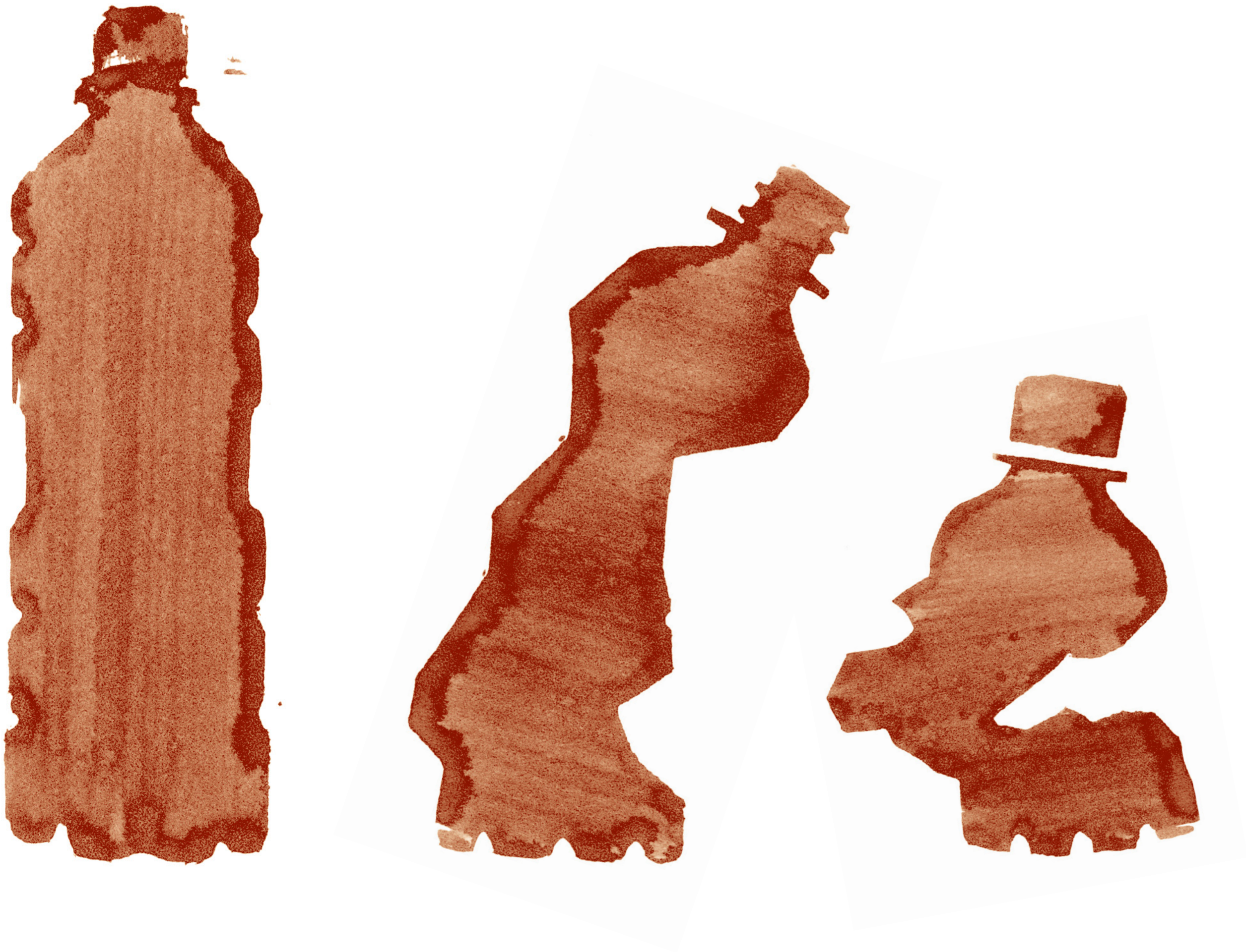
humanitarian innovation fund

WASH in Emergencies
Problem Exploration Report

# Solid Waste Management



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# Preface

The Humanitarian Innovation Fund (HIF) is a programme of ELRHA, and we are here to support organisations and individuals to identify, nurture and share innovative and scalable solutions to the challenges facing effective humanitarian assistance.

The HIF has a dedicated fund to support innovation in water, sanitation and hygiene (WASH) in all types of emergencies, from rapid onset to protracted crisis. WASH is a broad theme with serious consequences in many other areas such as health, nutrition, protection and dignity. In the absence of functioning toilets, clean water systems, effective hygiene practices, and safe disposal of waste, pathogens can spread rapidly, most commonly causing diarrheal and respiratory infections which are among the biggest causes of mortality in emergency settings.

Despite this, there is a significant gap between the level of WASH humanitarian assistance needed and the operational reality on the ground. This is why the HIF works closely with multiple stakeholders from across many humanitarian agencies, academia and private sector to understand and overcome practical barriers in the supply and demand of effective solutions.

Over the past three years the HIF has been leading a process to identify the key opportunities for innovation in emergency WASH. Fundamental to this is having a strong understanding of the problems that need to be solved. We note that many innovations focus on improving technology because the problems can often be clearly defined, compared to more complex problems with supply chains, governance or community engagement.

Our problem research began with an extensive Gap Analysis (Bastable and Russell, 2013) consulting over 900 beneficiaries, field practitioners and donors on their most pressing concerns. From these results we prioritised a shortlist of problems including solid waste management. However drawing lines between where one problem ends and another starts is difficult given the feedback loops within each system. For example reducing waste from plastic bottle usage relies on the availability of other safe water options which in turn is linked to environmental sanitation and hygiene.

This report is one of a series commissioned by ELRHA to explore priority problems in emergency WASH. The researcher selected for each report was asked to explore the nature of the challenges faced, document the dominant current approaches and limitations, and also suggest potential areas for further exploration.

The primary purpose of this research is to support the HIF in identifying leverage points to fund innovation projects in response to the complexity of problems. We seek to collaborate closely with those already active in these areas, avoid duplication of efforts, build on existing experiments and learning, and take informed risks to support new ideas and approaches.

In publishing these reports we hope they will also inform and inspire our peers who share our ambitions for innovation in emergency WASH. In addition to engineers and social scientists who are crucial to this work we hope to engage non-traditional actors from a diverse range of sectors, professions and disciplines to respond to these problems with a different perspective.

The content of this report is drawn from a combination of the researcher's own experiences, qualitative research methodologies including a literature review that spanned grey and published literature and insights from semi-structured interviews with global and regional experts. The report was then edited and designed by Science Practice.

We would like to thank the members of our WASH Technical Working Group for their ongoing guidance: Andy Bastable (Chair), Brian Reed, Dominique Porteaud, Mark Buttle, Sandy Caincross, William Carter, Jenny Lamb, Peter Maes, Joos van den Noortgate, Tom Wildman, Simon Bibby, Brian Clarke, Caetano Dorea, Richard Bauer, Murray Burt, Chris Cormency, and Daniele Lantagne.

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The present report was written by Brian Reed and Rubis Mena-Moreno at the Water, Engineering and Development Centre (WEDC), School of Civil and Building Engineering, Loughborough University. They led the research, compiled and analysed existing literature and case studies, and conducted interviews with key stakeholders in the field.

The report has benefited greatly from the valuable insights and consideration provided by the following experts: Veronica Di Bella (Senior Consultant, Environment IMC Worldwide LTD) and Olmo Forni (Disaster Waste Recovery). Field observations were provided by former students of WEDC. As these often report failure in precarious situations, their contributions have been anonymised but their contribution is gratefully acknowledged.

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The report was edited and designed by Science Practice.

# Abbreviations

| | |
|---|---|
| **BATNEEC** | Best Available Technology Not Entailing Excessive Costs |
| **ELRHA** | Enhancing Learning and Research for Humanitarian Assistance |
| **HIF** | Humanitarian Innovation Fund |
| **IDP** | Internally Displaced Person |
| **INGO** | International Non-Governmental Organisation |
| **$kg/m^3$** | Kilograms per cubic metre (Density) |
| **kpd** | Kilograms per person per day |
| **Lpd** | Liters per person per day |
| **NGO** | Non-Governmental Organisation |
| **OCHA** | The United Nations Office for the Coordination of Humanitarian Affairs |
| **SWM** | Solid Waste Management |
| **UN** | The United Nations |
| **UNEP** | The United Nations Environment Programme |
| **WASH** | Water, Sanitation and Hygiene |

# Glossary

The terms listed in this glossary are defined according to their use in this report. They may have different meanings in other contexts.

**Aid Agency waste** — Waste generated by aid agency staff and their activities. This may include packaging materials and other materials related to the emergency response; tyres, batteries and used oil from vehicles; domestic waste, which may include beer bottles and cans and other items that are in contrast to the local context.

**Composting** — The biological decomposition of organic waste in the presence of air.

**Domestic waste** — Solid waste originating in a dwelling. This may include bottles, cans, clothing, compost, disposables, food packaging, food scraps, paper, cardboard, wood, or similar materials.

**Incineration** — Waste treatment process that involves the controlled burning of waste at high temperatures.

**Informal Recycling (waste picking, scavenging)** — The extraction of recyclable and reusable material from the waste stream by people devoid of any official institutional directive and motivated by financial incentives.

**Leachate (landfill)** — The liquid that passes through a landfill as waste decomposes. It varies widely in composition depending on the age of the landfill and the type of waste that it contains.

**Primary collection (of waste)** — The gathering and loading up of waste from storage containers located close to dwellings that generate the waste and the transport to the transfer point (secondary collection point – communal storage area).

**(Formal) Recycling** — The activity or process of extracting and reusing useful materials or substances found in waste.

