Fecal Sludge Management (FSM) Strategy for Rohingya Response

August 2023

Final Version

Approved by SAG 20.08.2023

WASH SECTOR, COX'S BAZAR

WASH Sector Cox's Bazar

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Acronyms

ABR – Anaerobic Baffled Reactor

ADS – Anaerobic Digester System

BNFSC – Bangladesh National Fertilizer Standardization Committee

Capex – Capital Expenditure

DEWATS – Decentralized Waste Water Treatment System

DoE – Department of Environment

DPHE – Department of Public health Engineering

FDMN – Forcibly Displaced Myanmar Nationals

FS – Fecal Sludge

FSL – Fecal Sludge Laboratory

FSM – Fecal Sludge Management

FSTN – Fecal Sludge Transfer Network

FSTP – Fecal Sludge Treatment Plant

IFSTN – Intermediate Fecal Sludge Transfer Network

IRF – Institutional Regulatory Framework

l/p/d – Liter per person per day

LSP – Lime Stabilization Pond

MRF – Material Recovery Facilities

ODP – Open Desludging Pond

Opex – Operational Expenditure

PPE – Personal Protective Equipment

RRRC – Refugee Relief & Repatriation Commissioner

UFF – Up Flow Filter

WLC – Whole Life Cost

WSP – Waste Stabilization Pond

1. Background

Fecal Sludge Management (FSM) is defined as the system that safely collects, transports, treats and disposes fecal sludge from containment (pit latrines, septic tanks or other onsite sanitation facilities) to environment.

Following the influx of Forcibly Displaced Myanmar Nationals (FDMN) into Bangladesh in 2017, humanitarian organizations implemented emergency response programs to support refugees. As of July 2023, there are 931,447 refugees accommodated in 33 camps around the towns of Ukhiya and Teknaf (+30,282 FDMN in Bhasan Char are not considered in this report). Different agencies provide WASH services to refugees. FSM is one of critical services provided in camps.

In Cox's Bazar Rohingya refugee response, the climate, topography, socio-cultural behavior, and high-density of population create challenging conditions for FSM. Several agencies have implemented FSM projects in refugee camps. As the Rohingya emergency has been extended to longer term, the WASH Sector would like to focus their FSM efforts on systems which have good treatment performance, limited operational input, low space requirements and are cost effective.

Following initial technical study in 2019, with eight fecal sludge treatment technologies, most efficient FSM technologies will be suggested based on evidence gathered through practical experience on best practices in FSM for disaster response.

1.1 Policy

The National Strategy for Water Supply and Sanitation for Bangladesh, 2021 includes a focus on FSM. The key component of the strategy for FSM are capacity building, promotion of appropriate technologies, ensuring the existing regulatory compliance as well as new guideline development and coordination improvement.

The Institutional Regulatory Framework for FSM (IRF-FSM) 2017: DPHE has established an FSM support cell to plan, design and monitor the activities of capacity building, awareness campaigns and standardization of the services and implementation of IRF-FSM through different projects.

Other major policies related to governing WASH are:

- National Strategy for Water Supply and Sanitation 2021
- Pro-Poor Strategy for Water and Sanitation in Bangladesh 2020
- Sector Development Plan (FY2011-25)
- NAP-Implementation of IRF FSM Paurashava 2020
- NAP-Implementation of IRF FSM City Corporation -2021 to 2030
- National Strategy for Water and Sanitation in Hard to Reach Areas of Bangladesh 2012
- National Strategy for Water Supply and Sanitation 2014
- The National Sanitation Strategy 2005
- The Environment Conservation Rules, 1997

2. Why FSM is Important?

Access to a functional sanitation service is considered to be a critical requirement for basic human dignity and health. The management of excreta disposal is complex and crucial. In Rohingya camp context where latrine pits get filled quickly, and around 1 million liters of fecal sludge require a safe management every day.

- Lack of functional sanitation facilities can endanger public health of the community and compel them to go back to open defecation.
- Human waste escaping to environment can contaminate ground water and surface water sources, which increases the risk of epidemics among the existing vulnerable population.
- With FSM, deadly diseases, such as Cholera and Dysentery, can rapidly become dangerous outbreaks in crowded camps.

3. Specific Objectives/Vision

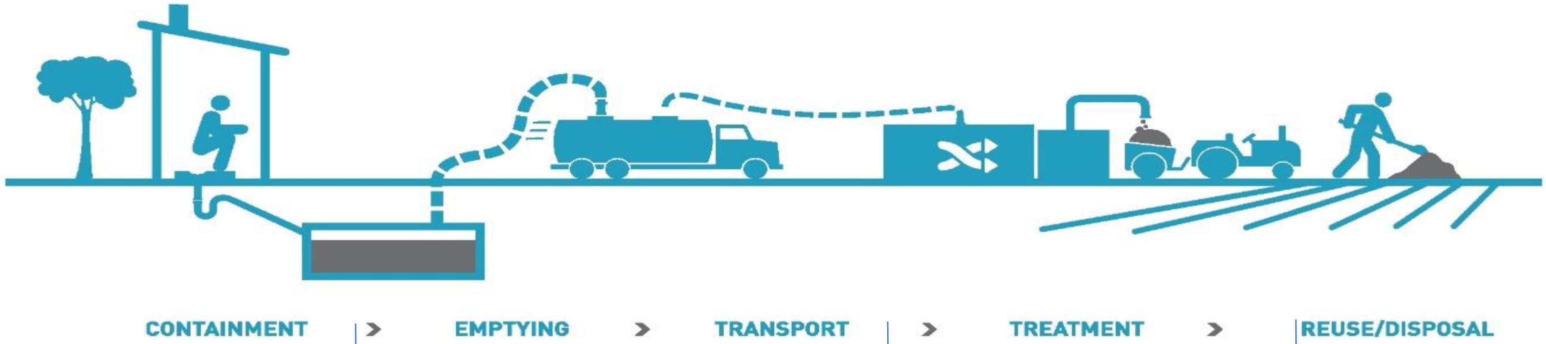
The objective of this strategic plan is to provide recommendations for potential future investment in collection, transport, treatment and safe disposal or reuse (both liquids and solids) of fecal sludge based on the five years of Sector's experience as well as the technical assessment on FSM in Cox's Bazar conducted in 2022. These recommendations include longer term operational and maintenance solutions for Fecal Sludge Management for the Ukhiya and Teknaf camps, which have to be agreed with all the major agencies and organizations involved in sanitation or coordination, and that can be adopted as a unilateral approach by the office of the Refugee Relief & Repatriation Commissioner (RRRC), as well as the Department of Public Health Engineering (DPHE) of the Government of

