HNP DISCUSSION PAPER

Health Care Waste Management Guidance Note

Lars M. Johannessen, Marleen Dijkman, Carl Bartone, David Hanrahan, M. Gabriela Boyer, and Candace Chandra

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Health, Nutrition and Population (HNP) Discussion Paper

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Abbreviations Used in This Report

EA:	Environmental assessment
HCW:	Healthcare waste
HCWM:	Healthcare waste management
HIV:	Human Immunodeficiency Virus
HVB:	Hepatitis B
HVC:	Hepatitis C
ICC:	Infection control committee
MSW:	Municipal solid waste
TCDD:	Tetrachlorodibenzo-p-dioxin
WHO:	World Health Organization
CDC:	Centers for Disease Control
MSCS:	Micro and Small Enterprises
NGO:	Non-Governmental Organizations
USAID:	United States Agency for International Development
TOR:	Terms of Reference

Authors' Note

This guidance note should be viewed as an internal World Bank working document that attempts to synthesize the currently available knowledge and information in the field of healthcare waste management. There is much interest, but a lack of practical information, in this rapidly developing field. WHO has just released technical guidelines for healthcare facilities and waste management projects. These relatively comprehensive and explicit guidelines (Safe Management of Wastes From Health-care Activities, WHO, 1999) are the technical basis for this guidance note. In the meantime, we hope that this guidance note will help to fill the current information gap on specific issues relative to the World Bank.

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1. SCOPE OF THE PROBLEM

1.1 Healthcare Waste and its Management

Healthcare waste typically derives from two sources in developing countries: emergency relief donations (leftover from international donor response to either a humanitarian crisis or a natural disaster) and long term healthcare services. Healthcare services aim to reduce health problems and to prevent potential health risks. In doing so, however, waste is often generated that is potentially harmful to public health and the environment. Leftover emergency relief donations normally create a one-time healthcare waste issue, and can be dealt with in much the same way as long term healthcare services waste.

In several countries, where many health concerns often compete for very limited resources, the management of healthcare waste may not get the priority it deserves. The goal of this guidance note is to raise awareness of the importance of proper healthcare waste (HCW) management, help define the various types of healthcare waste, and offer practical guidance on ways to assess and improve HCW management in a variety of settings. This note intends to serve an internal World Bank audience.

1.2 Definition of Healthcare Waste Types

Most waste generated in healthcare establishments can be treated as regular solid municipal waste. But a varying proportion of HCW requires special attention, including sharps (e.g. needles, razors, scalpels), pathological waste, other potentially infectious waste, pharmaceutical waste, biological waste, and hazardous chemical waste. Collectively, these wastes are known as "special healthcare waste". In addition, all waste generated under certain circumstances, such as in isolation wards and microbiological laboratories, requires special attention. (See Annex A for the WHO definition of special healthcare waste and its components.) Other waste streams generated by HCW could include packaging, reusable medical equipment, and secondary waste created through disposal technologies.

The mismanagement of healthcare waste poses risks to people and the environment. Healthcare workers, patients, waste handlers, waste pickers, and the general public are exposed to health risks from infectious waste (particularly sharps), chemicals, and other special HCW. Improper disposal of special HCW, including open dumping and uncontrolled burning, increases the risk of spreading infections and of exposure to toxic emissions from incomplete combustion. For these reasons, occupational health and safety should be a component of HCW management plans.

Transmission of disease generally occurs through injuries from contaminated sharps. Infections of particular concern are Hepatitis B (HBV), Hepatitis C (HCV), and the human immunodeficiency virus (HIV). HBV, for example, can remain infectious for a week, even dried at room temperature, and the probability that a single needle stick will result in sero-

conversion is approximately 30 percent. For HIV and HCV, the probability that a single needle stick will result in sero-conversion is 0.3-0.5 percent and 2-5 percent, respectively (WHO, 1997). In the healthcare sector alone, the World Health Organization estimates that unsafe injections cause approximately 30,000 new HIV infections, 8 million HBV infections, and 1.2 million HCV infections worldwide every year. Toxic risks arise among others from reagents (particularly laboratory reagents), drugs, and mercury thermometers (CEC, 1993).

Furthermore, sensitivity is needed in the management of special HCW when dealing with biological waste. Many cultures have definite views on the disposal and burial of body parts. It is important to consider cultural factors in the disposition plans of special HCW. Additionally, appropriate consideration of local community perception in the proposed waste management plan for all HCW is integral to a sustainable disposition plan. This includes proper consideration of a reliable waste management plan for the community (Essential Waste Management Plan). Quite often, rural healthcare facilities will utilize different methods of waste management from urban health facilities.

Health Care Waste* is defined as the total waste stream from a healthcare establishment, research facilities, laboratories, and emergency relief donations. HCW includes several different waste streams, some of which require more stringent care and disposal:

1. **Communal Waste** is all solid waste **not** including infectious, chemical, or radioactive waste. This waste stream can include items such as packaging materials and office supplies. Generally, this stream can be disposed of in a communal landfill or other such arrangement. Segregation of materials which are able to be reused or recycled will greatly reduce the impact burden of this waste stream.
2. **Special Waste** consists of several different subcategories:

- *Infectious*: Discarded materials from health-care activities on humans or animals which have the potential of transmitting infectious agents to humans. These include discarded materials or equipment from the diagnosis, treatment and prevention of disease, assessment of health status or identification purposes, that have been in contact with blood and its derivatives, tissues, tissue fluids or excreta, or wastes from infection isolation wards. Such wastes shall include, but are not limited to, cultures and stocks; tissues; dressings, swabs or other items soaked with blood; syringe needles; scalpels; diapers; blood bags. Incontinence material from nursing homes, home treatment or from specialized health-care establishments which do not routinely treat infectious diseases (e.g. psychiatric clinics) is an exception to this definition and are is not considered as infectious health-care waste. Sharps, whether contaminated or not, should be considered as a subgroup of infectious health-care waste. Includes: Syringe needles, scalpels, infusion sets, knives, blades, broken glass.
- *Anatomic:* consists of recognizable body parts.
- *Pharmaceutical:* Consisting of/or containing pharmaceuticals, including: expired, no longer needed; containers and/or packaging, items contaminated by or containing pharmaceuticals (bottles, boxes).
- *Genotoxic:* Consisting of, or containing substances with genotoxic properties, including cytotoxic and antineoplasic drugs; genotoxic chemicals.
- *Chemical:* Consisting of, or containing chemical substances, including: laboratory chemicals; film developer; disinfectants expired or no longer needed; solvents, cleaning agents and others.
- *Heavy Metals:* Consisting of both materials and equipment with heavy metals and derivatives, including: batteries, thermometers, manometers.
- *Pressurized containers:* Consisting of full or empty containers with pressurized liquids, gas, or powdered materials, including gas containers and aerosol cans.
- *Radioactive materials:* Includes: unused liquids from radiotherapy or laboratory research; contaminated glassware, packages or absorbent paper; urine and excreta from patients treated or tested with unsealed radionuclides; sealed sources.

*Safe Management of Wastes from Health-Care Activities, WHO, 1999.

Proper management of HCW can minimize the risks both within and outside healthcare facilities. The first priority is to segregate wastes, preferably at the point of generation, into reusable and non-reusable, hazardous and non-hazardous components. Other important steps are the institution of a sharps management system, waste reduction, avoidance of hazardous substances whenever possible (e.g. PVC-containing products, mercury thermometers), ensuring worker safety, providing secure methods of waste collection and transportation, and installing safe treatment and disposal mechanisms.

Generally, there are four key steps to HCW management: 1) segregation into various components, including reusable and safe storage in appropriate containers; 2) transportation to waste treatment and disposal sites (see Annex B2); 3) treatment (see Annex D2); and 4) final disposition.

Technology Choices and Dioxins

Currently, each technology that ensures destruction or elimination of infectious and other types of special HCW potentially produces a secondary waste stream. When choosing an appropriate technology (e.g., incineration, autoclave, or microwave irradiation) for the type of HCW, a manager must review the secondary waste stream and the affected population. Weighing the balance of the technology (and its secondary waste stream) with the current problem (while assessing the cost benefit and available technologies) is a key point in decisionmaking. A comparison of different technologies and their secondary waste streams is in Appendix D. Quite often, successful HCW management includes several technologies within one facility.

Creation of dioxins (dibenzo-p-dioxins) are of particular concern due to the possible carcinogenic nature of these compounds. Incineration can create dioxins, depending on the HCW material and the temperature (and scrubbers) of the incinerator plant. Plastics and chlorinated substances (such as dyes) can create dioxins when incinerated. Therefore, segregation of materials is vitally important. Furthermore, ensuring that the incinerator plant continually burns its materials at a temperature at or above 1200 degrees will virtually eliminate dioxins from release. Further discussion can be found in Appendix D2.

Incineration remains an important technological tool in HCW management due to its ability to completely destroy infectious or contaminated materials (such as used syringes). In fact, in some instances, the public health threat from contaminated needles is of a much greater concern and probability than that of potential dioxins. Decision makers must make the difficult choice for the greater good of the population in a particular time and place.

1.3 How to Use These Guidance Notes

This guidance note should be viewed as a working document that attempts to synthesize the currently available knowledge and information in the field of healthcare waste management. There is much interest, but a lack of practical information, in this rapidly developing field. WHO recently formulated technical guidelines for healthcare facilities and waste management projects. This guidance note is meant to complement WHO's guidelines. The guidance note provides particular information necessary for World Bank projects (such as sample TORs).

As the source of both hazardous and non-hazardous waste, all healthcare facilities need to accept basic responsibility for good waste management. At the same time, overall management and disposal of HCW often has to be addressed in terms of municipal or regional waste management. Policies and plans to deal appropriately with HCW are needed from the healthcare facility up to the local, regional, and national level.

The objective of these guidance notes is to help project teams involved in the preparation and supervision of both healthcare projects and waste management projects. The notes can be used

in a variety of settings--from small to large healthcare facilities, and in local, regional, or national waste projects.

This note begins with a look at HCW management issues at small healthcare facilities with limited resources (Section 2). Section 3 looks at the more complex HCW issues at large healthcare facilities. Each of these sections includes a checklist for assessing a facility's current healthcare waste management practices, followed by suggested steps for improving HCW management at this level. These checklists (Sections 2.1 and 3.1) are designed to be used by managers of individual healthcare facilities, who may be working in conjunction with project team counterparts from the World Bank or other agencies.

Section 4 provides guidance on assessing municipal and regional healthcare waste management and implementing centralized waste treatment and disposal projects at the municipal level and above. Section 5 looks at steps for developing a national healthcare waste strategy. The note concludes with a summary of important reference works that can provide further guidance in the areas of healthcare waste management, solid waste disposal, and the design of training programs in these areas (Section 6).

The annexes provide additional details on management and regulatory issues, technology and cost considerations, environmental issues, packaging, and other important aspects of healthcare waste management.

1.4 Policy Options and a Decision Tree for Healthcare Waste Management

The policy framework surrounding HCWM in a country is extremely important for effectiveness. Not only are applicable laws and regulations important, but a method of enforcement is equally important. Policy issues surrounding HCWM include: transport, procurement, occupational safety, hazardous materials use and disposal, and pollution prevention.

Policy options for HCW management are varied and require local context in order to be effective. Cost is often the main driver for HCW management. Additionally, locally available technology and maintenance is an important consideration. Generally, a HCW management plan should be implemented from the onset of planning a healthcare facility.

Below are two decision trees devised to help project teams integrate HCW management into healthcare facilities. The first is a policy oriented framework. The second decision tree focuses on questions surrounding a specific installation. Further information can be found from Sections 2 to 6, which provide helpful checklists.

