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Waste Management at Rapid Onset Disaster Sites

Waste Management Solutions Catalogue

Commented [CJ1]: Advisors: Word Document is provided for any comments. The PDF version will be submitted.

Commented [HJP2R1]: A few spelling errors were corrected in this doc, but otherwise it looks quite good!



Photo by Greenhumanitarian; Port-au-Prince, Haiti; January. 2010^[1]

This document contains descriptions and analysis of suggested systems to reduce solid waste during a rapid onset disaster. The team developed a series of questions, found below, that should be used to analyze the feasibility of solid waste management solutions. As a sample, this analysis has been performed on the solutions recommended by the group.

¹ (Greenhumanitarians, 2013)

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1. How does the waste management solution get deployed after the disaster occurs?
 - a. Where do these solutions get deployed?
 - i. Is the waste management solution mobile?
 - b. What is required for deployment of this solution? What is the power source needed?
 - c. How can repairs be performed?
 - d. Who is operating any necessary machines?
 2. How is waste collected to be processed with this waste management method?
 3. How is waste stored until being processed?
 - a. What kinds of waste can be processed?
 4. How is waste prepared for processing?
 5. How long does it take to process waste/how much can be processed at a time?
 6. What happens after waste has been processed?
 7. What are the major operating costs involved?
 8. Can the waste be used for anything after being processed?
 9. Will any machines or systems remain onsite or be reclaimed after recovery efforts end?

Centralized Brick/Shredding Machine

The Centralized Brick/Shredding Solution requires collecting, sorting, cleaning, and melting, and compacting plastic into a brick form. This method is inspired by Conceptos Plasticos, a Colombian company that partners with UNICEF. These bricks interlock and can be used to build structures suitable for habitation.

Centralized Brick/Shredding Machine

1. How does the waste management solution get deployed after the disaster occurs?
 - Shipped on a pallet via shipping container or plane.
 - Shredder, Brick Compactor, Air Compressor, Tongs/Heat resistant gloves.
 - a. Where do these solutions get deployed?
 - Brick Compactors and Shredders are brought into a distribution center to process waste via plane or shipping container. A pallet should hold one compactor and one shredder.
 - b. What is required for deployment of this solution? What is the power source needed?

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- This solution would require electricity, further investigation is needed to incorporate solar power as a power source as this isn't used with current designs, batteries can be sourced from various locations such as car scraps, until then rely on electricity from distribution centers.

c. How can repairs be performed?

- Shredder would need to be unjammed using something like a broom handle as a hypothetical. A technician to service it. Requires someone familiar with the shredder to determine more specific issues.

d. Who is operating any necessary machines?

- This should be operated by USAID Personnel on the ground at the distribution center.

2. How is waste collected to be processed with this waste management method?

- Trucks deliver assistance and come back full of waste from where assistance was supplied. This reverse logistics would assist with ensuring waste is collected from areas at the same frequency with the amount of assistance supplied.

3. How is waste stored until it is processed?

a. What kinds of waste can be processed?

- Waste should be collected in bags, cleaned, and shredded as soon as possible to minimize space consumption. These shredding's should be stored at the distribution facility. Until further processing can be performed.

4. How is waste prepared for processing?

- Plastics should be sorted by what type of plastic it is, separate HDPE, Polypropylene, PVC, etc. These should then be cleaned with a hose or, if water is limited, an air compressor should be used to knock off materials.

5. How long does it take to process waste/how much can be processed at a time?

Processing is completed by taking the sorted plastic, shredding it, heating it until it's malleable, then compacting it in the brick compactor while it's warm. Will need tongs or heat resistant gloves to move the warmed plastic.

6. What happens after waste is processed?

- The bricks should be stacked on pallets until they are able to be used. They should be used by USAID Development divisions to assist with rebuilding communities and destroyed buildings.

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- Shredded plastics that are not used in brick development should be sold to outside vendors as materials for production.
7. What are the major operating costs involved?
 - Worker wages, Electricity costs for heating, shredding, and compacting, maintenance of machines.
 8. Can the waste be used for anything after being processed?
 - Refer to 7.
 9. Will machines remain onsite or be reclaimed after recovery efforts end?
 - This is up to USAID to look at the costs involved.

Decentralized Brick/Shredding Machine

The Decentralized Brick/Shredding Solution requires smaller, hand crank or lever operated shredders and compactors. Developing this brick will not have the same quality as the bricks produced by Conceptos Plasticos. These bricks are not able to interconnect to form structures. However, their use is left to the creativity of the beneficiaries. It is encouraged to find innovative ways to utilize the lower quality bricks. Pathways, retaining walls, or basic structure repairs are some of the ways the bricks can be used.