Bangladesh.

4. FSM Value Chain

FSM refers to the containment, emptying/collection, transportation, treatment, and safe end use or disposal of treated fecal sludge. Collectively, the collection, transportation, treatment and reuse or disposal of excreta constitute the "value chain" of FSM. In the context of Cox's Bazar, we are referring to fecal sludge contained within non-sewer sanitation systems, such as pit latrines and septic tanks.

Please refer to the infographic (next page – figure 1) for an overview of the FSM Value Chain.



Major Containment Type:

a) Single pit latrine
b) Twin pit latrine
c) Septic tank latrine

Key data:

- 49,530 latrines in the camps
- 21 person per functional latrine in camps
- 99% of households reporting using latrines
- 902,798 beneficiaries
- 995m³/day of sludge produced

Way of desludging

a) Desludging through pump
b) Desludging through Vacutug
c) Manual desludging (only in exceptional circumstances – access issues)

Way of transportation

a) FSTN (Fecal Sludge Transfer Network) – recommended way from a cost-efficiency point of view
b) Pit to pit transfer
c) Vacutug truck
d) Carrying in drums / tricycle

Key data:

- 29,718 m³ of FS in transit per month (+26% in wet season)
- Desludging rate: from few times a month to few times a year

Main treatment

a) Anaerobic Baffled Reactor (ABR)
b) Decentralized Waste Water Treatment System (DEWATS)
c) Anaerobic lagoon
d) Planted drying beds
e) Up Flow Filter
f) Waste Stabilization Pond (WSP)
g) Lime Stabilization Pond (LSP)

Key data:

- 164 FSTPs
- Capacity to treat 879m³ per day

Main solutions

a) Liquid discharge in surface drain
b) Infiltration
c) Incineration
d) Deep burial
e) Omni-processor
f) Co-composting

4.1 Sludge Production

The population in camps is estimated to be 931,447 beneficiaries (June 2023) with sludge generation rate of 1.1 l/p/day, we get a daily sludge of production of 1025 m^3. Based on rationalizing the existing rates used by NGOs, a range of 0.8 to 1.5 l/p/d could be used.

SLUDGE GENERATION
Average 1.1 Liter per person per day

It is fair to consider the disparities between camps, as there are some sludge retentions in the camps' latrines and tanks. Despite the evidence of low level of open defecation, it has been observed that increasing number of shelters have built or privatized their latrines, as well as informal urinals are also popular (mostly around mosques). Finally, during the wet season, the increased volume of sludge (+26%) impacting negatively on treatment capacity and quality.

4.2 Containment

In the FSM value chain, containment is an important part, because it helps to prevent the spread of contamination in the environment at the initial stage. Proper containment also ensures the safe collection and transportation of fecal sludge, which can improve overall public health and living conditions in the affected communities. There are around 49,530 latrines in Cox's Bazar camps (as per WASH Sector infrastructure dataset May, 2022). Most of them use pits with circular concrete rings for containment.

For the continuation of proper FSM as well as future programmatic decisions, following aspects need to be considered in terms of containment:

Total 1025 m^3 of fecal sludge (1.5 to 2% solid) is generated everyday (June 2023)

- **Extraction and safe disposal of settled solid** from the containment need to be carried out regularly to increase the capacity of existing pit. Solid settled sludge could be brought to FSTPs (especially FSTPs with dewatering system/drying beds).
- **Upgradation** work of latrine pits need to be initiated by replacing **less than 4 feet diameter** lining pit to increase the volume of the containments (and decrease desludging).
- In case of gaps (WASH Sector is aiming to 1 latrine for 20 people), new latrine should be constructed according to the unified latrine design 2023 (revised version from 2019).https://rohingyaresponse.org/sectors/coxs-bazar/wash/ (to access latrine design)
- **Gender and disability inclusion** needs to be considered during upgradation and new construction of latrines.
- Need to strengthen community engagement to develop ownership for ensuring maintenance, cleanliness etc. (through user group).
- Existing latrine repair & maintenance by Partners (using paid volunteers) is a critical and long-term activity in the camps.

Did you know?

Some latrine pits are disludged every week (or few time a month)! It could be done for different reasons: small pit volume (small ring diameter; inadequate depth or settled sludge at the bottom), poor infiltration rate or flood prone area, over population…

Such latrines have a significant cost in term of Operation. They should be identified and replaced or upgraded.

