such as clinics and health centers. Nevertheless, it is important to determine the different waste management practices at these establishments in the formulation of a sound medical waste management framework for Metro Manila.

To achieve one of the objectives of this study, an assessment was conducted of the following types of facilities:

- Dental Clinics
- Veterinary Clinics
- Diagnostic and Laboratory Clinics
- Mortuaries/Funeral Parlors

The following sections of this report provide information on the sources, estimated generation rates, segregation and storage methods, mode of collection and disposal systems for the health care wastes generated in the facilities surveyed.

A summary of the establishments surveyed is presented in Table 11.

Table 11. Type, Number and Location of Minor Health Care Facilities Surveyed

Type	Number	Location
Veterinary Medicine	7	Quezon City, Pasay, Manila, Makati, Las Piñas
Dental	6	Quezon City, Parañaque, Manila Makati, Caloocan
Diagnostic/Laboratory	4	Caloocan
Funeral Mortuaries/Mortuaries	5	Manila, Pasay, Makati

7.3.1 Veterinary Clinics

Seven veterinary clinics were surveyed. Two facilities were located in Quezon City, one in Pasay, one in Manila, two in Makati and one in Las Piñas. All of the facilities are privately owned, six are located in commercial areas, and one is located in a residential area.

The number of staff working in the veterinary clinics, ranged from 2 to 16. The clinics surveyed had been established anywhere from 3 to 56 years ago and occupy a space of 20 to 480 square meters. Only two of the establishments have established a committee that looks after the solid waste generated in the clinic. However, no specific person had been nominated to be responsible for the waste generated by the different services offered by the clinics.

General wastes typically are stored in plastic bags, are disposed through open burning or are collected by a municipal waste collector. These wastes usually are disposed in a designated dumpsite.

Sharps are separated from other medical waste and are placed in plastic containers, either specifically designed to contain such waste or not, and in plastic bags. The sharps eventually are taken to the municipality's disposal site.

Infectious or potentially infectious wastes generally are not disinfected prior to disposal.

Pharmaceutical wastes typically are flushed into the sewer or disposed at the disposal site.

Most medical wastes currently are separated from the general wastes. But eventually, during collection, these are mixed with other wastes. Only a few of the veterinary clinics practice segregation of wastes into color-coded containers; i.e., yellow for medical waste and black for general waste. The final disposal of wastes generated at these facilities is the dumpsite. The waste or leftover food is flushed into the sewer via the toilets.

Medical wastes are stored, labeled and sealed. The waste is collected and transported to the disposal site through municipal refuse collection services using conventional collection vehicles. None of the respondents keep records of the daily/weekly shipments of their medical wastes.

Two respondents indicated that private contractors collect all special wastes on a daily basis while another respondent reported that these wastes are collected on a weekly basis by municipal health staff. The rest of the respondents were non-committal regarding this aspect.

The estimated quantities of waste generated at these clinics fluctuate from 4 to 7 bags a week (it is estimated that each bag weighs 2 kg). These are either mixed or segregated wastes. None of the respondents have access to private contractors to transport their medical waste to a treatment facility or to a final disposal site.

All respondents indicated that they fund their solid waste management activities either through their operating revenue or through local government subsidy. Collection and disposal of the waste is funded through the municipal services and is included as part of their annual business tax (about Php 1,200/year).

7.3.2 Dental Clinics

Six dental clinics were surveyed two were located in Quezon City, one in Parañaque, one in Manila, one in Makati, and one in Caloocan City. These facilities are all privately owned and are located in commercial and in residential areas.

The number of staff working at these facilities varies from 1 to 8. The clinics surveyed have been in operation from 6 to 20 years and occupy a space of 50 to 85 square meters. None of the dental clinics have established a committee to look after waste management.

In most of the clinics surveyed, general wastes are stored in plastic bags, are collected by a municipal waste collector and are disposed of in a designated disposal site.

In most of the clinics surveyed, sharps are segregated from other medical waste and placed in plastic containers, either specifically designed to contain such waste or not, and in plastic bags. The sharps eventually end up in the municipality's disposal site. One dental clinic stores sharps in tin cans, which are filled with plaster of paris prior to disposal. The same dental clinic also has access to the incinerator located at the East Avenue Medical Center.

Disinfection procedures generally are not carried out for infectious wastes prior to disposal. Only one clinic indicated that infectious surgical gloves and needles are segregated and undergo heat and chemical sterilization prior to disposal.

Pharmaceutical wastes such as water-soluble chemicals are flushed into the sewer or disposed at a landfill site.

In general, medical wastes are separated from other wastes. However, during the collection process, medical wastes are mixed with general wastes. Only one of the dental clinics surveyed practice segregation of wastes into color-coded containers. The final disposal of wastes generated is at the municipal disposal site.

The containers in which medical wastes are stored are labeled and sealed. The waste is collected and transported to the disposal site through municipal refuse collection services using conventional collection vehicles. One respondent pays Php5 daily to a private collector. No specialized vehicle is used to transport the medical wastes. Respondents do not keep records of their shipments of medical wastes.

One respondent practices recycling of pressurized tanks by selling them to junk shops.

All respondents fund their solid waste management processes from either operating revenue or through local government subsidy. Collection and disposal by means of the municipal services is part of their annual business tax.

7.3.3 Diagnostic Clinics and Laboratories

The survey was conducted in four establishments located in Caloocan.

The facilities have been operating for at least the past 4 years and have a minimum of 6 people (including Administration and Finance) on their payroll.

None of the establishments surveyed have an organized committee that oversees the collection and disposal of the wastes. The facilities have designated cleaning personnel (or janitors) as the persons in charge in the disposal of all the wastes generated in the clinics.

All of the respondents make use of plastic bags as means of storing rubber gloves, swabs, cotton, etc. Disposal of these wastes and all other wastes are through the municipal/city government. Chemical and liquid wastes are discharged into the sewerage system.

The establishments surveyed practice little (if any) segregation in the management of their wastes due to the limited amount that is generated. The disposal of solid wastes depends on the frequency of which the municipal/city government provides collection services.

During some of the site visits, it was observed that although there was not a defined management scheme, all of the establishments have allocated a small space within the premises to store waste until collection is possible. Only one establishment uses chemicals for sterilizing all used sharps prior to storage and disposal.

The budget for waste management was not established during the conduct of the survey. The respondents are not comfortable in answering specific questions regarding budget and finance. Three respondents indicated that they financed waste management from their operating revenues while the other one (a semi-government institution) indicated that the local government unit subsidizes part of the budget.

7.3.4 Funeral Parlors and Mortuaries

Five funeral parlors were surveyed. All of these facilities are privately owned; three are located in Manila, one in Pasay, and one in Makati. The number of persons working at these facilities ranges from 6 to 8. These funeral parlors and mortuaries have been in operation from a minimum of 14 years to a maximum of 56 years. No committees have been established for dealing with waste management.

Contaminated waste is stored in plastic bags either to be burned (only in one facility) or to be sent to the final disposal facility of their respective municipality. Placenta and fetuses were collected by family members or buried in a cemetery. One facility practices disinfection of wastes generated from embalming activities prior to disposal. Chemical wastes and water-soluble wastes are discharged (untreated) into the sewer by means of toilet bowls and sinks. Only one respondent practices segregation of medical wastes, which are treated by open burning.

Only one of the establishments surveyed practices the use of different colored plastic bags to store wastes. All types of wastes are collected and disposed through the municipal collection and disposal services. No records are used to monitor the waste disposal. Waste collection and disposal is conducted on a daily basis. One funeral home disposes approximately 5 bags per day. None of the respondents have access to incineration facilities. Unclaimed cadavers either are sold or donated to medical schools, or are buried in the nearest public cemetery. The results of the survey are presented in Table 12.

Table 12. Results of Surveys of Minor Health Care Facilities

Name	Years in Operation	Floor Area	No. of Staff	No. of Patients per wk	Medical Waste Generation per day	Type of Storage	Type of Collection	Treatment
Veterinary Medicine								
Animals Unlimited Veterinary	5	-	2	-	-	Plastic Bags	-	Burial in Grounds
Billy Leysa Vet. Clinic	3	-	1	7	-	Plastic Bags	Municipal	Landfill
Cartimar Vet. Clinic	20	-	2	100	half bag	Plastic Bags	Municipal	Landfill
Dog and Cat Clinic	3	20	3	10	1 bag	Plastic Bags	Municipal	Landfill
GMC Dog and Cat Clinic	12	-	2	-	-	Plastic Bags	Municipal	Landfill
Makati Dog and Cat Hospital	10	-	14	30	-	Plastic Bags	-	Burial in Grounds
Modomo Vet. Clinic	7	480	16	-	8 kilos	Plastic Bags	Municipal	Landfill
Dental and Orthodontics								
Alejo Maria A. F. Clinic	6	50	1	-	1 bag	Plastic Bags	Municipal	Landfill
Amancio Dental Clinic	10	-	1	5	2 bags, small	Plastic Bags	Municipal	Landfill
Andal Dental Clinic	20	-	1	6	-	Plastic Bags/ Tin Can	Municipal	Landfill/ Incineration
Andrade Dental Clinic	12	60	1	6	1 bag, large	Plastic Bags	Private	Landfill

Table 12. Results of Surveys of Minor Health Care Facilities (continued)

Dental and Orthodontics (continued)								
Name	Years in Operation	Floor Area	No. of Staff	No. of Patients per wk	Medical Waste Generation per day	Type of Storage	Type of Collection	Treatment
Esguerra & Esguerra Dental	18	85	2	3	1 bag, medium	Plastic Bags	Private	Landfill
Magtoto – Aquino Dental	10	-	8	25	-	Plastic Bags	Municipal	Landfill
Roman Dental Clinic	5	25	1	28	-	Plastic Bags	Municipal	Landfill
Ramos Dental Clinic	13	25	1	49	-	Plastic Bags	-	-
Diagnostic/Laboratory								
Archon Diagnostic Center	13	20	6	4	3 bags, large	Plastic Bags	Municipal	Landfill
Asuncion Asistio Puericulture	30		13	20 to 30	2 bags, large	Plastic Bags	Municipal	Landfill
BIOSCAN Laboratories	4	50	11	4 to 5	2 bags, small	Plastic Bags	Municipal	Landfill
Mortuaries								
RE Mallari Diagnostic Centre	7	20	7	3	2 bags	Plastic Bags	Municipal	Landfill
Dulce Memorial Services	27	270	8		1 bag, small	Plastic Bags	Municipal	Landfill
Funeraria Filipinas Inc	56	150	7	5		Plastic Bags	Private Contractor	Landfill/Open Burning
Funeraria Lorenzo	23	140	8			Plastic Bags	Municipal	Landfill
Funeraria Malaya	35	170	8	4	1 bag, small	Plastic Bags	Municipal	Landfill
Sol Memorial Services	14	120	6		2 bags, small	Plastic Bags	Municipal	Landfill
Crown Funeral Parlor	-	-	4	-	5 kilos	Plastic Bags	Municipal	

7.4 Waste Treatment Systems and Equipment

In addition to the survey conducted of 18 public and private hospitals in Metro Manila (see Section 7.2), another survey was carried out to supplement the information related to the different practices associated with the management of health care wastes. A total of 36 hospitals participated in the survey, 14 were government hospitals and the rest were private.

The hospitals surveyed are listed in Table 13. In addition, the data in the table describe the reported waste generation and the mode of treatment being used. According to the respondents, regulated waste (infectious, toxic and hazardous) ranges from 3 to 700 kg per day and represents 3% to 10% of the total waste generated.

Table 13. Hospitals Surveyed Regarding Waste Treatment Practices

Name of Hospital	Reported Waste Generation Total (Regulated) kg/day	Method of Treatment	Contractor
Government			
Amang Rodriguez Medical Center	250(75)	Microwave	Chevalier
Dr. Jose N. Rodriguez Memorial Hospital	-- (--)	Burned in improvised burning chamber	None
East Avenue Medical Center	2470(270)	Incinerator	On-site
Las Piñas District Hospital	1,200 (40)	Microwave	Chevalier
Novaliches General Hospital	---	Microwave	Chevalier.
Philippine General Hospital	--(300 – 500)	Incineration	IWMI
PNP General Hospital	288 (--)	Buried in hospital grounds	None
Quezon City General Hospital	--(3.7)	Microwave	Chevalier
Quezon Institute Hospital	120(4-16)	Microwave	Chevalier
Quirino Memorial Medical Center	-- (166)	Incineration	IWMI
Research Institute for Tropical Medicine	-- (120)	Incineration	On-site
San Lazaro Hospital	550(400)	Incineration	On-site
University of the Philippines Health Service	150-200 (--)	Disposal to Payatas	Mum. system
Valenzuela General Hospital	-- (--)	Microwave	Chevalier
Private			
Asian Hospital and Medical Center	-- (--)	Incineration	IWM
Bernardino General Hospital	15(3)	Microwave	Chevalier
Chinese General Hospital and Medical Center	--(--)	Incineration	-
De Ocampo Memorial Medical Centre	6-10(2-3)	Incineration	IWMI
Delos Santos Medical Centre	--(100)	Microwave	Chevalier
Dr. Jesus C. Delgado Memorial Hospital	40(15)	Microwave	Chevalier
Fairview General Hospital	-- (10)	Contracted out	Not mentioned
FEU – Dr. Nicanor Reyes Medical Foundation Center	130(130)	Microwave	Chevalier
F.Y. Manalo Medical Foundation Inc./ New Era General Hospital	12 (--)	Being Disposed without treatment	MMDA
Hospital of the Infant Jesus	31(--)	Incineration	IWMI
Immaculate Conception Hospital	5 – 10 (0.5 – 1)	Incineration	IWMI
Makati Medical Center	1500 – 2000 (600-700)	Incineration	On-site
Manila Adventist Medical Center (Formerly Manila Sanitarium Hospital)	--(15-16)	Microwave	Chevalier
Manila Doctors Hospital	-- (--)	Incineration	IWMI
M.V. Romano Hospital	2-3(1-2)	Disposed	Local govt.
National Children's Hospital	-- (139)	Incineration	IWMI
Optimum Healthcare Systems, Inc.	--(5)	Microwave	Chevalier
St.Clare's Medical Center	-- (--)	Incineration	IWMI
St Jude Hospital and Medical Center	-- (--)	Microwave	Chevalier
St. Martin de Porres Charity Hospital	-- (4)	Microwave	Chevalier
University of Perpetual Help Medical Center	450 (92)	Microwave	Chevalier
University of Santo Tomas Hospital	--(250)	Microwave	Chevalier

As shown by the data, at the time of the study (early 2003), most regulated wastes are treated by incineration or through microwave. The majority of government hospitals (6 out of 14) surveyed use the microwave technology. Five facilities rely on incineration. A similar situation exists in the private sector where the majority of hospitals surveyed reported to use microwave. The two companies that provide incineration and microwave services to these hospitals are the Integrated Waste Management Inc. (IWMI) and Chevalier Enviro Systems Inc. (CESI), respectively. These companies are also responsible for the collection of the regulated wastes.

East Avenue Medical Center has its own incineration facility. The incinerator is a Ferro model PD2SH-P6520 operating at 1,000 degrees centigrade with a burner capacity of 1.5 x106 kJ/hr. The medical center operates at a capacity of 500 kg per load. The incinerator was acquired in 1994 but underwent major repairs in 1997. Other hospitals surveyed that reported having their own incinerators include Quirino Memorial, Research Institute for Tropical Medicine, San Lazaro, and Makati Medical Center.

Most hospitals report that they segregate regulated wastes from the rest of the solid wastes. However, due to the lack of financial support, the wastes may be eventually collected by the municipal service and taken to the municipal disposal site.

Disinfection of infectious wastes is being conducted in all of the hospitals that were surveyed. Among the chemicals used are soap, cider, sodium hypochlorite, vinegar, Lysol, Xonrox, Sanlene, Domex and Chlorine granules. Three hospitals use Ultra Violet light.

The data show that up until the time of the study (early 2003), incineration has played an important role in the management of infectious wastes generated by large health care facilities in Metro Manila.

7.5 Summary

The following are key results of the surveys of current practices, conducted in early 2003:

- In general, hospitals realize the importance of proper waste management and are trying to comply with regulations. Most hospitals have segregation programs in place. There is heavy reliance on private contractors for treatment and disposal of medical wastes. Of the hospitals surveyed, 65% use private contractors for treatment and disposal of sharps, 45% for infectious wastes, and 45% for pharmaceutical wastes.

- Many of the other health care facilities (dental clinics, veterinary clinics, diagnostic and laboratory clinics, and mortuaries/funeral parlors) practice some segregation; in particular sharps are placed in rigid containers. Some pharmaceutical wastes are flushed into the sewer system, and others are discarded. In general, all wastes (including untreated infectious waste and sharps) are mixed and collected as municipal solid waste.

- Hospitals report that regulated waste (infectious, toxic and hazardous) represents 3% to 10% of the total waste generated.

- The majority of government hospitals surveyed use microwave technology or incineration to treat infectious wastes.

8. Treatment of Medical Wastes at DOH Hospitals

In November 1996, the DOH completed the acquisition of various types of waste disposal equipment (including 25 incinerators and 36 small microwave units), medical equipment, and related services for DOH hospitals. The capacity of the incinerators varied from 300 to 500 kg/day and that for microwaves from 84 to 144 kg/shift. The equipment and services were acquired from Vamed Engineering of Vienna, Austria. The total cost of the contract was approximately P 541,620,600, financed through a buyer's credit from the Bank

Austria (AG). The amortization of the loan has been estimated at about P 57.7 million per year and payable beginning December 2002 until 2013.

A photograph of one of the incinerators acquired through the loan is shown in Figure 8, and of a typical microwave unit in Figure 9.

Figure 8. View of a DOH Incinerator Acquired Through the Austrian Loan

Figure 9. View of DOH Microwaves Acquired Through the Austrian Loan

The DOH has 20 facilities in Metro Manila. Eleven of the DOH health care facilities in Metro Manila have incinerators, two of which are not operational. Seven of the incinerators were acquired from Vamed under the Austrian loan. As shown in Table 14, five of the seven incinerators acquired from Vamed were operational at the time of the study.

Table 14. Location and Status of Incineration Units Installed in DOH Facilities in Metro Manila (September 2002)

Name of Hospital	Type	Incineration Units	Status
East Avenue Medical Center	CV2*	2	Operational
Jose Reyes Memorial Medical Center	Other	1	Operational
Lung Center of the Philippines	Other	1	Operational
National Center for Mental Health	Other	1	Operational
National Kidney and Transplant Institute	Other	1	Operational
Philippine Heart Center	Other	1	Non-operational
Philippine Orthopaedic Center	CV2*	1	Operational
Research Institute for Tropical Medicine	CV1*	2	Non-operational
Rizal Medical Center	CV2*	1	Operational
San Lazaro Hospital	Other	1	Operational
Tondo Medical Center	CV1*	1	Operational

*Acquired from Vamed.

The reported condition of existing microwave units acquired from Vamed by the DOH is summarized in Table 15. As shown in the table of the 35 units that were acquired for the DOH facilities nationwide, 4 are operational, 17 are functional but not operational and 14 are defective. Verbal reports by some of the representatives of the institutions that have the microwave units in Metro Manila indicate various reasons for not using the units from difficulty and cost associated with operation and maintenance to unpleasant odors emitted by units.

Table 15. Condition of DOH Microwave Units in the Philippines (as of early 2003)

Model	Operational	Functional but not Operational	Defective
M60	2	6	4
M160	2	11	10
Total	4	17	14

Information related to the location, type, number, capacity and status of the microwave units owned by the DOH that have been installed in health care facilities in the Metro Manila area is summarized in Table 16. As the data in the table demonstrate, of the 13 units that were installed in Metro Manila, only one is operational. In addition, the data in the table show that if all of the units were to operate two shifts per day (8 hours per shift), the total capacity would be about 3,024 kg/day.

According to information provided by the DOH, twelve of the hospitals use a private contractor to treat their infectious wastes (six hospitals rely on microwaves and the other six use incineration).

Table 16. Location and Status of Microwave Units Installed in DOH Facilities in Metro Manila

Facility	Model No.	Number	Capacity (kg/8-hr day)	Capacity (kg/2 shifts)	Status
Amang Rodriguez	M60	1	84	168	Non-operational
East Avenue	M60	1	84	168	Non-operational
Jose Reyes	M160	1	144	288	Non-operational
Las Piñas	M60	1	84	168	Non-operational
Mental Hospital	M160	1	144	288	Non-operational
National Children's	M160	1	144	288	Non-operational
Philippine Orthopaedic	M160	1	144	288	Non-operational
Quirino Memorial	M160	1	144	288	Non-operational
Research Inst for Tropical Med	M60	1	84	168	Operational
Rizal Medical	M160	1	144	288	Non-operational
San Lazaro	M60/M160	2	228	456	Non-operational
Tondo Medical	M60	1	84	168	Non-operational
Total		**13**	**1512**	**3024**	

9. Private Sector Participation

Currently, there are two privately owned facilities, the operating companies of which provide collection, treatment, and disposal services to both private and public health care facilities in Metro Manila (IWMI and CESI). IWMI uses incineration and CESI uses a large-scale microwave. Collection schedules vary for each hospital from daily to once or thrice per week. A photo showing one of the private companies during the collection process at a Metro Manila hospital is shown in Figure 10.

The treatment facility for Chevalier is located in Green Village, Parañaque while the existing treatment plant for IWMI is located in Calamba, Laguna. Additional details about the technologies can be found in Annex 4. The facilities charge between Php28 and Php76 per kg of medical waste collected, treated and disposed. The price difference primarily is a function of distance from the treatment facilities.

Figure 10. Collection of Infectious Waste by the Private Sector

The present incineration facility operated by IWMI does not have air pollution control equipment. A partial view of the IWMI facility is shown in Figure 11. Ash collected from the combustion process is disposed on-site in a cement vault.

Figure 11. Partial View of Facility Operated by IWMI

The company providing disinfection by means of microwaves has had formal complaints from neighbors living near the site due to the generation of unpleasant odors. Although the number and frequency of the complaints were not available to the project team, it was reported that the level of complaints has led, at least on one occasion, to the temporary closure of the facility. Furthermore, currently the company does not seem to have access to a well-designed final disposal site. Unfortunately, the Consultants were unable to meet with representatives of CESI despite several attempts. Permanent closure of the facility operated by CESI would have a significant negative impact on the management of infectious wastes inasmuch as the company (with the exception of St. Luke's Medical Center which uses an autoclave) was the only one that used a technology that complied with the Clean Air Act. Relocation of the facility would conceivably have an impact on the collection and transportation system, thus increasing the costs to the entities that receive service from CESI.

In addition, St. Luke's Medical Center (a private entity) installed an autoclave for the treatment of its residues. The unit is capable of processing about 330 kg/hr and it is for the exclusive use of the hospital. At current

rates of generation, the unit would be able to treat in 4 hours all of the infectious wastes generated at St. Luke's each day.
A summary of the privately owned health care waste treatment facilities including the various types and capacities is presented in Table 17.

Table 17. Privately Owned Health Care Waste Treatment Facilities (June 2003)

Entity	Approximate Capacity	Type	Treatment Fee (Php/kg)
Chevalier Enviro Services (CESI)	250-400 kg/hr	Microwave	28 to 76
Integrated Waste Management, Inc.	2000 kg/day	Incineration	
St. Luke's Medical Center	330 kg/hr	Autoclave	Only for St. Luke's

Since the use of direct combustion facilities for the treatment of medical wastes is not allowed by the Clean Air Act after July 2003, representatives from IWMI indicated that they have acquired a new system to replace their existing one, a pyrolysis unit capable of treating 10 tons per day. According to representatives of IWMI, the new unit would be installed at the same site as the existing incinerators (Calamba, Laguna). The representatives of IWMI have also indicated that the pyrolysis unit would be fully operational by mid-July 2003.

Based on the results of the surveys and on information collected from the Government and from the private service providers, the consultants estimated the type of treatment currently used by major hospitals in Metro Manila. The results of the estimate are presented in Figure 12. As shown in the figure, at the time of the study, about 66% of the accredited hospitals relied on off-site treatment by the private sector, 28% by incineration and 38% by microwave. Approximately 12% of the hospitals incinerated waste on-site, and the rest (about 22%) relied on open air burning, burial at their own grounds or land disposal at municipal facilities. The majority of the "minor" health care facilities surveyed during this study disposed of their infectious waste in land disposal sites along with the rest of the waste collected by the municipal service.

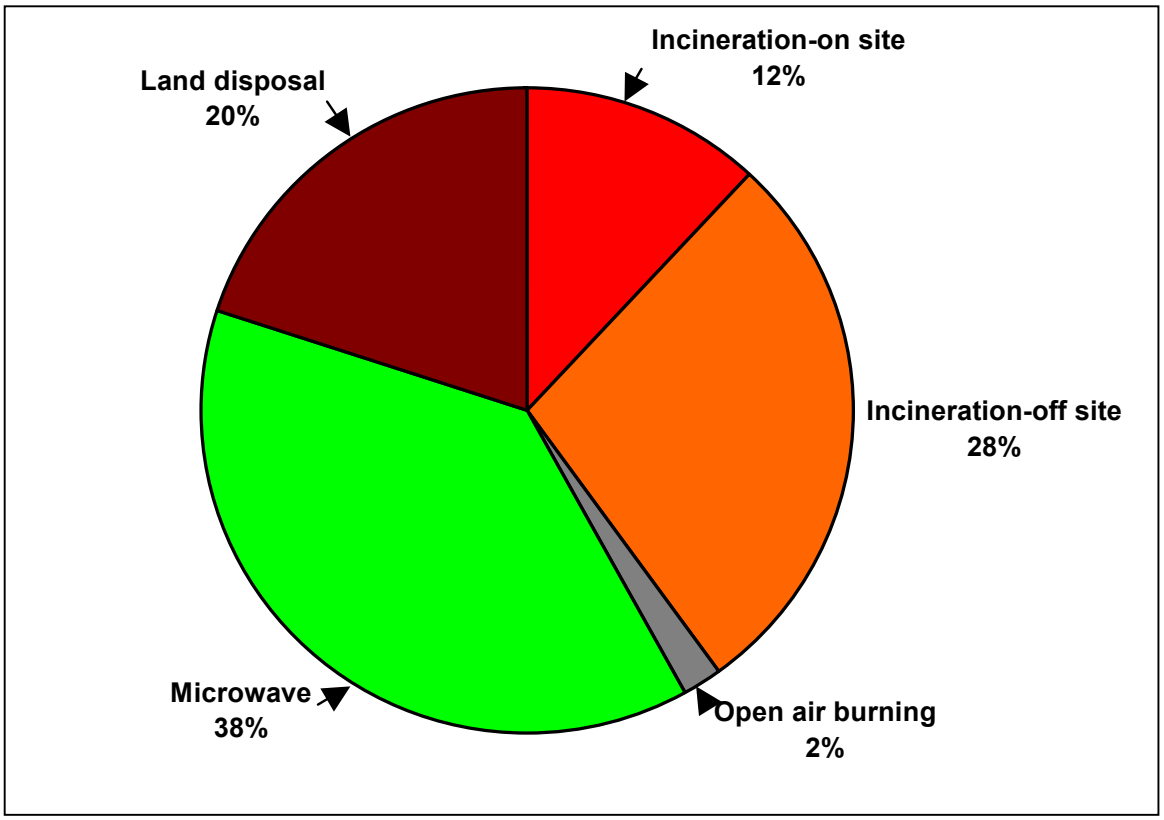


Figure 12. Estimated Type of Waste Treatment Used by Hospitals in Metro Manila (based on the number of facilities)

10. Alternative (Non-burn) Technologies

The Consultants conducted a comprehensive analysis of technologies that could treat the portion of medical wastes that is considered infectious or potentially infectious and meet the requirements of the Clean Air Act. These technologies are also known as "non-burn" technologies. In the analysis, the following technologies were evaluated:

- Mechanical – size reduction and compaction
- Thermal – autoclave, pyrolysis/gasification
- Chemical – chlorination, ozonation
- Radiative – electron beam, Cobalt-60, microwave
- Biological – enzymatic processes, composting

The Consultants used the following criteria to evaluate the technologies:

- Prevailing regulations
- Available options in the region
- Quantities of generated waste categories
- Availability of qualified personnel
- Technologies available on the market
- Capital and operating and maintenance cost

The information presented in Table 18 summarizes key advantages and disadvantages of some of the technologies evaluated. A detailed description of the technologies evaluated is presented in Annex 4.