**Sanitary landfill** — Isolated site where waste is disposed of by being buried either underground or in large piles.

**Secondary collection (of waste)** — The collection of waste placed at communal areas after primary collection has taken place. This includes the transfer to secondary collection vehicles and the subsequent transport of the waste to the disposal site.

**Sludge** — Thick, soft, wet mud or a similar viscous mixture of liquid and solid components, especially the product of an industrial or refining process.

**Slurry** — A thin mixture of a liquid, usually water, and any of several finely divided substances, such as cement, plaster, or clay particles.

**Solid waste** — Non-liquid waste generated by human activity and a range of solid waste material resulting from disasters. This includes general domestic waste, emergency waste such as plastic water bottles and packaging from other emergency supplies, rubble resulting from the disaster, mud and slurry deposited by the natural disaster, fallen trees and rocks obstructing transport and communications, specialist wastes, such as medical waste from hospitals, and toxic waste from industry.

**Sphere Project** — Launched in 1997, the aim of the Sphere Project is to develop a set of minimum standards in core areas of humanitarian assistance, improve the quality of assistance provided to people affected by disasters, and enhance the accountability of the humanitarian system in disaster response.

**Sullage/ Greywater** — Wastewater from sinks, showers, baths, and laundry washing; does not include foul sewage flows or excreta from toilets.

**Vector-based disease** — Infection transmitted by the bite of infected arthropod species, such as mosquitoes, ticks, triatomine bugs, sandflies, and blackflies.

# Executive Summary

Solid waste is a very visible issue in an emergency, but it is often a neglected area of environmental sanitation. It is a diffuse problem that can impact adversely on health, sanitation, drainage and the wider environment. Solid waste also affects public space, reducing the sense of ownership of the problem, both to the general population and to the aid agencies providing relief. Each agency produces waste, from its activities (especially bringing in supplies from elsewhere), their general operations (using and maintaining vehicles) and from their staff (whose living conditions may be in contrast to those of the local population).

The solutions for solid waste management (SWM) are technically simple but managerially complex (UNEP/OCHA, 2011). Very little innovation is taking place in the area, although reporting failures is common. Current SWM initiatives focus mainly on restoration of public services rather than addressing the solid waste issue in earlier stages of the response.

Plastic bottles are often seen as being a major problem, blocking drainage channels and littering the landscape. However, the continued demand for bottled water stems from the perception that local water supplies are not safe; therefore, identifying and addressing the source of solid waste is not always straightforward. Often proposed solutions, such as formal recycling, are only an economically viable option in specific circumstances. A technical fix will likely only mitigate the worst aspects of the issue rather than create sustainable solutions.

A theme running through the analysis of this problem was ownership; ownership of the waste by agencies, by waste pickers, and by the public. Changing the way waste is viewed and what perspective it is viewed from introduces some novel ways to rethink the issues. Three contrasting areas have been identified as being worth exploring based on better processes, better communication, and better technology.

**Better Processes:** One of the challenges is that of rethinking agency waste (i.e. waste generated by staff and their activities). Managing this waste is both a challenge of morality and image. Improving sorting and reuse of waste safely with local people may prove to be a preferable alternative to expensive shipping or wasteful burial.

**Better Communication:** A second challenge is that of changing perceptions and behaviour around the ownership of public space and waste. A key challenge in this area is the development of programmes and promotional activities to encourage a healthy environment. In particular, promotional materials and messages need to be developed and tested to help create a sense of ownership of public spaces.

**Better Technology:** Finally, the technology for SWM is not complex — bins, carts and excavators or spades represent the main physical resources. However, managerial and logistical issues often make the provision of these resources in sufficient numbers challenging. Solutions such as shredding or compaction to reduce waste volumes can be a way of making waste cheaper to transport and dispose of, but they make any subsequent reuse challenging. Alternatively, reducing packaging waste or creating dual purpose packaging could address the problem of large quantities of waste paper, plastic and wooden crates being generated by humanitarian response efforts.

# Part 1: The Challenge of Solid Waste Management in Emergencies

## 1.1 Introduction and Current Practices

Poor solid waste management has multiple negative consequences on communities. It can adversely affect health and the wider environment, as well as impact on well-being beyond the spread of disease. During an emergency the disposal of solid waste or rubbish can become a critical issue as existing disposal and collection methods are likely to cease, or be heavily disrupted. On new sites such as refugee camps, there will be no waste management system in place, requiring immediate plans for disposal to be made.

Crisis situations often cause extra waste, such as flood debris or rubble from destroyed buildings. This must be dealt with quickly, as the sight of waste is a demoralising reminder of the event for the affected population, and may discourage efforts to improve other aspects of environmental health (Wisner & Adams, 2003). Humanitarian responses also generate waste from packaging of emergency supplies, as well as from the activities of aid organisations that generate medical waste. This is a significant issue throughout an intervention, from first response, to the decommissioning of sites.

**THE SPHERE PROJECT STANDARD**
**related to solid waste disposal in emergencies**

**Solid waste management standard 1: Collection and disposal**

The affected population has an environment not littered by solid waste, including medical waste, and has the means to dispose of their domestic waste conveniently and effectively.

**Key actions:**

- Involve the affected population in the design and implementation of the solid wastedisposal programme;
- Organise periodic solid waste clean-up campaigns;
- Consider the potential for small-scale business opportunities or supplementary income from waste recycling;
- In conjunction with the affected population, organise a system to ensure hat household waste is put in containers for regular collection to be burned or buried in specified refuse pits and that clinical and other hazardous wastes are kept separate throughout the disposal chain;
- Remove refuse from the settlement before it becomes a health risk or a nuisance;
- Provide additional waste storage and collection facilities for host families, reflecting the additional waste accumulation in disaster situations;
- Provide clearly marked and appropriately fenced refuse pits, bins or specified area pits at public places, such as markets and fish processing and slaughtering areas;

- Ensure there is a regular refuse collection system in place;
- Undertake final disposal of solid waste in such a manner and place as to avoid creating health and environmental problems for the host and affected populations;
- Provide personnel who deal with the collection and disposal of solid waste material and those involved in material collection for recycling with appropriate protective clothing and immunisation against tetanus and hepatitis B;
- In the event that the appropriate and dignified disposal of dead bodies is a priority need, coordinate with responsible agencies and authorities dealing with it;

**Key indicators:**

- All households have access to refuse containers which are emptied twice a week at minimum and are no more than 100 metres from a communal refuse pit.
- All waste generated by populations living in settlements is removed from the immediate living environment on a daily basis, and from the settlement environment a minimum of twice a week.
- At least one 100-litre refuse container is available per 10 households, where domestic refuse is not buried on-site.
- There is timely and controlled safe disposal of solid waste with a consequent minimum risk of solid waste pollution to the environment.
- All medical waste (including dangerous waste such as glasses, needles, dressings and drugs) is isolated and disposed of separately in a correctly designed, constructed and operated pit or incinerator with a deep ash pit, within the boundaries of each health facility.

(Sphere, 2011:117-118)

## 1.2 SWM Emergency Responses

In emergencies, there are various stages of response. SWM responses vary according to the emergency phase and context, with urban disasters requiring different management than displaced people settling in a rural area.

***The first priority after an environmental disaster is often the clearance of post-disaster debris to reduce health risks, open transport routes and lessen the psychological impact of the disaster.***

During the first days of an emergency response, the most urgent tasks with respect to solid waste management are the clearing of any toxic materials and the removal of rubble blocking thoroughfares or drainage channels. This is done to enable safe access as debris removal will normally require the use of heavy construction vehicles. In tandem with this, the removal of scattered waste, and the introduction of an on-site disposal system, however basic, should follow (Rouse, 2006). Removal of dead bodies is a high priority as their presence is psychologically distressing to the affected population.

As part of the clean-up operation after a disaster such as an earthquake, building rubble should be cleared as quickly as possible; this needs to happen as soon as it has been determined that there are no survivors trapped in the rubble (people can remain alive for up to seven days). Demolition of dangerous buildings may then be necessary to stop them from collapsing. Such decisions, however, may be complex as there are structural risks and dangers, costs, and other such factors to be taken into consideration.

In highly developed urban areas it has been calculated that an average of 1.5 tonnes of building waste may be generated per square metre constructed, in the case of a disaster. In residential areas this amount ranges from 0.5 to 1.0 tonne per square metre constructed, depending on the materials used in each locality (Wisner & Adams, 2003). Initial assessments of the affected areas and estimated tonnes of material to be cleared are crucial elements for demolition activities and waste management. These assessments should be rapid and general, as detailed research is usually time consuming and a prompt response is required. In the short term debris is most likely moved to the side of roads, but as soon as possible this should be removed out of the affected area.

The various components of removed rubble should be separated for recycling. Metals, mainly iron and steel, can be smelted for reuse. Concrete can be crushed for road-building and land reclamation, while wood can be used as fuel. It is likely that the local population will recover useful materials for themselves, however this activity may need monitoring to reduce the risks of accidents and avoid legal problems such as theft of valuable property (Wisner & Adams, 2003).

In other disaster scenarios, ash from volcanoes and slurry from floods can collect inside buildings and outdoors. It is recommended that this waste is removed manually from inside dwellings and mechanically from public roads, and then disposed of with other rubble. Families should be assisted in removing waste from their homes by situating trucks or skips at a convenient distance. These can then be transported out of the area and dumped. New ash falls may need to be cleared every day (Wisner & Adams, 2003).

