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Environmental Guidelines for Small-Scale Activities in Africa (EGSSAA)

Chapter 15
Solid waste: generation, handling, treatment and disposal
(EXCERPT)

Environmental Mitigation and Monitoring Guidelines

In designing and operating integrated solid waste management programs:

- Minimize the quantity of waste that must be placed in landfills through elimination, recovery, reuse, recycling, remanufacturing, composting and similar methods.
- Manage non-hazardous wastes and special or hazardous wastes separately.
- Collect and transport all waste effectively and efficiently.
- Design sanitary landfills and ensure appropriate siting, operation, monitoring and closure.
- Establish sound fiscal and administrative management, privatizing operations with open competition, whenever feasible.

Waste minimization

Reduce, reuse, recycle. Reducing the quantity of waste that must be transported and disposed of should be a primary goal of all municipal solid waste management programs. Waste should be recovered at the source, during transport or at the disposal site. The earlier the separation, the cleaner the material, and, in the end, the higher its quality and its value to users. Incentives which integrate and foster the involvement of the informal sector—itinerant collectors, microenterprises, cooperatives—can be essential to improved waste minimization. Other tips on reducing waste include:

- *Organize itinerant collectors and publicize prices.* In cities throughout Africa, itinerant collectors recover high-value recyclable materials at residences and small industries. Organizing collectors can improve both their standard of living and the stability of the collection services. Publicizing prices can help stimulate the market and mitigate possible exploitation by intermediaries.
- *Foster secondary markets.* The extent to which a material is recovered is dependent on the existence of local industries that can use the recovered material. Secondary markets to serve these industries do not always develop independently. Consider developing a program to identify and develop such markets where there is untapped demand.
- *Offer incentives.* A deposit system on glass bottles has maintained a high recovery rate throughout the continent. South African beverage manufacturers also issue deposits for tin and aluminum cans, which have generated high levels of reuse.

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Facilitate separation at disposal site. When waste pickers are allowed access to disposal sites, significant amounts of material can be recovered. However, because they interfere with efficient operation of dumps and landfills, waste pickers are usually excluded from these sites, lowering recovery rates and causing severe economic hardship. Some sites provide a measure of structured access to waste pickers—at the Bisasar Road landfill in Durban, for instance, registered pickers from an adjacent squatter settlement are allowed into the site after hours, earning US$77 per month from this activity. At all other times, armed guards restrict access to the site. Similarly, the South African Boipatong landfill limits access to 100 registered waste pickers.

Composting and anaerobic digestion. Organics make up 30–80 percent (~70 percent on average) of the waste stream in Africa, although this varies with the incomes of the neighborhood, region or country. If this part of the waste stream could be used for compost or methane production, many adverse impacts of open dumps and landfills would be reduced. Landfills would require less space, last longer, and produce less leachate.

- *Evaluate the possibility of composting.*

  Large centralized composting efforts, designed to separate the organic component from mixed waste, have almost always failed in Africa for reasons which include poor (or absent) feasibility studies and subsequent failure to meet cost recovery expectations. The city of Accra in Ghana has a successful creative variation on this theme: a **co-composting plant** that converts human waste sludge and solid waste to compost which is then sold to recover the plant's operating costs.

  Small composting enterprises have fared somewhat better. Higher urban demand or subsidies may be necessary if composting is to become a part of integrated waste management. For example, a city could pay small composting operations for each ton of material that is diverted from landfills and base that payment on the disposal costs the city can avoid.

  Backyard composting is a third option, but may be difficult to coordinate the level of effort needed for a city-level impact. In Uganda, community-based groups are experimenting with backyard composting, using the compost in a variety of ways, from conventional agriculture to producing fishpond algae as fish feed.

- *Promote vermiculture treatment of vegetable food waste.* Small earthworm composting farms, operated by 5–6 people, have proven more successful than traditional composting facilities in developing countries, though they are not yet in widespread use in Africa. Vermiculture benefits from better quality control and the cultural perception that the final product, consisting of "worm castings," is derived from "clean" vegetable waste, whereas compost is derived from unclean "garbage." The final product is also more nutrient-rich than compost.

- *Investigate anaerobic digestion.* Anaerobic digestion can generate a nutrient-rich slurry to be used on soil and a methane-rich biogas to be used for fuel.