Based on the results of the evaluation, the Consultants concluded that infectious and some hazardous wastes generated in health care facilities in Metro Manila could be treated by a combination of physical and thermal technologies. Given the degree of development of some of the technologies and the current conditions in the country, the most appropriate technologies for the Philippines seems to be disinfection by means of autoclaves or microwaves.

Table 18. Summary of Analysis of Key Non-burn Technologies

Technology	Advantages	Disadvantages
Autoclave	Proven, straightforward technology Relatively inexpensive Minimal personnel required	May require additional size reduction Requires careful segregation Potential for offensive odors
Biological	No dangerous chemicals to handle Relatively simple technology	Requires careful segregation Unproven technology in this application
Chemical	Proven, easily understood technology Relatively low capital cost Simple to operate	High maintenance cost (size reduction) Can be noisy Special training for handling/storage of chemicals Can produce toxic compounds when mixed with organic matter
Microwave	Modular Automated Self-contained Minimal personnel required No liquid waste produced Minimal emissions	Requires careful segregation Potential for offensive odors High capital cost
Pyrolysis/gasification	Almost complete destruction of waste No liquid waste produced Very little odor Heat may be recovered Automated operation	High capital and operating costs Process may emit dioxins Heat should be reused as steam or hot water

11. Capacity Building and Stakeholder Participation

The Consultants, throughout this TA, have made every effort to develop human resources, transfer information and consult with key members of Government agencies, pertinent entities and others. As such, seminars, workshops, and meetings were organized. In addition, a technical working group was established to discuss issues and obtain feedback on several initiatives. Some of the activities that were conducted include:

- Workshop on: Medical Waste – Issues and Problems
- Seminar on: The Management of Health Care Wastes
- Workshop on: Metro Manila Medical Waste Management Strategy Development

Additionally, the project team supported a "writeshop" to update the *Manual on Hospital Waste Management,* which led to the preparation of a final draft of the manual. A copy of the agenda for the writeshop is presented in Annex 5.

Pertinent information regarding the activities discussed in the previous paragraph is presented in Annex 6. Additional information regarding meetings and other items also are given in Annex 6.

12. Strategy for the Treatment of Medical Wastes Generated in Metro Manila

12.1 Rationale

The results of the surveys and evaluations were used by the project team to develop a strategy for collecting, treating, and disposing of the wastes. The strategy utilizes a combination of microwave and autoclaves providing service to either one or a combination of users. The system also relies on a waste collection system provided by dedicated, specialized vehicles to transport the waste from the generators to the treatment facilities using a reliable "chain of custody" system. The service providers can be a combination of public and private sector (taking advantage of the two existing private sector contractors). Finally, the strategy relies on the use of one or more sanitary landfills equipped with the appropriate features to accept the treated materials.

The Consultants have developed this strategy specifically for the treatment of the medical wastes generated by the health care facilities located in the Metropolitan Manila area. The strategy has been designed such that:

- currently estimated quantities of waste generated can be properly managed; and
- maximum use of existing appropriate facilities can be accomplished.

In addition, this strategy relies on the development and implementation of a continuous and comprehensive education and training program aimed at all of the staff and patients of health care facilities. The education and training program should emphasize waste minimization and proper and efficient segregation of the wastes such that the total amount of infectious and hazardous wastes is maintained to a minimum.

The focus of the strategy is on the treatment of the infectious component of medical wastes prior to final disposal. Nevertheless, for completeness, the following discussion briefly addresses segregation, collection, and storage at the health care facility. The following are some general minimum guidelines that should be followed in the different phases of the waste management process.

12.2 Segregation

Every health care facility should practice strict segregation procedures such that the proper types of waste are placed in colored-coded container (or in bags) as follows:

- Black - for the collection and storage of non-infectious dry waste (general waste)
- Green - for the collection and storage of non-infectious wet waste
- Yellow - for the collection and storage of dry and wet chemical and potentially infectious waste, pathological waste, sharps (contained in a puncture-proof container)
- Orange (with Trefoil sign) - for the collection and storage of radioactive waste.

In the event that plastic bags are used, the bags should be made of polyethylene or similar material of at least 0.004 gauge.

12.3 Interim Storage

Storage of health care waste at the point of generation should be carried out in properly labeled, special containers. The containers should be made out of a material that is sturdy and can be opened by means of a foot pedal. In addition, the containers should be able to be easily cleaned. The containers can also be lined with properly labeled, plastic bags. The color of the bags and of the containers should reflect the type of waste to be placed in them.

All containers shall be placed in an enclosed area especially dedicated for the storage of waste. The storage area should be secured with lock and key to prevent access by unauthorized personnel. The interim storage area should be signposted and must be readily accessible to personnel providing the collection service. One of the most important considerations in the storage of medical wastes is safe containment in a vermin-proof clean and tidy area. The requirements for the storage area will obviously depend upon the amount and type of waste generated by the particular facility. Measures should be taken to prevent obnoxious odors from escaping the area.

12.4 Collection

Waste collection, from the point of generation should be carried out at least once every shift. Personnel properly trained and using protective equipment should remove the materials. The waste should preferably be placed in carts or trolleys and should be isolated from the environment. The routes followed by the collection unit within the facility should be developed such that the risks involved in contaminating critical areas are substantially reduced.

12.5 Central Storage Facility

Depending upon the size of the health care facility, once the solid waste is removed from the point of generation, the material should be placed in a centrally located storage area. The storage area should be placed as close as possible to the points of waste generation. The storage area should be accessible to the personnel providing the collection service. Unauthorized personnel should not be allowed into the area and should follow the same general guidelines as those presented for the interim storage area.

12.6 Transport

Transport of the medical waste should be carried out in a specialized vehicle. The vehicle should be appropriately marked and painted with the necessary signs indicating the type of load carried. The area in which the waste is placed inside the vehicle should be made out of a metal and should have a smooth finish to allow for thorough cleaning and disinfection. The interior of the vehicle should be refrigerated. Transportation should be conducted relying on the principle of “chain of custody” or consignment. A sample form that can be used for this purpose is presented in Annex 7.

12.7 Treatment

Based on our analysis described in another section of this report, at the present time the health care system in Metro Manila consists of approximately the following number and type of facilities:

- 197 accredited hospitals (17, 500 government beds and 12,000 private beds)
- 400 health centers
- 1290 clinics
- 980 dental clinics, and
- 802 veterinary clinics, pharmaceutical labs, blood banks, funeral parlors, and others.

Using the results of the waste characterization study conducted at the EAMC and the results of other similar facilities, the project team estimates that the following amounts of infectious wastes are generated each day in Metro Manila: the DOH facilities produce a total of about 3,230 kg/day; and private and other facilities generate about 23,700 kg/day. Consequently, the total amount of medical waste requiring treatment amounts to about 26,930 kg/day.

Our estimates also show that hospitals (public and private) generate about 10,000 kg of infectious waste per day, which is equivalent to about 37% of the total amount of infectious waste generated by health care facilities in Metro Manila.

A strategy has been developed based on a number of considerations. Some of the considerations include: regulatory constraints (particularly the Clean Air Act), availability of qualified personnel to operate the facilities, availability of financial resources and existing equipment, degree of development and reliability of the treatment technology, climate, traffic and others.

As it has been emphasized in previous paragraphs, the proposed strategy is predicated on the implementation of comprehensive segregation programs at the health care facilities and on the establishment of a secure land disposal facility for final disposition of the treated residue.

The strategy basically consists of two options (Option 1 and Option 2) and it is based on the viability of repairing and operating existing microwaves that have been installed in several DOH facilities in Metro Manila. In both options, it is assumed that the private sector would play a critical role. Treatment facilities could be established through strictly private sector initiatives or in partnership with the public sector.

The strategy also provides the opportunity for the establishment of special lending programs aimed at encouraging the development of additional private sector participation in the management of health care wastes.

The performance of all of these treatment units should be closely monitored. Some guidance associated with monitoring the degree of microbial inactivation is presented in Annex 8.

A summary of the proposed options is provided in Table 19.

Table 19. Proposed Options for Treatment of Infectious Medical Waste*

	Option 1		Option 2	
	Technology	kg/day, 2 shifts	Technology	kg/day, 2 shifts
Quantity Generated				
Department of Health		3,230		3,230
All other facilities		23,700		23,700
Total		**26,930**		**26,930**
Service Provider				
DOH	Microwave	3,230	Autoclave	3,230
IWMI	Pyrolysis	10,000	Pyrolysis	10,000
Chevalier	Microwave	4,800	Microwave	4,800
St. Luke's Medical Center	Autoclave	900	Autoclave	900
New individual units at facilities**	Autoclave/Other	1,600	Autoclave/Other	400
New cluster units at facilities**	Autoclave/Other	3,200	Autoclave/Other	1,600
New private sector operation**	Autoclave/Other	3,200	Autoclave/Other	6,000
Total		**26,930**		**26,930**

*Large body parts and cadavers would be cremated.
**Other – implies the use of any technology that would meet the requirements of the Clean Air Act.

In both options it has been assumed that large body parts (infectious or not infectious) or cadavers that are not claimed by family would be cremated in properly managed facilities such as the one located in San Lazaro Hospital.

In addition, the success of the options would also rely on a properly designed and operated transportation system. Our estimates indicate that the total amount of infectious waste should continually decrease until it reaches a level of about 19 tons per day by 2010. The data presented in Table 19 show that the proposed strategy would have more than enough capacity to deal with these quantities of waste. However, it must be emphasized that these options will only work if thorough segregation practices are followed at all health care facilities. In addition, the operators of the treatment facilities must establish preventive and regular maintenance programs.

Option 1

The development of this particular option is based on the following assumptions:

- Wastes produced by St. Luke's Medical Center would be treated in its own autoclave.
- Continued reliance on the private sector to provide medical waste collection, treatment and proper disposal. As such, CESI is assumed to be able to manage about 4,800 kg/day. Additionally and as previously indicated, IWMI would use its new installation (pyrolysis unit) to treat up to 10,000 kg/day.
- The total amount of waste that would be treated by these three facilities would leave about 8,000 kg/day to be treated.
- The rest of the waste would be treated by a series of autoclaves installed in public and private facilities. Approximately 20% of the remainder would be treated by individual units, 40% by units providing service to a cluster of institutions and 40% would rely on the private sector.

Equipment

Collection: It is assumed that the waste would be collected in 5-ton trucks. It has been estimated that this option will require 8 vehicles. The vehicles will use a crew of three (a driver and two laborers). The vehicles

will operate for two shifts. The shifts will be operated during off-peak hours. A photograph of a typical collection vehicle with a refrigeration unit is shown in Figure 13.

Figure 13. Collection Vehicle with Refrigeration Unit

Treatment: This option is based on the use of microwave and autoclave units to sterilize infectious waste. The microwaves to be used would be those acquired by the DOH through a loan from the Austrian Government. There are 13 units installed in various health care facilities in Metro Manila. The location of each of the installations, the model of the unit and capacity are described in Table 20. These units would have to be repaired or rehabilitated.

The rest of the waste would be treated in 6 autoclaves. The capacity of each autoclave would be 150 kg/hr. One of the units is considered a "spare" and would normally be used at below capacity. This unit would be used at full capacity when another unit needs to be repaired or requires extensive maintenance.

Operation time: To maximize the investment, all units (microwaves and autoclaves) would be operated for two shifts per day (8 hr/shift). The third shift would be used for maintenance.

Labor

It has been estimated that each treatment unit would require the following number of laborers:

- Microwave: 3 laborers per unit per shift, 2 administrative persons per unit (only one shift).
- Autoclave: 3 laborers per unit per shift, 2 administrative persons per unit (only one shift).
- Trucks: 1 driver and 2 laborers per truck per shift. The vehicles would operate two shifts.

A summary of the number of treatment units that would be acquired by the public and private sectors is shown in Table 20.

Table 20. Number and Capacity of Autoclaves for Option 1

Ownership	No. of Units	Capacity (kg/hr)	Available Capacity (kg/day)
Private-Individual	1	150	2400
Private-Cluster	2	150	4800
New Private*	2	150	4800
Spare	1	150	2400

*This may consist of any other non-burn technology.

Estimated Cost

The estimated capital cost for repairing the microwaves and purchasing the autoclaves is presented in Table 21. In addition, the table presents estimated operation and maintenance costs. The estimated capital costs and O&M costs are subdivided by public and private sectors. As shown in the table, the total capital cost for the public sector is US$885,000 and that for the private sector is US$2,065,000. Similarly, the O&M cost for the public sector would be US$1,063,464 and that for the private sector US$1,179,320. These costs include amortization.

Option 2

This option essentially is the same as Option 1 with the major difference that in this case we assume that the DOH decides not to use the microwave units in Metro Manila. However, the Consultants recommend that in the event the DOH adopts Option 2, the microwave units be completely overhauled and be strategically located in other DOH facilities around the country where the units could be operated two shifts per day and provide service to more than one facility.

Table 21. Estimated Investment Costs and Operation and Maintenance Costs for Option 1 (US$)

	Public			Private		
Investment Costs						
	Life Span (years)	***Unit Capital Cost***	***Investment Year 1***	***Life Span (years)***	***Unit Capital Cost***	***Investment Year 1***
Fixed Equipment	10	250,000	250,000	10	1,250,000	1,250,000
Repair of Existing Equipment	10	300,000	300,000	10		
Building and Infrastructure	30	75,000	75,000	30	375,000	375,000
Trucks	8	80,000	240,000	8	80,000	400,000
Misc. (scales, etc.)	5	20,000	20,000	5	40,000	40,000
Total Inv. Cost by Sector			885,000			2,065,000
Annual Costs						
	No. of Units	***Unit Cost***	***Year 1 Costs***	***No. of Units***	***Unit Cost***	***Year 1 Costs***
Labor – Laborers and Drivers	102	4,320	440,640	60	4,320	259,200
Labor – Administrative	28	7,200	201,600	10	7,200	72,000
General and Administrative Costs	10%		64,224	10%		33,120
Operating and Maintenance Costs			238,500			619,500
Amortized Inv. Costs			91,500			195,500
Total Annual Costs			**1,036,464**			**1,179,320**

In Option 2, the waste that would have been treated by the microwave units would be treated by autoclaves. St. Luke's, CESI and IWMI would process wastes as suggested in Option 1.

The remainder of the waste would be managed as follows:

- individual units would treat about 5%
- other units providing service to a cluster of institutions would treat about 20%

- private sector initiatives would deal with about 75% of the rest.

Equipment

Collection: It is assumed that the waste would be collected in 5-ton trucks. It has been estimated that this option will require 8 vehicles. The vehicles will use a crew of three (a driver and two laborers). The vehicles will operate for two shifts. The shifts will be operated during off-peak hours.

Treatment: This option is based on the assumption that the microwaves owned by the DOH are beyond repair or that the possibility of using them in this manner is not acceptable to the Government or to the hospital administrators. Consequently, in this option, the microwaves are replaced by autoclave units to sterilize infectious waste.

The waste would be treated in 9 autoclaves (3 pubic and 6 private). The capacity of 8 autoclaves would 150 kg/hr and one would be 80 kg/hr. One of the units is considered a "spare" and would be used under capacity and would be used at full capacity one another unit needs to be repaired or requires extensive maintenance.

Operation time: All units would be operated for two 8-hr shifts per day. The third shift would be used for maintenance.

Labor

It has been estimated that each treatment unit would require the following number of laborers:

- Autoclave: 3 laborers per unit per shift, 2 administrative persons per unit (only one shift).
- Trucks: 1 driver and 2 laborers per truck per shift. The vehicles would operate two shifts.
-

A summary of the number of treatment units as well as vehicles that would be acquired by the public and private sectors is shown in Table 22.

Table 22. Number and Capacity of Autoclaves for Option 2

Ownership	No. of Units	Capacity (kg/hr)	Available Capacity (kg/day)
DOH	2	150	4800
Public-Other	1	150	2400
Private-Individual	1	50	800
Private-Cluster	1	150	2400
New Private*	3	150	7200
Spare	1	80	1280

*This may consist of any other non-burn technology.

Estimated Cost

The estimated capital cost for repairing the microwaves and purchasing the autoclaves is presented in Table 23. In addition, the table presents estimated operation and maintenance costs. The estimated capital costs and O&M costs are subdivided by public and private sectors. As shown in the table, the total capital cost for the public sector is US$1,235,000 and that for the private sector is US$4,829,000. Similarly, the O&M cost for the public sector would be US$705,592 and that for the private sector US$2,327,672. These costs include amortization.

A copy of the financial analysis that was conducted is provided in Annex 9.

Table 23. Estimated Investment Costs and Operation and Maintenance Costs for Option 2 (US$)

	Public			Private		
Investment Costs						
	Life Span (years)	***Unit Capital Cost***	***Investment Year 1***	***Life Span (years)***	***Unit Capital Cost***	***Investment Year 1***
Fixed Equipment	10	250,000	750,000	10	1,330,000	3,990,000
Repair of Existing Equipment						
Building and Infrastructure	30	225,000	225,000	30	399,000	399,000
Trucks	8	80,000	240,000	8	80,000	400,000
Misc. (scales, etc.)	5	20,000	20,000	5	40,000	40,000
Total Inv. Cost by Sector			1,235,000			4,829,000
Annual Costs						
	No. of Units	***Unit Cost***	***Year 1 Costs***	***No. of Units***	***Unit Cost***	***Year 1 Costs***
Labor – Laborers and Drivers	36	4,320	155,520	66	4,320	285,120
Labor – Administrative	6	7,200	43,200	12	7,200	86,400
General and Administrative Costs	10%		19,872	10%		37,152
Operating and Maintenance Costs			370,500			1,448,700
Amortized Inv. Costs			116,500			470,300
Total Annual Costs			705,592			2,327,672

12.8 Final Disposal

As previously indicated, the strategy presented herein is strongly dependent on the development and use of a properly designed and operated final disposal site in which the residues from the treatment facilities would be deposited.

12.9 Public Education and Outreach

An outreach strategy related to medical waste was developed based on the results of the evaluation of health care facilities. The strategy is summarized below; further information is presented in the report on Community Awareness Strategy.

- *Issues and Needs* – Two key issues related to medical waste management were identified, which demonstrate the need for additional IEC activities: (1) problems associated with improper segregation; and (2) an increase in public awareness and concern.

  - Problems associated with improper segregation -- Two key problems result from improper segregation: (1) dangers resulting from disposal of untreated infectious wastes commingled with general waste; and (2) additional cost resulting from treatment of general waste commingled with infectious wastes by non-burn technologies.

  - Increasing public awareness and concern -- Public concern related to the collection, treatment and final disposition of health care waste has increased considerably during the past few years. The concern has been magnified by the outbreak of SARS in Asia and Canada. To allay these

concerns, it is important that public education regarding the strategy for managing health care wastes be conducted.

- *Target Audiences* – Based on the issues and needs identified by the project team, two target audiences were identified:
  - *Hospital personnel* – doctors, nurses, laboratory technicians, aides, janitors, cafeteria personnel, administrative staff, others
  - *Non-hospital personnel* – patients, visitors, watchers (attendants)
- *Development of Strategy* – A listing of recommended activities is presented in Table 24.

Table 24. Recommended IEC Strategies Related to Medical Waste Management

Target Audience	Purpose	Strategy/Method
Hospital Personnel	Training	▪ Guidance document ▪ Trainer training ▪ Personnel training ▪ Interactive training guide
	Reminder	▪ Posters ▪ Fact sheets
Non-hospital Personnel	Instruction, motivation	▪ Posters

- *Preparation of Materials* –Outreach materials that have been prepared during the project include the following:
  - *Posters* -- Layouts for four posters were developed, two targeted at hospital personnel and two at non-hospital personnel. Copies of the posters are included in Annex 10
  - *Fact sheets* – Two fact sheets were prepared, the first one presenting results of the waste characterization analysis and facility data, and the second one providing information on non-burn alternatives for treating infectious medical waste. Copies of the fact sheets are presented in Figures 14 and 15.

Characteristics of Health Care Waste

The Ecological Solid Waste Management Act of 2000 (RA 9003) requires the proper segregation, recycling, and composting of the non-infectious fraction of health care waste in the Philippines.

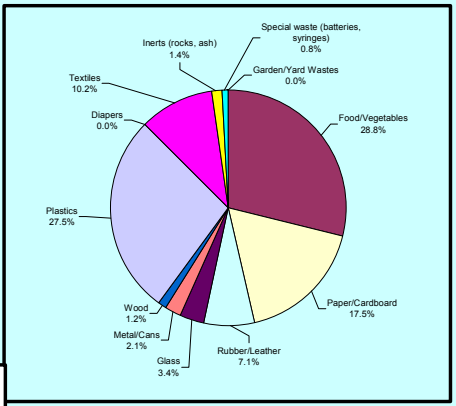
According to a recent study funded by the Asian Development Bank, there are 3,670 health care facilities in Metro Manila, including 197 accredited hospitals. The health care facilities generate approximately 47 tons per day of waste. Of this, about 27 tons per day are disposed as infectious or potentially infectious.

Estimated Quantities of Health Care Waste Generated in Metro Manila in 2002

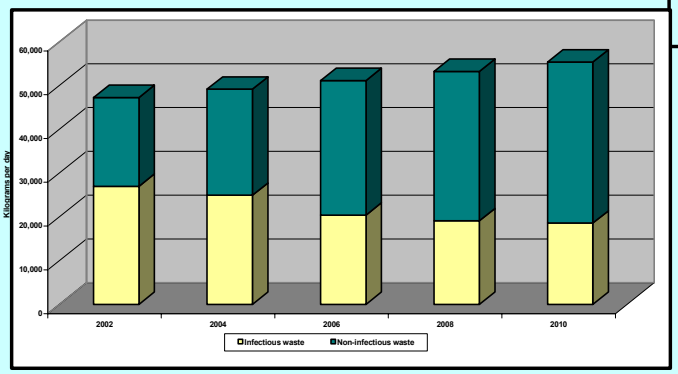
Type of Facility	No. of Facilities	No. of Beds	Infectious Waste (kg/day)	Non-Infectious Waste (kg/day)	Totals (kg/day)
Accredited Hospitals	197				
Government (no. of beds)		17,563	5,971	6,850	12,821
Private (no. of beds)		11,753	3,996	4,584	8,580
Health Centers	401		802	1,203	2,005
Medical Clinics	1,290		2,580	3,870	6,450
Dental Clinics	980		5,880	1,960	7,840
Veterinary Clinics	93		372	93	465
Pharmaceutical Labs	481		5,772	1,443	7,215
Blood Banks	17		204	51	255
Funeral Parlors	196		1,176	196	1,372
Medical Schools	11		132	33	165
Research Institutions	4		48	12	60
Totals	**3,670**		**26,933**	**20,294**	**47,228**

Non-infectious waste disposed by health care facilities contains potentially recyclable or compostable material, such as paper, plastics, and food waste.

Estimates indicate that the total amount of health care waste will increase to about 55 tons per day by 2010. Assuming that new practices and training programs are implemented that improve segregation, the amount of infectious waste is projected to decrease to 18.5 tons per day by 2010.



Average Composition of ER-Surgery Waste



Estimate of Current and Projected Quantities of HCW Generated in Metro Manila

ADB TA 3848-PHI – Metro Manila Solid Waste Management Project

Figure 14. Fact Sheet – Characteristics of Health Care Waste

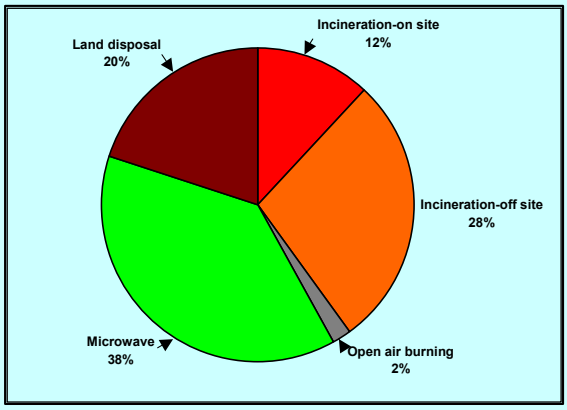
Alternative Technologies for Treating Health Care Waste

The Clean Air Act (RA 8749) prohibits the burning of infectious waste and requires that existing incinerators be phased out by July 2003.

Incinerator

According to a recent study funded by the Asian Development Bank, about 42% of hospitals in Metro Manila were still using incineration to treat their wastes as of early 2003.

At the time of the study, it was estimated that 28% of hospitals relied on off-site incineration by the private sector, 12% incinerated on-site, and 2% treated waste by open air burning. Off-site treatment using microwave technology was used by approximately 38% of the hospitals.



Estimated Type of Waste Treatment Used by Hospitals in Metro Manila (based on the number of facilities)

Alternative technologies that have been evaluated to treat medical waste include:

- Mechanical – size reduction and compaction
- Thermal – autoclave, microwave, pyrolysis/ gasification
- Chemical – chlorination, ozonation
- Radiative – electron beam, Cobalt-60
- Biological – enzymatic processes, composting

Autoclave

Microwave

ADB TA 3848-PHI – Metro Manila Solid Waste Management Project

Figure 15. Fact Sheet – Alternative Technologies for Treating Health Care Waste

13. Consultation with Key Entities

The Consultants conducted a series of meetings with key Government and Non-Government organizations including the Secretary of the DENR (Secretary Gozun), Undersecretary of the DOH (U. Sec. Lopez), other representatives from the DENR (Director of EMB), representatives from the DOH, the BOT Center, and the Philippine Medical Association on the 28th May 2003. In addition, the Consultants presented the proposed strategy to representatives of the DENR, DOH, BOT Center, MMDA, Philippine Hospital Association, Philippine Medical Association, the Heart Center, and others on June 9, 2003.

The participants in these meetings reached consensus and offered strong support for the strategies.

14. Conclusions

- Two important pieces of legislation have been passed in the last few years (the Clean Air Act and the Ecological Solid Waste Management Act) that impact the management of health care wastes. Nevertheless, few changes have taken place in the actual management of health care wastes in Metro Manila during the last two years. Two of the most notable changes include: an increased reliance on the private sector for the collection and treatment of health care wastes and the decision by the MMDA to stop its participation in the management of health care wastes.

- Those responsible for the management of health care wastes have a number of concerns including: complying with the requirements of recent legislation (the Clean Air Act and the Ecological Solid Waste Management Act), and the reassignment of responsibilities that were once under the purview of MMDA.

- Until recently, incineration has played a major role in the treatment of health care wastes. Technically viable and affordable alternatives are needed to treat wastes that have in the past been treated by incineration. A secure and reliable final disposal site is not available for accepting health care wastes treated by non-burn technologies.

- The DOH acquired 25 incinerators and 36 disinfection units from the Austrian Government for installation in some of its hospitals. Only four of the microwave units currently are in operation, the others either are defective or not used.

- Health care facilities in Metro Manila generate on the order of 47 tons of medical waste. Approximately 27 tons are considered infectious or potentially infectious. Based on the information collected during this evaluation, it is estimated that about 5 tons per day of infectious waste (or about 18.5% by weight) were disposed properly (i.e., through autoclave, microwave or incineration) and approximately 22 tons per day (or about 81.5% by weight) were disposed on the land (either buried on-site or discarded along with the rest of the waste collected by the municipal waste collection service).

- According to the survey results, most health care facilities that generate cytotoxic wastes pay private contractors to collect and dispose of the materials. Most of the other water-soluble pharmaceutical wastes are discharged into the sewer system. Radioactive wastes are carefully collected from the point of generation and appropriately stored until the radioactivity has decayed to safe levels and the materials can be safely disposed along with the general waste.