***After the acute phase, SWM increases coverage of facilities, frequency of collection, and improvement of final disposal in a gradual manner.***

After the acute phase, SWM follows a continuum of increasing service level. Whereas water or sanitation may use different technologies at different phases, SWM increases coverage of facilities, frequency of collection, and improvement of final disposal in a gradual manner. The goal is to establish a SWM system similar to those recommended for use in stable urban contexts. For this reason, much of the language in this report refers to “householders” rather than “refugees” or “IDPs” to emphasize the municipal nature of the response.

## 1.3 Perspectives on SWM

The challenge of effective solid waste management can be approached from different perspectives:

- **Public health:** Poor SWM can expose both waste workers and citizens to great health risks and accidents.
- **Environmental:** Poor SWM can have a negative impact on the environment contributing to air pollution, landfill leachate (i.e. the liquid that seeps from waste as it is decomposing) and land degradation.
- **Living conditions:** Poorly managed waste can create an ugly and unpleasant environment, attracting flies, which can cause a nuisance.
- **Financial:** SWM often requires a large proportion of the municipal budget (30-40% in a typical low-income country), so effective management can improve value for money.
- **Political:** SWM issues often attract great public interest and can provoke strong reactions from voters. Improvements to SWM, or promises of improvements, may be used to attract votes.
- **Poverty:** The presence and need to dispose of solid waste generates a key source of income for sweepers and waste pickers. A change in solid waste systems can have a major impact, positive or negative, on their livelihoods.
- **Relationship with other services and infrastructure:** Poor solid waste disposal may pollute water sources, increase the load on hospitals or health services, and cause blockages in sewerage systems and stormwater drains.

**Figure 1.**
Solid waste can be dumped in drainage ditches causing blockages.
(Source: Victoria Hammond)

## 1.4 Health Risks

Poor SWM can pose serious risks to the health and safety of both the local population and people who work with waste. These risks include:

- **Injuries and infection from direct contact with solid wastes:** While all sharp items and chemicals may pose risks, there are particular concerns about contact with hazardous industrial wastes and pathogenic wastes from hospitals and clinics.
- **Accidents and injuries:** Waste collection and recycling workers face risks from traffic accidents and lifting injuries.
- **Building rubble:** This can be a physical danger because of partly collapsed buildings and unsafe surfaces.
- **Contaminated air:** Irritants and pathogens can be inhaled directly from fine-grained refuse material at open collection points and during waste transfer. Also, burning waste generates a large amount of smoke which can cause respiratory problems.
- **Fire and explosion:** Methane is generated as waste decomposes. This gas may support long-lasting fires in landfills, or seep into basements of surrounding buildings and reach potentially explosive levels. Piles of uncontained rubbish are a fire hazard.
- **Spread of disease by vectors:** Heaps of discarded waste provide a breeding ground for flies and rats. These vectors can transmit disease and pathogenic micro-organisms from solid waste and excreta to the household. Concerns about the spread of pathogens are especially relevant in low-income countries where faecal matter is often present in solid waste. Water in tyres, old tin cans, or other containers encourages the breeding of mosquitoes, which also transmit diseases such as dengue, yellow fever, and malaria.
- **Spread of disease by other animals:** Foraging animals are likely to eat waste which may contain pathogens that are passed on when their meat is eaten.
- **Diseases:** Diseases that can spread through poor SWM include dysentery, viral and bacterial diarrhoea, gastro-enteritis, typhoid, trachoma, plague, typhus, salmonella, leptospirosis, filariasis, malaria, tapeworm, and trichinosis.
- **Scavenging:** Poor people, especially in times of famine or food scarcity, may also be attracted to waste to hunt for food, leading to an increased risk of gastro-enteritis, dysentery and other diseases.
- **Groundwater contamination:** Groundwater can become contaminated by polluted water (i.e. leachate) from unsatisfactory disposal sites.

## 1.5 Institutional Arrangements

Solid waste management is part of "environmental sanitation", which includes excreta disposal, surface water management, water pollution, and air pollution. "Sanitation" is mainly about excreta disposal. In stable situations, water supply and sanitation are often managed separately from the rest of environmental management, which is a municipal authority responsibility. In an emergency, all environmental sanitation falls under the responsibility of the WASH cluster, although there are overlaps with shelter and settlement. SWM stakeholders include the householder, other waste producers, the municipal authorities (if they operate) and a variety of formal and informal collectors, handlers and recyclers.

# Part 2: Current Approaches to Solid Waste Management

## 2.1 Solid Waste Management Systems

The objectives of SWM systems are: satisfactory storage, collection and disposal of solid wastes, as well as cleaning of streets and other public places. Apart from very rural areas, it is rarely possible to dispose of solid wastes within the boundaries of a residential development. Waste must be collected and transported away from the site, usually to a municipal disposal site on the fringes of the town or city.

SWM differs from other components of physical infrastructure in that it depends upon an efficient operational system being established from the very outset. Other services, such as roads or drainage, can operate adequately for a considerable period of time after construction with practically no input on the maintenance side until something actually goes wrong. While design and construction are important in effective SWM, operation is key and includes the appropriate selection of equipment.

*The technology for SWM is simple. The management is not.*

Within an emergency, SWM seems to have a low priority as it does not appear to have direct implications for health or other aspects. Medical waste does cause problems, so there is detailed advice on this and it is managed by the medical sector. Major debris blocks transport routes, so there are strong drivers to address this. General waste, although under the WASH sector, does not always seem a priority. The physical action of providing bins initially can draw the focus away from the operational aspects of managing the waste management chain. It can be neglected until local government services are restored. The technology for SWM is simple, the management is not.

## 2.2 Components of SWM Systems

SWM involves a number of interrelated operations that form a chain. These are:

- Storage of waste in household or communal containers;
- Waste collection from the storage containers (varies by methods and frequency);
- Transfer of waste from smaller containers to larger ones;
- Haulage of waste to a disposal site;
- Processing of any waste that can be recycled;
- Management of the disposal site.

*In urban areas, the rehabilitation of existing waste collection systems should be the first post-emergency SWM objective.*

Existing urban areas will probably have had a collection system prior to the emergency and the first objective should be to support its rehabilitation. It may be necessary to repair or replace the hardware for the collection system such as the collection bins, refuse trucks, or disposal vehicles. More importantly however will be the institutional and personnel support necessary. Providing funds to pay staff wages and the re-establishment of the management systems are likely to have the quickest effect on collection.

Within this overall management chain, there will be variations dependent on the institutional, social, technical, environmental, economic, and physical context.

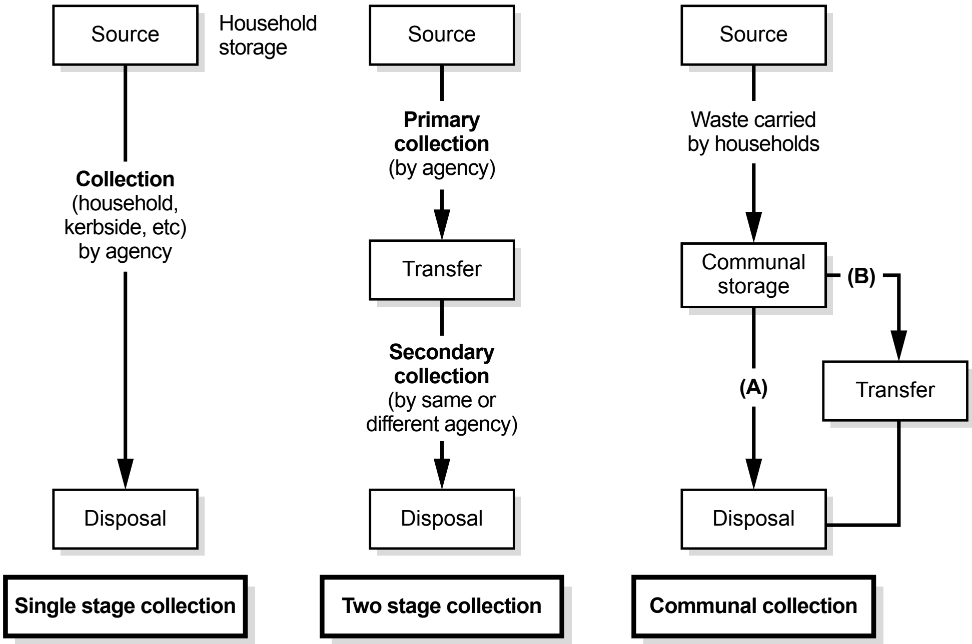



**Figure 2.**
Variations of the Solid Waste Management chain. (Scource: WEDC, Loughborough University)

There are a number of different waste collection methods that may be employed in SWM (see Figure 2):

- **Single-stage collection:** House-to-house collection, with waste loaded into a vehicle for haulage directly to the waste disposal site.
- **Two-stage collection:** House-to-house collection (i.e. primary collection) but with the waste being transferred from a smaller to a larger vehicle for more economic haulage to the disposal site. The need for two-stage collection with transfer is determined by comparing the unit costs (cost per tonne) of single- and two-stage collection with waste transfer.
  A two-stage collection system is likely if access to bin areas is difficult for large trucks or lorries. The primary collection may be done by small vehicles, either human powered, such as handcarts, tricycles or wheelbarrows, or animal powered, such as donkey carts. The operators of these should be provided with suitable protective clothing and tools to remove the waste and collect additional scattered refuse.
- **Communal collection:** Where there is no house-to-house collection service, it becomes the householder's responsibility to bring their waste to local communal collection points. These are usually emptied by the municipality and transported either directly to the disposal site, or via a transfer station. This can involve triple handling of the waste.