4.3 Collection/Emptying

The collection of sludge or emptying a latrine pit is commonly referred to as 'desludging' in the context here. There are mainly two methods of desludging that are being practiced in Cox's Bazar:

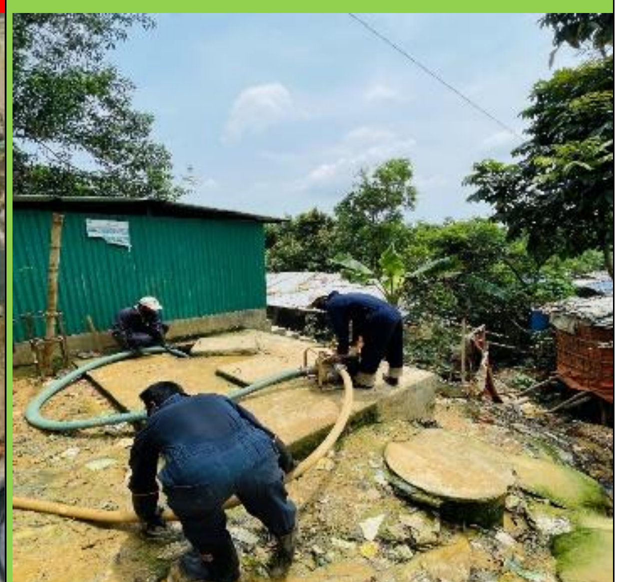
1. Manual desludging of a latrine pit with buckets, ropes, shovel and/or other relevant tools where sanitation workers come in direct contact with the fecal sludge.
2. Mechanical desludging using motorized or other appropriate pumps and pipes where the risk for sanitation workers exposure to fecal sludge is much less compared to manual methods.

Out of these two methods, it is, therefore, strongly recommended to use mechanical desludging over manual methods where feasible.

The current practices of desludging in the field showed a drawback where the liquid portion of the sludge is extracted through the mechanical pumps leaving the solid sludge/slurry accumulated at the bottom of the containment, resulting in accumulation of solid thickened sludge and making the removal difficult in future. It is, therefore, recommended to explore different options to identify suitable methods of mechanical desludging that can address this issue.

Personal Protective Equipment (PPE) must be worn by the sanitation workers throughout the desludging activities (refer to part 6).

Avoid manual desludging methods



Use mechanical pumps for desludging

4.4 Transport

Sludge transportation mode has significant impact on the whole sanitation chain. Improper and inadequate capacity of sludge transportation mode can lead to delayed desludging service & overflowing pits. Moreover, inadequate transportation approach can influence the cost of the overall treatment significantly. Therefore, the sludge collection area (catchment) and the transportation mode need to be considered in FSTP design, and ensure that, it will not be a bottleneck for the FSTP reaching its design capacity.

Considering the high number of users in the shared toilets, and the low infiltration rates in the containment system, the demand for fecal sludge emptying is very high. This situation is worsened during the rainy season (+26% increase of volume) due to the water table's raise and mixing of fecal sludge with rainwater.

Recent ARUP study found total 5 modes of transportation in the camp:

- Vacutug (vacuum trucks)
- Intermediate Fecal Sludge Transfer Network (IFSTN)
- Pit transfer/ temporary pipe and pump
- Manual Desludging and Transportation
- Combination of the above when more than one transportation mode is used.

30.750 m^3 of FS is in transit per month (26% average increase in the wet season)

In 2022, a technical assessment compared the existing transportation methods considering their performance in both dry and rainy seasons and the cost-effectiveness including Capital Expenditure (Capex) and Operational Expenditure (Opex) (*see Figure 1*). As a result, the piped network system is recommended as the most appropriate and effective fecal sludge (mostly liquid) transportation method in the Cox's Bazar context. It has to be considered that the IFSTN can be applied in centralized and decentralized systems. Additionally, it is not a permanent infrastructure and the existing containment solutions (such as septic tanks) could be used as transfer stations. For decentralized system, IFSTN could be as simple as flexible pipes connected to the nearest FSTPs (based on topography and distance). Detailed design and implementation guidelines could be found here (https://rohingyaresponse.org/sectors/coxs-bazar/wash/)

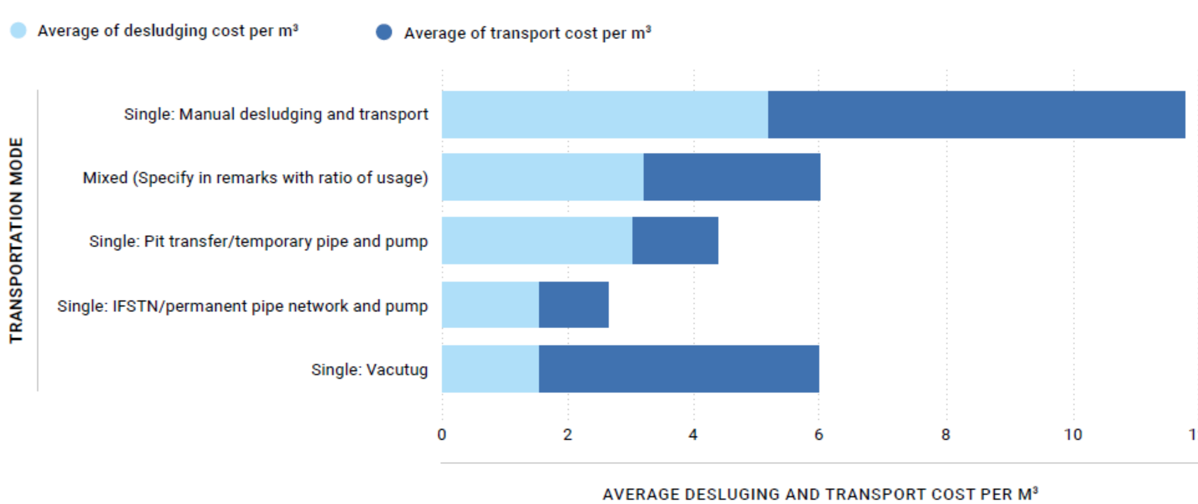


Figure 1: Monthly desludging and transportation costs per cubic meter of sludge (USD/m^3/month)
Source: Technical assessment on FSM in the Rohingya Response, ARUP 2022, page 30