- Hospitals generate on the order of 0.73 kg/bed-day of solid wastes. Approximately 0.34 kg/bed-day are considered infectious or potentially infectious. Most hospitals practice some segregation. Most (about 78%) of the accredited hospitals dispose of their infectious waste properly (either through

incineration or microwave), 66% of which is conducted off-site. The remaining hospitals (22%) relied on land disposal or open burning.

- Many of the other health care facilities (dental clinics, veterinary clinics, diagnostic and laboratory clinics, and mortuaries/funeral parlors) practice some segregation; in particular sharps are placed in rigid containers. In general, all wastes (including untreated infectious waste and sharps) are mixed and collected as municipal solid waste.

- The results of the waste characterization survey conducted in the course of this TA demonstrated that improper segregation still takes place in some facilities. Little if any inspection of segregation of wastes at health care facilities is conducted.

- Estimates indicate that the total amount of health care waste will increase in Metro Manila to about 55 tons per day by 2010. At the same time, our estimates show that thorough training programs and other activities will lead to proper segregation and therefore the amount of infectious waste will decrease to 18.5 tons by 2010.

- Information obtained in course of this study shows that the health care sector is not prepared to comply with the provisions set forth by the Clean Air Act. Recently, the DOH and the DENR have held a series of meetings in an attempt to address the Clean Air Act. Based on the discussions held with representatives from the public and private sectors, the majority of the entities seemed to be waiting for the Government to provide solutions.

- The Consultants have developed a strategy aimed at managing the infectious wastes generated in Metro Manila. The strategy has been presented to key representatives of the public and private sectors. The strategy has been widely accepted and supported.

15. Recommendations

- The Government and the public sectors must comply with the provisions set forth by the Clean Air Act.

- The infectious wastes generated in Metro Manila can be managed through a combination of public and private sector initiatives using microwave and autoclaves.

- The DOH in cooperation with other agencies should print and distribute the revised version of its *Health Care Waste Management Manual*. The manual should be used to conduct training programs on the proper management of health care wastes.

- Infectious wastes should be collected by means of special vehicles relying on a thorough system of chain of custody.

- The regulatory system seems to be adequate for the management of medical wastes. Some modifications may be required in the area of transportation of medical wastes to require the use of “chain of custody” procedures.

- The agencies currently involved in developing a memorandum of understanding (MOU) should make every effort to finalize it as soon as possible so that the responsibilities for monitoring the proper management of health care wastes are clearly delineated.

- The interagency MOU should include aspects for the enforcement of existing laws and regulations including strong penalties for the improper treatment and disposal of medical wastes.

- The DOH should carry out a technical and financial evaluation of the potential to repair and operate its existing microwaves. Based on the results of the evaluation, the DOH can decide whether to operate the units in Metro Manila or to transfer the microwave units to other DOH institutions in other regions.

- The DOH and the DENR should put into practice, as soon as practical, the strategy developed by Consultants.

- The proposed strategy should be implemented along with a comprehensive maintenance program.

- The DENR and the DOH must work jointly to identify and define a suitable final disposal site for the treated medical wastes.

Annex 1

List of Health Care Facilities in Metro Manila

List of Hospitals in Metro Manila

HospName	Street/District	Mun/City	Contact	Type	Beds	Phone	Region	Prov/Code	
Dr. Jose N. Rodriguez Memorial Hospital	Tala	Caloocan City	Dr. Remegio B. Reyes	T	2000	939-2253	NCR	Metro Manila	1427
MCU - F.D. Tanchoco Foundation Hospital	Samson Road, EDSA	Caloocan City	Dr. Raquel M. So-Sayo	T	200	365-4868	NCR	Metro Manila	1400
Martinez Memorial Hospital	198 Mabini St.	Caloocan City	Dr. Ferdinand A. Martinez	S	170	288-8861 to 63	NCR	Metro Manila	1410
Col Salvador T. Villa Memorial Hospital	109 Caimito Road	Caloocan City	Dr. Antonio C. Santos	T	115	361-2406	NCR	Metro Manila	1408
Nodado General Hospital	Area A, Camarin	Caloocan City	Dr. Susan U. Nodado	S	40	936-0970	NCR	Metro Manila	1400
Hospital ng Caloocan	450 Mabini St.	Caloocan City	Dr. Erlinda B. Mauricio	S	35	288-7077	NCR	Metro Manila	1400
Our Lady of Grace Hospital	8th Avenue, Grace Park	Caloocan City	Dr. Lourdes N. Sembrano	S	28	361-1138	NCR	Metro Manila	1403
Ronn Carmel General Hospital	115 Ponce St.	Caloocan City	Dr. Carolina T. Gabriel	S	25	363-2789	NCR	Metro Manila	1400
Lady of Lourdes Hospital, Inc. of Caybiga	133 Caybiga St.	Caloocan City	Dr. Erlinda B. Mauricio	S	20	936-3306	NCR	Metro Manila	1420
Clinica Terencio & Hospital	J.P. Rizal St., Maypajo	Caloocan City	Dr. Emmanuel Terencio	P	15		NCR	Metro Manila	1410
John Paul Hospital	26 M. Ponce St., Tirad Pass	Caloocan City	Dr. Antonio P. Bautista	S	15	361-8959	NCR	Metro Manila	1400
San Lorenzo General Hospital	24 Brgy. 170 Zone 15, Deparo	Caloocan City	Dr. Eduardo S. Noveloso	P	15	936-2683	NCR	Metro Manila	1420
Baesa Advent Polyclinic	238 Deparo St., Baesa	Caloocan City	Dr. Joel G. Ombao	S	10	364-8809	NCR	Metro Manila	1400
Hernandez General Hospital	1372 Rizal Avenue Ext.	Caloocan City	Dr. Carolyn Hernandez	S	10	364-5588	NCR	Metro Manila	1405
Sir John Medical & Maternity Clinic	121 1st Avenue, Grace Park	Caloocan City	Dr. Carmen R. Ty	P	10	361-4260	NCR	Metro Manila	1405
Bagbaguin Family Hospital	849 Gen. Luis St., Bagbaguin	Caloocan City	Dr. Eddie D. Acebedo	P	6	983-5363	NCR	Metro Manila	1400
University of Perpetual Help Rizal Medical Center	Alabang-Zapote Road, Pamplona	Las Piñas City	Dr. Ferdinand Francis M. De Leon	T	250	874-8515	NCR	Metro Manila	1701
Las Piñas Doctor's Hospital	8009 J.I. Aguilar Avenue, Pulang Lupa II	Las Piñas City	Dr. Cecilia Castillo	T	62	825-5236	NCR	Metro Manila	1750
Las Piñas City Medical Center	1314 Marcoa Alvarez	Las Piñas City	Dr. Geanie C. Lopez	T	56	800-5695	NCR	Metro Manila	1701
Jasmir-JSM Memorial Hospital	1335 Fruto Santos Ave., Zapote	Las Piñas City	Dr. Leopoldo Orantia, Jr.	S	25	871-5612	NCR	Metro Manila	1742
Las Piñas District Hospital	Real St.	Las Piñas City	Dr. Roland L. Cortez	S	25	874-6872	NCR	Metro Manila	1701
Las Piñas Medical Clinic	180 Real St., Almanza	Las Piñas City	Dr. Francisco E. Montillano	S	25	801-4535	NCR	Metro Manila	1750
Christ the King Maternity & Lying-In Hospital, Inc.	130 Real St., Pamplona	Las Piñas City	Dr. Leonida C.T. Almelor	S	20	873-1119	NCR	Metro Manila	1701
Pamplona Medical Clinic	46 Real St. Pamplona	Las Piñas City	Dr. Erlinda C. Vidal	S	15		NCR	Metro Manila	1701
Cabinte Maternity & Children's Hospital	Marcos Avenue, Talon	Las Piñas City	Dr. Restante P. Cabinte	P	10	801-4310	NCR	Metro Manila	1747
Callejo Medical Clinic	545 Talon Garden, Talon	Las Piñas City	Dr. David Callejo	P	10	802-0950	NCR	Metro Manila	1747
Makati Medical Center	2 Amorsolo St., Legaspi Village	Makati City	Dr. Raul G. Fores	T	618	815-9911	NCR	Metro Manila	1200
Fort Bonifacio General Hospital	Fort Bonifacio	Makati City	Lt. Col. Gamaliel J. Guerrero	S	200	812-7416 to 31	NCR	Metro Manila	1201
Manila Naval Hospital	Fort Bonifacio	Makati City	Ltc. Joselito P. Avancena	S	100	892-8261	NCR	Metro Manila	1201
St. Claire's Medical Center	1838 Dian St.	Makati City	Dr. Araceli P. Jo	T	100	831-6511 to 14/83	NCR	Metro Manila	1200
Ospital ng Makati	Malugay St., Brgy. Bel-Air	Makati City	Dr. Ramoncito R. Coronel	S	50	893-0692 to 94	NCR	Metro Manila	1209
Jose Viray Memorial Hospital	3525 Mola St.	Makati City	Dr. Gregorio S. Cerezo, Jr.	S	25	367-1892	NCR	Metro Manila	1200

List of Hospitals in Metro Manila (continued)

HospName	Street/District	Mun/City	Contact	Type	Beds	Phone	Region	Prov/Code	
HealthKard Hospital	104 Herrera St., Legaspi Village	Makati City	Dr. Gertrudes Axibal	T	24	810-5221	NCR	Metro Manila	12 29
Maria Lourdes Maternity Hospital	1076 Pasong Tamo	Makati City	Dr. Ben Hur S. Sales	S	20	895-3846 to 47	NCR	Metro Manila	12 31
Pagamutang Bayan ng Malabon	Maya-maya St. cor. Dagat-dagatan Ave.	Malabon	Dr. Isauro N. Garcia	P	18	285-2898	NCR	Metro Manila	14 70
A.P. Cruz Community Hospital	520 M.H. Del Pilar St., Santolan	Malabon	Dr. Leo Paul T. Balmeo	S	15	294-6352	NCR	Metro Manila	14 78
Franco Clinic	107 Letre Road, Tonsuya	Malabon	Dr. Serafin S. Franco	P	15	285-2853	NCR	Metro Manila	14 73
Divine Mercy Polyclinic Hospital	368 M. Santos cor. H. Javier, Santulan	Malabon	Dr. Ireneo A. Alfonso	P	6	23-9912	NCR	Metro Manila	14 78
National Center for Mental Health	Nueve de Pebrero St.	Mandaluyong City	Dr. Bernardino A. Vicente	T	4200	531-8578	NCR	Metro Manila	15 53
The Medical City General Hospital	San Miguel Avenue Ortigas, Ortigas Center	Mandaluyong City	Dr. Alfredo R.A. Bengson	T	409	631-8626	NCR	Metro Manila	15 01
Dr. Victor R. Potenciano Medical Center	163 EDSA	Mandaluyong City	Dr. Condrado Dayrit	T	170	531-4911	NCR	Metro Manila	15 54
Mandaluyong Medical Center	187 Boni Avenue	Mandaluyong City	Dr. Alfredo L. Lo	S	50	532-0480	NCR	Metro Manila	15 51
Unciano General Hospital	393 Boni Avenue	Mandaluyong City	Dr. Alberto M. Laigo	S	25	533-6565 to 66/63	NCR	Metro Manila	15 01
Philippine General Hospital	Taft Avenue, Ermita	Manila City	Dr. Juan V. Nanagas	T	1592	521-8450	NCR	Metro Manila	10 00
Dr. Jose Fabella Memorial Hospital	Lope de Vega St., Sta. Cruz	Manila City	Dr. Ruben C. Flores	T	700	734-5561	NCR	Metro Manila	10 03
Santo Tomas University Hospital	España Boulevard, Sampaloc	Manila City	Dr. Estrella P. Villar	T	700	731-3011	NCR	Metro Manila	10 08
Chinese General Hospital & Medical Center	286 Blumentritt St., Sta. Cruz	Manila City	Dr. Kasian Lim	T	600	711-4141 to 51/74	NCR	Metro Manila	10 03
San Lazaro Hospital	Quiricada St., Sta. Cruz	Manila City	Dr. Benito F. Arca	T	500	711-6979	NCR	Metro Manila	10 03
Dr. Jose R. Reyes Memorial Medical Center	Rizal Avenue, Sta. Cruz	Manila City	Dr. Ma. Alicia M. Lim	T	450	711-9491 to 98	NCR	Metro Manila	10 03
Manila Doctor's Hospital	667 U.N. Avenue, Ermita	Manila City	Dr. Dante D. Morales	T	300	524-3011	NCR	Metro Manila	10 00
Metropolitan Hospital	1357 Masangkay St., Tondo	Manila City	Dr. Chuang Chong Chian	T	300	255-0401	NCR	Metro Manila	10 12
Ospital ng Maynila Medical Center	Pres. Quirino Ave. Cor. Roxas Blvd., Malate	Manila City	Dr. Christia S. Padolina	T	300	524-6061	NCR	Metro Manila	10 04
Medical Center Manila	1125 Gen. Luna St., Ermita	Manila City	Dr. Napoleon M. Apolinario	T	250	528-81310 to 65	NCR	Metro Manila	10 00
Tondo Medical Center	Kalakal St., Balut, Tondo	Manila City	Dr. Victor J. Dela Cruz	T	250	251-8420 to 23/25	NCR	Metro Manila	10 12
Our Lady of Lourdes Hospital	46 P. Sanchez St., Sta. Mesa	Manila City	Dr. Florentino Gonzales, Jr.	T	200	716-3901 to 20	NCR	Metro Manila	
Gat Andres Bonifacio Memorial Medical Center	Delpan St., Tondo	Manila City	Dr. Ma. Dolores M. Luna	T	150	241-2643	NCR	Metro Manila	
Mary Chiles General Hospital	667 Gastambide St., Sampaloc	Manila City	Dr. Rolando A. Florendo	T	150	741-3941 to 45	NCR	Metro Manila	10 08
Mary Johnston Hospital	1221 Nolasco St., Tondo	Manila City	Dr. Myrna P. Velasquez	T	150	245-4021 to 25	NCR	Metro Manila	10 12
Hospital of the Infant Jesus	1556 Laong Laan St., Sampaloc	Manila City	Dr. Rolando S. Songco	T	140	731-2771	NCR	Metro Manila	10 08
De Ocampo Memorial Medical Center	2921 Nagtahan St., Sta. Mesa	Manila City	Dr. Antonio De Ocampo	T	100	715-1891	NCR	Metro Manila	
Galang Medical Center	1240 Batangas St., Sta. Cruz	Manila City	Dr. Melissa Galang	T	100	254-9459	NCR	Metro Manila	10 03
Seamen's Hospital	Cabildo cor. San Jose St., Intramuros	Manila City	Dr. Luis V. Vizcarra	T	100	527-3554	NCR	Metro Manila	10 02
St. Jude Hospital	Dimasalang cor. Don Quijote Sts., Sampaloc	Manila City	Dr. Ramon Atienza, Jr.	T	100	731-2761 to 65	NCR	Metro Manila	10 08

List of Hospitals in Metro Manila (continued)

HospName	Street/District	Mun/City	Contact	Type	Beds	Phone	Region	Prov/Code	
The Family Clinic, Inc., Hospital	1474 Ma. Clara St., Sta. Cruz	Manila City	Dr. Narciso G. Navarro, Sr.	T	100	731-2901 to 09/73	NCR	Metro Manila	
Perpetual Succor Hospital & Maternity, Inc.	836 Florentino Cayco St., Sampaloc	Manila City	Dr. Raymundo T. Macaraeg	S	65	731-1631 to 33	NCR	Metro Manila	10 08
Clinica Arellano General Hospital	1430 D. Jose St., Sta. Cruz	Manila City	Dr. Mercedez A. Villalobos	S	50	711-5631	NCR	Metro Manila	10 03
Emmanuel Community Hospital	2449 J. Abad Santos Avenue, Tondo	Manila City	Dr. Efren Francisco	S	50	21-04-08	NCR	Metro Manila	10 12
Ospital ng Sampaloc	Gen. Geronimo St. cor. Carola St., Sampaloc	Manila City	Dr. Erich R. Sison	S	50	749-0215	NCR	Metro Manila	10 08
Ospital ng Tondo	Jose Abad Santos Avenue, Tondo	Manila City	Dr. Remedios F. Timbol	S	50	252-3942	NCR	Metro Manila	10 12
Perpetual Help Hospital	1504 Laong Laan St., Sampaloc	Manila City	Dr. Teresita T. Salazar	T	50	731-8177	NCR	Metro Manila	10 08
St. Mary's General Hospital	1111 F. Huertas St., Sta. Cruz	Manila City	Dr. Antonio G. Clemente	S	50	711-9793	NCR	Metro Manila	10 03
Presidential Security Group Station Hospital	Malacañang Park	Manila City	Lt. Col. Benedicto S. Vitto, MC	T	35	521-2301	NCR	Metro Manila	10 05
Trinity Woman & Child Center	2732 New Panaderos St., Sta. Ana	Manila City	Dr. Edwin E. Dimayuga	S	25	564-1510 to 12	NCR	Metro Manila	
A.N. Ty Clinic	1401 San Marcelino St., Ermita	Manila City	Dr. Anita N. Ty	S	20	506-6961	NCR	Metro Manila	10 00
Santos Medical Clinic & General Hospital	2564 Mapua St., Tondo	Manila City	Dr. Libertad P. Santos	P	20	711-1961 to 63	NCR	Metro Manila	P
Vermont Maternity Clinic	931 J. Nakpil St., Malate	Manila City	Dr. Anastasia G. Macalinao	S	15	523-1852	NCR	Metro Manila	10 04
St. Rita Hospital	2407 T. Earnshaw St., Gagalangin, Tondo	Manila City	Dr. Ma. Claudia A. Marquez	P	10	251-4729	NCR	Metro Manila	10 12
Unciano General Hospital	V. Mapa St., Sta. Mesa	Manila City	Dr. Michael Unciano	S	10	716-7291 to 92	NCR	Metro Manila	
Amisola Maternity Hospital	1068 Hermosa, St., Manuguit, Tondo	Manila City	Dr. Narciso J. Ganac	P	25	252-3335	NCR	Metro Manila	10 13
Amang Rodriguez Medical Center	Sumulong Highway	Marikina City	Dr. Ricardo Gonzales	T	150	942-0245	NCR	Metro Manila	18 00
St. Vincent Hospital	35 Bayan-Bayanan St., Concepcion	Marikina City	Dr. Edgardo O. Deoduco	S	35	941-7320	NCR	Metro Manila	18 00
St. Victoria Hospital	444 J.P. Rizal St.	Marikina City	Dr. Adelaida S. Calderon	S	30	941-4081	NCR	Metro Manila	18 00
Sta. Monica Hospital	138 Boni Avenue, Tanong	Marikina City	Dr. Edgardo O. Deoduco	S	30	948-8402	NCR	Metro Manila	18 00
Immaculate Concepcion Hospital	Katipunan St.	Marikina City	Dr. Editha C. Zulueta	S	25	941-9362	NCR	Metro Manila	18 00
Garcia General Hospital	49 Bayan-Bayanan Ave. cor. T. Bugallon, Marikina Heights	Marikina City	Dr. Nestor C. Garcia	S	24	941-5511	NCR	Metro Manila	18 00
Hilario J. Lazaro Memorial Hospital	69 A. Bonifacio Avenue, Barangka	Marikina City	Dr. Sergio S. Ortega	S	20	941-1991	NCR	Metro Manila	18 00
Jose S. Santos Medical Clinic	136 Bonifacio St., Tanong	Marikina City	Dr. Leticia G. Santos	P	15	671-7365	NCR	Metro Manila	18 00
P. Gonzales Memorial Hospital, Inc.	45 F. Joset St., Concepcion	Marikina City	Dr. Gorgonia G. Zamora	P	15	941-3832	NCR	Metro Manila	18 00
San Ramon Hospital	38 Gen. Ordoñez St., Ranche 4	Marikina City	Dr. Gil M. Marasigan	P	9	941-8040	NCR	Metro Manila	18 00
New Bilibid Prisons Hospital	N.B.P. Reservation	Muntinlupa City	Dr. Ma. Luz E. Villanueva	T	500	842-2365	NCR	Metro Manila	17 02
MPI - Medical Center Muntinlupa	38 National Road, Putatan	Muntinlupa City	Dr. Rosalinda P. Deala	T	90	861-1687	NCR	Metro Manila	17 02
Research Institute for Tropical Med.	DOH Compound, Alabang	Muntinlupa City	Dr. Remigio M. Olveda	T	50	842-2828	NCR	Metro Manila	17 02

List of Hospitals in Metro Manila (continued)

HospName	Street/District	Mun/City	Contact	Type	Beds	Phone	Region	Prov/Code	
Hillside General Hospital	Alabang	Muntinlupa City	Dr. Gregorio M. Andaman, Jr.	S	40	842-3958	NCR	Metro Manila	17 02
Alabang Medical Clinic	297 Montillano St., Alabang	Muntinlupa City	Dr. Francisco M. Montillano	S	30	842-1639	NCR	Metro Manila	17 02
Muntinlupa Doctor's Clinic	1 National Road, Putatan	Muntinlupa City	Dr. Francisco E. Montillano	S	25	842-2718	NCR	Metro Manila	17 02
KMI Specialists Hospital	36 National Road	Muntinlupa City	Dr. Aquinas I. Paulino	S	24		NCR	Metro Manila	17 02
Alabang Medical Center	Alabang-Zapote Road	Muntinlupa City	Dr. Anita N. Ty	S	20	807-8189	NCR	Metro Manila	17 02
Babaran-Echavez Medical & Psychiatric Clinic	1125 Amparo Street, Poblacion	Muntinlupa City	Dr. Ma. Luisa A.B. Echavez	P	18	861-3066	NCR	Metro Manila	17 02
San Roque Medical Clinic	249 T. Montillano St., Alabang	Muntinlupa City	Dr. Estelita Santos	P	12	842-2950	NCR	Metro Manila	17 02
Beato Cauilan Maternity Hospital & Children's Clinic	Villa Carolina, National Highway	Muntinlupa City	Dr. Pacencia B. Cauilan	S	10	861-7741 to 45	NCR	Metro Manila	17 02
St. Joseph Maternity & Med. Clinic	855 Naval St.	Navotas	Dr. Celso C. Ramos	P	6	281-9091	NCR	Metro Manila	14 03
Medical Center Parañaque, Inc.	A. Santos Ave., Sucat Road	Parañaque	Dr. Humberto M. Villareal	T	95	825-6911 to 15/54	NCR	Metro Manila	17 00
Olivarez General Hospital	Dr. A. Santos Avenue, Sucat Road	Parañaque	Dr. Imelda O. Orteza	S	50	826-5035	NCR	Metro Manila	17 00
Parañaque Community Hospital	La Huerta, Quirino Avenue	Parañaque	Dr. Ricardo Salazar	S	50	826-3034	NCR	Metro Manila	17 00
South Superhighway Medical Center	West Service Road, Km. 17, South Superhighway	Parañaque	Dr. Jose C. Rabe	T	50	823-5250	NCR	Metro Manila	17 00
D.T. Protacio Medical Services, Inc.	484 Quirino Avenue, Tambo	Parañaque	Dr. Edgardo L. Protacio	S	30	832-2953	NCR	Metro Manila	17 00
Sta. Rita de Baclaran Hospital	97 G. Cruz St., Baclaran	Parañaque	Dr. Riorita Castor Lustestica	S	25	831-7005 to 06/83	NCR	Metro Manila	17 00
Pasay Parañaque Hospital	7 Taft Avenue, Baclaran	Parañaque	Dr. Juan F. Lim	S	22	831-9612	NCR	Metro Manila	17 00
Sto. Niño de Cebu Maternity Hospital	Sucat Road	Parañaque	Dr. Carmelita B. Sabitsana	P	6	827-9647	NCR	Metro Manila	17 00
San Juan de Dios Educational Foundation, Inc.	2772 Roxas Boulevard	Pasay City	Dr. Mirla M. Severino	T	230	831-6921	NCR	Metro Manila	13 00
Manila Sanitarium & Hospital & School of Medical Arts	1975 Donada St.	Pasay City	Dr. Bibly L. Macaya	T	150	525-9191	NCR	Metro Manila	13 00
Pasay City General Hospital	P. Burgos St.	Pasay City	Dr. Oscar C. Linao	S	100	833-6022	NCR	Metro Manila	13 00
Philippine Air Force General Hospital	Villamor Air Base	Pasay City	Col. Raul C. Sanchez	T	100	832-1007	NCR	Metro Manila	13 00
Miraculous Medical Hospital	2017 F.B. Harrison St.	Pasay City	Dr. Merian N. Uy	S	15	831-6922	NCR	Metro Manila	13 00
Sto. Niño Hospital	2197 Luna St., Cartimar	Pasay City	Dr. Mauro C. Luciano, Sr.	P	15		NCR	Metro Manila	13 00
Mira Mar Hospital	F.B. Harrison St.	Pasay City	Dr. Lolita M. Inocencio	P	6	831-6922	NCR	Metro Manila	13 00
Castillo Interhospital Specialist	2205 U/V Ground Floor, Aurora Bldg. Cor. EDSA	Pasay City	Dr. Bobby W. De G Castillo	P	3	833-8198	NCR	Metro Manila	13 00
Rizal Medical Center	Shaw Boulevard	Pasig City	Dr. Romeo M. Cruz	T	300	671-4216	NCR	Metro Manila	16 00
Pasig City General Hospital	F. Legaspi St., Maybunga	Pasig City	Dr. Anthony A. Marquez	T	100	642-7379	NCR	Metro Manila	16 00
Sto. Niño de San Antonio Maternity & General Hospital	Marcos Highway, de la Paz	Pasig City	Dr. Erlinda S. Estanislao	S	80	645-3060	NCR	Metro Manila	16 00
Optimum General Hospital	10 Gen. Araneta St., San Antonio Village	Pasig City	Dr. Eleanor M. Santiago	T	50	631-3925 to 26	NCR	Metro Manila	16 00

List of Hospitals in Metro Manila (continued)