In an emergency situation, the communal option is the most likely to be used. Part of the management plan will be the calculation of how often the bins need emptying, and whether the waste needs to be removed daily, on alternate days, or weekly. Daily refuse collection is ideal, particularly from food preparation areas. However, if this is not possible, collection at least once a week is essential to minimise insect breeding, as for example, flies produce a new generation approximately every eight days in warm conditions (Wisner & Adams, 2003).

### 2.2.1 Solid Waste Characteristics

The characteristics of waste are the most important technical factor in the planning, design and successful operation of a municipal solid waste management system. These are particularly important in the selection of appropriate vehicles for collection and transport. Waste can be characterised by the volume in litres per person per day (Lpd), the mass generated in kilograms per person per day (kpd), its density in kilograms per cubic metre (kg/m$^3$), and an analysis of the different materials contained within.

***The composition of solid wastes varies widely and depends on factors such as income levels, location, and environmental conditions.***

***The amount of waste collected is usually less than the amount generated because of informal systems of waste resale and recovery.***

The amount of waste collected by the municipal system is regularly notably less than the waste generated at source (households, commerce, and industry) because of the informal systems of waste resale and recovery that operate in many cities. It is important to note that direct comparisons between different cities and countries is difficult due to challenges in obtaining information about waste generation and disposal.

The volume generated, which is important in planning the local storage and collection on the site, can be anywhere between 0.4 and 10 Lpd and the composition varies from being largely inert, to containing a high proportion of vegetable matter which rapidly decomposes in hot and humid conditions.

Generally solid waste generation rates in low-income communities are low; however, waste density is high because of a greater percentage of organic matter, mud, ash and soil. In low-income communities much material is salvaged either for sale or reuse; the same material would be thrown away by richer people. As income levels rise, the mass of waste produced increases and its density decreases, leading to marked increases in volume. Where possible, the waste generation rate should be ascertained from the municipality. In the absence of any data, it is reasonable to assume a volumetric generation rate of 1 Lpd for low income areas.

***In an emergency situation domestic waste may be limited, but Aid Agency waste can be significant.***

In an emergency situation, resources are in short supply, so very little is wasted. “Domestic” waste may be limited to food peelings and packaging. Even if waste is not wanted by one household, it may get reused locally. This informal recycling can be called “waste-picking” or “scavenging”. While it may be hazardous to the people doing it, it can provide resources and an income, so should not be viewed negatively.

In an emergency situation domestic waste will be limited, but waste from Aid Agencies can be significant in terms of location, visibility, and type of materials.

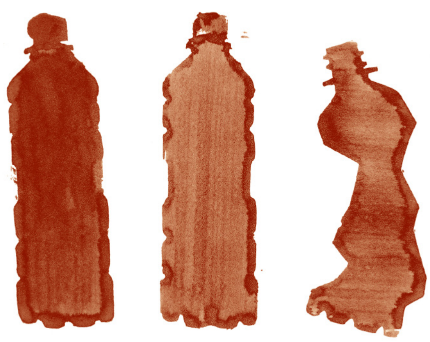
### 2.2.2 Sources of Solid Waste

Solid waste can be divided into different types depending both on where it is generated and on the nature of waste itself. However, different classification systems can and should be developed that are more relevant to the specific purpose for which they will be used.

A classification system may include these broad categories, based on the source of the waste:

- **Domestic/household waste:** Includes waste from food preparation, packaging, cleaning, fuel burning, old clothing, furnishings, appliances, and reading matter. May include human excreta where disposable nappies and bucket latrines are used, where people dispose of anal cleansing materials separately, or where latrines are not available.
- **Commercial waste:** From markets, shops, stores, offices, hotels, restaurants etc. This typically consists largely of packaging materials, used office supplies, and food wastes.
- **Institutional waste:** From schools, hospitals, government offices etc. Generally contains more paper than food.
- **Industrial waste:** Includes packaging materials, food wastes, metal, plastic and textiles, fuel burning residuals (e.g. ash) and used processing chemicals. May include hazardous chemicals. If industrial wastewaters are treated to reduce water pollution, the hazardous substances are concentrated in sludges which are sometimes also classed as solid waste.
- **Agricultural waste:** This may be included in industrial waste or be a separate category.
- **Abattoir waste:** This is mainly organic but often very socially objectionable and attracts vermin.
- **Street sweepings:** Includes dirt and litter, animal excreta, dead animals and spilled loads. May also include all other types of waste such as household and commercial wastes that are dumped in the street. Where sanitation services are inadequate street sweepings may also include human excreta.
- **Construction and demolition waste:** Mostly soil and masonry, but may also include residues of paints and other chemicals, wood, metal, plastic, and other materials.

Some sources are specific to some emergencies, such as food distribution points and feeding centres in famines, packaging from emergency supplies, and unused or unclaimed unsolicited material donations. Debris from earthquakes, explosions, windstorms and floods are short-term, but significant sources.



*The source of waste can be a relevant classifier, but its nature and content are often more important.*

Nevertheless, the source is very rarely the important issue when classifying waste, rather it is the nature and content of the waste that is significant, especially if they are hazardous. As the nature of waste is normally linked to the source this is often an easy way to define and classify wastes.

- **Construction waste** (e.g. concrete, rubble, roofing);
- **Organic waste** (e.g. food, carcases);
- **Combustibles** (dry waste that burns well, such as wood, packaging, paper);
- **Non-combustibles** (e.g. metal, tins, bottles, stones);
- **Bulky waste** (e.g. trees, branches, tyres);
- **Ashes/dust** (from cooking fires);
- **Hazardous waste** — such as:
  - Chemical waste: including oil, battery acid.
  - Sanitation waste: may be included in the household waste. It consists of human excreta and sludge from latrines and septic tanks.
  - Medical or clinical waste: may include pathological waste (blood and body parts), sharp objects, needles, chemical, and pharmaceutical waste.
  - Radioactive waste: very occasionally some industrial or clinical wastes may be radioactive and these need special handling, treatment, and disposal.

## 2.3 Storage of Solid Waste

Typically waste is initially stored within the household, but may at some stage be transferred to a communal storage container prior to eventual collection and removal.

**Figure 3.**
Informal pile of sorted plastic waste waiting for recycling. (Source: Brian Reed, WEDC, Loughborough University)

### 2.3.1 Levels of Storage

#### Household storage

Ideally, household waste should be stored in a sturdy container of sufficient capacity which is easy to empty and clean, not too light to be blown away, and has a well-fitting lid. Galvanised steel and plastic bins can satisfy these criteria, however, these are not affordable to some households in low-income communities. Householders typically use small containers for which no other use can be found, or accumulate a small pile of waste outside the house (Figure 3). This is eventually carried to a communal container in a basket. Better quality waste containers, suitable for house-to-house, roadside, or street corner collection, may only be appropriate when the level of collection service is highly efficient.

#### Communal storage

The use of communal storage containers or enclosures to which householders carry their waste is widespread and seems likely to remain a common option for low-income communities. A frequent problem is the provision of too few containers of insufficient capacity and that are inappropriately located. Communal storage containers are usually open, giving access to rats, flies, and animals, which is undesirable for both hygienic and aesthetic reasons.

*The UN recommend providing approximately 100 litres of storage for every 10 families.*

It is unlikely that many householders will want a communal container outside their house, therefore decisions on the location of the containers must be done in conjunction with residents. In some cases householders are prepared to walk longer distances to a larger communal storage point. The UN recommend providing approximately 100 litres of storage for every 10 families (UNHCR, 2007).

### 2.3.2 Types of Storage

Vertical walls constructed from concrete, masonry, or timber enclosing an area where waste is dumped on the ground are commonly used for communal storage. The walls have a gap in them to allow people to enter to leave waste and for emptying (Figure 4). The capacity of enclosures is typically in the range 1 to 10 $m^3$. Problems with this type of storage include:

- The full capacity of the larger enclosures is rarely used because people throw their waste just inside the entrance forming small heaps which overflow on to the street;
- Removing wastes from the enclosure is unpleasant and unhygienic;
- Scavenging animals and flies have unlimited access;
- They are not covered so rain can enter;
- Large enclosures may be used for defecation and urination.

Fixed storage bins differ from enclosures in having no direct entrance; the walls are normally less than 1.5 metres high so that waste can be dropped directly inside (Figure 5). There should be an access opening (normally closed by a flap) in one of the walls to enable wastes to be raked out.

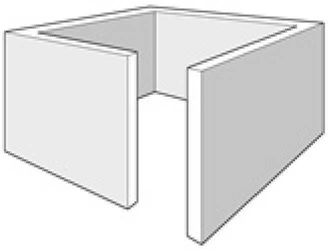


**Figure 4.**
Enclosures are open areas for storing waste. (Source: WEDC, Loughborough University)

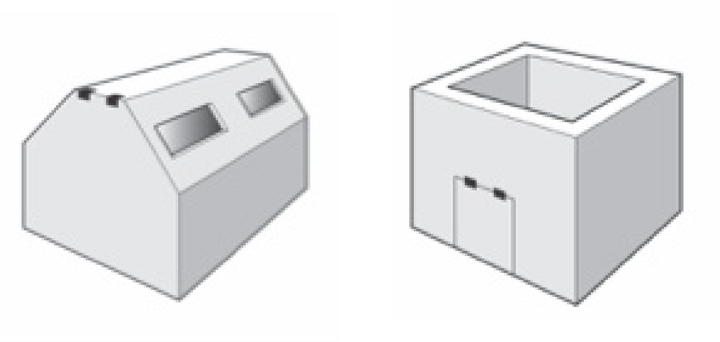


**Figure 5.**
Communal fixed bins have larger capacities than household bins and may be open or closed. (Source: WEDC, Loughborough University)

Concrete pipe sections or 200-litre oil drums placed upright along the roadside are sometimes used as communal waste containers (Figure 6). Their capacity is small, they are difficult to empty and waste tends to be spread around. Larger drums are difficult to lift when full.

