Waste Management and Disposal During the Philippine Follow-Up Measles Campaign 2004

A Joint Report by
Health Care Without Harm and
the Philippine Department of Health

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Executive Summary

The adverse health and environmental impacts associated with incineration, and the entry into force of the Stockholm Convention on Persistent Organic Pollutants on May 17, 2004, have challenged health-care providers to seek non-incineration methods for treating medical waste. With the banning of incineration under the 1999 Philippine Clean Air Act, the Philippines became the first country to deal with waste from a nationwide vaccination program without resorting to incineration or open burning.

The Philippine Follow-Up Measles Elimination Campaign (PMEC) targeted an estimated 18 million children during the month of February 2004. In a little over a month, the PMEC generated an estimated 19.5 million syringes collected in 162,000 safety boxes, amounting to about 810,000 liters or 130,000 kg of sharps waste. Also produced were an additional 740,000 liters or 72,000 kg of non-hazardous waste (empty vaccine vials and ampoules, syringe wrappers, empty vitamin capsules, cotton swabs, syringe caps, and packaging). The measles campaign presented an opportunity to demonstrate and document waste management and disposal without incineration or open burning during a mass immunization campaign. This report is the result of collaboration between Health Care Without Harm and the Philippine Department of Health, with the cooperation of the World Health Organization.

The study examined waste management practices during the PMEC in 19 documentation sites representing a wide range of geographic, socioeconomic, and ethnic conditions: wealthy urban enclaves, urban poor ("slum") communities, rural agricultural areas, very poor remote villages, mountainous and difficult to access places, indigenous communities, coastal regions, islands, as well as areas at high risk due to armed conflict. The number of children vaccinated in the documentation sites ranged from 640 children in a small neighborhood, to 18,256 children in a large municipality, to 360,200 in a province. About 406,300 children were vaccinated in the 19 documentation sites.

Before the immunization phase of the campaign, the Philippine Department of Health issued a comprehensive national Guide that included waste management guidelines. Local areas were required to develop microplans for the management of immunization waste. The Guide recommended the collection of used auto-disable syringes in 5-liter safety boxes, and their treatment and disposal using one of the following methods:

- Treatment in an autoclave facility
- Treatment in a microwave facility
- Encasement in a concrete septic vault
- Burial in a waste pit.

The basic approaches using centralized treatment (autoclave or microwave technology) and burial (concrete vault or waste pit) are presented schematically in Figure A. Filled safety boxes were transported through unpaved dirt and gravel roads, mountain paths,

plank bridges, bodies of water, asphalt streets, and concrete highways. Transportation methods included hand-carrying, bicycles with sidecars, motorcycles, motorcycles with sidecars, jeeps, minivans, vans, trucks, boats, horses, cars, ambulances, and vehicles used to deliver vaccination supplies. At the end of each day, the storage boxes were sealed with tape, labeled, and transported to temporary storage areas or central storage facilities. The transport and storage of safety boxes were conducted with little or no problems.

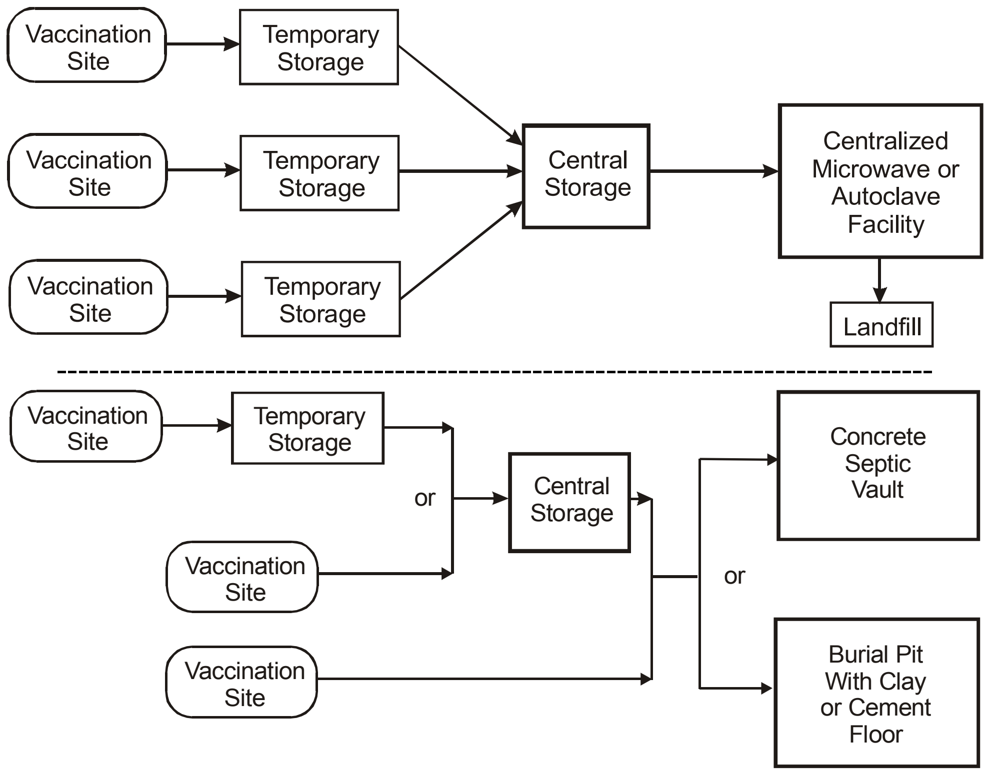


Figure A. Approaches to Waste Treatment and Disposal Used During PMEC

Many urban and rural areas that had access to centralized treatment facilities opted to use autoclave or microwave treatment. Illustrations of the microwave and autoclave systems are given in Figures B and C, respectively.

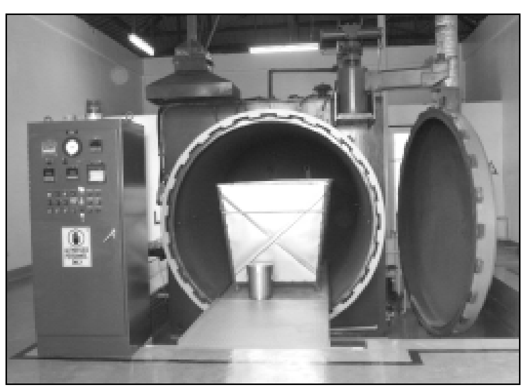


Figure B. Autoclave Treatment System (PAE Environmental, Inc.)

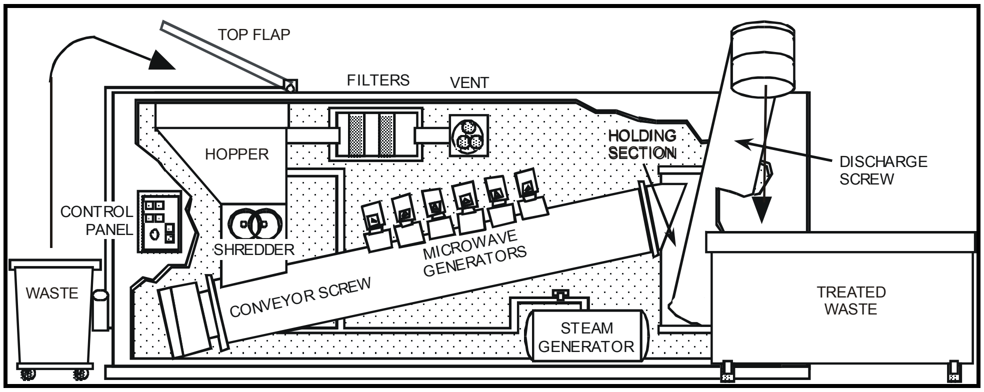


Figure C. Microwave Treatment System (Chevalier Enviro Services, Inc./Sanitec)

The autoclave was a 1.5-meter diameter x 2.5-meter long steel chamber wherein sharps waste was sterilized using steam at 142 ºC for up to 90 minutes to destroy pathogens. The microwave technology used an internal shredder, conveyor screw, and a bank of six industrial microwave generators to produced steam and achieve high levels of disinfection.

Rural and coastal areas, as well as islands, used concrete vaults as recommended in the Guide. Figure D shows the design of a standard rectangular concrete septic vault. They were built at the back of health facilities, in landfills, or cemeteries. The vault openings were above the ground to prevent water intrusion. Some areas used other designs, such as cylindrical vaults, aboveground vaults, and vaults built into walkways.

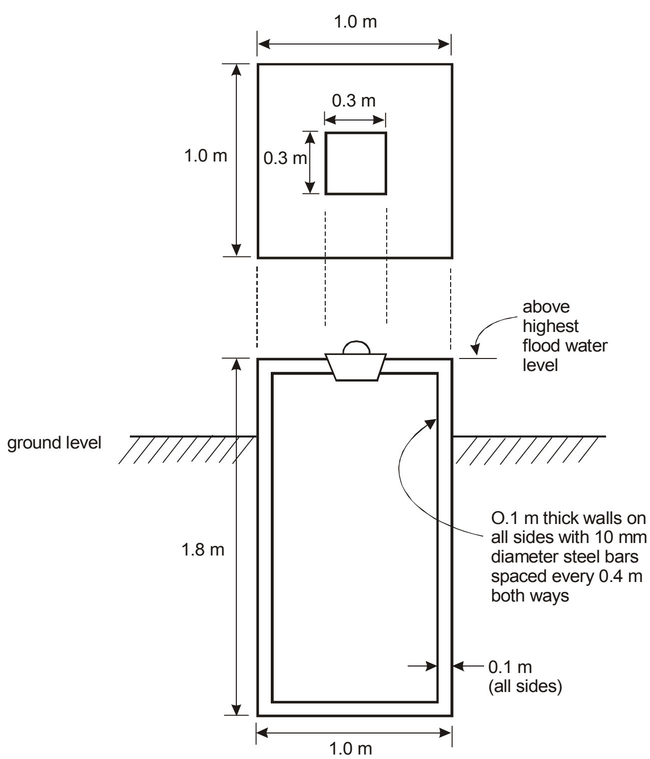


Figure D. Concrete Septic Vault

Poor communities in remote rural regions buried their waste in pits. Two basic burial pit designs were used: pits constructed with a cement floor and pits with bottom clay layers as shown in Figure E. The purpose of the cement or clay flooring was to minimize groundwater contamination. All vaults and pits were between 2 to 55 meters above the water table.

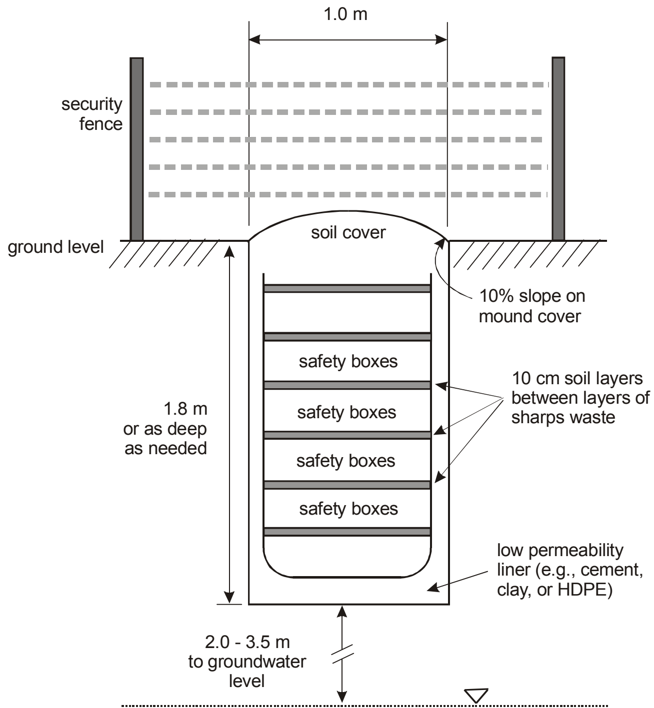


Figure E. Sharps Burial Pit

Two areas experimented with different approaches not mentioned in the Guide. One city used electric needle destroyers, small portable devices that melted the needles and sliced off the hubs. A remote, mountainous community decided to dispose of their safety boxes by depositing them in their communal latrine.

An analysis of costs showed that the simple clay-lined burial pits were the cheapest, followed by centralized treatment using autoclave or microwave technology. The most expensive methods were concrete encasement and burial pits with cement floors. The costs of treating 120 safety boxes (equivalent to immunizing about 12,100 children) are shown in Figure F. These costs include transportation and treatment costs for centralized treatment, and construction material and labor costs for vaults and pits.

For the purposes of planning, Table I below provides cost estimates for different treatment and disposal methods per 1000 children and per syringe.

Key data on waste generation from the PMEC are compared with estimates commonly used for planning purposes in Table II. The data reflect the fact that vaccination teams often reused mixing syringes and that some safety boxes were overfilled.

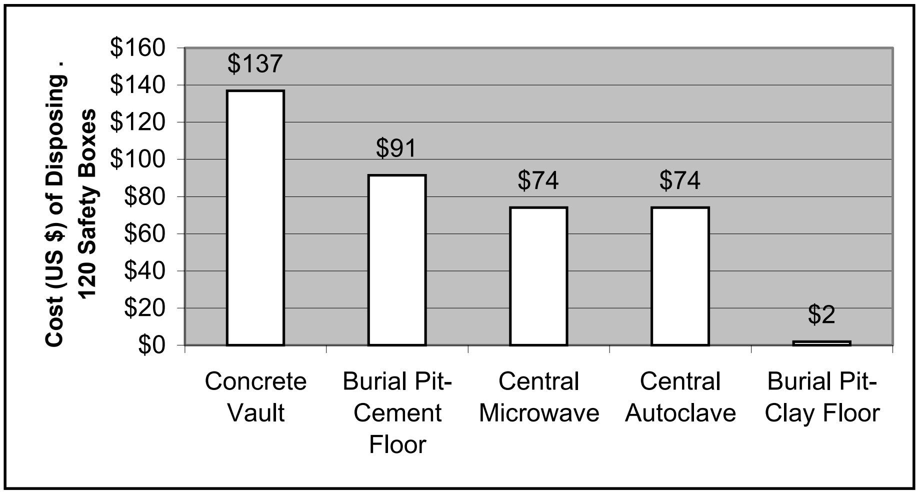


Figure F. Comparison of Costs for Treating 120 Safety Boxes

Table I. Cost Estimates for Treatment and Disposal *

Treatment and Disposal Method	Cost / 1000 Children (Dollars)	Cost / Syringe (Dollars)
Autoclave and Microwave Treatment Cost (including transportation)	9	0.008
Autoclave and Microwave Treatment Cost (excluding transportation)	4	0.004
Concrete Septic Vault Encasement	11	0.009
Burial Pit With Cement Floor	11	0.009
Burial Pit With Clay Floor	0.14	0.0001

* Autoclave and microwave treatment costs are based on regular prices charged per weight by existing treatment facilities and include the cost of transporting safety boxes. Concrete vault and burial pit costs are based on the cost of constructing a vault or pit of standard size (1m x 1m x 1.8m) to accommodate 120 boxes, corresponding to 12,100 children or 14,640 syringes.

Table II. Key Data on Waste Generation *

Parameter	Averages Based on PMEC Data	Estimates Used in Planning
# Syringes / 1000 Children	1,085	1,210
Syringe Wastage Factor (%)	7.1	10
# Syringes / Safety Box	123	100
# Safety Boxes / 1000 Children	9	12
Weight (kg) / Safety Box	0.8	0.7
Weight of Sharps Waste (kg) / 1000 Children	7	8
Weight of Other Wastes (kg) / 1000 Children	4	--

* Wastage refers to syringes that are broken and cannot be used. “Other wastes” refer to non-hazardous waste such as empty vials, syringe wrappers, and packaging.

Since all vaults and pits were oversized, they will continue to be used by local health centers. The immunization campaign brought the added benefit of raising awareness about the dangers of sharps waste and providing local health facilities with concrete vaults, pits, or the experience of using centralized treatment so that good waste management practices could be sustained.

The new cardboard safety boxes proved to be durable, puncture-resistant, moisture-resistant, and easy to carry. Nine needle-stick injuries were documented in 18 of the documentation sites, corresponding to 56,070 children or 1.5 needle-sticks per 10,000 syringes used. The few accidents and needle-stick injuries reported were caused by improper handling of sharps waste or the use of old, less sturdy safety boxes. Recommendations were made including the need for more time to develop microplans, better training and coordination, ensuring secure transport and storage at all times, post-treatment shredding, waste tracking, accident and injury reporting, better personal protection, recycling of other wastes, and providing a wider range of treatment and disposal options.

Before and during the immunization campaign, various suggestions were explored, including the use of reusable (metal or hard plastic) sharps containers, post-treatment shredding, gravity separation in water of shredded plastic and metal pieces, recycling of treated waste, solar-powered autoclaves and melters, and needle destroyers. Various stakeholders felt that many of these options could be implemented in the future. Further research is suggested for several methods, shown in Table III, proposed as best practices for immunization waste treatment and disposal.

Interviews conducted after the campaign showed that stakeholders affirmed the value of waste management for the protection of public health and the environment. Data from the documentation sites show that the cradle-to-grave management of immunization waste was completed relatively safely and with minimal impact on the environment. The PMEC waste management study shows that it is indeed possible to treat waste from mass immunizations successfully, while remaining in full compliance with the incinerator ban under the Philippine Clean Air Act.

Table III. Proposed Best Practices for Immunization Waste Treatment and Disposal *

I – Large to Medium Scale

Vaccination site	→		Treatment	→		Final Disposal
Collect syringes in reusable sharps container	Transport	Central storage	Autoclave treatment	Post-treatment shredding	Gravity separation	Recycle all plastic and metal pieces
Collect syringes in reusable sharps container	Transport	Central storage	Microwave treatment	Post-treatment shredding	Gravity separation	Recycle all plastic and metal pieces
Collect syringes in reusable sharps container	On-site storage or local transport & storage		Small on-site solar-powered autoclave or syringe melter	Manual grinding or Screen separation		Recycle plastic and metal pieces, or bury residues in landfill

II – Small Scale

Vaccination site	Treatment	→		Final Disposal
Insert syringe in needle destroyer	Needle melting by electric arc	Automatic slicing of hub	Collect plastic and metal portions	Recycle plastic; recycle or bury metal pieces
Insert syringe in electric or manual needle cutter or needle remover		Needle cutting and mutilation	Collect plastic and metal portions	Recycle plastic; bury or encase metal pieces in cement

III – Medium to Large Scale

Vaccination site	→	Final Disposal
Collect syringes in safety box	On-site storage or Transport & storage	Encase in a concrete septic vault, secure with fence & sign

IV – Small Scale

Vaccination site	→	Final Disposal
Collect syringes in safety box	On-site storage or Local transport & storage	Bury in a pit with cement or clay floor, secure with fence & sign

* Shown in order of decreasing priority; the selection of treatment and disposal methods depends on the amount of waste generated, local conditions, and availability of resources.

Introduction

A follow-up to the Philippine Measles Elimination Campaign (PMEC) was conducted nationwide in February 2004. The PMEC is a ten-year plan that began in 1998 to interrupt the circulation of the measles virus in all communities by 2008. Popularly known as *Ligtas Tigdas 2004*, the follow-up component of PMEC targeted all children between nine months and eight years old during the month of February. This amounted to an estimated 18 million children slated to receive the measles vaccine using auto-disable syringes. At the same time, Vitamin A capsules were also given to children between nine months to six years old. The PMEC used a door-to-door strategy supplemented by fixed vaccination posts such as hospitals, health centers, and barangay[1] health stations. Technical support and financial assistance were provided by the World Health Organization, United Nations Children's Fund, Japan International Cooperation Agency, and the Government of Japan, as well as various local donors and supporters.

Some 20 million syringes and over 126,000 kg of waste would be generated by PMEC. The Philippine Clean Air Act of 1999 prohibits the incineration of biomedical waste. The Philippine Department of Health (DOH), which implemented PMEC, recognized the need to document non-incineration approaches for the treatment and disposal of biomedical waste to further educate its personnel in complying with the provisions of the law. Health Care Without Harm (HCWH), an international coalition promoting best environmental practices in the health industry, has been interested in studying and promoting non-incineration methods for medical waste disposal. Thus, on January 26, 2004, HCWH and DOH signed a memorandum of agreement to coordinate the documentation of waste management and disposal during the PMEC. The Philippine campaign was probably the world's largest mass immunization wherein immunization waste was handled without use of any incineration or open burning for the first time.

Objectives

The overall goals of the project are to promote environmentally responsible methods for the management and disposal of waste from mass immunization campaigns. By documenting and analyzing the experience of waste disposal during the PMEC, lessons could be learned and good systems and practices could be replicated during future immunization campaigns in the Philippines and other countries.

The specific objectives of the project are:

- To document planning and implementation of waste management and disposal, from the pre-immunization to post-immunization stages of the PMEC
- To assess non-incineration methods for the treatment and disposal of immunization waste
- To make recommendations on best practices and areas for future research.

[1] The barangay is the smallest local government unit in the Philippines, equivalent to a small community or village.

Documentation Procedure

The documentation sites were chosen in order to evaluate waste management experiences in a wide range of settings in each of the three major areas of the country and the National Capital Region.[2] The 19 sites that were selected for the documentation project are shown in Table 1.[3] Since the sites do not necessarily comprise a representative sampling, the results are not intended for making statistical inferences about the waste disposal practices of the entire country during the PMEC. Rather, the sites were selected to illustrate a variety of socioeconomic, ethnic, and geographic conditions, namely:

- Urban areas (middle class and wealthy)
- Urban poor areas (depressed areas, “slums”)
- Rural areas
- Remote rural areas
- Remote and difficult to access areas (due to poor road conditions)
- Mountainous areas (remote upland communities, rugged terrain)
- Indigenous (tribal) communities
- Coastal areas
- Islands.

The category and population density of each documentation site are given in Table 2 along with other descriptive data. The documentation sites range in population densities from less than 0.4 persons per square kilometer (a remote mountainous area) to over 43,000 persons per sq km (a densely populated urban center). The table estimates what percent of the site is rural and urban, and supplements that information with estimates of electrification and water distribution. The sites range from very poor rural villages wherein only 3% of homes have electricity to very wealthy urban enclaves fully wired to the electrical grid. Note however that even though some areas report 100% electrification, not all homes may be legally connected to the grid, especially in urban poor communities. Also, reports that 100% of homes have running water could mean individual connections to a water distribution system as well as access to communal water wells. Documentation sites that are described as “high risk” security areas refer to places of armed conflict.

Table 3 lists the economic activities of each documentation site, showing a range of agricultural, industrial, and commercial endeavors. The level of industrialization may suggest the potential for more advanced treatment technologies in the future. Also noted are the types of transportation available. This is significant in relation to the transport of immunization waste to a central storage or treatment facility. Data on educational and

[2] The Philippines is divided into three major areas: the northern island of Luzon, the southern island of Mindanao, and the various islands in between them that comprise the Visayas. The National Capital Region is the major metropolitan urban center in the country and located in the island of Luzon.

[3] Tables are found in the Appendix except where noted. As much as possible, key data from the tables are summarized in the text.

health-care institutions are also provided since many fixed vaccination sites were done at these facilities and the immunization campaign availed of resources from these institutions. Information on bloodborne diseases, which could be transmitted through unsafe needle use or improper disposal of sharps, is also provided where available.

As the sites were chosen, volunteer researchers were recruited from the selected areas to ensure that the researchers were familiar with the local language, geography, culture, and governmental structure. The researchers had varied backgrounds and included a nurse, medical technologist, biologist, health worker, two engineers, two environmentalists, teacher, social worker, sociologist, architect, journalist, and several community workers. One was a former local government official. A professional videographer assisted with the photo-documentation.

The HCWH coordinator and medical waste consultant met with DOH and WHO personnel at various times between October and December 2003 to talk about waste management options and to share HCWH resources. On January 6-8, 2004, HCWH staff, Philippine DOH officials, and researchers met to discuss the measles campaign, the goals and objectives of the project, the documentation process, specific items to be documented, the documentation form (see Appendix), and reporting procedures. The researchers agreed on the following framework: (a) The main task of the researcher was to monitor and document waste management activities; (b) The researcher would not interfere with or obstruct immunization activities; (c) The researcher would be prepared to assist and support the activities if requested by the vaccination team; (d) The researchers would attend orientation sessions with the vaccination team, not only to document the training on waste management but also to be familiar with the overall vaccination strategy; and (e) The researcher could make suggestions on waste management to the vaccination team in the event of a serious violation of the PMEC guidelines that could harm public health or the environment.

Each researcher gathered information about the preparatory (pre-immunization) phase on the local level, including development of microplans, arrangements for waste management, and training of the vaccination teams on waste management. The researchers were then assigned to a vaccination team and followed the process from generation of waste to final disposal. At the end of the immunization phase, the researchers then summarized their data, obtained final costs, interviewed individuals, conducted their own assessments of the waste management process, and submitted their reports to HCWH. On April 14-16, HCWH convened a meeting of the researchers to compare and validate data and to evaluate the project as a whole.

Note that Cavite Province (site #19), with a population of 1.6 million and an area of 1,287 sq km (128,755 ha), was included as a documentation site since useful data were obtained for the whole of the province relative to waste treatment and disposal. As a result of site visits by HCWH researchers, partial data were obtained for Baguio City and are presented in the section on Other Methods. A tabulated compilation of the results of the field reports by the researchers is provided in the Appendix.

Preparation Phase

National PMEC Guide

The Philippine DOH, through multi-sectoral consultations involving experts from among policymakers, local government workers and officials, program implementers, international partners, and professional organizations, developed the "Guide to Ligtas Tigdas 2004: Philippine Follow-up Measles Campaign 2004" that served as a comprehensive national guide for the campaign. The 100-page Guide covered the following topics: general concepts, operations of the Philippine Follow-up Measles Elimination Campaign, vaccination strategies, vaccination team, vaccine handling and administration, administration of Vitamin A capsule, injection safety, communication and social mobilization, monitoring and supervision, reporting and recording, adverse events following immunization (AEFI), and planning and preparations. The guide included annexes that contained a waste management checklist as well as planning, monitoring, and reporting forms.

Waste Management Guidelines

Waste handling and disposal were covered in the Guide under "Vaccine Handling and Administration", "Injection Safety", "Planning and Preparations", "Waste Management Monitoring Checklist", "Planning Form: Logistics Requirement," and various monitoring forms. The "Planning and Preparations" section provided methods for computing the amounts of syringes, vaccines, safety collector boxes, and other supplies needed.

