अमृत 2.0
Atal Mission for Rejuvenation and Urban Transformation

उत्तर प्रदेश सरकार

स्वच्छ भारत
एक कदम स्वच्छता की ओर

DEPARTMENT OF URBAN DEVELOPMENT, GOVERNMENT OF UTTAR PRADESH

SOP FOR OPERATIONS AND MAINTENANCE OF FSTPs AND CO-TREATMENT PLANTS IN UTTAR PRADESH

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Acknowledgement

The Standard Operating Procedure for O&M of FSTP and co-treatment plants is inspired by a similar advisory issued by the Housing and Urban Development Department, Government of Odisha, letter no. 22241/HUD dated 24.12.2021.

Centre for Science and Environment developed this document to suit the Uttar Pradesh context, based on its regular supportive visits to the plants and discussions with various contractors who constructed the plants and carried out O&M activities.

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LIST OF ABBREVIATIONS

1.	ABR	Anaerobic baffled reactor
2.	AMRUT	Atal Mission for Rejuvenation and Urban Transformation
3.	BCC	Behaviour change communication
4.	BOD	Biochemical oxygen demand
5.	CAPEX	Capital expenditure
6.	CB	Capacity building
7.	COD	Chemical oxygen demand
8.	CPCB	Central Pollution Control Board
9.	CSE	Centre for Science and Environment
10.	CW	Constructed wetlands
11.	DoUD	Department of Urban Development
12.	DPR	Detailed project report
13.	EO	Executive officer
14.	FS	Faecal sludge
15.	FSM	Faecal sludge management
16.	FSSM	Faecal sludge and septage management
17.	FSTP	Faecal sludge treatment plant
18.	GoI	Government of India
19.	GoUP	Government of Uttar Pradesh
20.	KL	Kilolitre
21.	KLD	Kilolitre per day
22.	MLD	Million litre per day
23.	MoHUA	Ministry of Housing and Urban Affairs
24.	MSW	Municipal solid waste
25.	NMCG	National Mission for Clean Ganga
26.	O&M	Operation and maintenance
27.	OPEX	Operational expenditure
28.	OSS	On-site sanitation
29.	PPE	Personal protective equipment

30.	SBM	Swachh Bharat Mission
31.	SDB	Sludge drying bed
32.	SMCG	State Mission for Clean Ganga
33.	ST	Septic tank
34.	STP	Sewage treatment plant
35.	STT	Settling thickening tank
36.	TBF	Tiger bio-filter
37.	ULB	Urban local body
38.	UP	Uttar Pradesh
39.	UPJN	Uttar Pradesh Jal Nigam

Foreword

Since the introduction of the National Faecal Sludge and Septage Management (FSSM) Policy in 2017, India has made significant strides in strengthening its sanitation infrastructure. Over 1,500 faecal sludge treatment plants (FSTPs) have been established across the country, with many cities also upgrading their existing sewage treatment plants (STPs) to co-treat faecal sludge through specialised units. This effort marks a crucial shift towards sustainable and decentralised sanitation solutions, especially in cities and towns where centralised sewage networks are not feasible.

Initially, the FSTPs set up around 2017 predominantly employed nature-based and low-energy treatment approaches, which gained popularity for their minimal environmental impact and cost-effectiveness. Since then, evolving local contexts, varied space constraints, and technological advancements have led to the development of diverse FSTP designs. These designs now encompass a wide range of treatment technologies, including nature-based solutions (NBS), hybrid nature-based systems, electro-mechanical systems, and innovative methods like pyrolysis.

Despite these advancements, there remains a critical need for standardised guidance on the operations and maintenance (O&M) of FSTPs. This document addresses that gap, offering practical guidance for the effective O&M of FSTPs in Uttar Pradesh, where septage-based systems serve most of the urban local bodies. With 58 out of the 59 FSSM projects completed across 56 urban local bodies—ensuring their optimal functioning is essential for sustaining the state's efforts to reduce river and groundwater pollution.

The FSTPs in Uttar Pradesh utilise a mix of treatment technologies, providing flexibility in adopting different modules for septage treatment. This standard operating procedure (SOP) document aims to equip plant operators, engineers, and officials with a comprehensive understanding of O&M procedures for various treatment modules, supporting urban local bodies and institutions in monitoring and sustaining plant operations.

Moreover, this SOP is designed not only to serve India's needs but also to be a valuable resource for other regions in Asia and Africa, where faecal sludge management (FSM) is still developing. By providing actionable insights into establishing and maintaining well-functioning treatment plants, this document seeks to contribute to improved sanitation and public health outcomes on a broader scale.

1. Introduction

1.1 Background

It is essential that the faecal sludge and septage management infrastructures are well operated and managed to sustain services for the communities. It is essential that FSSM projects run with efficiency. A treatment plant that is operated and maintained properly shall remain efficient and long lasting. Hence, operation and maintenance (O&M) tasks become crucial once the plant is commissioned. In addition, the performance of treatment plant directly depends upon how well it is maintained and operated.

This standard operating procedure (SOP) is intended for use by the operators, caretakers, and maintenance personnel, and to facilitate them in carrying out routine and critical tasks.

Operational tasks involve activities necessary for running the infrastructure and ensuring proper usage by users. Maintenance, on the other hand, comprises of planned or reactive activities required to keep the plant functional. Effective O&M requires certain skills, tools, and spare parts. This document is intended to provide the necessary knowledge and skills for the operation and maintenance of FSTPs and co-treatments facilities in Uttar Pradesh.

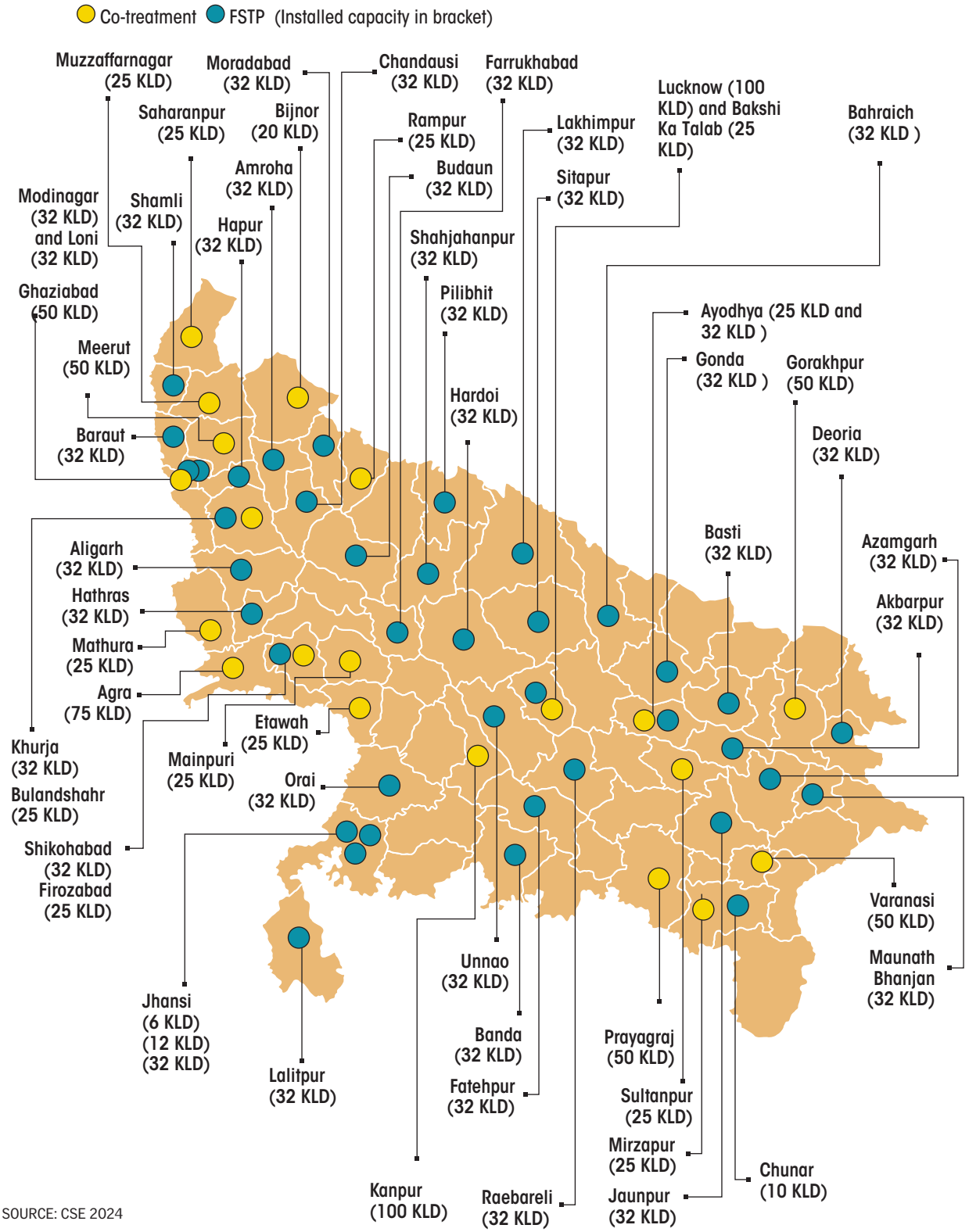
1.2 UP scenario

Effective and scientific management of faecal sludge and septage is critical for sustainable urban sanitation, especially in Uttar Pradesh, where most of the urban local bodies depend on septage-based systems.

UP is constructing total 59 plants—39 FSTPs and 20 co-treatment plants. As of September 2024, infrastructure for 58 FSSM projects has been completed, with one plant still under construction. As Uttar Pradesh transitions from the construction phase to the operational phase, regular O&M activities become imperative. Ensuring the proper functioning of these plants is crucial to sustain the state's efforts in mitigating pollution in rivers and groundwater.

At present, 59 FSSM projects in urban areas of UP, funded through either Atal Mission for Rejuvenation and Urban Transformation (AMRUT), National Mission for Clean Ganga (NMCG) or Urban Local Bodies (ULB), are spread across 56 ULBs of varying size.

Figure 1: Spread of FSSM projects in Uttar Pradesh



SOURCE: CSE 2024

1.3 Technology

- The analysis of the 39 FSTPs shows that there are two typologies of septage treatment:
  - o Hybrid: Modules comprising both natural and mechanised treatment technologies, used in the different combinations.
  - o Nature-based: Nature-based treatment modules, independent of electromechanical equipment involved in the treatment process.

Within the hybrid (Type 1 and Type 2) and nature-based (Type 3 and Type 4) treatment systems, two treatment chains have been identified for each system (see *Figure 2: Four broad configurations used in FSTPS of Uttar Pradesh*). Of the 39 FSTPs, 26 follow the Type 1 configuration, six follow the Type 2 configuration, three use the Type 3 configuration, and four follow the Type 4 configuration.

- An analysis of the 20 co-treatment units in the state reveal five broad module configurations (see *Figure 3: Five broad configurations used in co-treatment plants of Uttar Pradesh*). Out of 20 co-treatment plants, nine follow Type 1 configuration, four follow Type 2, one follows type 3, five follow Type 4, and one follows the Type 5 configuration.

1.4 Use of this document

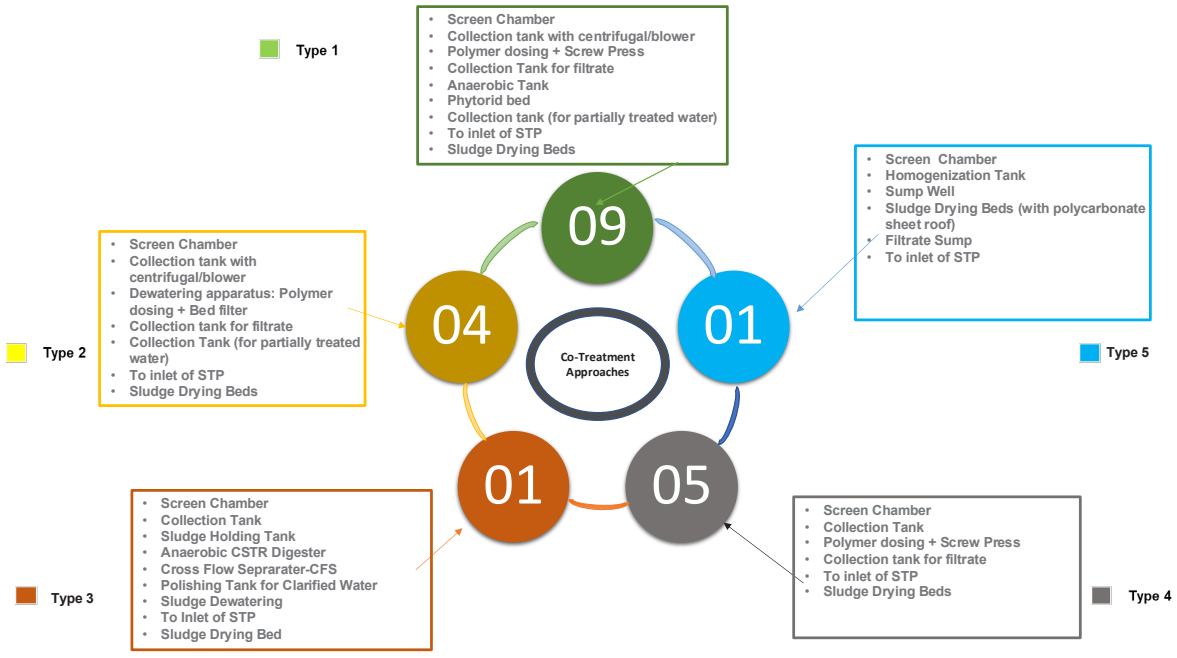
This is a reference document for any person or entity responsible for O&M of the infrastructure to:

- Carry out tasks related to O&M for the upkeep of the FSSM infrastructure.
- Transfer knowledge about the functioning of different components of infrastructure to operators and users.
- Monitor compliance of faecal sludge treatment system with effluent standards

Figure 2: Four broad configurations used in FSTPS of Uttar Pradesh

SOURCE: CSE 2024

Figure 3: Five broad configurations used in co-treatment plants of Uttar Pradesh



SOURCE: CSE, 2024

for safe reuse or disposal of treated wastewater.