Collection and transfer

As noted earlier, most African city dwellers lack regular waste collection or access to disposal services, except in the better-off neighborhoods or communities. Careful consideration of the city, climate, and culture is essential to achieving universal collection at recommended frequencies. The following general insights from international experience may be valuable:

- *Use appropriate technology—regular trucks and alternative vehicles.* Specialized compaction trucks are very expensive, difficult to repair and often out of service. Moreover, compacting garbage provides little advantage, considering the density of the waste currently produced in most of the region. Regular trucks require less capital investment and are easier to maintain. They may also be better adapted to poor road conditions and can be used for other purposes if the municipality or company decides to transfer collection responsibility to others. For waste collection in hard-to-reach areas—very narrow streets, alleys, deteriorated roads—alternative collection vehicles should be considered, including semi-motorized carts, front-loaded tricycles, donkey carts, or handcarts.

- *Integrate the informal sector*. Co-operatives and microenterprises are the primary users of smaller collection vehicles and can effectively collect waste from hard-to-reach areas at a low cost. Community members are generally more willing to pay for such flexible and inexpensive services.
- *Build on the existing system*. Radical changes are often difficult to achieve, especially with limited political support, administrative and technical capacity, or financial resources. Develop new structures and processes as part of a strategy of incremental improvement.
- *Introduce transfer activities*. Transfer activities often increase efficiency, for both small- and large-scale systems. In small-scale transfer, microenterprises or cooperatives bring waste to a centralized area for pickup by private or municipal trucks. In large-scale transfer, waste is transferred from a compactor or small truck to larger trailer trucks. Both types of transfer activities save fuel, reduce wear and tear on trucks, and shorten the amount of time spent traveling to and from the landfill. The farther the landfill is from the city, the greater the benefits of large-scale transfer. However, transfer activity is virtually unknown in sub-Saharan Africa.
- *Shift to direct fee-for-service and local financing*. Most solid waste collection is paid out of tax revenues collected by national or local governments and redistributed to the municipality. Mismanagement of funds, lack of competition, and the resulting inefficiencies often result in non-payment or unwillingness to pay for services. Market-oriented systems in which residents' fees support collection and disposal services are less likely to suffer from these crippling flaws. Nevertheless, unwillingness to pay can still be a problem under such systems. One strategy for overcoming this problem, used in a number of developing countries outside of Africa, has been to link billing for solid waste collection to utility bills. Electricity consumption is closely correlated with waste generation, so fees for waste collection can be tied to electricity use and integrated into the electrical bill. After charging a small administrative fee, the utility passes the payments to the municipal solid waste department.

Landfills

Most of the waste in Africa is disposed of in environmentally unsound open or controlled dumps. Even using the best waste minimization practices at all stages, some non-recoverable waste will remain, making landfills necessary. The ultimate goal for land disposal should be:

- separate disposal of hazardous and non-hazardous materials; and
- construction of clean and properly sited landfills with diligent management, including leachate and methane controls, during operation and after closure

When these conditions are met, the landfill becomes a *sanitary landfill*. It is recommended that the transition from open or controlled dumps to sanitary landfills be made incrementally. The following steps are suggested:

Open dumps. If open dumps are currently being used, initial upgrades can be made with little capital investment and minimal ongoing costs:

1. Construct perimeter drains to catch runoff and leachate.
2. Minimize leaching through soil by and repeating periodically (every two months is often sufficient compacting and grading. This causes rainwater run off into perimeter drains instead of soaking in. Manual labor or heavy equipment may be used (renting heavy equipment is often the least expensive option).

3. Protect the health of waste pickers and landfill staff by providing soap, water and hygiene training.
4. Regularly test groundwater for contaminants, including bacteria, heavy metals, and toxic organic chemicals.
5. Conduct a formal environmental assessment of the current site before making further upgrades. If it is environmentally sound and has adequate additional capacity, it can be converted directly to a controlled dump. Otherwise, an appropriate alternative site for a controlled dump or sanitary landfill must be located.
6. Engage the public in decision-making. Public involvement in upgrades, siting decisions, and subsequent planning is essential. Otherwise, strong opposition that delays or halts the project may develop.

Controlled dumps. To transform an open dump into a controlled dump:

1. Fence in the active face of the landfill and hire staff to monitor and control dumping.
2. Track how much waste is delivered.
3. Compact waste before or after dumping.
4. Schedule monitoring of methane gas production, landfill composition, and surface water and groundwater conditions.
5. Develop closure and post-closure plans.
6. Seal and cover the dump in stages as its capacity to receive waste is exhausted.
7. Maintain scheduled monitoring until sampling indicates it is no longer necessary—possibly 30 years or more.

Sanitary landfills. Sanitary landfills are the only land disposal option that enables control and effective mitigation of

- potential surface and groundwater contamination;
- health and physical threats to waste pickers and sanitation workers; and
- methane emissions.

Sanitary landfills require much greater initial investment and have higher operating costs than controlled dumps. Full community involvement throughout the life cycle of the project is essential. Proper design, operation and closure also require a much higher level of technical capacity.

