COMPENDIUM ON GREY WATER MANAGEMENT TECHNOLOGIES FOR RURAL AREAS

SUCCESSFULLY DEMONSTRATED DESIGNS, MODELS AND SOLUTIONS

DECEMBER 2022

WaterAid

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FOREWORD

This compendium is an attempt to articulate the work on Grey water management in rural India. In this regard, it was an attempt to capture various technological Interventions present across different climatic zones, terrain and conditions. This is structured to generate lessons and practical knowledge gained from the interventions and outcomes, and unblock bottleneck for practitioners through continuous analysis, research, documentation and learning from grassroots models and demonstrations.

The Government of India launched Swachh Bharat Mission (Gramin) Phase-II in February 2020 in succession to Swachh Bharat Mission Phase I, where the prime focus is sustenance of ODF status along with management of solid and liquid wastes generated from rural households. Appropriate and adequate grey water management solutions are crucial for protection of human and environmental health. Management of grey water is the dire need of the hour. There has been an increase in number of Grey water management innovations, for varied geographical and climatic condition emerging as a systematic overview of existing and emerging technologies appropriate for use in rural India as per geographical conditions.

The compendium provides a comprehensive and structured reference material for successfully demonstrated models which are present in rural areas in India. It has a compilation of all such Grey water management technologies to manage the Grey water coming out from the kitchen, showers, baths, cloth wash, vessel wash and basins flowing into the open drains or resulting in water-logged areas which is the major cause of waterborne diseases. All WASH practitioners, implementers, various SBM officials and various stakeholders may refer to it as comprehensive knowledge bank on Grey water management. Compendium is meant to facilitate informed decision making, strategizing and planning Grey water management system.

Furthermore, in succession to the same, an e-Compendium on Grey Water Management will be developed in the future, to share the enhanced implementation experiences of successful nature-based case studies.

PREFACE

About WaterAid

WaterAid India (WAI), since its inception in the country in 1986, has focused on Water, Sanitation and Hygiene (WASH), and has demonstrated scalable models of integrated WASH. Our vision is a world where everyone, everywhere has access to clean water, decent toilets and good hygiene to transform the lives of the poorest and most marginalised people by improving access to WASH. WaterAid India is a trusted and respected partner of choice for government and non-government actors. WaterAid India has leveraged government resources by enabling marginalised people and local institutes to demand and lead the processes of change. We understand the issues in their area, and provide them with necessary skills and support to help communities set up and manage practical and sustainable solutions that meet their needs. This approach contributes to universalisation of WASH Services and empowers the marginalised, leading to overall development.

About this Compendium

This Compendium on Grey Water Management which can be used as a reference book developed under WGAC interventions. It is hoped that the users of this compendium will be encouraged & enlightened to follow the path of various successful case studies in their respective fields. At the same time, they are advised to study the technologies in depth, contact the respective innovator & understand the essential features critically & thoughtfully adopt the new technologies. The structure of this compendium is to provide brief knowledge about the technological interventions required for the Grey water Management to the targeted audience. An annotated framework and a synthesis of the case studies were captured and compiled from rural India across different climatic zones. It provides technical information alongside demonstrated designs, models, and scalable solution with photographs at different stages on selected rural Grey water management issues.

Acknowledgements

WaterAid would like to thank each and everyone who has contributed in the development and production of the compendium. Special thanks to Mr. Shrikant Navrekar for bringing his expertise and experience in development of the compendium. We express our gratitude to WaterAid India's technical team which includes Mr. Purna Mohanty Mr. Lenin Jacob, Ms. Anjali Ray, Mr. Imran Khan, Mr. Sachin Tajne, Mrs. Baby Nayak, Mr. Rajeev Kumar, Mr. Atul Labhade, Mr. Rachan Gouda, Mr. Utkarsh Upadhyaya, Mr. Apurba Pathak, Mr. Paul Antony for their valuable contribution. We would like to acknowledge the NGOs, organizations, SBM coordinators and State Government for their timely response, inputs, contribution and patience to provide clarifications to our persistent queries. In addition, we also appreciate the contribution of all those who shared the photographs & designs for the compendium.

INTRODUCTION

As a result of concerted nationwide efforts in the field of rural sanitation over the years, India has achieved the status of an open defecation free nation in 2019. However, this is only halfway to achieving the goal of safe, clean, and healthy villages, and hence the second phase of SBM (Gramin) has been launched which very aptly emphasizes Solid and Liquid Waste Management. Grey water is the major liquid waste that is generated every day in every human settlement - large or small. Threats arising from its mismanagement are not uncommon. On the other hand, with the launch of the Jal Jeevan Mission with its motto 'Har Ghar Jal' and the ambitious target of providing 55 liters of water per capita per day, the volume of grey water is set to increase manifold. Recognizing the importance of this situation, the Government both at the Centre and State, are vigorously implementing Grey Water Management schemes.

A variety of technologies have been adopted for grey water management, ranging from household level interventions to centralized systems for the entire village. The treatment methods vary according to the principles of operation such as reuse, recycling and recharge. The difference in climate, soil terrain and availability of funds also affect the choice of technology to be used in a given geography.

The outcome of all this is a diverse picture across the country. A range of technologies can be seen in different states, from simple domestic soak pits to mechanized centralized systems.

An attempt has been made through this compendium to compile all such successful case studies at one place. In some instances, interventions at the local level do have some shortcomings that need to be dealt with.

THE FOLLOWING PROCESS WAS FOLLOWED WHILE PREPARING THIS COMPENDIUM

1	2	3	4
Desk review of various case studies from different states - For this, sources like DDWS, State SBM websites, personal contacts in State and District SBM cells, and some development partners etc. were explored.	Screening of information collected during desk review & selecting the technologies for inclusion in the compendium	Visits to States - to get first hand information and to address any insufficiencies in desk review.	Finalising the case studies/technologies to be included in the compendium.

It is hoped that this compendium will benefit various stakeholders of the sanitation program to gain knowledge of different technologies followed in different situations. Similarly, it will also serve the purpose of a guide for the implementation of the Grey water management program at Gram Panchayat level.