- Prevent system breakdown.
- Ensure long-term functionality of all the infrastructure components.
- Ensure personal safety and hygiene within the plant campus.

1.5 Aspects covered in the SOP

The major parts of this SOP are:

- Safety measures along with the tools and equipment required for operating a treatment plant.
- Details of different modules, including operation and maintenance tasks.
- Safety protocols along with the emergency response measures to be observed while working.
- Responsibilities of personnel deployed at treatment plant sites.

1.6 Target users

This manual is intended for individuals, authorities, or agencies responsible for the maintenance and management of plant infrastructure. These may include:

- Engineers and officials of UP Jal Nigam and Jal Kal department.
- Municipal engineers and officials of different urban local bodies.
- Any agencies engaged in the O&M tasks.

2. Safety measures

This section provides an overview of the basic dos and don'ts related to the safety measures which need to be followed during O&M activities. Before proceeding, it is necessary to understand the two vital aspects of safety, i.e., hazards and risks.

- **Hazard:** A hazard is anything that could cause harm.
  - Natural hazards: Result from environmental phenomenon, and can be often predicted, for example, cyclones, earthquakes, and river flooding.
  - Man-made hazards: Arise from prior human intervention, such as a faulty anaerobic baffled reactor (ABR) tank with improper lids potentially crashing or breaking down.

- **Risk:** The likelihood of harm occurring when exposed to a hazard, potentially leading to adverse health effects. For example, opening an ABR lid without proper PPE and inhaling harmful gases constitutes a risk.

2.1 Need for a safety and health programme

The need for a robust health and safety programme in the workplace is critical to preventing work-related injuries, illnesses, and fatalities. Such a programme not only safeguards the well-being of employees but also spares workers, their families, and employers from the hardship and financial difficulties that can arise from these incidents. Additionally, a strong health and safety programme contributes to improvements in production and quality, enhances employee morale, and aids in recruiting and retaining top talent. Moreover, it helps cultivate a positive image and reputation among customers, suppliers, and the community at large. In this direction, a first step could be hazard identification and risk assessment (HIRA) at the workplace.

2.2 Hazard identification and risk assessment (HIRA)

Systematic, critical appraisal: Conduct a thorough and systematic evaluation of all potential hazards related to personnel, plant, services, and operational methods.

- **Safeguard identification**: Determine the existing safeguards in place to manage the risks associated with these hazards.
- **Control measures**: Recommend additional control measures to further reduce the risks to an acceptable level.
- **Risk register**: Develop and maintain a risk register to regularly monitor risks, detect changes, and ensure the effectiveness of control measures.

2.3 General site safety

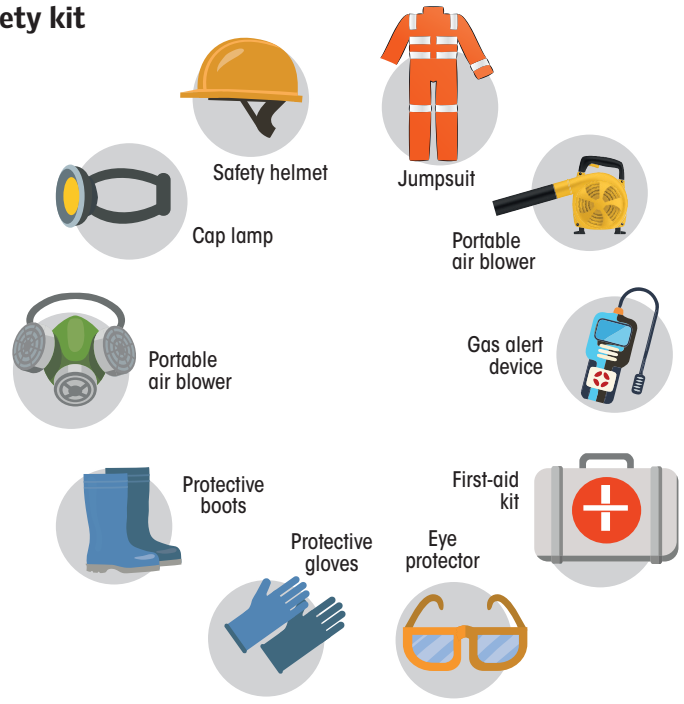
- Be cautious and observant at all times.
- Ensure maintenance holes are suitably covered or supervised when no O&M activity is being performed.
- Do not leave open chambers unattended.

Figure 4: Safety precautions

2.4 Personal safety precautions

- Follow the safety precautions while emptying the septic tanks (see *Figure 4: Safety precautions*).
- Use appropriate clothing (long-sleeved shirt, long trousers, shoes and gloves, apron, mask) while performing the tasks (see *Figure 5: PPE, safety kit*).
- Wash your hands and disinfect them after completion of tasks.
- Keep a first-aid kit, lime or concentration of chlorine solution, hand-wash and hand sanitiser, spare gloves, and masks at the treatment plant.
- Avoid direct contact and protect wounds from wastewater exposure.
- Wash clothes, gloves, and boots after conducting the activity. The maintenance provider should change into off-duty clothes on completion of desludging; and wash and disinfect the clothes used while desludging before the next use.
- Do not walk barefoot or bare handed while handling sludge and performing the O&M activities.
- Refrain from eating or drinking during work.

Figure 5: PPE, safety kit



2.5 Proper disposal of waste

- Dispose of waste (scum, gloves, masks, paper towels) in designated garbage bags or bins.
- Ensure that the waste from the O&M tasks are collected and disposed of at least ten meters away from any wells or other water bodies, so that it cannot leach into the ground or contaminate any water body.
- Ensure that the garbage cannot be ransacked by animals.
- Bring the garbage from O&M tasks to an official collection facility, where it is disposed of in a safe manner.
- Dispose the garbage promptly.
- In case there is spillage, the spill must be cleaned by the operator promptly. This can be done by using a vacuum pump to transfer the spill into the cesspool tank. If that is not feasible, the spill should be covered with lime. If covering with lime is also not possible, the spill should be washed away, directing the wash water to a covered drain. Additionally, a chlorine solution (0.5 per cent) should be applied to the spill area, prepared by mixing one part of household bleach (typically containing around five per cent available chlorine) with nine parts of water.
- Never dispose of garbage at unofficial dumping sites or burn waste to eliminate it.

3. List of equipment

The following section covers equipment used for routine operations and maintenance at the plant, as well as equipment required for general safety and precautionary measures, and personal protective equipment.

Table 1: List of equipment and description

S. no.	Equipment name	Image	Description
A. O&M equipment			
1.	Bucket		For carrying solid waste collected during cleaning of the screen chamber, can also be used for general cleaning purposes
2.	Trowel		To remove the solid waste, civil works, removal of grit, etc.
3.	Wheelbarrow		To carry dried sludge and wet sludge post dewatering
4.	Shovel		For maintenance inside the treatment systems
5.	Garden scissors		For gardening works
6.	Wooden pole		For sludge measurement
7.	Fishnet mesh		For scum removal from STT and ABR

S. no.	Equipment name	Image	Description
8.	Measuring tape		For measurement purposes
9.	Broom		For cleaning
10.	Ladder		To get into the system for deep cleaning
11.	Torch		To see the dark areas
12.	Rake		For cleaning of screens
13.	Plastic sheet		For any maintenance work
14.	Pressure washer		To clean the premises, outlet registers at SDB, PGF; and pressure wash the filter materials of PGF, SDB, and AF etc.
15.	Dewatering pump		To dewater any water logging
16.	Dustbin		To collect the waste, such as solid waste coming in FSS, and all other waste

S. no.	Equipment name	Image	Description
17.	Electric tester		For electrical works
18.	Spanner set		For opening of screens for internal cleaning
19.	Sludge judge		A sampler used for measuring accumulated sludge in ABR, stabilisation ponds, etc.
B. Safety equipment			
1.	Fire extinguisher		To doze the fire in case of any fire emergency
2.	First-aid kit		To treat the wounded person
3.	Insulating mat		To prevent electrical shock
C. Personal protective equipment			
1.	Mechanical resistant nitrile gloves		For protection of hands
2.	Shoes (safety shoes)		For protecting the legs
3.	Goggles		For eye protection

S. no.	Equipment name	Image	Description
4.	Jumpsuit or full-body clothes		To protect the full body
5.	Gas mask		To be worn while opening manholes or cleaning of collections tanks
6.	Safety helmet		To be worn while climbing ladders
7.	Surgical mask		For all the staff, especially sanitation workers who empty the sludge from tankers
8.	Hand-wash soap or hand sanitiser		To sanitise hands after various errands, like handling sludge, etc.

4. Detailed operation and maintenance tasks

This section provides a comprehensive operations and maintenance (O&M) procedure for various treatment modules. Cities in Uttar Pradesh referring to this section should read it alongside the table in the **annexure**, which details city-specific treatment chains available in 56 cities and 59 plants.

The modules are categorised into solid and liquid treatment processes. Liquid treatment modules are further divided into primary, secondary, and tertiary units (see *Table 4.1, 4.2, and 4.3*). The solid treatment process includes a table (see *Table 4.4*) outlining sludge-processing units. In the primary units, raw faecal sludge, containing both solid and liquid components, is processed.

4.1 Primary units

Table 2: Primary units

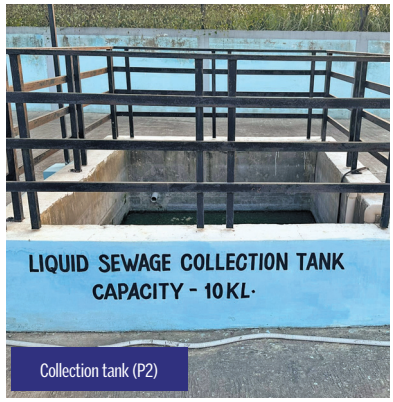
Activity	Module (image reference)	Operations and maintenance	Frequency	Precautions (if any)
Decanting at the screen chamber	Screen and grit chamber (P1, P1.1, P1.2)	The desludging operator will connect the hose pipe from the vacuum tanker to the opening of the screen chamber, and open the valve at the outlet of vacuum tank.	Every trip	Gloves, gum boots, and mask
Cleaning of screen chamber		Remove all the floating material and other heavy wastes (like bricks, sanitary pads, stones, plastics, etc.) deposited in the screen chamber and wash the screen chamber. Equipment such as rake, shovel, and buckets should be used for cleaning.	End of the day or as and when the chamber is full of waste material or obstructing the passage of FSS to the next unit	Gloves, gum boots, and mask
Check for any obstruction in the screen chamber		Check and remove sand and gravel from the bed of the chamber using a rake and shovel.	End of every day	Gloves, gum boots, and mask

Activity	Module (image reference)	Operations and maintenance	Frequency	Precautions (if any)
Collection of FSS	Collection tank (P2, P2.1)	Check the opening of the screen chamber to pass the FSS to the collection tank.	Every trip	Gloves, gum boots, and mask
Removal of accumulated sludge		Remove the accumulated sludge from the bottom of the tank using shovel and cart for collection.	Monthly or when necessary	Gloves, gum boots, and mask
Monitor and adjust sludge inflow	Integrated settler cum scum removal tank (P3, P3.1)	Monitor the sludge inflow from the screen chamber and adjust in accordance with the levels in the integrated settler cum scum removal tank.	Daily observe and adjust	Gloves
Removal of accumulated sludge		Remove the accumulated sludge from the bottom of the tank using a shovel and cart. Empty the settler tank completely before the sludge removal.	Monthly or depending upon visual inspection	Gloves, gum boots, and mask
Removal of scum		Remove the scum from the top layer by using fishnet mesh.	Weekly	Gloves, gum boots, and mask
Removal of rocks and gravel material from FSS	Destoner tank (P4)	Turn on the switch for the destoner tank.	Every cycle of treatment	Use nitrile cut-resistant gloves while dealing with electrical equipment
Cleaning of sediment		Check for sediment accumulation in the destoner tank. Clean it if required. Pressure draining through pipes and cleaning method should be used. Use rake for collection.	Weekly	Gloves, gum boots, and mask
Pumping the septage from the collection tank	Septage feed pumps (P5)	Operate the septage feed pump daily to transfer the FSS from collection tank to the next unit.	Daily	Use nitrile cut-resistant gloves while dealing with electrical equipment
Lubrication of pumps		Lubricate the bearings and moving parts for proper friction inside and to avoid wear and tear.	Yearly	Gloves, gum boots, and mask for taking out the pumps and filters in case of submersible pumps Clean the pumps prior to the maintenance job
Operating filtrate pump	Filtrate pump (P6)	Operate the filtrate pump daily to transfer the filtrate from the dewatering unit back to the collection tank.	Daily	Use nitrile cut-resistant gloves while dealing with electrical equipment
Lubricate filtrate pump		Lubricate the pump moving parts for smooth functioning and to avoid wear and tear.	Yearly	Gloves, gum boots, and mask for taking out the pumps and filters in case of submersible pumps Clean the pumps prior to the maintenance job