According to the Guide, safety collector boxes are provided to contain only used auto-disable (AD) needles-syringes and mixing syringes, which should be placed in the boxes immediately after each vaccination session. Once a box is 3/4ths full, the box should be sealed with tape, labeled "USED—DO NOT OPEN," and submitted to the person tasked with its disposal. If the box cannot be submitted at the end of the day, it should be kept in a safe place and submitted the next day. Boxes should not be opened. Storage areas should allow easy access for waste handlers but should be locked to prevent access by unauthorized persons.

Three basic methods were recommended in the Guide for proper disposal of safety boxes: (1) autoclaving or microwaving, (2) burial in a concrete septic vault, or (3) burial in a waste pit.

The Guide noted that autoclave and microwave facilities could be contracted to handle the immunization waste. The Guide noted that non-burn technologies such as autoclaves and microwaves are to be established to handle health-care waste in selected DOH hospitals, in Metro Manila, Metro Cebu, and Metro Davao. The cost of treatment and disposal was estimated in the Guide at P40 to P50 per kilogram in Metro Manila.

For rural areas and urban areas with sufficient space, the Guide recommended concrete septic vaults with a minimum size of 1 meter x 1 meter x 1.8 meter depth. The rectangular vault would be constructed of concrete walls 0.10 meters in thickness with an opening at the top. It should be reinforced by 10-millimeter diameter reinforcing bars spaced 0.4 meters apart vertically and horizontally. Class A mortar should be used. The vault should extend at least a few centimeters above the ground to prevent infiltration of surface water. The vault should be protected by a security fence and situated at least 150m from water sources and houses. Cost of construction was estimated at P5,111.

The simple burial pit was also proposed. The Guide recommended the same minimum dimensions of 1m x 1m x 1.8m depth. The pit should have a low permeability liner (such as clay, high density polyethylene, or preferably, cement) on the sides and bottom to prevent groundwater contamination. An earth mound should be made at the mouth of the pit to minimize infiltration of surface water. About 10 centimeters of soil should separate each layer of waste. When full, the pit should be covered with a soil mound having a 10% slope to divert water. The pit should be protected by a security fence and a sign saying "NEEDLES-SYRINGES BURIED HERE."

According to the Guide, other wastes such as cotton balls, syringe wrappers, empty vitamin capsules, etc. should be placed in black plastic bags or other appropriate containers and disposed with the regular municipal solid waste.

Planning, Procurement and Training

Each area of the country was asked to prepare a microplan to establish logistical requirements, schedules, waste management strategies, and other plans. Table 4 shows that at least one site did not prepare a microplan as recommended by the DOH Guide. Other areas began their microplans anywhere from 6 months to 2 weeks before the start of the immunization campaign. The length of time to prepare the microplans ranged from 1 day to 6 months. On average, microplans were completed in about a month. However, it is worth mentioning that even with the accomplished microplans, some members of the vaccination team had a hard time getting copies of the microplan, so much so that some remained uninformed of the details of the microplan.

Table 5 provides data on the estimated number of children eligible to receive the vaccine in each site, and the corresponding numbers of auto-disable syringes, mixing syringes, and safety collector boxes obtained. These figures are based on the microplans or information from local health officials. The numbers of eligible children ranged from less than 1,000 to over 71,000; depending on what information was available, those numbers refer to either an entire city or municipality or only the researcher's documentation site.

In the documentation areas, Terumo® auto-disable syringes (0.5ml) were used for vaccination and Terumo® mixing syringes (5ml) with a luer lock tip were used as mixing or reconstitution syringes.[4] Based on a few samples, an empty AD syringe without a cap weighed about 2.1 grams; the cap weighed about 0.6 grams. Mixing syringes used to reconstitute the vaccine weighed about 4.9g with the cap. (These average weights were used by HCWH to estimate the amount of waste that would be generated.) A few areas also used 0.5ml BD SoloShot™ IX auto-disable syringes[5] for vaccination. Attenuated (freeze-dried) measles vaccines[6] in 10-dose glass vials weighed about 6.5g.

The safety collection boxes[7] were Polysafe 5-liter cardboard boxes made of recycled raw materials by Polynor AS (Gjovik, Norway). The sturdy boxes met WHO/UNICEF Standard E10/I.C.2 and were donated by the Japanese government. A safety box weighed about 325g and had dimensions of 0.162m x 0.127m x 0.292m high. Note that old safety boxes from a previous immunization campaign were available in some areas. The old boxes were not as robust and moisture-resistant as the new ones and had slightly different dimensions. Because no data were obtained on the old boxes, all calculations in this report are based on the new Polynor safety boxes.

Designation of responsibilities is important in planning. Table 6 shows who was responsible for the overall management of immunization waste in each documentation site, as well as specific responsibility for collection and storage, and responsibility for waste at the local level. The data indicate that there was generally a clear understanding of who was responsible although the person responsible varied according to site. Generally, the sanitary officers or sanitary inspectors were in charge of the waste, although in other sites, it was the provincial or city health officer, Expanded Program in Immunization (EPI) assistant coordinator, or vaccination team. The same person could also be in charge of collection and storage, with the help of local health workers who took custody of safety boxes at a central storage facility. On the local level, it was often a member of the vaccination team or local village health worker, and in some cases the researcher, who took charge of waste.

Except for a few areas, there seemed to be good coordination on waste management. In sites that experienced some difficulties, the problem was often one of lack of coordination in scheduling pick-ups or provision of safety boxes. One site (#18, Miag-ao), a coastal rural and mountainous area, provided a good example of a collaborative approach to waste management. A committee on waste management and disposal was formed. It was headed by the municipal health officer and included the sanitary inspector, the person assigned to transport the boxes, the persons in charge of the storage room and concrete vault, and even the researcher.

Table 7 summarizes the overall plan for transport, storage, treatment, and disposal in each site. The initial step involved transporting safety boxes from door-to-door vaccination sites and/or fixed sites to a temporary storage at the end of the day. Boxes were then

[4] Terumo-Philippines, Binan, Laguna, Philippines
[5] Becton Dickinson S.A., Spain
[6] Serum Institute of India Ltd., 212/2 Hadapsar, Pune 411 028 India
[7] The terms "safety collection boxes", "safety collector boxes" (used in the DOH Guide) and "safety boxes" are used interchangeably in this report.

collected and transferred to a central storage facility. The frequency of collection ranged from daily to weekly to once during the campaign. In rural and remote areas, the storage facility at the end of the day was often also the central storage facility. The next step entailed one of several approaches: (1) treatment in a centralized microwave facility, (2) treatment in an autoclave facility, (3) encasement in a concrete septic vault, (4) burial in a waste pit with a cement floor, or (5) burial in a waste pit with a clay bottom layer. These steps are summarized in Figures 1 and 2 below.

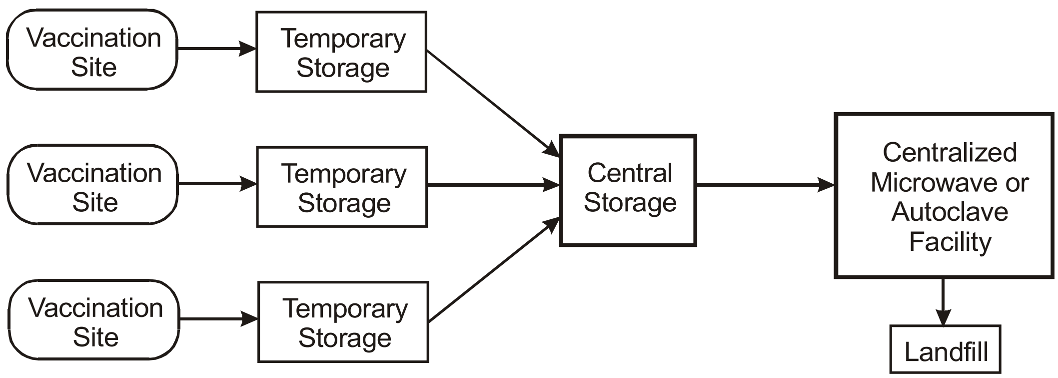


Figure 1: Centralized Treatment

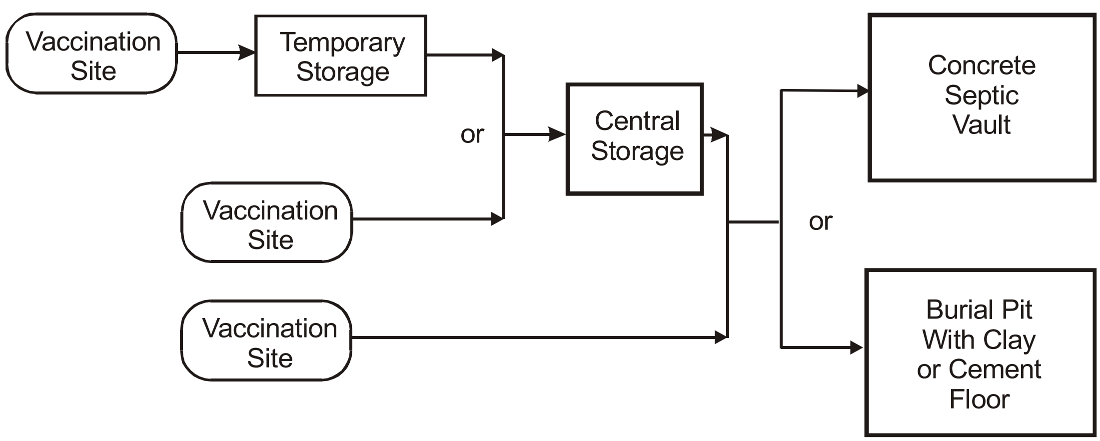


Figure 2: Burial Methods

Each of these steps is discussed in greater detail below. It should be noted that alternative methods were implemented in a few areas: (1) burial in existing concrete cemetery vaults, (2) disposal in an existing communal latrine, and (3) small-scale needle destruction. Some approaches came out of the need for creative local solutions to the problems of funding limitations and lack of resources.

Researchers interviewed decision-makers and asked why treatment and disposal options were selected. Table 8 shows that affordability, practicality, and availability of resources were among the most important considerations.

Training is a key component of any waste management system. Some researchers were able to attend orientation sessions; others asked members of the vaccination team to describe their training in waste management. Table 9 provides data on training. Training on waste management was not provided in at least five areas and training seemed insufficient in others. However, several areas had adequate training that covered awareness-raising about the dangers of sharps, the recommendation not to recap syringes, how to assemble and use safety boxes, what types of waste to put in the boxes, proper fill levels, handling, daily storage, transport, responsibility of vaccination team members, disposal methods, and even education of the public about the safety boxes. Several researchers noted that one obstacle to training in waste management was the attitude by some health workers that their past experience in immunization was sufficient. Future campaigns should incorporate awareness-raising and training in waste management as part of the orientation given to health workers and volunteers.

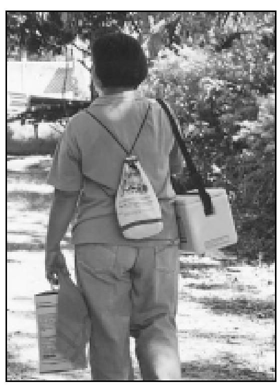
Immunization Phase

Collection, Transport, and Storage

Table 10 describes the placement of the safety boxes in the vaccination set-up. In general, safety boxes were placed within arm's reach of the vaccinator along with other equipment as shown in Photograph 1. In some cases, boxes were placed side by side with other containers to facilitate segregation of sharps from other waste streams such as syringe wrappers. Once filled, the safety boxes were placed under tables or in areas outside the reach of children. One site taped the boxes to the vaccination table to prevent their tipping over.

Photograph 1. Vaccination Set-up

During door-to-door vaccination, the safety boxes were hand-carried by members of the vaccination team or volunteers. In Photograph 2, the vaccinator is shown carrying the safety box in her left hand.



Photograph 2. Hand-Carrying of Safety Boxes Between Vaccination Sites

Creative methods were devised to allow workers to carry large numbers of boxes at a time especially when moving boxes to and from central storage facilities. Photograph 3 shows a waste worker using a pole inserted through the handles of multiple safety boxes and balancing the pole on his shoulder.

Photograph 3. Method of Carrying Multiple Safety Boxes

For transport involving longer distances, locally available public and private transportation was used. The variety of vehicles used simply reflects the assortment of local transportation available, as described in Table 11 and listed below:

- Pedicab (bicycle with sidecar)
- Tricycle (motorcycle with sidecar)
- Jeepney or jeep
- Motor scooter
- Motorcycle
- Modified motorcycle with extended seating
- Local ambulance
- Minivan
- Van
- Taxi
- Pick-up truck
- Dump truck
- Boat
- Horse
- Private vehicle
- Vehicles used to deliver vaccination supplies.

Tricycles are motorcycles with steel sidecars and are the most common form of transportation in the Philippines (Photograph 4). Passengers can sit in the sidecar (most of which have a metal or canvass cover) and behind the driver. Some areas used a modified motorcycle, locally called “habal-habal” or “skylab,” in which the seat is extended so as to allow as many as three or more people to sit behind the driver (Photograph 5). Motorcycles in the Philippines typically have 125 or 175 cc engines. Motorbikes or motor scooters are smaller and simpler versions of motorcycles. Pedicabs are bicycles attached to sidecars that may or may not have canvas or metal covers (Photograph 6).

Photograph 4. Tricycle Transporting the Vaccination Team (left);
Inside of Tricycle Sidecar Showing the Safety Box (right)

Photograph 5. Motorcycle With Extended Seating

Photograph 6. Pedicab Transporting Vaccinators and Safety Boxes

A jeep specifically refers to a Philippine "jeepney," a vehicle modified from an old army transport jeep design (Photograph 7). It is an extended vehicle with two bench seats facing each other at the back; passengers enter and exit from the rear. The jeep is one of the most common and inexpensive modes of public transportation. Many sites also used minivans or vans. A typical minivan (e.g., Toyota Tamaraw FX) is capable of seating about 8 people (Photographs 8 and 9). Vans (such as the KIA Besta, Mitsubishi L300, and Anfra) are slightly larger and can sit eleven or more people. Modified vans or minivans have also been used as ambulances (see Photograph 10).

Photograph 7. Philippine Jeepney


Photograph 8. Regular Minivan Used to Transport Safety Boxes

Photograph 9. Open Minivan Used to Transport Vaccinators and Safety Boxes

Photograph 10. Ambulance Van Used to Transport Safety Boxes

Photograph 11 shows a boat used to transport the vaccination team, immunization supplies, and safety boxes for site # 6 (Sulat).

Photograph 11. Boat Transporting Vaccinators and Safety Boxes

The road conditions under which safety boxes were transported also reflect the myriad of conditions found throughout the Philippines, as shown in Table 11. They include:

- Asphalt roads
- Concrete roads (generally found in highways)
- Rough gravel roads
- Unpaved dirt roads
- Mountain paths
- Wood plank bridges.

Information about daily temporary storage is given in Table 12. Usually, the fixed vaccination sites—especially the city, village, or rural health centers—were also used for daily temporary storage of safety boxes. The actual storage location could be a cabinet, nurses' station, storage room, unused toilet, designated room, a corner space, or even the concrete vault or waste pit itself. Some storage locations were more secure than others. The storage areas were generally accessible to workers but not to the public after clinic hours. Some were kept locked throughout the day, others were covered under plastic, but a few were readily accessible to people visiting the health centers. Generally, the local nurse or health worker, sanitation officer, EPI coordinator, or volunteer took custody of the boxes. Many followed the Guide by sealing the boxes with tape and labeling them "Used – Do not open" (Photograph 12). In addition to helping seal the boxes, researchers also weighed, recorded, and numbered the boxes with colored marker pens. The numbering was used to account for boxes in the documentation site. In all cases, boxes were neatly stacked horizontally or vertically (Photograph 13). There were no incidents of boxes falling and breaking open, or syringes spilling out in the daily storage areas.

Photograph 12. Marked and Numbered Safety Boxes
[Bag of regular non-hazardous waste shown at the top; old safety box from past immunization campaign shown on the right]

Photograph 13. Compact Stacking of Safety Boxes

As mentioned earlier, the daily storage location was also the central storage facility for some sites, especially rural and remote areas. This was not necessarily the case for urban and other areas wherein the safety boxes had to be collected from each of the smaller temporary storage locations and moved to a large centralized storage facility. Data on this second transport are given in Table 13. The second collection was usually done once or twice a week, or once or twice during the immunization campaign. Distances were typically several kilometers under different road conditions. In general, larger vehicles were used such as ambulances or delivery vans.

When larger, central storage facilities were used, they were generally the main municipal or city health centers, major hospitals, or storage area at the cemetery, as shown in Table 14. These facilities were kept locked and away from the public. In one site, a few boxes were broken and some syringes had fallen out; the problem boxes turned out to be old boxes left over from previous immunization campaigns. Those boxes were not as thick and rugged as the new ones. The numbering by researchers was helpful in accounting for the boxes.

Treatment and Disposal

A final transport was needed to bring the boxes to the treatment facility, except when the central storage was near or at the treatment facility itself. Table 15 describes that last transport stage. Distances as far as 194 km (round trip) on concrete or asphalt roads were recorded. In the National Capital Region, the transport took place in heavy traffic. In general, the waste treatment facility's 20-foot van (two-ton capacity) or a large pick-up truck was used. The treatment facility's enclosed van was a safe mode of transportation. In one case, an open pick-up truck was used; this method was questionable since boxes were not loaded carefully, not secured during transport, and some boxes could have fallen off during transport.

As discussed earlier, the main treatment and disposal methods were:

- Treatment in a centralized microwave facility
- Treatment in an autoclave facility
- Encasement in a concrete septic vault
- Burial in a waste pit with a cement floor
- Burial in a waste pit with a bottom clay layer.

Disposal in a communal latrine and needle destruction were also done. Figure 3 shows the number of times each method was selected among the documentation sites. (Needle destruction is discussed in another section.) Note that the total number of sites in the graph exceeds 19 since some sites used more than one method. Also note that site #19 (Cavite) covers an entire province and encompasses two other sites (namely, sites #3-Aguado and #17-Dalahican).

Figure 4 compares the selection of treatment and disposal methods with the geography of the area. As one might expect, urban areas used centralized treatment via autoclaving or microwaving where they were available. Some rural and coastal areas also had access to centralized treatment and chose this method. Rural and coastal areas as well as islands primarily used concrete vault encasement. Remote rural areas in mountainous terrain used burial pits. The total number of sites in Figure 4 exceeds 19 since many sites fit more than one geographical category.

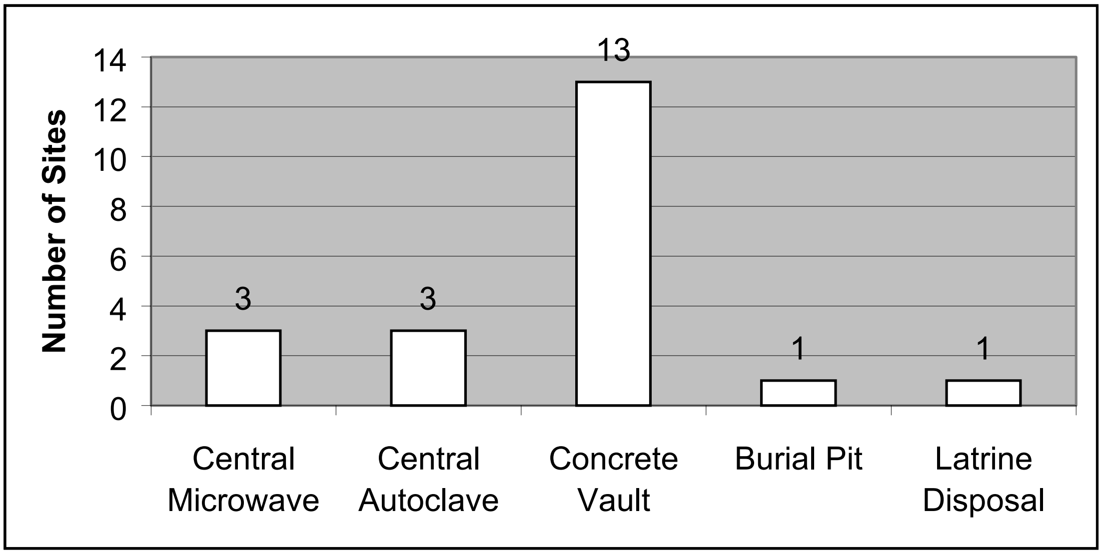


Figure 3. Treatment and Disposal Methods

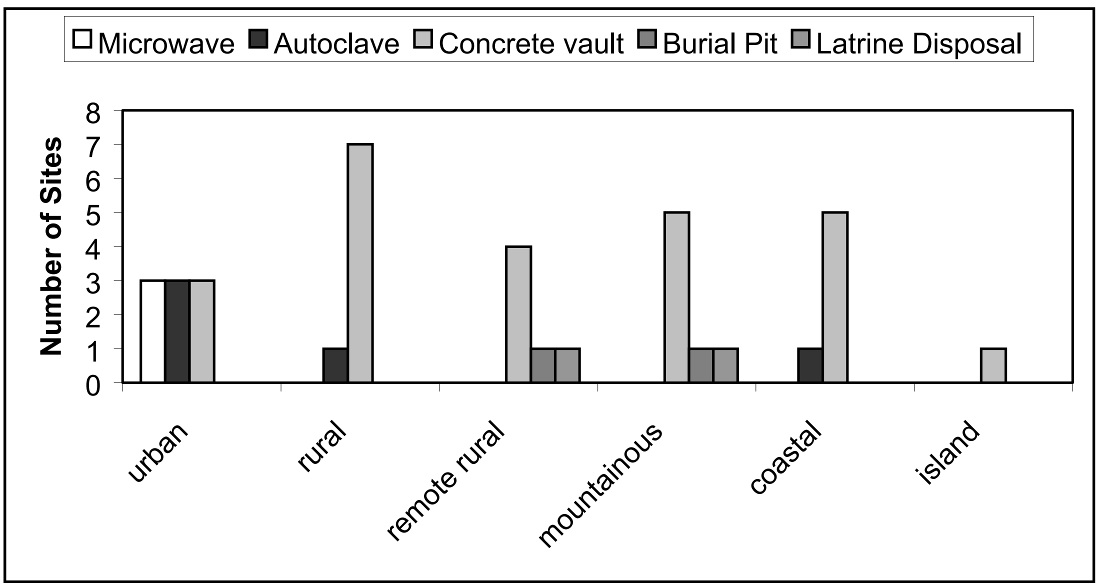


Figure 4. Treatment and Disposal Methods According to Geography

Centralized Microwave Treatment

Microwave treatment of the safety boxes was provided *pro bono* or at a discount by Chevalier Enviro Services, Inc. (CESI) in Paranaque City, Philippines.[8] CESI is a member of the Chevalier Group. It has operated a microwave unit with a 6 ton per day

[8] Chevalier Enviro Services, Inc. (Chevalier Envirotech Ltd.), Km. 17 West Service Road, Cervantes Street, Bormaheco Compound, South Super Highway, Sucat, Paranaque City, 1700 Philippines; Ph. (632) 823-4245, (632) 821-0136; Fax (632) 776-7042.

capacity since August 2000 (see Table 16). The microwave unit was provided by Sanitec Industries[9] which has sold their microwave technology for medical waste treatment since 1990.

Microwave treatment is essentially a steam-based process since disinfection occurs through the action of moist heat and steam generated by microwave energy. The heat denatures proteins within microbial cells thereby inactivating pathogens. Microwave units are routinely used to treat sharps waste such as needles as well as other types of medical waste. The microwave system consists of a large tube into which microwave energy is directed from six microwave generators. The six magnetrons used have an output of about 1.2kW each. The unit also consists of an automatic charging system, hopper, internal shredder, conveyor screw that brings the waste through the tube, steam generator, discharge screw, and electronic controls (see Figure 5).

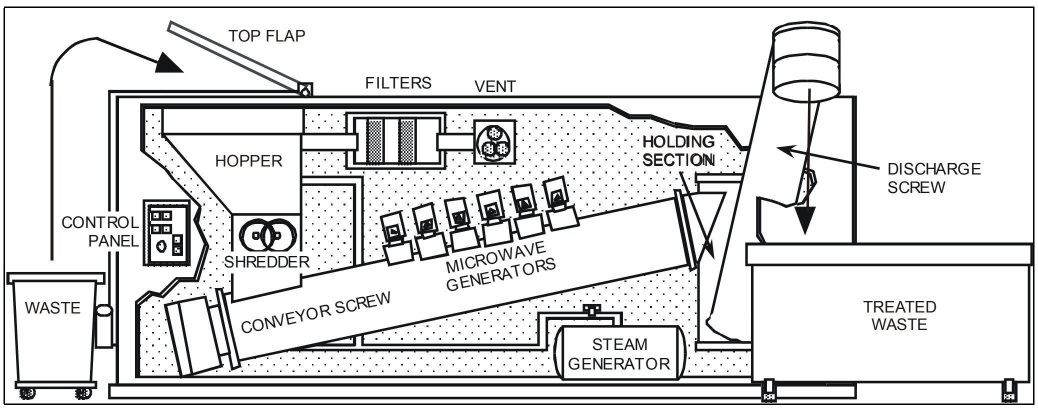


Figure 5. Microwave Treatment System

The operation of a microwave unit consists of the following:

- Waste loading: Waste bags or boxes are loaded into carts that attach to the feed assembly. High temperature steam is injected into the feed hopper. While air is extracted through a high efficiency particulate air (HEPA) filter, the top flap of the hopper is opened and the container with the waste is lifted and tipped into the hopper.
- Internal shredding: After the hopper flap is closed, the waste is broken down into small pieces by an internal shredder.
- Microwave treatment: The shredded particles are conveyed through a rotating conveyor screw where the waste is exposed to steam and heated to between 95° and 100°C.
- Holding section: A holding section ensures that the waste is treated for a minimum of 30 minutes.

[9] Sanitec Industries, 1250 24th Street NW, Suite 350, Washington, DC 20037, USA; Ph. (202) 263-3630, Fax (202) 466-3079; www.sanitecindustries.com

- Discharge: The treated waste is conveyed using a second conveyor screw, taking waste from the holding section and discharging it directly into a bin or roll-off container.