4.5 Fecal Sludge Treatment Plant

During the first phase of emergency in the Rohingya response (2017-2020), a number of fecal sludge treatment solutions were implemented to cope with the increasing demand. There are 164 FSTPs operational in the camps (Feb 2023, WASH Sector). Among the existing technologies, Lime Stabilization Ponds, Solid Separation Units, Centralized Treatment Plants, Anaerobic Baffled Reactors, Up Flow Filters, Waste Stabilization Ponds, Anaerobic Digesters, Aerobic Digesters, Constructed Wetlands, Decentralized Treatment Systems (DEWATS), geotubes and others could be mentioned.

The existing treatment facilities have a total treatment capacity of 879 m^3/d, which shows that there is still a small gap for fecal sludge treatment (995 m^3 of sludge production are estimated per day as per data from March 2022).

After 5 years of the emergency response, in 2022, a technical assessment conducted by ARUP and led by WASH Sector (FSM core team) in Cox's Bazar evaluated the existing systems considering the following parameters: land requirement, capex, opex and whole life cost, operation and maintenance, and treatment performance (please refer to figure 3 below)

PARAMETERS	Centralised	Lime	ABR	Aeration	WSP	Anaerobic digesters	UFF	DEWATS
Design Capacity m^3/day	165 ave (150 to 180)	7 ave (5 to 10)	10 ave (6 to 15)	23 ave (15 to 30)	3.25 ave (2.5 to 4)	5	3 ave (3)	4.5 ave (3 to 6)
Treatment area m^2/m^3	45 ave (33 to 58)	47 ave (17 to 98)	49 ave (9 to 175)	23 ave (18 to 28)	13.5 ave (9 to 18)	61	28 ave (28)	29.5 ave (20 to 39)
Scalability	Medium	Medium	Low	High	Low	Medium	High	High
Capex UDS $/ m^3	5,517 ave (4,646 to 6,388)	2,891 ave (1,554 to 4,060)	5,758 ave (1,564 to 13,907)	3,983 ave (3,333 to 4,633)	5,244 ave (2,600 to 7,888)	1,392	8,133 ave (8,133)	3,555 ave (3,555)
Opex UDS $/ m^{3*}	3.65 ave (0.60 to 6.7)	5.94 ave (3.44 to 9.57)	11.7 ave (0.4 to 44.2)	29.46 ave (26.75 to 31.4)	3.3 ave (2.6 to 4)	0.39	4 ave (1.4 to 7.22)	0.8 ave (0.69 to 0.91)
Whole life cost	653 ave (474 to 831)	2,188 ave (1,607 to 2,858)	3,063 ave (419 to 8,530)	3,579 ave (1,553 to 5,604)	1,584 ave (1,248 to 1,921)	306	939 ave (939)	500 ave (453 to 548)
Construction time (months)	12	1.3 ave (1 to 2)	4.5 ave (2 to 8)	9 ave (8 to 10)	2.5 ave (2 to 3)	2	1.5 ave (1.5)	1 ave (1)
Complexity of process	Medium	Medium	Low	High	Low	Low	Low	Low
Treatment performance	Good	Poor	Poor (for pathogens)	Good	Medium	Medium	Medium	Medium

Figure 3: Review of parameters for each FSTP type

Based on figure 3 (and aligned to finding from January 2020 ARUP's studies), WASH Sector is not recommending the following technologies anymore. Such units should be decommissioned and replaced by more performing units in the context of the camps:

1) Geotube
2) Lime Stabilization Pond (LSP)
3) Solid Separation Unit (SSU)
4) Open Desludging Pond (ODP)

In the camps, there is a wide range of FSTP technologies used, all with their advantages and disadvantages (refer to figure 3). There are different approaches to implement FSTPs:

- Centralized approach (Capacity > $50m^3$/ day) covering few camps)
- Semi-centralized / decentralized (Capacity 15 to $50m^3$/day covering one full camp or few blocks)
- Decentralized approach (Capacity between 3 to $15m^3$/day covering one or two blocks of a camp)

This FSM strategy recommends neither centralized nor decentralized approach. However, it provides evidence and criteria that should help the decision makers to choose the most adaptable technology based on the context.

A) Budget:

Capital expenditure (Capex):

- Centralized approach: 5,500 USD per m^3 of sludge (ARUP, 2022)
- Decentralized approach: 4,700 USD per m^3 of sludge (ARUP, 2022)

Both approaches are very similar in terms of investment per cubic meter of treated sludge. However, if you have a small budget (few thousand USD to few tens of thousands USD), decentralized approach will be recommended. If you are able to mobilize a significant budget (between 400 thousand to one million USD), then a centralized approach could be considered.

