PARTNERS

TECHNICAL SUPPORT

Camp 18 Sustainable Faecal Sludge Treatment Plant in Cox's Bazar refugee's camps

1 Introduction

Historically the humanitarian sector focused upon the provision of latrines in emergency settings without necessarily considering how to handle and treat the resultant faecal sludge. Recently, however, there has been a growing recognition of the need to deliver end-to-end faecal sludge management solutions following the onset of an emergency, where the collection, transportation, treatment and safe disposal of faecal sludge are all taken into consideration.

The Red Cross / Red Crescent Movement has been a leading advocate and practitioner in the emerging field of Faecal Sludge Manager (FSM) within an emergency context. It is within this context that in 2022 a consortium of the British Red Cross, Swedish Red Cross and Bangladesh Red Crescent Society completed the construction and commissioning a 15m^3/d Faecal Sludge Treatment Plant (FSTP) within Camp 18 of the Cox's Bazaar Refugee Camp, Bangladesh.

Details of the design brief for the FSTP included:

- Safe to operate
- Treatment capacity of 20,000 people
- Minimum power requirement
- Safe disposal of sludge (with eventual re-use)
- Effluent quality achieving – where possible – Bangladeshi government standards
- Zero chemical use
- Capable of receiving pumped sludge and manually handled sludge
- Easy to operate and maintain
- Maximise use of locally available materials and equipment
- Minimal odour impact

The total cost of the FSTP was **USD 210,000**, resulting in a unit cost of **USD 14,000 per m^3 of capacity**, or **USD 10** per individual served by the plant.

2 Technical Overview

2.1 Process Description

*Figure **2.1*** below depicts the process flow diagram (PFD) of the 15 m^3/d FSTP.

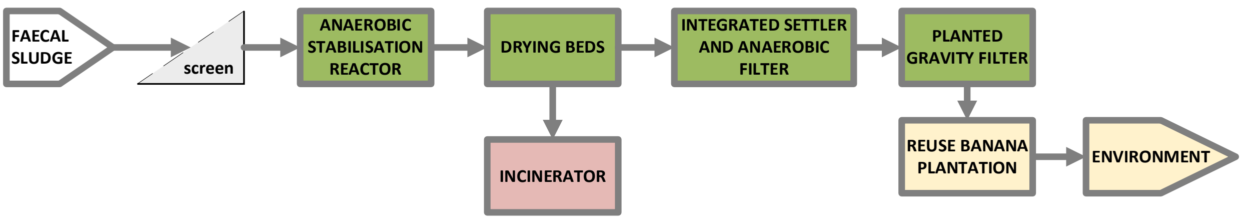


Figure 2.1: FSTP Process Flow Diagram

Faecal sludge arrives at the site either **carried manually** or **pumped** (from outlying FS transfer stations or relayed to site via temporarily commandeered septic tanks) and is discharged into a **screened reception chamber**. The reception chamber also acts as a sand and grit trap. From the reception chamber, flow passes through a pair of vertical openings within the far end of the reception chamber into a pair of balancing tanks referred to as the **anaerobic stabilisation reactors** (ASRs). The tanks operate on an alternating basis, with one tank being filled on one day, and the other tank being filled the following day. These tanks are fully enclosed, each with a dedicated ventilation cowl designed to avoid the build-up of an explosive methane atmosphere.

Each ASR tank is sized to provide a few days of FS storage to ensure the homogenisation of the incoming sludge. The tanks are equipped with a floating depth indicator, and when the volume of FS within one of the ASR tanks has reached a sufficient volume, part of the tank's FS volume (approximately 15m^3 or enough to fill four drying beds) is transferred by sludge pump via a dedicated sludge pipework to the **sand drying beds**. Prior to transfer, the sludge pump is first used to mix and homogenize the contents of the ASR to ensure as uniform a feed to the sand drying beds as possible.

Screening (i.e., solid waste) and grit/sand from the reception chamber are manually removed and transferred to one of the drying beds on a daily basis.