The model #HG-A 250 at CESI is capable of treating about 250 kg/hr or more. It has approximate dimensions (including height of flap when opened) of 24 feet long x 17 feet high x 10 feet wide. The microwave at CESI requires two persons to operate. (See also Table 17.) The treated waste may be processed through a second (optional) shredder that breaks waste into even smaller pieces. The optional second shredder can be attached in about 20 minutes to the end of the second conveyor screw. A second shredder is often used with sharps waste for fine shredding, but one was not available during the immunization campaign. Researchers noted that the primary shredder only provided coarse shredding, enough to render syringes unusable but not enough to completely destroy all the needles. The treated waste was buried in a controlled 400 sq m area of a large dumpsite (60,000 sq m) and three feet of earth was added immediately after dumping (see Table 18).

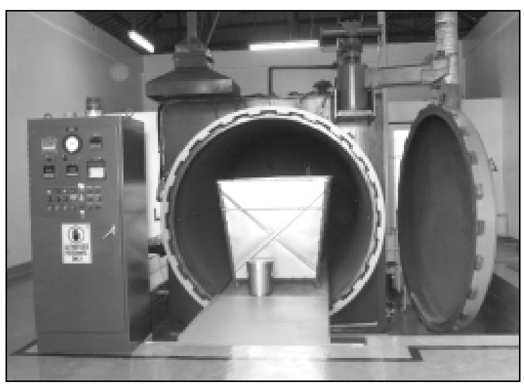
Photograph 14. CESI Microwave Treatment System

Landfill workers added a disinfectant to the waste before burial but that procedure was unnecessary. Past microbiological studies of treated waste from this type of microwave system showed a microbial inactivation efficacy of 7 $\log_{10}$ kill or better for the following test microorganisms: *Bacillus subtilis, Pseudomonas aeruginosa, Staphlococcus aureus, Enterococcus faecalis, Nocardia asteroides, Candida albicans, Aspergillus fumigatus, Mycobacterium bovis, Mycobacterium fortuitum*, and duck hepatitis. CESI conducts periodic monitoring of their disinfection levels using heat-resistant Bacillus spores.

Photograph 15. Special Trench at a Controlled Area of a Landfill for Treated Waste From Microwave Treatment

Centralized Autoclave Treatment

Autoclave treatment was provided *pro bono* by PAE Environmental, Inc. in Trece Martires City, Cavite, Philippines.[10] PAE Environmental Company[11] is an international company based in California with offices in the Philippines, Hong Kong, and Thailand. It was established in 1995 as a waste management company and is a manufacturer's representative of the Thermal Equipment Corporation autoclave technology. (See also Tables 16, 17, and 18.) On February 2004, around the time the immunization campaign began, PAE completed the installation of a new 1.5m diameter x 2.5m long autoclave unit capable of treating 10 tons per day.



Photograph 16. PAE Autoclave System

An autoclave or retort consists of a metal chamber sealed by a charging door. Steam is introduced into the inside chamber which is designed to withstand elevated pressures. Because air is an insulator, air is removed by pre-vacuuming. Figure 5 shows a typical autoclave design.

[10] PAE Environmental (Philippines), Inc., 510 ALPAP II Building, Trade Street corner Investment Drive, Madrigal Business Park, Alabang, Muntinlupa City, 1770 Phiilppines; Ph. (632) 842-7087, (632) 842-7177; Fax (632) 842-7154; www.paenvco.com
[11] PAE Environmental Co., Suite 104, 800 W. Torrance Boulevard, Redondo Beach, CA 90277 USA; Ph. (310) 372-7451; Fax (310) 792-9922.

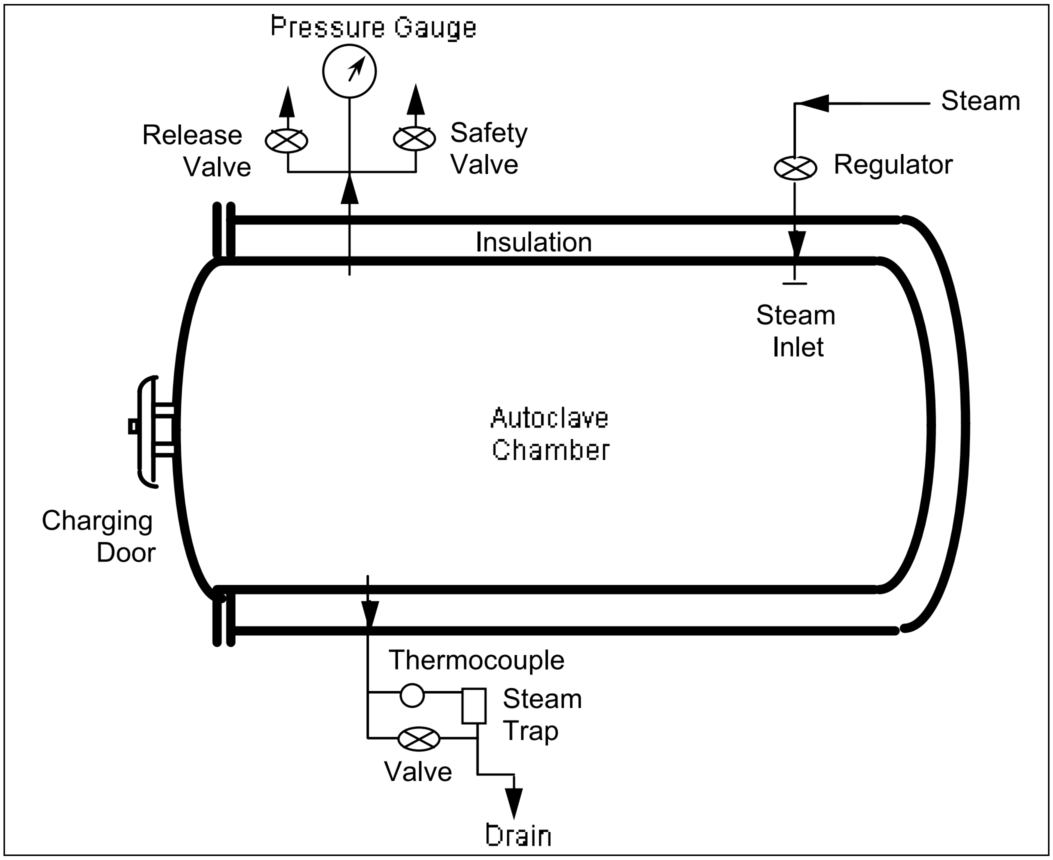


Figure 6. Typical Autoclave Treatment System

The basic operation of an autoclave unit involves the following:

- Waste collection: Waste bags or boxes are placed in reusable containers such as metal or autoclavable plastic bins. In some cases, the container is lined with autoclavable bags or liners to prevent waste from sticking to the container while allowing steam to penetrate.
- Waste loading: Waste containers are loaded into the autoclave chamber through ramps or tracks. Periodically, color-changing indicators are placed with the waste load to monitor disinfection. The charging door is closed, sealing the chamber.
- Air evacuation: Air is removed by pre-vacuuming.
- Steam treatment: Steam is introduced into the chamber until the required temperature and pressure are reached. Additional steam is automatically fed into the chamber to maintain the temperature for a set period of time.
- Steam discharge: At the end of the treatment, steam is vented from the chamber to reduce the pressure and temperature.
- Cooling and unloading: Additional time is provided to allow the waste to cool down after which the treated waste is removed.
- Monitoring disinfection: The color indicator is checked to monitor disinfection.

The PAE autoclave has the usual safety features including pressure relief from overpressure and a manual door opener in the event that a person is inside the chamber when the door closes. Autoclaves require a minimum exposure time and temperature to achieve proper disinfection. A common minimum temperature-exposure time standard is 121°C (250°F) for 30 minutes. The PAE autoclave operates at higher temperatures and exposure times: 142°C (288°F; 41 psig or 283 kPa gauge pressure) for 45 to 90 minutes depending on the load to ensure proper disinfection. Often, sharps waste is processed through a post-treatment shredder to destroy the needles prior to disposal in a landfill. A shredder was not available at the time of the immunization campaign. Arrangements were previously made to bury the treated waste in a controlled landfill but due to delays, a concrete septic vault was built measuring 2m x 3m x 4m deep to accommodate the treated PMEC wastes.

Burial Methods

Many of the central storage facilities were near or next to the location of the concrete vaults or pits. In some cases, instead of a separate storage, the boxes were deposited directly inside the vaults or pits. Table 19 gives an example of transport from the central storage facility to the concrete vault; it was done at the end of the campaign using local transportation.

There were two basic burial methods: (1) encasement in a concrete septic vault and (2) burial in a waste pit with either a cement floor or a bottom clay layer to protect the groundwater. The concrete vaults were generally the rectangular vaults recommended in the Guide. Some areas used existing concrete cemetery vaults that had been used to store human remains, while others used cylindrical vaults. Some vaults were designed to become walkways or parts of culverts. The list below illustrates some of the variations of vault and pit designs that were used:

- Rectangular concrete vaults
- Cylindrical concrete vaults
- Cylindrical concrete vaults build as part of culverts
- Underground cemetery vaults
- Aboveground cemetery vaults
- Burial pits with cement floors
- Burial pits with clay bottom layers.

The basic designs of standardized vaults and burial pits, as recommended in the DOH Guide, are shown in Figures 7 and 8.

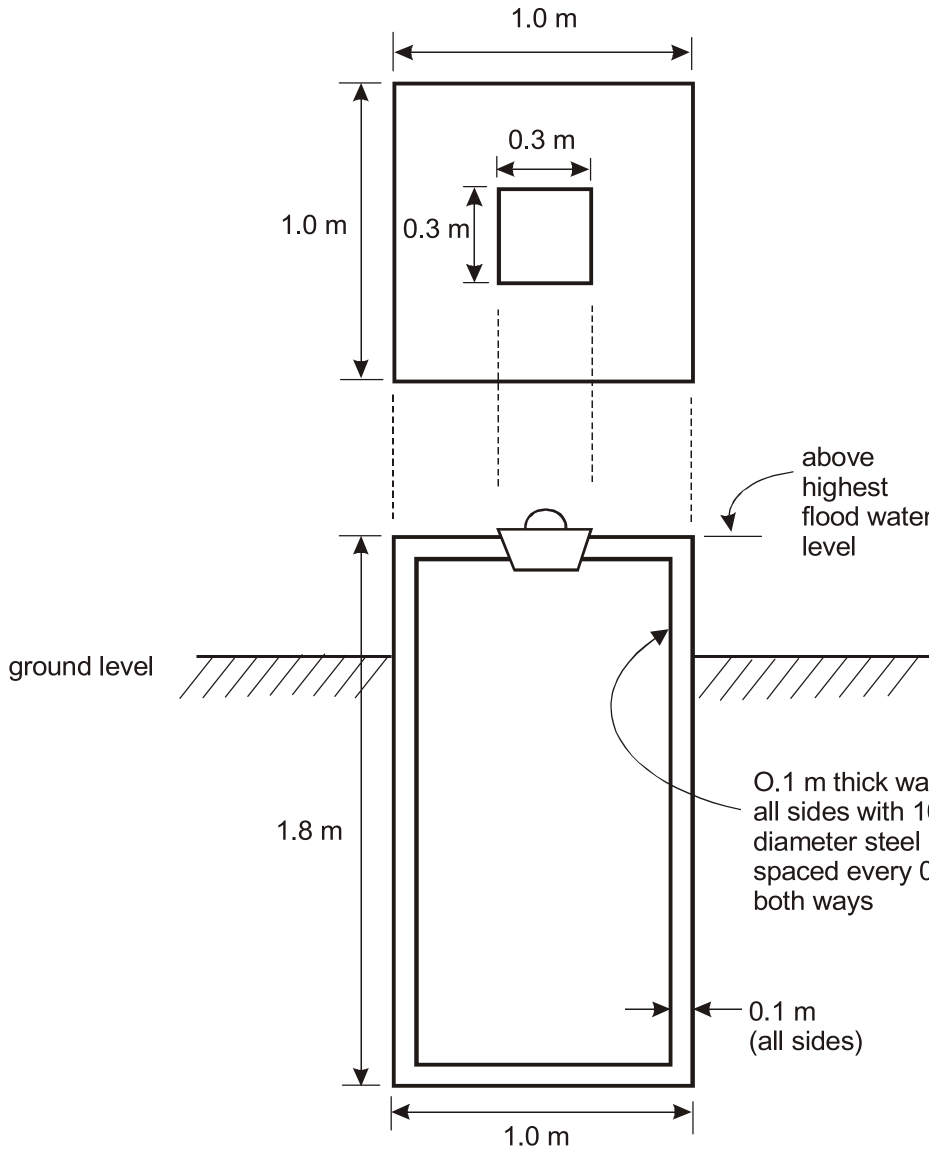


Figure 7. Basic Concrete Septic Vault Design

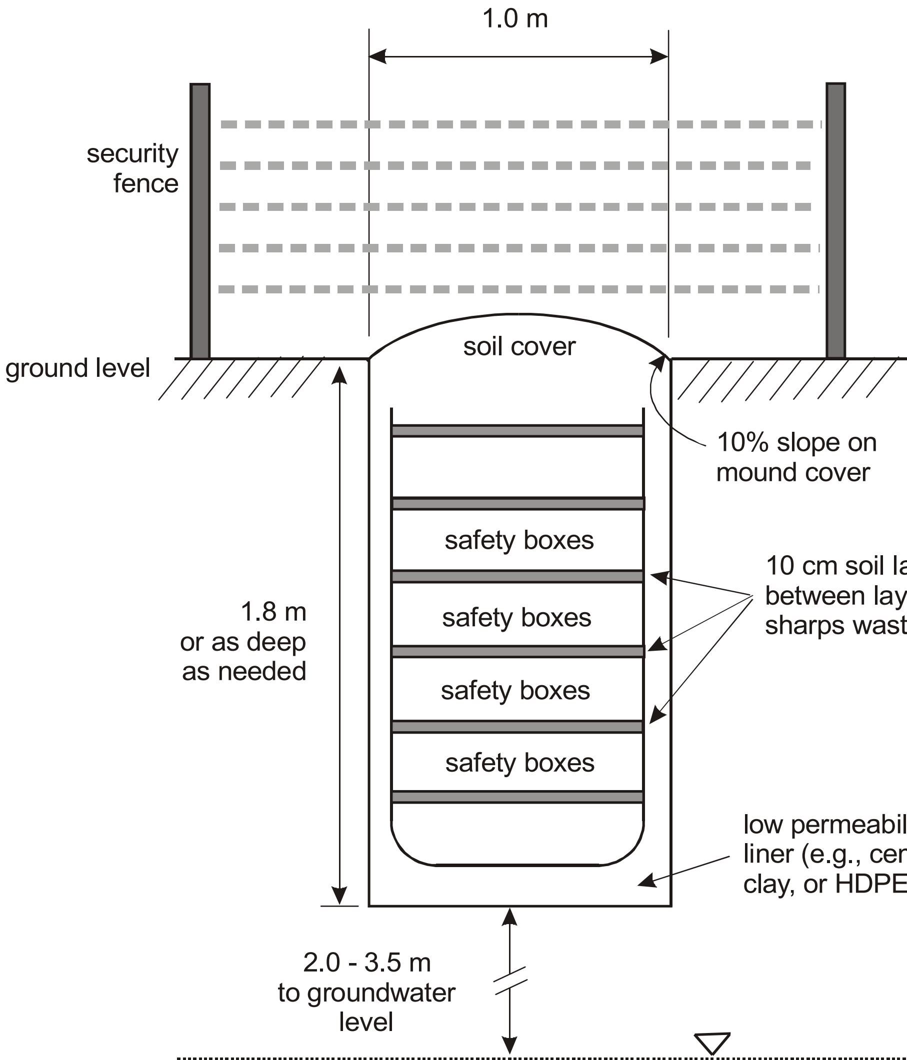


Figure 8. Basic Burial Pit Design

Detailed data on the vaults and pits are given in Tables 20 to 22. To construct the vaults, 4-inch cement hollow blocks were used in conjunction with 10mm reinforced steel bars spaced evenly every 0.4m. A mixture of cement, sand, and graded gravel was poured to form 0.1m walls and slabs. Some sites used waterproof cement to finish surfaces and flooring. Construction generally took two to five days involving between two to six workers. Basic masonry and carpentry skills were required. Table 21 summarizes construction time, human resources, tools, and construction steps as reported for each site. Additional data can also be found in the section on costs.

Photograph 17 shows a rectangular concrete vault without the cover and in the process of being filled with safety boxes. Photograph 18 shows workers placing a heavy cement slab as the top cover of an aboveground concrete vault. Photograph 19 shows the inside of a cylindrical concrete vault and a makeshift wooden hoist used to arrange the safety boxes inside the vault.

Photograph 17. Safety Boxes Being Encased in a Concrete Vault at a Cemetery

Photograph 18. Cover of a Rectangular Concrete Septic Vault

Photograph 19. Cylindrical Concrete Vault and Makeshift Wooden Hoist

Most sites used the basic rectangular concrete vault and pit design in the Guide although many used slightly larger dimensions to accommodate safety boxes and future sharps waste. Two sites built two vaults side by side. In flood plains, concrete vaults were built protruding above the ground such that the top of the vault was above the highest known flood level in order to prevent water intrusion.

Photograph 20 shows a simple burial pit with a clay floor. It was constructed in a remote rural area.

Photograph 20. Burial Pit

Pits and vaults were generally built some distance away from residences and surface water. They were generally located behind the health centers or hospitals or within government facility premises. Several were built inside cemeteries and one was built at a municipal dumpsite. Many had security fencing and signs (see Photographs 21 and 22).

Photograph 21. Large Sign at a Concrete Vault

Photograph 22. Bamboo Fence and Sign at a Burial Pit

All sites built their vaults or pits well above groundwater levels ranging from 2 m to 55 m above the water table, except for one site which constructed their concrete vault in an area where the groundwater was about 1 m below the bottom of the vault. In particular, the waste burial pits were 20 to 40 m above the water table. Unlike other types of medical waste that could adversely affect groundwater, safety boxes containing only used stainless steel needles and plastic syringes probably have minimal environmental impact. The use of waterproof cement and clay layers further protects the groundwater.

At the end of the vaccination campaign, most concrete vaults and pits were only between 10 to 67 percent full. Calculations showed that a 1m x 1m x 1.8m vault with 0.1m walls could accommodate as much as 120 boxes when stacked vertically in a compact arrangement. Workers at a few sites dumped the safety boxes in a haphazard manner but most workers carefully stacked the boxes in compact configurations (as shown in Photograph 17) to maximize the number of boxes that could fit in the vault or pit.

After the campaign, most vaults or pits remained open under the supervision of the sanitary inspector or health officer. They will be used for disposal of future sharps waste from health facilities in the area. Hence, a side benefit of the measles immunization campaign is the implementation in the local area of segregation and safe disposal of sharps waste, which in the past had been burned or discarded in open dumps. When full, the concrete vaults will be sealed with cement. (Photograph 23 shows a vault behind a government health center being sealed temporarily.)

Photograph 23. Sealing of a Concrete Vault

Other Methods: Needle Destruction and Latrine Disposal

Two sites experimented with other disposal methods, as summarized in Table 23. These methods differed from the approaches described above.

HCWH documenters were able to visit and obtain information from one area that used a novel approach to sharps disposal. Baguio City is an urban area with a population of about 200,000 situated in a mountainous part of the country. Economic activities include tourism, some farming, mining, electronics, and other commercial activities. The City Health Department was responsible for waste management during the immunization campaign. The safety boxes were stored in the basement of the City Health Office. The original plan was to place the safety boxes in drums and encase them in cylindrical concrete vaults three feet deep and with a diameter slightly larger than the drum's diameter. Four cylindrical concrete vaults were built on the culvert between a government building and a road within the health office premises.

During the campaign, a local non-governmental organization donated a Nulife DOTS needle destroyer to the city health office (see Photograph 24). Nulife DOTS, obtained from MRK Healthcare,[12] is a compact desktop device that automatically creates a small electric arc to melt needles.

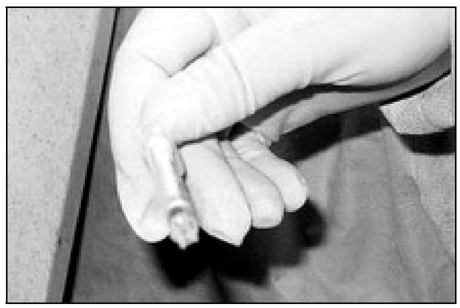
The operation of the needle destroyer is simple. The needle is inserted into an opening and pushed down until the needle is melted into pellets known as swarf (the process takes a few seconds). The worker then pulls the handle of a steel cutter thereby slicing off the hub and rendering the syringe unusable as shown in Photograph 25. The high temperatures needed to melt the stainless steel needles would suffice to destroy pathogens. The pellets fall into a cartridge that can hold about 500 needle residues. The device is 165mm x 115mm x 120mm in size, weighs 1.7kg, and is protected by a fuse. The City Health Office's original plan was to recycle the remaining plastic portions and dispose of the pellets with regular solid waste.

Since the needle destroyer is designed for use on-site at the point of waste generation, i.e., immediately after an injection is given, a modified procedure had to be adopted. Immediately after the vaccine was injected, the vaccinator recapped the needle using a one-hand technique and deposited the capped syringes into a safety box. As the safety boxes were brought in, a worker was tasked with opening the safety boxes and removing the used needles. The worker then took each syringe, removed the cap, and destroyed the needle using the Nulife DOTS device. The plastic portion was then collected in a sharps container. The process was labor-intensive.

A second type of needle destroyer was also procured (Photograph 26) but no technical data were obtained except that it has a capacity for holding 600 needle residues. Despite the potential for needle-stick injuries with the added handling of sharps, the City Health Office reported that there were no injuries. Later, because of the amount of time needed to handle large amounts of sharps waste, health officials decided to reconsider the use of cylindrical concrete vaults.

[12] MRK Healthcare, B4/5 Byculla Service Industries Premises, Sussex road, D.K. Marg, Byculla, Bombay 400 027, India; www.mrkhealthcare.com/needle_burner_syringe_destroyer.htm

Photograph 24. Nulife DOTS Needle Destroyer Used in Baguio

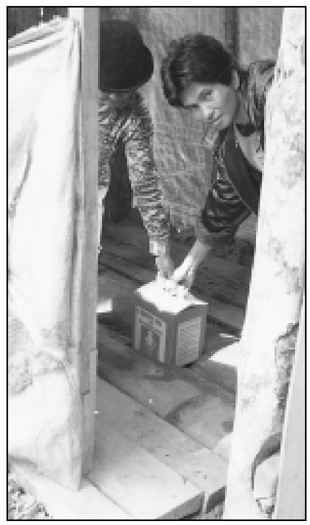


Photograph 25. Remaining Plastic Portion of the Syringe
After Treatment in the Needle Destroyer

Photograph 26. Second Type of Needle Destroyer Used in Baguio

Today, there are both manual and electric needle destroyers available commercially. The manual devices range from simple needle cutters to needle removers or pullers to heavy desktop devices that cut the needles into small pieces. Some needle destroyers are designed for one-hand operation to reduce the risk of needle-stick injuries. The electric needle destroyers, many of which are portable and run on batteries, produce different results; some merely melt the tip of the needle, others melt the needle up to the nub. Due to the electric arc, some of these devices cannot be used near flammable vapors. Devices such as the Nulife DOTS incorporate a needle cutter with their needle destroyer thereby rendering the syringe unusable, another important criterion for selecting needle destruction devices. Needle destroyers are a viable option for dealing with small quantities of syringes at the point of generation but they present difficulties if used as a centralized treatment and disposal system for large amounts of sharps waste. The added steps of recapping needles and then removing caps again prior to needle destruction could increase the risk of needle-stick injuries.

In a poor rural upland area far from the urban centers (site #12-Marilog), safety boxes were disposed in traditional communal latrines that had been in existence for many decades. Decision-makers argued that the method was safe since the public would not be exposed to sharps as no one ever went down into the latrine pit. The communal latrines, locally known as "antipolos," were 6 ft x 7 ft by 8 ft deep and had more than enough space for all the safety boxes. Photograph 27 shows workers dropping a safety box into the communal latrine. Presumably, the latrines would be backfilled with soil and gravel should they ever need to be closed in the distant future.



Photograph 27. Disposal in the Communal Latrine

Post-Immunization Phase

Summary of Waste Generation

At the end of the immunization campaign, researchers were asked to compile their data on waste generation. Tables 24 and 25 provide data on the number of injections given in each documentation site, the amounts of waste produced, and other information. The number of injections in a documentation site ranged from 640 in a small urban poor village, to 18,256 for most of a municipality in the National Capital Region, to 360,200 in a province. When averaged per day, the first two figures correspond to between 49 and 912 immunizations per day, the latter involving multiple vaccination teams.

During planning, a 10% "wastage factor" is generally assumed when estimating how many AD syringes are needed. The wastage factor tries to account for syringes that cannot be used, such as syringes that are inadvertently locked, broken, dropped, defective, or not usable for other reasons. Table 26 below shows the percent wastage in AD syringes. This was calculated by computing the total number syringes needed for the actual number of children vaccinated (1 AD syringe per child, 1 mixing syringe per 10 children) and comparing that number with the actual number of syringes disposed of. Several negative values may be because some vaccination teams reused mixing syringes. Thus, the actual wastage may be higher than those shown in Table 26. In sites #2 (Midsayap) and #15 (Sudipen), the field researchers counted and recorded the number of syringes that could not be used, namely, 300 out of 6,181 syringes or 4.8% wastage; and 209 out of 2,208 syringes or 9.5%. These are within the 10% wastage factor used to estimate the number of syringes needed.

Figure 9 gives a graphical representation of the average number of syringes per box based on data from each documentation site. (As noted earlier, all calculations are based on the new Polynor safety boxes even though a few areas had also used some old safety boxes from an earlier immunization campaign.) At least one area reported that some under-filled boxes were reopened and the contents consolidated into other boxes. Several areas showed large numbers of syringes per box, which confirmed field reports that some vaccination teams were overfilling the safety boxes. The Guide estimates that each 5-liter safety box could hold about 100 syringes if filled to the $3/4^{th}$ fill level. Data from the documentation sites gave an average of 123 syringes per box, if one were to exclude the data for site #2 (Midsayap) which seemed inordinately high.