Figure 1.1 Decision Tree for HCWM at the National or Regional Level

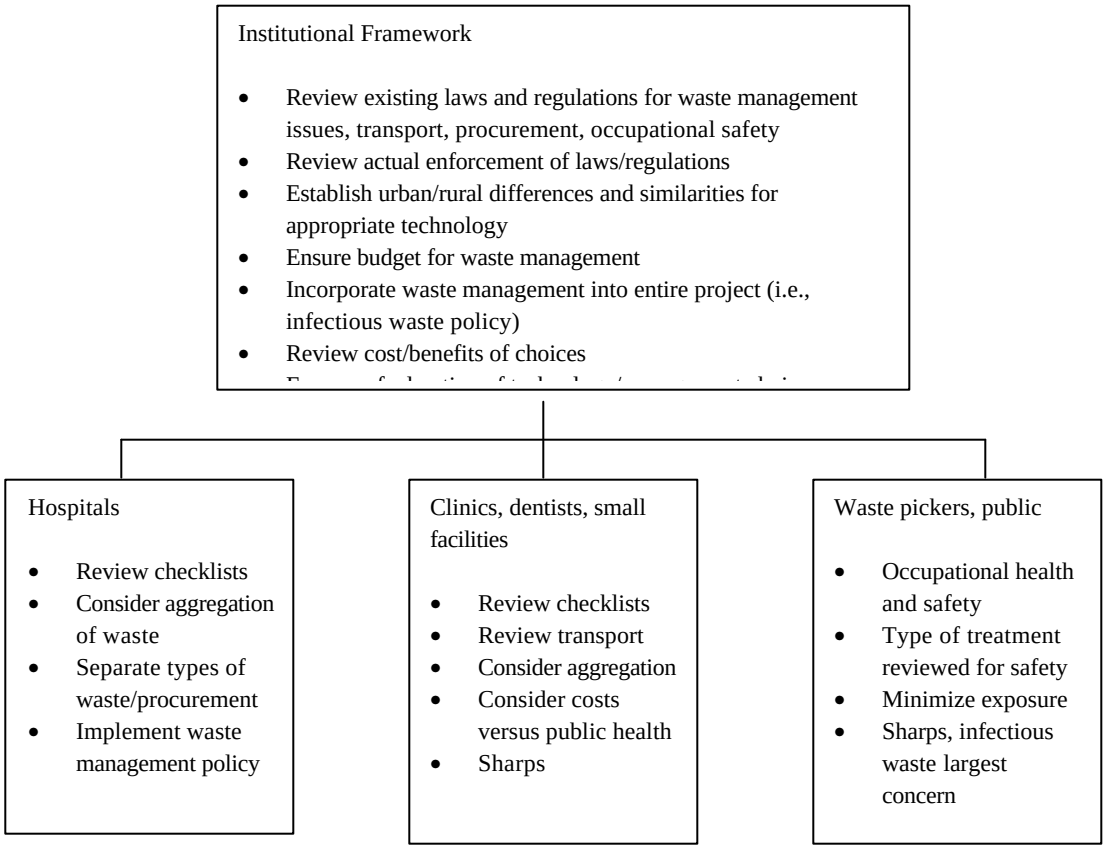

Figure 1.2 Decision Tree for HCWM at the Facility Level

Installation of new healthcare facility			
	Determine size		
	Determine prevalence of type of waste		
	Determine institutional framework in country/region		
		If urban	
			Consider air/water pollution
			Determine if other healthcare facilities in area with similar needs
		If rural	
			Review transport issues
			Review technology options for best feasibility (duration and availability of energy source, type of waste stream produced)
	Look at procurement issues for reducing waste stream; where can recycle/reuse		
	Institute measures for reducing burden of cost: reusing items; sending communal waste to landfill or other; picking appropriate technology for type and amount of waste		
	Review worker safety precautions at both facility and ultimate disposition site (this would include waste pickers)		
	Go over appropriate checklist for additional information/		
	Review sample TORs		
	Review costs of total waste management plan (from procurement, separation, transport-if any, treatment, final disposition, worker safety, environmental hazards, public perception)		
Dealing with pre-existing waste problem			
	Conduct site surveys using checklists		
	Determine whether waste stream is continuous or one-stop		
		If continuous	
			Look for nearby healthcare facility with similar types of waste and already instituted good waste management plan
			Determine whether need to institute local waste management plan on site
			Review reuse and treatment technologies for best local alternative
		If one-stop	
			Review institutional framework
			Determine transport, separation, treatment issues
			Pick most cost-efficacious treatment solution

2. GUIDANCE FOR SMALL HEALTHCARE FACILITIES WITH MINIMAL RESOURCES

This section is generally appropriate for small healthcare facilities (i.e. facilities with less than about 50 beds, immunization posts, reproductive health posts, and so on) that have relatively few resources to devote to HCW management. Guidance for larger healthcare facilities is found in Section 3.

To improve healthcare waste management in a small healthcare facility, it is important to begin by surveying the facility's current healthcare waste practices. Careful completion of the checklist in Section 2.1 should identify problems and risks involved in waste management at most small healthcare facilities. Even if no such problems are identified, however, there may be significant room to improve HCW management in order to enhance safety and prevent the development of problems in the future. The steps outlined in Section 2.2 are basic elements of good HCW management at small healthcare facilities and should be reviewed carefully by healthcare facility managers and project teams involved in healthcare or waste management projects. If a facility cannot implement these steps on its own, it should seek help from waste management experts. Section 6 of this report contains a list of information sources that may provide further assistance.

2.1 Small Facility Assessment Checklist

2.1.1 General facility information

- How many employees does the facility have?
- How many beds does the facility have, and what is the bed occupancy rate?
- What medical and supporting departments does the facility have? (Include pharmacy, laboratories, kitchen, general store).

2.1.2 Handling of healthcare waste

- How much healthcare waste is generated daily by each department or at each ward/lab within the healthcare establishment? (Waste quantity may be measured using a small hand-held scale).
- How much of this is special healthcare waste? (See Annex A for waste definitions). The answer to this question will help determine the magnitude of the problem and treatment method.
- What is the general composition of the waste, i.e. the percentage of plastic, cotton, food-waste, sweepings, and pathological-waste? Visit all wards, specialized departments, laboratories (including blood bank), pharmacy, kitchen, and general store to note the waste composition at each location. This can be determined visually, by glancing through the waste at the waste end-point inside the healthcare establishment.
- How and where is the facility's healthcare waste stored before collection?
- Does any formal or informal separation of waste take place? For example, are syringes kept separately for resale? This type of operation (resale of syringes) should not be

condoned. Are plastic I.V. sets kept separately for recycling? Are x-ray films collected for extraction of silver?

- Does the establishment generate any wastes of special concern, such as radioactive waste, cytotoxics, pathological waste, reagents, or outdated pharmaceuticals? How and in which department are each of these special wastes generated? How is their disposal handled?
- How is liquid waste handled? Specify for cytotoxics, reagents, and used x-ray film processing liquids. If the liquid waste is discharged in the sanitation system, where does the latter discharge and what is its capacity?

2.1.3 Treatment and disposal of healthcare waste

- What treatments (if any) are done to the waste before disposal? How efficient are the treatments and how are residuals handled?
- Is the healthcare waste disposed of at the healthcare facility or off-site?
- If any waste is taken off-site, how is the waste transported outside the premises of the healthcare facility? How is the waste packaged? What types of vehicles are used to transport the waste?
- Is any of the waste taken to a dump or landfill site? If so, what happens to the waste at this facility? Is the healthcare waste buried immediately after arriving at the landfill/dump? Is it burned on the site? Is it left unattended at any time after being unloaded?
- If there is open access to the landfill/dump, to what extent do waste pickers, children, or others have access to the healthcare waste?

2.1.4 Management issues

- Who is responsible for healthcare waste management at the healthcare facility?
- What are the current operational standards for HCW and what are the applicable national, regional, and local policies?
- How many people are involved in waste collection and are special skills required by the healthcare facility? What sort of worker safety measures are in place?
- Is procurement of new healthcare materials reviewed to reduce the waste stream and to avoid potential treatment problems (such as PVC)?
- What are the daily waste collection routines, including waste packaging?
- What are the transportation needs and costs?
- How much does HCW management cost the facility? Does the budget provision cover these costs?

2.1.5 Risks of the current waste management system

- Does the management of the healthcare facility have concerns about the facility's current HCW practices? If so, what problems do they identify?
- Does the assessment above indicate that the facility's current waste management practices pose any health risks to patients, nurses or doctors, other staff, or visitors? If yes, what kind of risks?
- Does the waste pose any risk to waste collectors? If yes, what kind?
- What are the risks for spillage of waste or for scavenging along the transportation route?

- Does the waste disposal system pose any risk to waste-pickers or users of resold/recycled waste? If yes, what kind?

2.2 Basic Steps in HCW Management at Small Facilities

2.2.1 Raise awareness at the management level and develop an integrated waste management plan

The managers of the healthcare facility need to recognize the importance of good healthcare waste management, and should designate a special group with responsibility for overseeing the situation. This may be done by setting up a waste management team or by working with an existing infection control committee. A waste management team should include, at a minimum, the manager of the healthcare facility and a representative for each of the following: procurement or accountants, physicians, nurses, and waste collectors. It is important to move beyond the committee and develop a waste management plan (including healthcare waste) for the facility that is integrated into the daily operations.

2.2.2 Ensure segregation of special HCW from other waste generated at the establishment

Using the information gathered in 2.1, categorize the waste generated at the facility as either municipal solid waste or special healthcare waste (see definitions in Annex A). The first priority should be segregating sharps and pathological waste from all other waste. Sharps must be put into rigid, puncture-proof containers, which should be available at the health worker's workplace. Pathological waste should be put into non-transparent plastic heavy-duty bags. When three-quarters full, the containers and bags should be disposed of safely. Toxic liquids and pharmaceuticals should also be separated from regular solid waste materials, and disposed of properly.

From a cost- and waste-management perspective, syringes that can be re-used (after proper cleaning and sterilization in a steam sterilizer) are preferable to disposable syringes. However, from a public health perspective, one-time use or auto-destruct needles are safer. Evaluation of local conditions are needed to make an informed decision. Badly designed needle crushers can lead to contamination of the crusher and the area around it, and/or generate many small sharps. WHO is currently developing affordable and safe needle crushers. The report entitled *Vital to Health? Briefing Document for Senior Decision-Makers* (WHO/USAID, 1998) listed in Section 6, contains more information on disposal of sharps. WHO has a new initiative devoted to the study and use of proper, safe injections (Safe Injection Global Network).

2.2.3 Determine the most appropriate treatment and disposal site for the facility's waste

Generally speaking, small healthcare facilities in urban areas should choose off-site treatment and disposal for both economic and safety reasons -- most often in the municipal landfill. Landfills must be carefully sited away from water sources, agricultural land, and land where other development might take place and should include liners to protect leaching. (Technical Guide on Solid Waste Landfills). Landfills should be protected from human and animal waste pickers. Burial of HCW and other municipal solid waste in a municipal landfill (see Table D2) could be done by the person who delivers the waste from the healthcare facility, or by a person

employed at the landfill. In either case, this person must receive specific instructions for such burial. Cytotoxics and other hazardous chemical wastes (see Annex A) should never be buried in a landfill, however. Instead, they need to be returned to the original supplier or incinerated at a central facility (see Annex D for the difference between burning and incineration). Other special HCW should also receive more intensive treatment to ensure a reduction in public health and environmental consequences.

Small, isolated facilities with limited resources and without access to centralized waste treatment and disposal may find burial of special healthcare waste their best solution. Such burial should be done only under controlled circumstances, in a secluded area following landfill principles, including liners, water diversion, groundwater monitoring, careful siting, and gas release mechanisms.

2.2.4 Develop and implement a healthcare waste management plan

Every healthcare facility should have or develop a waste management plan that includes daily routines for collection, handling, segregation, and packaging of the different categories of waste. Facility managers should ensure that this plan is in place, with adequate budget and personnel to implement it. Implementation of the healthcare waste management plan and routine monitoring should be carried out in parallel with the information/training program described below.

2.2.5 Train healthcare workers in proper HCW procedures

All healthcare staff should be aware of the facility's basic healthcare waste management plan and their role in the plan. This includes management and regulatory staff, medical doctors, nurses and nursing assistants, cleaners, waste handlers, and visitors to the facility. The waste management plan should be presented in simple terms and displayed in a diagram at all points of waste generation. Better health and environmental working conditions for waste handlers should be addressed in planning resources for waste management. This includes but is not limited to the use of protective clothing and specialized equipment to ensure worker safety as well as safety for the general public.

Hands-on staff training in the details of the waste management plan is optimal. Training should include:

- Basic information about HCW and the risks of bad management of HCW.
- Basic information on the facility's waste management plan.
- Each employee's responsibility and role in healthcare waste management.
- Technical instruction on application of the practices described in the waste management plan.

For more information on conducting training programs, refer to the *Teacher's Guide: Management of Wastes from Healthcare Activities* (WHO, 1998) listed in Section 6.

3. GUIDANCE FOR LARGE HEALTHCARE FACILITIES

The checklist and recommended steps outlined below are appropriate to guide a review of waste management operations at a larger healthcare facility (roughly speaking, more than 50 beds). They should also be reviewed during any major upgrading of a large healthcare facility, establishment of a new healthcare facility, or as part of regional HCW management projects. Section 3.1 provides guidelines for assessing current HCW management practices within the healthcare facility. Section 3.2 contains suggested steps to improve HCW management at the facility level. Centralized waste treatment and disposal often make sense for large healthcare facilities, especially those in large urban areas or in smaller communities served by a central waste facility or system. Section 3.2 thus also deals with assessing the municipal or regional context for a facility's waste management.

3.1 Large Facility Assessment Checklist

3.1.1 General facility information

Basic data

- How many employees are there at the facility in total and within each category? Categories should include doctors, nurses, other healthcare workers, waste collectors, cleaners, and other hospital staff.
- What are the facility's medical specialties and departments?
- How many beds does the facility have within each medical specialty?
- What other departments support the medical departments? Examples include laboratories, blood bank, radiology, operating theaters, intensive-care units, renal dialysis units, and outpatient services.
- What non-medical departments are there? These may include general store, laundry, operations and maintenance, workshops, kitchen, and waste management department.

Financial data

- What is the facility's annual budget?
- How much is spent on salaries and wages; medical supplies; pharmaceuticals; maintenance and services expenses; consumables; and waste management?

Health conditions among employees

- What is the prevalence of HBV, HCV, HIV, malaria, and syphilis among the categories of employees at the healthcare facility, compared to that of the general public?

3.1.2 Handling of healthcare waste

Healthcare waste composition and quantity

- What is the composition of the facility's healthcare waste? Determine by segregating random portions of the waste into defined waste categories (see Annex A). Weigh the total portion and each segregated fraction of the waste; a hand-held scale may be used.
- What are the major sources of special healthcare waste? How much is generated by each medical and non-medical department? Is HCW segregated?

- What are the major sources of liquid healthcare waste, hazardous waste, and radioactive waste? Can the source be reduced?
- What is the total quantity of HCW generated at the healthcare facility? This may be determined through a 1-4 week survey in which all waste generated/disposed of at the healthcare establishment is weighed. Weighing may be done by truckload (e.g. at a weigh bridge in the neighborhood of the healthcare facility) or by weighing every container/trolley immediately after collection.
- How much of this is special HCW (based on the composition proportions determined in step one)?
- What is the amount of total healthcare waste and special healthcare waste generated per bed per day?

