International Organization for Migration (IOM)
The UN Migration Agency

# Technical Guidelines – WaSH UNIT

Sewage and Faecal Sludge Management in
Rohingya Refugee Camps in Cox's Bazar, Bangladesh

**DEWATS**: Decentralized Wastewater Treatment **System (Plastic Structure)**

## Key Design Considerations

- The Plastic DEWATS (Decentralized Wastewater Treatment System) is composed of two parts: the **Anaerobic Treatment System** (ATS, in plastic tanks) and the **Infiltration** process
- Average of **3.1 m$^3$ of black wastewater** received daily at each ATS, or a maximum of 6.2 m$^3$ in one day– can be scaled up with additional tanks
- Assuming that the daily sewage volume treated at DEWATS equals the daily sewage generation (3.1 m$^3$), one system can serve **5170 users** (producing 0.6 L of sewage daily [1]), or **258 pit latrines** (20 users per latrine)
- 50% to 90% cutting target of BOD (Biological Oxygen Demand) and COD (Chemical Oxygen Demand) from the influent
- Hydraulic Retention Time (HRT): **40 hrs** [3]
- Filter material size ranges between 15 and 50 mm diameter (ideally coconut husks [4])
- ATS can be backwashed from the top by gravity

Many latrines have been constructed in Cox's Bazar refugee camps to retain sewage from more than 900,000 Rohingya Refugees. Latrines must be routinely emptied (often manually) and sewage subsequently needs to be treated and safely disposed of to prevent health risks to the population due to infectious waterborne diseases.

The IOM WaSH Unit has been confronted with a double challenge:

-Lack of space and access: treatment often occurs in crowded areas;
-Effluent infiltration rate into the soil is a major bottleneck.

To overcome those challenges, a specific process called DEWATS (Decentralized Wastewater Treatment System) including an Anaerobic Treatment System (ATS, inspired from EAWAG [2]) along with an effluent infiltration design has been developed by the IOM WaSH Unit. The main objective of this compact system is to cut suspended solids and organic matter concentration to facilitate a better and sustainable infiltration of the effluent into the soil. Failing to contain suspended solids and organic matter ultimately clogs the soil porosity, jeopardizing a steady infiltration rate overtime.

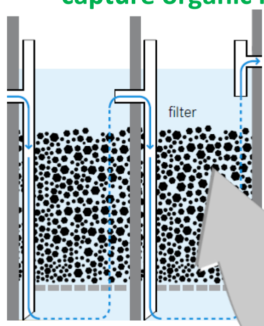
This portable version, using locally available plastic tanks, can be directly deployed in the field. This solution has been specifically developed to cope with the urgent need to address sewage and sludge management gaps.

**Plastic Tank DEWATS Flow sheet:** IOM WaSH Unit implemented a **5 steps** treatment system:

1 **Solid waste removal by a racking system in plastic tank**

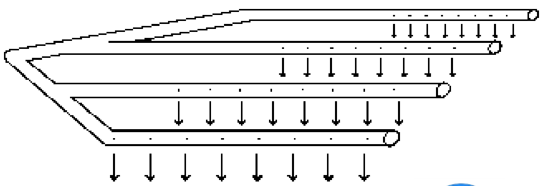
2 **Suspended particles are bio-digested and settle to the bottom of the tank while scum are retained at the top (septic tank)**

3 **Two stages of up-flow anaerobic bio-filtration allowing fixed biomass to capture organic matter**




4 **Final clarification and, <u>in case of emergency only</u>, disinfection by adding a chlorine solution to reach a concentration of 1-2mg/l at the final effluent of the treatment plant)**