Decentralized Brick/Shredding Machine

1. How does the waste management solution get deployed after the disaster occurs?
 - Shipped on pallets, with enough protection can potentially be air dropped. Should be transported to remote areas in trucks delivering assistance.
 - Lever operated Compaction machine and Hand cranked shredder. Many machine combinations per pallet. Each brick mold is 120 in³, we will use 175 in³ to include room for packaging. The shredder and hydraulic press can be stored within the mold. Approximately 420 machines packages per 42" x 42" x 42" pallet.
 - \$480 per commercially available shredder.
 - Hydraulic Hand Press and Brick Mold \$170.



Sample Hand Operated Shredder^[2] and Compactor^[3]

- Total Per full Pallet- \$136,000 (assuming you need 210 of each machine) in actuality far fewer machines are needed but specific are dependent on disaster type and waste quantities.
- a. Where do these solutions get deployed?
 - These machines should be deployed at a high frequency throughout the disaster area to make up for the slower processing rates for the machines.
 - It is recommended that USAID set up a few workstations in dense locations where Assistance workers can oversee brick production and collect the bricks so they can be used in coordinated rebuilding efforts.
 - In remote areas a simple training should be given when machines first arrive. This could be in the form of instruction manuals, visuals, or personnel providing guidance. Bricks should then be used in local rebuilding efforts.
 - b. What is required for deployment of this solution? What is the power source needed?
 - These machines use Manpower to function.
 - c. How can repairs be performed?
 - These simple machines can be cleaned by workers on the ground, for repairs they may need to be taken to a distribution facility. The machines are intentionally simple to minimize repair complexity.

² (Precious Plastic, n.d.)

³ (Magnatronics Jewelry Design, n.d.)

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- d. Who is operating any necessary machines?
- It is recommended that USAID set up a few workstations in dense locations where Assistance workers can oversee brick production and collect the bricks so they can be used in coordinated rebuilding efforts. In remote areas a simple training should be given when machines first arrive. This could be in the form of instruction manuals, visuals, or personnel providing guidance. Bricks should then be used in local rebuilding efforts.
2. How is waste collected to be processed with this waste management method?
- Waste is collected by local peoples and processed at nearby processing machines. In particularly remote areas USAID should designate bins for waste collection that can be visited and emptied regularly.
3. How is waste stored until being processed?
- a. What kinds of waste can be processed?
- This machine can process most common plastics, before processing waste can be stored at designated locations at the processing site. It is recommended to shred waste as it arrives to minimize the space it takes up.
4. How is waste prepared for processing?
- This processing method does not require major cleaning or sorting.
5. How long does it take to process waste/how much can be processed at a time?
- Process rate varies from types of plastic being processed and operator skill level. Large quantities of machines are intended to compensate for slower processing rate when compared to electric machines.
6. What happens after waste has been processed?
- After waste is processed into bricks they can either be collected for larger efforts or used immediately in repair efforts where some of the structure is still standing.
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7. What are the major operating costs involved?
- The operation costs with this system is mainly the cost of machinery.
8. Can the waste be used for anything after being processed?
- Waste can be used in repair and construction efforts, anywhere where bricks might regularly be used.
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9. Will it remain onsite or be reclaimed after recovery efforts end?

- It is recommended the machines remain onsite however this is left up to USAID. Recollecting will minimize costs as new machines will not be needed for each disaster.

Cardboard Backpacks

The reshaping and reuse of cardboard boxes requires minimal effort on the part of USAID. The only requirement is that instructions be provided, to instruct beneficiaries how to reshape the box into a usable form. This can include but is not limited to: Backpacks, Carrying Cases, and even Sandals. Please see the document in Appendix C example Instructions.

Cardboard Backpacks

1. How does the waste management solution get deployed after the disaster occurs?
 - a. Where do these solutions get deployed?
 - This waste management does not require any machines to deploy. The only changes needed to implement this reuse method is to print methods to reconstruct cardboard packaging into new shapes. This project investigates turning boxes into backpacks and carrying cases using minimal materials not already included in prepackaged kits.
 - b. What is required for deployment of this solution? What is the power source needed?
 - In order to deploy this method, instructions for how to reshape packaging should be printed directly on cardboard packaging. In the case of making cardboard backpacks the only other materials needed is the plastic wrappings that surround boxes during shipping.
 - c. How can repairs be performed?
 - New backpacks can be created from waste instead of repairing boxes that have broken.
 - d. Who is operating any necessary machines?
 - Reshaping can either be performed by disaster victims or by humanitarian workers. If even a portion of people reuse cardboard waste it could

drastically reduce the quantity of cardboard that ends up being improperly processed.