Siting. Siting is possibly the most difficult stage in landfill development.

1. Carry out an environmental impact assessment that addresses all siting criteria (see box at left).
2. Organize full community involvement. This is especially important given the greater expense and often greater size of sanitary landfills.

Design. To mitigate environmental impacts, sanitary landfill designs should include:

1. An impermeable or low-permeability lining (compacted clay and polyethylene are most common in developing countries; geopolymers and asphalt are prevalent in the developed world).
2. Leachate collection, monitoring, and treatment.
3. Gas monitoring, extraction, and treatment.
4. Fencing to control access.
5. Provisions for closure and post-closure monitoring and maintenance.

Leachate management. Leachate impacts can be controlled only with lined landfills.

1. Install collection systems to retrieve leachate from the bottom of the landfill.

2. Treat leachate physically, chemically, or biologically through:
   a. An off-site sewage treatment plant (adequate sewage treatment facilities are readily available in only some parts of Africa), or in a dedicated on-site treatment plant.
   b. Recirculation that sprays leachate from the bottom of the landfill onto its surface. This is a popular landfill management practice in Africa. It reduces leachate volume by increasing evaporation, stores remaining leachate in the body of the landfill, and may accelerate degradation and extend the life of the site. However, recirculation is a new technique whose long-term effects are not yet known.
   c. Evaporation of leachate through a series of open ponds. This method requires pumping and some means for disposing of possibly toxic residues. Ponds should be designed with enough capacity to accommodate increased volume during the rainy season.
3. Monitor groundwater and surface water regularly, both down-gradient and up-gradient from the landfill. At a minimum, monitoring should include indicators of core contaminants, chemical oxygen demand, biological oxygen demand, and total nitrogen and chloride levels.
4. If it is uneconomical to recover and use landfill gas as fuel, it should be vented and flared. Currently, recovery and processing systems are both expensive and difficult to operate. These systems are economical only when the landfill generates large quantities of gas, where local or regional demand exists, or where the price for natural gas or other substitutes is high. At a minimum, buried perforated pipes that can safely vent gas should be installed, and a flaring system should be added to reduce global methane release to the atmosphere.
5. Fence in landfills to prevent waste pickers from accessing the site. This enables landfill personnel to work efficiently and protects waste pickers from exposure to harmful substances. However, it also deprives them of their livelihood. They should thus be integrated into formal collection or disposal operations by, for instance, helping them organize a cooperative and offering them structured access at the landfill gates. Also, they should be made a part of the earlier stages of the collection process, perhaps by helping them establish a cooperative that collects recyclables from industry.
6. When the landfill is full, implement the activities specified in closure and post-closure plans that were developed during design. These should include sealing the landfill and applying a final cover (including vegetation) to it, land use restrictions on both the old landfill and surrounding areas, and long-term gas, leachate, surface water and groundwater monitoring.

Incinerators

Do not construct incinerators. Incineration of municipal solid waste is rarely economically feasible for developing countries. Burning the wet waste found in Africa often requires adding supplemental fuel. Furthermore, the composition of the waste often varies a great deal between neighborhoods, which makes consistent and optimal operation difficult to achieve. Without proper controls, incinerators can be highly polluting, generating dioxins and depositing toxic heavy metals into water bodies. The proprietary technologies involved require very large capital investments and have high maintenance costs.

Wastes Requiring Special Attention

Certain wastes merit special handling and disposal because of their dangers or volume. The best option is to minimize or eliminate the generation of these wastes by encouraging users to apply cleaner production approaches and substitute materials or change processes (see “Environmental Guidelines for Activities with Micro- and Small Enterprises” in this volume). Those that are generated should be collected and disposed of separately from one another and away from the rest of the solid waste stream.

Hazardous waste. Wastes pose a wide range of risks. They may be chronically and acutely toxic, cause cancer, trigger birth defects, explode, corrode many materials, and cut, puncture, crush, burn and infect people and animals. Hazardous wastes endanger many different classes of people, placing waste producers, collectors, landfill workers, waste pickers, and nearby residents at risk. The leachate from a landfill may be dangerous as well; its level of toxicity is directly related to the quantity and toxicity of hazardous materials mixed in with other solid waste.

Management of hazardous wastes needs urgent attention in Africa. The variety and classes of materials and sources—from households to industrial and medical facilities—makes this particularly challenging. Action is constrained by limited financial resources to deal with these problems and ignorance or unwillingness to acknowledge the risks.