Primary units

Screen and grit chamber (P1)


Screen chamber (P1.1)

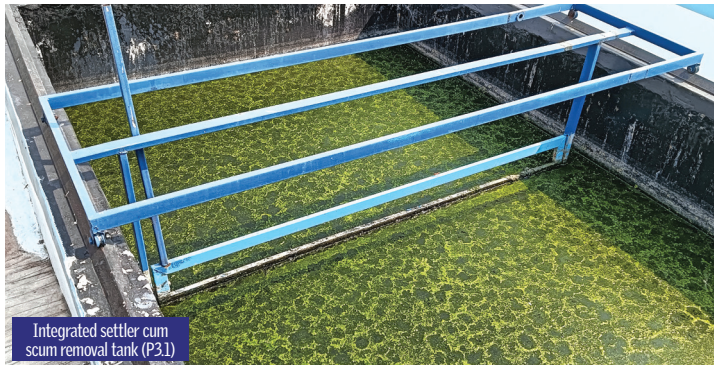


Collection tank (P2)


Collection tank (P2.1)

Integrated settler cum scum removal tank (P3)


Screen and grit chamber (P1.2)


Integrated settler cum scum removal tank (P3.1)


Destoner tank (P4)

Filtrate pump (P6)


Septage feed pumps (P5)

IMAGE CREDITS: CSE

4.2 Secondary units

Table 3: Secondary units

Activity	Module (image reference)	Operations and maintenance	Frequency	Precautions (if necessary)
Solid-liquid separation	Control panel for screw press (S1)	Transfer sludge from the primary unit to sludge dewatering unit by using the control switch for pumps.	When required or as per schedule	Use nitrile cut-resistant gloves while operating electrical equipment
Polymer dosing	Polymer dosing tank (S2)	Set the polymer dosing by doing a jar test. Prepare the polymer solution by adding 300–500 gram in 60–100 litres of water (0.005 g/ml or 0.5 per cent solution) for treating around 2500 litres of sludge, depending on the sludge quality. Prepare the polymer solution by using the SOP provided by the polymer supplier and avoid having lumps. Note: Refer to the manufacturer's manual for specific requirements and processes.	For every 2500 litres of FSS	Use mask, gloves, and goggles
Inspection, lubrication, and drive belt tensioning of screw press	Screw press (S3)	Inspect for leaks, unusual noises, and vibration. Lubricate bearings and moving parts and ensure proper tension of the driver belt, which should not be shaggy, misaligned or have any wear and tear. Note: Refer to the manufacturer's manual for lubricants list.	Daily	Use nitrile cut-resistant gloves while operating electrical equipment Use helmets, boots, and goggles while working with mechanical moving parts
Cleaning of screw press and inspection of wear parts, seals, and gaskets		The operator should clean pump housing, auger, and discharge port. Inspect for screw auger and check the seals for wear and tear or any damage. Replace if anything is worn out or damaged.	Weekly	Use nitrile cut-resistant gloves while operating electrical equipment Use helmets, boots, and goggles while working with mechanical moving parts
Inspection of mechanical components, motor alignment, and driver mechanism		Thorough inspection of bearings, seals, gearbox, and driver mechanism is required. Check for any wear and tear, replace if there is any worn part. In motors, check the alignment of the motor (common symptoms are excessive vibration, frequent belt failure, overheating, and unusual noise) and the coupling connections.	Monthly	Use nitrile cut-resistant gloves while operating electrical equipment Use helmets, boots, and goggles while working with mechanical moving parts
Disassembly and cleaning, corrosion checking, and vibration analysis		The operator should call a proper authorized mechanic for thorough cleaning and lubrication of screw pumps by disassembling. Any corrosion or erosion observed should be properly addressed through replacement of painting.	Yearly or as needed, whichever is earlier	Use nitrile cut-resistant gloves while operating electrical equipment Use helmets, boots, and goggles while working with mechanical moving parts

Activity	Module (image reference)	Operations and maintenance	Frequency	Precautions (if necessary)
Cleaning and lubrication	Screw press Q-press (S3.1)	Clean the screw press using the service water pump after every feeding cycle or when manual cleaning is required. Utilise high-pressure water jets to remove stubborn deposits. Lubricate moving parts like screws and bearings as needed to prevent wear.	Every feeding cycle	Wear protective gear (gloves and safety glasses) Avoid using harsh chemicals or abrasive materials Ensure proper lockout or tag out procedures during cleaning Use the correct type of lubricant recommended by the manufacturer
Check for clogging, low pressure, and vibration		Apply a corrosion-resistant coating to metal parts to prevent rust. Check alignment, balance, and lubrication to mitigate vibration. Verify pressure settings and inspect for worn-out seals.	As required on inspection	Ensure machine stability and proper alignment to avoid excessive vibration Check settings and seals carefully to maintain proper pressure levels
Wear and tear checks		Regularly inspect screw flights, seals, and gaskets for wear and replace as necessary to maintain efficiency. Lubricate moving parts, like screws and bearings, as needed to prevent wear and tear.	Quarterly	Use genuine spare parts to ensure compatibility and reliability Follow the manufacturer's instructions for replacement Use the correct type of lubricant recommended by the manufacturer
Manual cleaning of filter basket		Perform manual cleaning of the filter basket with a diluted form of HCL every six months.	Half yearly or as per the manufacturer's guide	Use proper protective gear and handle acid with care Follow the manufacturer's guidelines for dilution and application
Scraper replacement		Replace the scraper above the screw conveyor every three years for effective operation.	Every three years	Ensure the scraper replacement is performed by technical experts to avoid damage and ensure precise installation
Check influent flow rate	Anaerobic baffled reactor (S4, S4.1, S4.2)	Measure and record influent flow rate to ensure it falls within the acceptable range for the ABR system. Use appropriate flow meters. A flow rate of 1.3 m^3/hour and an HRT of 27 hours in ABR must be maintained for achieving considerable BOD and COD removal (source: DPR by J.M. EnviroNet Pvt. Ltd.).	Daily	Gloves, gum boots, and mask

Activity	Module (image reference)	Operations and maintenance	Frequency	Precautions (if necessary)
		Note: Refer to the manufacturer's manual for specific requirements and processes.		
Inspect influent screens or grids		Check for any blockages or debris in the influent screens or grids and clean if necessary to maintain proper flow into the ABR. Use brushes, waterjets, scrapers, rakes, air blowers, and chemical agents for cleaning.	Weekly	Gloves, gum boots, and mask
Monitor influent pH		Measure and record the pH of the influent to ensure it is within the optimal range for anaerobic digestion (typically between 6.5 and 7.5).	Weekly	Gloves, gum boots, and mask
Inspect and perform sludge removal		Open the valves of all the chambers. Clear the sludge from the bottom of the ABR using pumps to transfer it back to the collection tank. Perform backwashing to remove thick sludge.	As required on inspection	Gloves, gum boots, and mask
Inspect and clean the effluent screens		Check effluent screens by opening the valves at the bottom of the ABR. Observe any buildup of solids or debris and clean or replace them as needed to prevent clogging and ensure proper effluent quality. Use brush and steel wires for removing clogs.	Twice a week	Gloves, gum boots, and mask
Measure sludge depth in compartments		Measure and record sludge depth in each compartment of the ABR to monitor accumulation and plan for periodic sludge removal. Use sludge judge tube or sludge blanket sampler (see *Table 1: Primary units*). A metal stick or PVC pipe marked with depth graduations can also be used.	Half yearly	Rubber gloves
Inspect and calibrate instrumentation		Inspect and calibrate all instrumentation and sensors used to monitor ABR operation (e.g., flow meters, pH meters, gas analysers) to ensure accuracy and reliability.	Half yearly or as per the manufacturer's guiding manual	
Conduct comprehensive system inspection		Perform a thorough inspection of the entire ABR system, including tanks, pipes, valves, and controls, to identify any signs of wear, corrosion, or malfunction.	Annually	

Activity	Module (image reference)	Operations and maintenance	Frequency	Precautions (if necessary)
Inspection	Constructed wetlands/ planted gravel filter/ phytorid bed (S5, S5.1, S5.2, S5.3, S5.4, S5.5, S5.6)	Check for blockages, damage to plants, erosion, and overall wetland health.	Weekly	Gloves, gum boots, and mask
Weed and vector control		Remove invasive or non-target plant species to prevent competition with desired wetland plants using plant cutters. Monitor and control mosquito breeding and other vectors around the wetland area using appropriate chemicals.	Monthly	Gloves, gum boots, and mask
Inlet and outlet inspection		Check and clean inlets and outlets to ensure proper water distribution and flow using pressure flow, brushes, and jetting.	Weekly	Gloves, gum boots, and mask
Water level adjustments and hydraulic loading monitoring		Ensure proper water levels are maintained; adjust inflow and outflow structures as necessary by visual inspections and swivel arm. In constructed wetlands system I, a flow rate of 1.3 m^3/hour and a hydraulic retention time of 7.5 hours, whereas in constructed wetlands system II, a flow rate of 1.3 m^3/hour and a hydraulic retention time of 24 hours must be maintained for considerable reduction of nutrients such as nitrogen and phosphorus. If in the visual inspections you observe standing water (i.e., if the retention time from a wetland I and II is more than 7.5 hours and 24 hours respectively), then it must be clogged. Record inflow and outflow volumes to ensure the system is not overloaded.	Monthly	
Sediment removal		Remove excess sediment from the inlet zone and surface to maintain water flow and prevent clogging using shovel, spades, rakes, buckets, and wheelbarrows.	Annually or as needed	Gloves, gum boots, and mask
Plant health monitoring		Monitor plant health; look for signs of nutrient deficiency, disease, or pests.	Quarterly	
Plant replacement and vegetation harvesting		Inspect the plant density by observing whether sufficient light from the sun can reach to the bottom. Replant areas with dead or unhealthy plants to maintain wetland efficacy. Harvest excess biomass to maintain plant growth and system performance. Plant density should be maintained between five to eight plants per square metre and free board of 1.6 metre should be provided.	As needed	Gloves, gum boots, and mask

Activity	Module (image reference)	Operations and maintenance	Frequency	Precautions (if necessary)
Monitor sludge blanket	Lamella clarifier (S6, S6.1, S6.2)	Observe sludge blanket level to prevent carryover. Use a sludge judge (see *Table 1: Primary Units*) to measure the sludge blanket. A measure stick can also be used for observation. Maintain the level one to two feet below the lamella plates.	Daily	Measuring should be done at the start of every day Wear gloves and mask
Clean the plates, inlet and outlet chambers		Remove accumulated sludge and debris from plates. Ensure there are no blockages and sludge build-ups in the channels. Use iron wire brushes, a shovel, and a wheelbarrow.	Weekly	Gloves, gum boots, and mask
Inspect plater integrity and lubricate moving parts		Check for cracks or damage to the plates. Lubricate any moving parts as per the manufacturer's instructions.	Monthly	Gloves, gum boots, and mask
Inspect mechanical components and calibrate instruments		Check the condition of mechanical components (e.g., pumps and valves). Calibrate flow meters, pH sensors, and other instruments.	Quarterly	
Monitoring parameters	Anaerobic filter (S7)	Regularly check parameters such as pH, adjust as needed.	Daily, for pH and temperature Once in month, for effluent quality	
Maintain influent inflow rate		Continuously or intermittently feed faecal sludge into the filter, maintaining consistent flow rates. For a 25–50 KLD plant influent inflow rate ranges from 17–35 L/min.	Daily	Avoid overloading the system to prevent clogging
Preventive maintenance		Inspect the filter media for clogging or channeling and clean or replace media as necessary. Ensure mechanical components are functioning correctly.	Once in six months	Schedule regular maintenance to avoid unexpected breakdowns