Figure 10 shows the average weight of the safety boxes based on data from each documentation site. The overall average weight of a filled box using data from all documentation sites was 790g. The weights do not fully correspond to the number of syringes per box in Figure 9. This may be explained by the fact that some sites also discarded empty vaccine vials and/or diluent ampoules in the safety boxes. In some cases, even within a site, there was inconsistent practice of including or excluding empty vials and ampoules in the safety box. By comparison, one could compute an estimated theoretical weight of filled boxes using the average weights of syringes and vials given on page 6. Assuming 100 syringes in a 3/4th full box (91 AD syringes, 9 mixing syringes), one obtains an estimate of 619g without vials, 673g with vials.

Table 26. Waste Generation Data

Site #	# Children	# Syringes	% Wastage*	# Boxes	Ave. # Syringes / Box	Ave. Weight (kg) / Box
1	859	908	-4.1	11	83	0.65
2	5,408	6,181	4.8 **	25	247	0.96
3	640	716	1.7	7	102	0.66
4	4,117	4,545	0.4	39	117	0.86
5	1,217	1,356	1.3	8	170	1.05
6	3,228	3,690	3.8	25	148	0.82
7	18,256	19,841	-1.2	160	124	0.57
8	1,195	1,370	4.1	18	76	0.50
9	1,500	1,650	0.0	9	183	0.86
10	772	787	-7.9	8	98	0.58
11	2,644	2,986	2.6	34	88	0.73
12	761	855	2.1	7	122	0.59
13	4,785	4,959	-6.1	29	171	0.70
14	2,064	2,099	-8.2	22	95	0.92
15	2,308	2,418	9.5 **	24	101	1.20
16	3,462	3,462	-10.0	34	102	0.67
17	1,281	1,300	-8.4	12	108	1.06
18	4,217	4,744	2.2	24	198	0.83

* Wastage was computed by using the number of children vaccinated and adding 10% for mixing syringes (1 mixing syringe per 10 doses) and comparing the total number with the actual number of syringes used. Negative and low positive wastage values may reflect frequent reuse of mixing syringes. Actual wastage may be significantly higher.
** Percent wastage values for sites #2-Midsayap and #15-Sudipen were based on actual wastage counts.

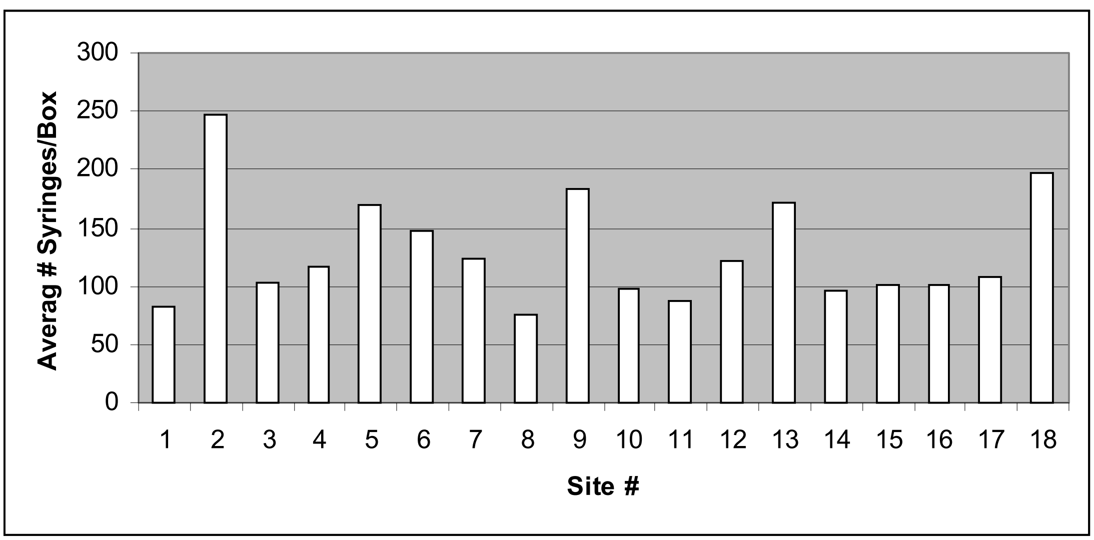


Figure 9. Average Capacity of Safety Boxes

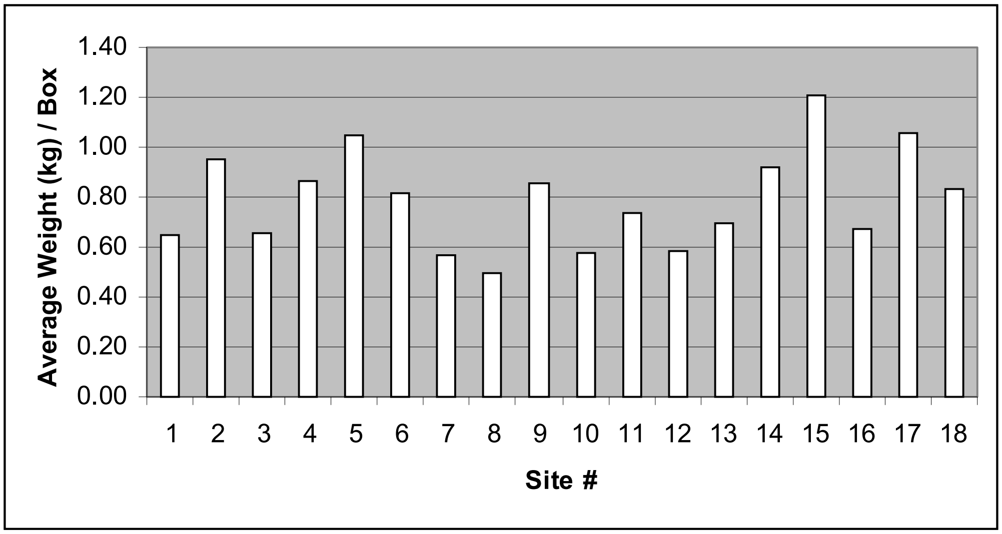


Figure 10. Average Weight of Filled Safety Boxes

It may be useful for future campaigns to compute the average number of safety boxes, weight of filled boxes, as well as the average volume and weight of non-infectious and non-hazardous "others wastes" per 1000 children vaccinated. Results of these calculations are given in Table 27 below and shown in Figures 11 and 12. The term "other wastes" included some or all of the following:

- Syringe wrappers
- Empty Vitamin A capsules
- Used cotton swabs
- Empty vaccine vials
- Empty diluent ampoules
- Syringe caps
- Empty boxes and other packaging
- Food wrappers and food waste

The volume and weights of "other wastes" varied considerably as shown by the data in Table 25. The volumes depended on the sizes of containers used, whether those containers were plastic bags or boxes, and the extent to which they were filled. The table also gives estimated volumes of other wastes.[13] The overall average was about 41 liters per 1000 children, keeping in mind that this was a rough estimate. The weights of "other wastes" in the documentation sites also varied greatly. These differences were due to the fact that the other wastes included discarded food, food packaging, and other non-immunization wastes in some sites but not in others. Nevertheless, the values are

[13] When researchers measured and recorded the circumference of bags, volumes were approximated by assuming a spherical bag. For researchers that provided dimensions of empty rectangular plastic bags, volumes were estimated by assuming oblate spheroidal volumes and providing allowances for tying the bags.

reported here since food and other wastes are all part of the normal operation of a mass immunization campaign.

Table 27. Waste Generation Data Per 1000 Children

Site #	# Boxes / 1000 Children	Weight of Sharps Waste / 1000 Children	Volume of 'Other Wastes' (liters) / 1000 Children	Weight of 'Other Wastes' (kg) / 1000 Children
1	12.8	8.3	n/a	2.3
2	4.6	4.4	3	2.4
3	10.9	7.2	n/a	4.4
4	9.5	8.2	1	0.7
5	6.6	6.9	n/a	5.2
6	7.7	6.3	30	3.0
7	8.8	5.0	2	n/a
8	15.1	7.5	42	2.8
9	6.0	5.1	59	3.1
10	10.4	6.0	18	2.7
11	12.9	9.4	n/a	n/a
12	9.2	5.4	18	10.8
13	6.1	4.2	101	3.1
14	10.7	9.8	13	3.6
15	11.0	13.2	n/a	5.9
16	9.8	6.6	52	3.8
17	9.4	9.9	40	0.4
18	5.7	4.7	159	5.8

n/a = no data available

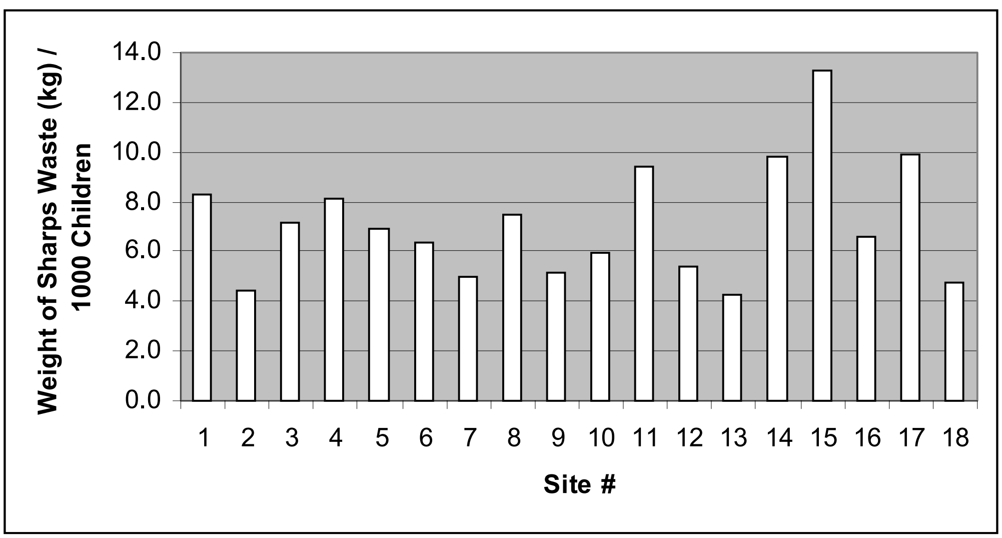
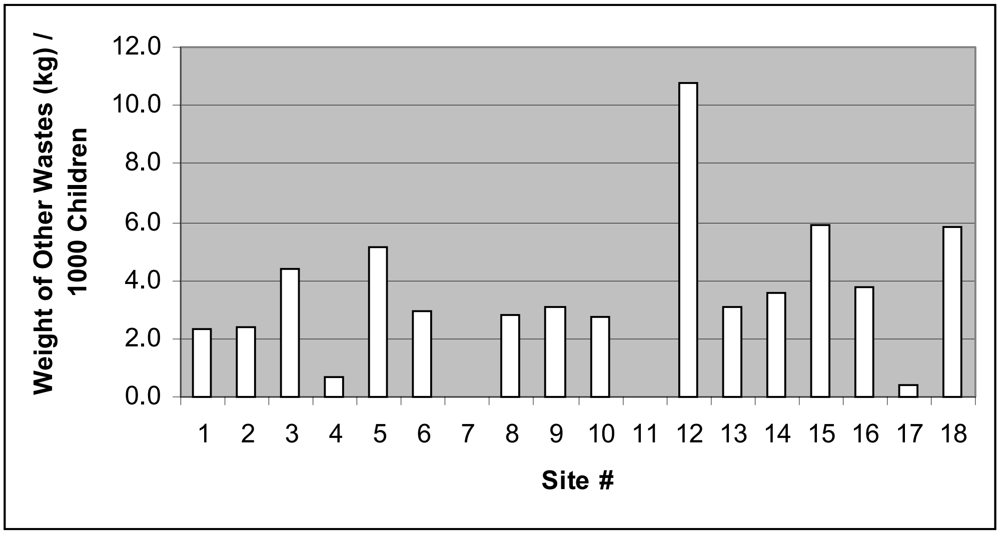


Figure 11. Average Weight of Filled Safety Boxes per 1000 Children



[No data available for sites #7-San Juan and #11-Bilar]

Figure 12. Average Weight of "Other Wastes" per 1000 Children

Only site #11 (Bilar) recycled some portion of their other wastes due to the personal initiative of one of the vaccination team members. Except for sites #11 and #18 (Miag-ao), which deposited their other wastes along with the safety boxes in the concrete vault, all other sites simply disposed of the other wastes with the regular municipal solid waste or garbage of the community or health center (see Table 28). In the future, more attention needs to be given to these "other wastes" generated by the campaign.

Table 29 below summarizes the key data and compares them to standard estimates used before the immunization campaign.

Table 29. Summary of Key Data Regarding Waste Generation

	Averages Based on Actual Data	Estimates Used in Planning	Notes
# Syringes/1000 Children	1,085	1,210	Estimate includes a 10% wastage factor
Syringe Wastage Factor (%)	7.1	10	Average based on two actual wastage counts
# Syringes/Safety Box	123	100	Estimate assumes a box that is 3/4th full
# Safety Boxes/1000 Children	9	12	
Weight (kg) per Safety Box	0.8	0.7	Estimate assumes 100 syringes; includes empty vials
Weight of Sharps Waste (kg)/1000 Children	7	8	
Weight of Other Wastes (kg)/1000 Children	4	--	Other wastes include syringe wrappers, cotton, empty vitamin capsules, etc.

Waste Management Costs

Tables 30-32 provide data on overall costs in U.S. dollars and a detailed breakdown of costs in Philippine pesos for centralized treatment, concrete vaults, and burial pits. (Note: an exchange rate of US $1 : Ph P55 was used.)

The cost of centralized treatment has three principal components: transportation, storage, and treatment. In general, transportation costs include rental of vehicles, cost of fuel, and labor. However, for the measles campaign, the vehicles were usually provided for free by the local health centers along with the labor cost of the driver or waste hauler. Where available, data on the cost of fuel are shown. These costs were of course dependent on the distances traveled from the central storage locations to the treatment facility. For sites #1 (Quezon City), #7 (San Juan), and #8 (Malabon), the average transportation costs were P270/1000 children.

In all cases, the cost of storage (storage space and labor) was provided free by the local health centers. The other main cost was for treatment and disposal. However, actual costs were less than what one would expect because both the centralized microwave and autoclave facilities agreed to provide their services *pro bono* or at a discount. Regular treatments costs were P32/kg. This of course does not include capital equipment costs for installing a centralized facility, although the treatment price probably reflects an amortized capital cost. If one were to compute treatment cost per syringe, one gets 46 centavos/syringe for transportation (based on actual transportation costs) plus treatment of safety boxes (based on the regular treatment price of P32/kg). Excluding transportation costs of safety boxes, the treatment cost alone is 21 centavos/syringe at the regular price. Alternatively, one can calculate 27 centavos/child for transportation of safety boxes, and 23 centavos/child for centralized treatment. (The above figures are based on the average 1,085 syringes computed per 1,000 children.)

For the purposes of future planning, if one assumes about P270/1000 children for transportation and storage and P32/kg for treatment of waste, the cost of centralized treatment in an existing facility is about P500/1000 children or 50 centavos/child. These are summarized in Table 33 along with corresponding dollar amounts.

Table 33. General Cost of Centralized Treatment *

	Cost/1000 Children (Pesos)	Cost/1000 Children (Dollars)	Cost/Syringe (Pesos)	Cost/Syringe (Dollars)
Treatment Cost (including transportation)	500	9	0.46	0.008
Treatment Cost (excluding transportation)	230	4	0.21	0.004

* Treatment cost is based on regular prices per weight normally charged by existing treatment facilities in the National Capital Region.

Both treatment facilities in this study are large-scale operations that handle 6 to 10 tons per day. Smaller microwave and autoclave systems may be possible in low-income areas especially if they are deployed to treat not just immunization waste but also other medical waste streams from hospitals and health centers in the locality.

The cost of concrete vaults and burial pits depends on size and is shown in Table 34.

Table 34. Actual Cost of Concrete Septic Vaults and Burial Pits *

Site #	Description	Overall Size ** (cu m)	Cost (Pesos)	Cost (Dollars)
2	1 vault	2.7	10,180	185
4	2 vaults	7.8	4,000	73
5	1 vault	2	6,000	109
6	1 vault	1.8	5,032	91
10	1 vault	1.8	6,914	126
14	1 vault	1.8	5,478	100
15	1 cylindrical vault	6.3	5,230	95
16	1 vault	1.8	12,701	231
18	2 vaults	4	21,465	390
13a	1 pit w/ cement floor	2	5,030	91
13b	6 pits with clay floor	9.3	100	2

* The cost is for materials and labor needed to construct vaults, and does not include any associated costs for transportation from storage areas to the burial site.
** Overall size is computed using the *external* dimensions of the vault or the *internal* dimensions of the pit.

From Table 34, one could calculate the average construction costs of a vault on a per volume basis as P3,357 per cubic meter or $61 per cubic meter. The construction costs of burial pits are considerably less.

Table 35 shows the actual cost per child and per syringe. These costs average out to P4.00/child or P3.76/syringe for concrete vaults; P5.94/child or P5.73/syringe for burial pits with concrete floors; and 3 centavos/child or 2 centavos/syringe for burial pits with clay floors. However, these costs can be misleading since all the vaults and pits were oversized for the amount of sharps waste generated by the measles campaign. In other words, none of the vaults or pits was completely filled with safety boxes and most of them will continue to be used for other sharps waste in the coming years.

As noted above, the number of boxes that can fit in a vault or pit depends on the specific dimensions. It can be shown that a 1m x 1m x 1.8m vault with a 0.1m wall thickness (1.8 cu m overall size) can accommodate approximately 120 safety boxes if the boxes are stacked vertically in a compact configuration. From the data in Table 34, the average cost of a standard vault was P7,531. Similarly, a 1m x 1m x 1.8m burial pit can hold between 120 to about 210 safety boxes depending on how they are stacked. The cost of such a pit with a cement floor is about P5,030 or less.

Table 35. Actual Cost (in Pesos) Per Child or Per Syringe of Partially Filled Vaults or Pits *

Site #	Cost/Child (Pesos)	Cost/Syringe (Pesos)
2	1.88	1.65
4	0.97	0.88
5	4.93	4.42
6	1.56	1.36
10	8.96	8.79
14	2.65	2.61
15	2.27	2.16
16	3.67	3.67
18	5.09	4.52
13a	5.94	5.73
13b	0.03	0.02

* Note that vaults and pits were only partially filled with safety boxes at the end of the campaign; they will continue to be used for other sharps waste. The numbers of children and of syringes corresponding to the cement-floor pit (13a) and clay-lined pits (13b) were prorated based on the relative capacities of the pits.

For the purpose of planning, one could consider increments of vaults or pits of a standard size (1m x 1m x 1.8m) corresponding to about 120 safety boxes (96 kg) or 14,640 syringes. If mixing syringes are not reused and one assumes 10% wastage, the 14,640 syringes correspond to about 12,100 children vaccinated. One could assume negligible transportation costs for vaults and pits since they can be constructed close to central storage areas. Table 36 gives approximate costs per 1000 children and per syringe.

Table 36. General Cost of Concrete Encasement and Burial *

	Cost/1000 Children (Pesos)	Cost/Syringe (Pesos)	Cost/1000 Children (Dollars)	Cost/Syringe (Dollars)
Concrete Septic Vault Encasement	622	0.51	11	0.009
Burial Pit With Cement Floor	582	0.48	11	0.009
Burial Pit With Clay Floor	8	0.007	.14	0.0001

* These costs are based on constructing a vault or pit of standard size (1m x 1m x 1.8m) to accommodate 120 boxes, corresponding to 12,100 children or 14,640 syringes.

Since 120 boxes is about 96 kg, the comparable cost of centralized autoclave or microwave treatment of the same amount of waste is P3,072. One could estimate an additional P1000 for transporting 120 safety boxes to a treatment facility using data from site #1 (Quezon City). These approximate comparative costs are presented in Table 37 below and graphically (in U.S. dollars) in Figure 12. The data show that concrete vaults and burial pits with cement floors are more expensive than centralized treatment as currently priced. Not surprisingly, burial pits with clay floors are the cheapest method of disposal.

Table 37. Approximate Comparative Costs (Philippine Pesos) of Disposing Increments of 120 Safety Boxes

# Boxes	# Syringes	# Children	Cost of Concrete Vault	Cost of Burial Pit w/ Cement Floor	Cost of Central Treatment	Cost of Burial Pit w/ Clay Floor
120	14,640	12,100	7,530	5,030	4,072	100
240	29,280	14,200	15,060	10,060	8,144	200
600	73,200	60,500	37,650	25,150	20,360	500
1,200	146,400	121,000	75,300	50,300	40,720	1,000

Note: 120 safety boxes can fit a standard 1m x 1m x 1.8m concrete vault if stacked in a compact arrangement. Columns 4, 5, and 7 are the costs of constructing multiple vaults or pits to accommodate increments of 120 boxes. Column 6 gives the cost of centralized microwave or autoclave treatment at a rate of P32 per kg plus assuming an additional P1,000 in transportation cost for every 120 boxes. The number of vaccinated children assumes no reuse of mixing syringes (i.e., 1,210 syringes per 1,000 children) and a 10% wastage factor.

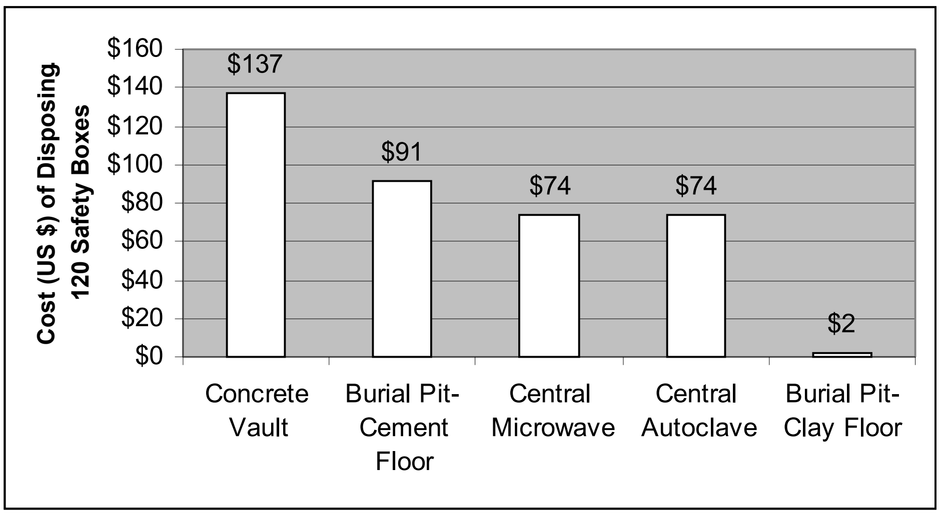


Figure 13. Approximate Comparative Costs ($) of Treating a 120 Box-Increment
(equivalent to 96 kg waste or 14,640 syringes or immunizing 12,100 children)

Occupational Safety

Accidents and injuries were reported by the researchers and are summarized in Table 38. In all, nine needle-stick injuries were reported in 17 of 19 documentation sites. (Due to the large number of vaccinations given in site #7 [San Juan], it is possible that the number of needle-stick injuries in this documentation site may be under-reported.) Six of the nine needle-sticks happened while improperly handling sharps waste or using old safety boxes, while three needle-sticks occurred immediately after vaccinating children and as syringes were being deposited in the safety box. These nine needle-stick injuries occurred out of 60,818 syringes used (or 56,070 children vaccinated). This corresponds to a ratio of 1.5 needle-sticks per 10,000 syringes used. The main causes of accidents and injuries are listed below:

- Use of old and less durable safety boxes from a previous immunization campaign
- Overfilling of safety boxes
- Re-opening under-filled safety boxes and transferring contents to other boxes
- Using plastic bags when safety boxes were not available
- Spraying safety boxes with disinfectant thereby weakening the boxes.

In all cases, first-aid was immediately applied. Of the few accidents reported, two involved children playing with or briefly carrying away safety boxes and one involved safety boxes falling out of a parked transport vehicle when the door was opened.

The data confirm the value of the new Polynor safety boxes, which were durable, puncture-resistant, and moisture-resistant. They also highlight the importance of not overfilling, not re-opening and transferring contents of boxes, of sealing boxes with tape when they are $3/4^{th}$ full, preventing boxes from getting wet and not spraying them with disinfectant (which is unnecessary), using heavy-duty gloves when handling large numbers of boxes, securing boxes during transport, and keeping an eye on safety boxes during vaccination.

Assessments by Stakeholders

Researchers interviewed members of the vaccination team, local health or sanitary officers, and community members. They were asked to comment on each aspect of waste management. Some interviews were done informally. This was not intended to be a scientific survey but an opportunity to allow stakeholders to provide comments and suggestions. Important comments and recommendations are presented in Table 39.

Many vaccination team members expressed appreciation for the new safety boxes, which were found to be sturdier, easy to assemble, and lighter to carry. The inadequacy or lack of training was mentioned several times. Team members felt that monitors were helpful in ensuring that waste was properly managed and in raising awareness about the importance of waste management.

Local officials were generally pleased with how the immunization waste was managed. Many local officials expressed concern that no funding was provided for waste disposal and local governments had to use their limited funds. Many officials also commented that good waste management and disposal should be promoted in more areas. In general, community members appreciated the attention given to waste management to protect public health and the environment.

Recommendations

Specific Recommendations for PMEC

By and large, waste management during the Philippine Follow-Up Measles Elimination Campaign was successful. The sharps waste was segregated and disposed in ways that protected communities from exposure and prevented reuse of syringes, while minimizing the impact on the environment. For future immunization campaigns, the following recommendations are made:

- *DOH Guide*: The Guide should include some of the recommendations presented below in relation to waste management, especially the need to designate individuals to take responsibility for waste management from the vaccination team level on up. The Guide could also include a waste tracking form to track the safety boxes from cradle to grave, and an accident/injury report form to record and analyze any injuries or accidents in order to continue improving occupation safety for future campaigns. Examples of forms are provided with the documentation form in the Appendix.

- *Planning, procurement, and training*: Microplans should be developed well in advance to give local areas enough time to find the safest and most cost-effective approaches to waste disposal and to be able to raise sufficient funds. Ideally, microplans should be started at least six months before the start of immunizations. The microplans should be made available to all vaccination teams in the area. As part of the microplan, a committee involving the EPI coordinator, sanitation officer, health officer, persons in charge of transport and storage, and other stakeholders should be created to help plan and coordinate waste management activities. Future campaigns should make use of the new safety boxes which are durable, puncture-resistant, and moisture-resistant.