Drying times on the sand drying beds is approximately 10 days. Leachate from the drying beds in collected in a series of interconnected register chambers and passed forward to **Integrated Settlement and Anaerobic Filter** (ISAF) unit, comprising of three sequential up-flow chambers, the first being a settlement unit and the second and third being anaerobic baffled reactors. From the ISAF, the flow then passes forward to a **Planted Gravity Filter** (PGF). The PGF comprises of two parallel units, which operate in a daily alternating mode. The discharge of the PGF represents the **official final discharge point** from the FSTP, although the effluent is re-used in an adjacent banana plantation prior to discharging to the watercourse.

Sludge from the drying beds is removed and incinerated in a pair of De Montfort incinerators. Ash from the incinerator is then used as a soil conditioner and fertiliser.

The majority of the treatment process described above is new-build, although some elements of the previous aerobic treatment plant were retained and incorporated into the new plant. In particular, the 14 drying beds[1] used to dry the sludge from the aerobic process were retained and are used to dry sludge from the new plant. However, unlike the 24 new drying beds, leachate from the old beds cannot flow under gravity to the IFAS and instead has to be pumped. This represents only a small operational inconvenience, and the retention of the old beds was seen as a sensible approach to reduce construction costs and time. In addition, the De Montford Incinerators used to burn the dried sludge from the aerobic FSTP were re deployed to burn sludge from the G-FSTP.

A summary of the main treatment units and their key design criteria are given below

Unit	Capacity	*Loading Criteria*
Anaerobic Stabilisation Reactor	2 no. 60 m^3 chambers	8d hydraulic retention time
Sludge Drying Beds (new)	26 no. 3m x 5m (390 m^2)	10d drying time, 138 kg/m^2/an
Sludge Drying Beds (existing)	14 no. 3m x 5m (210 m^2)	10d drying time, 138 kg/m^2/an
Integrated Settler	1 no. 3.3 m^3	up-flow of < m/hr
Integrated Anaerobic Filter	2 no. 4 m^3 (sequential)	up-flow <1.5 m/hr
Planted Gravity Filter	2 no. 10m x 10m (parallel)	80 l/m^3/d

[1] The construction of these drying beds dates in fact back to the period of lime treatment

3 Treatment Performance

Due to issues with logistics and capacity, it has generally proved difficult for institutions to fund and undertake routine sampling for FSTPs within refugee camp settings. However, in this instance the Red Cross committed to undertaking weekly samples from the FSTP and carrying out analysis at its central laboratory in Cox's Bazaar. In addition, accurate record keeping of daily volumes of FS delivered to the plant has provided an accurate account of the weekly load to the plant.

Weekly samples taken at various points through the FSTP treatment process (incoming crude FS, sludge drying bed effluent, AF effluent and SBD effluent), allow both the **overall** performance of the FSTP to be assessed as well as the performance of **individual** treatment process units.

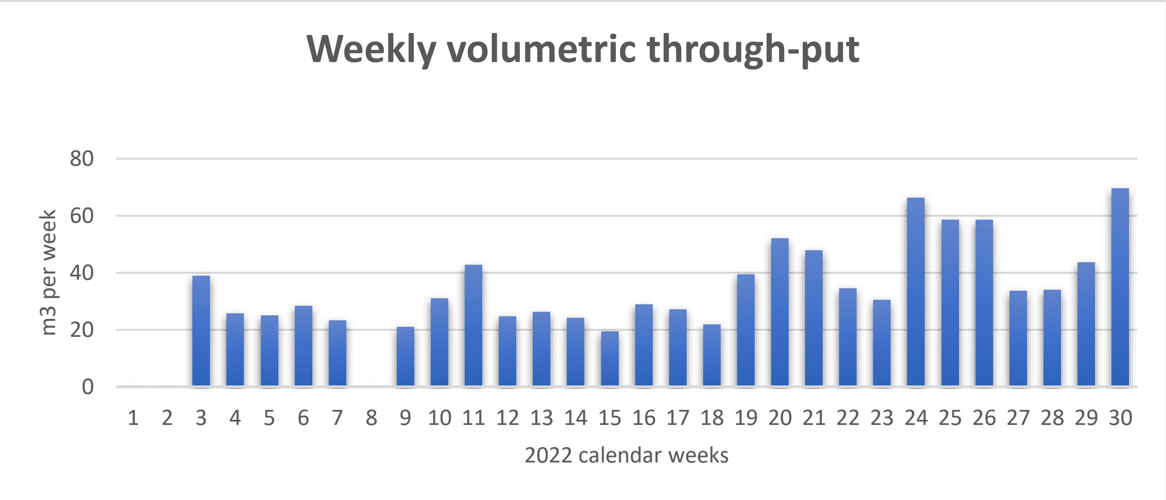
The Red Cross's commitment to this sampling programme should be recognised as a major contribution to the project's overall success. Whilst it represents an on-going operational cost, the undertaking of routine sampling provides accountability, public health protection, operational effectiveness, and – ultimately – evidence to the wider FSM community on how to effectively handle FS in emergency settings.