Activity	Module (image reference)	Operations and maintenance	Frequency	Precautions (if necessary)
Incoming water quality assessment	Anaerobic digester (S8)	Ensure the digester is properly set up with the correct conditions, including temperature and pH controls. Verify that all connections and components are secure.	Once	Double-check all connections and controls to prevent operational issues
Nutrient addition process		Continuously or intermittently feed faecal sludge into the digester, maintaining consistent flow rates, and loading conditions.	Daily	Avoid overloading to prevent system imbalance
Agitate contents uniformly		Ensure proper mixing within the digester to maintain uniform conditions and prevent stratification.	Daily	Regularly check mixing mechanisms to ensure they are working properly
Input quality control	Integrated settler and anaerobic filter (ISAF) (S9)	Regularly assess the quality of incoming faecal sludge to ensure it meets design specifications.	Daily	Test for contaminants and adjust the process as necessary
Sludge introduction		Continuously or intermittently add faecal sludge to the filter, ensuring stable flow rates of 8 m^3/day for both settler and filter for 10 KLD FSTP.	Daily	Avoid overloading to prevent system imbalance
Parameter monitoring		Regularly monitor parameters such as pH, temperature, and effluent quality. Adjust as necessary.	Daily	Calibrate monitoring instruments regularly for accurate readings
Routine maintenance		Inspect filter media for clogging or channeling, clean or replace as needed. Ensure that all manholes are closed.	Daily	Schedule regular maintenance to avoid unexpected breakdowns
Replacing cinder material		Clean the cinder material with brushes and chemical cleaning every year. Replace the cinder material if required.	Replacement to be done between three-four years	Use rubber gloves, mask, and safety goggles while cleaning with chemicals
Maintenance of chambers		Desilting of the chambers	As and when required	Use rubber gloves, mask, and safety goggles while cleaning with chemicals

Activity	Module (image reference)	Operations and maintenance	Frequency	Precautions (if necessary)
Waste input	Tiger bio-filter 1 (S10)	Monitor the quality of incoming organic waste to ensure it is within acceptable parameters. a) pH levels: Ensure the organic waste has a neutral to slightly alkaline pH (6.5–8) to support vermiculture. b) Nutrient composition: Verify that the waste has sufficient carbon and nitrogen content in the right ratio (typically C:N ratio of 20:1 to 30:1). c) Contaminants: Test for heavy metals, chemicals, and other toxins to avoid damaging the worms.	Daily	Test for contaminants and adjust the process as necessary
Feeding		Continuously or intermittently add organic waste or wastewater to the bio-filter, maintaining consistent flow rates, generally 4–6 litres per minute.	Daily	Avoid overloading to prevent system imbalance
Maintain moisture control		Maintain optimal moisture. Aim for 60–80 per cent moisture content. a) Visual inspection: Media should appear damp but not waterlogged. b) Action: Add water or adjust inputs if the media appears too dry or too wet.	Daily	Gloves, gum boots, and mask
Temperature regulation		Maintain optimal temperature conditions suitable for tiger worms (15–25°C).	Daily	Install reliable temperature monitoring and control systems
Vermicomposting collection and processing procedure		a) Observe the vermicomposting accumulation into all chambers of TBF 1. b) As per vermicompost generation rates from each chamber and TBF 1 bags, collect all generated vermicompost into one corner of each chamber and create a heap. c) Use the heap method for vermicompost collection into each chamber. Allow the heap to rest for a day. d) On the next day remove the heaps carefully, avoid the worms and cocoon from vermicompost during collection. e) Scoop the collected vermicompost while wearing safety gloves. f) Keep the vermicompost in the sun to dry for at least 15 days for disinfection before packing.		Handle vermicompost carefully to avoid harm to worms and ensure proper disinfection Use mask, rubber gloves, and safety jackets while performing the tasks
Preventive maintenance		Inspect the filter media for signs of clogging or channeling, clean or replace media as necessary. Ensure mechanical components are functioning correctly.	Weekly	Schedule regular maintenance to avoid unexpected breakdowns
Effluent management		Collect and direct treated effluent to subsequent treatment processes or for safe discharge.	Daily	Ensure seamless transition between treatment stages

Activity	Module (image reference)	Operations and maintenance	Frequency	Precautions (if necessary)
Observation and monitoring	Tiger bio-filter 2 (S11)	Regularly observe the accumulation of vermicompost and monitor the condition of the worms and cocoons.	Daily	Ensure worms are healthy and vermicompost is properly accumulated
Water distribution		Ensure even distribution of treated water using the sprinklers. Check for clogs and clean if necessary.	Daily	Regularly inspect sprinklers to ensure even water distribution
Bio-media maintenance		Inspect bio-media for degradation or compaction. Replace coco-husk if needed.	Monthly	Schedule regular checks to maintain bio-media quality
Sprinkler maintenance		Check sprinkler heads for clogs or malfunctions. Clean or replace as necessary.	Weekly	Ensure sprinklers are functioning properly to avoid water distribution issues
Flow control		Adjust control valves to maintain a flow rate of 1.25 litres per minute per bag (source: TBV Env. Sol. Pvt. Ltd.).	Weekly	Regularly adjust valves to maintain optimal flow rates
Plumbing and fittings check		Inspect plumbing and fittings for leaks or blockages. Perform necessary repairs or replacements.	Monthly	Schedule regular inspections to avoid leaks and blockages
Bag integrity check		Check the HDPE bags for tears or wear and replace damaged bags.	Monthly	Regularly inspect bags to ensure they are intact and functional
Cleaning and sanitisation		Clean the entire system monthly and sanitise to prevent contamination (TBF 1 and 2).	Monthly	Regularly clean and sanitise to maintain system hygiene and efficiency
Mixing or agitation	Continuous stirred tank reactor (S12)	Monitor the agitator for consistent mixing. Lubricate moving parts and check for wear.	Daily	Regular lubrication and wear checks to prevent mechanical failure Use nitrile cut-resistant gloves while operating electrical equipment Use helmets, boots, and goggles while working with mechanical moving parts
Flow rate monitoring		Monitor flow rates and adjust control valves to maintain 17 litres per minute (L/min) for 25 KLD plant.	Daily	Regularly adjust valves to maintain optimal flow rates Use nitrile cut-resistant gloves while operating electrical equipment Use helmets, boots, and goggles while working with mechanical moving parts
Inspect seals and gaskets		Inspect seals and gaskets for leaks and replace as necessary.	Weekly	Check for leaks and replace faulty seals or gaskets promptly
Pump and motor maintenance		Perform routine maintenance on pumps and motors. Lubricate and replace worn parts.	Monthly	Schedule regular maintenance to avoid unexpected breakdowns

Activity	Module (image reference)	Operations and maintenance	Frequency	Precautions (if necessary)
Inspection	Cross flow separator (CFS) (S13)	Conduct a detailed inspection of the cross-flow separator unit. Check for any signs of wear, corrosion, or damage to the internal components. Ensure that the separator is clean and operating correctly.	Weekly	Look for wear and tear, clean thoroughly to ensure efficiency
Cleaning		Clean the filtration screens to remove any accumulated solids, grease, or other debris. This ensures that the screens remain effective in separating solids from the wastewater.	Twice a week	Keep screens clean to maintain separation efficiency
Sludge removal		Remove sludge from the sludge collection area of the separator. Proper disposal or processing of the removed sludge is essential to maintain system efficiency.	Monthly	Ensure proper sludge disposal to maintain system efficiency
Monitoring		Continuously monitor the performance of the separator, including flow rates, separation efficiency, and the quality of the effluent. Make necessary adjustments to maintain optimal operation.	Daily	Continuously adjust to maintain optimal separation efficiency
Repair and maintenance		Perform necessary repairs on the separator unit and related infrastructure. This includes fixing any identified issues, replacing worn out parts, and ensuring the overall integrity of the system.	As needed	Promptly address any identified issues to maintain system integrity Use nitrile cut-resistant gloves while operating electrical equipment Use helmets, boots, and goggles while working with mechanical moving parts
Inspection	Facultative horizontal spiral chamber with growth media (S14)	Conduct a thorough inspection of the spiral chamber. Check for any signs of wear, structural damage, or buildup of sediments. Ensure that the chamber is clean and that water flow is unobstructed.	Weekly	Ensure the chamber is clean and structurally sound
Cleaning		Clean the growth media by removing any accumulated solids, biofilm, or debris. This ensures that the media remains effective in promoting microbial growth and treating wastewater.	Twice a week	Keep growth media clean to maintain effectiveness
Sediment removal		Remove accumulated sediments from the sediment collection area of the chamber. Proper disposal or processing of the removed sediments is essential to maintain system efficiency.	Monthly	Ensure proper sediment removal and disposal
Repair and maintenance		Perform necessary repairs on the chamber unit and related infrastructure. This includes fixing any identified issues, replacing worn out parts, and ensuring the overall integrity of the system.	As needed	Promptly address any identified issues to maintain system integrity

Activity	Module (image reference)	Operations and maintenance	Frequency	Precautions (if necessary)
Feeding	Moving bed biofilm reactor (S15, S15.1)	Continuously or intermittently feed wastewater into the reactor, maintaining consistent flow rates (67 litres/minute for a 32 KLD plant)	Daily	Avoid overloading the system to prevent clogging
Oxygen supply		Maintain the optimal dissolved oxygen (DO) levels to support aerobic microbial activity. The diffusers should be run at the prescribed flowrate and specific number of hours as specified by the manufacturer.	Every cycle	Install a reliable DO monitoring system
Temperature control		Maintain the optimal temperature range for microbial activity (usually 20–35°C).	Every cycle	Install a reliable temperature monitoring system
Monitoring parameters		Regularly check parameters such as pH, DO, ammonia, nitrates, and effluent quality. Adjust as needed.	Daily	Calibrate instruments regularly to ensure accuracy
Preventive maintenance		Inspect the biofilm carriers for wear and tear, and ensure mechanical components like aerators and mixers are functioning correctly. Assess biofilm growth and health; it should be evenly distributed without excessive thickness.	Monthly	Gloves, mask, and safety goggles
Monitoring parameters	Sequential batch reactor (SBR) (S16)	Regularly check parameters such as pH, dissolved oxygen, sludge volume index, and effluent quality. Adjust as needed.	Daily	Calibrate monitoring instruments regularly for accurate readings
Preventive maintenance		Inspect aerators, mixers, and decanters for proper operation. Clean or replace parts as necessary.	Periodically	Schedule regular maintenance to avoid unexpected breakdowns

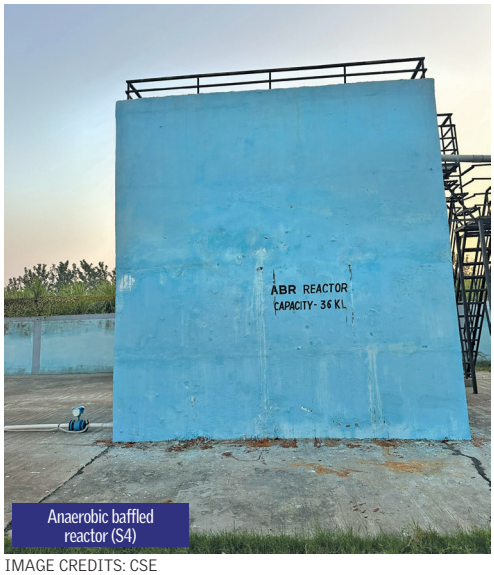
Secondary units

Control panel for screw press (S1)

Polymer dosing tank (S2)

Screw press (S3)


Screw press Q- press (S3.1)



Anaerobic baffled reactor (S4)


Anaerobic baffled reactor (S4.1)

IMAGE CREDITS: CSE

Anaerobic baffled reactor (S4.2)

Constructed wetlands (S5)

Constructed wetland (S5.1)

Constructed wetland (S5.2)

Constructed wetland (top) (S5.3)

Planted gravel filter (S5.4)

Phytorid bed (S5.5)

IMAGE CREDITS: CSE

Phytorid bed (S5.6)

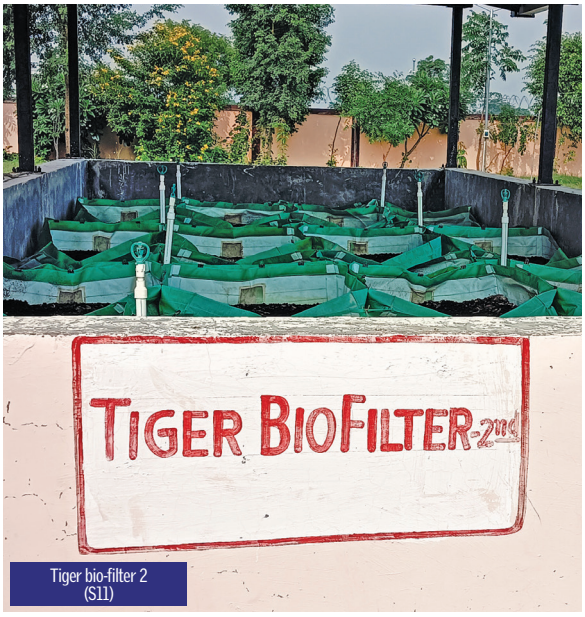

Lamella clarifier (S6)


Lamella clarifier (S6.1)


Lamella clarifier (S6.2)

Anaerobic filter (S7)

Integrated settler and anaerobic filter (S9)



Tiger bio-filter 2 (S11)

IMAGE CREDITS: CSE

Continuous stirred tank reactor (S12)

Cross flow separator (CFS) (S13)