HospName	Street/District	Mun/City	Contact	Type	Beds	Phone	Region	Prov/Code	
John F. Cotton Hospital	Meralco Center, Ortigas Avenue	Pasig City	Dr. Fidencio C. Sanchez	T	40	632-5558	NCR	Metro Manila	1600
Mission Hospital	Km. 17 Ortigas Ave. Ext., Rosario	Pasig City	Dr. Purisima A. Barbosa	S	32	656-7906	NCR	Metro Manila	1600
Mary Immaculate Hospital	E. Rodriguez Avenue	Pasig City	Dr. Ma. Concepcion C. Vesagas	S	30	671-3928	NCR	Metro Manila	1600
Javillonar Clinic & Hospital	73 Dr. Pilapil St., Sagad	Pasig City	Dr. Edgardo Javillonar	S	25	641-2023	NCR	Metro Manila	1600
Mary Infant General Hospital	49 A. Luna St., Bambang	Pasig City	Dr. Mariano Vizconde	P	25	641-6622	NCR	Metro Manila	1600
Mother Regina Hospital	2 Ruby St., Doña Juana Subd., Rosario	Pasig City	Dr. Purisima A. Barbosa	S	20		NCR	Metro Manila	1600
St. Therese Hospital	C. Raymundo Ave., Maybunga	Pasig City	Dr. Ma. Rowena C. Eusebio	P	19	643-7510	NCR	Metro Manila	1600
Sabater General Hospital	Caruncho Avenue	Pasig City	Dr. Rodolfo I. Sabater	S	15	641-8194	NCR	Metro Manila	1600
Our Blessed Mother Maternity & Children's Clinic	3 Gen. Roxas Antonio Village	Pasig City	Dr. Bonifacio R. Torres	P	8	673-3789	NCR	Metro Manila	1600
Pasig Medical & Maternity Hospital Foundation, Inc.	101 London St., Pasig Greenpark Village, Santolan	Pasig City	Dr. Estradella O. Ermita	P	6	927-0962	NCR	Metro Manila	1600
AFP Medical Center	V. Luna Road	Quezon City	Col. Patemo L. Palangdao	T	1300	921-1753	NCR	Metro Manila	1100
Veterans Memorial Medical Center	North Avenue	Quezon City	Dr. Salvador Flores	T	766	927-6426	NCR	Metro Manila	
Philippine Orthopedic Center	M. Clara St. cor. Banawe St.	Quezon City	Dr. Jesus D. Duenas	T	700	712-4601	NCR	Metro Manila	
St. Luke's Medical Center	279 E. Rodriguez Sr. Boulevard	Quezon City	Mr. Jose Ledesma	T	673	723-0101	NCR	Metro Manila	
East Avenue Medical Center	East Avenue, Diliman	Quezon City	Dr. Nenita Fernandez	T	350	927-9900	NCR	Metro Manila	
U.E.R.M. Memorial Medical Center	Aurora Boulevard, Sta. Mesa	Quezon City	Dr. Vicente V. Tanseco, Jr.	T	307	716-1853	NCR	Metro Manila	
FEU - Dr. Nicanor Reyes Medical Foundation	Regalado Ave., West Fairview	Quezon City	Dr. Lilia P. Luna	T	300	427-0213	NCR	Metro Manila	
Lung Center of the Philippines	Quezon Ave. Ext.	Quezon City	Dr. Fernando A. Melendrez	T	286	924-6101 to 19	NCR	Metro Manila	
Philippine Heart Center	East Avenue, Diliman	Quezon City	Dr. Ludgerio D. Torres	T	283	925-2401 to 50	NCR	Metro Manila	
Quezon City Medical Center	960 Aurora Boulevard	Quezon City	Dr. Carlos P. Crisostomo	T	276	913-8391	NCR	Metro Manila	
National Children's Hospital	264 E. Rodriguez Blvd.	Quezon City	Dr. Ma. Isabelita V. Gozon	T	250	724-0656	NCR	Metro Manila	
Quezon City General Hospital	Seminary Road	Quezon City	Dr. Marina Y. Bringas	T	250	929-7224	NCR	Metro Manila	
Fairview Polymedic Hospital	1041 Quirino Hwy, Sta. Monica, Novalichez,	Quezon City	Dr. Hermogenes D. Jarin	S	15	939-8764	NCR	Metro Manila	
Capitol Medical Center	Sct. Magbanua cor. Panay Avenue	Quezon City	Dr. Thelma N. Clemente	T	200	372-3825 to 44	NCR	Metro Manila	
National Kidney & Transplant Institute	East Avenue, Diliman	Quezon City	Dr. Filoteo Alano	T	200	924-3601 to 19	NCR	Metro Manila	
Philippine Children's Medical Center	Quezon Avenue	Quezon City	Dr. Lilian V. Lee	T	200	924-6601 to 25	NCR	Metro Manila	
Quezon Institute	E. Rodriguez Sr. Blvd.	Quezon City	Dr. Ernesto Molina	T	200	781-3761 to 65	NCR	Metro Manila	
Quirino Memorial Medical Center	Katipunan, Quirino Road, Proj. 4	Quezon City	Dr. Domingo L. De Guzman, Jr.	T	200	723-7724	NCR	Metro Manila	
United Doctor's Medical Center	290 España cor. 6th N. Ramirez St.	Quezon City	Dr. Delfin Tan	T	160	712-3640 to 49	NCR	Metro Manila	
Delos Santos Medical Center	201 E. Rodriguez Boulevard	Quezon City	Dr. Efren V. Delos Santos	T	150	723-0041 to 45/72	NCR	Metro Manila	
PNP General Hospital	EDSA, Camp Crame	Quezon City	Col. Adolfo S. Avenido	T	150	722-6850	NCR	Metro Manila	

List of Hospitals in Metro Manila (continued)

HospName	Street/District	Mun/City	Contact	Type	Beds	Phone	Region	Prov/Code	
Children's Medical Center Philippines, Inc.	11 Banawe St.	Quezon City	Dr. Melinda Atienza	T	113	712-0845	NCR	Metro Manila	
Casaul General Hospital	16 Tandang Sora Ave., Sangandaan, Novaliches	Quezon City	Dr. Romeo B. Casaul	T	85	938-7789	NCR	Metro Manila	
J.P. Sioson General Hospital & Colleges, Inc.	75 Bukidnon St., Bago Bantay	Quezon City	Dr. Juanito P. Sioson	S	80	927-1339	NCR	Metro Manila	
Dr. Jesus C. Delgado Memorial Hospital	7 Kamuning Road	Quezon City	Ms. Ma. Violeta D. Cojuangco	T	75	924-4051 to 61	NCR	Metro Manila	
Sta. Teresita General Hospital	100 D. Tuazon St.	Quezon City	Dr. Raymond Ramirez	T	65	731-9803	NCR	Metro Manila	
Sta. Lucia General Hospital Corporation	797 Quirino Highway, Sta. Monica, Novaliches	Quezon City	Dr. Feliciano P. Legaspi	T	60	418-5593	NCR	Metro Manila	
PNP General Hospital Annex	Camp Panopio, P. Tuazon	Quezon City	Supt. Renato J. Dela Cruz	S	50	723-6730	NCR	Metro Manila	
Q.C. St. Agnes General Hospital	241 Roosvelt Avenue	Quezon City	Dr. Marianito Abagon	T	50	374-2769	NCR	Metro Manila	
U.P. Health Service	U.P. Campus, Diliman	Quezon City	Dr. Marcia E. Macalinao	P	50	928-3608	NCR	Metro Manila	
Novaliches General Hospital	793 Quirino Highway, Novaliches	Quezon City	Dr. Francisco Tan, Jr.	S	45	936-1817	NCR	Metro Manila	
Bernardino General Hospital	680 Quirino Highway, San Bartolome, Novaliches	Quezon City	Dr. Emmanuel Dela Cruz	S	41	936-6050	NCR	Metro Manila	
F.Y. Manalo Medical Foundation	Don Mariano Marcos cor. Tandang Sora, Diliman	Quezon City	Dr. Jesse C. Baylon	S	40	924-4311	NCR	Metro Manila	
San Lorenzo General Hospital	Quirino Highway, Pasong Putik, Novaliches	Quezon City	Dr. Eduardo S. Noveloso	S	35	930-7054	NCR	Metro Manila	
St. Louis Medical Clinic & Hospital	Marianito St., San Bartolome, Novaliches	Quezon City	Dr. Matilde Legaspi	S	35	936-1243	NCR	Metro Manila	
Fairview General Hospital	Lot 20 Fairview Ave., cor. Mercury St., Brgy. Fairview, Capitol District	Quezon City	Dr. Hermogenes D. Jarin	S	30	939-9689	NCR	Metro Manila	
Pascual General Hospital	130 Baesa, Novaliches	Quezon City	Dr. Mariano F. Pascual	S	30	364-4973	NCR	Metro Manila	
Casaul General Hospital, Inc.	L5 Blk 11, Sacred Heart Village, Lagro	Quezon City	Dr. Romeo B. Casaul	S	28	930-1190	NCR	Metro Manila	
Bernardino General Hospital II Corporation	North Olympus, Zabarte, Novaliches	Quezon City	Dr. Raul C. Sanchez	P	25	418-6711	NCR	Metro Manila	
Camp General Emilio Aguinaldo Station Hospital	Camp Gen. Emilio Aguinaldo	Quezon City	Col. Renato P. Ty	S	25	911-6001	NCR	Metro Manila	
Mt. Banawe General Hospital	448 Quezon Boulevard	Quezon City	Dr. Edgardo C. Santos	S	25	721-3476	NCR	Metro Manila	
Villarosa Hospital	11 Salalilla, Proj. 4	Quezon City	Dr. Romualdo R. Villarosa	S	24	913-9713	NCR	Metro Manila	
Bonifacio Medical, Dental & Optical Clinic	225 Roosvelt Avenue	Quezon City	Dr. Consorcia C. Bonifacio	S	20	95-11-23	NCR	Metro Manila	
Gen. Miguel Malvar Medical Foundation	531 Commonwealth Avenue	Quezon City	Dr. Potenciano R. Malvar	S	20	932-7267	NCR	Metro Manila	
Dr. Montano Ramos Hospital	46 Bukidnon St., Bago Bantay	Quezon City	Dr. Montano G. Ramos	P	17	927-6628	NCR	Metro Manila	
Neopolitan General Hospital	Lagro, Novaliches	Quezon City	Dr. Orlando Cabahug	P	12	936-4575 to 76	NCR	Metro Manila	
OCW General Hospital	39 Tandang Sora Avenue, Brgy. Culiat	Quezon City	Dr. Roger A. Ramones	S	10	931-3529	NCR	Metro Manila	

List of Hospitals in Metro Manila (continued)

HospName	Street/District	Mun/City	Contact	Type	Beds	Phone	Region	Prov/Code	
Cruz-Dalida Maternity Hospital	1025 F. Salvador, Jordan Pains, Novaliches	Quezon City	Dr. Rosario Cruz-Dalida	P	8	417-4080	NCR	Metro Manila	
Valdez-Padron Hospital	12 Marianito St., Galud, Novaliches	Quezon City	Dr. Cherry V. Padron	P	7	419-9339	NCR	Metro Manila	
Ann-Francis Maternity Hospital	606 Quirino Highway, Novaliches	Quezon City	Dr. Rommel Felix	P	6	938-9424	NCR	Metro Manila	
San Juan Medical Center	N. Domingo St.	San Juan	Dr. Lorenzo M. Hocson	S	150	724-3266	NCR	Metro Manila	1500
St. Martin de Porres Charity Hospital	70 A. Bonifacio St.	San Juan	Dr. Soledad C. Cortez, OP	T	100	723-0741 to 43	NCR	Metro Manila	1500
Cardinal Santos Medical Center	Wilson St., Greenhills	San Juan	Dr. Charles C. Chante	T	245	727-0001 to 17	NCR	Metro Manila	1500
Taguig-Pateros District Hospital	East Service Road, Western Bicutan	Taguig	Dr. Eleazar B. Lim	P	48	837-8132	NCR	Metro Manila	
Dr. Sabili General Hospital & Health Services	313 Gen. Santos Avenue, Lower Bicutan	Taguig	Dr. Jose A. Sabili	S	20	837-0917	NCR	Metro Manila	1604
Cruz-Rabe General Hospital	Tuktukan, Taguig	Taguig	Dr. Jose Cruz-Rabe	S	50	642-0747	NCR	Metro Manila	1604
Holy Mary Family Hospital	461 Bagumbayan	Taguig	Dr. Narciso G. Osorio, Sr.	P	11		NCR	Metro Manila	1604
Taguig Doctor's Hospital	184 Bagumbayan	Taguig	Dr. Mario T. Aquino	P	8	822-0178	NCR	Metro Manila	1604
Fatima Medical Center, Inc.	120 McArthur Highway	Valenzuela City	Dr. Vicente M. Santos	T	250	361-5995	NCR	Metro Manila	1405
Valenzuela General Hospital	Polo, Poblacion	Valenzuela City	Dr. Winston S. Go	S	100	293-2936	NCR	Metro Manila	1405
Calalang General Hospital	16 R. Valenzuela St.	Valenzuela City	Dr. Fidel R. Calalang	S	35	361-5136	NCR	Metro Manila	1405
F.M. Cruz Orthopedic & General Hospital	Prudencia Subdivision, Marulas	Valenzuela City	Dr. Frederico M. Cruz	S	15		NCR	Metro Manila	1405
M.V. Romano Hospital	Balubaran, Malinta	Valenzuela City	Dr. Ma. Vida M. Romano	P	15	432-4145	NCR	Metro Manila	1405
Sanctissimo Rosario General Hospital	2 Espiritu St., Marulas	Valenzuela City	Dr. Elpidio B. Serapio	S	15	291-7011	NCR	Metro Manila	1405
St. John's Hospital	323 Malinta	Valenzuela City	Dr. Amelia Ll. Gonzales	P	15	292-0473	NCR	Metro Manila	1405
Carloz Clinic	257 Palasan St.	Valenzuela City	Mr. Leopoldo A. Carlos	P	10	292-2623	NCR	Metro Manila	1405
Pasolo Maternity & Med. Center, Inc.	87 Pasolo St.	Valenzuela City	Dr. Roel A. Santiago	P	7	292-2753	NCR	Metro Manila	1405
F & P Hernandez Maternity & Lying-In Hospital	17 <cArthur Highway, Marulas	Valenzuela City	Dr. Florante S.J. Hernandez	P	6	293-5453	NCR	Metro Manila	1405

Sources: Philippine Hospital Association, September 2001;
Allen Engineering & Sciences, *Technical Assistance for Biomedical Waste Treatment and Disposal*, TDA Activity No. 2001-30075B, Prepared for US Trade and Development Agency, May 2002.

Characterization of Medical Waste

1 Background

A waste characterization survey was conducted by the project team from 18 to 22 November 2002, at the East Avenue Medical Centre (EAMC) in Quezon City, Metropolitan Manila. The EAMC is a public hospital owned and operated by the national government under the direct supervision of the Department of Health (DOH). The EAMC provides a variety of services to its patients and has a total capacity of about 600 beds. The study was carried out in close coordination with the EAMC's staff.

2 Objectives

The key objectives of the survey were:

- to determine the physical composition of non-infectious (black bag) dry wastes; and
- to determine the quantity and density of the various types of wastes generated by the hospital.

3 Methodology

The following information was obtained or determined during the survey:

- quantity of the wastes produced;
- bulk density of the various types of wastes; and
- physical composition of the non-infectious wastes.

A general description of the procedures used for determining the various parameters is presented in the following sections.

A training program was conducted for the sorters prior to initiating the waste characterization study. Safety precautions were emphasized and were based on the safety and health guidelines in the procedures for the waste characterization studies for the municipal waste. The sorters were outfitted with gloves, uniforms, and masks and cautioned about the possible presence of hazardous materials, in particular sharps. The sorters were also required to advise the supervisors and Consultants about the possible presence of body fluids, blood bags, or similar materials.

3.1 Quantity and Composition

Solid waste was collected from four different sources at the EAMC, namely:

- Out-patient Department (OPD);
- Emergency Room (ER);
- General Wards (WARD); and
- Intensive Care Unit (PICU).

Random sampling of waste generated by the various sources was undertaken to meet the required sample size. The sampling was conducted over a five-day period, during which samples were collected from the four different sources and labeled. The wastes were categorized into two main groups: a) infectious, and b) non-infectious.

The infectious wastes were collected from all of the departments and transported to the medical centre's processing station, where they were weighed. The weights were used to determine the bulk density. The bulk density was measured by weighing the uncompacted wastes in the collection containers (approximately 120 litres in capacity). After weighing, the infectious wastes were stored for their eventual removal by a private contractor.

The non-infectious wastes were also transported to the medical centre's processing station, where they were subsequently segregated and analyzed according to procedures consistent with those of ASTM D5231 Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste. The occupational safety and health guidelines followed are those that were developed for the waste analysis and characterization studies of municipal solid waste, which are presented in the *Waste Analysis and Characterization Study* report. Upon arrival at the processing station, the wastes were weighed, and the weights were recorded. After weighing, the material was unloaded onto a platform, where half of the load was selected for segregation. The sample was then transported to a sorting area, where it was separated into the following categories:

- Garden/Yard wastes
- Food/Vegetables
- Paper/Cardboard
- Rubber/Leather
- Glass
- Metal/Cans
- Wood
- Plastics
- Diapers
- Textiles
- Inerts (rocks, ash)
- Special wastes (batteries, syringes)

The components of the wastes were placed either in plastic containers or bags and weighed, and the weights were recorded. The information for each sample was recorded on a data sheet. A copy of the data collection form is presented in Annex 2a.

3.2 Bulk Density

The bulk densities of the major types of wastes (non-infectious and infectious) were determined by loosely placing them either in a plastic container or a wooden box of known volume. The container and its contents were then weighed and the total weight recorded. The bulk density of the contents was calculated by first determining the net weight of the sample and dividing the net weight by the volume of the container.

A summary of the basic data collected during the survey is included in Annex 2b.

4 Findings

4.1 Quantity

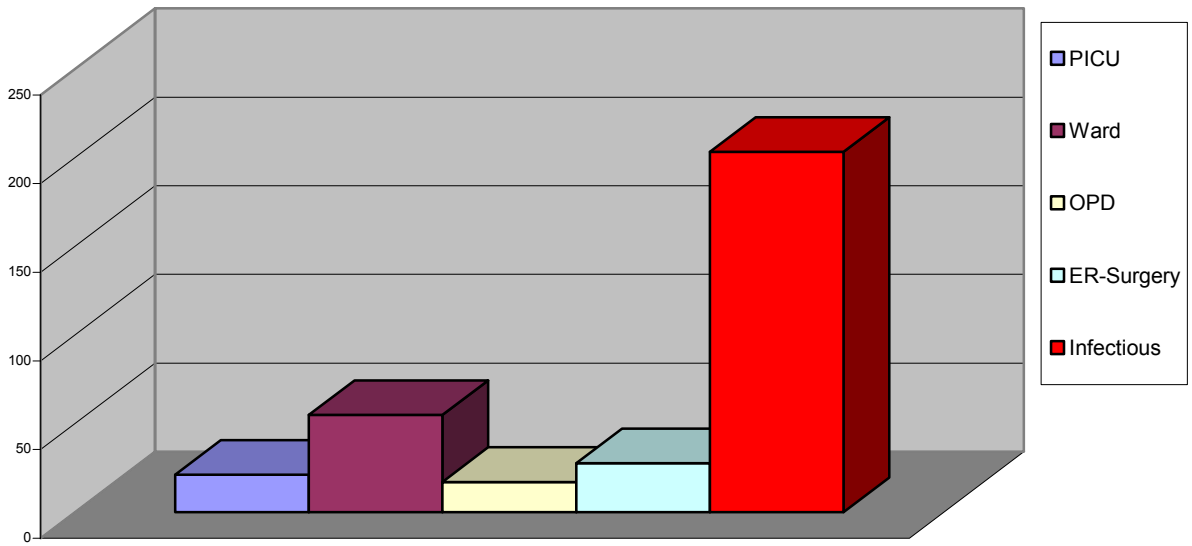
The results of the study to determine the quantity of solid waste generated at the EAMC are given in Table 1. The results are also illustrated in graphical form in Figure 1. As shown in the data in Table 1, the total amount of waste generated during the survey was approximately 1,602 kg. The total amount of infectious waste was 1,016 kg, and the amount of non–infectious waste generated during the same time period was 586 kg. Based on an average occupancy of 600 beds per day, the average unit rate of total waste generation at the health care facility was 0.53 kg per bed-day. Using the same basis, the average unit rate of generation of infectious waste was equivalent to 0.34 kg/bed-day and that of non-infectious waste was 0.19 kg/bed-day.

Table 1. Average Medical Waste Generation at EAMC (kg)

Source of Waste	Day 1	Day 2	Day 3	Day 4	Day 5	Total (kg)	Average (kg/day)
Infectious							
Total Weight	257	219	180	205	155	1016	203
Non-infectious							
PICU	21	25	17	33	10	106	21
Ward	73	75	70	34	22	274	55
OPD	N/A	9.2	20.1	16	23	68.3	17
ER-Surgery	29	32	30	27	20	138	28
Total Weight	123	141.2	137.1	110	75	586.3	117
Grand Totals	380	360.2	317.1	315	230	1602.3	320
No. of beds	600	600	600	600	600		600
Waste Generation (kg/bed)							
Infectious	0.43	0.37	0.30	0.34	0.26		0.34
Totals	0.63	0.60	0.53	0.53	0.38		0.53

The rate of generation of infectious waste (about 203 kg/day) was about twice that of non-infectious waste (117 kg/day), as reflected by the data in Table 1. Among the non-infectious sources of waste, the largest rate of generation was found for the general wards (Ward). The Ward generation rate was 55 kg/day, which was two to three times that of the other three sources of non-infectious waste. As will be seen later in the report (i.e., in Section 4.5), food waste, paper, plastic, and diapers are the primary contributors to the wastes generated among the wards. Therefore, the rates of generation of these four waste components in the case of ward waste are substantially greater than those of the other three sources.

Figure 1. Average Rate of Generation of Medical Waste (kg/day)



4.2 Density

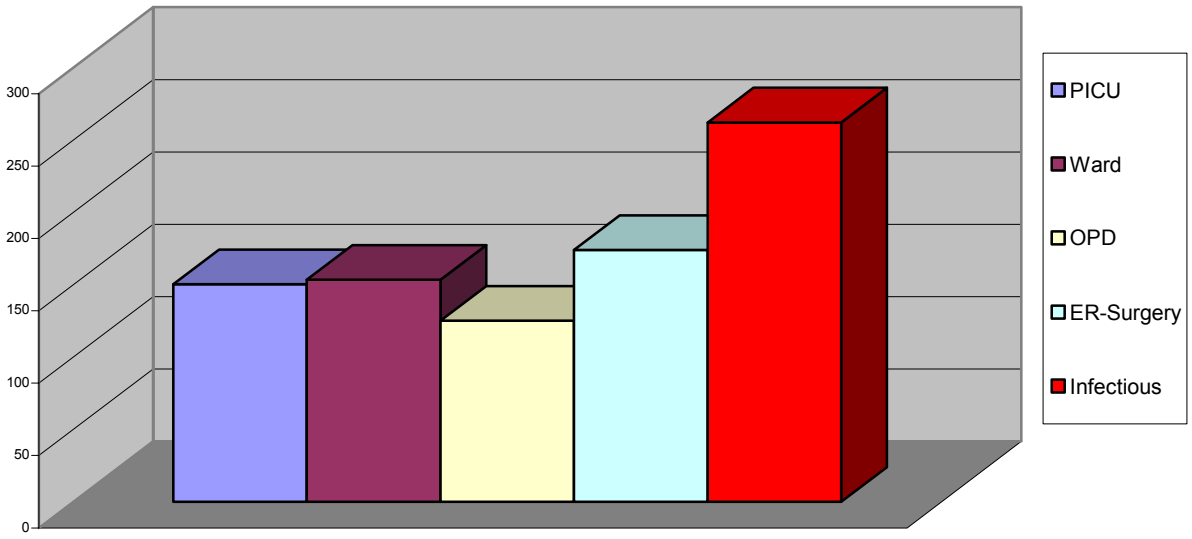
The average densities of the waste samples from the various departments are presented in Table 2, along with the results of the daily samples that were analyzed. The average bulk density of infectious waste (262 kg/m^3) was found to be substantially greater than that of the average of non-infectious waste samples (i.e., 151 kg/m^3). Also, the range of daily bulk density results obtained for infectious waste indicates that the variability in bulk density for this waste type generated by the health care facility is relatively small (on the order of +/- 20 to 30 kg/m^3, compared to the average of 262 kg/m^3). On the other hand, for example, the variations in the bulk densities for the other three types of waste are relatively large. For example, in the case of PICU waste, the range was found to be 91 to 253 kg/day over the 5–day sampling period, compared to the 5-day average of 150 kg/day.

A comparison of the bulk densities of medical wastes among all of the various sources investigated in the study is shown graphically in Figure 2.

Table 2. Bulk Density of Medical Wastes (kg/m^3)

Source of Waste	Day 1	Day 2	Day 3	Day 4	Day 5	Average
Non-Infectious						
PICU	101	181	126	253	91	150
Ward	256	110	104	96	202	154
OPD		129	160	78	134	125
ER-Surgery	230	201	206	105	129	174
Average						151
Infectious						
Combined	284	285	243	271	228	262

Figure 2. Average Bulk Density of Medical Waste (kg/ cu m)



4.3 Composition

The average percentage composition of non-infectious waste is presented in Table 3.

Table 3. Composition of Non-Infectious Medical Waste Generated at EAMC (% wet wt.)

Component	PICU	Ward	OPD	ER-Surgery	Totals
Garden/Yard Wastes	0.11%	0.01%	0.00%	0.02%	0.0%
Food/Vegetables	29.98%	30.86%	26.43%	28.79%	29.0%
Paper/Cardboard	14.11%	16.65%	10.75%	17.48%	14.7%
Rubber/Leather	0.93%	0.85%	4.40%	7.09%	3.3%
Glass	2.68%	2.41%	2.96%	3.37%	2.9%
Metal/Cans	1.02%	1.90%	1.39%	2.09%	1.6%
Wood	2.33%	0.25%	2.48%	1.19%	1.6%
Plastics	29.94%	24.10%	13.94%	27.48%	23.9%
Diapers	9.23%	16.47%	7.71%	0.00%	8.4%
Textiles	4.55%	4.74%	15.00%	10.23%	8.6%
Inerts (rocks, ash)	4.80%	0.27%	10.52%	1.45%	4.3%
Special waste (batteries, syringes)	0.33%	1.49%	4.43%	0.79%	1.8%
Totals	100.00%	100.00%	100.00%	100.00%	100.00%

Graphical depictions of the composition of PICU, Ward, ORD, and ER-Surgery wastes are shown in Figures 3 through 6, respectively.

Figure 3. Average Composition of PICU Waste

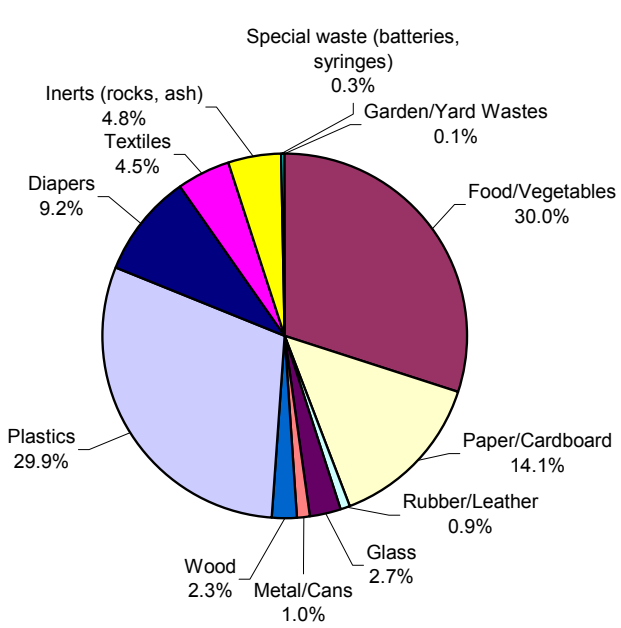


Figure 4. Average Composition of Ward Waste

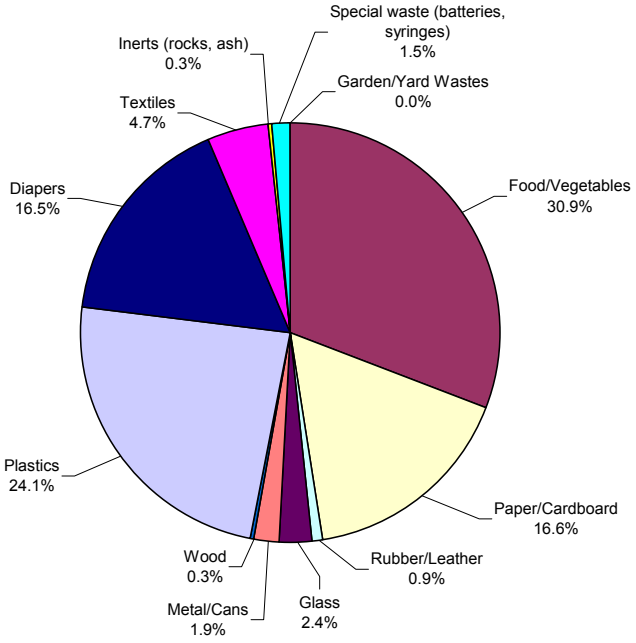


Figure 5. Average Composition of OPD Waste

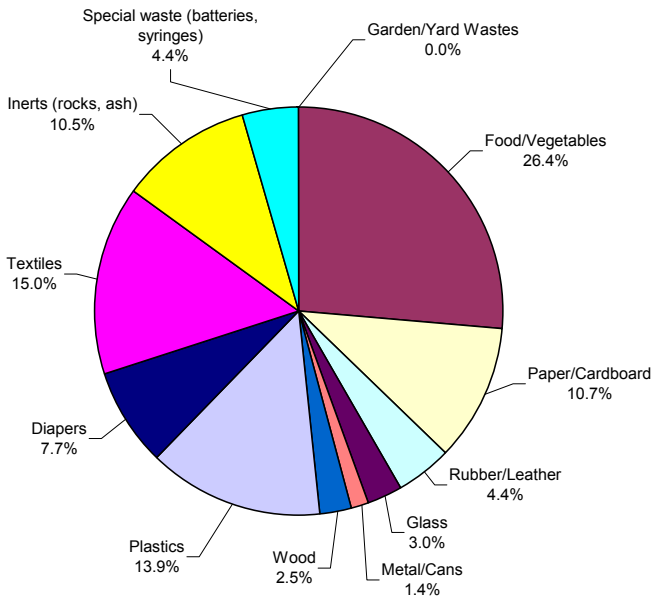
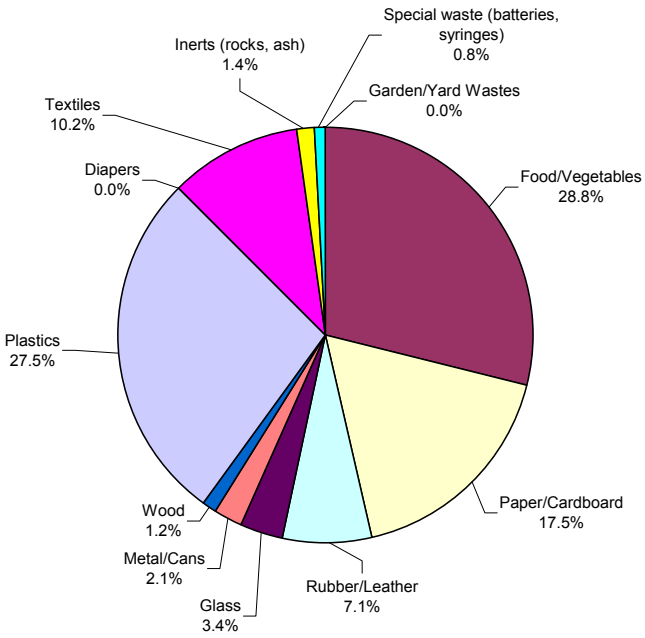


Figure 6. Average Composition of ER-Surgery Waste



The results of this analysis show that based on the physical composition, all waste sources produced wastes that had a relatively high concentration of food and vegetables. PICU waste had a food and vegetable concentration of almost 30%; that generated by the Ward category of waste sources had a similarly high concentration (about 30.1%). OPD waste exhibited a concentration of 26.4% for food and vegetables, and ER-Surgery showed a concentration of 28.8% for the same components. The average concentration of food and vegetable wastes was 29.0%.