  Waste management should be viewed as an integral part of the campaign. This should be reflected in the training and orientations, which should also be provided to volunteers. The training should cover the following topics: awareness-raising regarding the danger of sharps waste, demonstrating the proper assembly of boxes, waste containment procedures (what should and should not be put in safety boxes), discouraging the re-capping of syringes, the proper fill level for safety boxes, monitoring of boxes during vaccination, sealing boxes when $3/4^{th}$ full, marking and numbering boxes on all sides, accounting of boxes using a tracking form, record-keeping, proper handling and transport, personal protection for waste workers, accident/injury response and reporting, proper storage of safety boxes, treatment and disposal options, what to do with other wastes and recycling options, roles and responsibilities, and public education.

- *Collection, transport, and storage*: Collection schedules should be coordinated with all parties involved. Contents of boxes should not be transferred, boxes should not be overfilled, haulers and waste workers should use heavy duty gloves when handling boxes, boxes should be secured during transport, boxes should be neatly stacked so as to minimize space, and boxes should not be spray with disinfectant.

- *Centralized treatment*: The treated waste from centralized treatment facilities should not be sprayed with disinfectant, since sterilized waste is even cleaner than regular household waste.

  Microwave treatment facilities should use secondary (post-treatment) shredders when treating sharps waste in order to ensure that needles are blunted and shredded into small pieces. This minimizes further hazards when treated sharps are disposed of in a regular landfill or dumpsite. Similarly, autoclave treatment facilities should employ post-treatment shredding to physically destroy needles. Post-treatment shredding also reduces waste volume. High-efficiency shredders can reduce waste volume by as much as 70%. The combination of autoclave or microwave disinfection plus shredding eliminates both the biological and physical hazards of sharps waste.

  Discussions with the centralized microwave and autoclave facility managers generated ideas on treatment approaches that could have been implemented if there had been more time to prepare. A good approach with the microwave system would have been as follows: (1) use reusable sharps containers with large lockable openings, (2) modify the hopper design to allow emptying of reusable containers with minimal manual handling to protect workers from sharps injuries and prevent release of aerosols, (3) after treatment, use water tubs and scoops to separate shredded needle bits and plastic pieces, (4) recycle shredded plastic and metal parts through arrangements with plastics manufacturers and metal foundries, and (5) rinse and disinfect reusable sharps containers.

  If this approach were used with the autoclave system, the reusable sharps container would be disinfected in the autoclave chamber along with the sharps waste. The reusable sharps containers could be made of metal or autoclavable plastic. The main advantage of this approach is that no sharps waste ends up in a landfill or dumpsite and all residues are recycled. The reusable sharps containers could then serve many health facilities in conjunction with the central treatment facility after the immunization campaign is over. Further research into this approach is recommended.

  Areas far from the centralized treatment facilities in major urban centers could also consider installing their own central facilities. In the future, it may be possible for hospitals in provincial capitals to install small microwave or autoclave units to treat medical waste generated daily in their areas. The facilities could then be used for immunization waste. A small microwave unit capable of handling about 35 kg/hr has a capital cost of about $45,000. Small autoclave systems designed specifically for medical waste are generally cheaper: about $30,000 for an autoclave with a capacity of about 70 kg/hr, and $25,000 for an autoclave handling about 15 kg/hr. Capital equipment costs would be lower if the autoclave or microwave unit is manufactured locally. Further research is recommended.

Rural and remote communities could consider small low-cost treatment alternatives as discussed below. Further research in this area is recommended.

- *Concrete septic vault and burial pit methods*: The location of vaults and pits in areas not accessible to the public and to animals should be emphasized. The Guide should include information on sizing of vaults and pits based on estimates of waste generation. A simple spreadsheet could be used to estimate the amounts of waste generated based on the number of eligible children in an area. The spreadsheet could then calculate the minimum dimensions of a vault or pit to accommodate the amount of waste generated.

  Concrete vault openings should be large enough to allow workers to stack boxes neatly. Workers could use a simple wooden hoist to arrange boxes in compact, vertical stacks to maximize the space inside the vault or pit. Vault or pit covers should be fashioned with a simple lock. Disinfectants should not be added to boxes in the vaults or pits so as to prevent groundwater contamination; as long as only cardboard safety boxes, syringes, and empty glass vials are disposed of in the vault or pit, the impact on groundwater would be minimal.

  If the vault or pit continues to be used after immunization, a person should be designated to take responsibility for the vault or pit, including its final closure. Vaults should be closed by cement encasement. Pits should be covered with a mound of soil; ideally, a cement slab or wire mesh should be placed just below the soil mound to prevent animals from digging up the waste. Closure should also include fencing and the placement of warning signs.

- *Other methods*: The Guide should be updated to include new, low-cost technologies being developed and tested by various organizations including Health Care Without Harm. Providing resources and information on these treatment alternatives would expand the range of options that local areas can use as appropriate to their financial and technical capacities.

  Needle destruction could be an option for small amounts of syringes but the device should be used at the point of waste generation (i.e., immediately after the injection is given at the vaccination site itself). Other newer technologies include solar-powered autoclaves, solar-powered syringe melters, small-scale lime slurry treatment and encasement, manual post-treatment grinders or needle blunting devices, etc.

- *Waste generation and management of other wastes*: Only sharps waste should be put in boxes. Developers of the microplan should be encouraged to explore recycling of "other wastes" such as empty vials, plastic caps, empty boxes, syringe wrappers, and other recyclable waste from the immunization campaign.

- *Partially filled vaults, burial pits, and remaining safety boxes*: After the immunization campaign, local health officials should be encouraged to use the concrete vaults or burial pits and any remaining safety boxes to continue to segregate and dispose of sharps waste from local hospitals and health centers. This could help promote and sustain good waste management practices in the area.

- *Assessment of practices, correction of errors, and sustenance of good practices*: The immunization campaign is an opportunity for local areas to assess their waste management practices, identify errors, and set goals for improvement. Through the promulgation of policies and guidelines, regular training, planning, establishment of waste management systems, monitoring, and corrective action, good practices pertaining to the management of medical waste could be sustained on the local level.

General Recommendations for Best Practices

This section outlines some proposed best environmental practices based on the experience from PMEC 2004. The suggestions may be useful for future mass immunization campaigns and vaccination campaigns in other countries.

- *Development of a written guide that integrates waste management into the immunization campaign*: The guide should cover all aspects of waste management and present environmentally sound options, the pros and cons of each option, and estimated costs. The guide should include waste tracking and injury/accident reporting forms. The development of microplans along with the assignment of responsibilities for waste management should be required. Microplans should be prepared at least six months prior to the start of immunization. Local areas should form committees comprised of stakeholders to plan and coordinate waste management.

- *Computational guidelines for estimation of waste generation to assist in procurement, budgeting and planning*: If the types and amounts of syringes, vaccine vials, diluents, safety boxes, and other sources of potential wastes are known, it would be helpful to get average weights and dimensions and to derive simple computational factors. These factors could then be used to estimate the weights and volumes of waste that would be generated for a given number of eligible children in an area, which in turn could be used in determining costs of transportation, storage, and centralized treatment, as well as the sizes and costs of concrete vaults or pits. This would help local decision-makers determine their best options and plan accordingly.

- *Training as a key element of waste management*: The training should include such topics as: awareness-raising, proper use of reusable sharps containers or safety collection boxes, waste containment and segregation, waste handling and transport, proper storage, treatment and disposal, cradle-to-grave tracking of sharps waste, management and recycling of non-hazardous waste, personal protection for workers, roles and responsibilities, public education, periodic monitoring, corrective action, accident/injury reporting, and record-keeping.

- *Use of sharps collection containers*: Sharps containers should be durable, puncture-resistant, and moisture-resistant. If possible, reusable sharps containers should be used to minimize environmental impact. Sharps containers should have a large opening, a cover that can be locked or kept securely closed during transport, a fill line to avoid overfilling, biohazard markings, and printed warnings in the local language. Monitoring and accounting of sharps containers could be facilitated by placing a unique number on each container and recording that number in cradle-to-grave tracking forms. A numbering system could be devised so as to easily identify the general region where the waste was generated.

- *Transport and storage*: During transport, sharps containers should be kept secure and protected from rain, snow, strong winds, etc. The transporter should have contingency plans in case of spills or accidents. Centralized storage locations for sharps containers should be designated ahead of time. The storage area should be: secure and kept locked to prevent access to unauthorized persons; protected from the elements of weather; designed to keep insects, rodents, and other animals away; readily accessible to waste workers; and periodically kept clean.

- *Centralized treatment as a primary option*: A recommended approach is one that involves: the use of reusable sharps containers; an autoclave, microwave, or dry heat treatment system in conjunction with an internal or post-treatment shredder designed for sharps waste; use of water tubs to separate shredded needle pieces and plastic parts by gravity; and total recycling of plastic and metal parts. With this first option, there is minimal handling of sharps and no treated waste is discarded thereby eliminating the use of landfills or dumpsites.

- *Small, local treatment units as a primary option for remote rural areas*: In remote rural areas far from central treatment facilities, the recommended approach is an on-site, small-scale treatment technology such as a low-cost solar-powered autoclave (e.g., a modified pressure cooker heated by a solar reflector or solar collector), solar syringe melter (solar-powered melter wherein syringes are placed in a screen or wire-mesh container to separate molten plastic and needles), treatment with lime slurry and ash (to disinfect and encase the waste in a cement-like material), boiling chamber with manual grinder and compactor, etc.

- *Needle destruction as a secondary option for small-scale use*: For small amounts of syringe waste, on-site needle destruction as another option. The ideal needle destroyers are those that completely prevent reuse of syringes, remove all physical hazard (cutting syringes down to the nub and blunting sharp points), are designed to minimize needle-stick injuries to the worker (e.g., one-hand placement of needles into the device), do not release aerosols or noxious gases, and are easy to use and transport. These devices should be used at the point of generation. The plastic portions should then be recycled and the metal residues recycled or buried.

- *Encasement in concrete septic vaults as a tertiary option*: Guidance should be provided on sizing, design, and construction; siting (e.g., located away from sources of water); protection from water infiltration during rain, surface runoff, or floods; protection of surface water and groundwater; fencing and signage; and proper closure. In order to maximize the space in the vaults, boxes should be stacked in compact configurations. Vault covers should be fashioned with a simple lock. After immunization, vaults with remaining space should be used to dispose of other sharps waste from local hospitals and health centers. With this tertiary option, there is minimal handling of sharps and the encasement of waste to prevent exposure to humans or animals as well as to minimize groundwater contamination. The disadvantage is that the vault will have to be kept secure for the long term. A permanent record of the size and exact location of vaults should be kept by local health and environmental authorities.

- *Burial in waste pits as a last resort*: Guidance should be provided similar to that for concrete vaults. Burial pits should have a low-permeability bottom liner (cement, high density polyethylene membrane, or clay) to protect the groundwater. During closure, a cement slab could be placed underneath the soil mound cover. While minimizing the handling of sharps, burial pits present a lower hindrance to prevent human and animal exposure and to groundwater contamination as compared to concrete encasement. As with vaults, burial pits must be kept secure for the long term. A permanent record of the size and exact location of burial pits should be kept by local health and environmental authorities.

- *Record-keeping and accounting of all sharps containers*: A cradle-to-grave tracking of sharps containers will help ensure that all sharps waste generated by the immunization campaign has been accounted for, properly treated, and disposed of.

- *Recycling of non-hazardous immunization waste*: Empty vials, plastic caps, empty boxes, syringe wrappers, etc. should be collected, separated, and recycled to further reduce the environmental impact of immunization campaigns. Part of the preparation should include arrangements for the recycling of glass, rubber, plastic, and cardboard waste streams.

- *Promotion and sustenance of good practices*: Immunization campaigns could be an opportunity to promote and sustain good practices related to the handling, segregation, storage, transport, treatment, and disposal of medical waste including sharps waste.

Table 40. Proposed Best Practices for Immunization Waste Treatment and Disposal *

I – Large to Medium Scale

VACCINATION SITE	→		TREATMENT	→		FINAL DISPOSAL
Collect syringes in reusable sharps container	Transport	Central storage	Autoclave treatment	Post-treatment shredding	Gravity separation	Recycle all plastic and metal pieces
Collect syringes in reusable sharps container	Transport	Central storage	Microwave treatment	Post-treatment shredding	Gravity separation	Recycle all plastic and metal pieces
Collect syringes in reusable sharps container	On-site storage or local transport & storage		Small on-site solar-powered autoclave or syringe melter	Manual grinding or	Screen separation	Recycle plastic and metal pieces, or bury residues in landfill

II – Small Scale

VACCINATION SITE	TREATMENT	→		FINAL DISPOSAL
Insert syringe in needle destroyer	Needle melting by electric arc	Automatic slicing of hub	Collect plastic and metal portions	Recycle plastic; recycle or bury metal pieces
Insert syringe in electric or manual needle cutter or needle remover		Needle cutting and mutilation	Collect plastic and metal portions	Recycle plastic; bury or encase metal pieces in cement

III – Medium to Large Scale

VACCINATION SITE	→	FINAL DISPOSAL
Collect syringes in safety box	On-site storage or transport and central storage	Encase in a concrete septic vault, secure with fence & sign

IV – Small Scale

VACCINATION SITE	→	FINAL DISPOSAL
Collect syringes in safety box	On-site storage or local transport and storage	Bury in a pit with cement or clay floor, secure with fence & sign

* Shown in order of decreasing priority; the selection of treatment and disposal methods depends on the amount of waste generated, local conditions, and availability of resources.

Conclusions

Waste management during the Philippine Measles Elimination Campaign was by and large successful in the 19 areas documented in this report. If the waste generation averages calculated in this study are representative of the whole country, one would estimate that the PMEC generated about 19.5 million syringes, 162,000 safety boxes or 130,000 kg of sharps waste, in addition to 740,000 liters or 72,000 kg of other (non-hazardous) waste. PMEC 2004 was perhaps the first mass immunization campaign worldwide wherein the huge amounts of immunization waste were successfully treated and disposed of without the use of incineration or open burning.

The DOH Guide proved to be a valuable and comprehensive guide that was used by local areas to develop microplans which included waste management. The Guide provided the options of centralized microwave or autoclave treatment, concrete encasement in vaults, and burial pits. These options were followed, and in some cases, modified by local areas to deal successfully with their waste.

An important component of waste management was the use of safety collection boxes that kept sharps waste segregated and protected the public from exposure to a potentially infectious and physical hazard. The new safety boxes were found to be sturdy, durable, puncture-resistant, moisture-resistant, and easy to carry. Local areas were able to arrange for the transport and storage of safety boxes using a wide variety of transportation modes and storage facilities. With a few exceptions, transport and storage of safety boxes were conducted with little or no problems.

The treatment and disposal options varied in cost and allowed local areas to select options according to their financial and technical capabilities. Centralized treatment technologies were already available in major urban areas. The cost of microwave or autoclave treatment at their regular prices turned out to be more cost-effective that concrete vault construction. Actual costs were even lower since the microwave and autoclave treatment firms agreed to provide their services for free or at a discount. Not surprisingly, simple burial pits were found to have the lowest cost. The centralized treatment facilities using autoclave and microwave technologies functioned well. Cement encasement in concrete vaults was the choice of many areas and vaults were located and constructed in ways that would minimize any adverse environmental effects. Burial pits were used in one remote rural site. Some areas attempted innovations, such as needle destruction and communal latrine disposal. In general, the cradle-to-grave management of immunization waste was completed relatively safely and with minimal environmental impact thus far.

The report found some areas in need of improvement. These include, among others, the need for earlier planning and development of microplans, better training in waste management, clarification of some waste handling procedures, better coordination in some areas, more secure transport and storage in some cases, the need for post-treatment shredding, waste tracking, accident/injury reporting, better personal protection for waste workers, recycling of other wastes, and more information on a wider range of treatment and disposal options based on new and emerging small-scale treatment technologies. A few accidents and needle-stick injuries were reported in the documentation sites. They were generally caused by improper handling of safety boxes.

Based on post-immunization interviews, many vaccination team members, local officials, and community representatives affirmed the value of waste management in the protection of public health and the environment. Waste management planning and implementation during the immunization campaign had the added benefit of raising awareness about good waste management practices in the local communities and providing health facilities with concrete vaults, burial pits, or the experience of centralized treatment so that local hospitals and health centers could continue to segregate and properly dispose of sharps waste from ongoing healthcare activities.

The PMEC waste management study shows that it is indeed possible to treat waste from mass immunizations successfully without the use of incineration and open burning, while remaining in full compliance with the incinerator ban under the Philippine Clean Air Act.

Photograph 28. Beneficiaries of the Philippine Follow-Up Measles Elimination Campaign

APPENDIX

Symbols, Units, and Dimensions

#	Number
’	feet
”	inches
C	Centigrade or Celsius
cc	cubic centimeter
cm	centimeter
cu m	cubic meter
dia	diameter
F	Fahrenheit
ft	feet
g	gram
ha	hectare
hr	hour
in	inch
kg	kilogram
km	kilometer
l	liter
lb	pound
m	meter
min	minute
ml	milliliter
mm	millimeter
P	Philippine peso (P55 : US$1)
pcs	pieces
sq km	square kilometer
wk	week

TABLES

Table 1. Documentation Sites

#	Site	Province	Area of Country
1	4 villages in District 1 of Quezon City	Metro Manila	National Capital Region
2	16 villages in Midsayap	North Cotabato	Mindanao
3	Aguado village in Trece Martires	Cavite	Luzon
4	19 villages in District 2 of Manila	Metro Manila	National Capital Region
5	Municipality of Gubat	Sorsogon	Luzon
6	18 villages in Sulat	Eastern Samar	Visayas
7	21 villages in San Juan	Rizal	Luzon
8	5 villages (out of 21) in District 2 of Malabon	Rizal	Luzon
9	Village in Rodriguez (Montalban)	Rizal	Luzon
10	Coastal area and urban area of Babak District, Samal City; Villarica Village in Samal City	Davao	Mindanao
11	19 remote rural villages in Bilar	Bohol	Visayas
12	3 villages in the district of Marilog	Davao	Mindanao
13	Municipality of Matalom in the 5th District	Leyte	Visayas
14	13 villages in Datu Odin Sinsuat of Maguindanao municipality	South Cotabato	Mindanao
15	17 villages in Sudipen	La Union	Luzon
16	Municipality of Agoo	La Union	Luzon
17	District 1, Dalahican, Cavite City	Cavite	Luzon
18	Municipality of Miag-ao	Iloilo	Visayas
19	Province of Cavite (20 municipalities and 3 cities including Cavite City)	Cavite	Luzon

Table 2. Description of Sites

#	Category	Population of City, Municipality, or Province	Population Density (per sq km)	% Urban - % Rural	% of homes with running water	% of homes with electricity
1	Urban (wealthy, middle class, and poor)	26,546	From 7700 to 22,000	100% urban	100	100
2	Rural, remote rural, and mountainous areas including high risk areas		50	100% rural; more than 100 km from nearest urban area	30	85
3	Urban poor			100% urban	100	100
4	Mostly urban poor	1.65 million	43,258	100% urban	78	95
5	Coastal area—rural and urban; remote rural and high risk areas	55,980	400	25% urban- 75% rural by population; 19% urban-80% rural by area	40	76
6	Poor rural and urban	14,193	87	69% rural, 31% urban	3	85
7	Urban	112,335	18,598	100% urban	100	100
8	Urban and urban poor	413,072	33,600	100% urban	12% communal, 74% individual	Nearly 100
9	Rural part near a mostly urban area	143,666	12	92% urban, 8% rural	70	90
10	Coastal area and small island city	3,853		80% urban and 20% rural	95	98
11	Remote rural and mountainous	17,358	128	100% rural, 42 km from nearest urban area	16	100
12	Poor rural, remote and mountainous areas	47,486	Less than 0.4	100% rural, about 25 km to urban area	20-30	Less than 10
13	Remote rural, mountainous (rugged terrain)	34,373		100% rural, 27 km from nearest urban area	88	90
14	Remote rural, mountainous and coastal	81,085	150	Mostly rural, 3 km from nearest urban area	70	80
15	Rural (mountainous and hilly) – indigenous communities	16,401	16.4	90% rural, from 1-18 km to urban areas	90	90
16	10 urban, 8 coastal, 2 rural and 3 remote rural areas	56,727	1,073	29% urban, 71% rural	100	100
17	Coastal and urban poor areas	12,619		73% urban, 27% rural	40	99
18	Coastal rural and mountainous	57,092	275	92% rural, 8% urban; 40 km from major urban center	90	70
19	Urban and rural	1,610,324	1,016	Urban and rural		

Table 3. Description of Sites (continued)

#	Category	Economic Activity	Local Transportation	Educational System	Health System	Bloodborne Diseases
1	Urban (wealthy, middle class, and poor)	Small vehicle manufacturing, textile, plastics and chemical factories, banking	Jeep, tricycle, bus, private cars	14 daycare and pre-school, 4 elementary, 1 secondary, 4 colleges	1 health center, 8 clinics, 1 local health station	139 cases (6.5%) of hepatitis in 2000
2	Rural, remote rural, and mountainous areas	Mainly farming and some fishing	Tricycle, skylab	51 daycare and pre-school, 27 elementary, 10 secondary	3 hospitals; 18 health stations, 1 health center, 24 clinics	No known AIDS cases; 8 hepatitis cases in 2003
3	Urban poor	Agro-industrial activities	Tricycle, jeep, bus	18 daycare, 13 elementary, 4 secondary	4 hospitals; 14 health stations, 2 private clinics	No known hepatitis cases
4	Urban and urban poor	Varied economic activities typical of a major urban center	Jeep, tricycle, pedicabs	302 daycare and preschool, 61 elementary and secondary schools, 81 colleges and universities	33 hospitals; 10 health centers	No registered AIDS and hepatitis cases
5	Coastal area—rural and urban; remote rural and high risk areas	Tourism, beach resorts, farming, fishing	Mostly tricycle, motorcycle, jeep, truck, and carts	53 daycare and preschool, 19 elementary, 7 secondary, 2 colleges & universities	2 hospitals,1 health center, 7 clinics, 11 health stations	No reported AIDS cases, 1 hepatitis case in 2003
6	Poor rural and urban	Farming, fishing, small industries	PD cabs, tricycles, motorboats, jeep, multicab, buses	19 daycare and preschool, 8 elementary, 4 secondary	1 local health unit, 2 clinics, 10 village health centers	No reported cases of AIDS or hepatitis
7	Urban	Commercial, service, recreational and manufacturing industries	Jeep and tricycle	17 elementary, 7 secondary, 1 college	4 hospitals, 9 health centers, 5 health and nutrition offices, 7 health stations	No recorded AIDS cases, 3 hepatitis cases in 2002
8	Urban and urban poor	Industrial and commercial area including metal forming, garment, canning, soap, and food	Pedicabs, tricycles, jeep, and buses (open air or air-conditioned)	27 daycare & pre-school, 101 elementary, 17 secondary, 4 universities	3 hospitals, 67 private clinics, and 24 health centers	45 reported cases of hepatitis; no reported AIDS cases
9	Rural part near a	Manufacturing,	Tricycles and jeep	20 pre-school and daycare;	1 hospital, 22	No data

	mostly urban area	mining, forestry and farming		15 elementary, 3 secondary, 1 college	health centers, 21 clinics	
10	Coastal area and small island city	Fishing, farming, tourism, and trade	PUJ, tricycle, motorcycle	2 daycare, 1 secondary, 1 small college	1 hospital, 1 clinic, 1 health station	No reported AIDS, some hepatitis
11	Remote rural and mountainous	Farming	Jeep, tricycle, motorbike, van, multicab, bus	21 pre-school and daycare, 19 elementary, 2 secondary, 1 college	1 rural health unit, 4 village health stations	No AIDS and hepatitis cases
12	Poor rural, remote and mountainous areas	Agriculture and upland farming	Motorcycle with extended seating, jeep, open air bus	12 daycare and pre-school, 39 elementary, 4 secondary	1 hospital, 1 health center, 10 village health stations	No reported AIDS cases, about 5% with hepatitis
13	Remote rural, mountainous (rugged terrain and hard to reach areas)	Farming, weaving, fishing	Motorcycles with extended seating, tricycles, and multicabs	32 daycare and pre-school, 22 elementary, 6 secondary	1 hospital, 30 health centers, 5 village health stations, 1 rural health unit	No reported AIDS cases; 15 reported hepatitis cases in 2003
14	Remote rural, mountainous and coastal	Farming, fishing and forestry	Jeep, motorbike, and skylab	15 daycare and preschool, 39 elementary, 4 secondary, 1 college	2 hospitals, 1 health center, 4 clinics, 17 village health stations	No reported cases of AIDS, 13 cases of hepatitis
15	Rural (mountainous and hilly) – indigenous communities	Farming and fishing	PUJ, tricycle, motorized boats, jeep, motorcycle	14 pre-school and daycare, 12 elementary, 4 secondary	7 health centers and 1 clinic	No reported cases
16	10 urban, 8 coastal, 2 rural and 3 remote rural areas	Farming and fishing	Tricycle, mini-bus, jeep	54 pre-school or daycare, 23 elementary, 6 secondary, 3 colleges or universities	1 hospital, 1 health center, 8 clinics, 12 village health stations	No AIDS cases, 3 hepatitis cases in 2003
17	Coastal and urban poor areas	Fishing and garment industry	Sidecar, jeep, tricycle, bus	8 pre-school and daycare, 2 elementary, 2 colleges or universities	1 hospital, 1 health center, 3 clinics	No reported AIDS cases, about 1% hepatitis rate
18	Coastal rural and mountainous	agro-industries, forestry, livestock, fishing, quarrying, and small commercial activities	Tricycles, public utility vehicles, vans	22 daycare or pre-school, 32 elementary, 6 secondary, 2 colleges or universities	1 health center, 4 clinics, 18 health stations	No reported AIDS, 4 cases of hepatitis

19	Urban and rural	Agriculture, forestry, fishing, tourism, trade, and industries	Jeep, tricycle, bus, vans, public utility vehicles, private cars			

Table 4: Development of the Microplan

#	Was Microplan Made?	How Early Microplans Started	How Long to Complete Plans
1	Yes	2 months	1 month
2	Yes	3 weeks	7 days
3	Yes	6 months	6 months
4	Yes	3 months	3 months
5	Yes	10 weeks	1 day
6	Yes	13 weeks	6 days
7	Yes	2 months	1 month
8	Yes	3.5 weeks	16 days
9	Yes	4 weeks	1 month
10	Yes	3 weeks	10 days
11	No data		
12	No	--	--
13	Yes	10 weeks	1 month
14	Yes	3 weeks	9 days
15	Yes	3 weeks	3 days
16	Yes	3 weeks	1 day
17	Yes	6 months	6 months
18	Yes	2 weeks	14 days

Table 5. Procurement of Syringes and Safety Boxes

#	Number of Eligible Children	Number of AD and Mixing Syringes Procured	Number of Safety Boxes Procured
1	5,774	6,500 AD; 700 mixing	70
2	8,447	9,344 AD; 1,123 mixing	115
3	982	1,080 AD; 135 mixing	14
4	9,563	9,600 AD; 1,200 mixing	425
5	12,158	13,374 AD; 1,672 mixing	166
6	3,122	3,434 AD; 429 mixing	47
7	24,442	26,886 AD; 3,361 mixing	332
8	71, 120	43,918 AD; 9,918 mixing	986 *
9	31,249	32,000 AD; 3,200 mixing; 3,200 wastage	12 **
10	881	1,069 AD; 121 mixing	12
11	3,775	4,000 AD; 400 mixing	19
	(whole area)	4,702 AD	51
12	972	1,000 AD; 100 mixing	202
13	7,476	8,223 AD; 1,028 mixing	102
14	17,636	19,000 AD, 2,228 mixing	200
15	3,567	3,924 AD and mixing	48
16	12,276	15,886 AD; 1,985 mixing	843
17	2,746	3,020 AD and mixing	34
18	13,440	14,842 AD; 1,854 mixing	183
19	350,200 (est.)		