Moving bed biofilm reactor (S15.1)

Tiger bio-filter 1 (S10)

Sequential batch reactor (SBR) (S16)

IMAGE CREDITS: CSE

4.3 Tertiary units

Table 4: Tertiary units

Activity	Module (image reference)	Operations and maintenance	Frequency	Precautions (if necessary)
Run the filtration process	Activated carbon filter (ACF) (T1)	Run the ACF by the help of the control switches. Ensure all the water from the previous unit passes through the filters.	Every cycle of treatment	Use rubber gloves while operating electrical equipment
Check pressure in activated carbon filter		Regular maintenance of the filtration units must be carried out. Generally, maximum pressure drop allowed in the filter units is 0.5 bar. Note: Refer to the manufacturer's manual for specific requirements and processes.	Every cycle of treatment	Use rubber gloves while operating electrical equipment
Backwashing of ACF and replace activated carbon media		If the pressure drop across ACF is above 0.5 bar value, backwashing must be carried out. Even after several backwashing, the pressure drop tends to increase, then changing of filter beds is recommended. Replace the activated carbon media. Authorised personnel from the manufacturer should perform the task.	It is recommended that after five days of running the filters, one cycle of back wash is mandatory	The manufacturer's guide should be considered for specific tasks
Running filtration through dual media	Dual media filter (DMF) (T1)	Run the DMF by the help of the control switches. Ensure all the water from the previous unit passes through the filter.	Every cycle of treatment	The manufacturer's guide should be considered for specific tasks
Checking pressure in dual media filter		Regular maintenance of the filtration units has to be carried out. Generally, maximum pressure drop allowed in the filter units is 0.5 bar. Note: Refer to the manufacturer's manual for specific requirements and processes.	Every cycle of treatment	The manufacturer's guide should be considered for specific tasks
Backwashing of DMF and media replacement		If the pressure drop across DMF is above 0.5 bar value, backwashing must be carried out. Even after several backwashing, the pressure drop tends to increase, then changing of filter media is recommended. Replace the dual media.	It is recommended that after five days of running the filters, one cycle of backwash is mandatory	Use rubber gloves while operating electrical equipment
		Authorised personnel from the manufacturer should perform the task.		

Activity	Module (image reference)	Operations and maintenance	Frequency	Precautions (if necessary)
Running filtration through multigrade filter	Multi grade sand filter (MGF) (T2)	Run the MGF using the control switches. Ensure all the water from the previous unit passes through the filter.	Every cycle of treatment	Use rubber gloves while operating electrical equipment
Inspection of clogging and pressure drop check		Regular maintenance of the filtration units has to be carried out. Generally, maximum pressure drop allowed in the filter units is 0.5 bar. Note: Refer to the manufacturer's manual for specific requirements and processes.	Every cycle of treatment	The manufacturer's guide should be considered for specific tasks
Backwashing of MGF		If the pressure drop across DMF is above 0.5 bar value, backwashing must be carried out. If even after several backwashing, the pressure drop tends to increase, then changing of filter media is recommended. Note: Refer to the manufacturer's manual for specific requirements and processes.	It is recommended that after five days of running the filters, one cycle of back wash is mandatory	Use rubber gloves while operating electrical equipment
Media replacement		Replace sand filter media. Authorised personnel should carry out this task.	Annually	Use rubber gloves while operating electrical equipment
Inspection of chlorine levels	Chlorine dosing (T3, T3.1)	Inspect chlorine levels in the dosing tanks. Refill chlorine if required or indicated from the meter.	Daily	Use rubber gloves while operating electrical equipment
Balanced dosing		The chlorine dosing should be balanced to avoid formation of disinfection by products (DBPs). The manufacturer's manual should be followed for the same.	Every cycle of treatment	Rubber gloves, mask, safety goggles, and boots should be worn while dealing chlorine Make sure chlorine dosing is balanced to avoid disinfection byproducts
Inspect chlorine dosing pump		Inspect dosing pump for proper operation.	Weekly	Rubber gloves, mask, and boots should be worn while dealing chlorine
Dosing pump output check		Calibrate the chlorine dosing pump according to the desired amount.	Monthly	Rubber gloves, mask, and boots should be worn while dealing chlorine

Activity	Module (image reference)	Operations and maintenance	Frequency	Precautions (if necessary)
Ozone generator inspection	Ozonator (T4)	Check for proper operation, observe for unusual noises or vibrations, and ensure all connections are secured.	Daily	
Monitoring ozone concentration		Measure and record the ozone concentration being generated and injected into the sludge with help of the meter installed in the equipment. Adjust settings if necessary. Follow the manufacturer's manual for desired levels.	Daily	
Check diffusers or injectors		Ensure diffusers or injectors are functioning correctly and not clogged. Clean if necessary. Use a brush and clothes for cleaning moving parts.	Daily	Use mask, rubber gloves, and safety glasses
Leak detection		Inspect the system for any ozone leaks using an ozone detector. Address any leaks immediately by replacing damaged seals and gaskets immediately.	Daily	If a leak is detected, immediately open the windows and increase the ventilation
Clean ozonator and maintain pressure and flow rate		Clean the ozone generator components according to the manufacturer's instructions to prevent buildup. Verify that the pressure and flow rates are within the operational range for effective ozone delivery.	Weekly	
Calibration of sensors and replacing ozone filter		Calibrate ozone concentration sensors and other monitoring instruments to ensure accurate readings. Replace air or oxygen filters in the ozone generator as per the manufacturer's guidelines.	Monthly	

Activity	Module (image reference)	Operations and maintenance	Frequency	Precautions (if necessary)
Inspect UV lamps	UV disinfection (T5)	Ensure all lamps are functioning and there are no visible signs of damage.	Daily	Use rubber gloves while operating electrical equipment
Clean quartz sleeves		Use a soft cloth and approved cleaning solution to remove any deposits.	Weekly	Use rubber gloves while operating electrical equipment
Check UV intensity sensors		Ensure sensors are clean and provide accurate readings.	Weekly	
Calibrate UV intensity sensors		Follow the manufacturer's guidelines for calibration.	Monthly	
Replace UV lamps		Replace UV lamps according to the manufacturer's lifespan recommendations.	Annually or as needed	Use rubber gloves while operating electrical equipment
Inspect electrical connections		Check for any loose or corroded connections.	Monthly	Use rubber gloves while operating electrical equipment
Check for leaks in system		Inspect all joints and seals for any signs of leakage.	Monthly	
Test UV system alarms		Ensure that alarms are functioning and test for different scenarios.	Quarterly	
Check and clean wiper mechanism (if applicable)		If applicable, clean the wiper mechanism to ensure it operates correctly.	Weekly	
Log operating hours and performance data		Record the daily operational data to monitor performance and detect trends.	Daily	
Check the cleanliness of the tank	Treated water tank (final collection tank) (T6)	Always keep the treated tank clean. Empty it on regular intervals.	Empty daily and clean it once every two weeks	
Check the opening of the tank		Always keep the tank covered.	As and when required	
Cleaning of the pond	Polishing pond (T7)	Regularly check the polishing pond for any debris in it and clogging in its inlet pipes.	Monthly	Gloves, boots, and mask

Tertiary units

Activated carbon filter (ACF)
Dual media filter (DMF) (T1)

Multi grade sand filter
(MGF) (T2)


Chlorine dosing (T3)

Chlorine dosing tank
(T3.1)

Ozonator
(T4)

Treated water tank (final
collection tank) (T6)


UV disinfection (T5)

Polishing pond (T7)

IMAGE CREDITS: CSE

4.4 Sludge-processing units

Table 5: Sludge-processing units

Activity	Module (image reference)	Operations and maintenance	Frequency	Precautions (if necessary)
Visual inspection for blockages	Sludge drying beds (SDB)/ Unplanted drying bed/ Bed filter (SP1, SP1.2, SP1.3)	Inspect the bed for any visible damage, standing water, or irregularities in the sludge layer. Check inlet and outlet structures for blockages or damage. Ensure proper flow of sludge into the bed and drainage from the bed.	Daily	Gloves, boots, and mask
Loading of sludge		Evenly distribute the sludge over the drying bed to a uniform depth, typically between 20–30 cms. Use a shovel and rake for handling the sludge.	As needed	Gloves, boots, and mask
Monitor drying		Monitor the drying process by using a moisture meter.	Daily	
Sludge inflow control		Control sludge inflow by control valves or by observing. If there is less space or the bed is not empty, or the previous batch of sludge has not dried yet, avoid loading the sludge.	As and when needed	
Removing sludge		Remove dried sludge with help of a shovel, rake, and wheelbarrow. In SDB, the drying cycle is between 12–15 days based on the climatic conditions. Note: Refer to the manufacturer's manual for site specific information.	Every few weeks/ months	Gloves, boots, and mask
Transportation of dried sludge		Transport dried sludge to a sludge storage yard using a truck and wheelbarrow.	Weekly or monthly	Mask, boots, and gloves
Cleaning of bed		Clean the bed after each sludge removal cycle. Use a broom, hose, and water supply.	After each removal	Mask, boots, and gloves
Check and clean drainage systems, remove any debris and vegetation		Clean the drainage system if it clogs, with help of hose and cleaning rods. Remove any debris left with help of rake and trash bags; and discard appropriately using trash bags.	Weekly or monthly	Mask, boots, gloves, and goggles
Maintaining bed linings		Specialised technician is required for repairing bed linings and walls. Repair kit, concrete mix, and trowel is used.	Quarterly	
Sludge layer measure		Measure and record sludge layer thickness with help of the measure tape or ruler. It should be 0.5 metre maximum. Note: Refer to the manufacturer's manual for specific requirements and processes.	Weekly	Gloves and boots
Filter media replacement		Replace filter media if clogged or degraded. Use a shovel, wheelbarrow, and new filter media.	Annually	Mask, boots, gloves, and goggles

Activity	Module (image reference)	Operations and maintenance	Frequency	Precautions (if necessary)
Visual inspection for blockages	Planted drying bed (PDB) (SP3)	Inspect the bed for any visible damage, standing water, or irregularities in the sludge layer. Check inlet and outlet structures for blockages or damage. Ensure proper flow of sludge into the bed and drainage from the bed.	Daily	Boots, mask, and gloves
Sludge loading		Load sludge onto the drying beds as per the operational schedule. Monitor the distribution pipes, and observe if the sludge is distributed evenly.	As per schedule	Boots, mask, and gloves
Plant health check and weeding		Inspect the health of the plants (usually macrophytes like reeds) for signs of stress, disease, or die-off. Remove any unwanted vegetation (weeds) that may compete with the planted macrophytes. Plants can be removed from the roots by pulling.	Twice a week	Boots, mask, and gloves
Cleaning of bed		Remove dried sludge after each drying cycle and before loading new sludge. Clean the surface to ensure proper drying in the next cycle. In PDB, the loading frequency is five to six days (it may vary) and after the sludge is filled up to designed height, drying duration will be four to six months before the sludge is taken out (source: CDD). Note: Refer to the manufacturer's manual for specifications.	After each cycle	Boots, mask, and gloves
Soil aeration and nutrient management		Loosen the top layer of the soil to prevent compaction and ensure good aeration for the plants. Add necessary nutrients if the plants show signs of nutrient deficiency. Use a shovel and a trowel for loosening the soil.	Quarterly	Boots, mask, and gloves
Inspection of underdrain		Check the underdrain system for blockages or damage to ensure proper drainage of leachate.	Quarterly	Boots, mask, and gloves
Pest and disease control		Monitor for pests and diseases affecting the plants and take appropriate control measures.	As needed	Boots, mask, and gloves
Leachate monitoring		Test the quality of the leachate collected from the drainage system to monitor for contaminants.	Quarterly	Boots, mask, and gloves
Inspect spillage	Sludge storage yard (SP2)	Inspect signs of spillage and leakage in the sludge storage yard or room.	Daily	Mask and boots
Storage of sludge		Transport dried sludge to storage yard or room. Evenly distribute the sludge.	As needed	Wheelbarrow, truck, rake, and shovel
Leachate monitoring		Visually monitor runoff. Clean the leachate.	Weekly	Mask and gloves

Activity	Module (image reference)	Operations and maintenance	Frequency	Precautions (if necessary)
Cleaning of spills and overflow		Clean any spillage and overflow while loading the dried sludge by using a shovel, absorbent materials, or containment barriers.	As needed	Mask, boots, gloves, and goggles
Debris removal		Remove and properly dispose spilled debris.	Weekly	Mask, boots, and gloves
Main roads to yard		Maintain and repair access roads to sludge storage yards with help of experts	Annually	

Sludge-processing units

Sludge drying beds (SDB) (SP 1)

Wet bed filter (SP1.3)

Sludge drying bed (SDB) (SP1.2)

Sludge storage room (SP2)

Planted drying bed (PDB) (SP3)

IMAGE CREDITS: CSE

5. Safety requirements

This section outlines essential safety requirements that need to be strictly adhered to for personal safety and precautions that need to be taken within the FSTP and co-treatment premises. All the operational and maintenance tasks in the FSTP should be performed in a safe and efficient manner with utmost regard for the health and safety of the employees and the public. Safety is an integral responsibility for all personnel.