All four sources of waste produced similar concentrations of paper/cardboard and plastics. The average concentrations of plastics and of paper and cardboard were found to be about 23.9% and 14.7%, respectively. As expected, PICU, Ward, and OPD generated a relatively high concentration of disposable diapers, namely 9.2%, 16.5%, and 7.7%, respectively. The waste from the ER-Surgery department did not contain disposable diapers. The waste generated by the ER-Surgery department had the highest concentration of rubber/leather (about 7.1%).

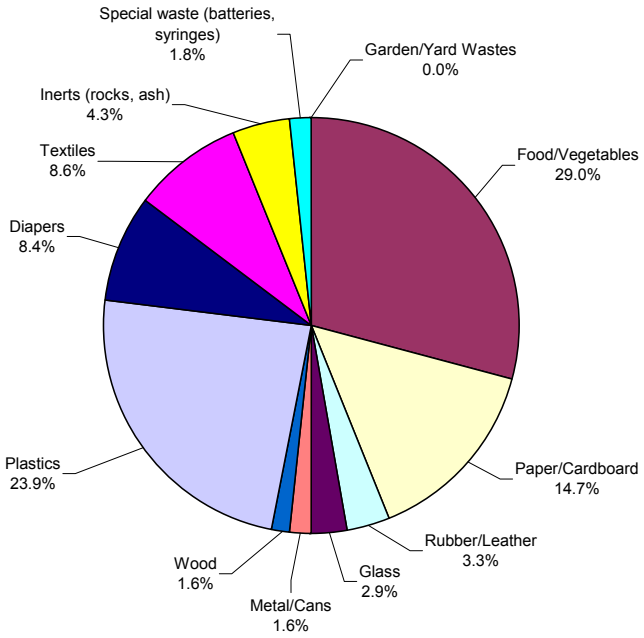
The results of the survey also indicate that a small, but significant, concentration of batteries, needles, and syringes (about 1.8%) was found in the waste stream.

Additionally, the simple average composition of the non-infectious waste stream is shown in pie chart form in Figure 7.

5 Acknowledgements

The Consultants would like to thank the staff of the EAMC for their cooperation throughout the study. In particular, the Consultants would like to express their gratitude to Mrs. Imelda Cruz.

Figure 7. Average Composition of Non-Infectious Medical Waste (Simple Average)



Annex 2a. Sample Data Collection Form

Sample No. :		**Date:**	**Surveyor :**
Name of Institution:		**Type of Institution:**	
Person in charge of solid waste:		**Area/Department:**	

CATEGORY	Gross Weight	Container (Tare)	CATEGORY	Gross Weight	Container (Tare)
Paper			**Other Organics**		
Corrugated / cardboard / kraft paper bags			Food/Vegetables		
Newspapers			Garden/Yard Wastes		
Office paper			Wood		
Mixed paper			Textiles / gauze / dressings		
Disposable gowns/masks			Rubber (gloves, other), leather		
Glass			Disposable diapers		
Bottles and containers (clear glass)			Tissue/ body parts		
Bottles and containers (color glass)			Other composite		
Green			Diapers		
Amber					
Blue			**Other Inorganics**		
Flat glass			Inert materials		
Misc. broken glass			Medicines (solid residue)		
			Medicines (expired)		
Other composite			Stones		
Metals			Bulky items		
Ferrous metals			Plaster		
Cans			Soil / fines		
Other ferrous metals					
Non-ferrous metals					
Aluminum cans			**Hazardous Materials**		
Other non-ferrous metals			Cytotoxic drugs		
Electronic products			Radioactive materials		
Sharps (needles)			Solvents		
Sharps (blades)			Batteries/Syringes		
Sharps (other)			Insecticides/pesticides		
Other composite			Others (i.e., paint)		
Plastics			**Special Wastes (e.g., ash, other)**		
PET			Ash		
HDPE			**Comments:** (continue on the other side if necessary)		
LDPE/Film plastic					
PVC					
Tygon tubing					
X-ray film					
Other composite					

Annex 2b. Basic Data

Summary Table: Medical Waste Characterization (in kg)

Particular	Nov. 18	Nov. 19	Nov. 20	Nov. 21	Nov. 22
1. Infectious	2	21	180	205	
Sample	29	20[b]	[b]	19[b]	1
Density (kg/m^3)	284	28	243	271	228
2. Non-Infectious					
Total Weight					
a. ER-Surgery	29	32	30	27	20
b. OPD	--	9.	20.1	16	23
Ward	73	75	70	34	22
d. PICU	21	25	17	33	10
ht of Samples					
a. ER	16.11[b]	14.05	14.45	25.08[c]	9.04[b]
	230	20	206	105	129
b. OPD	--	7.7	9.58[d]	4.65[e]	8.02[e]
Density (kg/m^3)		129	160	78	134
c. Ward	17.90[b]	51.8 [f]	49.09[f]	23.0[c]	12.12[b]
Density (kg/m^3)	256	11	104	96	202
d. PICU	6.08[e]	10.89	7.57[e]	15.18[e]	5.44[e]
Density (kg/m^3)	101	181	126	253	91

[a] Volume of bin = 0.85 m x 0.346 m x 0.346 m = 0.102 m^3
[b] Volume of plastic drum = лD^2/4 x H = 3.14 x 0.41^2/4 x 0.56 = 0.07 m^3
[c] Volume of wooden box, half-filled = 0.95 m x 0.99 m x 0.99 m x 0.25 m = 0.24 m^3
[d] Volume of plastic bin, ¾ filled = – лD^2/4 x H = 3.14 x 0.41^2/4 x 0.46 = 0.06 m^3
[e] Volume of plastic bin 0.9 cm less in height = – лD^2/4 x H = 3.14 x 0.41^2/4 x 0.47 = 0.06 m^3
[f] Volume box = 0.95 m x .99 m x 0.5 m = 0.47 m^3

Annex 3

Survey Forms for Assessment of Current Practices at Health Care Facilities

Annex 3a. Survey Form for Hospitals, Clinics, and Minor Health Care Facilities

Survey of Waste Management Practices in Health Care Facilities

(ADB TA 3848 PHI)

Respondent Name .....
Designation .....
Name of Hospital/Establishment .....
Address for Correspondence .....
.....
.....
Telephone: .....
Fax: .....

General Information

TYPE OF ESTABLISHMENT

General hospital .....
District hospital .....
Health centre (government) .....
Public institution .....
University/teaching hospital .....
Private hospital .....
Government clinic .....
Private clinic .....
Other (specify) .....

INDICATE NUMBER OF MEDICAL PRACTITIONERS, PROFESSIONAL STAFF, NURSING STAFF, TECHNICAL SUPPORT STAFF, AND ANCILLARY STAFF

Discipline	No. of Staff
Medical officers	.....
Dental officers	.....
Consultant physicians	.....
Medical specialists (surgeons)	.....
Professional staff (e.g., pharmacists, nutritionists, research staff)	.....
Nursing staff	.....
Technical staff	.....
Ancillary staff	.....
Other (specify)	.....
Total staff:	.....

INDICATE WHICH OF THE FOLLOWING IN-PATIENT SPECIALIZED DEPARTMENTS ARE INCLUDED IN YOUR FACILITY

Discipline	Yes	No
General medicine		
Surgery		
Intensive Care Unit (ICU)		
Coronary Care Unit (CCU)		
Obstetrics		
Gynaecology		
Paediatrics		
Orthopaedics		
Cardiology		
Thoracic/TB clinic		
Urology and nephrology		
Ophthalmology		
Radiology		
Oncology		
Pathology		
Dermatology		
Plastic surgery		
Dental		
Psychiatry		
Other (specify)		

NUMBER OF IN-PATIENTS AND OUT-PATIENTS
Total number of in-patients

Wards/Departments	**Total No. of Beds Allocated**	**Ave. No. of Beds Occupied Daily**
Medical Ward – including general medicine, cardiology (and Coronary Care Unit (CCU)), nephrology, chest, neurology, rheumatology, and dermatology		
Surgical Ward – including general surgery, cardiothoracic, urology, gastroenterology, neurosurgery, and plastic surgery		
Obstetrics and Gynecology – including gynecology ward, maternity ward, labor room, and nursery		
Pediatrics – including general ward, neonatal ICU, and isolation ward		
Orthopedics		
Ophthalmology		
Ear, Nose, and Throat		
Psychiatry		
Intensive Care Unit (ICU)		
Totals		

NUMBER OF IN-PATIENTS AND OUT-PATIENTS (CONT.)

Total number of out-patients

Out-patient Department (OPD) – What is the "average number of out-patients per week" using the general outpatient department and the following outpatient clinics: medical clinics (including chest, skin, cardiology, and nephrology clinics), surgical clinic, antenatal clinic, post-natal clinic, gynecology clinic, pediatric clinic, orthopedic clinic, ophthalmology clinic, and ENT clinic?

Total number (ave.) of out-patients per week = ...

Accidents and Emergencies (A&E)

Average number of patients per day = ...

Dental Department

Average number of patients per day = ...

Total number of cases (both in-patients and out-patients) handled by the operating theatres, hemodialysis unit, radiology department, and postmortem room

Wards/Departments	**No. of Cases**
Operating Theatres (OT) – including general OT, maternity OT, orthopedic OT, eye OT, ENT OT, and minor OT	.....
Dialysis Unit	.....
Radiology	.....
Postmortem Room	.....

Location

Is your health care facility located in a/an:

- Residential area? .....
- Commercial area? .....
- Light industrial zone? .....
- Industrial zone? .....

Approximate land area ..... m^2

Approximate age of establishment ..... years

Waste Management Committee

Is there a committee that looks after waste management? Yes _____ No _____

If YES, what is the name of this committee? _____

Are there nominated individuals having overall responsibility for the following areas? If YES, what is the designation of staff responsible for each area?

- Chemical/microbiological safety Yes _____ No _____

If YES, state designation of staff _____

- Radiological safety Yes _____ No _____

If YES, state designation of staff _____

- Infection control Yes _____ No _____

If YES, state designation of staff _____

- Disposal of medical waste Yes _____ No _____

If YES, state designation of staff _____

- Disposal of radioactive waste Yes _____ No _____

If YES, state designation of staff _____

- Disposal of non-medical solid waste (e.g., kitchen waste and household type waste) Yes _____ No _____

If YES, state designation of staff _____

- Disposal of wastewater (e.g., sewage) Yes _____ No _____

If YES, state designation of staff _____

Segregation of Medical Waste

For the purpose of this survey, medical waste will be divided into the following categories: Groups A through E, radioactive waste, cytotoxic waste, and general waste (household type and kitchen wastes). If the disposal of these wastes is carried out by a private contractor, please state the method of disposal used (municipal landfill, incinerator, etc.) in each case.

Group A

- Soiled surgical dressings, cotton wool, gloves, swabs, and all other contaminated waste from treatment areas; plasters and bandaging which have come into contact with blood or wounds; and cloths and wiping materials used to clear up body fluids and spills of blood.

- Material other than linen from cases of infectious disease (e.g., human biopsy materials, blood, urine, and stools).

Note: Infectious waste contains pathogens in sufficient concentration or quantity that exposure to it could result in disease. This category includes cultures and stocks of infectious agents from laboratory work, waste from surgery and autopsies on patients with infectious diseases, waste from infected

patients in isolation wards, waste that has been in contact with infected patients undergoing hemodialysis (e.g., dialysis equipment such as tubing and filters, disposable towels, and gloves) and waste from animals or carcasses of animals inoculated with an infectious agent.

- All human tissue (whether infected or not), limbs, placenta; animal carcasses and tissues from laboratories, and all related swabs and dressings.

What types of bags/containers are used for the storage of Group A wastes?

- Plastic bags .....
- Paper bags .....
- Waste placed directly into unlined (i.e., no disposable bag inside) refuse bins .....
- Other (specify) .....

What is the method of disposal for Group A waste?

- Burial on hospital grounds .....
- Disposal to landfill .....
- Open burning .....
- Incineration .....
- Other (specify) .....

How do you dispose of specific maternity wastes such as placenta and fetuses?

Muslim

- Collected by family members .....
- Burial on hospital grounds .....
- Disposal to landfill .....
- Open burning .....
- Incineration .....
- Other (specify) .....

Non-Muslim

- Collected by family members .....
- Burial on hospital grounds .....
- Disposal to landfill .....
- Open burning .....
- Incineration .....
- Other (specify) .....

Group B

- "Sharps" such as discarded syringes, needles, cartridges, broken glass, scalpel blades, and any other sharp instruments.

What is the average number of syringes used per day in your establishment?

Average number of syringes used per day = _____

Do you separate "sharps" from other medical waste (i.e., sharps for disposal are stored separately, not mixed with other medical waste)?

Yes _____ No _____

If sharps are separated from other medical waste, what types of containers/bags are used for the storage of sharps (Group B wastes)?

- Plastic containers suitably designed for sharps waste (e.g., to prevent removal of contents, sealable when full, leak proof, impervious to moisture, strong) _____
- Plastic containers/boxes not specifically designed for sharps waste (e.g., used drip bottles) _____
- Cardboard containers/boxes _____
- Plastic bags _____
- Paper bags _____
- Waste placed directly into unlined (i.e., no disposable bag inside) refuse bins designed for sharps only/designated for sharps only _____
- Other (specify) _____

What is the method of disposal for Group B waste?

- Burial on hospital grounds _____
- Disposal to landfill _____
- Open burning _____
- Incineration _____
- Other (specify) _____

Group C

- Medical waste arising from laboratories (e.g., pathology, hematology and blood transfusion, microbiology, histology) and postmortem room waste other than waste included in Group A.

For some wastes, such as those that are highly infectious or potentially infectious, biological material from laboratories and postmortem room, disinfection prior to final disposal may be required. Are disinfection procedures carried out in your health care establishment prior to disposal of these wastes?

Yes _____ No _____

If YES, state the disinfection procedures used:

- Steam sterilization (autoclave) Yes _____ No _____
- Chemical methods (specify chemicals and concentration used, e.g., 10% chlorine) _____

If YES, on which potentially infectious waste streams is this practice routinely carried out:

- Discarded syringes/needles Yes _____ No _____
- Petri dishes Yes _____ No _____
- Human biopsy materials Yes _____ No _____
- Human/animal tissues Yes _____ No _____
- Microbiological wastes Yes _____ No _____
- Other (specify) _____

If YES, what is the final method of disposal for wastes from autoclaves?

- Burial on hospital grounds _____
- Disposal to landfill _____
- Disposal to sewer _____
- Open burning _____
- Incineration _____
- Other (specify) _____

Group D

- Pharmaceutical and chemical waste.

- Chemical wastes (e.g., organic solvents, laboratory reagents, inorganic compounds).

Are pharmaceutical wastes from the different wards segregated from other wastes?

Yes ..... No .....

If YES, what happens to the separated pharmaceutical waste from the different wards?

- Flushed into the sewer via a toilet or sink waste disposal unit .....
- Returned to the manufacturer .....
- Burial on hospital grounds .....
- Disposal to landfill .....
- Open burning .....
- Incineration .....
- Other (specify) .....

How do you dispose of water-soluble chemicals?

- Down the sink, flushed by large volumes of running water .....
- Disposal to landfill .....
- Open burning .....
- Incineration .....
- Other (specify) .....

How do you dispose of solvents and hazardous chemicals?

- Flushed down the sink .....
- Disposal to landfill .....
- Incineration .....
- Other (specify) .....

How do you dispose of effluents from automated equipment and general washwater?

- Discharged directly into the wastewater plumbing system .....
- Other (specify) .....

Group E

- Used disposable bedpan liners, urine containers, incontinence pads, and stoma bags.

Group E wastes (except when they arise from designated high-risk areas) could be discharged to the sewer via purpose-built disposal units such as macerators and low-speed disintegrators (shredders). Are these disposal units available in your health care facility?

Yes _____ No _____

If NO, how do you dispose of items in this category, which cannot be discharged to the sewer via the toilet (e.g., bags and liners)?

- Disposal to landfill _____
- Open burning _____
- Incineration _____
- Other (specify) _____

Segregation and Disposal of Radioactive Wastes

Does your establishment generate radioactive wastes? Yes _____ No _____

Does your establishment generate radioactive waste from the following activities?

			If YES, isotopes used
• Radio immunoassay	Yes _____	No _____	_____
• Radiotherapy	Yes _____	No _____	_____
• Radiological practices	Yes _____	No _____	_____
• Research activities	Yes _____	No _____	_____
• Other (specify)			_____

How do you dispose of low-level radioactive solid wastes (less than 400 kBq activity per 0.1 m^3 of waste, and no individual article exceeding 40 kBq)?

- Dispersed into non-radioactive waste for collection by the waste disposal service and then sent to a designated landfill _____
- Dispersed into non-radioactive waste and then burned in the open _____
- Dispersed into non-radioactive waste and then incinerated _____
- Stored safely onsite for a predetermined period of time, then sent to a designated landfill _____
- Stored safely onsite for a predetermined period of time, then burned in the open _____
- Stored safely onsite for a predetermined period of time, then sent to an incinerator _____
- No such waste generated _____
- Other (specify) _____

How do you dispose solid wastes of higher radioactivity?

- Stored safely onsite for a predetermined period of time, then sent to a designated landfill .....
- Stored safely onsite for a predetermined period of time, then burned in the open .....
- Stored safely onsite for a predetermined period of time, then sent to an incinerator .....
- Collected for disposal by an official government agency .....
- No such waste generated .....
- Other (specify) .....

Segregation and Disposal of Cytotoxic Wastes

Does the hospital/establishment generate cytotoxic waste? Yes ..... No .....

Do you separate (and place into designated cytotoxic waste containers) cytotoxic wastes and associated contaminated materials, such as tubings, containers, and preparation materials from other wastes?

Yes ..... No .....

If YES, do you separate (and place into designated cytotoxic sharps containers) sharp objects contaminated with cytotoxics, such as needles, syringes, broken glass, vials, and ampoules?

Yes ..... No .....

What is the method of disposal for the separated cytotoxic wastes?

- Disposal to landfill .....
- Open burning .....
- Incineration .....
- Other (specify) .....

If cytotoxic wastes are sent to an incinerator (either onsite or offsite), if known, what is the temperature used for the incineration of these wastes? ..... °C

Disposal of Pressurized Containers

How do you dispose of pressurized containers such as aerosol cans and disposable compressed gas containers?

- Disposal to landfill .....
- Open burning .....
- Incineration .....
- Other (specify) .....

Disposal of General/Non-Medical Solid Waste

Do you separate medical wastes from general wastes (e.g., newspapers, letters, documents, packing materials, cardboard containers, plastic bags/film, food wrappings, metal cans, food containers, flowers, floor sweepings, etc.)?

Yes _____ No _____

If YES, state color of containers for:

- Medical waste _____
- Medical waste requiring autoclaving/ sterilization _____
- General (non-medical) household type waste _____
- Other (specify) _____
- Mark "X" if no color coding system is used _____

What is the final disposal method used for the segregated general (non-medical) waste?

- Disposal to landfill _____
- Open burning _____
- Incineration _____
- Other (specify) _____

Is kitchen waste (e.g., food waste) collected separately from general household type waste?

Yes _____ No _____

If YES, what is the final disposal method?

- Collected by contractor to be used as animal feed _____
- Flushed down the sewer via special units _____
- Flushed down the sewer (no purpose-built waste disposal units available) _____
- Disposal to landfill _____
- Open burning _____
- Incineration _____
- Other (specify) _____

Storage, Collection, Transportation, and Disposal

Are the bags for storage of medical waste labelled and sealed? Yes _____ No _____

Are there specific areas set aside for storage of medical waste? Yes _____ No _____

If YES, describe _____

How is the medical waste collected and transported to the disposal site (e.g., landfill site or incinerator)?

Note: If your establishment has its own incinerator (i.e., transportation of medical waste offsite is not required): not applicable.

- By a private waste disposal company _____
- By your own (i.e., hospital) vehicles _____
- Through normal municipal refuse collection services _____

Are purpose-designed vehicles used for the transport of medical waste?

Yes _____ No _____

Do you keep records of the daily/weekly shipment in a log (e.g., date, weight of waste transported, location of treatment/disposal facility, signatures of transporter, and treatment/disposal facility operator)?

Yes _____ No _____

How frequently is each category of waste collected from the premises and by whom?

Note: D = daily, W = weekly, M = monthly, or state "___" times per week/month"

	Hospital Staff	Municipal Staff	Private Contractor
• Group A			
• Group B			
• Group C			
• Group D			
• Group E			
• Radioactive			
• Cytotoxic			
• General waste			
• Kitchen waste			

Quantity of Waste Generated/Cost of Disposal

Can you give an indication of the quantity of medical waste that your hospital disposes of in either:

- Bags per day _____ size of bags _____
- Kilos per day _____
- Tonnes per day _____
- Other (specify) _____

Is this mixed waste (i.e., general household type waste plus medical waste) or segregated medical waste?

- Mixed waste Yes _____ No _____
- Segregated medical waste only Yes _____ No _____

Is it possible to give an approximate weight per bag? Yes _____ kg/bag No _____

Do you use outside contractors for any of your medical waste disposal?

Yes _____ No _____

If YES, is it possible to give an indication of unit cost by bag or kilo or tonne?

Yes _____ No _____

What percentage of your medical waste produced is contracted out for disposal?

10% _____ 50% _____ More _____

Medical Waste Incineration

Does the hospital/establishment have access to an operational incineration facility either onsite or offsite?

Yes _____ No _____

Is the incinerator located offsite (i.e., not within the hospital compound)?

Yes _____ No _____

If YES (i.e., incinerator is offsite), what is the location (i.e., name of place) and distance of incinerator from your hospital/establishment?

- Location of incinerator _____
- Distance from hospital/establishment _____ km

Is this incinerator dedicated for the combustion of medical waste only (e.g., a medical waste incinerator belonging to a nearby hospital)?

Yes _____ No _____

OR

Is this a municipal waste incinerator? Yes _____ No _____

What are the details of the incinerator and operating conditions?

- Brand name/model .....
- Type of incinerator (e.g., primary combustion chamber followed by a secondary combustion chamber) .....
- Capacity ..... kg/hrs
- Age ..... years
- Temperature in primary chamber _____ °C
- Temperature in secondary chamber (if present) _____ °C
- Stack height _____ meters above ground level
- Daily hours of operation _____ hours/day

Have difficulties been experienced with the process? Yes _____ No .....

If YES, what are the difficulties?

- Volatile organic compounds in stack emissions Yes ..... No .....
- Difficulties in achieving design operating temperatures Yes ..... No .....
- Large variations in operating temperature Yes ..... No .....
- Bad odor Yes ..... No .....
- Other (specify) .....

All aspects of relating to the handling, storage, collection, transportation, and disposal of medical waste cannot be thoroughly covered within the limits of a questionnaire. Have you anything that you would like to add, particularly details pertinent to your local situation?

.....

.....

.....

.....

Form adapted from WHO/WPRO

Annex 3b. Survey Form for Waste Treatment Systems and Equipment

CODE_____

July 28, 2002

Information on Biological Waste Treatment Systems/Equipments

Please fax completed questionnaire to 927-8130
ATTN: ADB Tech. Asst. 3848 PHI Project
Inquiry, comments & questions: ask Dr. Luis Diaz or Dr. Palaypay

Dear Sir/Madam:

Please fill out this form regarding your medical facility and it's biomedical waste (regulated medical waste or RMW) disposal/treatment practices. This is not intended as a tool or enforcement but as a part of study of biomedical waste treatment technologies that are commonly used in the R.P.

No. of beds:_____
Tool Waste:_____ _kgs/day
Regulated Medical Waste:_____kgs/day
Name of contact person(s):_____ Tel:_____
Director/Chief:_____
Current Practice RMW (circle)

Treat on site (Treat off site) Other (describe)

Contacted by:_____ Where: _____

Describe how & where RMW is treated/disposed off: _____

Cost P_____ kg_____ Collection days: _____

Name of existing RMW System

Year installed (if known) _____ Max Capacity _____

Type of existing RMW Treatment System (circle one) *Incineration*Microwave/Stem Autoclave* Mechanical/Chemical/Pyrolysis* Radio Frequency*Others:_____ (describe) Composted: _____ (etc.)

If known or readily available, please fill in this information

Waste

Alternative Technologies for the Treatment of Medical Waste

1 Introduction

Health care facilities throughout the world must deal with the difficult tasks associated with the treatment and disposal of unique types of infectious and hazardous materials generated by them. Hospitals, veterinary facilities, health clinics, and other similar facilities generate a broad range of infectious and potentially infectious waste materials (tissue, swabs, cultures, etc.) as well as a large variety of toxic and hazardous items (chemicals, sharps, etc.), each with unique treatment requirements. Incineration systems, once regarded as one of the best options for the treatment of medical waste, can produce toxic discharges and are costly to maintain and operate properly. Many incinerators particularly those located in developing countries are not adequately funded, and are not operated by properly trained personnel leading to increased pollution and health risks to staff, the public and the environment. Due to increased pressure placed on government by the public and by environmental advocacy groups to make regulations governing the incineration of medical waste more stringent than the current ones, facilities are actively looking for alternative (non-combustion) technologies to process and ultimately dispose of their contaminated waste.