Operational expenditure (Opex):

- Centralized approach: 3.7 USD per m^3 of sludge (ARUP, 2022)
- Decentralized approach: 9.3 USD per m^3 of sludge (ARUP, 2022)

The Opex of FSTPs is heavily influenced by energy usage (usually for pumping), and chemicals required (such as lime); as well as the number of operators needed, and the rent of the land.
Opex is a key criteria in the design of action and it's not recommended to implement FSTPs with high Opex costs (e.g..: Aeration, Lime Stabilization Ponds).
For most of the FSTP technologies, using a centralized approach would be more cost effective in terms of operation costs but some small scale FSTPs offers low Opex (ABR, DEWATS).

Opex: have you thought about it?

When pumping is required, solar energy could be used to reduce the Opex. A thoughtful layout design, which minimizes the use of space could also help reduce the cost by reducing the rent and the needed area for general site maintenance.

Whole Life Cost (WLC):

A comparison of "Whole life cost" per year per m^3 capacity showed that most FSTP types are within the range of USD 500 to 1,500. The centralized plants were at the lower end of this range, showing that, across their lifecycle, they are comparable or more cost effective than most decentralized FSTPs (except DEWATS and well-designed ABR).

B) Surface area:

In highly dense camps with limited space available, this criteria is the key. According to WASH Sector, centralized plants require 2 times[1] more space per cubic meter of sludge treated than decentralized plants (based on total useful area of 3 centralized FSTPs compared to 18 decentralized units – refer to figure 4).

Camp Name	Technology	Design Capacity (m3/day)	Total FSTP Area from Goolge Earth (without bush area)	Area Required (m2/m3) treated
Total decentralized		154	10345	67
Camp 09	DEWATS	3	80	27
Camp 08W	WSP	2.5	131	52
Camp 07	WSP	5	154	31
Camp 12	DEWATS	6	192	32
Camp 08W	ABR	10	240	24
Camp 14	ABR	10	255	26
Camp 01W	Lime	5.5	320	58
Camp 05	ABR	10	330	33
Camp 19	Aeration	30	682	23
Camp 18	Aeration	15	893	60
Camp 04	Lime	10	1,440	144
Camp 12	ABR	10	1,683	168
Camp 18	ABR	15	2,454	164
Camp 07	Upflow Filter	3	34	11
Camp 08W	Upflow Filter	2.85	120	42
Camp 26	ADS	5	670	134
Camp 26	Lime	5	253	51
Camp 07	ABR	6	414	69
Total centralized		450	60624	135
Kutupalong	Centralised System	180	15,655	87
Camp 04 Ext	Centralised System	150	35,369	236
Teknaf camp	Centralised System	120	9,600	80

Figure 4: Comparing footprint per technology and their treatment capacity (WASH Sector, 2023)

[1] ARUP study shows limited differences as centralized FSTP are using 46m2/m3 against 39m2/m3 for decentralized FSTPs .The methodology used by ARUP in that case to calculate m^2/m^3 of sludge by ARUP is: "*tank areas plus an additional 5%*".

C) Treatment performance and efficiency:

A majority of FSTPs fail to meet the DoE effluent standards for most of the parameters (especially for Nitrogen). However, significant progress is continuously being made on the performances (refer to monitoring dashboard). Moreover, despite not reaching all the standards, risk to human health and the environment is significantly decreasing (minus 97% of coliform; minus 96% for COD & BOD) – see figure 5

Department of Environment Guidelines update 2019, Schedule 7 – Standards for Sewage Discharge									
Sampling Point	pH (6 to 9)	BOD (30 mg/L)	COD (200 mg/L)	Nitrate (250 mg/L)	Phosphate (35 mg/L)	Total Nitrogen (15 mg/L)	Suspended Solid (100 mg/L)	Temperature (30 ℃)	Coliform (1000 cfu/100 mL)
Inlet (Avg)	7.7	5,284	14,684	79.0	124	2,122	10,661	28.5	53,307,101
Outlet (FSL Data Avg)	8.1	237.7	660	43.6	42	506	199	28.2	1,827,040
% of Reduction		**96%**	**96%**		**66%**	**76%**	**98%**		**97%**

Figure 5: FSTP effluent quality monitoring (WASH Sector, April 2023)

The ‘centralized’ FSTPs showed generally better and more consistent performance than the smaller ‘decentralized’ FSTPs (refer to monitoring dashboard). Moreover, it has the advantage to bring away any risk from population. Following one year of monitoring performances of the decentralized FSTPs: Aeration system, ABRs (Anaerobic Baffled Reactor), DEWATS, UFF (Up flow filtration) ADS (Anaerobic Digester system) are showing significant performances and progress.

The ‘centralized’ FSTPs are also able to cope with variability of the sludge, which can happen during rainy seasons. FSTP (mostly DEWATS), where the final step of disposal is infiltration, could lead to lower performances during monsoon season as the soil is saturated with water.

Construction time of centralized FSTPs is to be taken into consideration (3 to 6 times more than decentralized FSTPs) when considering performances, as not having FSTP for one or two years may create a significant health risk on short-term.