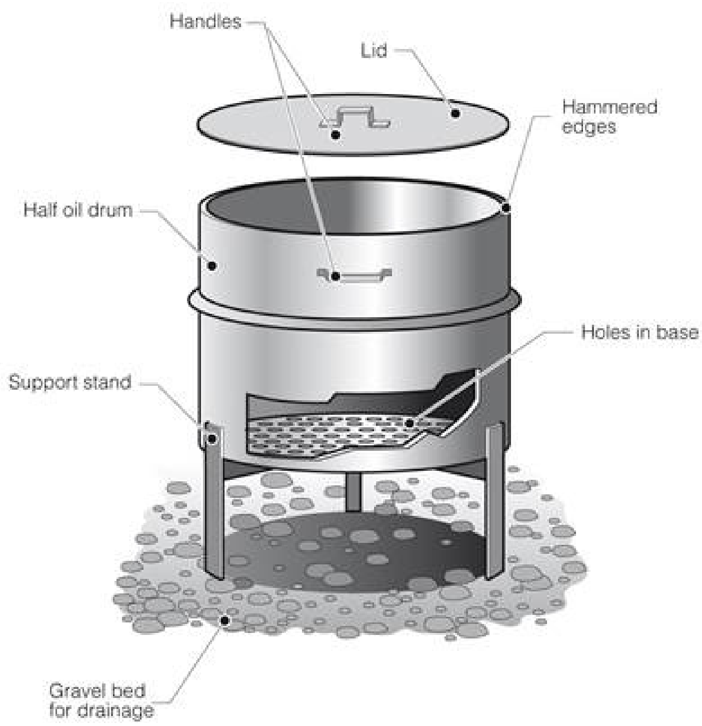



**Figure 6.**
A communal bin made from an old oil drum. (Source: WEDC, Loughborough University)

Small portable steel or plastic bins with fitting lids provide hygienic storage if the collection frequency is high. However, they can be expensive and are likely to be stolen if their resale value is significant. The use of portable containers or skips which when full can be hoisted onto a standard vehicle and replaced by an identical empty container is another option for communal storage. This method usually depends upon the local authority possessing the equipment, but in some cities the existence of private skip operators may offer an alternative solution for the community.

*Transport costs are the most expensive component of the solid waste management process in low- and lower-middle income countries.*

## 2.4 Collection Systems

Waste bins must be emptied frequently to prevent overflowing, developing odours, and becoming breeding sites for insects. Collection frequency varies depending on climate, quantity of waste generated, and composition of waste, but rarely exceeds one week. In hot climates where there is a lot of organic waste, collection may have to be carried out every day. Transport costs are the most expensive component of the solid waste management process in low- and lower-middle income countries. This is due to the cost of purchasing vehicles, operating, and maintaining them.

An important feature of storage and collection systems for solid waste is the variable degree of participation required from individual householders. There are four basic options.

- **House collection:** Workers collect waste containers from within the boundaries of the plot; this involves minimum effort on the part of the householder;
- **Roadside collection:** The householder leaves waste storage containers by the side of the road at an appointed time; these are emptied by waste collectors;
- **Street corner collection:** Collection vehicles collect waste at predetermined places and householders carry their solid waste to the vehicles;
- **Collection from communal storage:** Householders are required to carry solid waste from their house to the communal storage container. This may entail walking considerable distances and thus requires the highest level of effort from householders.

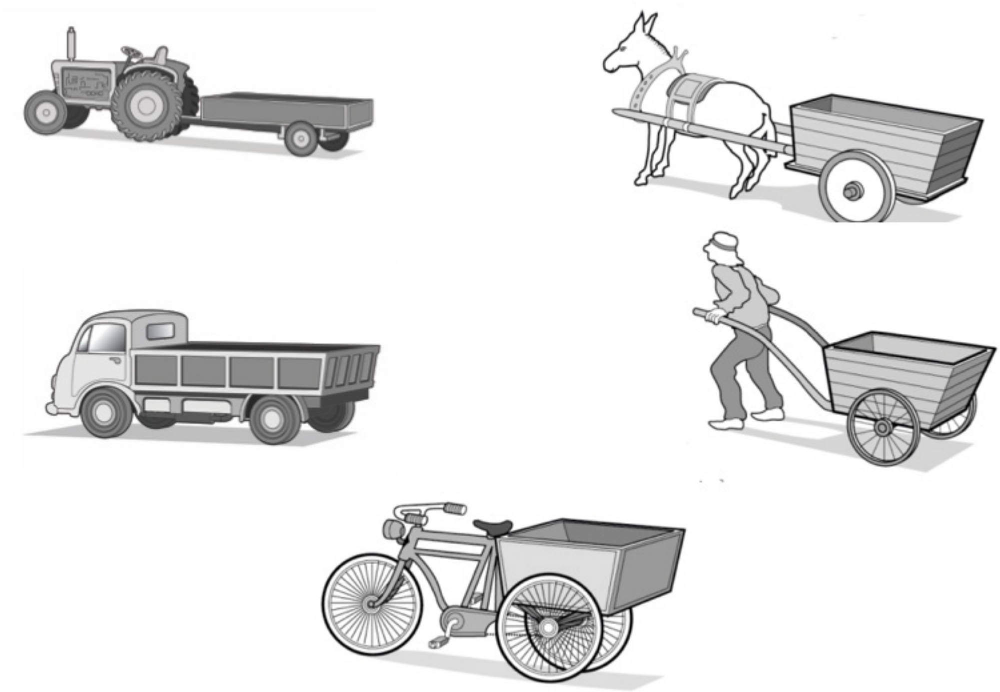


**Figure 7.**
Commercial refuse vehicles may not always be appropriate or necessary.
(Source: WEDC, Loughborough University)

## 2.5 Waste Disposal Options

Safe and controlled final disposal of solid waste is important for the protection of both public health and the city environment. Indiscriminate dumping of waste creates a number of serious problems, namely:

- **Health hazards for residents and waste workers:** This may be through actual contact with waste; inhalation of smoke from waste burning, or dust from the waste; diseases carried by animals and insects that feed and breed in the waste;
- **Environmental pollution:** From burning of waste, or from leachate.
- **Blockage of open drains and sewers:** Can create serious secondary problems relating to public health and environmental pollution.

The local institutional context of SWM is of major importance. The appraisal of options for waste disposal has to consider the capacity of urban local government to finance and manage operations.

There are a number of high-technology waste disposal options, yet their feasibility still needs to be proven in the context of developing countries. Some of these options include incineration, gasification, pyrolysis, and refuse-derived fuel:

- **Gasification** is a process that converts waste into carbon monoxide, hydrogen, and carbon dioxide by exposing the waste material to temperatures above 700°C, without combustion, with a controlled amount of oxygen and/or steam. The resulting gas mixture is called syngas (from synthesis gas or synthetic gas) and is itself a fuel.
- **Pyrolysis** is a form of treatment that chemically decomposes organic materials by heat in the absence of oxygen.
- **Refuse-derived fuel** is produced from combustible components of solid waste. The waste is shredded, dried and baled, and then burned to produce electricity, thereby making good use of waste that otherwise might have ended up in landfill.

Of the available options for disposal of solid waste, sanitary landfill is by far the most common. Sanitary landfill is usually the cheapest method of refuse disposal and is comparatively simple to operate.

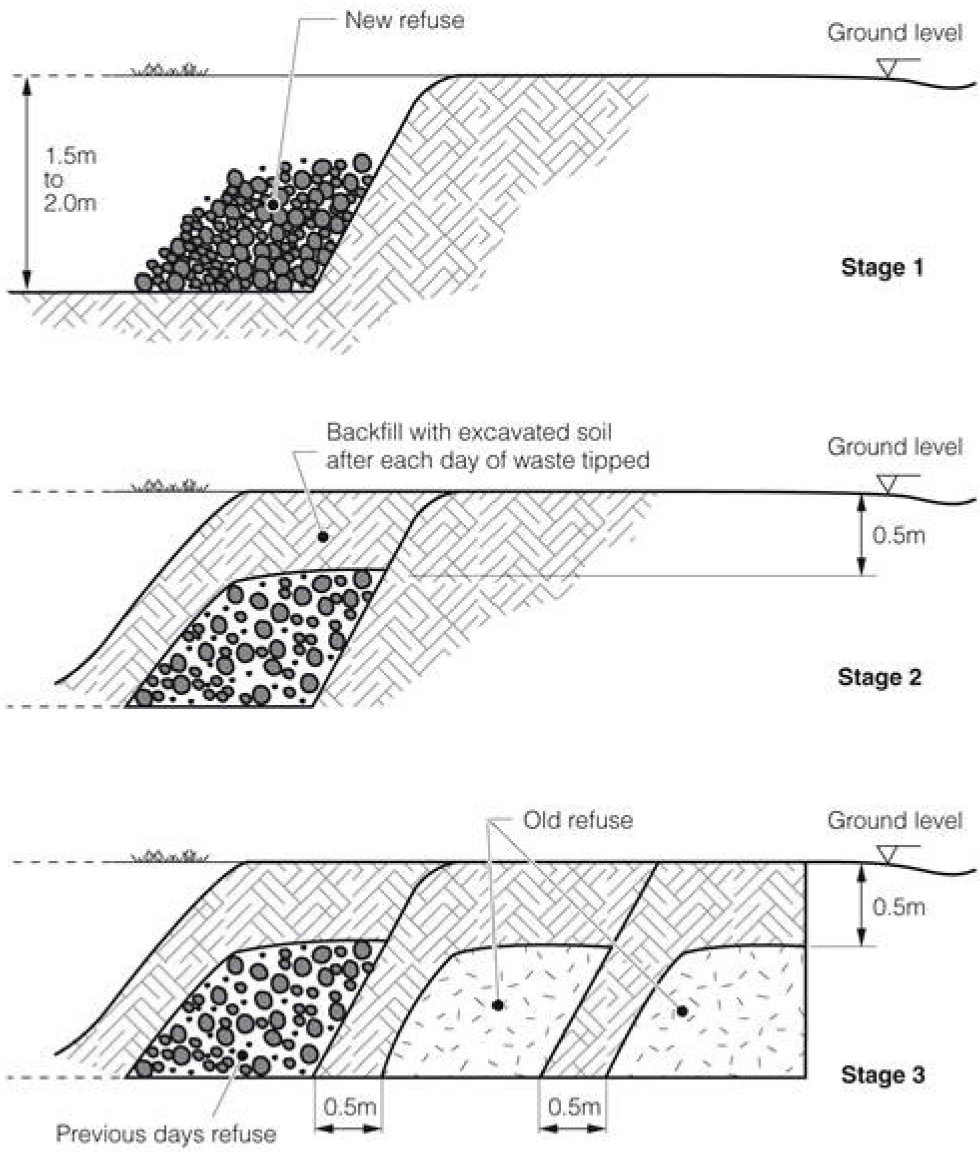
*Sanitary landfill is the cheapest and most common method of final disposal of solid waste.*