5.1 Personal safety

The plant operator and all labourers must take precautions as faecal sludge (FS) and septage contain various coliform bacteria, mostly pathogens and parasite eggs. The plant operator and all the labourers should strive to maintain good health by taking care of the following:

- Wear a clean uniform, work boots, face mask, and gloves.
- Wash hands and disinfect them after work and before having a meal. Take a shower, if possible, after work (see *Figure 6: Hand-wash and shower*).
- Do not enter the offices and lounges wearing dirty clothes.
- Take vaccinations against COVID, tetanus, leptospirosis fever and so on, if necessary.
- Consuming liquor during working hours is strictly prohibited.
- Wearing sandals or open toe shoes in the treatment plant premises is discouraged, especially when handling tools or entering the treatment module or areas where weeds and debris can hide glass or sharp objects.
- Wear rubber boots or leather shoes, as shown on page 52, in areas with potential contact with biological organisms found in faecal sludge. Hazards

Figure 6: Hand-wash and shower

arise from biological processes involving pathogens, which can cause serious illnesses. Inhaling or ingesting contaminated mists may lead to severe health risks (see *Figure 7: Biological and chemical hazards*).

- Confined spaces—such as treatment modules, manholes, or any space that is below ground level or has inadequate ventilation—may contain hazardous gases. Prior to entering any confined space, remove sludge and keep the cover slab open for at least one hour.
- When additional lighting is required while working on the treatment plant premises, use a battery powered flashlight or an approved, properly guarded electrical extension light. Do not use open flames, such as a match, torch, or cigarette lighter.
- Do not enter a confined space without the proper equipment and standby rescue personnel.
- Ensure that the rubber gloves extend well above the wrist, leaving no gap between the glove and coat or shirtsleeve.
- Wear safety shoes whenever there is a risk of tools or materials falling on the feet (see *Figure 8: Common physical hazards*).
- Use a gas mask for respiratory protection when entering any treatment modules.

Figure 7: Biological and chemical hazards

Hazard originates from the biological process of living organisms

Hazards originate from the biological process in living organisms that also includes pathogens and chemicals used at the plant

IMAGE CREDIT: CSE

IMAGE CREDIT: CSE

Always wear safety shoes

Figure 8: Common physical hazards

<table>
<tr><td>  </td><td colspan="2">Common hazards that can cause immediate injuries and illness</td></tr>
<tr><td>  </td><td>  </td><td>  </td></tr>
<tr><td colspan="2">Slips, trips, and falls due to slippery, sloping, or improper access</td><td>Risk of receiving pinch and cuts from sharp edges or objects</td></tr>
</table>

IMAGE CREDIT: CSE

5.2 Site precautions

- Be cautious of common physical hazards on-site that can lead to immediate illnesses, accidents or injuries, such as slips, trips, and falls on slippery surfaces (see *Figure 8: Common physical hazards*).
- Materials and supplies used at a plant site should be stored in a neat and orderly manner at the site to prevent them from falling off shelves.
- Dispose of any junk parts removed from the treatment module properly, ensuring segregation into categories such as metal, plastic, organic, and inorganic waste. Recycle plastic, metal, and e-waste wherever possible.
- Spare parts used in the operation of the plant should be kept in a neat and orderly manner with the item labelled to indicate on what piece of equipment the spare part is to be used.
- Prevent accumulation of paper and other lighter combustible materials in the treatment plant premises to keep them from entering the treatment modules and causing fire hazards.
- Do not store flammable liquids, such as gasoline and diesel fuel, on the treatment plant premises where they may cause a fire or leak onto the floor, causing hazardous working conditions.
- Pay strict adherence to 'No smoking' signs. Do not accumulate oily rags and papers, as they can spontaneously combust under the proper conditions.
- Assess the size and weight of objects before attempting to lift or move them. Do not lift any material that cannot be handled comfortably. If necessary, take assistance or wait until assistance is available.
- Exercise caution when carrying objects near treatment modules to avoid falls or dropping items into the tanks.
- Always use tools suitable for the task at hand and ensure they are in good condition.
- Hoses, extension cords, and ropes not in use should not be left where operating personnel might trip over them and possibly fall into the tank.
- Indoor areas should have adequate lighting.
- Use carbon dioxide or halon compressed gas extinguishers to control fires.
- The site should be free from ergonomic hazards, such as poorly designed workspaces, limited mobility, malfunctioning tools, awkward movements of mechanical parts, or contort body (see *Figure 9: Ergonomic hazards*).

Figure 9: Ergonomic hazards

Strains and stresses on the body caused by workplace motions and body postures

Poorly designed workspaces, repetitive movements, and lifting heavy loads, along with improperly designed or maintained tools, can lead to awkward body postures or strain

IMAGE CREDIT: CSE

5.3 Medical emergency or first-aid

In case of sudden onset of medical condition characterised by acute symptoms of sufficient severity such that the absence of medical attention could reasonably be expected to result in placing the patient's health in serious jeopardy, serious impairment to bodily functions or serious dysfunction of any bodily organ or part, the following steps need to be followed while administering first-aid:

- Keep the victim lying down.
- Examine the victim for serious bleeding, breathing difficulties, or signs of poisoning.
- Keep the victim warm and comfortable.
- Send someone to call a physician or ambulance.
- Remain calm. Avoid moving the victim unless absolutely necessary.
- Do not give an unconscious victim anything to eat or drink.
- If a crowd has gathered, keep it away from the victim.
- Ensure the victim is comfortable.
- Shield the victim from seeing their injury.
- Administer artificial respiration if required.

First-aid: The first-aid toolbox should contain the following items. Unnecessary and out of date items should not be placed in the first-aid box.

- Band-aid, scissors, cotton
- Adhesive plasters of assorted sizes
- Disinfection lotion or powder
- Eye-wash cup
- Unused sealed twin blade razor
- Cotton gauze
- Crepe bandages
- Analgesic (ointment, cream, gel, or spray)
- Anti-allergic medicine
- Antacid

6. Emergency response procedures

Improperly treated faecal sludge carries infectious bacteria, viruses, parasites, and toxic chemicals. Human contact with raw or improperly treated sludge and wastewater can lead to serious health problems. If the treatment plant functions as designed, then there is a reduced risk to public health or environment; however during emergencies, there can be increased risks. The purpose of this section is to minimise the potentially damaging effects of spills, valve failure, and leakages in the system. This section details out the types and level of emergencies and the specific responses for each emergency. These are usually out of the ordinary and not part of the day-to-day operations of the FSTP.

Emergencies that can occur at the FSTP and co-treatment facilities:

- Spillage from the desludging truck
- Valve breakdown
- Overflow from any treatment module
- Flooding of sludge drying beds
- Power supply cut or solar panel malfunction
- Fire break

These have been detailed out in the following section:

6.1 Spillage from truck or valve breakdown

Figure 10: Spillage from truck

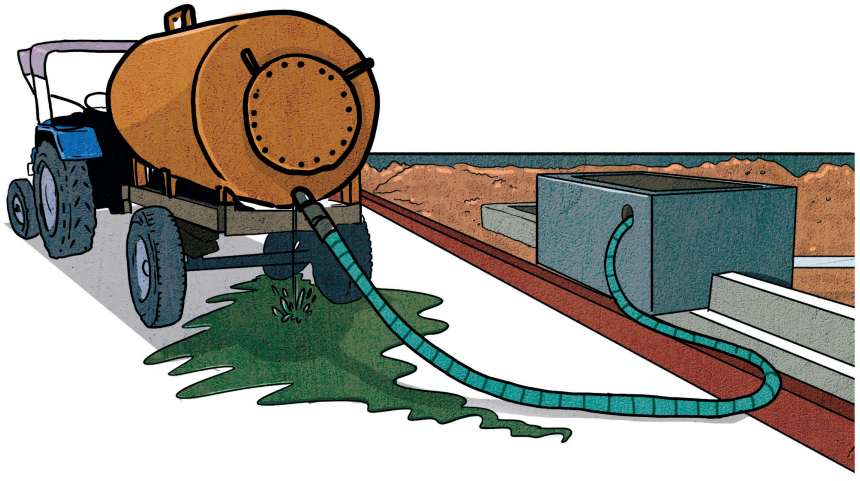


Table 6: Spillage from truck

What may be the cause?	Failure of outlet valve of desludging vehicle or wrong operation of outlet valve of the desludging vehicle.
How could this happen?	• Damage of the desludging vehicle's outlet valve during feeding. • Failure of valve may happen due to solid waste or debris stuck at the valve's opening. • Damage to the valve may happen due to wrong operations of the valve by • the operator and turning the valves in the wrong direction forcefully.
Emergency response	• Desludging vehicle driver should close the outlet valve according to their standard operation. • If the above step does not work, connect the hose pipe of the desludging vehicle to the FSTP so that the sludge is bypassed to the FSTP instead of spilling on the ground surface. • To clean the spilled sludge, pour soil over the sludge and leave it for at least two hours and then clean it with water. Using the shovel, collect all the soil mixed with sludge in a container and dispose this sludge at SDB. • Repair or replace the valve if necessary. • Keep a standby hosepipe in such emergencies.

6.2 Overflow from any treatment module

Table 7: Overflow from any treatment module

What may be the cause?	The module outlet or the inlet of the next downstream module is clogged.
How could this happen?	• This can happen due to the excessive accumulated scum or sludge as well as debris blocking the pipes or modules. • Crushed or frozen modules or damage in the pipes connecting the various modules or excessive inflow of water into the module due to flooding may also be responsible for this kind of issue.
Emergency response	• Stop the flow into the module immediately. • Clear the blockage in the pipes using the iron bar and pumped water. Insert the iron bar in the outlet pipe of the module and force out the pumped water. • Check if any debris is stuck in between outlet of the module and inlet of downstream module. If found, try to push it to the next module using the iron bar and collect the debris from the inlet of the downstream module. If debris cannot be moved from its place, immediately report it to the Plant Manager. • Check for damage or crushing of pipe and immediately report any issues to the plant manager.

6.3 Flooding of SDB

Figure 11: Flooding of SDB

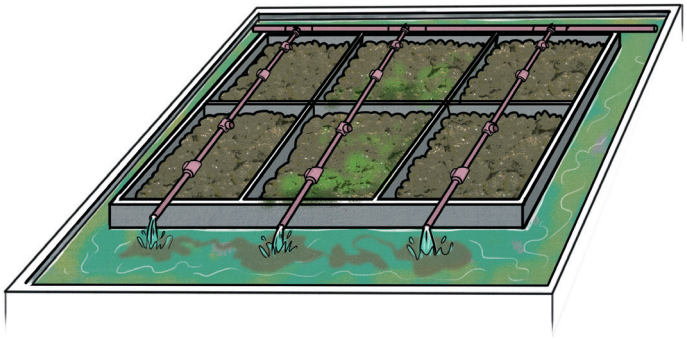


Table 8: Flooding of SDB

What may be the cause?	Due to heavy rain in the plant area.
How could this happen?	As SDBs are constructed at the point of lowest elevation they are prone to flooding during rainy seasons. The rainwater may enter the beds. Leakage of rainwater from the beds can be another source of flooding of SDBs.
Emergency response	• Locate the beds filled with water. • When the water enters SDB, it will flow by gravity to the leachate sump. To lower the water level in SDB, pump out water from the leachate sump. This water may be discharged to the drain instead of to the ABR. • Remove all the dry sludge chunks outside SDB. Clean the surroundings of the SDB with disinfectant and water using the tap. Clean the entire affected area. • If the problem persists, report it to the ULB officials. Use an alternate method to transport incoming sludge from dewatering to an elevated area that is fully enclosed.

6.4 Emergency situations in the system

These emergencies typically result from improper operations, such as excessive inflow to the system or improper desludging. External factors, such as heavy rain or windfall, can also contribute to these situations.

6.4.1. Overflow of a wastewater from system

Figure 12: Overflow of wastewater

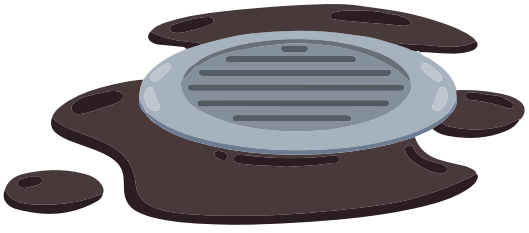


Table 9: Overflow of wastewater from system

What may be the cause?	The outlet of module is clogged or intrusion of water into the module.
How could this happen?	• This can happen due to garbage being flushed, excessive accumulated scum or sludge, as well as debris blocking the pipes or modules. • Excessive inflow of water into the module due to flooding may also be responsible for this kind of issue.
Emergency response	• Maintenance action to be taken up immediately in the concerned module ensuring free wastewater flow. • Additionally, check the sludge level in all the systems and if required, de-sludge the system. • Dewatering may be required in units submerged in water by operating DG sets in case of power supply failure or using diesel pump sets.