D) Contextualization of the approach:

Many of the above criteria are in favor of the centralized plants with a transfer network. However, existing context need to be considered:

- Lacking land access near or inside the camps is a serious limitation to implement centralized FSTPs.
- RRRC/Government is reluctant to long-term infrastructures (and therefore to the massive use of concrete).
- All small FSTPs built within the emergency phase (2017 – 2020) or FSTPs not recommended anymore (Geotube, LSP, SSU, ODP) should be decommissioned. However, significant investments have been done over the past years (2021 – 2023) with performing small FSTPs, so building centralized FSTPs in areas which are already well-covered by small FSTPs require field-based need assessment or to be a part of “build back better” after disaster (mostly fire).
- Funding for the FDMN has decreased significantly (especially for centralized large-scale infrastructures) over the past years and will continue to decrease in the coming years.
- Refugees are not meant to stay on long-term (despite significant likeliness) and the existing land for the refugees is meant to return to natural land/national park, so any major infrastructures

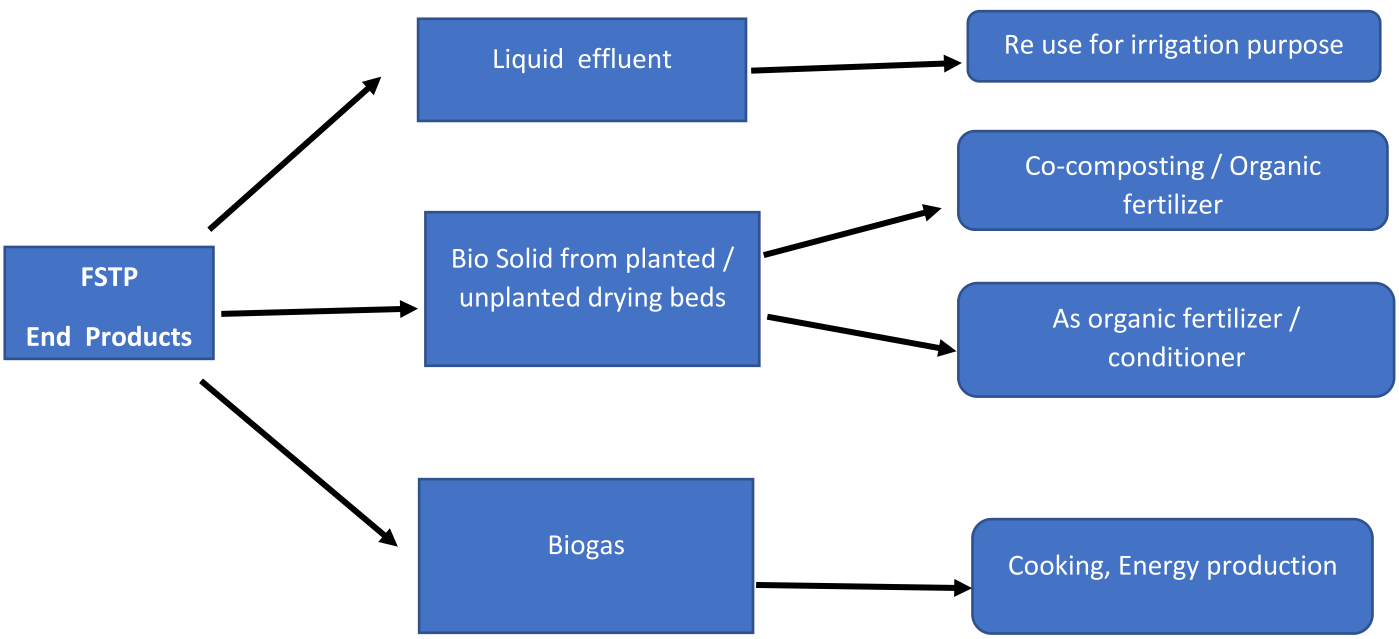
may be more costly and complex to decommission, and there may not be any alternative usage of it (except in Teknaf area where refugees and Host Community live in the same area).

Therefore, this FSM strategy does not provide a clear recommendation for selection between centralised and decentralised approach rather provides evidence and criteria that should help decision makers to choose the most adaptive technology based on the context.

5. Disposal / Reuse

It is recommended that all FSTPs should have the capacity or plan for safe solid disposal or reuse process. It includes a pre-treatment unit for dewatering and drying in order to enhance the quality of the waste and decrease its volume, thereby reducing its overall impact. Raw settled sludge typically contains a large concentration of Helminth eggs and larvae, making it necessary to follow proper procedures and guidelines prior to any application.

Till date, the potential for generating value from the end products of FSTPs in camps has not been extensively explored. To move forward, it may be worthwhile to consider the following areas of opportunity.



Special cautions and guideline should be followed before blending the fecal sludge into agricultural sector.

5.1 Co-composting

Dried fecal sludge collected from unplanted and planted drying beds can be mixed with organic portion of solid waste with 1:3 ratio[2], taking the advantage of destroying helminth eggs with higher degree of temperature. To get a quality product, the whole co-composting process in the field needs to be maintained complying with certain guidelines on C:N ratio, Size, texture and moisture content of input materials, composting period, bacteriological activity, turning frequency, environment etc.

Challenges in reuse of co-compost product

List of barriers

1. Assessment for total generation quantity, quality of product and market demand analysis are missing in Rohingya camp context.

2. There is no specific guideline/standard in Bangladesh for using the end product of fecal sludge in agricultural sector under agricultural fertilizer/compost category.

3. Licensing process is available in Bangladesh for compost products, but not for co-compost products. Bangladesh National Fertilizer Standardization Committee has given approval for several organic fertilizer producing companies which produce fertilizer from solid waste mainly.

4. No clear envision/plan engaging private sector for value generation and creating business model based on existing centralized systems.

"Public Perceptions of Reuse of Faecal Sludge Co-Compost in Bhubaneswar, India" reveals that, the fear of infection and bad odor were the key factors influencing fertilizer retailers' negative perceptions[3], while inadequate information, unavailability, and lack of government policy on FS co-compost reuse were the key factors influencing the negative perception of the Farmer Producer Organisations.