TECHNOLOGIES FOR GREY WATER MANAGEMENT

Grey Water and its Management

Used water from the kitchen, bathroom, laundry, dishwashing, etc. is called grey water. In other words, wastewater from households or institutions excluding black water (from toilets) and yellow water (urine) is called grey water.

At the Gram Panchayat level, a proper scientific survey of all grey water generating areas (households, institutions, public water points, etc.) followed by comprehensive planning including technology options, implementation strategies, etc. can lead to sustainable grey water management. Choosing the right technology and observing the technical standards of the chosen technology play a very important role in this process.

There can be three levels of implementation of grey water management in a village.

1) Decentralised - management at the individual household level.
2) Semi- centralised - management at the cluster level (for a group of houses where individual household scale management is not feasible).
3) Centralised - management at the village level (collecting grey water from the village & treating it).

In some villages, the situation may require a combination of all three levels.

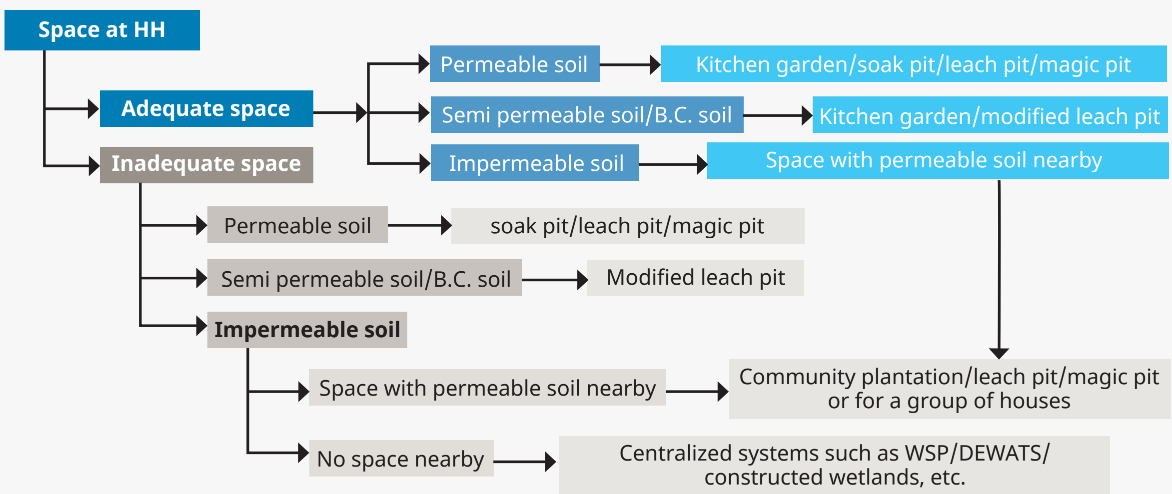
Apart from the above, a village may have some other sources of grey water generation such as public water points like hand pumps and stand posts which require wastewater management facilities.

Selection of right technology is dependent on the following factors:-

1. Availability of space near houses & housing pattern.
2. Geo-Hydrological condition of the village including terrain, soil structure & groundwater conditions.
3. Sources of water & pattern of water supply (individual/public).
4. Availability of common spaces in & around the village.
5. Economic status of the GP & human resources available with the Gram Panchayat.

After collecting preliminary information about the status of grey water generation through a proper survey, some simple algorithms can be followed for the selection of technology for its management as shown below.

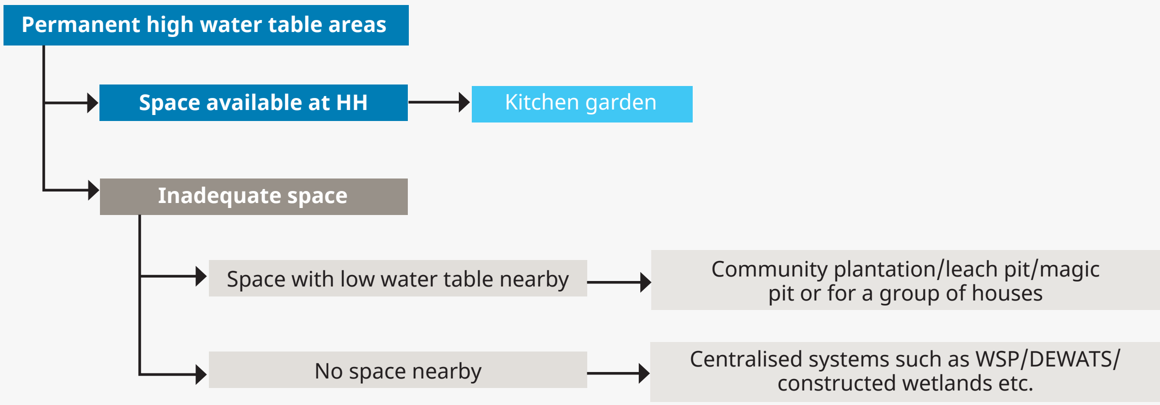
(A) FOR GENERAL AREA



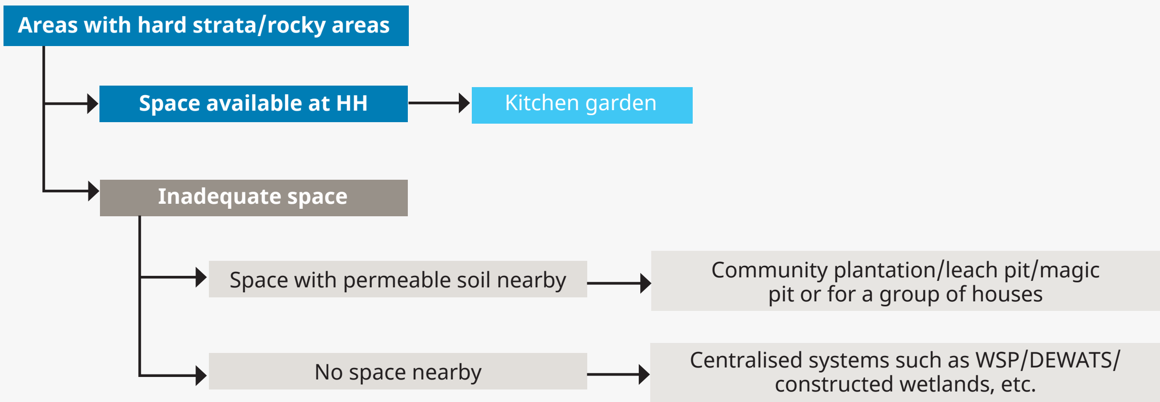
(B) FOR AREAS WITH SEASONAL HIGH-WATER TABLES (ONLY IN THE RAINY SEASON)