Sound management of hazardous materials includes four elements: waste reduction, segregation, safe handling, and disposal. The best solution is to not generate this waste in the first place. When this is not possible, every effort should be made to minimize generation, and generated wastes should be handled cautiously to reduce risks. Producers of hazardous waste should segregate different types of materials to make recycling easier and prevent chemical reactions or explosions. Suggested best practices for accomplishing these goals in the developing world include:

- *Providing technical assistance and training* to educate decision-makers, system operators, and the public. These efforts should strengthen stakeholders' capacity to identify cost-effective waste reduction measures, and to help design and to put in place practical hazardous waste management plans. (See the Cleaner Production approach described in the "Small and Micro Enterprises" section of these guidelines.)

- *Establish incentives, disincentives, or regulations* to promote waste reduction where it is not otherwise cost-effective.

- *Establish dedicated hazardous waste recycling and disposal facilities.* Few countries in Africa operate hazardous waste treatment and disposal facilities. Thus, much of the hazardous waste generated continues to be disposed of in dumps and landfills without any provisions for segregation, containment or treatment.

- *Develop systems to ensure that waste is not illegally dumped*. One model that provides checks on illegal dumping is the hazardous waste manifest system in the United States, where a "paper trail" (a sequence of required documents) is generated to prove that the material reached its intended final destination.

- *Explore options for contracting private sector firms that specialize in the handling and disposal of hazardous wastes.*

Medical waste. Wastes from health posts, clinics, hospitals, and other medical facilities pose serious and urgent problems in the Africa region. (A detailed discussion of impacts and appropriate mitigating measures can be found in the "Healthcare Waste: Generation, Handling, Treatment and Disposal" section of this volume.)

These wastes can contain highly infectious organisms, sharp objects, hazardous pharmaceuticals and chemicals, and even radioactive materials. Since the various forms of healthcare waste require different types of treatment, they should be segregated at the source. General waste should be segregated from hazardous material to reduce volume: sharps should be placed in puncture-proof containers, infectious waste separated for sterilization, and hazardous chemicals and pharmaceuticals segregated into separate bins.

Unfortunately, all of the available disposal options are imperfect. The most immediate threat comes from highly infectious waste. On-site treatment is generally preferred to reduce the risk of disease transmission to waste handlers, wastepickers and others. Suggested mitigation measures include:

- In rural areas, burn infectious waste in a single-chamber incinerator, if possible. This kills >99 percent of the organisms and is the best option for minimal facilities.
- In urban areas, burning is not advisable, as the fly ash, toxic gases and acidic gases pose a much greater health threat in more densely populated urban environments than in rural areas. Thus larger facilities should autoclave infectious waste. While high-temperature incineration is theoretically the best option in urban environments, in practice the equipment is rarely operated properly and disposal is highly polluting.
- In some large cities, off-site wet thermal, microwave or chemical treatment options may be available.
- The least expensive option is land disposal. If waste is to be disposed of in a dump or landfill, it should be packaged to minimize exposure, placed in a hollow dug below the working face of the landfill, and immediately covered with 2 m of mature landfill waste. Alternatively, it may be placed in a 2 m deep pit and covered in the same manner. Waste-picking must then be prevented.

Tires, oil, and batteries. These three common automotive wastes cause difficulties throughout the continent:

- Stockpiled tires can spontaneously combust, producing prolonged, polluting fires. Reuse or retreading are the best alternatives available for reducing tire waste in developing and industrializing countries.
- Used motor oil from auto shops is often burned as fuel, contributing to air pollution. Re-refining this oil is the best alternative, but this alternative is neither readily available nor commercially feasible in most of Africa.
- Lead acid batteries should not be placed in landfills—the lead is toxic, the acid corrosive and contaminated. Lead acid batteries are often recycled in small-scale foundries that are highly polluting and located in residential areas. Recycling in large facilities that have emission and environmental controls is preferable, if this option is available.

Construction and demolition debris. Prevent disposal of construction and demolition debris in dumps or landfills, as this will greatly reduce the life of the facility. Residual lead paint, mercury switches, asbestos and PCBs can also make this debris toxic. Arrange for the return of unused construction materials, recovery of all reusable or recyclable materials, and on-site separation of different waste materials to simplify reuse. The UN Environment Programme's *International Sourcebook on Environmentally Sound Technology for Municipal Solid Waste Management* recommends the following best practices for construction and demolition debris:

- *Inventory control and allowance for return of construction material.* This ensures that unused materials will not be disposed of unnecessarily.
- *Selective demolition.* This involves dismantling, often for recovery, selected parts of buildings to be demolished before the wrecking process is initiated.
- *On-site separation systems.* Use multiple smaller containers instead of a single roll-off or compactor.
- *Crushing, milling, and reusing secondary stone and concrete materials.* There can be a tie-in to approved road construction material specifications.