* Safety boxes not provided every day; ** Number of boxes estimated since actual number was not recorded.

Table 6. Responsibilities

#	Overall Responsibility for Waste Management	Responsibility for Collection and Storage	Local responsibility
1	DOH Regional, City Chief Sanitation Officer, and Sanitary Inspectors	Sanitary Inspectors, sanitary supervisors, and resident nurse	Vaccinator and village health worker
2	PMEC Coordinator and municipal health officer	Municipal health center staff	Supervisor and team leader
3	Sanitary inspector	Sanitary inspector, treatment facility coordinator	Sanitary inspector, vaccinator
4	City sanitation officer, district sanitation officer, and sanitary inspectors	District sanitation officer	HCWH volunteer
5	Regional sanitary inspector	Regional sanitary inspector, janitor takes custody of boxes	Vaccination team
6	Regional sanitary inspector	Regional sanitary inspector	
7	Assistant EPI coordinator	District sanitary inspector	
8	Sanitary inspector	City hall employee, driver	Recorder and guide w/in the team; health center personnel
9	Sanitary engineer	Sanitary engineer, head nurse	Village health worker and Midwife
10	Regional health office, provincial and city health offices	District sanitary inspector	Village sanitary inspector
11	Vaccination team	Vaccination team	Vaccination team
12	District sanitary health inspector	Senior sanitary health inspector	Village health worker and vaccinator
13	Municipal sanitary officer	Municipal health officer	Sanitary officer
14	Sanitary inspector, municipal health office	Sanitary inspector, municipal health office	HCWH volunteer
15	Provincial sanitary engineer and rural sanitary inspector	Two rural sanitary inspectors	HCWH volunteer
16	Municipal sanitary inspection team head and municipal planning and development council	Municipal sanitary inspector	Village volunteer sanitary inspector
17	Sanitary inspector	Sanitary inspector, city health officer	
18	Municipal sanitary inspector; committee on waste disposal formed	Municipal sanitary inspector	HCWH volunteer

Table 7. Overall Plan for Transport, Storage, Treatment/Disposal

#	Method of Transport	Method of Storage	Method of Treatment	Method of Final Disposal
1	Carried by hand, van	6 health centers chosen as temporary storage areas in the 5 districts of the city	Centralized Microwave Facility	Controlled area within landfill
2	Tricycle, motorcycle, and carried by hand	Municipal health center		Concrete septic vault behind health center
3	Treatment facility's van	Storage facility within hospital and treatment center	Centralized Autoclave Facility	Burial in deep concrete vault, controlled landfill in the future
4	Van	Storage inside health center		Burial in concrete vault in major cemetery
5	Trimobile to centralized storage	Storage at main health center		Concrete septic vault
6	Tricycle, boat	Local health unit		Concrete septic vault
7	Transported by van to centralized treatment facility	Storage at a high school	Centralized Microwave Facility	Controlled area within landfill
8	Transported by van to centralized treatment facility	Storage in an abandoned building of the District Health Office inside a hospital compound	Centralized Microwave Facility	Controlled area within landfill
9	Health unit's service vehicle (old ambulance)	Stored in the Rural Health Unit		Existing concrete vault in the municipal cemetery (tomb had been used for displaced skeletons); note: two boxes from remote areas were buried in a farm
10	City health office ambulance	Stored near the district health center beside the concrete vault		Burial in a concrete septic vault
11	Vehicles of the local government unit	Rural health unit		Existing concrete vault
12	Motorcycle with extended seating, jeep or horses	Rural health unit		Concrete septic vault and traditional communal latrine for remote upland area
13	Motorcycle, multicab and ambulance	Directly to burial pit		Burial pit and concrete septic vault
14	Local transportation	Rural health unit		Concrete septic vault and burial pits (for some remote and coastal areas)
15	Service or rented vehicle	Old toilet in the Municipal health office		Concrete septic vault
16	Transported by tricycle, ambulance or private car	Storage room in Municipal Health Office		Concrete septic vault

17	Transportation by City Health vehicle	Central deposit area	Centralized Autoclave Facility	Burial in deep concrete vault, controlled landfill in the future
18	Municipal government vehicles, trucks, private vehicles	Municipal health office		Concrete septic vault
19			Centralized Autoclave Facility	

Table 8. Reasons Given for Selecting the Treatment/Disposal Method

#	Reason for Selection of Disposal Method
1	City government received a 50% discount on centralized treatment
2	Recommended by local government
3	Centralized treatment facility offered services for free
4	Lot of free space in cemetery; easy to get permit
5	Best option determined by local government
6	Affordable and environmentally sage
7	Availability of microwave technology; lack of space for burial
8	Microwave facility offered to treat for free; water table is shallow
9	Deemed best option at no cost (existing concrete vault) instead of using an open dump
10	Followed the guide in the DOH manual
11	There was already an available concrete vault
12	Use of communal latrine was deemed safest method to avoid transport of boxes down from the upland areas; most of the wastes encased in concrete septic vaults
13	Deemed most practical; recommended by the Provincial Department of Health
14	Deemed safest and most commonly used
15	Proven to be more cost-efficient, and space for the vault was already prepared at the MRF of the municipality
16	Deemed most feasible and safest since they do not have funds for an autoclave or microwave system
17	Centralized treatment facility offered services for free
18	Suggested by HCWH researcher

Table 9: Training on Waste Management

#	Training and Content	Duration	Notes
1	Discussed how to dispose of used syringes and other wastes; assembly, handling and storage of safety boxes; which wastes and how much waste to be put inside the boxes	Part of a day-long orientation	Ineffective, lack of attention to important details
2	None	0	Need training and orientation
3	Discussed fill level of safety boxes, no recapping, what not to put in safety boxes	Small portion of overall training	Training was not sufficient, not all read manual, not effective
4	None	0	
5	Separate training for midwives, nurses; trained not to recap	25 min	Concise but not well understood in English, discussed it in local language
6	Presented overview of waste management	20 min	Insufficient time for training
7	No mention of waste management in training session	0	Workers felt they had enough experience in immunizing
8	No mention of waste management in training session	0	Only one member of the team attended training; inconsistent practice based on past experience
9	None	0	
10	Presented orientation and demonstration on use of safety box	Less than an hour	Trainer claimed that training was nderstandable and effective
11	Discussed waste management including use of safety boxes, where to place them during vaccination, where they should be deposited daily, and educating the public (parents of children) about safety boxes	30 minutes	
12	Presented waste management disposal with a few minutes of questions and discussion	30 minutes	PMEC team coped with local conditions and developed appropriate plans in the course of the campaign.
13	Presented orientation on waste management including use of safety boxes, the burial pit, and its construction	1.5 hours	Waste management training seemed effective but most vaccinators recapped syringes and reused mixing syringes
14	Raised awareness regarding waste issues, discussed proper procedures for handling and disposal	3 hours	Effective
15	Discussed dangers of sharps	30 min	Sufficient
16	Data not available but apparently training included development of the microplan	8 hours for entire training	
17	Specific tasks of team members were assigned.	15-20 minutes	Understandable and sufficient
18	Quick review of DOH guide	Brief	Not sufficient

Table 10. Local Set-up for Containment of Syringes and Other Wastes

#	Local set-up
1	In the field, the safety box is placed inside a large medical bag, along with the other supplies (boxes of unused syringes, Vitamin A, vials, etc). It is never removed from this bag. Each team has one such bag and a health worker carries it. During the vaccination, it was usually placed beside the vaccinator on top of a stool/chair or table, whichever was available. If there were no stools or tables available, the bag was either placed on the ground or just carried by the health worker in charge.
2	The safety collector box was placed in the side and front of the vaccinator during the activity, more or less 1-2 feet from the vaccinator.
3	During vaccination boxes were placed beside the vaccinator for easy disposal of syringes. During trips to other areas, the boxes were carried by other members of the vaccination team.
4	Safety box was placed on a chair on the right side of the vaccinator, comfortably within reach but not to near.
5	Safety box was on the table along with other supplies.
6	Safety box and plastic bag were placed side by side on the vaccinator's table, along with supplies. Once filled, the safety box was placed under the table.
7	Filled safety boxes were stored under the table during vaccination.
8	Safety boxes and containers for other waste were in separate areas or beside each other in the fixed vaccination centers.
9	Safety boxes were on the table within an arm's length of the vaccinator. Filled boxes were placed in the corner of the room.
10	Safety collector boxes were put on the table near the vaccinator for easy access and disposal of used syringes. During the vaccination, the safety collector boxes were right beside other materials, including the syringes.
11	The safety boxes were always at the side of the vaccinator. The position of the safety boxes depended on whether the vaccinator was right- or left-handed. The used syringes, vaccine vials, diluents vials, cotton balls, and empty Vitamin A capsule were put in the safety boxes, except the wrappers of the syringes.
12	Safety box was within reach of vaccinator.
13	Safety boxes were placed beside the vaccinator for easy disposal of used syringes.
14	A safety collector box was placed beside the vaccinator, whereas the filled boxes were placed where they could not be reached by children.
15	A table was placed at the center of the temporary or fixed vaccination center, facing the direction where the recipients entered. Two to three members of the team stayed at the back of the table to mix and aspirate vaccines. Two vaccinators stayed in front of the table, parallel to each other with 1 or 2 safety boxes and other waste containers placed in between them.
16	Commonly, some safety collector boxes were placed in the table together with some vaccination equipment. Other items were placed on the ground beside a vaccinator in a sitting position. Filled boxes were usually placed below the table away from the reach of people.
17	An empty safety box was placed on top of the table during vaccination and filled safety boxes were placed under the table near the vaccinator/midwife.
18	Mostly the safety collector box was place on the floor, between two vaccinating teams. At other times it was placed on a table or bonded by tape to the side of the table.

Table 11. Daily Collection and Transport of Safety Boxes

#	Type of Vehicle Used	Road Conditions	Notes
1	Carried by hand	Concrete and asphalt roads; rough wooden plank bridges across canals in urban poor areas	Health workers careful in handling boxes
2	Tricycle, motorcycle, boat or carried by hand	Rough gravel roads	Skylab can carry 2 boxes, tricycle can hold 6-8 boxes
3	Ambulance or tricycle, van	Concrete roads	
4	Closed van used for delivering supplies	Concrete and asphalt roads	
5	Carried by hand or jeep	90% unpaved earth, 6% concrete, 4% gravel roads	
6	Rented tricycle	Concrete roads and rough roads	10 boxes in a tricycle
7	Van and large taxi	Concrete and asphalt roads	Vehicles could carry between 29 to 39 boxes
8	Carried by hand, pick-up truck, tricycle, minivans and vans	Mostly concrete and some asphalt roads	Heavy traffic
9	Local transportation such as tricycles or jeeps	Secondary roads of asphalt and rough dirt roads; concrete highway	
10	Tricycle or motorcycle	Rough dirt roads, gravel, concrete	Only one box per day is used by vaccination team and deposited at temporary storage facility.
11	Jeep, tricycle, motorbike or carried by hand	49% gravel roads, 29% rough dirt roads, 15% asphalt roads, and 7% cement roads	All boxes are stored inside a vacant room in the health center.
12	Motorcycle with extended seating, horse, jeep, and carried by hand; city vehicle used to transport immunization supplies	Rough dirt roads, some concrete, asphalt highway	Between 2 to 5 filled boxes were transported
13	Motorcycles with extended seating or minivans (during rains)	Rough gravel roads, concrete roads in the main highway	Between 4 – 6 boxes can be carried in extended motorcycle; boxes covered in plastic during rains
14	Jeep, motor scooter, and motorcycle with extended seating	Rough dirt roads	
15	Service or rented vehicle	Concrete, asphalt and dirt roads	Vehicle can carry 40 boxes at a time
16	Tricycles, ambulance or private car	80% concrete, 20% rough dirt roads	Tricycle can carry up to 3 persons and 4 boxes
17	City Health vehicle (van)	Rough dirt, asphalt and concrete roads	
18	Municipal dump truck, police pick-up truck, government closed-door van, private vehicles (pick-up truck, minivans), tricycle	Paved gravel, rough dirt, trails, asphalt and concrete roads	

Table 12: Daily Storage of Safety Boxes

#	Storage Location	Description of Storage Area	Safety Features	Organization	Notes
1	Local health or vaccination center	Under a cabinet in a nurses' station	Off limits to the public except during routine vaccination	Local health nurse takes custody of the safety boxes	Boxes were marked, sealed and weighed
2	Municipal health center	Toilet facility	Toilet is locked, only opened when boxes are deposited	Municipal health center personnel	Boxes were marked, sealed and weighed
3	City health office or vaccination center	Inside a room in the health center	Kept lock, only sanitary inspector has key	Sanitary inspector takes custody every day	Boxes were marked, sealed and weighed; treatment facility acts as central storage
4	Local health center	Corner of the health center or stair landing	Accessible to workers and public during the day; health center locked at night	Local health volunteer	Boxes stacked
5	Main health center	Nurses or storage room	Accessible to waste worker	Brought by midwife and given to regional sanitary inspector	Boxes organized in a pile and accounted for daily
6	Local health unit	Steel cabinet outside the health unit	Kept locked	Sanitary inspector takes custody of boxes	Boxes stacked neatly and accounted for
7	Designated local health center and then the main health center	Stored in the health office	Closed in the evenings and weekends	Transferred to custody of EPI assistant coordinator	Boxes placed in full view of health center patients
8	Local health centers or kept locked inside transport vehicle	Vacant space inside the local health unit	Only accessible to authorized personnel	Custody transferred to city employee	City employee collected boxes while announcing campaign through loud speakers
9	Rural health unit or village health stations	Vacant corner behind the door	Room and building kept locked after hours	Head of rural health has key to the building	Boxes are sealed and stacked neatly
10	Village health center	Vacant room	Kept closed and locked	Village sanitary inspector records and stores boxes; rural health midwife takes custody	Boxes stacked horizontally, all are numbered with a green marker
11	Rural health unit	Storage area in the rural health unit	Room is closed and kept locked by health center	Health center nurse keeps track of boxes	Boxes were sealed with packaging tape and

			nurse		labeled "Used Do not Open"; daily storage is also central storage
12	District health center	Small storage space	Boxes hidden underneath black plastic bag	Sanitary health inspector	Boxes stacked vertically; no boxes fell or broke open
13	Directly in the burial pit; in some cases, temporary storage in a cabinet in the rural health unit	Pit behind the rural health unit or village health centers	Health facilities have a concrete wall and burial pit itself is surrounded by a security fence; one pit has a locked cover	Municipal sanitation officer takes custody of boxes	Boxes are stacked horizontally with the aid of an improvised manual hoist
14	Rural health unit	Storage area in rear portion of the rural health unit, has a lock	Has a security fence	HCWH volunteer authorized to take custody of boxes	Boxes accounted for; storage area used for sorting out boxes and other waste
15	Rural health unit	Store Room	Has a lock	Rural sanitary inspectors take custody	Municipal doctor and sanitary inspector account for all boxes
16	Municipal Health Office	Vacant storage room in the building beside the Municipal Health Office	The storage area is locked	Municipal sanitary inspector responsible for transport and storage	Boxes stacked vertically, no fallen or broken boxes
17	Health center	Counseling room designated temporary storage area	Room has a door but not locked	City health officer takes boxes for transfer to city health office (the pick-up of boxes not clear in the plan)	Boxes stacked vertically at landing of second floor
18	Rural health center	Abandoned toilet that was cleaned, repaired and secured with a lock	Waste put together in a large plastic bag	Sanitary officer	Stacked vertically; no boxes have fallen; other wastes stored in same storage room

Table 13: Transport of Safety Boxes to a Central Storage (if different from daily storage)

#	Frequency of Collection	Distances Traveled	Road Conditions	Type of Vehicle Used
1	Once every two weeks		Concrete and asphalt roads; heavy traffic	City ambulance, nutrition project vehicle, and minivan
3	Twice a week	Less than 500 meters	Concrete roads	Air-conditioned van
4	Once	Less than 10 km	Concrete and asphalt roads	Closed delivery van
5	No data		90% unpaved earth, 6% concrete, 4% gravel roads	Carried by hand
7	Twice a week		Concrete and asphalt roads	
8	Five times in 5 weeks	Most health centers are within 2 km of central storage	Concrete and asphalt roads	Vehicle with loud speaker
9	Variable, every few days	500 meters	Asphalt and rough dirt roads	Van used as an ambulance; can carry over a 100 boxes
10	Once a week	Less than 1 km	Rough dirt roads, gravel and concrete	City health office ambulance
11	Daily	Within the compound	Rough dirt roads, gravel and concrete	Municipal service jeep
12	Variable		Rough dirt roads, some concrete, asphalt highway	Motorcycle with extended seating, horses, jeep, and carried by hand; vehicle used to transport immunization supplies
15	Once		Concrete, asphalt, and dirt roads	
17	Twice during campaign	Less than 5 km	concrete roads, light to heavy traffic depending on time period	City health vehicle (van); pick-up schedule was not set

Table 14: Data on Central Storage (if different from daily storage)

#	Storage Location	Description of Storage Area	Safety Features	Notes on Storage
1	Designated health center	A secondary waiting room in the health center; 2 doors: door to the main waiting room kept locked, access only through the doctor's office	Boxes stacked vertically and horizontally on the floor; some were in large plastic garbage bags	Most boxes properly labeled and sealed; many boxes were overfilled; few old boxes from previous campaign were broken and syringes had fallen out
3	Central treatment facility warehouse	Warehouse is inside the treatment facility's compound	Only facility personnel are allowed access to the warehouse	Boxes stored vertically; boxes sealed and not overfilled
4	Storage area under a monument in the cemetery	Place is cool and dark (no light available)	Gate to the central storage area is locked	Very few boxes are placed in the storage area
5	Main health center at cemetery, near local government offices	Near cemetery	Storage area is locked, not accessible to the public	
7	Major hospital	Stored at the morgue		Boxes put on portable trash bins and weighed
8	Abandoned building of the District Health Office	Within compound of the government hospital	Kept locked, only accessible to authorized personnel	Little or no accounting of safety boxes; many boxes not sealed and marked
9	Rural health unit	Office shelf	Room and building kept locked after hours	Boxes stored horizontally 3 boxes x 8 boxes and 3 boxes up
10	Near the district health center	Beside the concrete vault	Facility is kept locked, only rural sanitary inspector has key	Boxes are stacked safely and near the septic vault
12	District hospital	Unused toilet	Hospital security guard watches the area	For remote areas, boxes put directly in communal latrines
15	Municipal Health Office	Old toilet (0.8m x 0.9m)	Kept locked, only waste worker has key, no public access	Boxes are stacked vertically with other wastes
17	City Health Office	An office on the second floor		Boxes stacked horizontally, no fallen, broken, or spilled boxes

Table 15: Transport to Central Treatment Facility (if applicable)

#	Frequency of Collection	Distances Traveled	Road Conditions	Type of Vehicle Used	Notes on Transport
1	Three times during the campaign; two trips in one day	97 km each trip; 194 km total	Concrete and asphalt roads; heavy traffic	Waste treatment facility's 20-foot closed van with a 2 ton capacity	Traffic is a problem
3	Twice a week	Less than 500 m	Concrete roads	Air-conditioned van	Pick-up from daily storage facility
7	Twice a week	12 km per trip one way	Concrete and asphalt roads	Waste treatment facility's 20-foot closed van with a 2 ton capacity	No problems encountered
8	Twice during campaign	16 km one way; took two hours in heavy traffic	Concrete and asphalt roads	Van	City employee checked if boxes are sealed; boxes stacked vertically; vehicle broke down after delivery
17		Less than 40 km	Concrete road, light to heavy traffic	Pick-up truck	Boxes not loaded carefully (boxes were thrown) and not secured; pick-up schedule not set

Table 16: Centralized Treatment

#	Type of Treatment	Service Provider	Technology Vendor	Location	Rated Capacity	When Technology was Installed	Cost of Treatment
1	Microwave treatment	Chevalier Enviro Services, Inc. (Chevalier Envirotech Ltd.)	Sanitec	Paranaque	6 tons per day	August 2000	P32 per kilo (but CESI treated waste for free)
3	Autoclave treatment	PAE Environmental Company	Thermal Equipment Corporation	Trece Martires City	10 tons per day	February 2004	P32 per kilo (but PAE treated waste for free)
7	Microwave treatment	Chevalier Enviro Services, Inc. (Chevalier Envirotech Ltd.)	Sanitec	Paranaque	6 tons per day	August 2000	P32 per kilo (but CESI treated waste for free)
8	Microwave treatment	Chevalier Enviro Services, Inc. (Chevalier Envirotech Ltd.)	Sanitec	Paranaque	6 tons per day	August 2000	P32 per kilo (but CESI treated waste for free)
17	Autoclave treatment	PAE Environmental Company	Thermal Equipment Corporation	Trece Martires City	10 tons per day	December 2003	P32 per kilo (but PAE treated waste for free)

Table 17: Treatment Process

#	Operating Parameters	Volume reduction	No. of workers	Skills required	Notes
1	Disinfection by steam injection and microwave heating, 95-100 C	Primary shredder	2	Provided by in-house training	Boxes weighed; primary shredder shreds to small pieces to prevent reuse
3	Autoclaving at 142 C, 40 psi, 70 min		3	Provided by in-house training	Boxes remained relatively intact after steam treatment
7	Disinfection by steam injection and microwave heating, 95-100 C	Primary shredder	2	Provided by in-house training	Boxes weighed; primary shredder shreds to small pieces to prevent reuse
8	Disinfection by steam injection and microwave heating, 95-100 C	Primary shredder	2	Provided by in-house training	Boxes weighed; primary shredder shreds to small pieces to prevent reuse
17	Autoclaving at 142 C, 40 psi, 70 min		3	Provided by in-house training	Boxes remained relatively intact after steam treatment
19	Autoclaving at 142 C, 40 psi, 70 min		3	Provided by in-house training	

Table 18: Final disposal for centralize treatment

#	Description of Landfill	Notes on Land Disposal
1	Controlled area (400 sq m) of a large dumpsite (60,000 sq m)	Dumpsite used by central treatment facility; three feet of earth cover added immediately after dumping; disinfectant Plantex (organic mixture) added; no fence or sign
3	Two concrete vaults (controlled landfill in the future)	Two concrete septic vaults were constructed inside the open dumpsite while plans for the conversion to a sanitary landfill are being finished
7	Controlled area (400 sq m) of a large dumpsite (60,000 sq m)	Dumpsite used by central treatment facility; three feet of earth cover added immediately after dumping; disinfectant Plantex (organic mixture) added; no fence or sign
8	Controlled area (400 sq m) of a large dumpsite (60,000 sq m)	Dumpsite used by central treatment facility; three feet of earth cover added immediately after dumping; disinfectant Plantex (organic mixture) added; no fence or sign
17	Two concrete vaults (controlled landfill in the future)	Two concrete septic vaults were constructed inside the open dumpsite while plans for the conversion to a sanitary landfill are being finished
19	Controlled area (400 sq m) of a large dumpsite (60,000 sq m)	Dumpsite used by central treatment facility; three feet of earth cover added immediately after dumping; disinfectant Plantex (organic mixture) added; no fence or sign

Table 19: Examples of Transport to Burial Site

#	Frequency of Collection	Distances Traveled	Road Conditions	Type of Vehicle Used
5	End of campaign		90% unpaved earth, 6% concrete, 4% gravel roads	trimobile
18	Once, at the end of the campaign	6 km	Paved gravel, rough dirt trails, asphalt and concrete roads	Municipal dump truck (7 cu m capacity)

Table 20: Basic Data on Vaults and Pits

#	Disposal Method	Dimensions (length x width x depth) in meters	Location	Depth of Water Table and Distance to Surface Water and Residences	Safety Features	Notes
2	Concrete vault	1.5 x 1.2 x 1.5, with 0.6 x 0.6 opening	Behind municipal health center, 14 m from nearest house	Water table is 0.9 to 1.0 m; site is very far from any bodies of water	Removable concrete cover (no markings, fencing)	Vault used to dispose 86 boxes from vaccinating 19,700 children
3	Two concrete vaults	2 x 3 x 4 m deep	Open dumpsite		Concrete cover for safety	Open dump site being converted to sanitary landfill
4	Two concrete vaults	1 x 2 x 1.8; 1 x 2.5 x 1.7	Major cemetery	About 1000 m to nearest body of water, 500 m from nearest house	Clay soil	Vaults used for treating waste from vaccinating 347,806 children
5	Concrete vault	1 x 1 x 2	40 m from nearest house	60 m from nearest body of water; water table is 2 m deep, sandy soil	Mouth of vault is elevated to prevent water intrusion; concrete cover, fence and clear markings	Construction well done
6	Concrete vault	1 x 1 x 1.8	Beside the regional health unit	15 m from nearest house, 150 m from surface water	Concrete cover-takes four people to lift; markings on the side of the vault	
9	Existing above-ground cemetery vault	2.67 x 2.67 x 2.46 (17.54 cu m) with 0.2 x 0.3 opening	Main cemetery	Water table is 5 m deep; 300 m from nearest body of water; 100 m away from nearest house	Concrete block (2 kg) used as cover (no fence, lock or signs)	2 years old concrete vault
10	Concrete vault	Patterned after DOH Guide; vault extends	Near the District health	Water table is 17 m below the vault; 30 m	Surrounded by concrete wall and covered with a heavy slab	Vault location was for easy