For these areas also the above algorithm (A) can be followed. However, selection of decentralised treatment technologies should be done logically. If the water logging conditions are found to prevail for a longer portion of the year it should be treated as permanent waterlogged condition and algorithm (C) should be followed

(C) FOR AREAS WITH PERMANENT HIGH-WATER TABLE/WATER LOGGED AREAS



(D) FOR AREAS WITH HARD STRATA (ROCKY STRATA)



While there are many technologies available for grey water management, a few key technologies have been found to be prevalent. Some such technologies are included in this compendium. Similarly, some newly developed and successful technologies are described in a separate chapter. A small section is devoted to some innovative and experimental technologies that have been tried on a limited scale.

TECHNOLOGIES AT A GLANCE

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2. Household Magic Pit
3. Household Leach Pit
4. Household Kitchen Garden
5. Household Kitchen Garden with Piped Root Zone System
6. Modified household Soak Pit (Grease Trap)

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SECTION 1

EXISTING TECHNOLOGIES

A. Decentralised Technologies

1. Household Soak pits
2. Household Magic Pit
3. Household Leach Pit
4. Household Kitchen Garden
5. Household Kitchen Garden with Piped Root Zone System
6. Modified household Soak Pit (Grease Trap)

1. Household Soak Pit (HH Soak Pit)

A household Soak Pit is the simplest and perhaps the oldest structured way of managing grey water at the household level in India. References to a scientific design of soak pits are found in publications related to Gandhian movements of rural development from the post-independence period in the sixties.

A conventional soak pit has a kachcha pit (3ft x 3ft x 3ft) dug in the courtyard of a house. It is filled with graded stones up to a height of 2.5ft. A filter made of an earthen pot with 5 to 6 holes in the bottom filled with a filter medium such as coconut husk is placed on the upper layer of the stones. The surrounding is covered by twigs, and gunny bag and compacted with mud. A small chamber is constructed around the pot filter. The grey water outlet pipe is directed into the chamber to facilitate the flow into the filter.

Household soak pits are found in almost all states where the soil structure and terrain is suitable. However, the form and design of the soak pit vary to a great extent and very few conform to the required scientific design. With the advent of the Solid Liquid Waste Management program in the country, many states have given priority to decentralised management of grey water in which soak pit has been duly emphasized.

Implementing states – Maharashtra, Madhya Pradesh, Chhattisgarh, Jharkhand, West Bengal, Gujarat, Odisha.

Household Soak Pit In Village Bhakuri -1, District Malda, West Bengal (2019)

Excavation of the pit

Filling with overburnt bricks (in place of boulders)

Placing the earthen pot filter over the last layer of filling medium

Making low-cost cover with bamboo pieces

Making a washing platform near the soak pit

Completed soak pit along with washing platform

SALIENT FEATURES

WORKING PRINCIPLE – Recharge of groundwater

COMPONENTS OF THE SYSTEM

Pit – This is a kaccha pit (3ft x 3ft x 3ft) excavated near the grey water discharge point of the house taking into account all the site selection parameters.

Filling medium – The pit is filled with graded stones (boulders) or overburnt bricks where boulders are not available. The filling is to be done up to a height of 2ft 6 inches.

Earthen pot filter – A low-cost filter is made out of an earthen pot of suitable size. A bunch of coconut husk is placed in the pot as a filter medium.

Cover of the pit – The pit is closed using twigs/bamboo pieces, a gunny bag and rammed earth.

Brick chamber – A small chamber is built around the clay pot filter to ensure water flow into the pit itself.

Drain pipe – PVC pipe (2.5 to 3 inches diametre) is used as the drain pipe. It should end up in the chamber.

OTHER FEATURES

Capacity	150 to 250 l grey water per day
Area required	16 to 20 sq. ft. per unit
Population covered by a single unit	5-6, 1 Household
Capex	INR 3000 - 7000 (including washing platform)
Opex	Almost nil
Technology is material-intensive or labor-intensive or both	Labour intensive. Requires only local material. Local skilled workers can construct it after proper training.
Reuse of treated water	Not applicable
Quality of treated water	Not applicable
Energy (power) required	Not required

OPERATION AND MAINTENANCE REQUIRED

Cleaning of earthen pot	Twice a month
Cleaning of the pit by excavating and refiling again	Once in 7-8 years
Cleaning of pipes	As and when required
Who does it?	Family members

Level of implementation	Decentralised
Suitability to terrain	All terrains except i) hard (impervious) rock and ii) permanently waterlogged areas.
Suitability to climatic conditions	All climatic conditions. In very high rainfall zones the function of a soak pit may hamper during the peak rainfall period
Suitability to housing pattern	Well suited to scattered housing but also possible in houses with 20 sq. ft. open space in the backyard.
Technical complexity	Low
Scalability	Easily scalable

A modified version of Soak pit at Village Luing, District Gangtok, Sikkim

Drain pipe directly inserted in the filling medium. Pit open to the atmosphere

Soak Pit filled up to the upper layer with boulders.