This report provides a description of available non-combustion technologies that can be used for the management of infectious, potentially infectious and hazardous wastes generated in health care facilities. The report is designed to serve as a reference and to provide an overview of currently available technologies, but should not be regarded as an alternative to site-specific research.

Although waste reduction and recycling are two viable and critical components of modern waste management, these techniques are not discussed in this document in order to focus on alternative treatment technologies prior to final disposition.

In addition to direct combustion, there are a number of methods for treating medical waste prior to land disposal. The methods are categorized and described in the following sections.

2 Classification of Currently Available Technologies

This report groups technologies based upon the primary method used to process and to render the waste safe for land disposal or alternate final disposal. As such, treatment methods can be categorized into the following basic types:

1) Mechanical – size reduction, compaction, and others
2) Thermal - autoclave, pyrolysis/gasification, and others
3) Chemical -, chlorination, ozonation, etc.
4) Radiative- microwave, electron beam, Cobalt-60, etc.
5) Biological – Enzymatic processes, composting.

Several proprietary systems use a combination of the treatments outlined in the previous paragraph as well as some form of mechanical processing to prepare the waste for disposal.

An assessment of the various technologies was conducted to allow an evaluation of the advantages and disadvantages of each type of technology specifically for use in Metro Manila. As part of the assessment, information was collected on the capacity and cost of equipment currently on the market. A number of sources have prepared lists of manufacturers in the past (e.g., *Waste Age*, 1998; Healthcare Without Harm, 2001; and Allen Engineering, 2002). Nevertheless, given the rapidly changing environment of these technologies, the consultants deemed it prudent to review and update the information in order to provide the most current information possible to the EA.

This report presents a listing of technology manufacturers/vendors, followed by a discussion of each major type of technology, and concludes with a discussion of the advantages and disadvantages of the key technologies. The information presented throughout the report was collected primarily from manufacturer information (from websites and printed literature) and from personal communication with the technology suppliers. As necessary, the information was supplemented with information in the literature.

A listing of technology manufacturers/vendors is presented in Table 1. The table excludes those vendors that indicated a lack of interest in marketing systems/equipment to the Philippines. A list of vendors contacted under this study is provided in Attachment 1 to the annex. The list excludes businesses that indicated that they do not currently offer the equipment.

The authors have made a conscientious effort to identify and report on companies with commercialized technologies; the inclusion of their products should by no means be considered an endorsement.

Table 1. Partial List of Alternative Technology Vendors*

Vendor	Technology	Location	Prices	Capacities	
			(1000 US $)	Values	Units
Aegis Bio-Systems LLC	Steam	Oklahoma, USA	1000	680-1136	kg/hr
Bio Arc, Inc.	Pyrolysis/Gasification	Florida, USA	750	~6	m^3/hr
BondTech Corporation	Steam	Kentucky, USA	40-205	20 to 2270	kg/hr
Circle Medical Products, Inc.	Chemical	Indiana, USA	300 to 600	140 to 1360	kg/hr
CMB	Microwave	Graz, Austria	45	35	kg/hr
Contaminatable Container Co.	Sharps	West Virginia, USA	N/R**	N/R	
Daystar Technologies	Pyrolysis/Gasification	Tokyo, Japan	N/R	90	kg/hr
Duratek	Heat/Steam	Maryland, USA	N/R	N/R	
Earth-Shield Company	Sharps	California, USA	~.05	1000	sharps
Ecodas	Steam	Roubaix, France	180-500	20-200	kg/hr
Ecolotec	Steam	Ontario, Canada	N/R	136	kg/hr
Electro-Pyrolysis, Inc.	Pyrolysis/Gasification	Pennsylvania, USA	1000 to 10000	45 to 1360	kg/hr
Endesco Clean Harbors	Heat/Cement Mfg.	Illinois, USA	172000	N/R**	
Environmental Waste International	Reverse Polymerization/Heat	Ontario, Canada	1100	70 to 200	kg/hr
EnviroPack Development Corp.	Chemical/Sharps	New Jersey, USA	Under 1	125	sharps/vessel

Table 1. Partial List of Alternative Technology Vendors (continued)

Vendor	Technology	Location	Prices	Capacities	
			(1000 US $)	Values	Units
HI Disposal Systems/Golden State Energy	Pyrolysis/Gasification	Nevada, USA	N/R	1360	kg/hr
Hydroclave Systems Corp.	Steam	Ontario, Canada	200 to 363	90 to 1000	kg/hr
Imagination Medical, Inc.	Sharps	Florida, USA	N/R	N/R	
Interscience, Inc.	Pyrolysis/Gasification	New York, USA	1300	160	kg/hr
LogMed	Steam	Nienburg, Germany	N/R	270	kg/hr
Lynntech	Chemical	Texas, USA	N/R	100 to 230	kg/cycle
Mark-Costello Co.	Steam	California, USA	25 to 350	100 to 1360	kg/hr
Matrix Technology	Chemical	Queensland, Aus	N/A	N/R	
MCM Environmental Technologies	Chemical	New Jersey, USA	N/R	310	liters/hr
Medical Innovations	Sharps	Massachusetts, USA	N/R	N/R	
MedPro, Inc.	Sharps	Kentucky, USA	0.895	1 by 1 operation	
Meteka	Microwave	Burggasse, Austria	N/R	60-160	liters/8 hr shift
Microtek Medical, Inc.	Liquids/Sharps	Mississippi, USA	N/A	15	liters
MSE Technology Applications	Pyrolysis/Gasification	Montana, USA	N/R	Up to 160	kg/hr
Oxidation Technologies	Pyrolysis/Gasification	Maryland, USA	1600 to 3300	45 to 1300	kg/hr
Peat, Inc.	Pyrolysis/Gasification	Alabama, USA	N/R	N/R	
Positive Impact Waste Solutions	Chemical	Texas, USA	N/R	up to 1000	kg/hr
Safeguard Medical Devices	Electrical/Sharps	Ohio, USA	159 to 208	1 by 1 operation	
San-I-Pak	Steam	California, USA	60 to 700	10 to 1100	kg/hr

Table 1. Partial List of Alternative Technology Vendors (continued)

Vendor	Technology	Location	Prices	Capacities	
			(1000 US $)	Values	Units
Sanitec, Inc.	Microwave	New Jersey, USA	550 to 635	90 to 450	kg/hr
SPS Medical Equipment Corporation	Sharps	New York, USA	N/R	N/R	
Startech Environmental Corp.	Pyrolysis/Gasification	Connecticut, USA	N/R	5 to 100	TPD
Sterile Technologies, Inc.	Steam	Pennsylvania, USA	N/R	270 to 1800	kg/hr
Tempico	Steam	Louisiana, USA	200+ to 1,000+	60 to 1000+	kg/hr
Thermoselect	Pyrolysis/Gasification	Switzerland	N/R	N/R	
Tuttnauer USA	Steam	New York, USA	50 to 500	up to 300	kg/hr
U. Miami E-Beam	Irradiation	Florida, USA	N/R	80	kg/hr
Univec	Heat	Connecticut, USA	Check	3 to 5	kg/hr
Waste Reduction by Waste Reduction, Inc.	Alkaline Hydrolysis	Indiana, USA	133 to 1300	14 to 3200	kg/3 hr cycle
WPS Co.	Steam	Maryland, USA	200	60 to 130	kg/hr

Sources: Information from manufacturer/vendor websites and printed literature, personal communication, and published information (Health Care Without Harm (2001), Allen Engineering (2002), and *Waste Age* (1998)).
*Excludes manufacturers/vendors that expressed a lack of interest in marketing equipment/systems to the Philippines.
**N/R=Not Reported

3 Mechanical Treatment

Available mechanical treatment methods do not disinfect the wastes, this method of treatment either prepares the materials for efficient treatment or processes them so that: the wastes cannot be re-used, the wastes do not pose a physical threat to any one that may come in contact with them or the wastes can be disposed in a relatively safe manner. Some of the most common methods of mechanical treatment include: size reduction and densification (compaction).

3.1 Size reduction

When applied in the field of solid waste management, “size reduction” has at least five synonyms: milling, shredding, hammermilling, grinding, and comminution. Shredding is the term that has become one of the most widely adopted when discussing the size reduction of solid wastes.

Size reduction has been widely used in solid waste management as a preparatory step for additional processing and as a step prior to final disposal of the residues on the land.

There are several types of size reduction equipment: shears, cage disintegrators, shredders, cutters, hammermills, grinders, and others. Hammermills and cutters are the most widely used in the processing of health care wastes.

The basic forces associated with size reduction of solid wastes are: shear, tension, and compression. The performance of a particular size reduction unit is influenced by three basic parameters (known as dependent variables): particle size distribution of the output, machine wear and specific energy consumption. Operational factors that influence the dependent variables include: size distribution of the feed, throughput of the material through the size reduction device, moisture content of the material being processed, spacing between the grates or plates in the unit and the relative velocity of the devices (knives, hammers, etc.) accomplishing the size reduction.

The process of size reduction is used in the treatment of health care wastes to: reduce the size of the particles to be treated and consequently achieve a large surface area, expose the majority of the materials to be treated to the following unit processes and, in some instances, to facilitate volume reduction processes. At the present time, shredders generally are used in health care waste prior chemical treatment, microwave, composting, and some heat treatment systems.

Size reduction equipment must be properly designed and operated in order to perform properly. Otherwise, these units can wear very rapidly and at the same time consume a substantial amount of energy. A very important consideration in the selection of a shredder must include maintenance. Equipment buyers must be well aware of the maintenance issues related to a shredder operation. Furthermore, shredder maintenance is a very labor-intensive operation.

Since in this application the material to be processed is or may be hazardous, size reduction devices must be completely enclosed and constructed and operated such that emissions from the units are controlled and properly treated. Generally, shredders used to process health care wastes are operated under negative pressure.

3.2 Densification (Compaction)

Densification, in the solid waste management industry, is a process whereby the density of the material is increased so that the waste can be stored, transported, used or disposed more efficiently than when the material is not compacted. Some of the most common technologies used in the industry include: baling, cubing, and pelleting. The unit process that is most widely used in the management of health care wastes is the baler.

Balers are units which operate at high pressures (generally on the order of 6 to 12 atmospheres) to produce a relatively small, compact rectangular or cylindrical mass. Typical bale sizes range from 122x76x107 cm. up to 182x76x112 cm. The mass of the bales depends on the material being densified but it can range from about 500 to 1000 kg for the small and large bales of paper products.

Compaction generally is applied in the management of health care wastes after steam disinfection to try to render the waste unrecognizable and to reduce the volume of the material to be transported to a final disposal site.

4 Thermal Treatment

This form of treatment uses the application of high temperatures in the form of heat or steam directly to the waste in order to destroy the pathogenic organisms. There are several types of processes that can be included in this category. Some of the most common processes include: autoclaves and retorts, autoclave hybrids, microwaves, and pyrolysis/gasification. Other forms of heat/steam processing use an enclosed chamber that is electrically heated.

4.1 Autoclaves and Retorts

The use of heat, in particular, moist heat to achieve some level of disinfection has been practiced throughout the world for many years. It is common practice for health care facilities and other institutions to use hot water or steam for disinfecting reusable instruments.

There are two basic types of systems that utilize steam for disinfecting health care wastes. These are autoclaves and retorts. Autoclaves and retorts need a supply of steam. The steam for the units is generated by means of a boiler. The boiler can be one used for other services in the health care facility (such as for ambient heating) or it can be one that is specifically used for the treatment of the wastes.

An autoclave is a metal container typically made out of steel. The container or vessel is hermetically sealed with a door and is designed to withstand relatively high temperatures and pressures. Normally a steam jacket surrounds the autoclave to decrease the amount of condensation and therefore reduce heat loss.

Disinfection in an autoclave is a discontinuous process (carried out in batches). The unit is loaded, disinfection takes place, and then the treated materials are taken out from the autoclave. During a typical operation, the material to be treated is charged into the autoclave and the air in the unit is removed. Air is removed from the autoclave because air is a good insulator. The process of air removal is accomplished by means of a vacuum pump at the start of the operation. Another method of air removal depends on the fact that the density of air is higher than that of steam so that as steam is introduced into the autoclave the air moves towards the bottom of the unit. Once the air is concentrated at the bottom, it is removed through a drain. The air that is removed from the autoclave should be treated prior to discharge into the environment. In the process, steam is injected into both the interior of the autoclave as well as into the steam jacket.

The main difference between an autoclave and a retort is that the retort does not have a steam jacket as part of the system. The lack of a steam jacket results in inefficiencies in heat transfer and therefore the retort requires higher temperatures than those required for an autoclave.

In a health care facility, the waste to be treated would be stored in plastic bags and introduced into rigid containers. Eventually, the bags are collected in carts or in bins. The bins should be lined with a special plastic to keep the bags from attaching to the carts when heated. In addition, the bags should be manufactured from a particular type of plastic that meets the following requirements: it is resistant to the high temperatures inside the autoclave and it is permeable to the steam in the direction towards the waste. In a typical cycle, steam is first introduced into the outer jacket of the autoclave (“pre-heating”). The bins or carts loaded with the wastes are placed into the autoclave and the door is shut. Once the door is closed, the air is removed from the unit by either of the methods discussed in a previous paragraph. In the next step, steam is introduced into the vessel until the desired temperature is reached. In some instances, steam is continually introduced so that the desired temperature is maintained for certain period of time. In some countries or states in countries, regulations dictate that records of the time-temperature history be kept for each batch of waste undergoing treatment. Once the required time-temperature levels have been met, vents are opened and the steam is released. Some systems incorporate size reduction, compaction, or both.

Thermal treatment systems of this nature normally include the use of chemical or biological indicators to determine the efficiency of the process.

It is important to emphasize that wastes treated in autoclaves or in retorts (with the exception of those units that incorporate mechanical processing) do not change considerably from their original state. Furthermore, since in some cases water has to be added and depending upon the design of the particular system, the mass of the waste may increase. Therefore, to meet regulations, some manufacturers include some degree of mechanical processing into their designs. Two of the most common types of processing are: shredding and compaction. Shredding changes the appearance of the waste and substantially increases its bulk density.

The data in Table 2 show the minimum requirements for the inactivation of spores under ideal conditions. In addition, the data show the substantial increase in exposure time required as the temperature decreases. Since ideal conditions typically are difficult to achieve, it is recommended that the minimum exposure time to kill off infectious agents be twice that of the ideal (spore kill time).

Table 2. Criteria for Steam Sterilization

Temperature (degrees C)	Spore kill time (minutes)	Min. exposure time (minutes)
138	1	2
132	2	4
125	8	16
121	12	24
118	18	36
116	30	60

Source: E. Hamel, "Chemical Disinfection," *Control of Biohazards in the Research Laboratory, 1981*

Other factors that play a key role on the effectiveness of steam sterilization particularly with adequate temperature distribution within the treatment unit include: low heat capacity of the waste mixture, excessive mass (weight) placed in the unit, low heat conductivity of the materials, barriers to heat transfer, incomplete removal of air from chamber (air acts as an insulator), and others.

Information from representative vendors is provided on the following pages.

,Tracy, CA, USA

A stand alone San-I-Pak unit.

San-I-Pak manufactures many different varieties of autoclaves and retorts for the treatment of medical residues covering a wide range of capacities. San-I-Pak's sterilization process begins by loading the waste (in the US it must be placed in red bags) into the treatment chamber (either by hand or with an optional automatic tipping device). The air is evacuated and steam at153° C is introduced to the chamber. (The air that is removed from the chamber is also treated with steam prior to venting into the atmosphere to destroy any pathogenic organism in it.) When the chamber reaches 132° C a 30-minute timer is activated and the chamber continues to heat to its maintained temperature of approximately 138° C. Once treatment is completed the steam is routed through a diffuser, recondensed to water and drained to a sanitary sewer connection. At this point the operator can open the loading door, and commence the discharge cycle. The waste is automatically discharged and conveyed to the compactor section of the system where it is automatically compacted directly in to a roll-off container, ready for final disposal.

Installations:
Two dozen systems located in Canada, the UK, Italy, Greece, Kuwait, Taiwan, New Zealand, Chile and Colombia.

Approximate cost:
$60,000.00 - $700,000 US dollars
Capacity:
25 to 2500 lbs /hr (11.4 to 1140 kg/hr)

Advantages:
Proven, straightforward technology (most health care facilities are used to operating autoclaves).
Minimal personnel required (1 operator).
Self-Contained.
Automated.
Low cost when compared to other alternative technologies.
Minimal emissions.

Disadvantages:
Requires careful waste segregation to avoid hazardous discharges, (i.e., no chemical, radiological waste)
Process may require additional size reduction equipment to meet local ordinances.
Can produce offensive odors if not adequately vented.
Process adds weight to waste, which may result in higher disposal costs.

THE MARK-COSTELLO CO., Carson, CA, USA 

Mark-Costello, established nearly 50 years ago, has been manufacturing autoclaves and retorts since 1973. Although the process remains largely unchanged, Mark-Costello has made some additional options available which improve the automation of the loading and unloading of the vessel. Waste can be loaded into the autoclave in red bags, or in special carts out fitted with liners which eliminate the need for red bags. Once the waste has been loaded into the vessel, the door is shut and an automatic locking system takes over control of the process while documenting pressure, time, and temperature on a chart recorder. The waste is then exposed to about 135 °C at a maximum pressure of 5 atmospheres for approximately one hour. Once the treatment is completed, the steam is evacuated, and the waste can be compacted, baled, shredded, or disposed of as is depending upon local regulations.

Installations:
Numerous installations in the US and in other countries.

Approximate Cost:
$25,000-$275,000 US dollars
Capacity:
225-3000 lbs /hr (102 to 1364 kg/hr)

Advantages:
Proven, straightforward technology (most health care facilities are used to operating autoclaves).
Relatively inexpensive.
Minimal personnel required (1 operator).

Disadvantages:
Process may require additional size reduction equipment to meet local ordinances.
Process requires careful waste segregation to prevent hazardous discharge.
Potential for offensive odors if improperly vented.
Process adds weight to waste which may result in higher disposal costs.

4.2 Autoclave Hybrids

Several manufacturers have developed equipment and processes which combine proven autoclave technology with other processes, usually mechanical. Although some proponents support some type of size reduction prior to processing to insure better heat transfer within the mass to be treated, others claim that doing so prior to disinfection puts operators and the public at unnecessary risk. Conversely, size reduction after processing could release pathogens that may not have been inactivated due to excessive loads, inappropriate bulk densities, poorly segregated waste materials, or cold spots. In an effort to minimize the volume of material discharged and cold spots during processing, the hybrid systems have been designed to mix, shred, or grind the waste during the treatment process. By incorporating size reduction into the treatment, system designers attempt to solve the problems associated with the mechanical size reduction of untreated medical wastes while maximizing heat distribution.

HYDROCLAVE Systems Corp. Medical Waste Solutions!, Ontario, Canada 

Hydroclave's proprietary process heats waste inside a jacketed vessel using the waste's inherent moisture (if available) to produce steam while mixing arms inside the unit tumble and break apart the load. Waste is introduced into the vessel through a loading window. Once the window is closed, steam is pumped into the outer jacket to heat the interior. As the waste is heated, the mixing arms churn the load and as the moisture contained in the waste turns to steam, the pressure in the inner vessel increases. If the moisture content of the waste is insufficient to achieve the mandated pressure, steam is introduced directly into the chamber until the desired pressure is reached. Temperature and pressure are then monitored by a computer controller to insure an appropriate exposure to the process, and complete processing of the waste. Once the pre-determined treatment parameters are met, steam is released from the inner vessel to a condenser, and the jacket continues to heat and dehydrate the load. Once dry, the material is unloaded by reversing the direction of the mixing arms.

Installations:
India, Greece, China, Egypt, Mexico, and several in Canada.

Approximate Cost:
$200,000-$363,000 US dollars.
Capacity:
200-2000 lbs/hr (90 –1000 kg/hr)

Advantages:
Based on proven autoclave technology so benefits and drawbacks are similar.
Can process sharps.
Primary size reduction incorporated into process.
Minimal personnel required (1 operator).

Disadvantages:
Process may require additional size reduction equipment to meet local ordinance.
Process requires careful waste segregation to prevent hazardous discharge.
Potential for offensive odors if improperly vented.

Tempico "Rotoclave" with automated cart tipper.

, Madisonville, LA, USA

Tempico manufactures a product they call a "Rotoclave." Essentially an autoclave, the vessel rotates and the waste is agitated and tumbled as it is exposed to steam. First, waste is loaded into the drum manually or using optional, additional equipment. Once shut, the Rotoclave evacuates air from the chamber and mixes removed air with steam to prevent releasing pathogens into the atmosphere. The rotating vessel is then heated to about 150 °C at a pressure of 3.4 atmospheres and continues agitating the waste for approximately 30 additional minutes. Once the treatment is complete, steam is condensed and routed to the sewer system and any air in the vessel is vented to atmosphere through activated charcoal filters. At this point, disinfected waste can be unloaded and transported to a grinder/shredder for size reduction.

Installations:
Domestic and International installations

Approximate Cost: $200,000 - $1,000,000+ US dollars
Capacity:
132-454 lbs/hr (60-1000kg/hr)

Advantages:

Based on proven autoclave technology so benefits and drawbacks are similar.
Can handle sharps.
Minimal personnel required (1 operator).

Disadvantages:

Process requires careful waste segregation to prevent hazardous discharge.
Potential for offensive odors if improperly vented.
Potential for noise and added maintenance costs depending on size reduction equipment.

A partial list of manufacturers of systems for autoclaves, retorts, and hybrids is as follows:

- Aegis Bio-Systems LLC
- BondTech Corporation
- Duratek
- Ecodas
- Ecolotec
- Endesco Clean Harbors
- Hydroclave Systems Corp.
- LogMed
- Mark-Costello Co.
- San-I-Pak

- Sterile Technologies, Inc.
- Tempico
- Tuttnauer USA
- Univec
- WPS Co.

5 Pyrolysis/Gasification

Remaining residue from Oxidation Technology pyrolytic process.

Pyrolysis/gasification processes utilize sufficiently high heat and high pressure to produce temperatures exceeding 1,500° C to break down waste in an oxygen depleted environment. As opposed to incineration which oxidizes (burns) material, pyrolysis melts or vaporizes material by using heat. Although the methods for heat generation vary from electric arc to plasma torch, conceptually the processes are very similar. While pyrolysis facilities can process all of the same wastes incinerators can, the production levels of toxic organic compounds are generally well below those of incinerators of comparable capacity. It is important to note that pyrolysis/gasification technologies for mixed solid wastes still are very young and few of them have been fully commercialized. They are included in this summary in an effort to be thorough and to afford the reader insight into emerging, high-technology solutions. Some of the designs of “pyrolytic” units incorporate two combustion chambers. The waste is loaded into the first chamber where it is combusted at high temperatures and pressures in an oxygen-deficient atmosphere. The gases given off by the “pyrolysis” chamber are burned off in the second chamber with the addition of a conventional fuel as needed. The gaseous emissions finally are directed through a series of air pollution control devices.

, Annapolis, MD, USA

Oxidation Technologies designs and implements a process which combines the oxygen depleted pyrolysis with more conventional oxidation processes. Before the process begins, waste must be loaded into cardboard boxes which meet appropriate feed stock dimensions and labeled with bar-code information. Once received by the processing facility, boxes are placed on a conveyor and fed past a bar code scanner which identifies the box and records the information, then the boxes are weighed to determine when to feed the waste, as well as how long to process the waste. The waste is automatically loaded into a sealed chamber located immediately above the pyrolysis chamber where it is then dropped into the pyrolysis chamber and heated by electric resistance to approximately 590° C. Vapors from this initial heating process are then mixed with specific amounts of oxygen and allowed to "burn" at temperatures between 980° C and 1090° C. The off-gases are passed through a heat exchanger where they are cooled, and the resulting hot water and steam can be reused for alternate purposes. Gases are routed through a wet scrubber and electrostatic precipitator to remove particulate matter and HCl and then vented to the atmosphere through low temperature ducting. Since the process involves very high temperatures, the waste is all but completely destroyed and is reduced in mass and volume up to 95%. The remaining ash accumulates in a tray at the base of the pyrolysis chamber, and can be disposed of as regular trash.

Installations:
Bio-Oxidation Services currently operates 4 units in the US and Bermuda.

Approximate Cost:
1.6 to $3.3+ million US dollars

Capacity:
45-1300 kg/hr

Advantages:
The high temperature results in almost complete destruction of the waste which translates to lower disposal costs as well as a capacity to handle many different kinds of waste.
The process generates no liquid waste.
Recovered heat can be used for several alternative purposes.
Very little odor.
Automated operation.

Disadvantages:
Technology is expensive.
Although in small amounts, process emits dioxin. Presumably part of the reason some facilities are examining alternative technologies.
In order to be efficient, heat recovered should be reused in the form of steam or hot water.

The data below show a partial list of manufacturers of pyrolysis/gasification equipment:

- Bio Arc, Inc.
- Daystar Technologies
- Electro-Pyrolysis, Inc.
- HI Disposal Systems/Golden State Energy
- Interscience, Inc.
- MSE Technology Applications
- Oxidation Technologies
- Peat, Inc.
- Startech Environmental Corp.
- Thermoselect

6 Chemical Treatment

The use of chemicals for disinfection has been a common practice in the health care sector for a number of years. Disinfectants have been used in a variety of applications in the treatment of a patient as well as for cleaning a variety of surfaces in the working areas (including floors, walls and other surfaces).

Chemical disinfection has also been applied to the treatment of health care wastes. This section, deals with the various chemical treatment methods available for the treatment of health care wastes.

Disinfection using chemical compounds uses the properties of the chemical agent to “destroy or inactivate” pathological organisms. The effectiveness of a particular chemical compound is a function of a number of factors including: pH, temperature, and on the presence of other agents or materials, which can reduce the effectiveness of the chemical agent. These factors are important on the ability of the chemical agent to act on the cells of the specific pathogenic microorganism. In addition, research has demonstrated that some microorganisms are more resistant to chemical treatment than others. Some of the most resistant microorganisms to chemical treatment include: bacterial spores and hydrophilic viruses. On the other hand, some of the least resistant microorganisms to chemical treatment are fungal spores and vegetative bacteria.

Antimicrobial agents act at the cellular and at the molecular levels. At the cellular level, these agents damage the wall of the cell or the membrane of the cell. At the molecular level, antimicrobial agents alter the synthesis of protein and DNA or cause inhibition through enzymatic reactions.

Chemical methods for the control of microbes include antiseptics and disinfectants, which are non-specific for the cells that they affect.

Sterilization can be accomplished by using several chemical compounds in the gaseous form. These compounds such as formaldehyde and ethylene oxide are extremely toxic.

There are several chemicals that have been used for chemical disinfection, some of these chemicals include: alkalis, acids, alcohols, phenols, heavy metal compounds, detergents, peroxides, and others.

Acids and bases are effective in chemical disinfection because enzymes are sensitive to pH and are inactivated by very acid or very basic compounds.

Some of the most important requirements to achieve a high degree of chemical treatment of health care wastes include: 1) have a sufficiently high concentration of the chemical compound, 2) have long enough “retention time” during which the wastes are in close contact with the chemical, and 3) the wastes should have as small a particle size as possible.

Small and large-scale systems have been designed and used for the treatment of health care wastes. These systems typically incorporate some type of size reduction equipment to shred the wastes before chemical treatment. One of the chemicals that has been widely used for disinfection has been a solution of chlorine. Eventually the treated solids are separated from the liquids. The addition of a liquid into a treatment system means that at some point in time the liquid must be managed before it is released into the environment. Up until recently, the liquids have been discharged into the sewerage systems (in some locations a special permit had to be obtained). It is now, generally necessary to treat the liquid discharges prior to discharge into the sewer (metals, organic contaminants, dissolved solids, and others). This is particularly the case in situations where the wastewater treatment facility depends on biological treatment as one of its unit processes.

Aerosols and particulate matter that may escape from the chemical treatment processes are managed by means of typical air pollution control devices. These devices include enclosures around the treatment processes, HEPA filters, and blowers providing negative pressure.