Healthcare waste collection

- What are the facility's healthcare waste collection practices? Include:
  - Level of segregation at source of waste
  - Location of collection points at department/ward level
  - Storage before collection by waste collectors
  - Routines for waste and laundry collection (since laundry procedures often can be applied to healthcare waste collection)
  - Collection equipment (trolleys, push carts, etc.)
  - Storage before final disposal or external transportation
  - Special procedures for liquid wastes
  - Special procedures for pharmaceuticals and cytotoxics

3.1.3 Treatment and Disposal

Treatment and disposal on the facility premises

- What are the on-site practices for healthcare waste treatment? (e.g. crushing of sharps; sterilization; chemical disinfection; destruction through burning or incineration).
- What are the practices for on-site disposal? (e.g. landfilling or dumping of healthcare waste or residuals from treatment, incineration).
- Is any of the healthcare waste recycled? (e.g. using kitchen waste for animal feeding, recovering silver from x-ray films, reusing cardboard from the general store).
- Does informal segregation/recycling of waste (syringes, unused medicine, etc.) take place by healthcare workers or waste collectors? If so, does this informal activity contribute to healthcare workers' income?

The ability to properly treat and dispose of liquid healthcare waste should be included in this section.

Treatment and disposal outside the facility's premises

- Is the facility's healthcare waste treated at a central treatment facility before final disposal?
- Is the facility's healthcare waste disposed of at a municipal dump/landfill?
- Does any scavenging of healthcare waste occur at the treatment or disposal site? If so, what waste is being scavenged and how does it contribute to waste-pickers' income?
- How significant is the scavenging in terms of the number of people involved?

3.1.4 HCW management and regulations (*See* Annexes B and C for further information)

Healthcare waste management on the facility premises

- Which departments and staff members at the facility are involved in healthcare waste management?
- Who are the key people within the facility responsible for HCW issues? These are likely to include upper management, members of the infection control committee, the internal healthcare waste manager (if one exists), and the engineering department manager.
- Have any outside parties been hired to help with the facility's waste collection, treatment, transportation, or disposal? If so, what aspects of waste management are they responsible for, and who is accountable for their performance?
- Does the facility conduct any training and public awareness programs on HCW management?
- Who pays for hauling and disposal of special HCW? This is often paid for in part by the local government or through a subsidy from the Ministry of Health for shared facilities. See Section 4.2.4 on Financing.

The role of outside authorities

- Which authorities are involved in HCW management at the municipal/regional/ national level? These may include municipal waste management authorities for bylaws on disposal of healthcare waste; environmental authorities (local/regional) for emissions standards from treatment plants; health authorities (regional/national) for internal hygiene and infection control requirements; and occupational health authorities (local/regional) for regulations governing for healthcare workers and waste collectors.

Budget issues

- How much does HCW management cost the facility? Is the budget provision adequate for these costs?
- Who pays for hauling and disposal of healthcare waste? (This is often paid for by the local government or through a subsidy from the Ministry of Health for shared facilities).

Healthcare waste regulations

- What existing healthcare waste regulations govern the facility? Are they specific to the facility or set by a higher governing body?
- What regional and national regulations apply to the facility's healthcare waste situation?

3.1.5 Risks of the current waste management system

- Does the management of the healthcare facility have concerns about the facility's current HCW practices? If so, what problems do they identify?
- Does the assessment above indicate that the facility's current waste management system poses any health risks to patients, nurses or doctors, other staff, or visitors? If yes, what kind of risks?
- Does the waste pose any risk to waste collectors inside the hospitals? If yes, what kind?
- What are the risks for spillage of waste or scavenging along the transportation route?

- Does the disposal system pose risks to scavengers or users of resold/recycled waste? If yes, specify.
- Are there other problems involved in the handling of the facility's healthcare waste?

The ability to properly treat and dispose of liquid healthcare waste should be included in this section.

3.2 Basic Steps in HCW Management at Large Facilities

The steps outlined below are basic elements of good healthcare waste management at large facilities, listed in order of priority. These steps should be reviewed carefully by facility managers, even if completion of the checklist above does not identify problems or risks involved in waste management at the facility. If a facility cannot implement these steps on its own, it should seek help from waste management experts. Section 6 of this report contains a list of information sources that may provide further assistance.

3.2.1 Raise awareness

As described in 2.2.1, managers of the healthcare facility should raise awareness of the importance of proper HCW management and designate a group with responsibility for overseeing the HCW situation.

3.2.2 Ensure that special healthcare waste is segregated from other waste for disposal.

Healthcare waste must always be segregated into special HCW and other waste. Waste segregation facilitates safe handling of special HCW and minimizes the amount of special waste requiring special treatment or disposal techniques. First, sharps must be separated from all other waste and stored properly in appropriate containers (see also 3.2.5). If any radioactive waste is generated, international standards for disposal must be followed, as described in Annex C.

3.2.3 Determine appropriate treatment technology

Some decisions regarding treatment technology are made at the healthcare facility level and others are made at the national or regional level. The satisfactory destruction of special healthcare waste is a major problem facing health services today. Research and development are still needed to find inexpensive and acceptable ways of destroying special healthcare waste.

Landfilling of special HCW by burial in other municipal solid waste should only be considered for small quantities of waste. For a city with larger facilities, a special landfill cell or pit should be developed to receive special HCW. The cell should be fenced to restrict access by waste pickers and animals, and at the end of each day the HCW deposited should be treated with lime and covered with 10 cm of soil. For more information on landfilling of special HCW, refer to Rushbrook and Pugh, *Solid Waste Landfills in Lower- and Middle-Income Countries: A Technical Guide to Planning, Design, and Operation*(World Bank, 1999) listed in Section 6.

If land filling is not an option, incineration, sterilization (autoclave or microwave), chemical disinfection, or a combination of these technologies need to be considered. See Annex D for the difference between incineration and burning, and for a summary of different technologies for waste disposal and treatment.

3.2.4 Consider facility-based vs. centralized waste treatment and disposal options

The choice between on-site or off-site treatment and disposal is often a political decision made at the regional or municipal level. If a healthcare facility is very large, or located near many other healthcare facilities, potential economies-of-scale should play a role in the decision. In many cases, environmentally-sound incineration sterilization, and/or landfill disposal will necessarily take place off-site. However, a large healthcare facility with adequate technical and financial capacity can consider installing an incinerator and even providing services to other nearby healthcare facilities (at cost). The questions below may help facility managers prioritize their options.

- Is the healthcare facility part of a larger healthcare system?
- Is there a comprehensive waste management system locally or regionally?
- Do waste management organizations or service firms exist that could be part of this facility's waste solution?
- Are there any local treatment facilities or operators that specialize in healthcare waste management?

3.2.5 Ensure proper packaging and storage of special healthcare waste

Primary packaging and storage takes place where waste is generated. Secondary packaging is used for transportation. Primary packaging of special healthcare waste should be in leak-proof and disposable bags or containers. Containers for sharps must be puncture-proof and should not be made of glass. A color code of yellow or red should be chosen for all special healthcare waste. For pathological waste, the opposite (and non-transparent) color should be used. For secondary packaging, leak-proof solid containers mounted with wheels should be used for easy transport. Color coding of secondary packaging should follow the primary packaging color code. For environmental reasons, non-PVC products are preferred. (For more on packaging choices, see Annex F). The centrally located storage room should also be secured. In-house storage may consist of two levels: a) A well-ventilated room at or near the ward, where waste collectors will pick up the waste; and b) A centrally-located storage room, where temperatures can be kept low (e.g. air conditioned), until waste is picked up for treatment.

3.2.6 Ensure safe transportation of special healthcare waste on public roads.

If the waste treatment and/or disposal facility is located off-site, the vehicle that transports special HCW should be used exclusively for this purpose. The vehicle should also be able to accommodate the secondary transportation packaging in a safe and controlled manner. Details on the design of HCW transportation vehicles can be found in the *Safe Management of Wastes From Health-care Activities* (WHO, 1999) or *Healthcare Waste Management Handbook* (WHO, 1997 draft) listed in Section 6.

3.2.7 Determine whether or not an environmental assessment is needed

If major new waste treatment facilities are being planned, an environmental assessment study may be needed. Simple projects or the upgrading of healthcare waste management systems generally do not cause significant environmental impacts. However, if a healthcare project generates significant quantities of healthcare waste that overwhelm the existing capacity of the waste management system, or involves construction of major new waste disposal facilities, then a formal review of the environmental impact is needed. If the management of healthcare waste requires a municipal or regional solution that goes beyond the boundaries of the healthcare sector, an environmental assessment study may be required as for other similar works. (See Annex F for guidelines on conducting an environmental assessment).

3.2.8 Develop a HCW management plan for the facility

Every healthcare facility should have or develop a waste management plan that includes daily routines for collection, handling, segregation, and packaging of the different categories of waste. Facility managers should ensure that this plan is in place, with adequate budget and personnel to implement it.

3.2.9 Train healthcare workers in HCW management procedures

All healthcare staff should be aware of the facility's basic healthcare waste management plan and their role in the plan. This includes management and regulatory staff, medical doctors, nurses and nursing assistants, cleaners, waste handlers, and visitors to the facility. Hands-on staff training in the details of the waste management plan is optimal, as described in 2.2.5. For more information on conducting training programs refer to the *Teacher's Guide: Management of Wastes from Healthcare Activities* (WHO, 1998) listed in Section 6. Training programs should include proper instruction on the use of protective clothing, materials, and special equipment to ensure the safety of both the HCW worker and the general public.

3.2.10 Address scavenging issues

If scavenging has been identified as a problem, steps need to be taken to protect waste pickers and to prevent access to hazardous waste. If possible, waste-pickers should also receive assistance to move into other income-generating activities. Alternative methods of waste management might be considered in these cases, to help reduce the risk to public health.

4. GUIDANCE FOR MUNICIPAL, METROPOLITAN OR REGIONAL HEALTHCARE WASTE PROJECTS

This section deals with centralized healthcare waste management projects, which are often components of broader municipal/metropolitan solid waste projects or projects of the regional environmental authority. These projects often focus on proper treatment and final disposal of special healthcare waste at a central regional facility. Environmental authorities will primarily be concerned with indiscriminate disposal of special healthcare waste at open dumps and landfills. Public health authorities and environmental authorities also need to be involved in planning, licensing and monitoring. And, since the method of treatment employed dictates the level of segregation of special healthcare waste at its source, it is imperative that the managers of the affected healthcare facilities be involved in the planning stage of these waste projects.

Central waste facilities at the municipal, metropolitan or regional level offer several advantages over those at individual healthcare facilities in treating special healthcare waste:

- They are more cost effective through economies of scale.
- Provision of spare capacity is more economical.
- Future modification or expansion is less expensive
- Operations are more efficient.
- Reduction of emissions is more effective.
- Monitoring and supervision are easier than for dispersed facilities.
- Environmental monitoring and control are easier.
- Healthcare facility administrators can devote their full attention to the primary activities of the healthcare facility.
- Specialized private sector operators can be invited to design, build, and operate central waste facilities.

4.1 Regional Healthcare Waste Sector Assessment

A regional HCW sector assessment like the one outlined below is usually conducted by an outside consultant with expertise in healthcare waste management, due to the number of facilities and relative complexity of the issues involved.

4.1.1 General information

The first step is to identify all healthcare facilities in the area under consideration and gather basic information on these facilities. This basic information may be gathered for a "study sample" that includes one or more facility of each major type in the region, including, where relevant, university hospitals, regional hospitals, general hospitals, municipal hospitals, and other healthcare facilities. The data from facilities in this sample can then be extrapolated to get a picture of all the healthcare facilities in the region. Section 3.1.1 provides guidance on the type of data needed from each facility in the sample.

4.1.2 Healthcare waste issues

Assess the healthcare waste generation, storage, and collection at one major healthcare facility of each type in the sample. Section 3.1.2 indicates the type of information that should be gathered at each sampled facility. Extrapolate the results to cover the entire region. Next, review and analyze existing healthcare waste treatment and disposal systems (on-site and off-site) at each healthcare facility in the study sample, following the guidelines in Section 3.1.3.

Assess the current regulations covering healthcare waste management, treatment, and disposal in the region, following the guidance in Section 3.1.4. In addition, the assessment will need to:

- Determine air emission standards required by law and those likely to be required in the next ten years.
- Determine the permit requirements, including environmental building permits and other permits and procedures that healthcare waste treatment/destruction facilities need to address.
- Outline any public participation or public hearing requirements and procedures. For each requirement, list the lead agency to be contacted. Assess the typical time demands for proposed facilities to obtain permits and address environmental impact assessment and public participation requirements.
- Examine the existing training and public awareness programs on healthcare waste management at the healthcare facilities in the survey sample and prepare a training needs assessment for the region.

4.2 Planning New Regional Waste Management Projects

In cases where new municipal or regional treatment and/or disposal facilities are indicated by the assessment results, the steps below should be taken for siting and developing new facilities. During this planning stage, technical assistance will usually be needed from specialists with expertise in the following areas: waste management; environment; public health; training; financial analysis; regulatory and institutional issues; and procurement. Annex H provides sample Terms of Reference and more detail on how to conduct a feasibility study for a new facility.