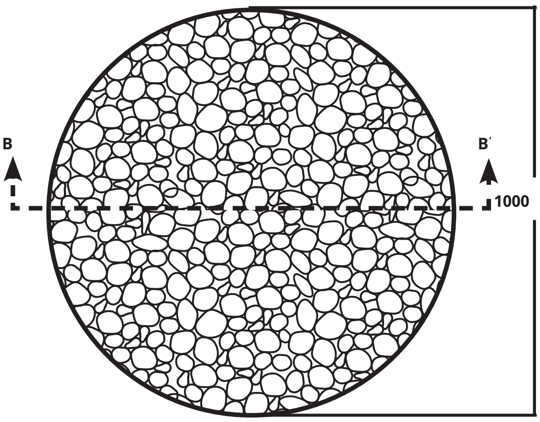
Soak Pit with brick lining over the ground

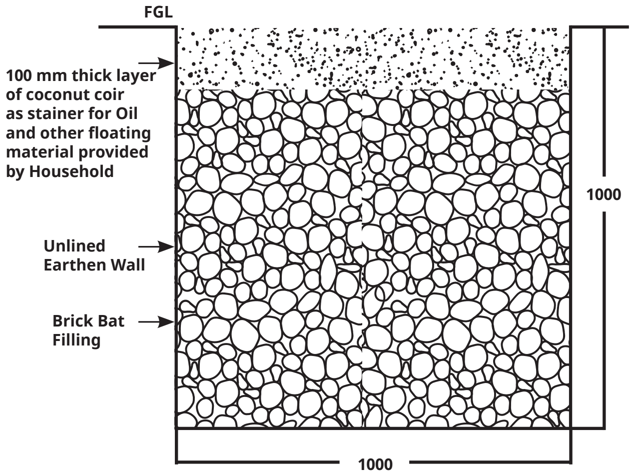
Soak pit covered with concrete slab

Capacity	150 l grey water per day
Area required	9 sq. ft. per unit
Population covered by a single unit	5-6, 1 Houeshold
Capex	INR 6800
Opex	INR 1000 per year
Technology is material-intensive or labor-intensive or both	Labour intensive. Requires only local material. Local skilled workers can construct it after proper training.

A modified version of Soak Pit – Odisha

Earthen pot filter replaced by a 100 mm thick layer of Coir on the top





REFERENCES

Desk Review	SBM Odisha, SBM Sikkim, ASJ, West Bengal, Unicef
Field Visit	Village Luing, District Gangtok, Sikkim

COMMENTS/REMARKS/OBSERVATIONS

Although they have similar mechanisms, a soak pit, a magic pit, and a leach pit are often mistaken for one another. They are generally called 'soak pits. This nomenclature should be very clear when choosing a technology as well as implementing it.

2. Household Magic Pit (HH Magic Pit)

The Magic Pit is a brainchild of Mr. Prahlad Patil, the then Sarpanch of Gram Panchayat Tembhurni, District Nanded, Maharashtra who in 2002, with a mission of making his own village clean and mosquito free designed this model and dug such pits at every house with villagers' own contribution. The CEO of Zila Panchayat Nanded in 2014 took up an initiative to widen the design all over the district.

The Magic Pit can be described as a modified version of the conventional soak pit (filled with graded stones and an earthen pot for screening of dirt). In Magic Pit, the earthen pot has been replaced by a cement bin (tank) and is placed inside the pit surrounded by stones. The cement bin has a few holes in the upper region. Wastewater flows to this bin through a pipe. The bin actually acts as a silt catcher and wastewater is spilled through the holes into the surrounding pit. The bin is covered with a cement lid and the stones around are covered with gunny bags and earth filling. In many pits, the only visible part is the pipe coming from the bath or washing place.

With the advent of the SLWM program of SBMG, this design became popular in many states and is now found to be widely adopted across the country. It is interesting to note that the design has also undergone many changes and many variants are seen in the field. Equally interesting is the fact that no scientific studies have been conducted to standardize the design or eliminate some of its flaws.

Implementing states – Maharashtra, Madhya Pradesh, Chhattisgarh, Rajasthan, Telangana, Andhra Pradesh, Tamil Nadu.

Magic Pit in Village Ramsinghpura, District Jaipur, Rajasthan

Excavation of the pit

Placing plastic bucket and construction of chamber

Pipe connection from chamber to pit

Covering pit with Polythene sheet

Paver blocks as final cover

Completed Magic Pit

SALIENT FEATURES

WORKING PRINCIPLE – Recharge into groundwater

THE DESIGN COMPONENTS

Pit – A pit of 4ft x 4ft x 4ft dimensions is dug at a suitable site near the house

Plastic bucket/drum – A 20 l plastic bucket with a row of holes 4 inches from the top. This arrests the sludge and only water spills out from the holes.

Filling of the pit with stones and stone metal

- First layer of stones – 2 ft from the pit bottom
- Placing the bucket in the center of the pit
- Filling of stones around the bucket
- Making a round neck with bricks around the bucket.
- Filling of 20mm stone metal around it

Silt chamber – Silt chamber near the grey water discharge of the house.

Drain pipe – 3-inch PVC pipe from silt chamber to the bucket

Closing the pit with 1. Polythene sheet, 2. Sand layer 3. Concrete layer and paver blocks.

Bucket to be covered with a movable cement cover.

OTHER FEATURES

Capacity	150 to 250 l grey water per day
Area required	25 sq. ft. per unit
Population covered by a single unit	5-6 persons / 1 household
Capex	INR 10000
Opex	Almost nil
Technology is material-intensive or labor-intensive or both	Requires both components equally. Requires only local material. Local unskilled workers can do it after some training.
Reuse of treated water	Not applicable
Quality of treated water	Not applicable
Energy (power) required	Not required

OPERATION AND MAINTENANCE REQUIRED

Cleaning of silt chamber	Once or twice a month
Cleaning of bucket	Once a year
Cleaning of pipes	As and when required
Who does it?	Family members

OTHER FEATURES

Level of implementation	Decentralised – Single household
Suitability to terrain	All terrains except i) hard (impervious) rock, ii) Impervious soil (e.g., black cotton soil) and iii) permanently waterlogged areas
Suitability to climatic conditions	All climatic conditions. In very high rainfall zones the function of a magic pit may hamper during the peak rainfall period
Suitability to housing pattern	Well suited to scattered housing but also possible in houses with limited courtyard
Technical complexity	Low
Scalability	Easily scalable

Original version of Magic Pit in District Nanded, Maharashtra (2016)

Excavation of the pit

Cylinder made out of cement concrete with lid

Cylinder placed in the pit

Pit filled with stones

Excavation of the pit

Filling with overburnt bricks (in place of boulders)

Magic Pit in village Pappankuzhi, District Kanchipuram, Tamil Nadu

Individual Household Magic pit costing Rs 9300 each

REFERENCES

Desk Review	DDWS website, SBM Rajasthan, Review of LWM practices in Maharashtra – The World Bank 2016- Shrikant Navrekar
Field Visit	Village Ramsinghpura, Dist. Jaipur, Rajasthan – Rajiv Kumar, WaterAid India

COMMENTS/REMARKS/OBSERVATIONS

Although they have similar mechanisms, a soak pit, a magic pit, and a leach pit are often mistaken for one another. They are generally called ‘soak pits. This nomenclature should be very clear when choosing a technology as well as implementing it.