		1 ft above ground	center within government property	from nearest house, 1 km away from sea, clay soil		access to workers in the campaign
11	Existing concrete vault	1 x 1 x 2; extends 0.3 m above the ground	At the back of the rural health unit	Vault is in an elevated area 15 m from water table and 250 m from nearest body of water	Area is restricted, public not allowed. Cover is made of galvanized iron sheet 1.5 x 1.5 m; no lock	
12	Concrete vault	1.5 x 1.5 x 2	Behind the district hospital near electric generator	Water table is 10-15 m below vault; Built on the side of a hill about 55 m above nearest body of water	Cover (12 x 12 inch) with round hook but no lock, no sign; surrounded by fence with a sign, hospital security guard watches the area	
13	Burial pit with cement floor	1 x 1 x 2	At the back of the rural health unit	Water table is 20 to 40 meters deep; 10 m from nearest house and 200 m from nearest body of water	Pit has a cement floor, galvanized iron cover with a lock, and a wooden sign. Pit has a security fence with a lock; not accessible to the public	Waste worker noted number of boxes
	Six burial pits with clay bottom	4 pits (1 x 1 x 1) 1 pit (1 x 1 x 2) 1 pit (1.5 x 1.5 x 1.5)	6 pits built at the back of the rural health units or village health centers; one was built in a remote isolated site	Water table is 20 to 40 meters deep; typically 100 to 500 m from nearest house; 1 was 30 m from nearest house; 4 pits were from 300 to 4,000 m from nearest body of water, 2 pits 50 to 100 m from water	Pits used clay layer at the bottom; 3 pits used corrugated galvanized iron covers with or without an additional wooden slab or regular galvanized sheet, 1 used a tarpaulin cover, 1 used a cover of coconut leaves; all except one had fencing; not accessible to the public	Waste worker noted number of boxes
14	Concrete vault (and burial pit)	1 x 1 x 1.8 m, vault extended over 0.3 m from the ground	Behind the rural health unit	Built on the side of a hill and 5000 m from surface water; water table is 10 m deep; 10 m from nearest residence; hard soil	Vault has a heavy cover (not easily lifted by one person) and cyclone wire security fence to prevent unauthorized access. Vault has a wooden sign with clear markings on a cemented post.	
15	Cylindrical concrete vault	Cylindrical, 1 m in diameter and 2 m deep, top of vault is 3 inch above ground, rest of the culvert is cemented	In a culvert at the municipal facility	Ground water is 5 m below bottom of vault; 100 m from water supply and residences	Gauge 23 flat sheet cover with a lock, ground base and joint use waterproof cement, and painted on the outside; wooden fence, sign "Medical waste" on 5 x 2" wood	
16	Concrete	1 x 1 x 1.8 m	Municipal	Water table is 13 m	Tight-fitting cover with lock,	

	vault		dump located in a mountainous area, rocky ground	deep, 500 m from nearest houses, 1,500 m from nearest body of water	security fence,	
17	Two concrete vaults	2 x 3 x 4 m deep	Open dumpsite		Concrete cover for safety	Open dump site being converted to sanitary landfill
18	Two concrete vaults	2 x 1 x 2 with wall in middle (in effect, two 1x1x2 side by side), vault opening is 2x2 ft, top extends 2 ft above ground	Municipal waste dump site	Nearest village is 1 km, vault is on the side of a hill, water table is 55 m deep, loose soil, nearest body of water is 1.5 km but dried up	3” concrete slab used as cover, takes 3-4 people to lift, dump area has a fence and sign, waste pickers are not allowed in the area, site is secure and secluded	

Table 21: Data on Vault and Pit Construction

#	Disposal Method	Construction Time	Human Resources / Skills Needed	Materials of Construction	Steps for Construction
2	Concrete vault	5 days: 1 day for digging, 4 days for cement work	2 workers for digging; 4 workers with masonry skills for concrete work	Hollow blocks, cement, tie wire, nails, steel bars, sand, gravel, plywood, water pump, gasoline	(1) Request budget and await approval; (2) Hire laborer; (3) Dig soil according to specifications; (4) Pump out any water accumulated in the hole; (5) Put steel bars, hollow blocks, and cement; (6) Make concrete slab cover
3	Two concrete vaults	3 days	6 workers	Sand, gravel, steel bars, cement, hollow blocks	(1) Dig soil to specified depth; (2) Put reinforcing bars then hollow blocks; (3) Put cement inside hollow blocks; (4) Make concrete slab cover
4	Two concrete vaults	2 days	2 workers with basic cement construction skills	Sand, Reinforcing bars, Hollow blocks	(1) Determine the location of the vault; (2) Determine the dimensions of the vault; (3) Dig the soil; (4) Put reinforcing bars then the hollow blocks; (5) Put cement inside the blocks; (6) Cement the bottom layer of the vault; (7) Make slabs for cover
5	Concrete vault	2 days	2 workers	Cement, sand, gravel, steel bars, construction pail, tie wire	(1) Find location; (2) Dig specified dimensions; (3) Put hollow blocks, cement and bars; (4) Apply cement finishing, cover with concrete cover; (5) Erect walls for safety
6	Concrete vault		4 workers with masonry and construction skills	Cement, Sand, Gravel, Concrete hollow blocks, Steel bar, Tri wire, Plywood, Lumber, Nails, Shovel & hammer	(1) Excavation of 1mx1mx1.8m septic vault; (2) Laying of hollow blocks to 1.8m in height; (3) Cement finish, inner side; (4) Concrete cover
9	Existing above-ground cemetery concrete vault	About 3 days	2-3 workers with masonry and carpentry skills	Cement: 90 kg Reinforcing bars: 20 pieces of 20 mm o. c. bars Gravel: 50 cubic feet River sand: 50 cubic feet Concrete hollow block: 432 pcs.	Dig up hole of proper dimensions; Lay the foundations; Erect the walls; Use 1:2:3 ratio for concrete mix; Cover with a concrete cover; Spread the concrete plaster.
10	Concrete vault	40 hours	3 persons with masonry and carpentry skills		

11	Existing concrete vault			Concrete hollow blocks; Class A mixture of cement, sand and gravel	
12	Concrete vault	2 person days for digging; 1 person-day for applying cement; 7 days to harden cement	5 workers skilled in masonry, 1 supervisor and engineer		
13	Burial pit with cement floor	4 days	2 workers with basic construction skills	Sand, gravel, cement, hollow blocks, reinforcing bars.	
	Six burial pits with clay bottom	2 days	3 workers with basic construction skills	Equipment for building pit: flat bar, long knife, shovel	A flat bar was used to start the hole at the specified dimensions. Soil was piled on the sides. A fence was added around the perimeter.
14	Concrete vault (and burial pit)	5 days	3 workers with masonry and carpentry skills	Portland cement; bars; shovel, saw, hammer, measuring tape, barrel and grub-hoe	
15	Cylindrical concrete vault				Constructed in the culvert next to government facility
16	Concrete vault	4 days	6 workers (supervisor, carpenter, mason, welder, 2 laborers)	Cement – 20 bags of cement reinforcing bars – 12 pieces diameter of reinforcing bars – 10 mm x 20’	Construction equipment used: form material, hammer, shovel, measuring tape, wheelbarrow, welding machine
18	Two concrete vaults	Jan 30 to Feb 9	1 mason and 3 construction workers; hole manually dug by 4 laborers	Portland cement 10mm RSB and 9mm RSB, no heavy machinery or equipment was needed	The pit was dug manually with the use of a crowbar and spade. The side of the pit was stacked with concrete hollow blocks reinforced with steel bars and cement. Waterproof cement was poured on flooring reinforced with steel bars. A cover was made the same way

Table 22: Use of Vaults and Pits

#	Disposal Method	Method of Stacking	Fill Level of Vault	Continued Use	Closure Plans	Notes
2	Concrete vault	Boxes stacked vertically	25% full (86 boxes)	To be used to dispose of wastes from the health center		Bleach dumped into the vault; as a result, boxes broke down
4	Two concrete vaults	Boxes horizontally stacked	Two vaults held 167 and 204 boxes	Vaults closed after immunization campaign	Vaults covered with concrete slabs, sealed with cement, covered with soil and made part of cemetery walkway	All boxes accounted for; closure took half an hour; plan to put markings
5	Concrete vault	Boxes stacked vertically	Almost 75% full	To be used for sharps waste by regional health unit after campaign	Vault will be cemented for permanent closure in the future	One box broken: top of box broken but no syringes fell out
6	Concrete vault	Boxes stacked vertically		To be used by regional health unit for sharps waste, expected to last 6 yrs	It will be sealed by cementing sides	No boxes opened or spilled
9	Existing above-ground cemetery concrete vault	Boxes dropped into vault haphazardly	60% full	To be used by rural health unit for sharps, and by cemetery to bury skeletons	No closure plans; sanitary inspector responsible for vault	Some spilled syringes inside vault from boxes not sealed well
10	Concrete vault	Boxes stacked vertically with alternate horizontal stacking	40% full	Temporarily sealed; to be used for routine immunization	No closure plans; sanitary inspector responsible for vault	All boxes accounted for, no opened boxes
11	Concrete vault	Boxes stacked horizontally to minimize volume	25% full	To be used by rural health unit for hazardous healthcare waste	Temporarily closed with galvanized iron sheet; plan to seal vault with concrete when full	All boxes accounted for
12	Existing concrete vault		37% full	To be used by the district health center and hospital for sharps waste	Sanitary inspector or hospital's chief doctor responsible for vault	
13	Concrete vault	Boxes stacked horizontally up to two layers (36 boxes per layer), then 15 cm gravel was added	10% full	To be used by rural health unit for regular immunization and medical waste; expected to last for 3 years	2 workers needed for 1 day for closure; cover with sand and gravel; municipal sanitary inspector responsible	Cost of closure estimated at P300 for material, P200 for labor
	Burial pit with	Soil cover after one to	10% full			

	cement floor	two boxes are added, enough soil to cover the boxes				
14	Six burial pits with clay bottom	Boxes stacked vertically in vault; some remote areas used pit	25% full	To be used by municipal health office for medical waste from rural health facilities		
15	Concrete vault (and burial pit)		25% full	To be used by rural health unit for sharps waste; expect to last another 5-10 years	Pit to be filled with cement; estimate 1 worker, 1 bag cement, 1 sack of sand and gravel needed; rural sanitary inspector responsible	Estimate cost of closure at P350 (cement bag P120, sand/gravel sack P30, labor P200)
16	Cylindrical concrete vault	Boxes dumped haphazardly into the vault				No broken boxes or spilled syringes
18	Concrete vault	Boxes stacked vertically	67% of one vault filled	To be used for medical waste, mostly syringes, from municipal health center and clinics; expect to last 4-5 years	Cover will be pored over with cement; requires good masonry carpenter, 1 cu meter of sand and 1 sack of cement	All boxes accounted for; general services office responsible for vault

Table 23. Other Methods

	Site # 12	Site # 19
Other Method of Treatment/Disposal	Burial in communal latrines	Electric needle destruction
Description	1.8m x 2m x 2.4m deep; latrines have existed for a long time	Nulife DOTS needle destroyers by MRK Healthcare, Bombay, India (donated in February 2004); automatic electric arc melting of needles into small pellets or swarf; also has a cutter to remove the nub
Location	Remote upland area	Baguio city
Capacity	Dozens of boxes	1 needle destroyed every few seconds
Procedure	Safety boxes were dropped down into the latrines	Three-steps: insert needle, press until needle is melted (2 seconds), pull handle to cut the hub; requires 1 worker
Final disposal	Latrine trenches could be covered with soil if they are ever closed	Pellets and hubs can be discarded with regular waste; plastic portions of syringes can be recycled

Table 24: Detailed Data on Waste Generation

#	No. of Injections	Ave. No. Injections per Day	No. of Syringes	No. of Safety Boxes	Weight of Boxes (kg)	Average Fill Level of Boxes
1	859	50	908	11	7.1	Some were 3/4th full, others were more
	Whole area		5,525	86	23.9	
2	5,408	300	6,181	25	23.9	Boxes were full or 3/4ths full
3	640	49	716	7	4.6	More than 3/4th full
4	4,117	217	4,545	39	33.6	More than 3/4th full
5	1,217	53	1,356	8	8.4	About 3/4th full except in areas with insufficient boxes
	Whole area		11,466	61	62.6	
6	3,228	215	3,690	25	20.4	Boxes 3/4th full
7	18,256	912	19,841	160	91.12 kg	Mostly overfilled; some underfilled boxes were being opened and consolidated into others
	Whole area (19,051 children)				105 kg	
8	1,195	57	1,370	18	8.95	Half to 3/4th full
	Other areas			494	355	96.2% coverage of 69,410 children
9	1,500	83	1,650	9	7.7 kg	Mostly overfilled
	Whole area (34,456 children)			133	112.1	27 boxes unaccounted for
10	772	52	787	8	4.6	Boxes full
	Whole area (14,799 children)					Waste in vault
11	2,644	139	2,986	34	24.9 kg	Boxes are about 3/4th full
12	761	198	855	7	4.1 kg	4 of the 7 are disposed in the communal latrine, other 3 are placed in concrete vault; boxes are between ¾ and full
	Whole area (9,000 children)			65	3 - 5 kg	Waste in vault
13	4,785	299	4,959	29	20.3	Most are less than 3/4th full
14	2,064	138	2,099	22	20.2	Less than or about 3/4th full
15	2,308	136	2,418	24	28.9	Most less than 3/4th full
16	3,462	346	3,462	34	22.9	
17	1,281	107	1,300	12	12.7	Boxes from 3/4th full to overfilled
18	4,217	234	4,744	24	20.0	More than 3/4th full
	Other areas		4,708	34		
19	Entire province			1,438	1,284.3 kg	

Table 25: Data on Other Wastes

#	No. of Bags	Description of Containers	Description of Contents	Estimated Volume (liters)	Weight (kg)
1	19	Black or yellow plastic bags	Wrappers, vial caps, empty Vitamin A capsules, cotton		1.98
2	36	Red plastic bags (12"x12")	Cotton, empty vials, wrappers, syringe caps, vitamin capsules	17	12.8
3	7	Medium size plastic bags	Cotton, wrappers, empty vitamin capsules, syringe caps		2.8
4	10	Plastic bags	Cotton swabs, packaging, empty vials, food waste, food packaging	6	2.8
5	50	Boxes	Vitamin A capsules, candy wrappers, syringe wrappers, caps, empty diluent vials, food wrappers		6.3
	22	Plastic bags	Vitamin A capsules, candy wrappers, syringe wrappers, caps, empty diluent vials, food wrappers	38	28
6	14	Plastic bags	Empty vitamin capsules, vaccine vials, syringe wrappers, caps, cotton, food wrappers	97	9.6
7	20	Plastic bags (5"x2"x10")	Syringe wrappers, empty vials, caps of vials, empty vitamin a capsules, needle caps, used cotton balls	33	0.524
8	21	Plastic bags (mostly 9"x13")	Syringe wrappers, syringe caps, syringe boxes, empty vitamin A capsules, plastic bag, empty diluent ampoules, used cotton	50	3.35
9	17	Boxes (5.2 l)	vials, ampoules, empty vitamin A capsule	88	4.6
10	10	Plastic bags (14"x14")	Used vaccine vials, cotton balls, wrappers, empty Vitamin A capsules, empty boxes	14	2.1
11	50	Small boxes	Syringe wrappers		0.05 kg
12	8	Plastic bags (15"x15" and 10"x12")	Mostly syringe wrappers; some of the vials, empty diluent, cotton balls, vitamin A capsules	14	8.2 kg
13	17	Boxes (12"x12"x12")	Cotton, vitamin A capsules, syringe wrappers, empty vials and diluent containers	481	14.7
14	13	Bags (8"x4"x8")	Used cotton, empty vials, syringe wrappers and empty Vitamin A capsules	27	7.4
15	39 bags	Bag (11"x5"x9") consolidated into 9.5 bags	Used cotton, empty vials, AP syringe cap, wrappers, empty vitamin A capsule	13.6	13.6
16	15	Different size	vaccine vials, cotton balls, empty wrappers, empty Vit. A Capsules and empty	179	13.1

		containers	boxes		
17	10	12x16 plastic bags	Plastic wrapper, syringe cover, cotton balls, empty vit. A capsule	51	0.5
18	17 (from all areas)	Bags (most with average circumference of 53 inches)	Empty boxes, syringe wrappers, cotton, vials, gauze, candy wrapper, empty vitamin A capsules, plastic cups, bottle caps, food waste, paper, and wrappers	672	24.5

Table 28: Method of Disposal of Other Wastes

#	Method of Disposal
1	Discarded as municipal waste
2	Discarded with regular waste in municipal dump site
3	Discarded with regular waste in city's open dump site
4	Discarded in any available trash container
5	Bags placed in large polyethylene bag and discarded as municipal waste
7	Discarded with regular municipal waste; plastic bags provided by health centers
8	Picked up by city dump truck and discarded with regular municipal waste
10	Discarded as regular municipal waste by city garbage disposal
11	Nurse recycled syringe wrappers, other wastes discarded with municipal waste
12	Some waste burnt in open pits or buried in small burial pits (3 x 4 x 3 ft deep)
13	Piled in a corner inside the rural health unit then buried in the burial pit
15	Buried in lower portion of cemetery and covered with truckload of soil
16	Waste bags left in vaccination site to be collected by village health worker and discarded with regular waste or buried in a pit
17	Picked up by garbage truck for regular disposal
18	Deposited with the safety boxes in the concrete vault

Table 30: Overall Costs (in US Dollars)

#	Item	Reported Cost Estimates	Notes
1	Centralized microwave treatment	$1,710	CESI provided half of treatment for free; other half at P30/kg
2	Concrete vault	$185	Local government health services budget
3	Centralized autoclave treatment	PAE provided free treatment	
4	Two concrete vaults	$72	Paid personally by staff who will be reimbursed when budget gets approved
5	Concrete vault	$109	Funded by local government unit
6	Concrete vault	$95	
7	Centralized microwave treatment	Hospital paid for treatment	
8	Centralized microwave treatment	CESI provided free treatment	
9	Existing cemetery vault	$145	
10	Concrete vault	$152	Funded by city health office
11	Existing concrete vault		
12	Concrete vault and existing latrine		
13	Seven burial pits	$102	Local government unit budget
14	Concrete vault and burial pit	$100.	Local government unit budget
15	Cylindrical concrete vault	$277	
16	Concrete vault	$231	Municipal government budget
17	Centralized autoclave treatment	PAE provided free treatment	
18	Two concrete vaults	$399	
19	Centralized autoclave treatment	PAE provided free treatment	

Table 31: Cost Breakdown for Centralized Treatment (in Philippine Pesos)

#	Item	Unit Cost	Total Cost
1	Centralized microwave treatment		
	Transportation (two trips)	P16.50/liter gasoline at 3.15 km/liter, 194 km	P 1,072.50
	Storage		Free
	Treatment	Half provided for free by CESI; other half (3,100 kg) at discount P30/kg	P 93,000
	Labor		Part of employee wages
3	Centralized autoclave treatment		
	Transportation	No data	
	Storage		Free
	Treatment	P32/kg; provided free by PAE	Free
7	Centralized microwave treatment		
	Transportation	P50 per local trip local (2x/week); P98 for trip to treatment facility	P498
	Storage		Free
	Treatment	Usually P32/kg; costs covered by local hospital	Free
	Labor		Part of employee wages
8	Centralized microwave treatment		
	Transportation	P350 per trip x 2	P700
	Storage		Free
	Treatment	Usually P32/kg; provided free by CESI	Free
	Labor		Part of employee wages
17	Centralized autoclave treatment		
	Transportation, storage, labor	No data	
	Treatment	Usually P32/kg; provided free by PAE	
19	Centralized autoclave treatment	Usually P32/kg; provided free by CESI	Free

Table 32. Cost Breakdown for Vaults and Pits (in Philippine Pesos)

#	Item	Quantity	Unit Cost	Total Cost
2	Concrete vault			
	Hollow block 4" CHB	150 pcs		825
	Portland cement	15 bags		2,325
	Sahara cement	10 kg		350
	Tie wire # 16	1 kg		45
	Assorted nail	1 kg		43
	Steel 10mm x 6m	10 pcs		1,150
	Washed sand	0.5 cu meter		175
	Washed gravel	0.5 cu meter		175
	¼ x 4 x 8 plywood	1 pc		290
	1 unit water pump	1 unit		500
	gasoline	15 liters		300
	laborers	4		2,000
	Subtotal: materials			8,180
	Labor			2,000
	TOTAL			P 10,180
4	Two concrete vaults			
	Cement, sand, reinforcing bars, hollow blocks			2,000
	Labor			2,000
	TOTAL			P 4,000
5	Concrete vault			
	Portland cement	9 bags		1,260
	Washed sand	1 cu meter		380
	Graded gravel	1 cu meter		500
	10mm dia x 6m reinforcing bars	10 pcs		900
	concrete hollow blocks, 10x20x40 cm	100 pcs		800
	construction pails	2		100
	waterproof cement	3 bags		75
	No. 16 GI tie wire	0.5 kg		20
	Subtotal: materials			4,035
	2 laborers (digging)	1 day		350
	4 skilled laborers	2 days		1,300
	Contingencies			315
	Subtotal: labor			1,965

	TOTAL			P 6,000
6	Concrete vault			
	Transportation			200
	Materials			3,732.50
	Labor			1,300
	TOTAL			P 5,232.50
9	Existing Cemetery vault			
	Construction cost estimate			P 8,000
10	Concrete vault			
	Transportation			1,429
	Materials			4,617.00
	Labor			2,296.80
	TOTAL			P 8,342.80
13	Seven burial pits			
	Transportation			500
	1 burial pit w/ cement floor			
	Materials			3,500
	Lock for the cover			30
	Labor			1,500
	6 burial pits w/ clay bottom			
	Labor			100
	TOTAL			P 5,630
14	Concrete vault			
	Concrete			
	Portland Cement	5 bags	155	775
	Washed Sand	1 cu meter	350	350
	Washed Gravel	1 cu meter	400	400
	10mmØ x 6m	4 pcs	115	460
	#16 G.I Tie Wire	1 kg	45	45
	Assorted nails	1 kg	45	45
	2 x 2 x 12” coco form	4 board ft	9	36
	4 x 4 x8” plywood	1 pcs	290	290
	Masonry			
	4” CHB	125 pcs	5.50	687.5
	Portland Cement	2 bags	155	310
	Washed Sand	1 cu meter	350	350
	10mmØ x 6m	2 pcs	115	230
	Subtotal: Materials			3,978.50

	Labor			1,500
	TOTAL			P 5,478.50
15	Cylindrical concrete vault			
	Transportation of boxes			10,000
	Cement	2 bags		220
	River mix	3 sacks		150
	Waterproof cement	2 bags		60
	Culvert	2 pcs		1,600
	Freight service			100
	Labor (3 workers)			1,600
	Other labor			1,500
	TOTAL			P 15,230
16	Concrete vault			
	Labor			3,200
	Other costs			9,501
	TOTAL			P 12,701
18	Two concrete vaults			
	4" CHB	230 pcs	9.00	2,070
	Portland cement	32 bags	160	5,120
	sand	2 cu meters	280	560
	gravel	3 cu meters	280	840
	10mm RSB	45 pcs	85	3,825
	9mm RSB	8 pcs	70	560
	GI tie wire #18	10 kg	60	600
	1/4x4x8 ordinary plywood	2 pcs	280	560
	CWN 4"	2 kg	45	90
	CWN 2"	1 kg	45	90
	2x2x8 coco lumber	10 pcs	50	500
	Water proof cement	5 kg	30	150
	Subtotal: materials			14,965
	Labor (180.55 per worker per day)	4 workers, 9 days	180.55	6,500
	Contingency			500
	TOTAL			P 21,965

Notes: CHB=concrete hollow blocks, RSB=reinforcing steel bars; GI=galvanized iron; coco=coconut lumber; CWN=common wire nail; pcs=pieces

Table 38: Occupational Safety

#	Nature of Incident	Person Involved	Description of Circumstances	Cause	Response or Recommendation
1	Needle-stick to the hand	Waste handler	Occurred while unloading safety boxes in plastic bags to the storage area	A few old safety boxes not properly sealed and got wet; needles fell out; broken boxes were put in plastic bags; worker did not notice syringes poking out; worker wearing thin surgical gloves; all broken boxes were over-filled	First-aid given; worker refused tetanus shot. Use only new safety boxes and do not overfill boxes
	Needle-stick to the hand	Driver of transport vehicle	Occurred while unloading safety boxes in plastic bags to the storage area	Same as above	Same as above
2	No injuries or accidents				
3	No injuries or accidents				
4	Needle-stick	Waste worker	Old boxes from routine immunization were placed into concrete vault; injury happened during a test run using old safety boxes	Old boxes were used and sprayed with bleach disinfectant; moisture had weakened boxes; worker was trying to force boxes into space	Boxes should not be wet with disinfectant; boxes should not be forced into the vault; workers replaced thin plastic gloves with heavy-duty gloves
5	No injuries or accidents				
6	No injuries or accidents				
7	Needle stick	Driver of waste transport vehicle	Two needles were sticking out of an old safety box	Old safety box was used and box had been overfilled	First aid, applied disinfectant; boxes should not be overfilled
	Needle stick	Assistant EPI coordinator and supervisory nurse	Injury occurred as used syringes were being transferred to other boxes	Underfilled boxes were opened and contents were transferred to other boxes and then overfilled	Boxes should not be opened and contents transferred to other boxes; boxes should not be overfilled
8	Dropped boxes	City employee	Several boxes fell off the transport vehicle when the vehicle door was opened	Boxes were not secured	Fewer boxes were transported; boxes should be secured during transport
	Safety box was turned over by child	Curious child from community	Child saw safety box and turned it over then replaced the used syringes	Safety box and child were not being watched properly	Child was scolded
	Needle stick on the right ring finger	Guide of the vaccination team	Guide moved safety box nearer to the vaccinator as vaccinator was about to	Safety box was moved at the wrong time	First aid, treated with alcohol

			deposit a syringe		
9	No injuries or accidents				
10	No injuries or accidents				
11	No data				
12	Needle punctured safety box and stuck out of the box		Occurred sometime during vaccination		Occurred using old safety boxes from the 1998 immunization campaign
	Ordinary carton box used instead of safety box				
	Child carried safety box for short time				Box was taken from the child by vaccination team member
	Some waste was burned				
13	Needle stick injury in the left ring finger	Midwife (vaccination team member)	Midwife was collecting 20 used syringes from a plastic bag	No safety boxes available on this day and workers recapped syringes and put them in a plastic bag	First aid, wound bled, cleaned with hydrogen peroxide; safety boxes should always be available
	Needle stick in the right pointer finger	Vaccinator	Vaccinator was stuck by an unused mixing syringe during house to house vaccination	Space was very limited inside the house	First aid, wound bled, cleaned with hydrogen peroxide
14	No injuries or accidents				
15	No injuries or accidents				
16	Needle stick in the finger	Vaccination team member	Vaccinator accidentally pricked co-worker with a needle while putting syringe in safety box		First aid, applied alcohol
17	No injuries or accidents				
18	No injuries or accidents				