Policies

The current regulations and approval process from BNFSC only recognizes compost as a product made from organic solid waste, excluding compost made from fecal sludge. This limitation creates obstacles for obtaining a license and conducting business related to co-compost products.

1. Bangladesh Standards and Guidelines for Sludge Management, DOE ,2015
2. DoE 2019

5.2 Incinerators to Burn Dry Sludge

Incineration of dry sludge is a common option, however, it needs to respect few conditions:

- Filtration systems should be installed on the incinerator as the combustion can emit toxic & harmful constituents impacting surrounding human and environmental health.

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[2] https://www.nepjol.info/index.php/IJE/article/view/14562#:~:text=Generally%20the%20compost%20ratios%201,for%20use%20as%20organic%20fertilizer

[3] https://www.mdpi.com/2071-1050/14/8/4489
https://www.nepjol.info/index.php/IJE/article/view/14562#:~:text=Generally%20the%20compost%20ratios%201,for%20use%20as%20organic%20fertilizer.

- Additional fuel (possibly wood and bamboo from Material Recovery Facilities) should be considered.
- Incineration of solid sludge inside the camp is not recommended due to potential health risks & air pollution (which could be tackled by filtration system) but also due to the risk of fire. Therefore, incineration could be considered outside the camps.

5.3 Burying Dry and Treated Sludge

Burying is also a common option but it's important to note that sludge burial should be considered as a last resort, after exploring the options for sludge reduction, reuse, and recycling. Efforts should be made to prioritize sustainable and environmentally friendly sludge management practices, such as composting, anaerobic digestion, or thermal treatment with energy recovery. In terms of burying dry and treated sludge, the following aspects can be considered:

- Safe distance from the ground water table during the time of preparing burying trench Needs to be checked and maintained.
- Centralized sanitary landfill can be an option for burying dry and treated sludge.

5.4 Other Innovative Options to Explore

1. Briquettes production: Charcoal briquette production done in Uganda[4], combining fecal sludge (40%) with charcoal dust (60%).
2. Utilizing sludge cake for fish farms[5], increasing the growth of phytoplankton.
3. Reuse of sludge cakes as construction materials[6], used for brick production.
4. Engagement of private sector: NGOs may adhere to the principle of not engaging in profit-making activities, such as the sale of compost or end products from FSTPs. In such cases, it may be necessary to involve the private sector to establish a viable and sustainable business model for operating FSTPs.

5.5 Infiltration

FSTPs that are not meeting DoE effluent standards for most parameters, can possess a risk to human health and the environment. Most of the FSTPs use infiltration via soak pit or infiltration field as the final disposal for liquid, perhaps negating the need to meet the DoE (discharge to surface water) standards. It is likely that larger or additional treatment units, hence larger areas, would be required for these FSTPs to achieve better effluent quality. Where infiltration is the final disposal route for FSTP effluent (and DoE pathogen standards are not achieved), ground water risk assessments as well as the water level variation depending on the season need to be considered to design the infiltration area and associated FSM chain properly.

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[4] https://thewashroom.waterforpeople.org/wp-content/uploads/sites/2/2019/09/Making-Briquettes-from-Fecal-Sludge-Fact-Sheet-Feb-2019.pdf
https://www.oxfamwash.org/en/innovation/_future/Briquetting%20WIF%20project%20Summary.pdf

[5] https://snv.org/assets/explore/download/snv_-_impact_of_treated_fecal_sludge_on_fish_growth.pdf
https://www.researchgate.net/publication/328498121_Assessment_of_Treated_Fecal_Sludge_for_Fish_Growth_and_Microbial_Load
https://www.fsmtoolbox.com/assets/pdf/34.Sanitation_TB_Fecal_Sludge_Use_2016-07_en.pdf

[6] https://www.researchgate.net/publication/295548404_Reuse_of_Water_Treatment_Plant_Sludge_in_Brick_Manufacturing

5.6 Release in Water Streams

Risk assessments should determine the minimum treatment requirement, but it is likely to meet the DoE discharge standards for pathogens (albeit they relate to surface water). If the effluent does not meet the DoE standard, disinfection methods (chlorination or other) should be used before discharging to reduce the risk of spreading disease via pathogens.

6 Protective Equipment for Sanitation Workers

Sanitation workers are engaged in FSM operations (desludging, transport, treatment, O&M), and fecal sludge handling increases the risk of waterborne diseases.

All agencies engaging sanitation workers should be accountable for ensuring the safety PPE for every worker.

Moreover, paid volunteers working on FSM should receive a bonus for "working in challenging environment where they face greater risks or exposures" (+1,100 Tk per month or + 50 Tk a day) while accepting through formal engagement risks and conditions, as per RRRC guidance from November 2022.

All FSM agencies should:

- Distribute regular PPE (face Mask, hand gloves, full body apron, safety gumboot, safety helmet).
- Provide refresher training for workers on risk, safety and hygiene (training content is available here)
- Make sure of key vaccination. Tetanus vaccinations should be up to date, and with consideration, Polio, Cholera, Typhoid fever, Hepatitis A and Hepatitis B vaccinations can also be given if needed.
- Need to ensure at least one washing station at every FSTP.

7 Way Forward and Recommendations

This section provides key recommendations for improvements on FSM as well as criteria to select the best technology and most appropriated approach.