4.2.1 Institute a waste management plan

A waste management plan should be integrated into the overall planning process (from procurement to treatment and disposal) to ensure the most cost-effective decisions are taken at all levels. The waste management plan should also incorporate aspects of infectious and hazardous materials management, often in conjunction with officials overseeing these aspects. Furthermore, a budget for waste management should be allocated from the beginning.

4.2.2 Ensure segregation of waste streams

Proper segregation of waste generated from healthcare facilities will greatly reduce the amount of waste that needs expensive treatment. For this reason, items such as foodstuffs, packaging,

and nonconsumable disposables (e.g., gauze pads) should be segregated from special HCW. Additionally, reusable items such as beds, bedpans, and other medical equipment should be segregated from special HCW. Only those items which pose a public health threat or are listed as special HCW should continue on to treatment (versus landfilling or reuse).

4.2.3 Determine appropriate technology

For the types and quantities of healthcare waste generated in the study area (relying on data from the cross-section of facilities included in the regional assessment), assess alternative technologies and facility sizes for waste treatment and destruction. The technologies to be considered include safe landfills, incineration, sterilization (autoclaves and microwaves), and chemical disinfection. (See Annex D for information on the advantages and disadvantages of each). Compare the alternatives on the basis of capital cost, operating cost, ease of operation, local availability of spare parts, local availability of operational skills, demonstrated reliability, durability, and environmental impact.

On the basis of this assessment, the consultant should be prepared to recommend a process flow for economically efficient and environmentally sound treatment and final disposal of healthcare waste at a regional facility, leading to a final choice of technologies.

4.2.4 Determine siting of facility

Once the choice of technology has been made, careful siting of the facility is required. For a regional facility it is cost-effective to select a site in or near the center of gravity for the waste catchment area. For most treatment facilities, non-sensitive industrial areas may be considered as a potential site. Public consultation/hearings must be held as part of the final assessment for siting of the treatment facility. (For detailed guidance on siting of a treatment facility, see information sources cited in Section 6). Other site considerations include:

- Accessibility.
- Distance from healthcare facilities.
- Distance to sensitive areas.
- Future development plans for the area.
- Possibility of buying the land.
- Proximity to cultural and historical sites.
- Noise and dust impact on nearby areas.
- If resettlement is an issue, the extent to which it is needed.
- Reliability of the power sources to run the treatment facility.

4.2.5 Financing

The regional or local government, potentially in conjunction with other municipal solid waste treatment and disposal activities, may finance a regional facility. An alternative approach is for

the private sector to provide the healthcare waste transport and treatment services for the entire region. Annex B contains more information on private sector participation.

Cost recovery at the regional level (public or private service provider) can be through user charges, based on the "polluter pays" principle, where each healthcare facility pays according to the volume of waste generated. Although user charges can generate substantial revenue, facilities are often unwilling to pay the full cost for treatment and disposal. This is true in general in municipal solid waste management systems and may also be true, although it has not been confirmed, in the healthcare sector. Experience in many countries has shown that charging the full cost of treatment and disposal may create incentives for indiscriminate disposal of waste. Therefore, enforcement of regulations is essential and financial incentives for healthcare facilities to improve their HCW management may be warranted.

In most cases, Micro and Small Enterprises (MSEs) should not become involved in the collection of healthcare wastes from hospitals and other medical establishments. It is acceptable for these businesses to become involved in the collection of non-hazardous, domestic wastes from medical establishments. However, separation of hazardous waste is sometimes not practiced. When environmental and health risks associated with healthcare wastes are known, MSEs may dump theses wastes at unauthorized locations.

4.2.6 Conduct environmental assessment

After determining the appropriate technology and site for the treatment facility, an environmental assessment of the project will be needed in most cases. A project that involves construction of a major new waste disposal facility, will generally need a formal review of the environmental impact. If proper management of the healthcare waste requires a municipal or regional solution that goes beyond the boundaries of the healthcare sector, then the responsible authority should undertake the environmental impact study. (See Annex F for guidelines on conducting an environmental assessment).

4.2.7 Conduct regional training and awareness program

Training at the regional level is a critical step for successful healthcare waste management. The training program should be designed for the following main groups: a) regional decision-makers and regulatory staff; b) healthcare facility administrators/managers; c) relevant regional/local authorities; d) solid waste managers (municipal and/or private); and e) healthcare and/or waste management workers (this can involve staff at all levels of waste management from healthcare staff who sort HCW, transport workers, disposition workers, and other related activities). The training aims to raise awareness of the health, safety, and environmental protection issues related to healthcare waste. The *Teacher's Guide*: *Management of Waste from Healthcare Activities* (WHO, 1998) provides detailed training curricula – see Section 6. An integral component of training would be the proper use of protective materials, clothing, and special equipment for HCW management workers and the general public.

5. GUIDANCE FOR NATIONAL HEALTHCARE WASTE PROJECTS

This section provides guidance for HCW management at the national level. The national government should regulate and enforce proper healthcare waste management, since mismanagement is associated with strongly negative health and environmental externalities. A sound national policy and planning framework is required to improve healthcare waste management.

Every country should have a national strategy for healthcare waste management, either separately or as part of its national solid waste management strategy. Developing such a strategy requires direct dialogue with the appropriate decision-making authorities. National authorities need to be committed to the process, and willing to change existing regulations and laws as necessary. The ministries involved are typically the Ministry of Health, the Ministry of Local Government; the Ministry of Labor, and the Ministry of Environment (see Annex B1).

To facilitate consensus-building, the national HCW planning process might be led by a task force that includes representatives from all the relevant ministries. It is frequently useful for the task force to hire outside experts to provide technical assistance in planning. Experts needed for a national planning project might include strategic planners and institutional experts on health and the environment; public health specialists; healthcare waste management/solid waste specialists; legal specialists; technology specialists; and economists. These experts should be familiar with the country, and it is essential that they work with local experts in all aspects of the national strategy and action plan.

This section is designed to be useful to national planners in various ministries whose area of responsibility includes or relates to HCW management. It includes guidance for conducting a national sector assessment (5.1) and preparing and implementing a national healthcare waste strategy (5.2). Existing strategies may need revision if they are not being implemented properly, if they are proving ineffective, or are leading to negative health and environmental outcomes.

Due to increasing private sector involvement in waste management activities, it is important to have established laws and regulations on all aspects of waste management (worker safety, adoption of segregation, transportation, treatment, and disposition). Increasingly, national ministries provide an oversight service, including monitoring and evaluation of services, emissions, and waste characterization.

5.1 National Sector Assessment

A national sector assessment can be carried out at various levels of detail, depending on the time and resources available. Information about the healthcare sector, types of facilities and current HCW management practices, may be collected by interviewing national and regional authorities, as well as by gathering data from a representational sample of facilities (as described in Section 4.1.1). The following should be included as a minimum:

5.1.1 General information

- Compile basic data on healthcare facilities in the nation (see 3.1.1). Include the total number of healthcare facilities (public, private, and military); the total number of hospitals with more than 50 beds; the total number of beds at all hospitals (nationwide, private, and public); the total national healthcare budget; and the estimated annual budget for healthcare programs nationwide.

5.1.2 Healthcare waste issues

- Estimate the total quantity of healthcare waste and special healthcare waste generation nationwide. A "quick and dirty" approach is to use key figures on healthcare waste generation per bed per day from other studies and extrapolate that to the number of occupied beds nationwide. In general about 10–15 percent of HCW is special HCW.
- Outline current HCW management practices, including segregation, transportation, and disposal.
- Identify ministries/authorities involved or potentially involved in HCW management at national, regional, and local levels (see Annex B). The distribution of responsibility between ministries/authorities should be identified. Also national and regional waste management training institutions that can contribute should be identified**.**
- Identify and review relevant legislation on HCW management, municipal solid waste management, hazardous waste management, and radioactive waste management (see Annex C).
- Identify international donor agencies active in the area of healthcare waste management and municipal solid waste management that can provide technical and financial support.

5.2 A National Strategy and Action Plan for HCW Management

5.2.1 Formulate a national strategy

Once the sector assessment is completed, planners can begin to identify a list of national priorities for HCW management that can be used as a tool to develop a national HCW management strategy. Where national legislation on HCW management already exists, the strategy should reflect the limitations provided by the legislation and recommend needed changes in the legislation.

A national strategy for HCW management should:

- Reflect priorities within healthcare facilities for treatment and disposal of healthcare waste.

- Set goals for and means of monitoring of infection control and environmental protection.
- Propose choice of technology for packaging, transportation, treatment, and disposal.
- Prioritize central or decentralized treatment and disposal.
- Reflect distribution of responsibility in the sector between national, regional and local governments.
- Make recommendations on private sector involvement.
- Propose an action and investment plan for implementation of improved HCW management.
- Propose mechanisms for financing healthcare waste management.
- Propose guidelines for HCW management training programs at facility and municipal/regional level.

5.2.2 Develop national guidelines

National guidelines for HCW management should provide practical and technical advice for those implementing the national strategy. In large countries where great differences exist in between regions, sub-national guidelines may also be considered. The guidelines should aim to accomplish the following:

- Establish legal frameworks for safe HCW management, healthcare establishment hygiene, and occupational health and safety.
- Compile and clarify/expand on definitions from legislation.
- Establish standards for emission from treatment and disposal facilities.
- Make recommendations for infection control procedures.
- Delineate responsibility of competent authorities, owners and managers of healthcare facilities, and healthcare waste treatment and disposal facilities.
- Provide guidance on segregation, packaging, collection, storage and transportation (internal and external) of healthcare waste.
- Provide guidance for treatment and disposal methods for healthcare waste (liquids and solids).
- Make recommendations on central or decentralized treatment of special healthcare waste.

The guidelines may also include recommendations on purchasing policy for goods, services and equipment; guidance on safe waste minimization; and models for private sector involvement in healthcare waste management.

5.2.3 Formulate a national action plan

A national healthcare waste strategy should include a plan for action, which may be implemented gradually through sustainable and affordable steps. These steps should include the following:

- Initial measures to be taken at all healthcare facilities for upgrading internal handling of special healthcare waste (e.g. provide steps for simple segregation of sharps from all other waste generated).
- Demonstration project at a national teaching hospital, including all steps of the developed strategy.

- Introduction of monitoring procedures for infection control, HCW management inside hospitals, and environmental impacts.
- Assessment of lessons learned from the demonstration project for incorporation in the next implementation steps.
- Development of regional and local institutional structure.
- Gradual implementation of strategy at teaching hospitals; regional hospitals; general hospitals; all other hospitals; and, finally, all healthcare facilities.
- In parallel, gradually plan and construct new treatment facilities as needed, that comply with the national strategy and regulations.
- Investment of the private sector in such areas as transportation and treatment.

5.2.4 Launch capacity-building and training measures

A national awareness program should be launched at the time of development of the national strategy for healthcare waste management. However, the awareness program should only be launched when appropriate means (budgetary and technical) for physical implementation of healthcare waste segregation plan are made available. The following target groups should receive training:

- Regulators and decision makers.
- Regional/municipal authorities.
- Healthcare facility managers.
- Healthcare workers and waste collectors.
- Transportation, treatment, and disposal operators.
- Local manufacturers of collection equipment and treatment facilities.

The *Teacher's Guide: Management of Wastes from Healthcare Activities* (WHO, 1998) provides detailed guidance on training programs (see Section 6).

5.2.5 Ensure adequate financing

Implementing a national strategy is a gradual process that often requires a minimum of one to two years. Depending on the level of local input, size of the country, and level of existing information, the budget to prepare a HCW management project at the national level may range from US$30,000 to as much as US$600,000.

An often important role for national authorities is to provide technical and financial assistance to lower-level authorities in implementing the national strategy. The Ministry of Environment and Ministry of Health may also help finance new waste regional treatment facilities when new healthcare waste management regulations are introduced. But these ministries are less likely to provide national subsidies for operation and maintenance of regional treatment facilities. Those generating the waste, i.e. the healthcare facilities, should absorb these costs based on the "polluter pays" principle. However, it should again be noted that recovering the full cost of treatment and disposal may create incentives for indiscriminate disposal. Therefore,

enforcement of regulations is also essential, and financial incentives for healthcare facilities to improve their HCW management may be warranted.

6. INFORMATION SOURCES AND REFERENCES

The following titles are good sources of information for project teams involved in the preparation and supervision of both healthcare projects and waste management projects. Several references are also very useful for healthcare facility managers, regulators, and policymakers involved in HCW management.

A. WHO publications in health-care waste management

Safe management of wastes from health-care activities, eds: A. Prüss, E. Giroult, P. Rushbrook, World Health Organization, Geneva, 1999, 228 pages, *price: SwF 72.-, SwF 50.40 for developing countries; English; French and Spanish in preparation.*
*Can be ordered from WHO, MDI, CH-1211 Geneva 27 (*e-mail:*publications@who.ch)*
This comprehensive handbook recommends safe, efficient and sustainable methods for the handling, treatment and disposal of wastes from health-care activities. It addresses not only a variety of technical options that have been applied in this field, but also organizational and policy issues that should be considered to achieve levels of health-care waste management that ensure the protection of public health. Although it particularly emphasizes the needs of developing countries and proposes approaches for gradual improvement, it provides a catalogue of options for diverse degrees of sophistication in health-care waste management. It is targeted at an audience of public health professionals, regulators and hospital managers and administrators.