2. How is waste collected to be processed with this waste management method?
 - As assistance is distributed in boxes, these boxes can either be recollected and reshaped by assistance workers, or reshaped by the locals receiving help who may be in need of things like a backpack, carrying case, or storage bin.
3. How is waste stored until being processed?
 - a. What kinds of waste can be processed?
 - This can be performed currently on cardboard waste, assuming instructions are included, or with further development, on some forms of plastic packaging.
4. How is waste prepared for processing?
 - Instructions for reshaping should be developed and printed on packaging. No additional cleaning or preparation is needed.
5. How long does it take to process waste/how much can be processed at a time?
 - The backpack that was investigated could be created in 15-20 minutes. Further processing rates will depend on instruction simplicity and worker experience.
6. What happens after waste has been processed?
 - Reshaped cardboard can be used for a variety of uses, once the cardboard decays to a point it is no longer useful it should be composted or disposed of appropriately.
7. What are the major operating costs involved?
 - The only foreseeable cost is the additional printing on packages.
8. Can the waste be used for anything after being processed?
 - As mentioned used cardboard should be composted, recycled, or otherwise disposed of appropriately.
9. Will any machines or systems remain onsite or be reclaimed after recovery efforts end?
 - Cardboard can continue to be reshaped as long as there is cardboard waste.

Composting

Composting is a method for processing organic waste. This requires minimal maintenance and has little to no operating costs. Organic waste, including cardboard, should be collected and deposited into compost piles. The compost piles will generate compost, providing extra economic benefit to beneficiaries. Local peoples may be paid, and be placed responsible for ensuring the pile is properly “turned”.

Composting

1. How does the waste management solution get deployed after the disaster occurs?
 - a. Where do these solutions get deployed?
 - i. Is the waste management solution mobile?
 - A compost pile can either be created on a large scale at a centralized facility or have multiple piles spread out over a disaster site. Having multiple piles will require more maintenance.
 - b. What is required for deployment of this solution? What is the power source needed?
 - Compost piles must remain warm and wet. They also need to be turned occasionally to maintain air flow throughout the pile.
 - c. How can repairs be performed?
 - There should not be any repairs needed.
 - d. Who is operating any necessary machines?
 - i. Is supervision/training required?
 - USAID is responsible for designating people to “turn” the compost pile and ensuring proper conditions for composting.
2. How is waste collected to be processed with this waste management method?
 - Cardboard and other organic waste can be collected by trucks that currently deliver supplies as they return to a centralized facility. This will be a form of reverse logistics.
3. How is waste stored until being processed?
 - a. What kinds of waste can be processed?
 - Cardboard and other organic waste should be shredded or broken in smaller pieces and placed in a compost pile. The shredding is necessary when starting the pile but as beneficial bacteria grows it is less essential.

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4. How is waste prepared for processing?
 - Organic waste should be shredded, any non-organic waste should be separated from the organic waste.
 5. How long does it take to process waste/how much can be processed at a time?
 - Organic waste takes many weeks to break down, fortunately compost piles are not capped on size and the rate that materials break down increases with the size of the pile.
 6. What happens after waste has been processed?
 - Once Compost is created it can be used in agriculture or gardening as a way of boosting crop growth rate. Until it is used it can remain in the compost pile and continue to supply beneficial bacteria to the pile.
 7. What are the major operating costs involved?
 - Man Power is necessary for turning the pile and ensuring proper air flow through the compost pile.
 8. Can the waste be used for anything after being processed?
 - As mentioned, compost can be used to boost agricultural output and help foster an economic recovery.
 9. Will any machines or systems remain onsite or be reclaimed after recovery efforts end?
 - This is up to USAID, it is critical to ensure only organic waste ends up in the pile and it is “turned” frequently.

Precious Plastics Partnership

Precious Plastic is an open source company, founded in the Netherlands, with the goal of repurposing plastic waste. The Precious Plastic method involves collecting plastic waste, shredding and extruding it to form new products like plastic chairs, tiles and beams. Due to the open source nature of Precious Plastic their technology is publicly available, making it feasible for a possible partnership.