Circle Medical Products, Indianapolis, IN, USA

This company develops and markets a chemical treatment unit which incorporates a hammer mill for size reduction and to render the waste unrecognizable. The process begins as waste is loaded by conveyor belt, under vacuum, into a chamber where it is soaked in a hypochlorite solution. Once saturated, the waste is transferred to a hammer mill where the waste is size reduced and then sent to a pressurized tank to soak in a sodium hypochlorite solution. Once the waste has been treated for the requisite period, it is forced through an extruder to remove the bulk of the solution and then loaded via auger into a local container to await final disposal.

Installations:
Over 120 units in US and abroad.

Approximate Cost:
$325,000-$500,000 US dollars
Capacity:
500-2000 lbs /hr (225 to 900 kg/hr)

Advantages:
Proven, easily understood technology.
Relatively low equipment costs.
Simple to operate.

Disadvantages:
High maintenance costs associated with hammer mill operation.
Can be very noisy.
Special training may be required for chemical handling and storage.
Sodium hypochlorite (bleach) use in quantity is believed to produce toxic compounds when mixed with organic matter.

MCM Environmental Technologies, Fort Lee, New Jersey, USA

Founded in 1993 as a research and development company in Israel, reorganized in 1996 as a corporation in Burlington, Massachusetts, MCM Environmental Technologies has developed a medical waste treatment system called SteriMed. A little under a cubic meter, the SteriMed process uses a proprietary disinfectant called Ster-Cid in combination with a shredding, mixing process to help better distribute the disinfectant and simultaneously render the waste unrecognizable. Fully automated, the operator need only load waste into the chamber, close the lid, and push the start button. Once the process is initiated, the SteriMed adds a measured solution diluted Ster-Cid and the shredder/grinder is activated. The process grinds the material for approximately 12 minutes, and then releases the waste into a centrifuge where solids are gathered into a “filter sack”, and liquids are drained to sanitary sewer. The system is also available in a smaller capacity unit, the SteriMed-Junior.

Installations:
40-50 units worldwide

Approximate Cost:
NA
Capacity:
2 to 20 Gals. / 15 min. cycle

Advantages:
Does not require a lot of space.
Minimal personnel required (1 operator).
Highly automated process.

Disadvantages:
Relatively small capacity.
Requires purchase of disinfectant chemicals.

LYNNTECH, Inc., College Station, TX, USA

Lynntech has been developing a process which utilizes ozone gas as the primary disinfectant. In the process, waste is placed into a sealed container. A low speed shredder churns the waste as ozone, which has been generated on site, is pumped into the decontamination vessel and permeates the waste. While this technology is not yet fully commercialized, a demonstration unit was tested for three weeks at Lackland Air Force Base in Texas and the technology was also being reviewed for use in other waste treatment applications.

Installations:
No Commercial Installations

Approximate Cost:
N/A

Capacity:
N/A

Advantages:
Self contained chemical generation.
Ozone treatment does not add water weight to waste.
Technology can be delivered in a portable configuration.

Disadvantages:
New, unproven technology.
Maintenance costs associated with mechanical size reduction.

A compilation of some manufacturers of chemical processes is given below:

- Circle Medical Products, Inc.
- Environmental Waste International
- EnviroPack Development Corp.
- Lynntech
- Matrix Technology
- MCM Environmental Technologies
- Positive Impact Waste Solutions
- Waste Reduction by Waste Reduction, Inc.

7 Radiative Technologies

7.1 Microwave Processing

Microwaves are very short waves in the electromagnetic spectrum and fall in the range of the radio frequency band. Microwaves have wavelengths in the centimeter range and are below the range for infrared waves and above the ultra-high frequency (UHF) waves used for television.

Microwaves are generated using klystrons. Klystrons also are known as magnetrons. The klystrons convert electrical energy into microwave energy. The microwaves are directed into a metallic channel known as the “wave guide.” The guide focuses the microwaves into a particular location. Microwaves cycle very quickly between positive and negative at a very high frequency. The high frequency forces the molecules in the body that is receiving the microwaves to vibrate very rapidly as the molecules try to align to the changing electromagnetic field. The vibration produces friction and the friction results in the generation of large quantities of heat.

Unlike the general belief, disinfection in the microwave units is not a result of the microwaves. The steam produced from the moisture in the waste by the microwave energy brings about the destruction of the

pathogenic organisms in the waste. This is the reason why microwave systems in the health care waste sector require the addition of water (or steam) into the waste during the treatment process.

A typical microwave disinfection system includes three major types of equipment: 1) material handling, 2) the disinfection process itself, and 3) environmental management units.

The disinfection area includes a completely enclosed chamber into which the waste materials are introduced. The microwaves from the klystron are directed into the chamber.

There are various types and sizes of microwave systems. Some of the units range in capacity from a few kg per hour to more than 300 kg per hour. Some of the systems are operated as a batch process and others are operated in a semi-continuous mode. Large-scale systems can have from 1 to 6 microwave generators (magnetrons). Generally, each magnetron has a power output on the order of 1.2 kW.

In a typical microwave system, the waste to be treated is collected from the health care facility and transported to the treatment plant. Once in the plant, the carts are lifted using a hydraulic mechanism, a “charging gate” is opened and the waste is discharged from the carts into the hopper. At the same time as the waste is introduced into the hopper, steam also is injected into the hopper and air is extracted from the unit. All of the air that is removed from the unit is forced through a high efficiency particulate air (HEPA) filter. From the hopper the waste is transported to a size reduction device (generally a shredder). The shredded waste is conveyed by means of a rotating screw, exposed to steam. Eventually the temperature of the waste is elevated to between 95° C and 100° C using microwaves. In some systems, the treated waste is passed through a secondary shredder to achieve a higher degree of particle size reduction than with only one shredder. Similar to chemical treatment, secondary size reduction is critical in the cases where sharps are part of the waste stream.

Sanitec Microwave unit.

SANITEC, North Salem, New York, USA

This company manufactures three different microwave disinfection systems for the treatment of medical waste; two fixed units, and one mobile unit. The system is fully enclosed in a steel all-weather enclosure and weighs between 25,000 and 27,000 lbs (11,400 and 12,300 kg) depending on the model. The process begins with a lift/charging system which tips the waste into a hopper. Prior to opening, the hopper is treated with steam (at approximately 150°C), and then evacuated through a series of filters including a high efficiency particulate air (HEPA) filter. Once loaded, waste in the hopper is broken down by a rotating feed arm and shredded. Shredded material is then transported via a screw conveyor to the treatment chamber where the material is treated first by steam, followed by six 1,200 watt microwave generators. This process is continuously monitored to insure that the waste is heated to a temperature between 95° C and 100° C for a minimum of 30 minutes. Following exposure to the microwaves, the material is passed through an optional second shredder and then discharged. The combined size reduction is reported to achieve up to 80% volume reduction.

Installations:
Sanitec Inc. currently has 48 units operating in the US and an additional 24 units world wide.

Approximate Cost:
$500,000-$600,000
Capacity:
220-1000 lbs /hr (100 to 450 kg/hr)

Advantages:
Can be ordered as mobile unit.
Minimal personnel required (1 operator).
Self-Contained.
Automated.
No liquid waste, no sanitary sewer connection.
Minimal emissions.

Disadvantages:
Require careful waste segregation to avoid hazardous discharge, (i.e. No chemical, radiological waste, etc.)
Can produce offensive odors.
High initial cost.

CMB, Graz, Austria

CMB, or Chirstof Group/Maschinenbau, markets a small microwave unit for use at the point of generation. The Sintion (approximately one cubic meter in size) accepts one steam-permeable bag of waste per cycle and uses steam to heat the waste from the outside, and microwave energy to heat the waste from within. The operator manually loads one bag into the Sintion, and selects the appropriate treatment time generally between 10 and 30 minutes. After the treatment has finished, the decontaminated waste can be put through a shredder, or disposed of as is depending on local ordinance.

Installations:
N/A

Approximate Cost:
$45,000 US dollars
Capacity:
78 lbs /hr (35 kg/hr) max.

Advantages:
Small and portable.
Minimal personnel required (1 operator).
Minimal emissions.

Disadvantages:
Relatively low processing capacity
Require careful waste segregation to avoid hazardous discharge, (i.e., no chemical, radiological waste, etc.)
Can produce offensive odors.

A listing of some of the manufacturers of equipment based on microwave technology is presented below:

- CMB
- Environmental Waste International (uses microwave as source of energy for polymerization)
- Meteka
- Sanitec, Inc.

7.2 E-Beam

Health care wastes can also be treated by using electrical radiation. Most irradiation technologies use electron beam (e-beam) technology instead of Cobalt-60. In e-beam technologies, the high-energy electrons that are released damage the DNA in cells and cause the cells to die-off. In addition, e-beams may produce x-rays as the beams strike metallic surfaces. E-beams can also convert the oxygen in the enclosure into ozone. Both x-rays and ozone possess their own disinfecting properties. A typical system consists of an electron accelerator, a power supply, a shredder, and a compacting unit. Although there is some concern about residual radiation with the use of e-beams, there is no question as to the complications and risks involved when working with radioactive materials.

One technology uses radio waves in the 14 MZ range to increase the temperature in the wastes (similarly to microwaves) to the required temperatures to achieve some degree of disinfection. This system is not recommended for the treatment of infectious wastes.

Laboratories for Pollution Control Technologies, Coral Gables, Florida, USA

University of Miami's "e-beam" technology uses a conveyor system to deliver the waste into a treatment vault where the computerized system determines the rate to pass the waste through so as to apply the correct dose. The waste is then passed by the beam a second time, this time the opposite side of the container is exposed to maximize coverage area. Once the waste has been treated, the conveyor transports the waste to a shredder where the waste is rendered unrecognizable. Since some ozone is produced from the interaction between the e-beam and oxygen, air that is vented to atmosphere is first routed through an ozone removal system. This technology has been licensed for use in Florida, but is not yet fully commercialized.

Installations:
No Commercial Installations

Approximate Cost:
N/A

Capacity:
400lbs /hr (180 kg/hr)

Advantages:
Quiet.
Minimal personnel required (1 operator).
Few toxic emissions (some ozone).

Disadvantages:
Relatively new, unproven technology in this application.
Heavy shielding required for e-beam use could add substantially to costs.
Additional monitoring of radiation levels maybe necessary.

A partial list of developers of irradiation equipment is presented as follows:

- U. Miami E-Beam

8 Biological Processing

Biological processing, in particular, composting has been proposed as method of treating some health care wastes. Since composting is an exothermic process, if the process is conducted under proper conditions, the composting mass can reach temperatures that exceed 60˚C for relatively long periods of time. These temperature levels can destroy some pathogenic organisms.

Depending upon the characteristics of the residues used as feedstock to the composting process, the finished product may be used as a soil conditioner. However, it is extremely important that caution be used in controlling the materials used for composting and in monitoring the quality of the finished product to ensure the safety of the public and the protection of the environment. This is particularly important due to the fact that the composting mass may experience relatively wide gradations in temperature. The compost usually reaches the highest temperature levels near the center of the composting mass while the material on the perimeter or on the outer portions of the unit may not reach sufficiently high temperatures to inactivate undesirable microorganisms. On the other hand, the temperatures may reach levels that are conducive to the growth or re-growth of pathogenic organisms.

Although the composting process could be conducted in windrows, it is strongly recommended that composting of residues from health care facilities be performed in enclosed systems and that the feedstock to the composting units exclude infectious or potentially infectious residues.

Information on the effectiveness of composting for the treatment of infectious wastes has not been found in the open literature.

Bio Conversion Technologies, Norcross, Georgia, USA

Developed by Virginia Tech, University of Virginia and the Medical College of Virginia, Bio Conversion Technologies biological process uses a mixture of enzymes to digest and disinfect medical waste. Consisting of a delivery hopper, a grinder with HEPA filtration, a saturation tank, and a separator, the system grinds and then soaks waste while monitoring temperature, pH, and enzyme levels. Once the process is complete, the waste material is forced through an extruder where liquid waste is drained to sanitary sewer, and solids are disposed of with the regular waste stream.

Installations:
No Commercial Installations

Approximate Cost:
N/A

Capacity:
10 tons / day

Advantages:
No dangerous chemicals to handle.
Relatively simple, established technology.

Disadvantages:
Requires careful segregation to avoid hazardous discharge.
Though established technology, unproven in this application.
Added water weight to final discharge.

9 Sharps

Image from Earth-Shield, Inc.

The collection, treatment, and disposal of infectious and potentially infectious sharps present a unique problem in an already complicated arena. From the instant that a syringe, scalpel, or other sharp is utilized until the time that it is either destroyed, or otherwise rendered safe, it is a liability. The disposal is compounded during large immunization campaigns.

A large number of accidental needle sticks each year attest to the urgency of designing and implementing safe management practices. In addition, some countries have reported the re-use of disposable needles and syringes particularly by drug addicts. Although some of the alternative technologies described in the previous sections are capable of handling sharps, there are also several technologies which have been designed to specifically treat sharps particularly needles.

Most companies involved in the treatment of used needles do so in one of three methods. The first method is to destroy or deform the sharp on site using mechanical force or high heat. Some of these technologies destroy the needle and the syringe; other technologies destroy only the needle, while still others destroy the needle and render the syringe useless by breaking the nib or other critical parts. The second method is to render the sharp “unusable” by encapsulating it in a solid mass such as cement, plaster of Paris, or acrylic. The final method involves the safe collection and transport of the sharps to a facility capable of processing them in bulk such as a gasification facility.

EARTH-SHIELD Inc., Bakersfield, CA USA 

Earth-Shield manufactures Sharp-Shield, a sharps collection and encapsulation system sold in two volumes (64 oz. and 96 oz.). The Sharp-Shield system consists of a collection container partially filled with a sodium hypochlorite solution, and a container of "Solidification Compound" to be used when the sharps container is nearly filled. When in use, care givers deposit sharps into the collection vessel until the sharps have reached the fill line on the side of the sharps container. Once full, the "Solidification Compound" is mixed with water, and added to the sharps collection container up to the fill line. The temperature will then increase to approximately 82 °C, and the container can be boxed and then stored for a minimum of 24 hours to allow the compound to cool and solidify. Once the prescribed 24-hour storage period has elapsed, both the sharps container and the now solidified residue of "Solidification Compound" can be safely, disposed of with the regular trash.

Installations:
N/A

Approximate Cost:
$34.95-$40.95 US dollars
Capacity:
64-96 oz.(1.8-2.8 liters)

Advantages:
Small and portable.
Simple technology
Minimal emissions.
No electricity needed, so technology is candidate for fieldwork.

Disadvantages:
Relatively low processing capacity
Technology adds mass and volume

MedPro, Lexington, KY, USA

MedPro manufactures the Needlyzer needle destruction system. The unit is about the size of a shoebox and weighs approximately 3 kg. The Needlyzer is a desktop unit which uses electricity to oxidize up to a 30-gauge needle. Needles are inserted into a hole on the top of the unit and complete a circuit between two positively charged electrodes inside the unit creating an arc generating a temperature of approximately 1500°C at the point of oxidation. Once processed, needles are reduced to a "granular powder, oxidized ferrous, nickel and chromium…," which is collected in a replaceable cartridge capable of holding up to 5,000 processed needles. Any particulate that is emitted is filtered through a 3-piece filter. The Needlyzer is a battery-powered unit, which makes it a good candidate for use in rural and isolated areas, but battery supply and other factors such as durability should first be evaluated.

Installations:
N/A

Approximate Cost: $895.00
Capacity:
3,000-5,000 needles
Advantages:
Small and portable.
Minimal emissions.

Disadvantages:
Relatively low processing capacity
Some tests have demonstrated problems in high use environments such as bulk immunizations.

A listing of some manufacturers of equipment to treat sharps is shown below:

- Contaminatable Container Co.
- Earth-Shield Company
- EnviroPack Development Corp.
- Imagination Medical, Inc.
- Medical Innovations
- MedPro, Inc.
- Microtek Medical, Inc.
- Safeguard Medical Devices
- SPS Medical Equipment Corporation

10 Summary

A summary of the key advantages and disadvantages of some of the technologies evaluated is presented in Table 3.

Table 3. Summary of Analysis of Key Non-burn Technologies

Technology	Advantages	Disadvantages
Autoclave	Proven, straightforward technology Relatively inexpensive Minimal personnel required	May require additional size reduction Requires careful segregation Potential for offensive odors
Biological	No dangerous chemicals to handle Relatively simple technology	Requires careful segregation Unproven technology in this application
Chemical	Proven, easily understood technology Relatively low capital cost Simple to operate	High maintenance costs (assoc. with size reduction) Can be noisy Special training for handling and storage of chemicals Can produce toxic compounds when mixed with organic matter
Microwave	Modular Automated Self-contained Minimal personnel required No liquid waste produced Minimal emissions	Requires careful segregation Potential for offensive odors High capital cost
Pyrolysis/gasification	Almost complete destruction of waste No liquid waste produced Very little odor Heat may be recovered Automated operation	High capital and operating costs Process may emit dioxins Heat should be reused in the form of steam or hot water

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Attachment 1. List of Alternative Technology Manufacturers/Vendors Contacted

Vendor	Comments	Website	Company Location	Contact	Email	Phone	Fax:	Contact Address
Aegis Bio-Systems LLC	I	www.jyd-1500.com	Oklahoma, USA	Ron Mercer, CEO	Rmercer@Aegisco.com	888-993-1500	405-844-9364	2500 South Broadway, Suite 250 Edmond, OK 73013
Bio Arc, Inc.	I	www.BioArc.com	Florida, USA	Dan Boylan	DanBoylan@BioArc.com	877-887-7710 and 352-357-9020	352-357-9026	820 S Bay Street Eustis, FL 32726
Bioconversion Technologies	NI	www.biodisposal.com	Georgia, USA		info@biodisposal.com	770-300-9595	770-300-9599	c/o Bio Medical Disposal 3690 Holcomb Bridge Rd., Norcross, GA 30092
Biomedical Disposal, Inc.	NI	www.biodisposal.com	Georgia, USA		info@biodisposal.com	770-300-9595	770-300-9599	3690 Holcomb Bridge Rd., Norcross, GA 30092
BondTech Corporation	I	www.Bondtech.net	Kentucky, USA	Angel Aguiar	aaguiar@aol.com	305-275-5940	606-676-9157	2400 N. Hwy. 27 Somerset, KY 42503
Changing World Technologies	NI	www.changingworldtech.com			cwt@changingworldtech.com	516-486-0100	516-486-0460	460 Hempstead Ave. West Hempstead, NY 11552
Circle Medical Products, Inc.	I	www.circlemedprod.com	Indiana, USA	John Watson	circlemed@netdirect.com	317-541-8080	317-541-0646	5616 Massachusetts Ave Indianapolis, IN 46218
CMB	I	www.christof-group.at	Graz, Austria	Carmen Spinotti or Karin Wilfling	c.spinotti@christof-group.at or k.wilfling@christof-group.at	+43 / (0)316 685515-0	+43 / (0)316 685515-210	CMB Maschinenbau und Handels GmbH Plabutscherstr. 115 8051 Graz, Austria
Contaminatable Container Co. (aka* Safe Sharps)	NR		West Virginia, USA	John Bailey	jbailey@safesharps.com	304-325-2455 ext. 10		PO Box 1702 Bluefield, WV 24701-1702

Vendor	Comments	Website	Company Location	Contact	Email	Phone	Fax:	Contact Address
Daystar Technologies	NR		Tokyo, Japan			81-3-5275-2411	81-3-5275-2415	Nibancho-on Bldg. 47 11-6 Nibancho, Chiyoda-ku Tokyo 102, Japan
Duratek	I	www.duratekinc.com	Maryland, USA	David Weigle	dweigle@DuratekInc.com	865-425-4597	865-481-2555	1009 Commerce Park Dr., Oak Ridge, TN 37830
Earth-Shield Company	I	www.earth-shield.com	California, USA	Mark Rodgers	mrodgers@earth-shield.com	661-322-0300	661-322-2303	304 Yampa St. Bakersfield, CA 93307
Ecodas	I	www.ecodas.com	Roubaix, France		contact@ecodas.com	33-3-20-7098-65	33-20-2423-81	28 rue Sébastopol 59100 Roubaix, France
Ecolotec	I	www.eco-concepts.com	Ontario, Canada	Fred DeVries	devries@eco-concepts.com	519-826-0803	519-826-7648	545 Silver Creek Guelph, ON N1K 1S7 Canada
Electro-Pyrolysis, Inc.	I	www.electropyrolysis.com	Pennsylvania, USA	Dr. Kenneth Wittle	kwittle@electropyrolysis.com	610-687-9070	610-964-8570	996 Old Eagle School Rd., Suite 1118 Wayne, PA 19087
Endesco Clean Harbors	I	www.gastechnology.org	Illinois, USA	Francis Lau	francis.lau@gastechnology.org	847-768-0592	847-768-0600	Gas Technology Institute 1700 S Mount Prospect Rd. Des Plaines, IL 60018
Environmental Techtonics Corp.	I	www.etcsterlization.com	Pennsylvania, USA	Michael Allen	sterilizers@etcusa.com	215-355-9100	215-357-4000	125 James Way, South Hampton, PA 18966-3877
Environmental Waste International	I	www.ewmc.com	Ontario, Canada	Michael Vocilka	Michael.Vocilka@ewmc.com	905-686-8689	905-428-8730	283 Station St. Ajax, ON L1S 1S3 Canada
EnviroPack Development Corp.	I	www.needleeater.com	New Jersey, USA	Andre DiMino	andre@admtronics.com	201-767-6040	201-784-0620	224 Pegasus Ave. Northvale, NJ 07647
HI Disposal Systems/Golden State Energy	I	www.goldenstateenergy.com	Nevada, USA	Tom Damberger	Damberger@goldenstateenergy.com	916-541-5350	775-786-6661	312 W Fourth St. Carson City, NV
Hydroclave Systems Corp.	I	www.hydroclave.com	Ontario, Canada	Richard van der Wal	rvanderwal@hydroclave.com	613-389-8373	613-389-8554	672 Norris Court Kingston, ON K7P 2R9 Canada

Vendor	Comments	Website	Company Location	Contact	Email	Phone	Fax:	Contact Address
Imagination Medical, Inc.	I	www.imaginationmedical.com	Florida, USA	Gary Burdette	info@imaginationmedical.com	904-288-9100	904-280-0870	12855 Philips Hwy. Jacksonville, FL 32256
Interscience, Inc. (fka* Plasma Pyrolysis Systems)	I	www.intersci.com	New York, USA	James Woo	woojt@intersci.com	518-283-7500 ext. 11	518-283-7502	105 Jordan Road Troy, NY 12180
LogMed	I	www.logmed.de	Nienburg, Germany		info@logmed.de	050 21-600672	050 21-600673	Wilhelmstrasse 25 D-31582 Nienburg
Lynntech	I	www.lynntech.com	Texas, USA	Craig Andrews	Craig.Andrews@Lynntech.com	979-693-0017	979-694-8536	7607 Eastmark Dr., Ste. 102 College Station, TX 77840
Mark-Costello Co.	I	www.mark-costello.com	California, USA	Mark Kelleher	m.kelleher@mark-costello.com	310-637-1851	310-762-2330	1145 E Dominguez St. Carson, CA 90746
Matrix Technology	NR	www.iiq.com.au/matrix	Queensland, Australia	Michael Sumner Potts	msp@cairns.net.au	617-405-12955	617-405-18709	PO Box 1213 Cairns, Queensland Australia 4870
MCM Environmental Technologies	I	www.mcm-sterimed.com	New Jersey, USA	George Aaron	contact@sterimed.com	201-242-1222	201-592-0393	One Parker Plaza Fort Lee, NJ 07024
Medical Innovations	I		Massachusetts, USA	David Freedman	medicalinn@comcast.net	508-358-8099	508-358-2131	PO Box 148 Wayland, MA 01778
MedPro, Inc.	NR	www.needlyzer.com	Kentucky, USA	Robert Popoff	rpopoff@needlyzer.com	859-225-5375	859-225-5347	817 Winchester Rd., Suite 200 Lexington, KY 40505
Meteka	NR	www.Meteka.com	Burggasse, Austria	Roland Katschnig	roland.katschnig@meteka.com	(43)3572/85166	(43)3572/851666	A-8750 Judenburg Burgasse 108
Microtek Medical, Inc.	I	www.microtekmed.com	Mississippi, USA	Haley Irvin	hirvin@mikrotekmed.com	662-327-1863	662-244-3198	512 Lehmberg Road Columbus, MS 39702
MSE Technology Applications	I	www.mse-ta.com	Montana, USA	Jeff Ruffner	jruffner@mse-ta.com	406-494-7412	406-494-7230	200 Technology Way PO Box 4078 Butte, MT 59702
Oxidation Technologies	I	www.oxid-tech.com	Maryland, USA	Dave Smith	smithd@oxid-tech.com	410-990-9430	410-990-9431	PO Box 548 Annapolis, MD 21404
Peat, Inc.	NR	Peat.com	Alabama, USA	Omar Castellon	omar.castellon.peat.com	256-883-8954	256-883-8997	7529 Memorial Parkway SW Huntsville, AL 35802

Vendor	Comments	Website	Company Location	Contact	Email	Phone	Fax:	Contact Address
Positive Impact Waste Solutions **	I	www.piwsinc.com	Georgia, USA	Steve Dark	imwc@att.net	770-425-2049	770-425-1935	600 Kennesaw Ave., Ste. 100 Marietta, GA 30060
Safeguard Medical Devices	I	www.disintegratorproducts.com	Ohio, USA	Joe Adkins, CEO	ja@disintegratorproducts.com	440-717-9860	440-717-9863	403 Ken Mar Industrial Parkway, Ste. 475 Broadview Heights, OH 44147
San-I-Pak	I	www.sanipak.com	California, USA	Arthur McCoy	arthurmccoy@sanipak.com	209-836-2310 ext. 117	209-836-2336	23535 S Bird Road Tracy, CA 95304
Sanitec, Inc.	I	www.sanitecworldwide.com	New York, USA	J. Weinsten	jjw@sanitecworldwide.com		914-276-1453	PO Box 448 North Salem, NY 10560
SPS Medical Equipment Corporation	I	www.spsmedical.com	New Jersey, USA	Georgi Jossifov	gjossifov@spsmedical.com	800-722-1529	585-359-0167	6789 W Henrietta Rd. Rush, NY 14543
Startech Environmental Corp.	I	www.startech.net	Connecticut, USA	Steve Landa	sales@startech.net	203-762-2499 ext. 148	203-761-0839	15 Old Danbury Road, Ste. 203 Wilton, CT 06897
Sterile Technology Industries, Inc.	I	www.stichemclav.com	Indiana, USA	Joe Delloiacovo	jdelloiacovo@wr2.net	317-484-4200 or 973-989-2680	973-989-2681	32 Dogwood Trail Randolph, NJ 07869
Tempico	I	www.tempico.com	Louisiana, USA	Sid Alexander	salexander@tempico.com	985-429-9929	985-429-9740	1700 W Church St., Suite C Hammond, LA 70401
Thermoselect	NR	www.thermoselect.com	Switzerland			41-91-7562525	41-91-7562526	Via Naviglio Vecchio 4 CH 6600 Locarno
Tuttnauer USA	I	www.tuttnauer.com	New York, USA	Laura	Laura@tuttnauer.com	800-624-5836 ext. 167	631-737-1034	25 Power Drive Hauppauge, NY 11788
Unitel Technologies	NI		Illinois, USA	Alex Rhandhava		847-297-2265	847-297-1365	411 N Business Center Dr., Mount Prospect, IL 60056
Univec (fka Thermal Waste Technologies)	I	www.univec.com	Maryland, USA	Raphael Langford	univec2@msn.com	410-347-9959	410-347-1542	10 E Baltimore St., Ste. 1404 Baltimore, MD 21202

Vendor	Comments	Website	Company Location	Contact	Email	Phone	Fax:	Contact Address
U. Miami E-Beam	I		Florida, USA	Prof. Charles or Dean Thomas Waite	twaite@nsf.gov	305-284-2423 or 305-284-2908	305-284-2321 or 305-284-2885	Laboratories of Pollution Control Technologies PO Box 248294 Coral Gables, FL 33124
Vanish Technologies/LFR	NR	www.lfr.com	California, USA	Chuck Pardini		510-652-4500	510-652-2246	1900 Powell St., 12th Fl. Emeryville, CA 94608
Waste Reduction by Waste Reduction, Inc.	I	www.wr2.net	Indiana, USA	Joe Delloiacovo	jdelloiacovo@wr2.net	201-230-2913 or 973-989-2680	317-484-4201	5711 W Minnesota St. Indianapolis, IN 46241
WPS Company	I	www.RedBag.com	Maryland, USA	Bill Norton	WDNorton@redbag.com	443-524-4245		3051 Washington Blvd. Baltimore, MD 21230

* aka = also known as, fka = formerly known as.