Teacher's Guide – Management of wastes from health-care activities, A. Prüss & W.K. Townend, World Health Organization, Geneva, 1998, 227 pages, *price: SwF 35.-, SwF 24.50 for developing countries; English; French and Spanish in preparation.*
*Can be ordered from WHO, MDI, CH-1211 Geneva 27 (*e-mail: *publications@who.ch)*
The Teacher's Guide accompanies the forthcoming WHO publication on management of wastes from health-care activities. It provides teaching materials (ready-to-copy texts for overhead transparencies, lecture notes, handouts, exercises and course evaluation forms) and recommendations for a three-day training course. It is designed mainly for managers of health-care establishments, public health professionals and policy makers. This guide, and a selection of photographs to support training in health-care waste management is available from the WHO Web site:
http://www.who.int/peh/Watsanhealth/Environmental_sanit/health_care_waste.htm

Guidelines for safe disposal of unwanted pharmaceuticals in and after emergencies, World Health Organization, Geneva, 1999
31 pages, *Price: CHF 8.-, CHF 5.60 for developing countries*
*Can be ordered from WHO, MDI, CH-1211 Geneva 27 (*e-mail: *publications@who.ch)*
Practical guidance is provided on the disposal of drugs in difficult situations in or after emergencies, in relation to armed conflicts, natural disasters or others. In such situations, it may happen that large quantities of unwanted drugs accumulate due to difficulties, mismanagement of stocks and inappropriate donations. The guidance provided consists in relatively simple and

low-cost measures and is addressed to local authorities, health-care personnel or other professionals confronted to this type of problem. This document is available on-line on WHO's web site <http://www.who.int/dap/docs/drugdisp-gui.doc>.

B. Healthcare Waste Management

Hospital Waste Management in Four Cities: A Synthesis Report
Urban Waste Expertise Program, 1998
This document provides an overview of the techniques and systems applied to the segregation, storage, collection, disposal, and recycling of wastes generated in hospitals and other healthcare facilities in Bogota, Colombia; Hanoi, Vietnam; Karachi, Pakistan; and Manila, Philippines. The report focuses on the role of micro-enterprises and small enterprises in these processes.

Vital to Health? Briefing Document for Senior Decision-Makers (Draft), 1998
World Health Organization/US Agency for International Development (USAID)
This document provides information on unsafe injections. It illustrates misuse of medical sharps, and circumstances that lead to misuse of medical sharps. In addition, the document provides detailed information about safety standards for disinfecting sharps and for disposal of sharps, and addresses the choice of different kinds of injection equipment. The issue of waste management is also addressed.

Healthcare Waste: Local Authorities and Environment Series/ Solid Wastes.
World Health Organization/Regional Office for Europe, 1998
This document is most useful for middle-income settings and/or large healthcare facilities. It aims to help local authorities make informed decisions about healthcare waste management. The annexes contain practical information, which may also help both technical staff and public relations officers in their work.

Waste Incineration: Local Authorities and Environment Series/Solid Wastes
World Health Organization/Regional Office for Europe, 1996
This document aims to help local authorities make informed decisions about incineration as part of a complete waste disposal solution. The document contains practical information, which may also help technical staff and public relations officers in their work.

Managing Hospital Waste: A guide for health care facilities, M. Kela, S. Nazareth, A. Goel and R. Agarwal, SHRISTI, New Delhi, November 1999.
This guide, developed for Indian conditions, emphasizes that medical waste is a management issue and not a technological one. Technology can help but has to be part of a larger solution. Training for segregation, local housekeeping and disinfection, safety practices for nurses, ward boys and rag pickers from occupational hazards viewpoint, and waste minimization can only help and ultimately solve the problem of medical waste.

Guia para el Manejo Interno de Residuos Solidos Hospitalarios (Guide for Management of Healthcare Waste within Hospitals)
WHO, Pan-American Health Organization, CEPIS, and GTZ , 1994
This Spanish-language guide focuses on management of healthcare waste within hospitals in low- and middle-income countries. In addition, it includes data on management of solid wastes specific to Latin America. One of the annexes contains a methodology for quick evaluation procedures.

C. Waste Disposal

Solid Waste Landfills in Lower- and Middle-Income Countries: A Technical Guide to Planning, Design, and Operation
World Bank (Technical Report No. 426 (ISBN 0-8213-4457-9)), World Health Organization, Swiss Agency for Development and Cooperation, Swiss Center for Development Cooperation in Technology and Management, 1999
This guide presents practical, safe, and affordable approaches to solid waste landfills. By taking a "keep it simple" approach at all levels of operation, the guide focuses on a lower level of complexity, targeting senior managers in local government agencies. The guide considers climactic, cultural, and political factors, which significantly affect the criteria for selection, design, and operation of landfills. It includes minimum acceptable standards at all levels of the landfill's lifecycle. It is also available in summary form (see below).

Decision-Maker's Guide to Solid Waste Landfills (Summary)
P. Rushbrook and M. Pugh. World Bank, WHO, SDC, SKAT Edited by Maggie Thurgood, 1999
This report summarizes the technical document described above, and provides a tool for local politicians and others who must tackle the "hard core" issues of solid waste disposal but do not have technical background in this area.

Analysis of Priority Waste Streams: Healthcare Waste. Final Information Document
Commission of the European Communities (CEC), 1993
All the information in this document relates to the member states of the European Union. The document covers sources of healthcare waste; quantities produced; existing regulations; waste management systems and practices; transfer; treatment and final disposal; information; training and supervision of staff; and costs and risks of healthcare waste. Issues like prevention, re-use, and recycling are also addressed.

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Annex A: Healthcare Waste Terms Used in This Report

A. 1 Types of Healthcare Waste

Healthcare waste (HCW): The total waste stream from healthcare facilities, research facilities, and laboratories. Can be divided into municipal solid waste and special healthcare waste.

- ***No risk healthcare waste*** includes all waste comparable to domestic waste, such as packaging materials, non-infectious bedding, building rubble/demolition waste, hotel function waste (household, kitchen, administration), and other such wastes generated from patient wards and other patient care not related to medical care.

- ***Special healthcare waste*** always needs special attention and includes:

***Sharps*:** All sharp objects that could cause a cut or puncture (whether infectious or not) including hypodermic needles, suture needles, injector tips, scalpels, lancets, knives, blades, razors, pipettes, and broken glass (non-exhaustive list).
Pathological waste: Body tissues, organs, body parts, human fetuses, animal carcasses, liquid waste blood, plasma, coagulated factors, and body fluids.
***Redundant potential infectious waste*:** Disposable items contaminated with excreta, dressings, gowns, gloves, etc.; containers with blood products, I.V. tubing, emptied peripheral dialysis fluid bags, intravascular access devices introducers, culture dishes, microbiological slides and cover slips, test tubes, vials, vacutainers, etc.
***Hazardous chemical waste*:** Any substance, liquid or solid, with at least one of the following properties: explosive, flammable, toxic, corrosive, locally chafing, reactive or genotoxic (carcinogenic, mutagenic, teratogenic) including cytotoxic drugs. Also, all containers contaminated by these substances.
***Pharmaceutical waste*:** All pharmaceutical products, drugs, drug residuals and therapeutic chemicals that have been returned from wards; have been spilled; are outdated, contaminated, or are to be discharged because they are no longer required. Particular attention should be given to these wastes in the segregation process, as they may otherwise be resold by waste pickers.
Radioactive waste: Solids, liquids and gaseous waste contaminated with radionuclides. This type of waste is generated from in vitro analysis of body tissues and fluids, in vivo body organ imaging and tumor localization, and investigative and therapeutic procedures.
Pressurized containers: Containers holding gases used for anaethesia, oxygen delivery, or cleaning mechanisms. Can include gas cylinders, cartridges, and disposable aerosol cans. The most common types of gas are: ethylene oxide, oxygen, and compressed air.

The WHO definition for special HCW is found in the box below.

Health Care Waste* is defined as the total waste stream from a health care establishment, research facilities, laboratories, and emergency relief donations. HCW includes several different waste streams, some of which require more stringent care and disposal:

1. **Communal Waste** is all solid waste **not** including infectious, chemical, or radioactive waste. This waste stream can include items such as packaging materials and office supplies. Generally, this stream can be disposed of in a communal landfill or other such arrangement. Segregation of materials which are able to be reused or recycled will greatly reduce the impact burden of this waste stream.
2. **Special Waste** consists of several different subcategories:

- *Infectious*: Discarded materials from health-care activities on humans or animals which have the potential of transmitting infectious agents to humans. These include discarded materials or equipment from the diagnosis, treatment and prevention of disease, assessment of health status or identification purposes, that have been in contact with blood and its derivatives, tissues, tissue fluids or excreta, or wastes from infection isolation wards. Such wastes shall include, but are not limited to, cultures and stocks; tissues; dressings, swabs or other items soaked with blood; syringe needles; scalpels; diapers; blood bags. Incontinence material from nursing homes, home treatment or from specialized health-care establishments which do not routinely treat infectious diseases (e.g. psychiatric clinics) is an exception to this definition and are is not considered as infectious health-care waste. Sharps, whether contaminated or not, should be considered as a subgroup of infectious health-care waste. Includes: Syringe needles, scalpels, infusion sets, knives, blades, broken glass.
- *Anatomic:* consists of recognizable body parts.
- *Pharmaceutical:* Consisting of/or containing pharmaceuticals, including: expired, no longer needed; containers and/or packaging, items contaminated by or containing pharmaceuticals (bottles, boxes).
- *Genotoxic:* Consisting of, or containing substances with genotoxic properties, including cytotoxic and antineoplasic drugs; genotoxic chemicals.
- *Chemical:* Consisting of, or containing chemical substances, including: laboratory chemicals; film developer; disinfectants expired or no longer needed; solvents, cleaning agents and others.
- *Heavy Metals:* Consisting of both materials and equipment with heavy metals and derivatives, including: batteries, thermometers, manometers.
- *Pressurized containers:* Consisting of full or empty containers with pressurized liquids, gas, or powdered materials, including gas containers and aerosol cans.
- *Radioactive materials:* Includes: unused liquids from radiotherapy or laboratory research; contaminated glassware, packages or absorbent paper; urine and excreta from patients treated or tested with unsealed radionuclides; sealed sources.

*Safe Management of Wastes from Health-Care Activities, WHO, 1999.

A.2 Types of Healthcare Facilities

The facilities generating healthcare waste considered in these guidance notes include:
***Hospitals*:** Including private and public hospitals, university hospitals, general hospitals, district hospitals, and military hospitals.
Other types of health facilities: Including blood banks, convalescent nursing homes, dental clinics, emergency medical care centers, facilities implementing vaccination programs, healthcare centers and dispensaries, obstetrical and maternity clinics, out-patient clinics, dialysis centers, first-aid posts and sick bays, long-term healthcare establishments and hospices, transfusion centers, military medical service centers, mortuary and autopsy centers, animal research and testing facilities, veterinary service centers, and pharmacies.
Related laboratories and research centers: Including medical and biomedical laboratories, biotechnology institutions, and medical research centers.

Annex B: Management Issues

B.1 Authorities Involved in Healthcare Waste Management

- ***Healthcare Facility Authorities***

Healthcare facility management: The upper management of each healthcare facility has overall responsibility for healthcare waste management. However, routine healthcare waste management is often delegated to an engineering or waste collection department. The handling of healthcare waste at the ward/department level is usually the responsibility of the person in charge of each ward/department.

Infection control committee (ICC): The authority within the healthcare facility that customarily sets hygienic standards, monitors hygiene, and guides the relevant health surveillance. The ICC may also be responsible for awareness campaigns, training of personnel, and setting standards for the use of chemicals and pharmaceuticals. The ICC therefore plays an important role in successful implementation of a HCW management program. It is important to involve the ICC at an early stage of project preparation at healthcare facilities.

Some large hospitals can also have a separate "Waste Management Committee"

- ***Municipal and Regional Authorities***

Health authorities: Regional or municipal health authorities are likely to be involved in HCW management, in terms of monitoring healthcare facilities, infectious diseases, and occupational health issues. However, only the national health authority will normally be responsible for setting healthcare waste management policies and regulations and enforcing them.

Environmental authorities: These authorities often operate as regional divisions of a national environmental authority, delegated with implementing and enforcing national regulations and legislation. With respect to HCW management, regional environmental officials are often responsible for setting emissions standards for treatment plants, approval of environmental (impact) assessments (*see* Annex F), and licensing of treatment and/or disposal facilities. The regional authorities may also be responsible for supervision and monitoring of transportation, and treatment and final disposal of special HCW.

Solid waste management authorities: These may be a municipal or, in larger metropolitan areas, inter-municipal authorities. They are responsible for collection, treatment, and final disposal of municipal solid waste (MSW). If no special treatment is provided for HCW, it is

often handled as MSW. The system for transportation, treatment, and disposal of such HCW will therefore normally be the responsibility of the local solid waste authorities.

- ***National Authorities***

Health authorities (usually the Ministry of Health [MoH]): The responsibility of a health ministry in the area of HCW management is to regulate HCW procedures inside healthcare facilities, including infection control and surveillance related to handling of healthcare waste. Changes in organizational arrangements in public hospitals may, in some countries, require approval, from the MoH.

Environmental authorities (usually the Ministry of Environment, Environmental Protection Agency): The responsibility of national environmental authorities in relation to healthcare waste management is to regulate and set standards for emissions and monitoring of treatment and final disposal facilities for HCW.

Occupational health authorities (often the Ministry of Social Affairs, the Ministry of Labor or the Ministry of Health): Their responsibility within HCW management is to regulate and set standards for safety of waste collectors and handling of healthcare waste, both inside and outside of healthcare facilities.