3. Household Leach Pit (HH Leach Pit)

A leach pit is a robust, long-lasting, easy-to-use, and environment-friendly technology for the management of grey water at the household level. It can be a fit-and-forget system for a home if built to specification following simple site selection criteria. Unlike a soak pit or magic pit, it does not require any filling medium, one does not have to open and clean it frequently. Although permeable soils are more convenient, a leach pit can be constructed in semi-permeable soils with due modifications in the design.

Implementing states – Madhya Pradesh, Maharashtra, Jharkhand, Odisha, Uttar Pradesh, Haryana.

Household Leach Pits in Village Halgajiya, Disrict Damoh, Madhya Pradesh

Well-constructed silt chamber

Leach pit covered with two semi-circular concrete slabs

Complete unit – Washing platform, silt chamber and the leach pit

SALIENT FEATURES

WORKING PRINCIPLE – Recharge into groundwater

THE DESIGN COMPONENTS

Leach Pit – This is a circular pit constructed in bricks in a honeycomb fashion. It can also be constructed using precast cement rings. For a single household, the dimensions can be 3 ft and effective depth (up to invert level of pipe). It should have proper movable covers fitted at the end of construction.

Drain Pipe – 2.5-to-3-inch dia. PVC pipe can be used.

Nhani trap – At the grey water discharge point to prevent mosquito entry and foul smell emission.

Silt Chamber (Optional)- This is an additional arrangement which can help further in preventing solids and oils and grease from entering the leach pit.

OTHER IMPORTANT FEATURES

A leach pit requires minimal space and since it is underground, the space can be used for other purposes. Even houses with small backyards can easily accommodate a leach pit. It has following advantages

- In situ management of grey water. No drains, no flowing water and no filth.
- Freedom from mosquito infestation and foul odour.
- Recharge groundwater to the tune of around 14000 l of water per person per year.

Unlike a soak pit a leach pit

- Lasts longer
- Does not require any filling material
- Can accommodate more grey water as compared to a soak pit.
- Can work in semi-permeable soils with due modifications.
- Less Operation and Maintenance required

Capacity	150 to 800 l grey water per day
Area required	20 sq. ft. (2 sq. m.)
Population covered by a single unit	5-6 persons / 1 household
Capex	Rs 15000, (including washing platform, silt chamber, and pipeline)
Opex	Almost nil
Technology is material-intensive or labor-intensive or both	Requires both components equally. Requires only local material. Local skilled workers can do it after some training.
Reuse of treated water	Not applicable
Quality of treated water	Not applicable
Energy (power) required	Not required

OPERATION AND MAINTENANCE REQUIRED

Cleaning of silt chamber	Once or twice a month
Desilting of pit	Once every 6 years or as and when required
Cleaning of pipes	As and when required
Who does it?	Family members

OTHER FEATURES

Level of implementation	Decentralized – Single household
Suitability to terrain	All terrains except i) hard (impervious) rock and iii) permanently waterlogged areas. Can work in semi-permeable soils/black cotton soils with due modifications
Suitability to climatic conditions	All climatic conditions. In very high rainfall zones the function of a magic pit may hamper during the peak rainfall period
Suitability to housing pattern	Well suited to scattered housing but also possible in houses with limited courtyard
Technical complexity	Low
Scalability	Easily scalable

Household Leach Pits in village Bhasada, Dist. Panipat, Haryana (2016)

Leach Pit in Bhasada during construction in 2016

Leach Pit in Bhasada during construction in 2016

Mass production of pit covers in Bhasada 2016

Leach Pit commissioned (cover removed for observation) 2016

Leach pits in Bhasada in 2022- Functioning well

Leach pits in Bhasada in 2022- Functioning well

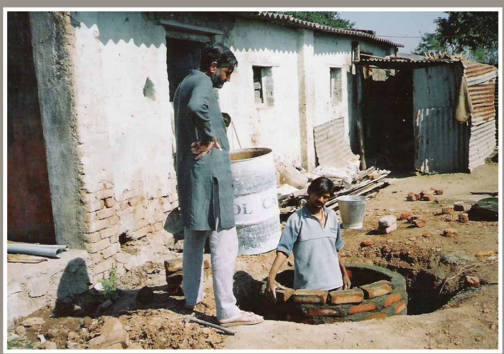
SALIENT FEATURES

Bhasada village in Haryana's Panipat district had 215 households in 2016. The village had roadside drains that were always overflowing and there was no room to walk freely. The village was infested with mosquitoes and there was a constant stench in the area. After training in SLWM the then village sarpanch resolved to change the situation with the encouragement and support of the then Assistant Commissioner of the District. In 2016, 205 out of 215 households were provided with individual leach pits with silt chambers at the cost of INR 4400 each.

The village is now free from mosquito infestation, the streets are dry and there is no stench. Groundwater recharge is around 60000 litres per day. It is interesting to note that all these pits are functioning well till today (2022)

Capacity	200 to 300 l grey water per day
Area required	20 sq. ft. (2 sq. m.)
Population covered by a single unit	5-6 persons/1 household
Capex	INR 4400 (2016)
Opex	Almost nil

Household Leach Pits in Village Govardhan, District Nashik, Maharashtra



Household Leach Pit constructed in 2005

The same leach pit working well - 2022

Capacity	100 to 150 l grey water per day
Area required	20 sq. ft. (2 sq. m.)
Population covered by a single unit	5 persons/1 household
Capex	INR 3000 (2005)
Opex	Almost nil

Household Leach Pits in Village Aturgaon, District Kanker, Chhattisgarh

Complete unit- Leach Pit with Washing Platform and Silt chamber

Leach pit with movable cover

Capacity	150 to 200 l grey water per day
Area required	25 sq. ft. (2.5 sq. m.)
Population covered by a single unit	4 persons/1 household
Capex	INR 8500 (including washing platform, silt chamber, and pipeline)
Opex	INR 400 per year

REFERENCES

Desk Review	Water Aid SBM Haryana, SBM Chhattisgarh, Nirmal Gram Nirman Kendra
Field Visit	Village Ramsinghpura, District Jaipur, Rajasthan Village Bhasada, District Panipat, Haryana Village Govardhan, District Nashik, Maharashtra

COMMENTS/REMARKS/OBSERVATIONS

Although they have similar mechanisms, a soak pit, a magic pit, and a leach pit are often mistaken for one another. They are generally called 'soak pits'. This nomenclature should be very clear when choosing a technology as well as implementing it.