### 2.5.1 Sanitary Landfill

In an emergency, the most common method of final disposal is landfill. Despite its simplicity it is rarely done properly. Wastes are commonly just dumped on the ground in a convenient place and allowed to decompose. This is not recommended as it is a health and environmental hazard. Other widespread methods of disposal include incineration and composting, but they are rarely appropriate in a post emergency situation unless facilities already exist.

Sanitary landfill is the controlled deposition of solid waste so that dangers to public health and the environment are avoided. Large excavations remaining after extracting natural resources are often used as landfill sites. Where these do not exist, solid waste has to be heaped above ground. As these sites are often large, decisions on location must be made carefully and in consultation with the local authorities. On a case-by-case basis, it may be possible to continue to use or extend a former site.

**Figure 8.**
The step-by-step process of simple landfilling. (Source: WEDC, Loughborough University)




***Sanitary landfilling can pose health and environmental risks if done incorrectly.***

In landfill sites rainfall can come into contact with contaminants in waste. These dissolve and are then carried into the surrounding ground (i.e. as leachates), potentially polluting groundwater and making it unsafe to drink. This is most likely to be a risk in a climate with high rainfall and where the water table is relatively shallow. Steps to reduce the impact of leachates include digging drainage ditches around a landfill site, or installing an impermeable membrane at the base of the landfill. If leachates are considered to be a potential problem, it is also advisable to minimise the liquid content of waste as much as possible. This can be done by keeping the refuse dry during collection, and by regularly covering the waste in the landfill with an impermeable layer.

Odours, vermin, nuisance from birds and insects, and wind-blown litter can all be problems on a landfill site. These problems are difficult to eradicate even on a well-managed site. The main way of minimising these challenges is to locate the site as far as possible from homes. The site should be accessible, but at least 1km downwind of the affected population, or any other settlements. For safety, the landfill site should be fenced.

A landfill site is essentially a large hole in the ground, where waste can be tipped, and ideally covered or backfilled with excavated soil. Earthmoving equipment, if available, can be used to modify the site and to manage the landfill operation. Otherwise, this can be done manually.

***It has been estimated that a landfill site of 0.4–0.5 hectares (4000–5000 $m^2$) can serve 10,000 inhabitants for a year (Wisner & Adams, 2003).***

Waste is deposited in strips, levelled, and ideally compacted in layers of up to 2 m depth. The width of the strips will depend upon the number of vehicles required to unload waste at the same time, but will typically be in the range of 6–30 m. The surface of each layer of waste deposited is covered on the same day with soil (or other suitable inert material) to a depth of 0.15–0.25 m. This reduces odours and flies and helps contain heat generated by the decomposition of organic matter. This assists in the destruction of fly larvae and pathogens.

In an emergency or in very low income areas where access is difficult, waste may need to be disposed of nearer its source. In these cases family or communal pits may need to be provided or promoted. Although recommended for immediate phase disposal, the use of such pits, if properly managed, is very practical and can continue into the long term phase in low-density areas.

### 2.5.2 Family Pits

Provided there is sufficient space, a small pit for domestic use, dug up to 1 m deep, is suitable for household on-site disposal. Such a pit is very practical in areas where access is difficult, in remote rural areas where employing staff is a problem, or where there is no means of transportation for waste removal. This option does require the cooperation and agreement of the households concerned, as it is labour intensive and requires domestic management, as well as significant community mobilisation for construction, operation, and maintenance. It may be suitable as an initial step in a phased response before collection services can be established.

To prevent the build-up of odours and to protect from scavengers the contents of the pit should be periodically covered with a thin layer of soil or ash. A family pit should be a short walk away from the dwelling, the recommended distance being less than 50 m. It should be noted that these pits can be a health and safety hazard, especially for small children. The possibility of groundwater contamination should also be investigated. Where a risk exists it may be easier to find an alternative water source than change waste disposal practices.

### 2.5.3 Communal Pits

A communal pit that serves a large number of households may be preferable to family pits if there is no sufficient space at each dwelling. The size guideline is 6 $m^3$ per 200 people in the acute phase, which should decrease to the same size for 50 people in the longer term.

Easy access should be maintained, preferably within 100 m of the households served, and fencing is recommended to prevent accidents. If it is sited too far from dwellings the affected population may not regularly use it causing waste to be dumped elsewhere. The location of these pits should also consider environmental factors such as drainage, being on the edge of a residential area, and preferably downwind. A caretaker or attendant should oversee the use of the pit, although a permanent presence is usually not required. Regular layers of soil or ash placed over waste will help reduce the number of flies and deter scavengers. This option is quick to implement and needs minimal maintenance, so again, it may be suitable as a temporary step in a phased response before collection services can be established.

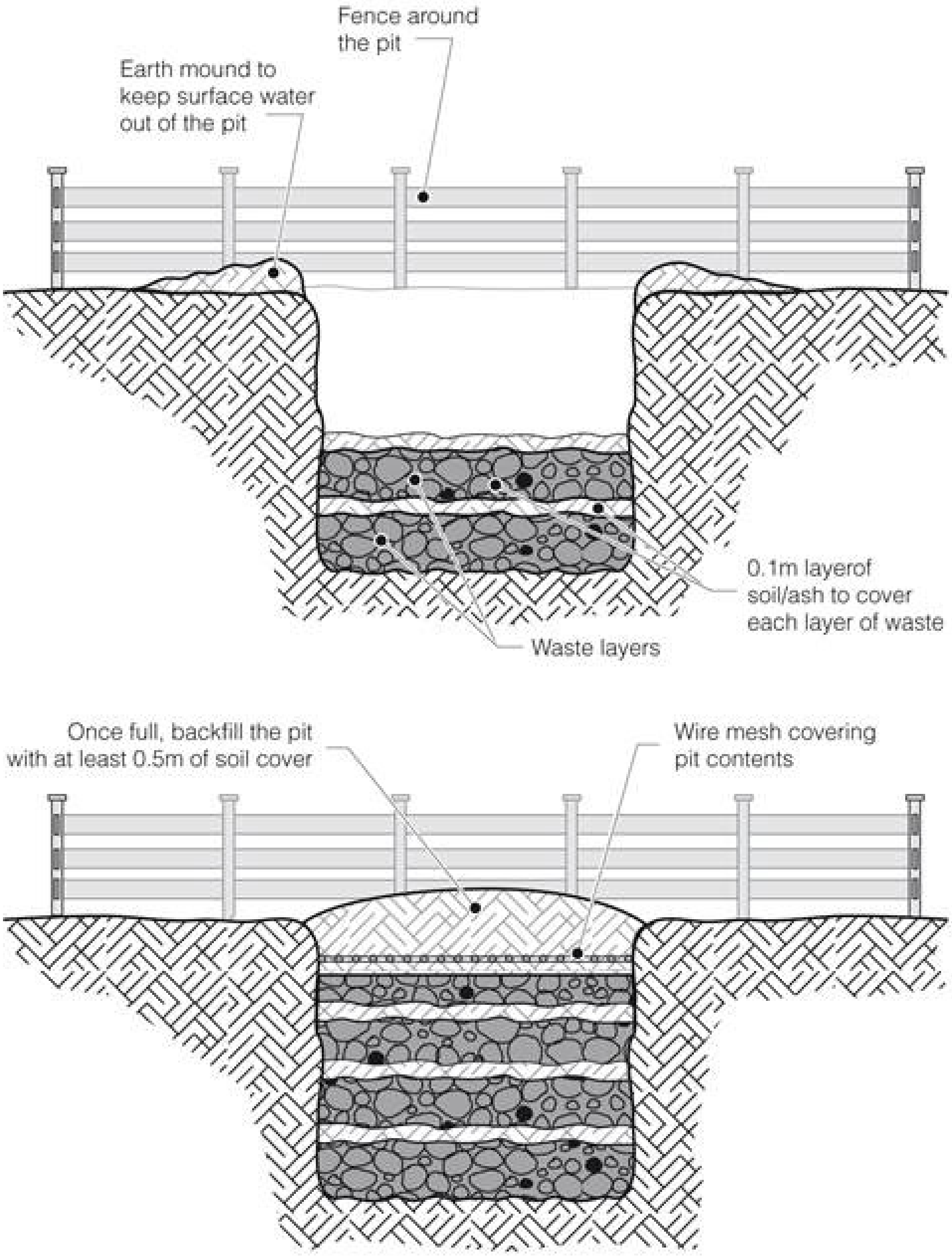



**Figure 9.**
Communal solid waste pit formation. (Source: WEDC, Loughborough University)

## 2.6 Composting

Composting is the biological decomposition of organic waste in the presence of air. Where appropriate, composting of organic waste is practicable on a domestic and even on an institutional scale, and should be encouraged, as it is environmentally friendly, and can considerably reduce the bulk of domestic waste. Vegetable and plant waste can be thrown into a pit, and will produce useful compost for gardens after a few months.