B.2 Role of the Private Sector

Private sector participation in healthcare waste management is possible at different levels. At the simplest level, the private sector may be subcontracted solely to provide waste transportation services to individual healthcare facilities. At the other end of the spectrum, the private sector may sign a contract to Build, Operate, and Transfer (BOT) or Build, Own, and Operate (BOO)[1] an entire HCWM treatment or disposal facility.

The private sector can play a significant role in providing waste treatment and disposal services if the contract establishes a clear set of rules about division of responsibilities between the parties involved (i.e. regulatory authority, healthcare facility, and private operator). The essential conditions for private sector participation are transparency, competition, and accountability. Adequate budget provision is also required at the healthcare facility or the local authority level to pay the private operator.

In the three countries described below, private contractors play differing roles in HCW management:

[1] For guidance on contracting services see draft in progress, "Checklist of Issues to be covered in different types of MSWM Contracts," World Bank May 11, 1997.

Malaysia:
Following a strategy for healthcare waste management developed by the Ministry of Health, Peninsula Malaysia is divided into three HCW management zones. Each zone has contracted a concession to a private company for 15 years. Within the concession zone, the private contractor is obliged (and restricted) to provide bins and bags for collection, internal collection and storage, external transport, and a central localized incinerator for special HCW generated at MoH hospitals. The three contractors can compete throughout Malaysia for handling of special HCW from private hospitals. The contractors must meet Malaysian standards for segregation, transportation, and treatment. The most stringent standard is treatment--all special healthcare waste must be incinerated and incinerator emissions must meet standards equivalent to those of the European Union (EU).

Republic of South Africa:
The state of Kwa Zulu/Natal (eastern part of South Africa) has one centrally-located incinerator for treatment of all special HCW generated in the state. The incinerator is located at the largest landfill of Durban and is operated by the city of Durban. Transportation of special HCW from healthcare facilities to the incinerator is carried out under individual contracts between each hospital and a private licensed contractor.

Mexico:
Mexico City has developed a free market for handling of healthcare waste. The market for HCW management is open to any private licensed contractor. So far, at least fourteen contractors are handling HCW in Mexico City's metropolitan area, either through autoclaving, radiowave irradiation or incineration. Contracts with hospitals range from one to five years in duration.

Annex C: National and International Healthcare Waste Regulations

- **National Regulations**

Healthcare facilities and centralized treatment/disposal facilities need to comply with relevant national legislation. This would include waste regulations; regulations on environmental and health impact assessments; environmental emissions standards; prevention and control of infectious disease regulations; regulations on management of radioactive materials; and emergency special procedures.

Few developing countries have appropriate laws and/or regulations concerning HCW management. In countries where such laws exist, they generally focus on treatment aspects of healthcare waste, usually by providing for on-site incineration. But on-site incineration may be neither cost effective nor environmentally sound.

Regulations developed in conjunction with a national healthcare strategy may be implemented faster than new legislation and yet may have essentially the same effect as laws. Regulations should include clear definitions; precise indications of legal obligations for healthcare facilities, municipal waste managers, and disposal facilities; applicable enforcement and penalty systems; and delegation of legal courts to handle disputes. In some cases, different schedules for compliance with such regulations are recommended: teaching hospitals first, for example, then larger hospitals, and then smaller facilities. This would help in cases where healthcare facilities have widely different levels of resources available to them, and some may need more time to conform to new regulations.

- **International Regulations**

National legislation and regulations on healthcare waste should also comply with international regulations established by multilateral environmental and waste agreements or international institutions. The following are the major international regulations relevant for HCW management.

Basel Convention
The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal was adopted in 1989 and entered into force on 5 May 1992. This environmental treaty strictly regulates the transboundary movements of hazardous wastes and obligates its parties to ensure that such wastes are managed and disposed of in an environmentally sound manner. The Basel Convention is administered at the national and also at the state level, depending on the contracting party's legislation. As of 22 July 1997, 113 countries had ratified the convention.

The Basel Convention makes specific reference to control of special HCW: sharps, pathological infectious waste, hazardous chemical waste, and pharmaceutical waste. Annex I of the Basel Convention includes the following waste categories that specifically refer to healthcare waste:

- Clinical wastes from medical care in hospitals, medical centers, and clinics.
- Wastes from the production and preparation of pharmaceutical products.
- Waste pharmaceuticals, drugs, and medicines, and
- Waste from the production, formulation and use of biocides and phytopharmaceuticals.

International Atomic Energy Agency (IAEA)

The IAEA is an autonomous intergovernmental organization within the United Nations system. The organization provides advice to member states on nuclear power development, health and safety, radioactive waste management, legal aspects of atomic energy, and prospecting for and exploiting nuclear raw materials. IAEA has also been promoting efforts to establish standards for safe handling of hazardous waste substances.

Presently, the agency is developing safety standards in the area of pre-disposal of hazardous wastes, which includes collection, handling, treatment, conditioning, and storage of radioactive waste. Such disposal wastes includes management of radioactive waste from medicine, industry, and research.

Annex D: Technology Considerations for Special HCW Treatment and Disposal

D.1 Technology Options

The choice of technology for waste treatment and disposal should always be driven by the objective of ***improving current health and environmental impacts.*** The technology choice should also be functional, safe, economically feasible, and sustainable. Choice of treatment/disposal technology needs to be made with cultural and religious sensitivities in mind. For example, in Hindu cultures, body parts should be cremated while in Muslim cultures, they should be buried below ground.

A basic principle in all waste management schemes is to segregate wastes as early as possible in the waste stream and to find the simplest solution for each type of waste. The first step in treatment and disposal is to ensure that all regular healthcare waste that can safely be sent to the normal municipal waste management system is managed in this way. The remaining wastes (special HCW) have characteristics that need particular treatment and disposal. A set of technical requirements for this treatment and disposal is provided in Table D1.

Table D1: Technical Requirements for Treatment and Disposal of Special HCW

Elimination of hazardous characteristics of the wastes	• Destruction of viable infectious organisms • Destruction of waste/used pharmaceuticals and medicines or transformation into harmless forms • Destruction of sharps and other materials capable of causing physical injuries • Final disposal or destruction of body parts, tissues, blood, and other organic material • Transformation of wastes into unrecognizable or inoffensive forms
Controls on processes	• Assured long term performance in eliminating the hazardous characteristics • Ability of the treatment and disposal system to cope with variations in waste composition and throughput
Environmental impacts of system	• Avoidance or minimization of secondary impacts from disposal system • Prevention of human access and/or scavenging activities • Control of contamination of land, air or water • Avoidance of disease vectors (insects, rodents, etc.)

Source: ERM for World Bank

Controlled disposal in a sanitary landfill may be an acceptable disposal option for some types of special healthcare waste but other types should – in ideal conditions – be treated before disposal. In any case, final disposal in a landfill will usually be required for the residues from a treatment system.

Capability should also be carefully assessed when planning HCW disposition. Urban areas might have sophisticated incineration, sterilization, or disinfection technologies available, while rural areas might have limited options. When reviewing disposition plans, the technological standards are vital to a safe, appropriate plan. For instance, incineration may be considered when the incinerator can reliably reach temperatures over 1000 degrees (over 1200 degrees is necessary if burning sharps or infectious waste). Lower temperature incinerators produce greater amounts of toxic releases. Autoclave or microwave facilities may generate contaminated wastewater that needs treatment. Landfills should also be reviewed for appropriate liners and leachate collection systems, and should include ground water monitoring (if applicable). A reliable affordable local technological solution is preferable to infeasible (and therefore not implemented) solutions. A summary of treatment and disposal technologies is provided in Table D2. Table D3 indicates the performance of typical practices and treatment options in relation to the requirements of Table 1.

Table D2: Treatment and Final Disposal Technologies for Special HCW

Type of treatment	Advantages	Disadvantages
Safe land filling: Trench method where healthcare waste is buried in a trench excavated in other waste (Final disposal)	? Simple and inexpensive to operate ? No specific construction costs required ? Operates within readily available landfill system ? Waste pickers are unable to access the special healthcare waste	? Special healthcare waste is not treated and preserves potential infectiousness ? High demand for coordination between collector and landfill operator ? Reduces awareness among healthcare workers of need to segregate waste types ? Potentially long transportation to landfill
Safe land filling: Separate disposal cell (Final disposal)	? Simple and relatively inexpensive to operate if operated in connection with existing landfill for other waste	? Special healthcare waste is not treated and preserves potential infectiousness ? Requires a safe landfill with fencing ? Requires control of scavenging and animals • Needs conscientious operation according to manual
Incineration : 1) Batch incineration 2) Dual chamber, or 3) Rotary kiln (Destruction	? Elimination of health risks ? The waste is non-recognizable ? Fully destroys micro-organisms and sharps ? Reduces volume/mass of the waste ? Destroys all types of organic waste (liquids, pharmaceuticals, and other solids)	? High investment costs ? Complicated to operate ? Continuous monitoring required ? High maintenance, especially for rotary kilns ? Relatively high operation costs; costs rise with the level of

treatment)	? Heat recovery possible ? High quantities of waste can be treated (except for batch incinerator)	sophistication of the emission controls system ? For batch incinerator: limited capacity ? Emits toxic flue gases (including dioxins and furans; level varies) Currently there is no accepted level of emission for dioxins and furans, however EU standards provide a good basis for comparison. ? Generates residue that needs safe landfilling ? Any residue generated may be toxic
Steam Disinfection: Autoclave (Sterilization)	? Simple to operate ?A known technology at healthcare facilities	? Relatively expensive to install and operate ? Requires boiler with stack emissions controls ? Relatively high maintenance costs ? Cannot be used to treat some hazardous wastes, pharmaceuticals, and cytotoxics ? Requires separate and additional packaging ? Generates odors ? Final disposal must be as for untreated special healthcare waste ? Generates contaminated wastewater that needs treatment
Microwave: Microwave or radiowave irradiation (Disinfection)	? The shredding process reduces the volume of the waste (not mass)	? Highly sophisticated and complex ? Relatively expensive to install ? Only solids can be treated and only when shredded ? Cannot be used to treat some hazardous wastes, pharmaceuticals, and cytotoxics ? Highly skilled operator required ? Expensive and difficult to maintain ? Final disposal must be same as for untreated special healthcare waste ? Generates contaminated wastewater that needs treatment
Chemical treatment: (Disinfection)	? The shredding process reduces the volume of the waste (not mass)	? Cannot be used to treat some hazardous wastes, pharmaceuticals, and cytotoxics ? Highly skilled operator required ? Expensive and difficult to maintain ? Final disposal must be same as for untreated special healthcare waste ? Generates hazardous water that needs treatment

It must be emphasized that the advantages and disadvantages listed assume the proper operation of the described treatment methods.

Table D3. Comparisons with Technical Requirements

(Broad comparisons, based on general experience – individual examples will vary)

	Typical Current Practices				Typical Disposal Options – properly operated				
	On-site dumps	Open burning	Municipal dumps	On-site incineration	High temp. incineration	Auto-claving	Micro-waving	Chemical sterilization	Sanitary landfill
Elimination of hazardous characteristics:									
Destruction of infectious organisms	none	poor	none	poor to moderate	Very good	good	good	good	good
Destruction of body parts, blood etc.	none	good	none	good	very good	poor to moderate	poor to moderate	poor to moderate	good
Destruction of waste pharmaceuticals	none	good	none	good	very good	none	none	poor to moderate	moderate to good
Destruction of sharps, etc	none	moderate	none	moderate	very good	poor to moderate	poor to moderate	moderate	moderate
Transformation of wastes	none	moderate	none	good	very good	moderate	moderate	moderate	good
Controls on process:									
Assured elimination of hazards	none	very poor	none	very poor	very good	moderate	moderate	moderate	moderate
Ability to cope with variations	good	poor	good	poor	very good	poor	poor	poor	vgood
Environmental Impacts:									
Avoidance of secondary impacts	poor	very poor	Poor	poor	poor to moderate	poor to moderate	moderate	poor to moderate	Poor to moderate
Prevention of human access	moderate	moderate	very poor	good	very good	very good	very good	very good	Moderate to good
Prevention of contamination of land	very poor	poor	very poor	good	very good	very good	very good	very good	good
Avoidance of disease vectors	poor	poor to moderate	very poor	very good	very good	very good	very good	very good	moderate

Direct disposal in a sanitary landfill may be the least expensive disposal option, if an acceptable landfill is located within reasonable transportation distance. However, some special healthcare wastes, such as cytotoxics, should not be put in a landfill. A dual chamber or rotary kiln incinerator can be used for treatment of this type of special healthcare waste. Pollution control systems (scrubbers, etc…) on incinerators are essential in order to avoid release of dioxins and other chemicals. The choice of an appropriate technology for treatment of the special wastes will depend on a range of local circumstances. Some examples are the state of the existing waste management system, the institutional capacity and the human resources available, and the

costs of the different options in relation to the financial situation of the health sector.

A number of general comments can be made:
Incineration is not the same as burning. Proper incineration is a highly advanced technology that can adequately treat all types of special healthcare waste. The key parameters of controlled incineration are summarized as "TTT": combustion at a sufficiently high **temperature** (between 1,000°C and 1,200°C in the combustion chamber) for a long enough **time**, in a combustion chamber with sufficient **turbulence** and oxygen for complete combustion to be achieved and problematic gases to be minimized.

An incinerator requires skilled operators, extensive flue gas emission controls and, frequently, imported spares and supplies. Properly controlled incineration is relatively expensive. Incineration of wastes generates residues, including air emissions and ash. Environmental controls on incinerators in developed countries have been tightened in recent years, principally because of concerns over air emissions of pollutants such as dioxins (see D.2) and heavy metals.