4. Household Kitchen Garden

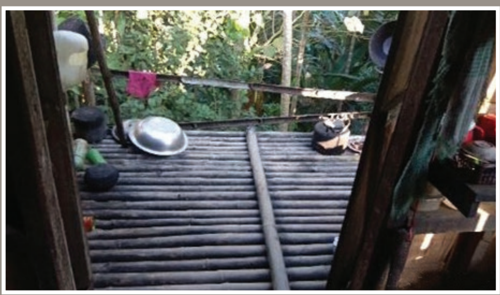
Kitchen gardening is among the most common methods of handling domestic grey water in rural areas in almost all states of India. Free-flowing wastewater and growing some vegetables, fruits, and flowers on it is a common scenario in many villages. Household kitchen gardens can be a self-reliant source of nutrition for the family in the form of fresh vegetables and fruits. However, this is a crude and somewhat unscientific way of treating grey water. A few improvements can make this a sustainable way to manage grey water at the household level.

Implementing states – Chhattisgarh, Madhya Pradesh, Karnataka, Tamil Nadu, Maharashtra.

Household Kitchen Gardens in Village Maulkhang and Khamrang, District Kolasib, Mizoram

Characteristic housing pattern in Mizoram. Houses hanging on a slopy ground

Each house has enough space below for gardening where the grey water is simply flown



A typical all-in-one washing place made of Bamboo

Efforts are being made to convince the community to undertake structured kitchen gardening

Bathing and washing water trickles down in the garden below

SALIENT FEATURES

WORKING PRINCIPLE – Reuse of household grey water in the kitchen garden to grow various crops.

Mizoram is a state nestled in the bosom of nature. Protecting the environment is a part of their lifestyle. The community's housing pattern, agriculture, food practices, and even waste management practices are all in harmony with nature. Domestic grey water management is no exception.

STRUCTURE OF KITCHEN GARDEN – The design of houses in many villages facilitates the easy flow of grey water down the slopes where several crops including vegetables, and fruits such as papaya, areca nut, banana, etc. are grown. Interestingly organic matter such as kitchen waste is consumed by hens, ducks and sometimes by pigs roaming around. Hence no separation of solids is required. All that is necessary is a pipe protruding from the house carrying grey water to the garden.

Structured kitchen gardens are now being attempted in courtyards in villages with relatively flat terrain. People are also encouraged to grow various vegetable and fruit crops.

IMPACT ON FAMILY ECONOMICS/HEALTH, NUTRITION – The families are able to rely on the vegetables grown from their garden and have started considerably saving money. They also sometimes sell some of the surplus vegetables in the neighbourhood from time to time.

Capacity	150 to 250 l grey water per day
Area required	1200 sq. ft. (120 sq. m.)
Population covered by a single unit	5-6 persons/1 household
Capex	INR 2000 (including washing platform, and pipeline)
Opex	INR 500
Technology is material-intensive or labor-intensive or both	Labor intensive. The family members themselves work in the garden.
Reuse of treated water	Reused to grow vegetables, fruits, and flowers
Quality of treated water	Not tested
Energy (power) required	Not required

OPERATION AND MAINTENANCE REQUIRED

Cleaning of pipes	As and when required
Who does it?	Family members

OTHER FEATURES

Level of implementation	Decentralised – Single household
Suitability to terrain	All terrains
Suitability to climatic conditions	All climatic conditions. In very high rainfall zones the function of a kitchen garden may hamper during the peak rainfall period
Suitability to housing pattern	Well suited to scattered housing but also possible in houses with limited courtyard
Technical complexity	Low
Scalability	Easily scalable

As mentioned above, kitchen gardens are very common in many states. However, the following aspects need attention

1. Scientific planning considering
   1) volume of grey water
   2) available space
   3) crops to be grown
2. Adding a silt chamber helps a lot. This removes impurities from the Grey Water and allows relatively clean water to flow into the garden. It helps to avoid the nuisance of mosquitoes and bad smells.
3. It is also advised not to use hard chemicals in the kitchen as well as in the laundry. Similarly, it is also advised not to grow underground crops like potatoes, onions, etc. to avoid direct contact of Grey water with the edible parts of the crops.

REFERENCES

Desk Review	WaterAid, SBM Haryana, SBM Chhattisgarh, Nirmal Gram Nirman Kendra
Field Visit	Village Khamrang, District Kolasib, Mizoram Village Maulkhang, Mizoram

5. Household Kitchen Garden with Piped Root Zone System

Designed and developed by Nirmal Gram Nirman Kendra, Nashik, Maharashtra, in 2005, Kitchen Garden with Piped Root Zone System is an improvisation over the conventional kitchen garden. The special features of this design are:-

1. The grey water is passed through a silt chamber which prevents physical impurities including kitchen waste and dirt etc. entering the system.
2. The grey water is circulated through a pipe network which is underground and invisible. Hence the grey water is also not visible in the courtyard.
3. Watering of garden plots/plants can be controlled with the help of control valves. This facilitates assured watering of plants and also saves unnecessary and indiscriminate watering of the garden.

Implementing states – Chhattisgarh

Household Kitchen Garden with piped root zone Ghugva, District Durg, Chhattisgarh

Washing Platform as a part of the improved kitchen garden

Flourishing Kitchen Garden

SALIENT FEATURES

WORKING PRINCIPLE – Reuse of household grey water in the kitchen garden to grow various crops.

COMPONENTS OF THE SYSTEM

Washing Platform (only where it does not exist) – This facilitates the flow of grey water to one point and it can be conveniently diverted to the pipe network.