6.4.2 No or minimal wastewater inflow to a module

Table 10: No or minimal wastewater inflow into a module

What may be the cause?	The module inlet or the previous upstream module is clogged.
How could this happen?	• This can happen due to garbage entering the system, excessive accumulated scum or sludge, as well as debris blocking the pipes or modules. • Crushed, broken, or damaged pipes may be responsible for this kind of issue.
Emergency response	Check the pipelines for obstructions.

6.4.3 Bad odour emanating from one or more modules

Table 11: Bad odour emanating from one or more modules

What may be the cause?	The vent pipe may be damaged or blocked and therefore releasing biogas and odour in a noticeable way. Accumulated scum or garbage may also release a bad smell.
How could this happen?	• This can happen due to garbage entering the system or excessive accumulated scum. • External influences may damage the vent pipes. Birds, insects, or other things may obstruct the vent pipes. • Improper removal of sludge from STT, ABR and entry of sludge to PGF.
Emergency response	To solve issues with bad odour, perform the task of 'Ensuring functionality of the vent pipes' at all the modules.

6.4.4 Externalities and force majeure

Figure 13: Natural emergencies

Table 12: Externalities and force majeure

What may be the cause?	Storms and other external influences can damage the pipes and the system itself or clog parts of the system with debris.
How could this happen?	• This may happen due to the debris being carried by storm water in the premises of the FSTP. • Uncovered treatment modules also allow some debris into the module.
Emergency response	• Clear debris by performing the following tasks: 1. Check for litter, dead leaves, and weeding around the surroundings. 2. Ensure that the maintenance pit covers are intact. • Check the physical or visual condition of systems for any structural damage as part of the task 'Ensuring free wastewater flow' and rectify any damages which are found. Also, perform the task 'Ensuring functionality of the vent pipes' for all the modules. If the system cannot be restored to operational condition, contact your service provider or the ULB official. • Check power supply to all pump sets. If pump sets remain idle for extended periods, they may not function due to rust, clogging, or internal damage.

6.5 Power supply cut or solar panel malfunction

Table 13: Power supply cut or solar panel malfunction

What may be the cause?	• Broken glass • Cell corrosion • Connection issues • Inverter failure • Shading • Dirt and debris • Hail damage • Hot spots • Power supply source failure
How could this happen?	• The glass covering the solar cells can crack or break due to impact from debris or extreme weather conditions. • Exposure to moisture or other environmental factors can lead to corrosion of the cells over time, reducing their effectiveness at converting sunlight into electricity. • Loose or faulty wiring connections within the solar panel system can lead to a decrease in power output or complete system failure. • The inverter is a crucial component of a solar panel system that converts the DC electricity produced by the panels into usable AC electricity for your home. • If part of the solar panel array is shaded by trees, buildings, or other obstructions, it can significantly reduce the overall energy production of the system. • Accumulation of dirt, dust, leaves, or bird droppings on the surface of the solar panels can block sunlight and reduce their efficiency. • Hailstorms can cause physical damage to solar panels, compromising their ability to generate electricity. • If certain cells within a solar panel become defective or damaged, they can create hot spots that reduce the efficiency of the entire panel. • The main supply may be interrupted due to power outages or extreme weather conditions.

Emergency response	• Broken glass –Replace any damaged glass covering the solar panels. • Cell corrosion –Regularly inspect and clean the panels to prevent corrosion. • Connection issues–Check and tighten all wiring connections within the system. • Inverter failure –Replace the faulty inverter with a new one. • Shading –Trim trees or remove obstructions to reduce shading. • Dirt and debris –Clean the solar panels regularly to maintain efficiency. • Hail damage –Install protective measures or replace damaged panels. • Hot spots–Replace defective cells or panel creating hotspots. • Power supply source failure–Report the issue to the local electricity board. Keep a backup arrangement of generator set to fulfill the treatment needs during such times.

6.6 Fire break

Figure 14: Fire break

Table 14: Fire break

What may be the cause?	• Short circuits in electrical equipment. • Overloading. • Fuel oil spillage from the decanting vehicles or generator.
How could this happen?	• Loose wires or sockets at the plant. • Overloading may happen due to poor distribution of electrical load. • Loose cap or broken fuel tank of the decanting vehicles or generator.
Emergency response	• Always keep a fire extinguisher at the plant and immediately cut the power supply from the source to stop escalation. • Maintain a clean distribution of electricity and avoid running multiple equipment simultaneously to prevent overloading. • Use fire extinguisher to stop escalation. Move the decanting vehicle away from the plant. If the fire is near generator, immediately cut off the power supply.

7. Responsibilities of the persons deployed at FSTP or co-treatment site

7.1 Plant manager

- In-charge of overall management of the plant.
- Maintains the attendance register for all staff involved in the operation and maintenance.
- Supervises the visitor log book of the plant site.
- Maintains and updates the septage load database coming to the plant, keeps records of the source of septage, and also oversees the collection of manifest forms.
- Monitors and maintains the record for the operation of various plant components, such as the operation of twin trains of settling tank, ABR, and PGF for weekly, monthly, or annual maintenance.
- Maintains the record for the treatment process of the plant site, such as desludging dates and time, pumping duration, cleaning time of beds, and operation time of STT, SDB, etc.
- Maintains the cesspool vehicle logbook and monitors fuel, mobil, and lubricant requirements for the vehicle (if the vehicle is stationed at the plant).

7.2 Pump operator

- Monitors septage loading from various sources transported by private and ULB cesspool vehicles.
- Ensures the register is properly updated for the various loading to FSTP.
- Ensures the collection of the manifest form from the various cesspool vehicles and makes sure that they are all in order.
- Oversees all the operation of the pumps installed at the FSTP or co-treatment plant.
- Maintains the inventory for the tools and plants of the FSTP.
- Ensures the issue of various tools and consumables and maintains the record as required.

7.3 Security

- Responsible for ensuring the safety of the plant around the clock.
- Collects manifest forms at the gate for maintenance of records.
- Ensures the lighting arrangement of the plant during night hours.
- Operates pumps when the pump operator is unavailable, ensuring the operation of the pumps as and when required.
- Manages the operation of pumps during the rainy season, to discharge excess water from the pond and leachate sump during heavy rainfall at night.
- Responsible for prevention of theft occurring in the septage plant premises.

7.4 Sanitation worker

- Responsible for the cleanliness and hygiene of the plant site.
- Cleans the administrative building (comprising of a lab room, admin room, toilet, staff room, and panel room) and the guard room twice a day.
- Removes debris, sand, dried leaves, and other objectionable material from the internal road, ABR roof, compost storage shed, etc., daily, or as and when required.
- Assists at the septage receiving chamber during the discharge of septage from the cesspool vehicle to the plant inlet for the following purposes:
    - Ensures that the septage load is properly discharged into the receiving chamber without spillage on the ramp.
    - Ensures a continuous and smooth flow through the screens installed in the inlet chamber by removing undesirable materials like plastics and polythene.
    - Maintains tools such as hand brush, wire brush and a bucket by placing near the receiving chamber for cleaning after each loading at the receiving chamber.
- Maintains the planted gravel filter (PGF) by harvesting excess plant growth to ensure proper growth and function.
- Cleans the settling tank monthly by pumping out sludge and liquid to the sludge drying beds, followed by manual scraping of the inner part of the tank and taking out the deposited sludge, wearing proper PPE.
- Scrapes off dried sludge from the sludge drying beds and transports it to the compost shed for storage.
- Cleans the polishing pond monthly by pumping out effluent and cleaning internal walls, the fountain pedestal, etc.
- Clean drains monthly using bleaching powder to prevent the growth of slime and moss.
- Moves the mobile shed over the sludge drying beds as and when required for natural drying of the pumped sludge.

7.5 Gardener

- Responsible for the maintenance of the landscape garden and other plantation within the premises.
- Maintains the grass turf and cut the excess growth for an aesthetic and uniform appearance.
- Removes weeds, unwanted grass, and any other unnecessary plants from the premises.
- Takes care of the seasonal plants.
- Monitors watering of the plants and turf grass as and when required.
- Prunes the trees and maintains even, uniform, and controlled growth of the plant area.
- Applies herbicides and pesticides as and when required.

Glossary

Sewage: Sewage consists of two primary components—grey water from kitchens, bathrooms, wash basins, and similar sources; and black water from toilets and urinals. These may sometimes be mixed with other municipal flows, such as surface water and storm water.

Management of sewage: Management of sewage includes collection, conveyance, treatment and recycling or disposal of all the above stated flows.

Off-site system: Off-site system consists of sewage conveyance and treatment at a sewage treatment plant (STP).

Sewer network: Sewer network consists of continuous pipes laid underground, typically along roads, to collect sewage from households and other establishments.

Septage (from septic tanks with soak-pits): Semi-solid matter from on-site sanitation systems, such as septic tanks. It is characterised by an offensive odour, appearance, and high concentrations of biochemical oxygen demand (BOD), chemical oxygen demand (COD), and total suspended solids (TSS), etc.

Faecal sludge: The settled contents of pit latrines and septic tanks. It differs from sludge produced in municipal wastewater treatment plants.

Sewage treatment plant (STP): Sewage treatment plants are used for treatment of used water coming out from domestic, commercial, or institutional establishments, etc.

Faecal sludge treatment plant (FSTP): Faecal sludge treatment plants are used for the treatment of faecal septage being periodically removed from the septic tanks of domestic, commercial, institutional establishments, etc. to maintain their efficiency.

STP-cum-FSTP or co-treatment: Septage can be economically treated at STPs with certain minor modifications, reducing capital expenditure (CAPEX), operational expenditure (OPEX), and land requirements.

Dewatering: Removal of water from solid material or septage through methods such as wet classification, centrifugation, filtration, or other solid-liquid separation processes. This includes the removal of residual liquid from a filter cake using a filter press, commonly applied in various industrial processes.

Desludging: The process of removing septage by draining and cleaning a septic tank.

Decentralised wastewater treatment system: A decentralised wastewater treatment system is a localised solution for managing and treating wastewater generated from specific areas, such as households, communities, or small commercial zones. Unlike centralised systems, it operates independently and treats wastewater close to its source, often using compact and cost-effective treatment units. These systems are particularly suitable for areas without access to extensive sewer networks, enabling efficient wastewater management while reducing the environmental footprint.

Centralised wastewater treatment system: A centralised wastewater treatment system, often referred to as a conventional treatment system, is a large-scale infrastructure designed to treat wastewater collected from various sources, including residential neighborhoods, commercial establishments, and public buildings. The wastewater is conveyed to the treatment facility through an extensive network of sewer lines, where it undergoes systematic treatment processes to remove contaminants and ensure it meets environmental discharge standards.

Effluent: The supernatant liquid discharged from a septic tank. The term also refers to the liquid separated from the septage.

Reuse: The practice of using an item, either for its original purpose (conventional reuse) or to fulfil a different function (creative reuse or repurposing). It differs from recycling, which involves breaking down used items to create raw materials for the manufacture of new products.

Septic tank: A water-tight, single-storied tank in which septage is retained long enough to permit sedimentation and digestion.

Stakeholder: A stakeholder is any party that has an interest in a company and can influence or be influenced by its operations. The primary stakeholders in a faecal sludge management (FSM) are government bodies, private entities, and citizens.

Biochemical oxygen demand (BOD): Biochemical oxygen demand measures the amount of oxygen consumed by microorganisms in the degradation of organic matter. Monitoring the oxygen demand of discharge water is crucial, as its release into the environment can deplete oxygen levels in water bodies, potentially leading to the death of aquatic fauna.

Chemical oxygen demand (COD): Chemical oxygen demand is the measure of oxygen being consumed during the oxidation of oxidisable organic matter in presence

of a strong oxidising agent. It is generally used to indirectly determine the amount of organic compounds in aquatic systems.

Scum: Scum is extraneous or impure matter like oil, hair, grease, and other light material that floats at the surface of the liquid in the septic tank, while the digested sludge is stored at the bottom of the septic tank.

Pit latrine: A latrine featuring a pit for the collection and decomposition of human excreta, allowing liquid to infiltrate into the surrounding soil.

Pour-flush latrine: A latrine that operates by using depends small quantities of water, poured manually from a container, to flush away feces from the receiving pan.

Planted gravel filter bed (PGF): Partially treated wastewater passes through the planted gravel filter bed for secondary or tertiary treatment. The PGF consists of crushed stones, pebbles, and wetland plants, such as *Canna indica, Typha.* These wetland plants offer further treatment by removing nutrients like phosphates and nitrates from the wastewater.

Storage tank: Treated wastewater is stored in a storage tank and utilised for horticulture purposes within the plant premises. In some cases, the wastewater from PGF enters a polishing pond for further treatment where removal of odours and pathogens takes place by aeration and sunlight.

Aerobic composting: It is the controlled decomposition of biodegradable organic matter in the presence of oxygen, facilitated by bacteria and other microorganisms. The segregated organic fraction of solid waste is a suitable substrate for composting. The resulting compost is rich in essential plant nutrients and minerals, beneficial for plant growth.

Vermicomposting: It is an aerobic process of organic waste degradation with the help of earthworms in a controlled environment. Earthworms consume the organic waste and produce vermicompost, which contains higher levels of nutrients than regular compost. Vermicompost can be used as a soil conditioner and nutrient source in agriculture.