3.1 Plant Throughput

Since commissioning, the FSTP operation team[2] have been keeping accurate records of both the quantity of sludge delivered to site, as well as the quantity of sludge transferred from the ASR to the drying beds.

As of 1/8/22, the total measured quantity of sludge delivered to the works since commissioning stood at 985 m^3, compared to 984 m^3 transferred to the drying beds[3]. It is estimated that approximately 69% (680 m^3) of the FS arriving at sites was pumped, with the remaining 31% delivered manually[4].

The weekly FS throughput of the plant in m^3 per week for 2022 is shown below in Figure 3.1.



[2] The operations team for the aerobic FSTP consisted of 2 supervisors, 3 operators, 3 volunteers and a 4-person washing team. For the G-FSTP this altered slightly to 1 supervisor, 3 operators, 5 volunteers and a 4-person washing team.

[3] The excellent reconciliation of these two numbers is a testament to the dedication and professionalism of the Red Cross field and operational teams.

[4] Although there is no demarcation in the records as to whether sludge was pumped or carried to the site, it is assumed on days when more that 5m^3 of FS arrived on site, it must have been associated with pumping.

Figure 3.1: Weekly volumetric load to the G-FSTP since commissioning

Since commissioning, the throughput of the plant has been steadily ramping up, doubling from approximate from around 25-30 m^3/wk towards 50-60 m^3/wk. The plant was designed for a weekly capacity of 90 m^3, and as such there is still a significant level of headroom within the plant.

3.2 Effluent Performance

The Government of Bangladesh effluent chemical oxygen demand (COD) target is 200 mg/l. Figure 3.2 shows the COD performance of the liquid treatment stream since commissioning in March 2022. It can be seen that following an initial period of stabilisation, the plant has been successfully achieving national COD standards.

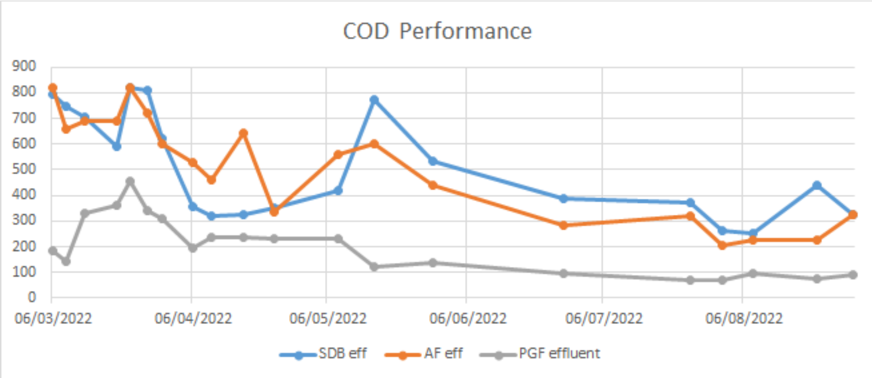


Figure 3.2: FSTP COD performance

The plant is also removes 90% of the ammonia within the incoming faecal sludge, and reduces *e coli* levels in the final effluent to levels suitable for agricultural re-use – in this case a banana plantation.

4 Future Sustainability and Viability

Having successfully achieved it's main treatment goals, efforts are now underway to increase the sustainability of the FSTP. This includes installing solar panels to operate the plant's sludge pump, as well as finding alternatives to incineration.

A.1 Anaerobic Stabilisation Reactor

A.2 Sludge Drying Beds

A.3 Integrated Settler and Anaerobic Filter

A.4 Planted Gravity Filter

A.5 Banana Plantation

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