Silt Chamber – Removes physical impurities such as organic solids as well as oil and greases.

Trench – The pipeline is laid through this trench. It is filled with gravel and covered with a polythene sheet and soil. The trench facilitates the flow of water to the root zones of the plants grown alongside. This helps in maintaining the aesthetics of the courtyard since no flowing wastewater is visible.

Pipe network – This is the major part of this system. There are two types of pipes. Main pipe and lateral pipes. The main pipe carries the water from the silt chamber. The laterals distribute the water to the plots of crops. There are control valves at the junction of lateral to the main pipe. This facilitates rotation of watering as and where required.

IMPACT ON FAMILY ECONOMICS/HEALTH, NUTRITION - The families are able to rely on the vegetables grown from their garden and have started considerably saving money. They also sometimes sell some of the surplus vegetables in the neighborhood from time to time.

Area of kitchen garden: 220 sq. ft.

Main pipe length = 12 ft (3 inch diametre)

Branch Pipe length = 8 ft 10 inches (2 inch diametre) 3 branches

Types of vegetables grown: Seasonal vegetables like mustard, beans, pumpkin, corn, cucumber, bitter gourd, onions, etc

Capacity	200 l per day (approximately)
Area required	220 sq. ft. (20.40 sqm)
Population covered by a single unit	5-6 persons/1 household
Capex	INR 14000 (including washing platform, silt chamber and pipe network)
Opex	INR 700
Technology is material-intensive or labor-intensive or both	Labor intensive. The family members themselves work in the garden.
Reuse of treated water	Reused to grow vegetables, fruits, and flowers
Quality of treated water	Not tested
Energy (power) required	Not required

OPERATION AND MAINTENANCE REQUIRED

Cleaning of silt chamber	Once in a month
Cleaning of pipes	Once in 3 to 6 months
Rainy season	Diversion of grey water since it is not required in the garden
Who does it?	Family members

OTHER FEATURES

Level of implementation	Decentralised – Single household
Suitability to terrain	All terrains
Suitability to climatic conditions	All climatic conditions. In very high rainfall zones the function of a kitchen garden may hamper during the peak rainfall period
Suitability to housing pattern	Well suited to scattered housing but also possible in houses with limited courtyard
Technical complexity	Medium
Scalability	Easily scalable

REFERENCES

Desk Review	SBM Chhattisgarh, WaterAid India
Field Visit	Village Ghugva, District Durg, Chhattisgarh

6. Modified Household Soak Pit (HH Soak Pit) with Grease Trap (Meghalaya)

It is an addition rather than a modification to a soak pit.

A traditional soak pit filled with stones of various sizes is a simple structure and has been widely adopted for domestic grey water management throughout Meghalaya. Previously, the domestic grey water from the kitchen was drained directly into the soak pit. This led to problems such as blockage of pipes, overflowing of pits, etc. A grease trap has been designed to overcome these problems.

Implementing states – Meghalaya

Modified soak pits with Grease Trap in different villages of Meghalaya

Primary design of grease trap

Improved grease trap cum silt chamber

Plain plastic strainer required frequent cleaning

Bio-filter introduced in the plastic strainer to reduce the cleaning frequency

Washing platform, Grease trap with bio-filter and covered soak pit

Brick-lined soak pit for rocky area with an overflow bypass

SALIENT FEATURES

WORKING PRINCIPLE – Recharge of groundwater

MAJOR PROBLEMS FACED IN CASE OF DOMESTIC SOAK PITS

1. Foul smell coming back into the house from the inlet pipe.
2. Blockage of the inlet pipe resulting in backflow of wastewater.
3. Blockage of the soak pit itself resulting in overflowing of the pit.
4. Sealing of soak pit walls due to oils and grease in the kitchen wastewater.

MEASURES TAKEN TO OVERCOME THE PROBLEMS

1. Inclusion of a grease trap.
2. Different designs of grease traps were tried.
3. Concept of bio-filter was introduced to avoid frequent clogging of the primary screen.

OIL AND GREASE TRAP

The oil and grease trap is basically a double-chamber civil structure. At the top of the first chamber, a plastic strainer is placed to screen and prevent all solid particles such as vegetables and rice leftovers from entering the trap. The filtered wastewater free of solid particles then flows into the first chamber where oil and grease float on top and the wastewater enters the second chamber.

The second chamber is provided with a T—outlet, through which the effluent flows through the trap into the soak pit. The T outlet by its design prevents residual oil and grease from entering the soak pit and at the same time provides airflow to prevent air lock in the pipe.

BIOFILTER

A plastic filter placed over the grease trap first receives raw grey water. It used to get clogged with organic matter and physical impurities. To overcome this the filter is filled with locally available coarse biomass. It traps organic and physical impurities but does not clog the pores of the filter.

OTHER FEATURES

Capacity	150 to 250 l grey water per day
Area required	32 sq. ft. (3 sq m) per unit
Population covered by a single unit	5-6 persons/1 household
Capex	INR 4500 to INR 13000 (inclusive of washing platform, grease trap and soak pit)
Opex	Almost nil
Technology is material-intensive or labor-intensive or both	Requires both components equally. Requires only local material. Local unskilled workers can do it after some training.
Reuse of treated water	Not applicable
Quality of treated water	Not applicable
Energy (power) required	Not required

OPERATION AND MAINTENANCE REQUIRED

Cleaning of silt chamber	Once or twice a month
Cleaning of strainer	Once a week
Cleaning of pipes	As and when required
Who does it?	Family members

OTHER FEATURES

Level of implementation	Decentralised – Single household
Suitability to terrain	All terrains except i) hard (impervious) rock, ii) Impervious soil (e.g., black cotton soil) and iii) permanently waterlogged areas
Suitability to climatic conditions	All climatic conditions. In very high rainfall zones the function of a soak pit may hamper during the peak rainfall period.
Suitability to housing pattern	Well suited to scattered housing but also possible in houses with limited courtyard
Technical complexity	Low
Scalability	Easily scalable

REFERENCES

Desk Review	SBM Meghalaya
Field Visit	Village Mawkhar, Mawdun, Thangkharng, Umrynjah, Meghalaya

COMMENTS/OBSERVATIONS

1. The problem of foul smell could have been solved by incorporating a Nhani trap.
2. A concealed pipe directly from the bathroom/washing place to the bottom of the pit is bound to clog and emit a smell. It should end up at an upper layer of boulders.
3. For rocky areas the soak pit needs to be carefully re-designed taking into account the permeability of the underlying layer.
4. Given the housing pattern, lifestyle, and proximity to nature in Meghalaya, a "Grease trap-cum-silt chamber plus kitchen garden" with an emergency bypass to a soak pit would be the most sustainable model for GWM.