It may also be possible to co-compost refuse and sludge from emptying latrines and septic tanks. In this case, special attention is required to ensure that compost heaps attain and maintain adequate temperatures to kill pathogens. If there is any doubt about this, the compost should be stored for at least a year before use (Wisner & Adams, 2003).

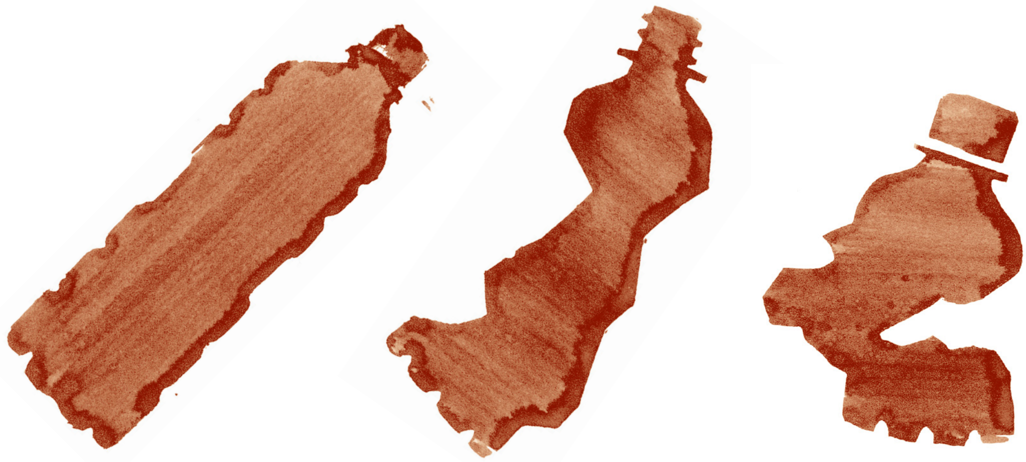
Composting on a large scale requires detailed monitoring to achieve the best conditions, and may not always be practical in an emergency situation. Organic waste has to be separated at source or at the disposal stage.

## 2.7 Recycling

***Formal recycling is an ideal practice to encourage, but unlikely to be used in emergency situations due to the high level of organisation and man-power needed.***

The recycling of refuse after collection and transport may be encouraged and facilitated where suitable conditions exist. Sorting paper, glass, metals, and plastics for recycling could be an income-generating activity where these materials are present in significant quantities in the refuse (Wisner & Adams, 2003). If recycling is taking place, it is important to ensure that people sorting the waste are protected from health hazards, such as exposure to harmful chemicals, or cuts from sharp objects.

Formal recycling of waste is an ideal practice to encourage as it is environmentally friendly and reduces the volume of landfill needed. However, because of the high level of organisation and manpower needed, recycling is unlikely to be practicable in the majority of emergency situations, except in the longer-term stages. Nevertheless, in an emergency situation, a certain amount of informal recycling will naturally occur, as there may be a shortage of items such as containers, bags, and other materials.



## 2.8 Current Challenges

### 2.8.1 Plastic Bottles

In discussions with interviewees, an obvious solid waste issue that came up was the disposal of plastic bottles and bags. However, going into more detail, a more complex issue emerges, as shown in the following case study.

**CASE STUDY — Plastic Bottles**

One very visible solid waste in some humanitarian responses is discarded plastic water bottles. This issue may also relate to packet water sachets, which are used in some countries. Although distribution of bottled water may be expensive, it is a rapid method of getting limited quantities of potable water to people.

**Water Bottles**

*"After emergencies like the Haiti earthquake, we often observe large numbers of in-kind donations of bottled water. Data provided by US Chamber of Commerce shows that the donation of drinking water by North American companies to Haiti during the first two months after the earthquake sums up to 6,948,000 bottles or 3,474,000 litres of water. The donations were mostly in half a litre plastic bottles.*

*On the other hand, according to the Water Sanitation and Hygiene Cluster, daily water production capacity in Port-au-Prince stands at 8 million litres. Although it is below 9 million litres of water per day required to meet the drinking water needs of the affected population, providing water from the city (local supply) seems to be much more sustainable than shipping bottled water. The main problem was not that water was lacking but rather a high risk of contamination. Thus, water sanitation can help much more than bottled water. We explore alternatives to external supply, such as bottled water and find that for the same expense one could have bought 46,320 filters locally that would serve the same number of families for five years instead of a couple of days.*

*Furthermore, if we assume that one empty and compressed 0.5 litre plastic bottle is approx. 80 $cm^3$, we would derive that all of the 6,948,000 bottles that were sent to Haiti resulted in 555.3 $m^3$ of waste. Finally, to stress the impact of the plastic bottles on the environment, the average time for a plastic bottle to biodegrade fully is more than 500 years."*

Humanitarian Research Group, (2011)

These single use bottles have to be disposed of. Household bins, community storage, and landfill sites all fill quickly due to the low density of waste. The volume of general waste collected is bulked up by these empty bottles, so bins require emptying more often, increasing transport costs. The convenient size of bottles means that people can carry the bottles with them and discard them when empty. If there are no public waste bins, the bottles litter the area.

Apart from the visual impact, these bottles can end up in drainage ditches, blocking drainage routes, and leading to flooding. Thummarukudy (2010) noticed emergency food packaging and plastic bottles blocking drains in Port-au-Prince, Haiti. The dumping in drainage ditches may be deliberate (in the absence of other options) or due to lightweight waste being blown away by wind, or washed by surface runoff to these low points where it then gets trapped. This makes the waste "public" rather than domestic.

***Water sanitation can help much more than bottled water.***

Bottles can also end up in latrine pits. People who use water for anal cleansing may carry water to the toilet and, once they have used the water, they throw the empty bottle down the pit. This reduces the useful life of latrines and makes emptying pits difficult.

**Disposal**

Assuming bottles can be collected and transported for disposal, the disposal itself can be problematic. Burning creates air pollution while composting is for organic waste not plastic. Landfill will fill rapidly with empty bottles although this will settle over time as the bottles gradually compress and degrade.

Recycling has been tried in some places. In one example in Sub-Saharan Africa, plastic bottles were shredded locally and compressed into bales for export to another country as facilities were not available nationally. This however has not been sustained. Recycling typically requires separation at source, increasing the need for storage at household or community level and requiring twice as many collection journeys. Separation of waste later in the chain increases labour costs with an unpleasant and potentially hazardous task. Even if recycling facilities and a market for the recycled material is available locally, the length of the management chain is increased and transport costs raised. Therefore, any environmental benefits of recycling have to be balanced with the impacts of the additional handling and conveyance.

Reuse of plastic bottles could generate an income for private collection and re-selling if there was demand. This is the case with some waste scavenging in stable situations, but the vast number of bottles reduces their value dramatically.

**Reduce**

Based on “reduce, reuse, recycle” principles, the first option would be to reduce the distribution of disposable water bottles once an adequate water supply is available. However, this brings a sociological element into the problem. Even when a good, reliable supply of potable water is available, people prefer the apparent “quality” of bottled water. Aid agency staff may insist on bottled water and this creates an impression that they do not trust their own official public supply. This may lead to more people opting for plastic bottled water. The quality of bottled water however may only be an impression of water safety, with lax regulation of bottled and sachet water in some countries. Thus the demand for bottled water may continue.

**Latrines**

In an attempt to reduce the number of bottles in trench pits, one Aid Agency in South Sudan had a full-time caretaker who would lend latrine users a small reusable water jug designed for anal cleansing. This was filled with water and returned after use. The attendant would also prevent people going into the toilet with plastic bottles. This worked during the day but at night the facility was not manned (for the security of the employee) so plastic bottles were still being thrown in the pits.

**Figure 10.**
Shallow latrines blocked with plastic bottles. (Source: Victoria Hammond)

### 2.8.2 Sense of Ownership

Other issues that have been raised relating to solid waste include the lack of ownership. One interviewee described the problem of littering as being a loss of a sense of ownership of the living space. The area immediately outside displaced people's homes would be kept tidy but the public spaces were not theirs and the responsibility belonged to "others".

**Empowering Communities**

Solid waste management can provide work opportunities for displaced people and help rebuild local government functions. The processes are reasonably straightforward, but there can be environmental, social, and institutional challenges.

*"…a decision was taken at last to have IDPs managing waste collection by themselves within IDP 'locations' (as they were and are still not official camps). Except that, traditionally, the disposal options would be either open dumping in the city outskirts, open burning, or river dumping.*

*In X refugee camp, [the INGO] provides waste collection through cash-for-work (which is one of the few types of work refugees are allowed to undertake). However, there are challenges. Most notably, the fact that the existing informal sector apparently hasn't been involved in the project, and is thus 'sabotaging' the ongoing source segregation efforts."*

SWM Expert - International activity

Informal re-use and recycling can provide resources for displaced people, but there are wider issues to consider. People fleeing violence do not have a lot of possessions and the small amount of waste generated is of little value. However staff from aid agencies and peacekeepers throw away larger amounts of waste that is seen as useful by IDPs.