Precious Plastics Partnership

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1. How does the waste management solution get deployed after the disaster occurs?
 - Shipped on a pallet via shipping container or plane.
 - a. Where do these solutions get deployed?
 - Items are brought into a distribution center to process waste via plane or shipping container. A pallet should hold one compactor and one shredder. They are kept in a centralized location.
 - b. What is required for deployment of this solution? What is the power source needed?
 - Electricity
 - c. How can repairs be performed?
 - Precious Plastic offers ongoing digital support, which will be used for repairs and troubleshooting.
 - d. Who is operating the machines?
 - i. Is supervision/training required?
 - Precious plastic offers a digital session on machine setup, maintenance, and safety. This video will teach people how to set up and run the machines, allowing it to be operated by either USAID workers or locals.
 2. How is waste collected to be processed with this waste management method?
 - Trucks will go out with assistance and come back full of waste from where assistance was supplied. This reverse logistics would assist with ensuring waste is collected from areas at the same frequency with the amount of assistance supplied.
 3. How is waste stored until being processed?
 - a. What kinds of waste can be processed?
 - Waste should be collected in bags, cleaned, and extruded as soon as possible to minimize space consumption. These extrusions should be stored at the distribution facility. Until extrusions can be put molds.
 4. How is waste prepared for processing?
 - Plastics should be sorted by what type of plastic it is, separate HDPE, Polypropylene, PVC, ect. These should then be cleaned with a hose or if water is limited an air compressor should be used to knock off materials.
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5. How long does it take to process waste/how much can be processed at a time?
 - Processing is completed by sorting plastic and extruding it. After which it is put in the specific mold of the desired product. After plastic is collected the process of extruding and creating a new product will take 4-8 hours, depending on the desired product.
 6. What happens after waste has been processed?
 - Repurposed plastic products should be stored in a centralized location before being sold in the local economy.
 7. What are the major operating costs involved?
 - Worker wages, Electricity costs for heating, shredding, and compacting, maintenance of machines.
 - Cost of machines 9000 euros total.
 8. Can the waste be used for anything after being processed?
 - Refer to 7A
 9. Will it remain onsite or be reclaimed after recovery efforts end?
 - This is up to USAID to look at the costs involved.

Shipping/Compacting Waste

Compacting and shipping waste is viable under some situations. Waste must be compacted before shipping to ensure optimum space usage, and to ensure waste will be accepted by waste processing facilities. Waste should be sorted and then either compacted into a container as shown by Machine 1, or baled and wrapped as shown with Machine 2. It is crucial to note, ports that will accept waste from a specific disaster must be determined before shipping can begin.

Shipping/Compacting Waste

1. How does the waste management solution get deployed after the disaster occurs?
Machine 1:



Hand Operated Compactor^[4]

- Cost: \$750 is mid-range for such a machine
- 3-4 of these machines at minimum should fit on each pallet

Machine 2:



Electric Baler^[5]

- Cost: \$4500, this is a low end cost for the machine shown above. Most machines range between \$5,000-\$10,000
 - 1-2 machines per pallet
- Where do these solutions get deployed?
 - This machine should get deployed at a few central facilities around a disaster area where trash can be compacted and sent to ports to be shipped out to established waste processing sites.
 - What is required for deployment of this solution? What is the power source needed?
 - The first machine is lever operated. Bins or barrels will be needed to store compacted trash while it is being shipped.
 - The second option is electric but gets rid of the need for a barrel to compact waste into.

⁴ (Material Flow & Conveyor Systems, n.d.)

⁵ (HSM V-Press 504 Bailing Press, 2020)

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- c. How can repairs be performed?
 - The first machine is relatively simple and thus will need minimal repairs.
 - The second machine will require a technician to do basic maintenance.
 - d. Who is operating the machines?
 - These machines can be operated by anyone with minimal training. It is recommended however that a few USAID Employees operate the machines to minimize liability and training.
2. How is waste collected to be processed with this waste management method?
- Waste should be collected from remote areas using assistance delivery trucks. Local waste should be delivered by local people to centralized facilities located around any major cities. Once compacted at these sites it should be transported by truck to a port where it can be shipped out to a port willing to accept this waste.
3. How is waste stored until being processed?
- a. What kinds of waste can be processed? (HDPE, all plastics, cardboard)
 - Compacting and shipping of waste can be performed on many forms of waste. Cardboard and harder to process plastic will not be sustainable as most ports will charge to take this waste rather than pay for it. Easier to process plastics such as HDPE, and metals such as Aluminum are high enough in value for the sale of waste to be profitable.
4. How is waste prepared for processing?
- Waste should be sorted before compacting. Different sorting categories are required for different metals, different forms of plastic, and organic waste.
5. How long does it take to process waste/how much can be processed at a time?
- The longest part of this processing method is the collection and sorting. The more this process can be shortened the faster the processing rate.
6. What happens after waste has been processed?
- One waste is sorted and compacted; it should be delivered via truck to a port where it can be shipped to nearby nations with established waste processing systems.
7. What are the major operating costs involved?
- Machine 1 requires manpower and new barrels for each compaction
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- Machine 2 requires minimal manpower, plastic wrappings should be used to hold baled waste together during shipping. Reusing the plastic wrappings used to ship in assistance should suffice here.

8. Can the waste be used for anything after being processed?

- Waste should be taken to recycling plants where it can be processed into new materials.

9. Will it remain onsite or be reclaimed after recovery efforts end?

- This is up to USAID but with the cost of the second machine it is unfeasible in this scenario. Hand power compactors like the option presented by Machine 1 can be left to further waste management efforts. Without the inflow of ships however, it may prove difficult to ship waste long term.

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