Table 39: Selected Comments and Recommendations

#	Comments by Vaccination Team	Comments by Local Officials	Comments by Community	General Comments
1	Newer safety boxes were sturdier, lighter and easier to assemble and carry; they suggested a larger box to hold more syringes	Despite minor glitches, waste management was satisfactory; highly recommended microwave treatment	Disposal of other waste was satisfactory	
2	Need to ensure training and to provide for transportation to central storage	Need budget allocation for transportation and concrete vault	Appreciate cleanliness of vaccination site and avoidance of sharps injuries	Concrete vault should be locked and protected by security fence; use of chlorine may be problem due to shallow water table
3	With monitoring of waste disposal, the risk of affecting the community will be minimized.	Awareness of problems of waste disposal has been raised. Willing to support alternative technologies if accepted by environmental department.	Glad to be part of the program; sees the importance of proper waste disposal.	Documentation of waste disposal should continue to increase awareness in the community
4	No training provided; they did not consider how to deal with other wastes	Cost of waste disposal should be included in budget	Glad safety boxes are not stored in community for long; hope waste management continues after measles campaign	
5	Appreciated no recapping and use of vehicles to transport waste; appreciated using vault to keep syringes away from community			
6	Training insufficient, safety boxes are good quality	Better sizing of the concrete vault	Community leaders should also receive training on waste management	
7	Team members seemed not to be concerned with waste management			
8	No supervision of waste management; boxes have thick walls and easy to carry although they would have preferred a wider box	Glad there were no needle-sticks; appreciated durable safety box; concerned there was only one vehicle for transport	Community leader appreciated segregation of waste	
9	Presence of monitors pressured vaccination team to be conscious of waste management	Interested in alternative waste treatment methods		Vault needs to have a secure cover and signage

10	Waste management was an added task but recognized as important to ensure public health and environmental protection; recommended continued use of safety boxes and use of the ambulance to transport boxes	A few instances when regular waste was dumped in safety boxes; appreciated designation of waste disposal area inaccessible to public; recommend one vault per district to minimize transport and continue waste management		Each district should have at least one septic vault, although the number of boxes accumulated are quite big. New safety box should be used for regular immunization.
11	Recommended having monitors of waste management throughout the whole province			
12	Training and orientation was insufficient; monitoring of waste disposal was thorough; would like to see continued monitoring and assistance on waste management	Would like to see vault constructed for other areas	Appreciate burying sharps waste	Need to coordinate with other volunteer organizations on waste management.
13	Suggest longer training seminar and better containers. Collection was efficient. Appreciate monitoring waste to protect the public.	Would like to see more safety collection boxes to sustain waste management practices	Appreciate concern for waste disposal	
14	Training was sufficient and safety boxes prevented accidents. Appreciated concern for occupational safety and promotion of clean air by not burning.	Construction of vault presented financial hardship for local government. Disposal method had good results.	Appreciated concern for safety of community. Suggested monitoring of other villages.	
15	Training should be at least 2 weeks before start of campaign. Safety boxes are safe and easy to carry. Transport of boxes is manageable. Disposal method has low cost.	Waste management and disposal was safe and effective.	Every village should have its own disposal pit or vault.	
17	Training was sufficient. Waste management was well supervised.	Appreciated assistance and presence of monitor to ensure careful waste management	Presence of monitor made community volunteers conscious of waste management	
18	Not enough time on training. Committee on waste disposal formed. Safety boxes were sturdier and more moisture resistant than old boxes. Taping up boxes important to prevent spills. Labeling boxes facilitated accounting. Setting example was good for community. Recommend unannounced visits by monitor.	Waterproofing and elevating vault was important due to heavy rains in the area.	Medical waste still burned in some areas. Recommend ordinance on medical waste management, seminars, monitoring, forging agreements with health facilities	

DOCUMENTATION FORM

Documentation of Immunization Waste Management and Disposal: A Guide for Researchers

General Points:

OBJECTIVES

- The overall objective is to promote environmentally responsible methods for the management and disposal of waste from mass immunization campaigns.
- The specific objectives are:
    - To document planning and implementation of waste management and disposal, from the pre-immunization to post-immunization stages, in order to allow others to replicate the systems used
    - To assess the non-incineration methods for the treatment and disposal of immunization waste, and to make recommendations

OUTCOMES

- Outcome of the project: the field reports from researchers will be compiled and used to generate a draft report to be reviewed by DOH and eventually submitted as a joint HCWH/DOH report to the World Health Organization, UNICEF and other international agencies.

POINTERS

- The main task of the researcher is to monitor and document waste management activities.
- The researcher should not interfere with or obstruct the immunization activities but should be prepared to assist and support the activities if requested by the vaccination team.
- Researchers should be courteous and diplomatic.
- The researcher should attend the orientation and trainings with the vaccination team, not only to document the training on waste management but also to be familiar with the overall strategy.

EQUIPMENT

- Equipment needed: pen, paper/documentation form, measuring tape (to estimate dimensions of pits or vaults, etc.), weighing scale, green broad marker pen (for numbering safety collector boxes), camera, battery for camera, extra film, optional tape recorder, resealable plastic bags, flashlight, extra clothes/weather protection, first aid kit, gloves, money

A. Documentation During the Pre-Immunization Stage

I. *For all areas:*

1. Obtain basic socioeconomic and health data for the area covered by the documentation (this may be available from the Office of Municipal Planning and Development, local government office, and/or local health officers):

    a. Population of the area to be covered by the documentation (see #2a below)
    b. <u>Population density</u> (number of people per square kilometer)
    c. Estimated percent of homes with running water
    d. Estimated percent of homes with electricity
    e. Percent urban, percent rural
    f. List the major industry in the area, if any
    g. List the major farming and fishing activities in the area, if any

h. If the area is rural, how far (in kilometers) is the nearest urban center
i. Describe the types of roads in the area (e.g., rough, gravel, asphalt, concrete, etc.)
j. Describe the main types of transportation used *within* the area
k. If the area is rural, describe the main types of transportation from the area to the nearest urban center
l. Number of colleges and universities in the area
m. Number of daycare centers, pre-schools, elementary and secondary schools (private and public)
n. Number of government and private hospitals in the area
o. Number of health centers, small clinics, and barangay health stations in the area
p. Rate of AIDS cases in the area
q. Rate of Hepatitis cases in the area

2. Document the planning, *related to immunization waste only*, on the municipal or local level where you will conduct your documentation. Most or all of this information should be available from the microplan (a written detailed plan developed by the municipal or local level staff) or from interviews with the municipal or local level staff. Information may also be available from the municipal or local Logistics Committees. Key information include:

    a. Define the "area of documentation" (AOD): provide the name of the city/district/barangay, municipality/district/barangay
    b. Does the AOD have a microplan? If so, when did they start developing the microplan, when did they complete it?
    c. Estimate of the total number of eligible children in the AOD
    d. Estimated total number of auto disable (AD) syringes and mixing syringes needed for the AOD
    e. Estimated number of safety collector boxes needed for the AOD
    f. Total number of barangays in the AOD
    g. Organizational structure for waste management:
        i. Who will be responsible for waste from the level of the vaccination team up to the regional level?
        ii. Who will be responsible for the centralized collection and storage of the filled safety collector boxes?
        iii. Describe what arrangements were made by the municipal or local governments for setting up a central deposit area or central storage facility, transportation of waste, and the treatment/disposal of the waste
    h. Method of treatment/disposal to be used (e.g., burial pit, concrete septic vault, burial in a cemetery, centralized autoclaving facility, centralized microwave facility, etc.):

        i. Describe the detailed plan from collecting used syringes in safety collector boxes up to their final disposal in the AOD
        ii. Ask the municipal or local government why the disposal method was selected

    i. Method of collection and transport

        i. Describe how filled safety collector boxes will be transported and stored
        ii. If a vehicle is used, describe the frequency of collection, the type of vehicle used and its storage capacity

    j. Obtain estimates and a breakdown of the costs of waste management, including any costs for transportation of filled boxes, rental of space for storage, labor, and cost of treatment/disposal for the AOD [NOTE: in all documentation of costs, include estimated costs of in-kind contributions]

3. Document the training and orientation of vaccination teams relative to immunization waste management:

    a. How much time was spent discussing waste management?
    b. Describe the content of the presentation on waste management.
    c. Provide your assessment on whether or not the training was sufficient, understandable, and effective.

II. *For areas using concrete septic vaults, pits and other burial methods:*

1. Obtain data on the construction of the concrete vaults or burial pits for the AOD. Key information includes:

a) Specifications used (dimensions, illustration)– unless the specifications used are identical to those in the DOH "Guide to Ligtas Tigdas 2004"
   i. Describe the floor of the pit or vault—confirm whether the bottom layer is cement, clay, high density polyethylene (HDPE) liner, geomembrane, or other bottom layer.
   ii. Describe the mouth of the pit or vault—what steps have been taken to prevent water run-off during rains from entering the pit or vault?

b) Describe the materials and equipment needed to prepare the vaults or pits, e.g., how much cement (kg) was used, diameter of reinforcing bars, how many reinforcing bars were used, what tools or construction equipment were used, etc.

c) Describe any safety features to prevent unauthorized access or accidents (e.g., Is there a security fence around the pit or vault? Is there a cover? Is there a lock on the cover?)

d) Location of the disposal site
e) Ask how or why the site was selected

f) Description of the site where the pit or vault is located:
   i. Estimate how far the nearest dwelling unit is
   ii. Estimate how far the nearest body of water (river, lake, stream, ocean) is
   iii. Describe the surrounding elevation: is the burial site on top of a hill, on the side of a hill, on a plain, in a valley, etc.?
   iv. Type of soil in the disposal site

g) Describe the basic steps for construction
h) Describe construction skills required
i) Number of workers needed and total construction time

j) Total cost of construction and a breakdown of costs (labor, materials)
k) Source of funding

l) Depth of the water table under the pit or vault (i.e., estimate how deep the groundwater is below the pit or vault) – this information may be available from the local public works department, the municipality's geologist or civil engineer, local well drillers, or from the community

m) Photo documentation: take several photos of the vault or pit (from different angles, wide-angled shots and close-ups of any special features)

III. *For areas using centralized treatment (NCR and other urban areas):*

1. Obtain data on collection and transport arrangements to the centralized treatment facility:

a) Frequency of collection and collection schedule

b) Map of collection route showing location of collection points, storage areas (or transfer points) and centralized treatment facility

c) Approximate distances between collection points, storage areas and centralized treatment facility

d) Describe typical road conditions and traffic conditions

e) Describe vehicle(s) to be used for transport, including storage capacity of the vehicle(s)

f) Describe procedures for transportation and handling, if any

g) Describe plans, if any, in the event of an accident or spill

2. Obtain data on the technologies used for centralized treatment:

a) Location of the treatment facility

b) Description of the treatment system including:
   i. Nature of the technology (autoclave, microwave, etc.)
   ii. Name of the manufacturer of the technology
   iii. Rated capacity
   iv. When technology was installed
   v. Other data such as footprint, safety features, degree of automation, auxiliary equipment, etc.

c) Operating parameters (exposure time, temperature/pressure, etc.)

d) Capital and operating cost of the technology, if available

e) Financial arrangement for use of treatment facility for immunization waste

f) Number of workers needed to operate the technology

g) Level of skills or training required to operate the technology

B. Documentation During the Immunization Stage

1. General information

a) Number and composition of the vaccination team
b) General location and description of the AOD (urban, urban poor, resettlement, rural, remote rural, upland, coastal, island, etc.)

2. Daily documentation of waste handling and disposal practices in the field during immunization (*Note: descriptions need not be repeated if the same practice is used every day*):

a) Date and description of each day's vaccination sites (main descriptions are listed below):
   i. Schools, pre-schools, day care centers
   ii. Fixed vaccination centers (bakuna centers) such as hospitals, health centers, and barangay health stations
   iii. Building to building
   iv. House to house
   v. High-risk areas such as urban poor communities and resettlement areas
   vi. Hard-to-reach areas such as rural areas with poor roads
b) Count and record the number of injections performed *per day* (see Form A)
c) Describe the local set-up (importantly, where is the safety collector box placed and where are the filled boxes placed during the vaccination; include a drawing if needed)
d) Describe how the safety collector boxes are transported during the day
e) After the boxes are about three-fourths full and closed, assist in sealing the boxes with tape, ensuring that the tops of the boxes are labeled "USED. DO NOT OPEN". Mark each box with a number using a marker pen, unless there is a number already. Blacken the box instruction to burn or incinerate, if it has not been done. *NOTE: Put the numbered label on all sides of the box.*
f) Amounts of safety box waste generated *per day*
   i. Record the total number of boxes

ii. Record each number labeled on the box
iii. For each number, record the corresponding weight of each box
iv. Calculate and record the total weight each day

g) Amounts of "other wastes" (used vaccine vials, cotton balls, wrappers, empty Vitamin A capsules, empty boxes, etc.)
   i. Describe type of container used to collect "other wastes" (plastic bag, box, plastic container, etc.)
   ii. Describe the contents of the "other wastes"
   iii. Record the amount of "other wastes" generated *per day* (number and approximate size of bags or containers, approximate total weight)
   iv. Describe how "other wastes" are disposed of

h) Describe where the filled safety collector boxes are deposited or stored at the end of each day (e.g., temporary location, bakuna center, central deposit area, etc.)

i) Describe the central deposit area (or central storage facility) where the filled boxes are kept:
   i. Where is the central deposit area or central storage facility?
   ii. Who is responsible for the central deposit area or central storage facility?
   iii. How are the filled boxes stored or stacked up? If the boxes are stacked up, make note if any of the boxes have fallen or broken open. Are boxes stacked vertically or horizontally?
   iv. How accessible is the deposit area or storage facility to the waste worker?
   v. How accessible is the deposit area or storage facility to the public?
   vi. Who takes custody of the boxes every day?
   vii. How are the boxes accounted for?
   viii. How is the area or facility secured (e.g., is the storage area locked)?

j) Document cases where needles punctured the safety box.
   i. Date and place
   ii. Description of how many needles, which part of the box
   iii. Cause of the puncture
   iv. Describe activities in response to the puncture

k) Documentation of injuries and accidents related to waste, if any: should an accident or injury occur involving needle-sticks, spillage of waste, etc.
   i. Date and approximate time of the injury or accident
   ii. Type of injury or accident
   iii. Function of the person (e.g., doctor, nurse, waste handler, etc.) injured or involved in the accident
   iv. Description of procedure being performed when injury or accident happened, including where and how it happened, what type of waste was involved
   v. Details of exposure, if exposure happened (such as severity of exposure)
   vi. Description of activities in response to injury or accident (e.g., first-aid, clean-up procedure used, etc.)

l) Sometime during the immunization stage, take photos showing:
   i. Typical location of open and filled boxes in the local set-up during vaccination
   ii. Typical method of transporting filled boxes
   iii. Typical storage at centralized deposit area

3. Documentation of the transport and treatment process *(for areas using centralized treatment)*

a) Document overall transport of waste to the central treatment facility
   i. Who is responsible for the transport of waste to the centralized treatment facility?
   ii. Make note of any problems you may have observed during transport

b) Documentation of the treatment of waste in the central facility
   i. Who is responsible for the treatment process?
   ii. Describe the residues after treatment in the technology; *take a photo* of the residues
   iii. Make note if you see any needles that are not destroyed by the technology and may cause needle-stick injuries

iv. Make note if any plastic portions of the syringes have not been destroyed and could still be reused

4. Documentation of the disposal *(for areas using burial methods)*

a) Describe how the safety boxes are buried:
   i. For burial pits, are stacks of boxes alternated with soil layers? If so, approximately how deep are the stacks of boxes and how deep are the soil layers? How frequently are the soil layers applied (every day, every few days, weekly, etc.)?
   ii. For concrete vaults, describe whether the safety boxes are deposited inside the vault every day, every few days, once a week, at the end of the immunization campaign, etc.

b) Describe the manner in which the safety boxes are stacked up inside the pit or vault (horizontally and/or vertically, in a haphazard manner, etc.); make note if you see any boxes that are broken and if you see any spilled syringes

c) During and/or at the end of the immunization stage, make an accounting of all the labeled safety boxes; if not all boxes are accounted for, conduct an investigation to determine the reason for the discrepancy (Form B)

d) Take photos of the pit or vaults showing how the safety boxes are stacked up and buried inside (take both close-ups and wide-angle shots)

C. Documentation at the End of the Immunization Stage

1. General information

a) Calculate and record the total amount of waste generated in your AOD (total number of boxes and total weight; estimate of total amount of "other wastes")

b) If other areas are using the same pit, vault or centralized treatment facility:
   i. Estimate the number of children vaccinated in the other areas (not including your AOD) using the pits, vaults or centralized facility
   ii. Estimate the total amount of waste generated in the other areas (not including your AOD) using the pits, vaults or centralized facility

c) Based on your notes:
   i. Summarize the general handling, collection, transport, storage, and treatment/disposal procedure
   ii. Make a shot list (number, date, place, time, short description)
   iii. Describe the average level of fill of the safety boxes (about three-fourths full, less than 3/4ths, more than 3/4ths, overfilled)

2. Documentation of the treatment process *(for areas using centralized treatment)*

a) Document overall transport of waste to central facilities
   i. Estimate the total number of vehicle trips to transport waste from the AOD to the centralized treatment facility, estimate the total distance (in km) traveled by the vehicle from the AOD to the centralized facility, and note the cost of gasoline or diesel
   ii. Estimate of the actual total cost of transport (costs of fuel, labor, other costs)
   iii. Interview the transport workers (drivers, waste handlers) and ask them to describe positive and negative aspects of the transport process
   iv. If other areas use the same centralized facility:
      1. Estimate the total distance (in km) traveled by the vehicle in all the areas using the centralized facility (including your AOD) to transport waste to the centralized facility
      2. Estimate the actual cost of transport (costs of fuel, labor, other costs) for all the areas using the centralized facility (including your AOD) to transport waste to the centralized facility

b) Documentation of the treatment of waste in the central facility
   i. Document any problems or abnormal conditions encountered during the treatment process

c) Documentation of the final disposal of treated residues in landfills or waste dumps
   i. Who is responsible for the final disposal of residues?
   ii. Follow the treated waste and describe how and where the residues are finally disposed of (such as in a waste dump, landfill, burial site, etc.); *take a photo* showing final disposal of the residues

3. Documentation of the final disposal *(for areas using burial methods)*

   a) Record the total number of pits or vaults used in your AOD; confirm the dimensions of the pits or vaults especially if new pits or vaults are added; record dimensions if different sizes of pits or vaults are used
   b) Make a final accounting of all the labeled safety boxes; if not all boxes are accounted for, conduct an investigation to determine the reason for the discrepancy (Form B)
   c) If the same pits or vaults are used by other areas, estimate the total number of safety boxes in the pits or vaults at the end of the immunization campaign
   d) Estimate how much space is left empty in the vault or pit at the end of the immunization campaign (take a photo)

   e) If the pit or vault is sealed or closed permanently, obtain data on the closure. Key information includes:

      i. Description of how the pit or vault will be sealed permanently
      ii. Description of the materials and equipment needed to close the vaults or pits, e.g., how much cement was used, what construction equipment was used, etc.
      iii. Description of any safety features to prevent unauthorized access or accidents in the future
      iv. Describe any markings or signs (e.g., "DANGER" or "NEEDLES-SYRINGES BURIED HERE", etc.); How clear and visible are the markings? How durable and weather-resistant is the sign?
      v. Steps used for closure
      vi. Worker skills required
      vii. Number of workers needed and total time needed for closure
      viii. Total cost of closure and a breakdown of costs (labor, materials)
      ix. Photo documentation: take a picture of the vault or pit before and after closure

   f) If the pit or vault will be closed temporarily and used again later, describe the temporary closure using the list above as a guide.

   g) If the pit or vault will continue to be used, describe plans for continued use:

      i. Who will use the pit or vault after the immunization campaign?
      ii. What types of waste will be placed in the pit or vault after the immunization campaign?
      iii. How will the pit or vault be kept secure from unauthorized access or accidents in the future?
         - Describe any signs or markings
         - Describe any covers, security fence, locks, etc.
      iv. How long will the pit or vault remain open (estimate)?
      v. How will the pit or vault be permanently closed and sealed in the future?
      vi. Who will be responsible for the pit or vault?

4. Interview all members of the vaccination team and get their assessment of the following aspects of the waste management and disposal process:
   a) Training and orientation on waste management
   b) Supervision and responsibilities in relation to waste management
   c) Handling of sharps
   d) Collection of sharps waste and use of safety collector boxes
   e) Collection and disposal of "other wastes"
   f) Transport of safety collector boxes
   g) Storage of safety collector boxes
   h) Treatment and/or final disposal of waste
   i) Occupational safety issues, if any

j) Public health issues, if any
k) Environmental issues, if any
l) Other problems encountered, if any
m) Positive and negative aspects of the waste management system
n) HCWH's monitoring and documentation process
o) Suggestions or recommendations for future immunization campaigns

5. Interview local government officials (EPI coordinator, Municipal Health Officer, Sanitary Engineering) regarding any problems and positive aspects of waste management and disposal, and any suggestions for the future
6. Interview some local community representatives (Barangay captain, barangay health worker) regarding any problems and positive aspects of waste management and disposal, and any suggestions for the future
7. Document any occupational safety and health problems that affected the vaccination team, waste transporters, waste handlers, etc. in relation to the management and final disposal of waste (e.g., needle-stick injuries)
8. Document any problems in the management and final disposal of waste that threatened or adversely affected the health and safety of the community (including photo where possible)
9. Document any environmental problems in the management and final disposal of waste (including photo where possible)

E. **Report Writing Phase**

a) Submit your report and photos to HCWH by March 15, 2004.
Address: Merci Ferrer, Health Care Without Harm, Unit 320 Eagle Court Condominium, 26 Matalino St., Quezon City, Philippines (Telephone 928-7572)
b) Attend a final meeting of researchers (about 1 to 1-1/2 weeks after submission) to compare notes, provide additional input on various aspects of waste management and disposal which may not be reflected in the reports, and to conduct an assessment of the documentation process
c) Be available for any follow-up questions
d) Notify HCWH if you would like to review and comment on the draft report
e) Provide HCWH with your mailing address where the final report can be sent
f) Notify HCWH if you would like to continue to be part of the HCWH network on environmentally sound management and disposal of medical waste.

Ligtas Tigdas 2004: Monitoring Form A for Sharps Waste

Immunization Area(s) ______________________________

Name of Researcher ______________________________

Initial Stock Position:

Date	Total No. of New Safety Boxes	Total No. of Syringes

Daily Record:

Date	Description of Vaccination Sites	No. of Injections Performed	Methods of Transporting Boxes	List Numbered Label of the Filled Safety Boxes below	No. of Boxes	Weights of the Filled Safety Boxes (kilograms)	Where Filled Box is Stored at Night	Approx. No. of Used Syringes

		Total No. of Injections Performed			Total No. of Filled Boxes	Total Weight of Filled Safety Boxes		Total No. of Used Syringes

Attach more pages as needed

End of Immunization Campaign: Monitoring Form B

For the Area Covered by Your Vaccination Team:

Date	Total No. of Filled Safety Boxes	Total Weight of Filled Safety Boxes	Total No. of Boxes Disposed Of	Method of Disposal	Total Number of *Used* Syringes
	Total Number of *Unused* Safety Boxes				Total Number of *Unused* Syringes
	Total Number of *Filled & Unused* Boxes				Total No. of *Used & Unused* Syringes

For the Area of Documentation, if different from Area Covered by Your Vaccination Team:

Date	Total No. of Filled Safety Boxes	Total Weight of Filled Safety Boxes	Total No. of Boxes Disposed Of	Method of Disposal	Total Number of *Used* Syringes
	Total Number of *Unused* Safety Boxes				Total Number of *Unused* Syringes
	Total Number of *Filled & Unused* Boxes				Total No. of *Used & Unused* Syringes

Describe the typical level of fill of safety boxes:

___ About 3/4th Full   ___ More than 3/4th Full   ___ Less than 3/4th Full   ___ Overfilled

Provide explanation for any discrepancy between “Initial Stock Position” and “Total Number of Used & Unused” in the space below:

Make an accounting of all the safety boxes in your Area of Documentation. If not all boxes are accounted for, conduct an investigation to establish the reason for the discrepancy. Provide the results of your investigation below:

Ligtas Tigdas 2004: Monitoring Form C for Other Wastes

Immunization Area(s) ____

Name of Researcher ______________________________

Daily Record:

Date	Number of Bags or Containers	Description of Contents	Dimensions of Filled Containers or Bags (LxWxH or circumference, inches)	Approximate Total Weight (kilograms)	Method of Disposal *

Total Number of Bags or Containers	Total Volume	Total Weight

Attach more pages as needed

End of Immunization Campaign: Monitoring Form D

For Area Covered by Your Vaccination Team:

Total Number of Bags or Containers	Total Volume	Total Weight

General composition of "other wastes" ______________________________

____

____

* Additional description of disposal method ______________________________

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