*"The waste collected from the IDPs [fleeing violence] is pretty much the leftovers of whatever they cannot use and by this point, there's not much left. However, the waste collected from the part of the camp where the peacekeepers and staff live is jam-packed full of useful stuff.*

*When the trucks leave the camps to head to the dump site (which is also pretty bad), the kids set off from the camp to the same dump site at rapid pace (protection issues along the way - absolutely), about 1.5 km. They arrive at about the same time as the trucks (the kids don't bother with security at gates, etc). They ignore the IDP waste and attack the UN waste with vigour, looking for useful things to then drag all the way back to the camp. Again, massive protection issues (and I've never seen peacekeepers so uncomfortable) but more importantly I think there are opportunities to manage this as a system.*

*Why not set up a recycling system for locals (IDPs or others) as part of a UN camp, figure out the security part of it, figure out better protection systems, people find things they want or can use, and you end up having to truck far less waste to a dump site?"*

Field Worker – East Africa

There are successes however; an interesting case study in cleaning up the area around displaced people's homes comes from Lebanon (Arab, 2015). Here, Syrian refugees are distributed in 1500 scattered locations. Limited funds and the fear of aid dependency led to the establishment of community WASH committees. Their initial mandate was to keep water and sanitation systems clean and functioning, but this transfer of responsibilities also led to the creation and improvement of existing waste management systems. This was noticeable in the spaces between communities that were seen as dividers and areas where rubbish was dumped. Clearing up these areas reduced tensions and improved relations with neighbours.

While public areas may lack ownership, INGOs can be all too aware of ownership. Concerns over disposing of car tyres or oil, leaving waste such as beer bottles, or abandoning equipment after a mission has ended, relate to how the organisation is seen by media or environmental organisations. Although local communities may reuse or recycle some of this waste informally, the extent to which it remains the responsibility of INGO remains unresolved.

**Figure 11.**
Waste may be collected but not always disposed of correctly. (Source: WEDC, Loughborough University)


Where there is formal waste collection by a private contractor the ownership of waste is handed over to them. However it is not clear the extent to which INGOs have a duty of care to ensure that this is done in an appropriate manner (i.e. waste is not subsequently dumped or inadequately burnt).

Specific wastes such as medical waste is dealt with at source by the INGO. Other wastes such as packaging or domestic waste go into the public system to be dealt with by "others". Unsolicited aid (such as food parcels) can remain unclaimed at ports and airports.

While “waste” comes under the responsibility of the WASH cluster, they may not have the technical expertise required, their primary focus being water and/or sanitation issues. The immediate demands for water and sanitation in an emergency can displace action on SWM, which may not be seen as so urgent. Co-ordination with a weakened local government can also delay action until municipal services are strengthened or restored.

### 2.8.3 The Normative View on Recycling

Both experts interviewed and assessments in this area seemed to regard recycling as a “best available” option. However this ideal solution may not meet the more practical standard of “Best Available Technology Not Entailing Excessive Costs” (BATNEEC). Some Aid Agencies have been shipping waste internationally for safe disposal in an industrialised country in order to meet international standards of disposal. While water and sanitation standards in humanitarian responses and development situations are appropriate to the context, a higher (and arguably) unrealistic standard seems to be expected of solid waste disposal.

The above case study on water bottles highlights that while interviewees suggested recycling as an option, the challenge of doing this formally, even in stable contexts, has many barriers (Brown et al., 2011). There are methods and examples of recycling in low-income contexts, but mainly where there is a large source of material (e.g. capital city dump sites) and a local market for the waste (pers comm Adeola Obadina, 2015). In addition to this, different recycling plants are required for each material (e.g. rubber, oil, plastic, organics, glass).

In contrast to the widely held perspective that formal recycling is an ideal to aspire to, more informal modes of recycling, such as scavenging, are typically viewed negatively. This is difficult to justify as scavenging is a way of managing waste that also provides an income and resources for local people.

# Part 3: Areas for Further Exploration

## 3.1 Ongoing Projects

After an extensive literature search and discussions with field experts, it appears many of the research papers on this topic are retrospective assessments rather than new developments. There are small pilot projects looking at some recycling options, but applicability in the early stages of an emergency and sustainability in the long term is questionable.

A strong "environmental" perspective, rather than a specific WASH focus, is apparent in the research. This is evident both in terms of the post-disaster assessments, as well as the proposed initiatives (e.g. trialling recycling). Some interesting initiatives and research directions include:

- S(P)EEDKITS are looking at "Concepts for generic novel packaging", which may reduce package waste, but this is not explicit.
- MSF are discussing with manufacturers the possibility of changing packaging to improve disposal.
- UNDP have been working on new publications on SWM — mainly from an "Early Recovery" perspective.

From discussions and comments, SWM has a low priority due to a combination of factors such as:

- Lack of expertise and knowledge within the WASH sector;
- Does not pose an immediate (health) threat;
- Lack of basic equipment (e.g. proper bins);
- Experience of failure (e.g. refuse vehicles/ dust carts breaking down);
- Inappropriate standards.

## 3.2 Areas for Innovation

A theme running through the analysis of this challenge was "ownership" — ownership of waste by agencies, by waste pickers, and by the public. Changing the way waste is viewed and the perspective it is viewed from introduces some novel ways to rethink these issues. Three contrasting areas were identified as being worth exploring, based on better processes, better technology, and better communication.

### 3.2.1 Rethinking Aid Agency Waste

While recycling was mentioned as a "nice to have option", the evidence from more stable, low-income nations is not encouraging. The area repeatedly mentioned by interviewees was "Aid Agency waste" (i.e. waste generated by staff and their activities). This includes:

- Packaging materials and other materials related to the emergency response;
- End of mission rehabilitation of sites;
- Tyres, batteries, and used oil from vehicles;
- Domestic waste, which may include beer bottles, cans, and other "luxuries" that are in contrast to the local context.

The first issue is that of ensuring good SWM practices. This is especially challenging as agencies may have to manage their own waste in the absence of a reliable public system. This can be problematic in the early stage of an emergency when packaging of supplies can generate large quantities of waste (Brangeon, 2015). This "good housekeeping" is the responsibility of the agency and is not the focus of Sphere Project standards. In fact, this area is not a WASH issue but a wider humanitarian action as each agency should be responsible for their own waste.

Discussions with field staff were less about the methods of disposal, as scavengers will promptly deal with the waste if it has any value. The concern is often with image, such as the discarded beer bottles. In addition to this, the sense that materials should be "recycled" is also problematic as there are concerns about worn out tyres being reused, or oil and batteries being used elsewhere but causing pollution.

Some agencies have trialled shipping waste to an industrialised country for processing. The moral position of not polluting the local area has to be weighed against the moral position of spending aid funds on what might be a small amount of waste compared with the larger picture locally, especially outside the emergency context.

Further insights into what is "appropriate" rather than "best" practice for the management of waste produced by aid agencies is needed. Waste-picking may not look ideal, but improving sorting and reuse of waste safely with local people may be preferable to expensive shipping or wasteful burial. This challenge goes beyond the immediate WASH sector, to engage with other humanitarian sectors to develop management solutions that can be adapted to a variety of local contexts.

### 3.2.2 Changing Perceptions, Changing Behaviour

Most interviewees spoke about the challenges posed by "litter", not domestic waste. The ownership of space and expecting "others" to deal with public waste is a challenge. Actively throwing waste in drains and latrines is a problem that requires a change of perspective. Just as handwashing promotion messaging has shifted from focusing on hygiene to ideas of beauty or fragrance, waste messages may have to change to promoting healthy lives or some other aspirational aspect rather than admonishing people for littering.

It is no good providing waste bins and collection services if people do not use them. So far, behaviour change programmes have focused on hygiene and health messages. Further field research is needed to understand how such programmes could be used to protect the wider sanitary environment from misuse. Promotional materials and key messages need to be developed and tested to create a sense of ownership of public spaces.

### 3.2.3 Making SWM Easier for NGOs

The technology for SWM is not difficult. Bins, carts, excavators or spades are the main physical resources. Shredding or compaction to reduce volumes could be a way of making waste cheaper to transport and dispose of, but would make any subsequent reuse difficult. Also, such machines require transport and operation which may be challenging in places where even basic systems are not managed well. While basic SWM resources can often be purchased locally, they do not seem to be a priority. Making SWM easier relates to a lot of issues, often managerial. One simple technical and logistical aspect is the provision of bins in a range of sizes, and in a sufficient quantity to ensure they do not get stolen.

At the same time, reducing packaging waste can address the problem of large quantities of paper, plastic, and wooden crates being generated due to humanitarian response. Inspired by standardised intermodal shipping containers such as Aquabox and S(P)EEDKITS, generic packaging could be designed for immediate reuse as waste bins. Supplies need to be protected in transit, but once unpacked, containers can become an asset, not a waste. This way the pollution caused by the supply of aid material can be mitigated through reduction and reuse, making the polluter pay for the solution. Bins are needed in various sizes, from household containers, though communal and neighbourhood facilities, to larger stores. Having dual purpose packaging may increase some logistical costs, but will ultimately reduce both waste and the cost of providing simple waste storage facilities where they are needed.

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# About the HIF

The Humanitarian Innovation Fund (HIF) is a non-profit grant making facility supporting organisations and individuals to identify, nurture and share innovative and scalable solutions to the challenges facing effective humanitarian assistance.

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