Anaerobic digestion: Also known as biomethanation, this process involves biochemical decomposition of organic matter through bacterial activity in an oxygen-free environment.

Annexure: Plant wise treatment chains of 59 FSSM projects in Uttar Pradesh

Co-treatment plants		
S. no.	**Cities (capacity in KLD)**	**Treatment chains**
1	Etawah (25 KLD)	Screen chamber, collection tank, polymer dosing, screw press, anaerobic tank, phytorid bed, sludge drying beds
2	Saharanpur (25 KLD)	Screen chamber, collection tank, polymer dosing, screw press, anaerobic tank, phytorid bed, sludge drying beds
3	Bulandshahr (25 KLD)	Screen chamber, collection tank, polymer dosing, screw press, anaerobic tank, phytorid bed, sludge drying beds
4	Rampur (25 KLD)	Screen chamber, collection tank, polymer dosing, screw press, anaerobic tank, phytorid bed, sludge drying beds
5	Mathura (25 KLD)	Screen chamber, collection tank, polymer dosing, screw press, anaerobic tank, phytorid bed, sludge drying beds
6	Gorakhpur (25 KLD)	Screen chamber, collection tank, polymer dosing, screw press, anaerobic tank, phytorid bed, sludge drying beds
7	Firozabad (25 KLD)	Screen chamber, collection tank, polymer dosing, screw press, anaerobic tank, phytorid bed, sludge drying beds
8	Mainpuri (25 KLD)	Screen chamber, collection tank, polymer dosing, screw press, anaerobic tank, phytorid bed, sludge drying beds
9	Muzaffarnagar (25 KLD)	Screen chamber, collection tank, polymer dosing, screw press, anaerobic tank, phytorid bed, sludge drying beds
10	Meerut (50 KLD)	Collection chamber, septage feed pump, screen chamber, polymer dosing, collection tank, bed filter, sludge drying beds, filtrate feed pump
11	Varanasi (50 KLD)	Collection chamber, septage feed pump, screen chamber, polymer dosing, collection tank, bed filter, sludge drying beds, filtrate feed pump
12	Prayagraj (50 KLD)	Collection chamber, septage feed pump, screen chamber, polymer dosing, collection tank, bed filter, sludge drying beds, filtrate feed pump
13	Ghaziabad (50 KLD)	Collection chamber, septage feed pump, screen chamber, polymer dosing, collection tank, bed filter, sludge drying beds, filtrate feed pump
14	Bijnor (20 (KLD)	Screen + grit chamber, homogenization tank, sump well, sludge drying beds, filtrate sump
15	Lucknow (100 KLD)	Screen chamber, collection tank, polymer dosing, screw press, collection tank for filtrate, sludge drying beds
16	Kanpur (100 KLD)	Screen chamber, collection tank, polymer dosing, screw press, collection tank for filtrate, sludge drying beds
17	Sultanpur (25 KLD)	Screen chamber, collection tank, polymer dosing, screw press, collection tank for filtrate, sludge drying beds
18	Ayodhya (25 KLD)	Screen chamber, collection tank, polymer dosing, screw press, collection tank for filtrate, sludge drying beds
19	Agra (75 KLD)	Screen chamber, collection tank, polymer dosing, screw press, collection tank for filtrate, sludge drying beds
20	Mirzapur (25 KLD)	Screen chamber, collection tank, anaerobic CSTR digester, cross flow separator (CFS), sludge holding tank, polymer dosing, screw press , collection tank, sludge drying beds

Faecal sludge treatment plants (FSTPs)		
S. no.	**Cities (capacity in KLD)**	**Treatment chains**
1	Khurja (32 KLD)	Screen + grit chamber, polymer dosing , screw press, sludge drying beds, anaerobic baffled reactor, constructed wetlands (1 and 2), ACF + MGF, chlorine dosing, treated water tank
2	Amroha (32 KLD)	Screen + grit chamber, polymer dosing , screw press, sludge drying beds, anaerobic baffled reactor, constructed wetlands (1 and 2), ACF + MGF, chlorine dosing, treated water tank
3	Hapur (32 KLD)	Screen + grit chamber, polymer dosing , screw press, sludge drying beds, anaerobic baffled reactor, constructed wetlands (1 and 2), ACF + MGF, chlorine dosing, treated water tank
4	Shamli (32 KLD)	Screen + grit chamber, polymer dosing , screw press, sludge drying beds, anaerobic baffled reactor, constructed wetlands (1 and 2), ACF + MGF, chlorine dosing, treated water tank
5	Baraut (32 KLD)	Screen + grit chamber, polymer dosing , screw press, sludge drying beds, anaerobic baffled reactor, constructed wetlands (1 and 2), ACF + MGF, chlorine dosing, treated water tank
6	Ambedkar Nagar (32 KLD)	Screen + grit chamber, polymer dosing , screw press, sludge drying beds, anaerobic baffled reactor, constructed wetlands (1 and 2), ACF + MGF, chlorine dosing, treated water tank
7	Hathras (32 KLD)	Screen + grit chamber, polymer dosing , screw press, sludge drying beds, anaerobic baffled reactor, constructed wetlands (1 and 2), ACF + MGF, chlorine dosing, treated water tank
8	Shikohabad (32 KLD)	Screen + grit chamber, polymer dosing , screw press, sludge drying beds, anaerobic baffled reactor, constructed wetlands (1 and 2), ACF + MGF, chlorine dosing, treated water tank
9	Fatehpur (32 KLD)	Screen + grit chamber, polymer dosing , screw press, sludge drying beds, anaerobic baffled reactor, constructed wetlands (1 and 2), ACF + MGF, chlorine dosing, treated water tank
10	Chandausi (32 KLD)	Screen + grit chamber, polymer dosing , screw press, sludge drying beds, anaerobic baffled reactor, constructed wetlands (1 and 2), ACF + MGF, chlorine dosing, treated water tank
11	Lalitpur (32 KLD)	Screen + grit chamber, polymer dosing , screw press, sludge drying beds, anaerobic baffled reactor, constructed wetlands (1 and 2), ACF + MGF, chlorine dosing, treated water tank
12	Jhansi (32 KLD)	Screen + grit chamber, polymer dosing , screw press, sludge drying beds, anaerobic baffled reactor, constructed wetlands (1 and 2), ACF + MGF, chlorine dosing, treated water tank
13	Orai (32 KLD)	Screen + grit chamber, polymer dosing , screw press, sludge drying beds, anaerobic baffled reactor, constructed wetlands (1 and 2), ACF + MGF, chlorine dosing, treated water tank
14	Badaun (32 KLD)	Screen + grit chamber, polymer dosing , screw press, sludge drying beds, anaerobic baffled reactor, constructed wetlands (1 and 2), ACF + MGF, chlorine dosing, treated water tank
15	Farrukhabad (32 KLD)	Screen + grit chamber, polymer dosing , screw press, sludge drying beds, anaerobic baffled reactor, constructed wetlands (1 and 2), ACF + MGF, chlorine dosing, treated water tank
16	Jhansi (6+12 KLD)	Screen chamber, planted drying bed, integrated settler and anaerobic filter (ISAF), planted gravel filter (PGF), polishing pond
17	Chunar (10 KLD)	Screen chamber, planted drying bed, integrated settler and anaerobic filter (ISAF), planted gravel filter (PGF), filtrate collection tank, sand and carbon filter, UV disinfection, treated water collection tank, sludge storage yard
18	Hardoi (32 KLD)	Screen chamber, integrated settler cum scum removal tank, anaerobic filter, lamella clarifier, planted gravel filter, ACF + MGF, polishing pond, sludge drying beds
19	Lakhimpur (32 KLD)	Screen chamber, integrated settler cum scum removal tank, anaerobic filter, lamella clarifier, planted gravel filter, ACF + MGF, polishing pond, sludge drying beds
20	Behraich (32 KLD)	Screen chamber, integrated settler cum scum removal tank, anaerobic filter, lamella clarifier, planted gravel filter, ACF + MGF, polishing pond, sludge drying beds
21	Azamgarh (32 KLD)	Screen chamber, integrated settler cum scum removal tank, anaerobic filter, lamella clarifier, planted gravel filter, ACF + MGF, polishing pond, sludge drying beds

22	Maunath Bhanjan (32 KLD)	Screen chamber, integrated settler cum scum removal tank, anaerobic filter, lamella clarifier, planted gravel filter, ACF + MGF, polishing pond, sludge drying beds
23	Modinagar (32 KLD)	Screen chamber, integrated settler cum scum removal tank, anaerobic digester, anoxy chamber (with MBBR media), lamella clarifier 1, aeration chamber 1 (with MBBR media), aeration chamber 2 (with MBBR media), lamella clarifier 2, holding sump + ozone dosing, ACF + MGF, sludge drying beds
24	Ayodhya (Faizabad) (32 KLD)	Screen chamber, anaerobic stabilization reactor, tiger bio-filter 1, liquid storage tank, tiger bio-filter 2, horizontal planted gravel filter, polishing pond
25	Aligarh (32 KLD)	Screen chamber, anaerobic stabilization reactor, tiger bio-filter 1, liquid storage tank, tiger-bio filter 2, horizontal planted gravel filter, polishing pond
26	Pilibhit (32 KLD)	Screen chamber, anaerobic stabilization reactor, tiger bio-filter 1, liquid storage tank, tiger bio-filter 2, horizontal planted gravel filter, polishing pond
27	Gonda (32 KLD)	Screen chamber, collection tank (with blower or centrifugal), polymer dosing, screw press, anaerobic digester, sequential batch reactor (SBR), ACF + MGF, chlorine dosing, phytorid bed, sludge storage yard
28	Jaunpur (32 KLD)	Screen chamber, collection tank (with blower or centrifugal), polymer dosing, screw press, anaerobic digester, sequential batch reactor (SBR), ACF + MGF, chlorine dosing, phytorid bed, sludge storage yard
29	Shahjahanpur (32 KLD)	Screen Chamber, collection tank (with blower or centrifugal), polymer dosing, screw press, anaerobic tank, sequential batch reactor (SBR), ACF + MGF, chlorine dosing, phytorid bed, sludge storage room
30	Banda (32 KLD)	Screen Chamber, collection tank (with blower or centrifugal), polymer dosing, screw press, anaerobic digester, sequential batch reactor (SBR), ACF + MGF, chlorine dosing, phytorid bed, sludge storage yard
31	Moradabad (32 KLD)	Screen chamber, collection tank (with blower or centrifugal), polymer dosing, screw press, anaerobic digester, sequential batch reactor (SBR), ACF + MGF, chlorine dosing, phytorid bed, sludge storage yard
32	Sitapur (32 KLD)	Destoner tank, sludge acceptance plant, sludge holding tank, polymer dosing, screw press, constructed wetlands (1 and 2), collection tank, service water tank, sludge drying beds, sludge storage room
33	Deoria (32 KLD)	Destoner tank, sludge acceptance plant, sludge holding tank, polymer dosing, screw press, constructed wetlands (1 and 2), collection tank, service water tank, sludge drying beds, sludge storage room
34	Basti (32 KLD)	Destoner tank, sludge acceptance plant, sludge holding tank, polymer dosing, screw press, constructed wetlands (1 and 2), collection tank, service water tank, sludge drying beds, sludge storage room
35	Bakshi Ka Talab (25 KLD)	Screen chamber, unplanted drying bed, anaerobic settling chamber, facultative horizontal spiral chamber (with growth media), storage tank
36	Raebareli (32 KLD)	Screen chamber, settling cum thickening tank, stabilization reactor, polymer dosing, screw press, anaerobic baffled reactor + anaerobic filter, planted gravel filter, equalization tank, collection tank (filtrate), pressure sand filter, polishing pond, sludge drying beds
37	Loni (32 KLD)	Screen + grit chamber, anaerobic stabilization reactor, batch reactor, polymer dosing, screw press, equalization tank, moving bed biofilm reactor (MBBR), sludge settler tank + treated water tank, dual media filter (DMF), UV filtration, collection tank, sludge drying beds, sludge storage room
38	Unnao (32 KLD)	Screen + grit chamber, thickening tank, stabilization reactor, polymer dosing, screw press, integrated settler + abr + af, planted gravel filter, sand filter + ACF, UV filtration, polishing pond, sludge drying platform, sludge drying beds

The SOP for operations and maintenance of FSTPs and co-treatment plants based on the treatment configurations used in state of Uttar Pradesh aims to equip plant operators, engineers, and officials with a comprehensive understanding of the O&M procedures, thereby acting as a reference document for monitoring and ensuring sustainable plant operations.

Moreover, it is designed not only to serve India's needs but also to be a valuable resource for other regions in Asia and Africa, where faecal sludge management (FSM) is still developing.

By providing actionable insights into establishing and maintaining well-functioning treatment plants, this document seeks to contribute to improved sanitation and public health outcomes on a broader scale.

Centre for Science and Environment
41, Tughlakabad Institutional Area, New Delhi 110 062
Phones: 91-11-40616000 Fax: 91-11-29955879
E-mail: cseindia@cseindia.org Website: www.cseindia.org