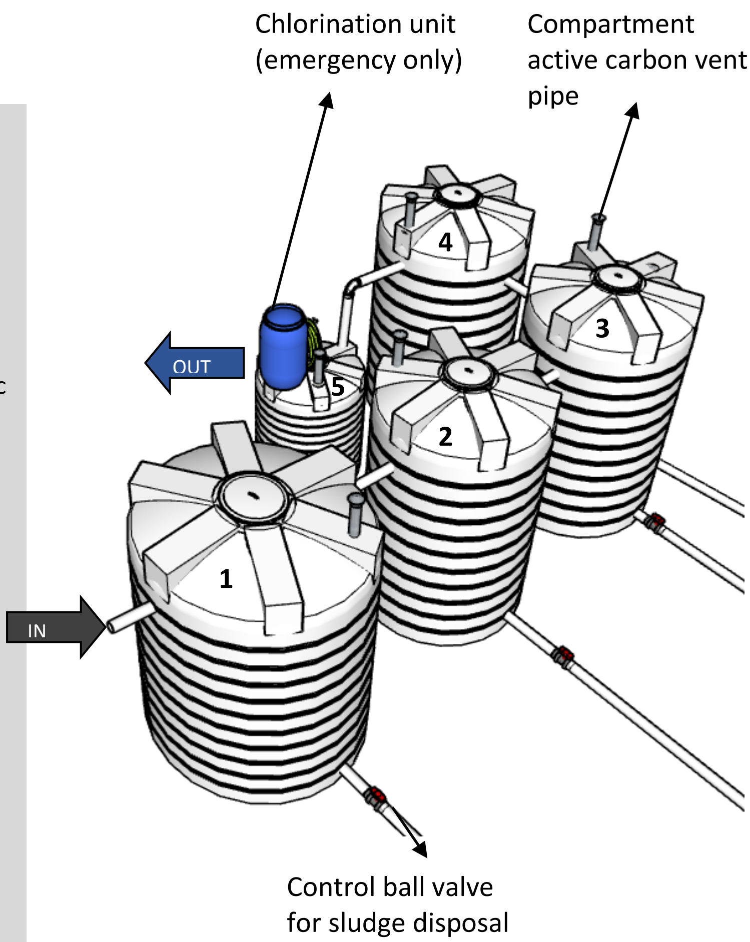
5 **Effluent infiltration into the soil through a soak field (infiltration trenches)**