The technology of small-capacity incinerators, for use by a single medical facility, is often rudimentary. These installations are not recommended, since they may constitute a serious air pollution hazard to the surrounding area. WHO recommends closing down small incinerators that are not operating satisfactorily.

Incineration is an option for certain types of HCW (and is the preferred method for some substances such as cytotoxins and other pharmaceuticals) but it needs to be carefully operated and controlled. Regulatory agencies in the United States and the European Union have adopted emissions limits for medical waste incinerators that include, among others, values for dioxins. It is recommended that incinerators installed under any major project pay attention to national regulations and/or look to the examples set in other countries such as in the EU Member States.

Autoclaving involves the heating of waste material, with steam, in an enclosed container at high pressure. At the appropriate levels of time (> 60 min), temperature (>121°C), and pressure (100 kPa) effective inactivation of all vegetative microorganisms and most bacterial spores can be achieved. Preparation of material for autoclaving requires segregation to remove unsuitable material and shredding to reduce the individual pieces of waste to an acceptable size.

Small autoclaves are common for sterilization of medical equipment but a waste management autoclave can be a relatively complex and expensive system requiring careful design, appropriate segregation of materials, and a high level of operation and maintenance support.

The output from an autoclave is non-hazardous material that can normally be landfilled with municipal waste. There is also a wastewater stream that needs to be disposed of with appropriate care and controls. Furthermore, large autoclaves may require a boiler with stack emissions that will be subject to control.

At present, the use of autoclaving, chemical disinfection or any other non-destructive technology like microwave or radiowave irradiation is not allowed for the treatment of special HCW such as organs, tissues, or amputated human body parts. Incineration or burial are the only accepted techniques for the treatment of such special type of HCW.

Microwave and Radiowave Irradiation involves the application over the wastes of a high energy electromagnetic field that provokes the liquid contained within the waste, as well as the liquid cell material of microorganisms, to oscillate at high frequency, heat up rapidly, and eventually cause the destruction of all infectious components of the waste. The technique takes place in enclosed containers at atmospheric pressure and temperatures below the normal water boiling point. The waste passes through a preparative process of segregation to remove undesirable material, then it is triturated, pulverized, and compressed prior to its disinfection.

Similar to the autoclaving technique, the output from a microwave or radiowave facility is considered non-hazardous and can be landfilled together with municipal waste. Since the technology does not involve the application of steam, there is a minimal generation of wastewater stream, and with the appropriate conditioning it can be recycled to the system. Since electricity is the main source of energy for operating this technology, gas emissions are also minimal compared to incineration or even autoclaving, which requires the combustion of fuel for the generation of steam.

Chemical disinfection, used routinely in healthcare to kill microorganisms on medical equipment has been lately extended to the treatment of HCW. Chemicals (mostly strong oxidants like chlorine compounds, ammonium salts, aldehydes, and phenolic compounds) are added to the waste to kill or inactivate pathogens. This treatment is most suitable for treating liquid wastes such as blood, urine stools or hospital sewage, but solid and highly hazardous HCW like microbiological cultures, or sharps must undergo a relatively complex and expensive preparative process of segregation shredding, and milling prior to the application of the chemical reagents. This technology requires special treatment of hazardous wastewater streams.

Land deposition of HCW is performed in the same manner as solid industrial wastes; that is, in a pit excavated in mature municipal waste at the base of the working face and immediately covered by a two-metre deep layer of fresh municipal waste. Alternatively , a specially constructed small fenced landfill pit or bunded area could be prepared on part of the site to receive only HCW. It should be covered immediately with soil after each load. For added health protection and odor suppression, it is suggested that lime be spread over the waste. In both cases it is essential to cover the HCW layer well enough to prevent animals or scavengers from re-excavating it. Landfilling is considered as a "bottom of the list" option for disposal of HCW, and is only recommended when the economic situation of the country does not permit access to environmentally safer technologies, such as the ones previously described.

Other technical issues:

Transport of special healthcare waste on public roads is inevitable under any system designed to treat and dispose of special healthcare waste outside the generating premises. Transportation of special healthcare waste should, as a minimum, be carried out by trained staff in a dedicated vehicle with closed containers. Recommended design criteria for special healthcare waste transportation vehicles are provided in the WHO handbook.

Operation and maintenance of equipment and facilities is essential for proper waste management. Good operation and maintenance requires trained and motivated staff, an adequate supply of consumables and spares, and a sufficient ongoing budget. Assessment of these matters must be a fundamental part of any decisions on choice of waste management treatment technology.

Case 1: HCW treatment and disposal technologies used in the Mexico City Metropolitan Area

Mexico generates approximately 160 tons/day of HCW of which 45 tons/day are generated in the Mexico City Metropolitan Area. At present, the Mexico City Metropolitan Area counts with an infrastructure of 15 facilities (13 companies) where the HCW are treated and conditioned for final disposal. Table D4 shows that incineration is still the prevailing technology. Nevertheless, the approval of new and more strict limits of air pollutant emissions by the federal government is forcing either the installation of more modern incineration and gaseous emission control equipment, or move to alternative disinfection and/or sterilization technologies like autoclaving or radiowave irradiation. It is important to emphasize that at present, the total installed capacity for the treatment of HCW in Mexico City is around 420 ton/day, whereas the demand does not surpass the 45 ton/day. This situation has forced some of the facilities to operate at only 30 to 40% of rated capacity.

Table D4. Facilities authorized for the treatment of HCW in Mexico City's Metropolitan Area (1999)

Technology	Number of Facilities	Treatment Capacity in ton/h[1/]
Incineration	9	5.19
Autoclave	2	4.00
Chemical Disinfection	2	1.80
Radiowave irradiation	1	6.25
Wet thermal	1	0.34

[1/] The installed treatment capacity of HCW in Mexico City's metropolitan area exceeds the service demand and so the operating hours of the facilities are variable (some work at 30-40% of their installed treatment capacity)

Table D5. Capacity of selected Facilities for the treatment of HCW in Mexico City Metropolitan Area (1999)

Technology	Treatment Capacity in ton/h	Operation hours	Nominal Treatment Capacity in ton/day
Radiowave	6.25	4-5	25-31
Incineration	1.4	24	33.6

Box D1: Comparative User Prices of Selected Facilities for the Treatment of Special HCW in the Mexico City Metorpolitan Area

Technology = Radiowave irradiation
HCW treatment capacity = 6.25 ton/h
Operation hours = 4-5 (depend on the demand)
Average price = 750 US$/ton (for transport, treatment and disposal)

Technology = Incineration
HCW treatment capacity = 1.4 ton/h (33.6 ton/day)
Operation hours = 24
Average price = 410 US$/ton (for transport, treatment and disposal

Case 2: HCW treatment and disposal technologies used in Buenos Aires

The metropolitan area of Buenos Aires generates more than 100 ton/day of HCW, from which 30% are produced in health institutions that lack of adequate facilities for their treatment, and 70% in public hospitals and clinics that posses primitive incinerators, most of them without adequate devices for the control of gaseous emissions. Until 1998, most of the HCW generated in Buenos Aires were incinerated by 9 private companies operating in the metropolitan aerie of the city. Although incineration is the predominant treatment, autoclave technology is being operating at present (see *Table D6*).

Table D6. Treatment Capacity of Selected Facilities for the Treatment of Special HCW in Buenos Aires

Technology	Treatment capacity in kg/h	Operation in h/day	Treatment capacity in ton/day
Autoclave	340	12	4.08
Incineration	330	12	3.96

Box D2: Comparative User Prices of Selected Facilities for the Treatment of Special HCW in Buenos Aires

Technology = Autoclave
HCW treatment capacity = 340 kg/h (4.1 tons/day)
Operation hours = 12
Price range = 660-1280 US$/ton (for transport, treatment and disposal)

Technology = Incineration
HCW treatment capacity = 330 kg/h (3.96 tons/day)
Operation hours = 12
Price range = 740-1460 US$/ton (for transport, treatment and disposal)

D.2 Dioxins and Related Compounds

The range of chemical compounds described as polyhalogenated aromatic hydrocarbons (PAHs) have been of concern over several decades because of their increasing occurrence and persistence in the environment and their biochemical and toxic effects. Some compounds, such as phenols, benzenes and polychlorinated biphenyls (PCBs) have been produced industrially because of their commercial uses. Other PAHs have been formed as residues or byproducts of chemical production, of combustion, or of other uses of chlorinated compounds. Among the most significant of these PAH compounds is the group known as dioxins, including the polychlorinated dibenzo-p-dioxins (PCDDs) and the dibenzofurans (PCDFs). These compounds tend to accumulate in fatty tissue. A broad range of toxic and biochemical effects has been reported for several of these compounds. In particular, there has been considerable debate about the carcinogenic impacts of exposure to low levels of these compounds.

Key positions of the International Agency for Research on Cancer (IARC) and WHO about dioxins can be summarized as follows:

- The International Agency for Research on Cancer decided in February 1997 to move 2,3,7,8-TCDD (the most toxic form of dioxins) from Group 2B (possibly carcinogenic) to Group 1 (carcinogenic).
- WHO considers a situation acceptable as long as a Tolerable Daily Intake (TDI) of 10 pg 2,3,7,8 TCDD /kg bw.day is not surpassed. In most developed countries a TDI of 10 pg (i)-TEQ / kg bw.day is being used. TEQ expressing the toxic potency of a mixture of different dioxins and dioxin-like substances. (Each dioxin has a specific Toxic Equivalency Factor (TEF). The total concentration of dioxin-related compounds is reported as an amount of toxic equivalents or TEQ's of a certain substance. In this case, toxicity is related to the toxicity of 2,3,7,8 TCDD, which also implies that all dioxins are considered to have toxic properties). However, since regular analysis of samples (flue gas, milk, or soil) for dioxins is generally not feasible in low-and middle income countries, this WHO guideline cannot be used as a practical way to regulate dioxin exposure.

Acceptable practice in Bank-financed projects with regard to dioxin emissions control from HCW incineration should meet the technical criteria described in Table D.1. Environmental contamination should be minimized even if it is not measured as recommended by IARC, and human contact, water, and soil contact should be restricted as much as technically possible.

Annex E: Cost Considerations for Waste Treatment and Disposal

The cost of investments in waste treatment and disposal varies dramatically depending on the waste quantity and quality, treatment method to be implemented, and capacity of the treatment facility. The capital costs indicated in the tables below are exclusive of shipment costs and of buildings required for the treatment facilities. These factors depend on local conditions; and the respective costs are often marginal in comparison with the costs for the treatment equipment. Further, technical assistance is required including contributions from the following specialists: supervision and quality assurance/control; and site engineer.

Table E1: Estimates of Capital Costs per Ton of Treatment Capacity/Various Treatment Options

Treatment method	Approximate investment cost per ton of special healthcare waste treatment capacity per day [US$/ton/day] (in 1997 prices)
Landfill[1]	-
Incineration including flue gas control	120,000 – 200,000
Autoclaving	40,000-125,000
Irradiation (Microwave)	120,000 – 200,000

[1/] There is no initial cost for the healthcare facility, since the investment cost required for landfills is reflected in the tipping fee. Tipping fees in developing countries often range from 8-15 US$/ton.

Table E2: Treatment and Disposal Costs per Ton of Special HCW/Selected Countries

	Treatment/disposal costs for special healthcare waste in US$/ton
Malaysia	2,080 [1/]
Denmark	200- 350
Egypt	150
France	150 – 500
Germany	500 - 1,500
Brazil	186 1530[2/]
United Kingdom	200 – 500
Argentina	630-1670
Mexico	410-750
USA	280 – 420

[1/] This price includes collection at healthcare facility, transportation, and treatment. Malaysia has found the average amount of special healthcare waste generated is 0.7kg/bed/day.
[2/] Higer cost of US$1530/ton corresponds to a system of mobile incineration utilized in Curitiba

Table E3: Average Treatment and Disposal Costs for Special HCW/Selected Cities

	Disposal costs in US$/bed/day
Curitiba/Brazil	0.26
Mexico City/Mexico	0.96[2/]
Buenos Aires/Argentina	0.76[3/]
Melaka/Malaysia	1.45[1/]

[1/] This price includes collection at healthcare facility, transportation, and treatment. Malaysia has found the average amount of special healthcare waste generated is 0.7kg/bed/day.
[2/] At an average generated HCW of 1.48 kg/bed/day.
[3/] At an average generated HCW of 1.2 kg/bed/day

Annex F: Conducting Environmental Assessments

An environmental assessment (EA) must be carried out following guidance for the appropriate environmental category. Depending on results of the environmental screening procedure, projects that include treatment of special healthcare waste should be rated either environmental (WB) category A or B. Projects which contain special HCW, especially including infectious waste and/or toxic materials, most likely become a WB category A, unless rigorous environmental measures can be enforced. This is especially an issue in rural areas or IDA countries. EAs assess the level of release to the environment and public health in a waste management project. Most HCW projects would most likely become a category B after a WB EA. This classification might mean that HCW waste is prevalent, but the treatment and management options are sufficient to keep environmental and public health risks at a minimum. A category C is also possible-this type of project frequently present little risk to the environment or public health sectors.