** Represented by IMWC (International Medical Waste Corp.).

Comments: I, NI, and NR indicate responsiveness to marketing to the Philippines – I, interested; NI, not interested; and NR, not reported.

Department of Health
NATIONAL CENTER FOR DISEASE PREVENTION AND CONTROL

THE ADB TECHNICAL ASSISTANCE PROJECT ON SOLID AND MEDICAL WASTE MANAGEMENT

WRITESHOP ON THE REVISION OF HEALTHCARE WASTE MANAGEMENT MANUAL

August 20-21, 2002
PHILIPPINE CHILDREN'S MEDICAL CENTER
Quezon Avenue, Diliman, Quezon City

P R O G R A M

Day 01

8:00 to 9:00	*Registration*	*Secretariat*
9:00 to 12:00	*Opening program*	
	Invocation	*Engr. Sonabel Anarna*
	National Anthem	*Engr. Sonabel Anarna*
	Message/Welcome Remarks	*Dr. Myrna C. Cabotaje* *Director IV, NCDPC*
	Introduction of Participants	*Dr. Desiree M. Narvaez* *Medical Officer VII, EOHO*
	Write shop Overview	*Dr. Desiree M. Narvaez* *Medical Officer VII*
	Write shop Mechanics and Grouping of Participamts / Topics	*Engr. Danilo L. de Guzman*
	Small Group Workshops	
12:00 to 1:00	***LUNCH BREAK***	
1:00 - 5:00	*Small Group Workshop*	*Facilitators*

Day 02

8:00 - 9:00	*Continue small group workshops*	*Facilitators*
9:00 - 12:00	*Small Group Presentation and Critiquing*	
12:00 - 1:00	***LUNCH BREAK***	
1:00 - 4:00	*Continue Small Group Presentation and Critiquing*	
4:00 - 5:00	*Next Steps and Closing Program*	*Dr. Robert A. Sadang*

Emcee : Dr. Robert A. Sadang
Medical Officer VII, EOHO

Annex 6

Capacity Building and Stakeholder Participation

Metro Manila Solid Waste Management Project (TA 3848-PHI)
Workshop on
Medical Waste: Issues and Problems

August 8, 2002
8:00 a.m to 5:00 p.m
Lakadula/Jumabon Room, Sulu Hotel
Matalino Road., Diliman, Quezon City

PROGRAM

8:00 – 8:30	Registration	
8:30 – 8:35	National Anthem	
8:35 – 8:40	Introduction	
8:40 – 8:50	Welcome Remarks	Dir. Myrna C. Cabotaje, Dir. IV National Center for Disease prevention and Control, DOH
8:50 – 9:10	Project Overview	Dir. Albert A. Magalang Chairman Technical Working Group MMSWMP, DENR
9:10 – 9:25	Workshop Mechanics/Expectations	Dr. Luis F. Diaz, Medical Waste Specialist, ADB Consultant
9:25 - 11:00	*Workshop Session* • institutional issues • data on solid waste (quantities, composition) & monitoring • legislation/regulatory enforcement • public awareness & the media	
11:00 - 12:00	Group Presentations/Discussions	
12:00 – 1:00	Lunch	
1:00 – 2:00	Workshop Session 2 • waste storage treatment/disposal practices • financial management • waste segregation and collection practices • social factors-current issues & potential impact arising from change	
2:00 – 3:00	Group Presentations/Discussions	
3:00 – 400	Discussion of Other Issues/Open Forum	

Proposed Technical Working Group for Medical Wastes
ADB/TA

(1) Dr. Desiree Narvaez, Department of Health, Environmental and Occupational Health Cluster
(1) ADB/TA
(2) DENR:
    a. Juvinia Serafin
    b. NCR-EMB, Corazon Davis
(1) Department of Science and Technology
(2) Engr. Hubert Jimenez, Head Environmental and Occupational Health Cluster, Center for Health Development, NCR (Regional Inter Agency Committee on Environmental Health (RIACEH)
(1) DILG, Region IV
(1) MMDA
(2) Hospitals:
    a. Government-owned
    b. Privately-owned
(1) Department of National Defense
(1) Representative of LGU-owned health care facility

Health Care Waste Management
Working Group Meeting

AGENDA

April 22, 2003
(14:00 to 17:00, EIA Conference Room)

1. Discussion of previous working group meeting.

2. Discussion of results HCW analyses obtained thus far.

3. Presentation of Proposed Strategy for Metro Manila.

4. Establishment of next WG meeting.

5. Adjourn.

MEETING/VISIT:	**Technical Working Group Meeting**
PERSONS VISITED:	**Ms. Aloha Samoza, Coordinating Council for Private Sector Participation** **Ms. Emy Aguinaldo, DENR** **Ms. Grace Favila, ADB TA**
DATE:	**Tuesday, 22 April 2003, 2:00-5:00 p.m.**
ATTENDEES:	**L. F. Diaz**

1) Luis Diaz began the meeting with a review of the main tasks associated with the Medical Waste component. Dr. Diaz also described the work that had been accomplished thus far and briefed the group on the most recent activities:
   - Contribution to the preparation of DOH's Hospital Waste Management Manual;
   - Estimate of the number of health care facilities in Metro Manila;
   - Results of the waste characterization work done at EAMC; and
   - Estimate of the quantity of infectious waste produced by the various facilities.

2) Dr. Diaz also presented to the group two general options for the management of the infectious portion of health care wastes:

   Option 1 takes advantage of the existing microwaves acquired by the DOH through a loan from the Austrian Government combined with investments in new equipment. It has been estimated that 5 or 6 units would be required in combination with a minimum of 4 vehicles to provide collection services.

3) The next Working Group meeting was tentatively set for May 7, 2003 at 2:00 pm.

AGENDA

Medical Waste Management Implementation Plan for Metro Manila

June 9, 2003
Sulo Hotel, Quezon City, Manila

9:00 – 9:15 am	*Registration*
9:15 – 9:20 am	*Introduction*
9:20 – 9:30 am	*Welcoming Remarks* Director J. Amador (EMB)
9:30 – 10:00 am	*Strategy for the Management of Health Care Wastes in Metro Manila* Dr. Luis F. Diaz, Technical Team Leader, ADB TA
10:00 – 10:15 am	Coffee
10:15 – 10:45 am	*Options for Private Sector Participation* BOT Center
10:45 – 11:15 am	*Monitoring of Health Care Facilities' Waste and Its Final Disposition* Ms. Leah Texon, EMB
11:15 – 12:00 noon	*Discussion* All Participants
12:00 – 13:00	*Lunch*

Presentations

Annex 7. Sample Chain of Custody Form

Example of Chain of Custody Form

Department of Health Serial Number: _____

Manila, Philippines Reference: _____

Chain of Custody Form for the collection, transport and final disposal of Medical and Related Wastes

Waste Producer's Certificate

A (1) The material described in A (2) is to be collected from:
_____
and taken to _____
Signed _____Name_____
On behalf of_____ Position_____
Address _____ Tel. No. _____

A

Date and time of Collection: _____
_____
A (2) Description of the waste (quantity and type):

Collector's Certificate

I certify that I collected the consignment of waste and that the information given in A (1) and in A (2) is correct, subject to any amendment listed below:

I collected this consignment on _____
at _____ hours_____
Signed _____Name_____
On behalf of_____ Position_____
Vehicle Regist. No. _____ Tel. No. _____

B

Date and time of Collection: _____
_____
Address: _____
_____

Disposer's

Name and address of facility _____
This load was delivered in vehicle (registration no.) _____
at _____hours _____on (date) _____
and the collector gave his name as _____
Representing _____
I certify that the information given in A (2) and as amended where necessary at B is correct, subject to any amendment listed in this space:

C

Signed _____Name_____
On behalf of_____ Position_____

Annex 8. Proposed Minimum Requirements for Microbial Inactivation

Microbial inactivation refers to the effects of physical or chemical processes that render microorganisms incapable of multiplication. Such processes may either kill the organisms, or injure them to the extent that effective repair and subsequent growth are not possible. Level IV is the most stringent of microbial inactivation. It is advisable that infectious waste treatment systems be able to achieve Level IV microbial inactivation.

Level I Microbial inactivation: Level I microbial inactivation destroys most disease-causing microorganisms. It indicates the inactivation or kill rate of at least 99.9999 per cent (referred to as "6 log 10") for vegetative bacteria and fungi, fungal spores and viruses. Level I microbial inactivation alone does not imply the ability to inactivate mycobacteria and bacterial spores.

Level II Microbial inactivation: Level II microbial inactivation causes inactivation of virtually all organisms except bacteria spores. It indicates the inactivation or kill rate of at least 99.9999 per cent (6 log 10) for mycobacteria, in addition to Level I microbial inactivation.

Level III Microbial inactivation: Level III microbial inactivation indicates the killing of microbial life forms as evidenced by the inactivation of at least 99.99 per cent (4 log 10) for indicator spores which are intended to respond similarly to human pathogenic spores. Thus *B. subtilis* may be used may be used to indicate Level III microbial inactivation for moist heat treatment, since they exhibit thermal death data similar to species of the pathogenic spore-forming *Clostridium*.

Level IV Microbial inactivation: Level IV microbial inactivation indicates the killing of microbial life forms as evidenced by the inactivation of at least 99.9999 per cent (6 log 10) for indicator spores recognized as most resistant to the treatment process. For example, the inactivation of at least 99.9999 per cent of the bacterium B. stearothermophilus, recognized as most resistant to moist heat, is an indication of Level IV microbial inactivation by steam autoclaving.

A summary of the proposed minimum requirements for the treatment of infectious waste is presented in Table 1.

Table 1. Minimum Requirements for the Treatment of Infectious Waste

Level	Minimum Requirements
I	6 log 10 Inactivation of vegetative bacteria and fungi
II	6 log 10 Inactivation of mycobacteria
III	4 log 10 Inactivation of *B. Subtilis* (heat) or *B. stearothermophilus* (chemical)
IV	6 log 10 Inactivation of *B. stearothermophilus*

Annex 9

Financial Analysis of Proposed Options in the Medical Waste Strategy

Financial Analysis of Proposed Options in the Medical Waste Strategy

Introduction

There are two types of hospitals that are considered in this analysis: public hospitals on one hand and private hospitals on the other. Both of these should have a similar SWM policy, but their funding arrangements are different.

Analyses

Alternative Options

The information presented in Annex 9a shows that there are two different options for a combination of Public and Private hospitals to obtain the same end result, and the rationale regarding this is explained earlier. Each has different inputs and so the expenditures for every year are different for both cases. The costs for each option are shown in this Annex, and it is necessary to establish which of these options is the optimum in financial terms: this is determined by using a discounted cash flow technique at the rate of 12%. A Net Present Value (NPV) is calculated for each case, and it should be noted that as all the figures are costs, these NPV results are negative giving a Net Present Cost (NPC) and so the smallest negative value is the optimum. Operational benefits were not quantified, as these would be the same for each of the two alternative options. However, there were other benefits that accrue for each case which were different, and these were the residual capital values remaining after the 2003 – 2013 analysis period, and these were calculated and put as a benefit in the final year.

Comparisons of the two options

A discounted cash flow analysis was undertaken, and gave the following results. These are shown in Annex 9b for Option 1 and Annex 9c for Option 2.

Option	NPV
Option 1	-14.54
Option 2	-20.47

This shows that Option 1, with the smallest NPC, is therefore the preferred option.

Funding

Polluter Pays Principle

According to the polluter pays principle, each hospital is entirely responsible for the collection and disposal of all the waste that it generates. This is applicable to both the private and the public hospitals. The financial resources available to the hospital will dictate the choice of system and the standard of operations.

Private Hospitals

Private hospitals rely on fees and charges imposed on the public for the financing of their services, and with any increase in the SWM function, it would be expected that these would be passed onto the public as an increase in fees. Based on interviews with private hospital staff it is estimated that these costs are about 1 percent of total maintenance costs (exclusive of any staffing costs). In the overall financial affairs of the hospital, the required extra SWM charges would be small compared with other charges, and could be passed onto patients with only a small increase in fees.

Public Hospitals

Almost no hospitals, public or private, keep a separate record of expenditures for health care waste management. This function is usually incorporated in expenses for house keeping, grounds management or general administration and support services. It seems prudent to assume the same percentage of 1%, as mentioned above for private hospitals, as the expense for the SWM function in the public hospitals.

However, for public hospitals, the situation is worse since in some cases, the medical waste is disposed of together with general waste. The hospital administrations have no medical waste management plan since there is reportedly no budget. Funds are given to other priorities such as personnel services, equipment and procurement of medicine and medical supplies.

From meetings with the Department of Health, it is apparent that there will be no increase in the budget allocation to compensate for any increase in expenditure in the waste collection and disposal; it must come from within the already hard-pressed allocation from the Department of Health. However, any funds raised by the hospital from its patient charges, can be kept by the hospital, though it must be noted that at the same time that this was allowed, the Government introduced a reduced budget, which in all respects maintained the status quo. The Department of Health lays down the charging formulae for patient charges, and the hospitals are not allowed to change it.

Cash Flow Analysis

The data in Table 1 shows the cash flows for the two different options for the total hospital sector in Metro Manila under the different scenarios described above. The shaded column indicates the recommended option. Apart from Option 1 being the optimum case as described above, it is also the cheapest option over the project lifespan.

Table 1. Cash Flow 2003-2013
(Php Million)

YEAR	Option1	Option 2
2003	4.91	8.51
2004	1.96	2.45
2005	1.96	2.45
2006	1.96	2.45
2007	2.02	2.51
2008	1.96	2.45
2009	1.96	2.45
2010	2.60	3.09
2011	1.96	2.45
2012	3.82	7.25
2013	1.96	2.45
TOTAL	27.02	38.48

Each hospital will have to make its own adjustments to their budgets to accommodate the extra costs involved. As mentioned above, the private sector can do this by amending their fee structure. The public sector relies upon funding from the Department of Health, though it appears that there will be no additional funding for this extra cost, so this funding will have to be taken from the existing budgets with savings found from other areas.

METRO MANILA SOLID WASTE MANAGEMENT PROJECT ANNEX 9a

FINANCIAL ANALYSIS MEDICAL WASTE

	Option 1						Option 2					
INVESTMENT COST SCHEDULE	Public			Private			Public			Private		
Item	Life Span (years)	Capital Cost Each	Investment Year 1	Life Span (years)	Capital Cost Each	Investment Year 1	Life Span (years)	Capital Cost Each	Investment Year 1	Life Span (years)	Capital Cost Each	Investment Year 1
Fixed Equipment	10	250,000	250,000	10	1,250,000	1,250,000	10	250,000	750,000	10	1,330,000	3,990,000
Repair of Existing Equipment	10	300,000	300,000									
Building and Infrastructure	30	75,000	75,000	30	375,000	375,000	30	225,000	225,000	30	399,000	399,000
Trucks	8	80,000	240,000	8	80,000	400,000	8	80,000	240,000	8	80,000	400,000
Misc. (scales, etc.)	5	20,000	20,000	5	40,000	40,000	5	20,000	20,000	5	40,000	40,000
Total Investment Cost			885,000			2,065,000			1,235,000			4,829,000
Annual Amortisation Costs			91500			195500			116500			470300
ANNUAL COSTS												
Cost Item	No. of Units	Cost Each	Year 1 Costs	No. of Units	Cost Each	Year 1 Costs	No. of Units	Cost Each	Year 1 Costs	No. of Units	Cost Each	Year 1 Costs
Labour -- Labourers and Drivers	102	4320	440,640	60	4320	259,200	36	4320.00	155,520	66	4320	285,120
Labour -- Administrative	28	7200	201,600	10	7200	72,000	6	7200.00	43,200	12	7200	86,400
General and Administrative Costs	10%		64,224	10%		33,120	10%		19,872	10%		37,152
Operating and Maintenance Costs			265,500			619,500			370,500			1,448,700
Total Annual Costs			971,964			983,820			589,092			1,857,372

ANNEX 9b

METRO MANILA SOLID WASTE MANAGEMENT PROJECT

FINANCIAL ANALYSIS — MEDICAL WASTE

Option 1

2003 CONSTANT PRICES - INCREMENTAL VALUES

Php Mil

YEAR	COSTS							BENEFITS	NET
	Fixed Equip	Repairs Exist equip	Building Infrastructure	Other Cap Costs	Labour Costs	Admin Costs	Total	Total	BENEFIT
2003	1.50	0.30	0.45	0.70	0.97	0.98	4.91		-4.91
2004					0.97	0.98	1.96		-1.96
2005					0.97	0.98	1.96		-1.96
2006					0.97	0.98	1.96		-1.96
2007				0.06	0.97	0.98	2.02		-2.02
2008					0.97	0.98	1.96		-1.96
2009					0.97	0.98	1.96		-1.96
2010				0.64	0.97	0.98	2.60		-2.60
2011					0.97	0.98	1.96		-1.96
2012	1.50	0.30		0.06	0.97	0.98	3.82		-3.82
2013					0.97	0.98	1.96	2.10	0.14
NET PRESENT VALUE AT			12%		-14.54				

ANNEX 9c

METRO MANILA SOLID WASTE MANAGEMENT PROJECT

FINANCIAL ANALYSIS — MEDICAL WASTE

Option 2

2003 CONSTANT PRICES - INCREMENTAL VALUES

Php Mil

YEAR	COSTS							BENEFITS	NET
	Fixed Equip	Repairs Exist equip	Building Infrastructure	Other Cap Costs	Labour Costs	Admin Costs	Total	Total	BENEFIT
2003	4.74	0.00	0.62	0.70	0.57	1.88	8.51		-8.51
2004					0.57	1.88	2.45		-2.45
2005					0.57	1.88	2.45		-2.45
2006					0.57	1.88	2.45		-2.45
2007				0.06	0.57	1.88	2.51		-2.51
2008					0.57	1.88	2.45		-2.45
2009					0.57	1.88	2.45		-2.45
2010				0.64	0.57	1.88	3.09		-3.09
2011					0.57	1.88	2.45		-2.45
2012	4.74			0.06	0.57	1.88	7.25		-7.25
2013					0.57	1.88	2.45	4.57	2.12
NET PRESENT VALUE AT			12%		-20.47				

Annex 10

Outreach Materials
for
Hospital and Non-hospital Personnel

TO ALL HOSPITAL PERSONNEL
PLEASE OBSERVE GUIDELINES FOR PROPER WASTE MANAGEMENT

BLACK CONTAINERS
FOR RECYCLABLE MATERIALS

- Empty tin cans, bottles, tetrapak containers and medicine bottles
- Plastic containers (bottles, buckets)
- Empty medicine boxes, wrappers, etc.
- Magazines, newspapers, and other paper products

GREEN CONTAINERS
FOR BIODEGRADABLE MATERIALS

- Fruit and vegetable peelings
- Perishable wastes
- Leftover food
- Garden wastes

YELLOW CONTAINERS
FOR INFECTIOUS WASTES

- Dressings and bandages
- Materials with blood, secretions and other exudates
- Used tissue paper, gauze, cotton balls and gloves
- Disposable materials used for collection of blood and body fluids
- IV tubings and used syringes
- Foley catheters, suction catheters and tubings
- Wound drains

SHARPS CONTAINERS

- Needles
- Scalpels and blades
- Broken ampules, test tubes and glass slides
- Suture removal kits

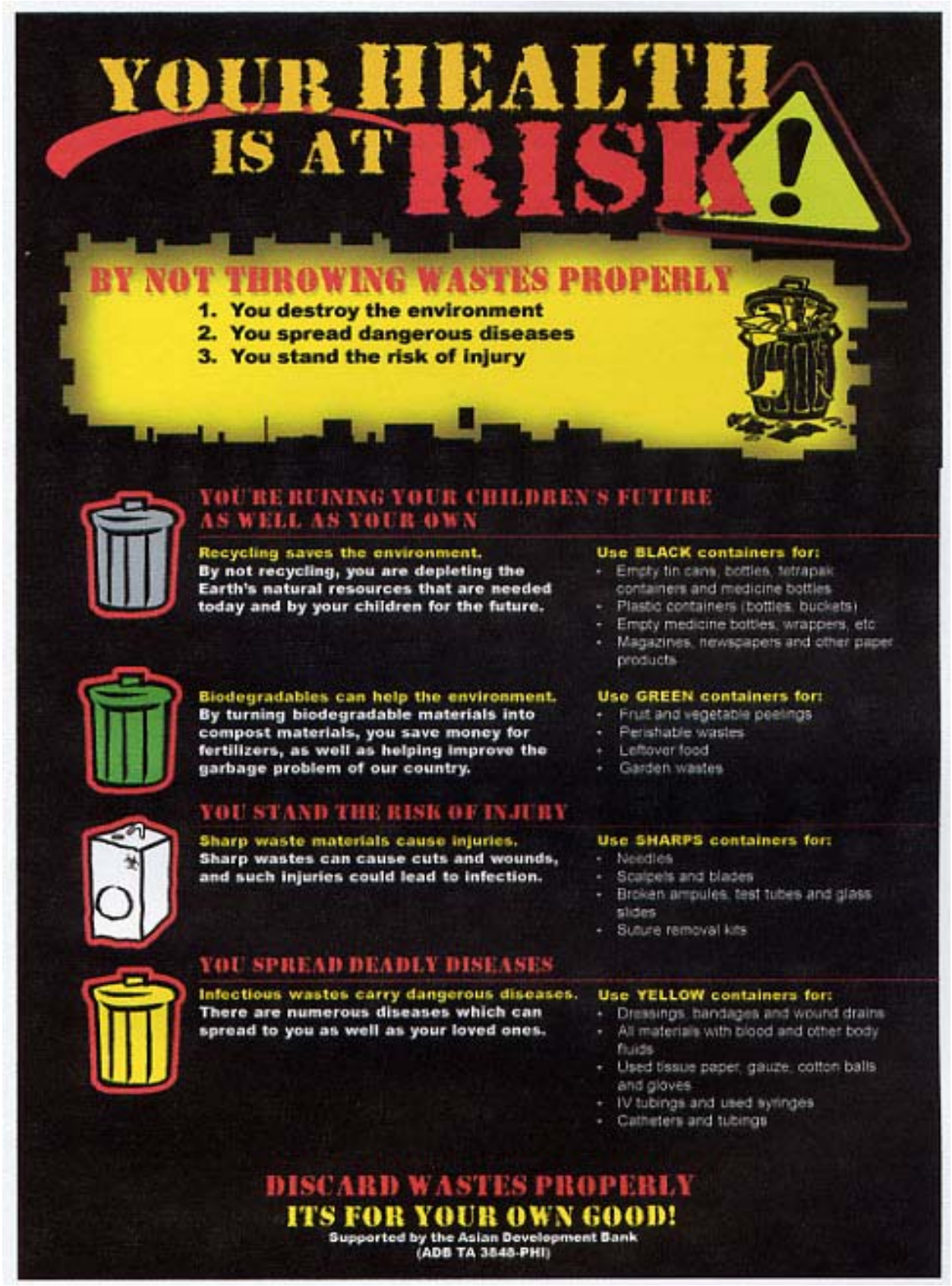
FOR YOUR STRICT COMPLIANCE

Hospital Management

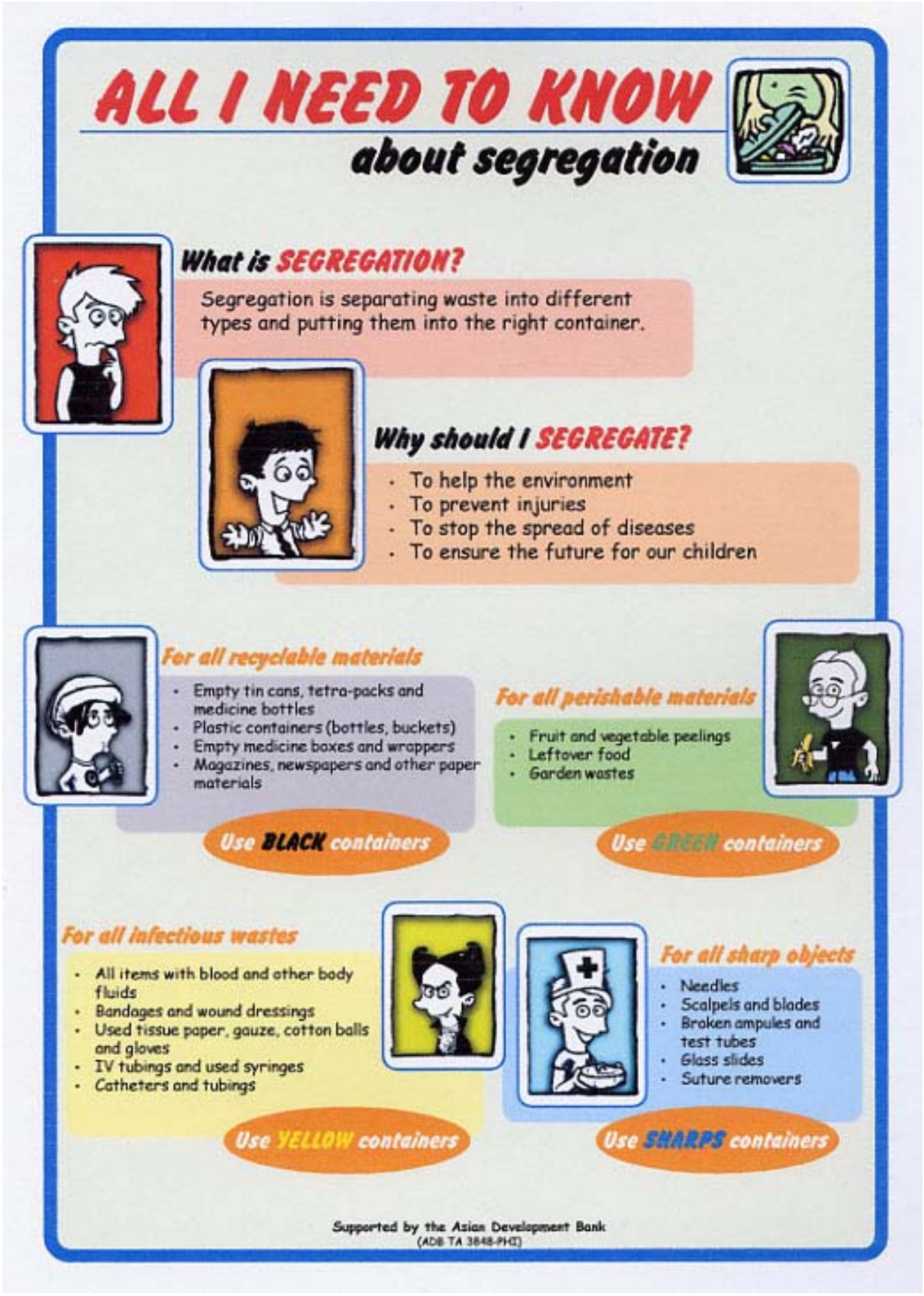
Supported by the Asian Development Bank
(ADB TA 3848-PHI)

Poster Concept 1, ICONs (hospital personnel)

Poster Concept 2, Let's Save Lives (hospital personnel)



Poster Concept 3, Your Life is at Risk (non-hospital personnel)



Poster Concept 4, All I Need to Know About Segregation (non-hospital personnel)