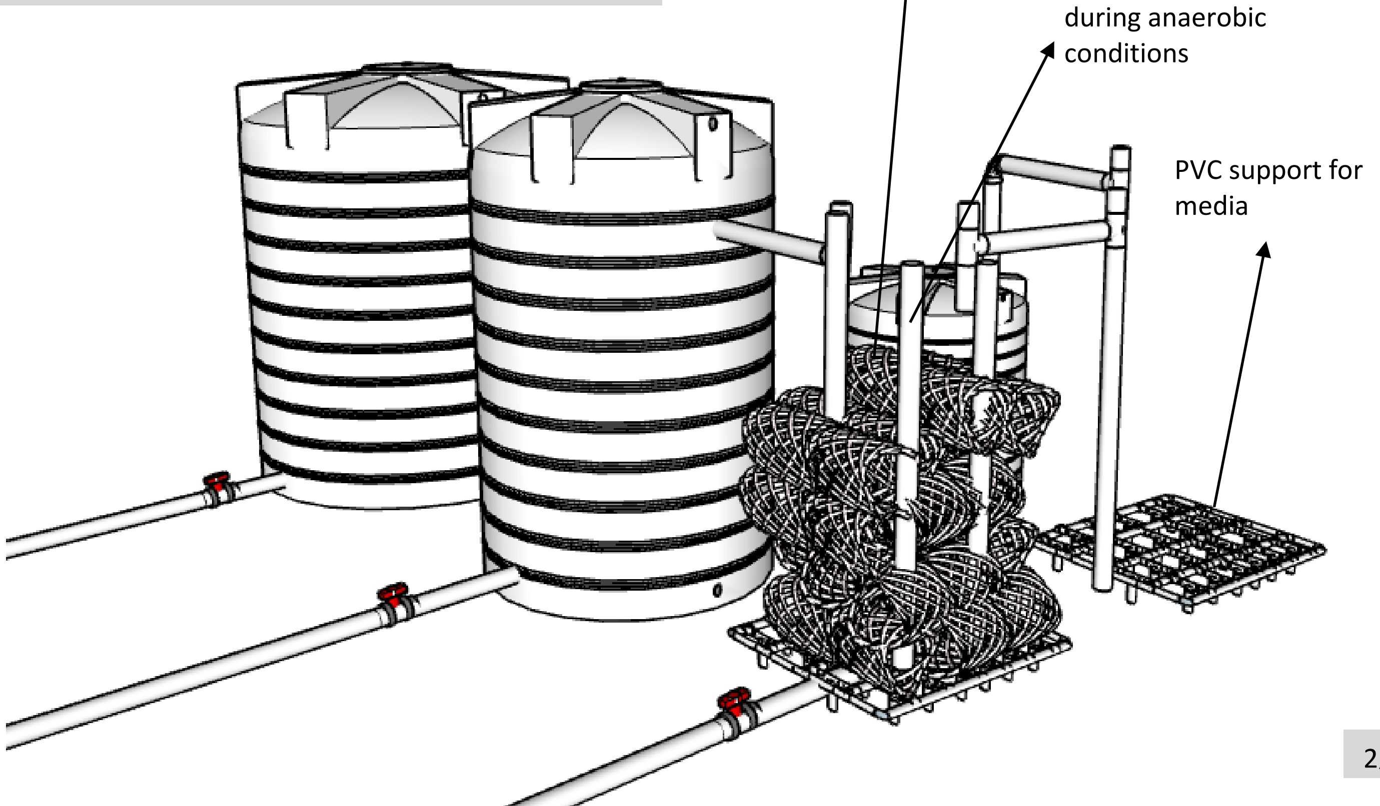


**Design:** DEWATS Anaerobic Treatment System

## Construction Guidelines

- A total of 5 plastic tanks is needed
- The first and second tanks (10,000 L and 7,500 L respectively) act as septic tanks by bio-digesting the sewage and retaining the majority of suspended solids
- The third and fourth tanks (7,500 L each) act as Upflow Anaerobic Filters and are filled by a media supporting biofilm growth (ideally, this should be coconut husk which have a proven life expectancy when immerged in wastewater) [9]
- The last tank (2000 L) is used for final clarification or disinfection, in case of emergency
- The structure is to be installed above ground or can be semi-buried
- 3 vent pipes are placed across the filter to evacuate gas (generated in anaerobic conditions)
- Each tank is fitted with a vent pipe filled with active carbon for odor elimination
- Inlet PVC pipe (bottom reference) is situated at 2.78 m from the base of the 10,000 L tank
- Outlet PVC pipe (bottom reference) is situated at 2.81 m from the base of the chamber (<u>but all 7,500 L tanks are located 0.25 below the level of the first tank as they are higher</u>)
- Sludge emptying is to be done by opening the draining valves of the filter chambers a couple of seconds, in case of filter clogging.
- Downward backwash can be operated in the filter chambers by releasing clean water from the tank manholes.



**Design**: Plastic DEWATS Sludge pits sizing

- **Septic tank sludge production**

Considering:

- Relatively high and constant temperatures year round in Cox's Bazar (mostly included between 28 and 33 Celsius Degree) which are in favor of a sustained anaerobic biological activity,
- Anal cleansing common practices within the Rohingya population, which significantly limit the solid material addition in the pits (compared to situations where wiping material is used),
  - ⇨ A solids sludge accumulation rate of **4.4 l/person/year** [1][5] has been considered for designing the system and to estimate the subsequent sludge disposal frequency and the necessary composting volume.

It should be noted that sludge emptying should be done as rarerely as possible in the septic tank and, when carried out, it should be ensured that a proportion of sludge (at least 10%) remains in the first compartment to seed bio digestion for subsequent batches.

Since the Anaerobic Treatment System presented is designed to serve 5170 people (or 258 latrines with 20 users) and considering the sludge proportion should not exceed 70% of the septic tank volume (i.e should not exceed a height of 1.7 m in the compartment), emptying process should be initiated once every 6 months (under prescribed operations).

IOM WaSH Unit has therefore opted for the construction of 6 reinforced concrete pits, of an internal volume of 3.45 $m^3$ each. IOM partners already have a thorough understanding and experience in the construction of those pits since they are the same used in twin pit latrine construction. From the 6 pits requirement, 3 of them are fed 6 months after the system has been initiated, 3 other pits are fed after 12 months. 18 months after the first desludging (we consider sludge stabilization already occurrs when sludge is in the septic tank), the composted sludge of the 3 first pits can be safely emptied and spread to fertilize landfill since most of the pathogens will have been deactivated [6]. The first 3 pits will be therefore readily available for hosting the new sludge batch.