An environmental assessment (EA) report evaluates environmental issues related to the proposed treatment facility/facilities. These assessments must be prepared in accordance with local environmental impact assessment guidance, as well as the World Bank's Operational Directive 4.01, "Environmental Assessment." Specific EA reports should apply to specific methods considered for waste management. Where adverse impacts are identified, the EA should outline mitigating measures to be included within the proposed design (including wastewater treatment, air pollution control, odor control, access of population, etc.). Mitigating measures that should be included within the operational procedures should also be part of the EA. In addition, the EA should provide a program for monitoring throughout implementation and operational activities. If any of the proposed facility sites have inhabitants that must be resettled, check the World Bank's requirements in Operational Directive 4.30, "Involuntary Resettlement," or any other relevant guidance provided by the agencies participating in this project.

The EA should include consultations with the responsible local authorities and affected communities. The consultations shall inform the community of the project proposal and incorporate their legitimate concerns in the design and selection of effective siting layouts, mitigation measures, monitoring programs, and community communication programs.

Following the recommendations in the EA, detailed design of the facility can be prepared, including performance specifications, cost estimates, annual operation and maintenance costs, and mechanisms for cost recovery.

Present and discuss a full draft EA report with the responsible authorities, and focus on the significant environmental issues in a format similar to the following:

- Executive Summary
- Policy, Legal and Administrative Framework
- Project Description

- Baseline Data
- Environmental and Health Impacts
- Analysis of Alternatives
- Mitigation Plan
- Environmental Management and Training for Institutions and Agencies
- Environmental Monitoring Plan
- Appendices
    - List of persons preparing the EA
    - References
    - Record of Interagency/Forum/Consultation Meetings

Annex G: Packaging Options

Packaging and storage of special healthcare waste consists of primary packaging at the source and secondary packaging for transportation. For primary packaging, all special healthcare waste should be packed in leak-proof and disposable bags or containers. In addition, containers for sharps must be puncture proof and glass containers are regarded unsuitable. A color code of either yellow or red should be chosen for all special HCW. For pathological waste, the opposite (and non-transparent) color should be used.

In the case of secondary transport packaging, leak-proof solid containers mounted with wheels should be used for easy transport. Color-coding should follow the primary packaging color code. For environmental protection reasons, non-PVC products are preferred.

In-house storage may consist of two levels:

1) a well ventilated room at or near the ward, where waste collectors pick up the waste, and
2) a centrally-located air-conditioned storage room, where temperatures can be kept low, until waste is picked up for treatment.

Table G1: Packaging Requirements for HCW and for Different Types of Treatment

	Landfill	Incineration	Autoclave	Microwave	Chemical disinfection
MSW	bag (black) containers	bag (black) containers	N/A	N/A	N/A
Special healthcare waste sharps	sealed containers	containers	containers w. holes	Containers w. holes	containers w. holes
Pathological waste	non-transparent bags, heavy duty (often red)	non-transparent bags, heavy duty (often red)	N/A	N/A	N/A
Other potentially infectious waste	colored bags/containers (often yellow)	colored bags (often yellow)	colored bags (often yellow)	colored bags (often yellow)	colored bags (often yellow)
Hazardous chemicals	containers (liquids) bags (solids)	containers (liquids) bags (solids)	N/A	N/A	N/A
Pharmaceutical waste	colored bags/containers	colored bags/containers	N/A	N/A	N/A
Radioactive waste	-[1/]	-[1/]	N/A	N/A	N/A

[1/] Special handling and treatment required.
N/A: Not applicable.

Annex H: Sample Terms of Reference: Regional HCW Management

Study Area
A feasibility study is planned for the study area of [please fill in], [please fill in]. The study area is located [please fill in], covers an area of [please fill in] square kilometers and has a population of [please fill in] inhabitants. The income level of the study area, expressed as Gross Domestic Product per capita per year, is [please fill in].

Introduction
Project background and project justification.

Goal
The project goal is to improve the health and reduce environmental impacts from handling of healthcare waste by its proper disposal.

Development Objective
The objective of the feasibility study is to identify the level of healthcare waste management that will be relevant to help implement and enforce proper health and environmentally-sound, technically-feasible, economically viable, and socially-acceptable systems for management of healthcare waste in [please fill in].

Outputs
The project will have the following outputs:

1. Report on regional sector assessment, including suggestions on institutional development, completed;

2. Choice of preferred treatment technology and siting of treatment facility made with determination of level of Environmental Assessment, based on report assessing various treatment technologies and a siting study carried out;

3. Preliminary design report and draft feasibility study report completed;

4. Draft environmental assessment report completed;

5. Final report on healthcare waste management in [please fill in] completed.

Activities

The Consultants alone will be accountable for their analyses and recommendations and for the interpretation of any information made available to them. [Please fill in] will make available to the Consultants existing data and reports relevant to their work and will provide all reasonable assistance in the retrieval of, and access to information appropriate to carry out the activities. The Consultants shall interact with those agencies, whether public or private, which are actively involved in research or development programs in waste management and environmental protection.

Task 1. Regional Sector Assessment

Determine the regulatory framework on healthcare waste management and treatment/destruction facility in [please fill in]. Include air emission standards which are currently required by [please fill in] law and which would likely be required in the next ten years.

Identify permit requirements, including environmental building, and other permits and procedures that healthcare waste treatment/destruction facilities would need to address.

Outline any public participation or public hearing requirements and procedures. For each requirement, list the lead agency to be contacted. Assess the typical time demands for proposed facilities to obtain permits and address environmental impact assessment and public participation requirements.

Identify all healthcare facilities in [please fill in], and include all basic information for each healthcare facility, such as: number of beds, bed occupancy rate, specialties, divided into the categories: university hospitals, regional hospitals, general hospitals, municipal hospitals, and other healthcare establishments.

Assess the healthcare waste generation at: i) one major teaching hospital (where existing); ii) one major regional hospital and, iii) one general municipal hospital. The details should include the minimum weigh of total waste generated at each healthcare facility for one week. Composition of the waste should be determined through segregation at the waste end-point, e.g. following specified definitions. Extrapolate the results to cover the entire [please fill in].

Assess the level of scavenging, if any, or recycling taking place inside healthcare facilities; along transportation routes, and at final disposal. Determine social issues in relation to scavenging taking place.

Review and analyze existing healthcare waste storage, collection and disposal systems with due regard for level of separation, the frequency of collection; and environmental and health impacts for existing treatment.

Review existing training and public awareness programs on healthcare waste management at hospitals and other healthcare establishments and prepare a training needs assessment.

Submit a Sector Assessment Report for [please fill in] with all compiled information in the form of technical annexes. These annexes should be updated as the remainder of the study progresses, as they are intended to eventually become annexes to the final environmental assessment and feasibility reports.

Task 2. Determination of technology and siting of facility

For the types and quantities of healthcare waste generated in the study area, assess alternative technologies and facility sizes for treatment and destruction. The assessment shall compare the alternatives on the basis of capital cost, operating cost, ease of operation, local availability of spare parts, local availability of operational skills, demonstrated reliability, durability, and environmental impacts. The technologies to be considered include: safe landfilling, incineration, sterilization (autoclaves and microwaves), and chemical disinfection. On the basis of this assessment, recommend a process flow for economic and environmentally sound treatment and final disposal of healthcare waste, leading to choose of technology for [please fill in].

Submit interim report for discussion with [please fill in]. The final decision on choice of technology should be made by [please fill in].

If site for disposal exists, collect all existing maps and topographical plans of suitable sites to be considered for the locations of the treatment facility(ies) and review general transport and traffic systems relative to appropriate sites. Further consider:
i) accessibility to the site; ii) distance from healthcare facilities to the site; iii) distance to sensitive areas; iv) future development plans for the area; v) possibility to acquire area; vi) cultural and historical sites; vii) public opinion; viii) noise and dust impact to nearby areas. Public consultation/hearing must be held as part of the final assessment for siting of the treatment facility.

Submit siting report for discussion with [please fill in]. The final decision on choice of site(s) is be made by [please fill in].

Task 3. Preliminary design and feasibility study

Develop a model process flow diagram and site layout for the recommended treatment facility(ies). Include treatment processes for wastewater, cooling water, drainage, odor, and air pollution in the model process flow diagram. Include facilities for parking, gate control, weighing loads, administration, worker sanitation and washing/changing, worker facilities, and truck washing and other relevant facilities. Assess spatial requirements for the facilities, as a function of their recommended healthcare waste handling capacities.

Determine the electrical power supply required and the type of fuel (i.e., oil, natural gas) required for operating the facility(ies). Assess the potential for energy recovery and which type of energy recovery would be preferred. Outline user requirements, such as steam pressure requirements or hot water requirement and outage procedures.

Determine how much land is required for each recommended facility. Outline the land acquisition issues and constraints that might exist in the study area, including human resettlement issues and constraints. Based on local land values and resettlement costs, estimate the costs of land acquisition.

Determine the required equipment needed inside healthcare facilities, with respect to disposable bags and containers; internal transportation equipment, and storage rooms. Estimate the investment costs and the annual preparation costs e.g. unit costs in bed/day and price/kg of waste generated.

Prepare a list of storage, collection, and transport equipment with performance specifications, as well as general collection frequencies and routings for each collection area.

For the model facility designs developed, prepare an estimate of the cost of construction, as well as operation and maintenance costs for the entire treatment and transportation system.

Calculating the annual operating costs of the entire system and cost recovery mechanisms (including the tipping charge to be applied per ton of healthcare waste), and the rate of return.

Prepare a Draft Feasibility Report for discussion with [please fill in], including: description of an action plan for management of healthcare waste with an accompanying implementation plan to include all necessary time schedules, cost estimates, and terms of reference; presentation of an optimal long term concept to separate, store, collect, and treat/dispose of healthcare waste; preliminary engineering designs showing the layout plans, typical sections and elevations of the treatment facilities, with performance specifications of all equipment; recommendations for private sector participation in construction and management of hospital wastes, with scenarios for pragmatic implementation; a financial and institutional framework that would assume responsibility for oversight and supervision of the healthcare waste management system as well as the proposed method of recovering the cost of debt service, operation and maintenance; a plan for implementation covering all project sub-components, including scheduling, cost estimates and terms of reference for training, institutional strengthening, additional studies, detailed engineering, and for all other work required to implement the healthcare waste management system.

Task 4. Environmental Assessment

Prepare an environmental assessment report which states and evaluates the environmental issues related to the proposed treatment facility(ies). These assessments are to be prepared in accordance with local environmental impact assessment guidance, as well as the World Bank's Operational Directive 4.01, "Environmental Assessment". For adverse impacts identified, outline mitigating measures which need to be included within the proposed design (including wastewater treatment, air pollution control, odor control, access of population, etc.). Further outline mitigating measures that should be included within the operational procedures. In addition, provide for a monitoring program throughout implementation and operational activities. If any of the proposed sites for the facilities have inhabitants or tribal nomadic dwellers, address the World Bank's requirements under Operational Directive 4.30, "Involuntary Resettlement" or any other relevant guidance provided by the agencies participating in this project.

Perform consultations with local community and municipal representatives in coordination with [please fill in]. The consultations shall inform the community of the project proposal and ensure that their concerns that are deemed appropriate are incorporated in the design and selection of effective siting layouts, mitigation measures, monitoring programs and community communication programs.

Present and discuss a full draft EA report with [please fill in], and focus on the significant environmental issues in a format similar to the following:

- Executive Summary
- Policy, Legal and Administrative Framework
- Project Description
- Baseline Data
- Environmental and Health Impacts
- Analysis of Alternatives
- Mitigation Plan
- Environmental Management and Training for Institutions and Agencies
- Environmental Monitoring Plan
- Appendices
    - List of EA Preparers
    - References
    - Record of Interagency/Forum/Consultation Meetings

Task 5. Final report

Revise the Draft EA Report and the Draft Feasibility Report in accordance with the comments of [please fill in] and international financial institutions and submit the Final EA Report and a separate Final Feasibility Report, incorporating all changes and modifications required to [please fill in].

STUDY SUPERVISION AND TIME SCHEDULE

The work of the Consultant would be supervised by [please fill in], who will coordinate with all other ministries, agencies, and international financial institutions.

The Consultant shall begin work no later than [please fill in] days after the date of effectiveness of the contract. It is anticipated that the Consultant would complete output 1 and 2 of the work over a maximum duration of [please fill in] months, while output 3, 4 and 5 of the work should be completed within a maximum additional [please fill in] months duration, with completion of the entire study within [please fill in] months. The Consultant should propose a clear schedule with critical milestones, and make all possible efforts to meet or complete the work in a shorter duration then the proposed time schedule.

STAFFING REQUIREMENTS

It is anticipated that the Consultant would establish a strong, focused team of specialists that contains a clearly indicated mix of local and foreign specialist inputs. It is envisaged that an (please fill in] expert would serve as project team leader with a resident national as deputy. The Consultant should create a project team that has technical competence in scientific, health, environmental, and engineering fields as well as competence in the private sector participation fields with skills in financial analysis, training, institutional strengthening, and regulatory fields. The team is expected to provide pragmatic and insightful planning to justify the chosen form of healthcare waste management in [please fill in].

The Consultant shall propose and justify the range of disciplines to be included in the project team. It is expected that the proposed project team will contain several of, but not necessarily be confined to, the following specialists:

Technical Specialists:

- healthcare waste management specialist
- environmental specialist
- public health specialist
- technology specialist familiar with operations and transport
- public consultation\social science specialist
- siting\environmental planning specialist
- infrastructure\cost estimation specialist

Institutional Specialists:

- public administration specialists with knowledge of health municipal and environment institutions
- training specialist
- financial analyst
- environment and health regulatory and institutional specialist
- supervision and quality assurance\control specialist
- project preparation\procurement specialist

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