1) Containment

   a. **Volume of containment:** all latrines should have adequate volume to limit the need for desludging through maintenance, upgradation or new construction.
   b. New latrine construction should be built according to unified latrine design 2023 https://rohingyaresponse.org/sectors/coxs-bazar/wash/ (to access latrine design).
   c. Gender and inclusion need to be considered in the implementation of the latrines.
   d. User committees need to be created for ownership and maintenance.

2) Collection
   a. **Desludging:** Manual desludging and manual transportation is not recommended. Actors should use mechanical pumps and IFSTN to desludge and transport the sludge.
   b. **Protection of FS workers**: Fecal sludge workers should be trained, protected (wearing Personal Protective Equipment) and vaccinated (mostly Tetanus with consideration for Polio, Cholera, Typhoid fever, Hepatitis A and Hepatitis B as well).

3) Transport

a. **Intermediate Fecal Sludge Transfer Network (IFSTN)** should be applied in all sanitation systems. They can be semi-permanent infrastructures for the bigger FSTPs or flexible hose for smaller FSTP units (potentially with transfer stations). In August 2022, big scale IFSTN has been approved by RRRC using cost-efficiency for operation and no-permanent infrastructures (transfer stations and network being mostly in plastic) as the main arguments.
b. **Gap analysis & design capacity:** WASH Sector and Partners should have a gap analysis approach on FSM per catchment areas (or camps) and make sure that all the areas are covered by correctly designed FSTPs and that cover the needs (production of sludge vs FSTPs capacity). This could help to identify areas with gaps and/or decommissioning needs.
c. **Centralized approach:** Few criteria are in favor of centralized approach. In case of any new influx of refugees, centralized approach needs to be considered as the most adapted approach. However, this recommendation needs to be contextualized (refer to part D of section 4.5) and it does not apply to camps where decentralized approach has been implemented already.

4) Treatment

a. **Decommissioning:** Before making the decommissioning plan, agencies should have an alternative FSM plan pre-approved by Actors and Partners. Decommissioning should be a priority to who oversees WASH at camp level, regardless of who builds the FSTPs. This is particularly true for old FSTPs (emergency phase 2017-2019) which have proven limited efficiency: Geotube, LSP, SSU and Open Desludging Pond (ODP). Old FSTPs represent a significant health and environmental risks that need to be addressed seriously.
b. **Build Back Better:** Disasters (especially fire or strong wind) may destroy camps and its infrastructures partially. After disaster response, one of the priorities is the "build back better phase". For FSTPs, it may mean building the most suitable FSTP technology (refer above) or changing the approach (e.g.: from decentralized to centralized). Despite all the challenges of a disaster response, it may also represent an opportunity to approach Fecal Sludge Management differently.
c. **Not recommended small scale FSTPs:** Geotube, LSP, SSU, ODP, constructed wetland and Aeration are technologies which are not recommended for small scale FSTPs.
d. **Most suitable small scale FSTPs in current context:** ABRs (Anaerobic Baffled Reactor), DEWATS, UFF (Up Flow Filters), ADS (Anaerobic Digester system) and Waste Stabilization ponds (WSP).
e. **Specific case of aeration FSTPs:** Due to high Opex and complexity of the system, "Aeration system" is not recommended anymore. However, if they are already existing in the camps and performing well, it does not mean they should be decommissioned either.
f. **Reduce Opex:** For long-term, the choice of approach and technology should be heavily influenced by low Opex. For short to medium-term, Opex is heavily influenced by energy, required chemicals, number of required operators, and the rent of the land. When pumping is required, solar energy could be used to reduce the Opex cost. A thoughtful layout design which minimizes the used space could also help reducing the cost by reducing the rent and the area in need of general site maintenance.
g. **Site identification:** Topography and road access to FSTPs should be considered in the design phase.

5) Final disposal/Reuse

   a. **Study sludge disposal & re-use**: WASH Sector should study innovative ways to deal with treated and solid sludge to potentially create value from it.
   b. **Disposal of dry sludge**: In the current context, burning and burying dry treated sludge (outside the camps) seems to the best solution.
   c. **Infiltration after treatment**: Where infiltration is the final disposal route for effluent (and DoE pathogen standards are not achieved), risk assessments for ground water are required to design the infiltration area properly (based on infiltration capacity which is lower in the monsoon) and define a groundwater protection zone.
   d. **Discharge to water streams:** The sites discharging directly to water sources/surface water drainage systems do not often meet the FE standards, and therefore, the FSTPs require improvement, disinfection system (chlorination or other) to reduce the risk of spreading diseases. However, turbidity needs to be controlled and cost could be a limitation to good chlorination.

6) Other recommendations

   a. **Support Fecal Sludge Laboratory (FSL)** need to continue to provide monitoring of the effluent quality (as third-party monitoring) for partners to take necessary corrective actions. A robust monitoring system for the performance of treatment plants based on standards set-up in Bangladesh is essential (refer to part C in section 4.5) and should be available on-line.
   b. **Resilience:** Resilience to heavy rain, landslide, flood and fire needs to be considered in the design of the FSTPs (despite space limitation).
   c. **Host's communities**: This strategy is focusing on camps and recommendations for camps does not necessary apply to host's communities where context it totally different. Cost's recovery system needs to be put in place for host's communities and could be more effective for semi-urban and urban areas.
   d. **Protection of FS workers**: FSM workers should be trained, protected (wearing PPE) and vaccinated (mostly Tetanus with consideration for Polio, Cholera, Typhoid fever, Hepatitis A and Hepatitis B)