- **Up Flow Anaerobic Filtration sludge production**

Sludge production by both anaerobic compartments is extremely limited as most of suspended solids would have already settled during the septic tank process. Nevertheless, our partner Practical Action [7] recommends to connect one pit (reinforced concrete ring design) to each chamber. According to their experience, this is exclusively used for backwash purposes and occasional desludging.

- **Clarification sludge production**

The last chamber aims to polish treated wastewater (and potentially for disinfection purposes in case of waterborne diseases reports) before releasing the effluent to the infiltration trenches.

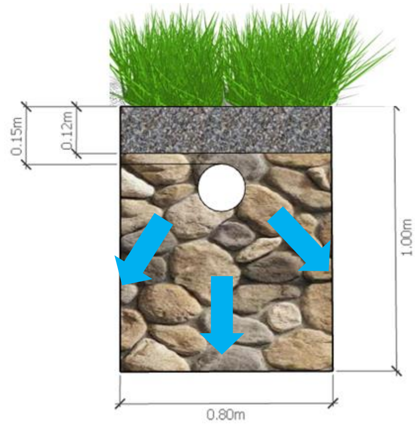
**Design**: DEWATS Soak field for effluent infiltration

The infiltration stage is crucial to ensure safe disposal of the effluent. General technical guidelines observed by IOM WaSH Unit are:

## Key Design Considerations for the Infiltration process

- Soil infiltration tests were conducted, finding a rate of 60 $l/m^2/d$ for semi-saturated sandy soil (within expected range for treated wastewater) [8] [9]
- Infiltration rate tests should be conducted at each site, before calculating the required trench size
- Average daily input of 3.1 $m^3$ of wastewater is considered as treated effluent from the ATS
- The infiltration surface of the Soak Field is given by the quotient of the effluent discharge and the infiltration rate: $3100\ (l/d)/60\ l/m^2/d) = 51.7\ m^2$
- The length of the Soak field is given by dividing the infiltration surface by the width + ½ height of the trenches: $51.7\ (m^2)/1.55\ (m) =$ **33 m**

○ Channels are dug in the ground: 0.80 m wide, 1.00 m deep and the length is determined by the effluent discharge (see Key Design Considerations).




○ System flat or with very light slope

○ Trenches are to be filled with stones (not easily available) or brick chips of good quality

○ Half perforated PVC pipe SCH40 4'' with 0.8 cm circular holes at a density of 100 holes per meter of pipe (bottom only) are placed 15cm below ground level (upper level of the pipe considered, see above picture).

○ A geotextile is put at the top of the pipe along the soak field to prevent vegetable root system and fine particles to enter and clog the drain pipe.

○ Trenches not to exceed 10 m length and separated by a distance of 2 m.

○ Manholes are to be constructed at each junction to facilitate infiltration monitoring

○ Vertical vent pipes to be positioned every 3m to maintain aerobic conditions

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**References**


[1] **Field observations, (2019) –** Operational desludging records from Cox's Bazar Rohingya camps.

[2] **EAWAG Compendium of Sanitation Systems and Tech., Geneva, Switzerland, (2014)** - Anaerobic Filters.

[3] **Research Center and Assistance in Technology and Design of Jalisco, Mexico, (2015)** - The Effect of the Hydraulic Retention Time on the Performance of an Ecological Wastewater Treatment System.

[4] **Springler Plus, Brazil, (2013)** - Coconut shells as filling material for anaerobic filters.

[5] **UPM Wastewater Charactreization Study, (2019)** – Quantification of total solids fraction of wastewater from Camp 3 & 5 pit latrines.

[6] **WHO, Geneva, Switzerland, (2016) -** Manual for Safe Use and Disposal of Wastewater, Greywater and Excreta.

[7] **Practical Action, Dhaka, Bangladesh, (2018)** - Up-Flow Filtration to Ensure Safe and Environment Friendly FSM.

[8] **FAO, http://www.fao.org/docrep/s8684e/s8684e0a.htm, (2018) -** Annex 2 Infiltration rate and infiltration test.

[9] **USEPA, Cincinnati, USA, (2002)** - Onsite Wastewater Treatment Systems.