SECTION 1

EXISTING TECHNOLOGIES

B. Semi-centralised Technologies

7. Community Magic Pit

8. Community Leach Pit

9. Community Plantation

7. Community Magic Pit

Community magic pit is a larger version of a domestic magic pit that can be connected to more than one house. It is useful for a group of houses where individual grey water management is not possible. In Gram Panchayat level planning for grey water management, it proves to be an economical and environment friendly option. A community magic pit works on a recharge principle which can significantly increase the groundwater level. Two other important advantages of magic pit technology are the elimination of mosquito infestation and clean and dry environment.

Implementing states – Rajasthan, Punjab, Chhattisgarh, Tamil Nadu, Telangana

Community Magic Pit in Village Ramsinghpura, District Jaipur, Rajasthan

Excavation of Pit (7ft x 7t x7ft)

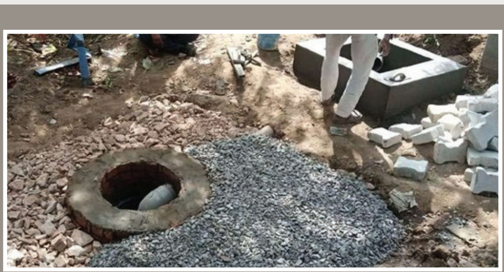
Filling with first layer of 200 mm stones up to 3 ft

Placing a PVC drum with a row of 1.5-inch dia. holes, 10 inches from the top

Construction of silt chamber and connecting pipe

Second filling with stones around the drum

Construction of round neck around the drum



Concrete layer with 20mm grit

Laying polythene sheet over concrete

Completed unit with top layer of paver blocks

SALIENT FEATURES

WORKING PRINCIPLE – A magic pit works on the principle of recharge of groundwater. The drum further arrests sludge from entering the stones filled around it lengthening the filling of gaps and life of the pit.

COMPONENTS OF THE SYSTEM

Silt Chamber – A silt chamber is an essential prerequisite of a community magic pit that prevents the entry of trash and other impurities into the pit.

The Pit – It is a kaccha dug pit with no brick lining. The dimensions are 7ft x 7ft x 7ft. It is filled with layers of stones of different sizes. First layer 3ft – 200 mm, second layer 3ft – 100 to 150mm, third layer- 1ft – 50 to 80mm, 4^{th} layer- 6 inches – 40mm

Plastic drum – A 200-lit plastic drum is placed on the first layer of 3 ft. It has holes in one row about 10 inches from the top. The drum receives the grey water from the chamber. The holes facilitate the spillage of water into the stone layer around. The drum holds the sludge at the bottom which needs to be removed periodically.

Polythene Sheet cover – This is spread over the last layer of the stones keeping only the mouth of the drum open. This prevents rainwater from entering the pit. Similarly, it prevents the entry of mosquitoes into the pit and exit of foul gases from the pit.

Paver blocks on the top – This provides a sturdy cover on the magic pit and prevents it from collapsing.

Capacity	500 l of grey water per day
Area required	70 sq. ft. (6.5 sqm)
Population covered by a single unit	60, 12 Household
Capex	INR 30000
Opex	INR 8000 per month (for the entire Gram Panchayat for all types of cleaning)
Technology is material-intensive or labor-intensive or both	Requires both components equally. Requires only local material. Local skilled workers can do it after some training.
Reuse of treated water	Not applicable
Quality of treated water	Not applicable
Energy (power) required	Not required

OPERATION AND MAINTENANCE REQUIRED

Cleaning of silt chamber	Once or twice a month
Cleaning of drum	As and when required
Cleaning of pipes	As and when required
Who does it?	Sweeper from local NGO

Level of implementation	Semi-centralised – group of houses
Suitability to terrain	Permeable soils. Not suitable in semi-permeable and non-permeable soils and hard strata.
Suitability to climatic conditions	All climatic conditions. In very high rainfall zones the function of a soak pit may hamper during the peak rainfall period.
Suitability to housing pattern	Well suited to scattered housing but also possible in houses with limited courtyard
Technical complexity	Low
Scalability	Easily scalable

This is an ideal case study of learning from one's own mistakes. Gram Panchayat Jahota initially planned and built 2-3 magic pits at the end of the main drain that carries all the wastewater of the village. This naturally failed because the pits in limited numbers were unable to absorb a full load of sewage. To overcome this problem the Sarpanch and PRI members planned and created 19 community magic pits at various locations with the participation of all the youth of the village and connected a certain number of houses to each. Similarly, they arranged silt chambers at different locations. This changed the situation and now the village has literally become clean and dry. It is also having a positive impact on the groundwater of the village.

Community Magic Pit in Village Jahota, District Jaipur, Rajasthan

Drain pipes

Creation of Magic pits

Open drains collecting liquid waste

Magic pit filled with stones

Community Magic Pit in Village Kheri Bir Singh, District Fatehgarh Sahib, Punjab

Community Magic pit with silt chamber

Placing a PVC drum with a row of 1.5 inch diametre holes, 10 inches from the top

Chambers of individual houses connecting to the Community Magic Pit

SALIENT FEATURES

WORKING PRINCIPLE – A magic pit works on the principle of recharge of groundwater.

COMPONENTS OF THE SYSTEM

Silt Chamber – A silt chamber (3ft x 3ft x 2ft) is an essential pre requisite of the community magic pit that prevents the entry of trash and other impurities into the pit.

The Pit – The pit is brick lined from all sides in 9 inches honeycombed structure. The dimensions are 15ft x 15ft x 8ft deep. It is filled with graded stone metal from 40mm to 20 mm.

Cement ring cylinder – In the center of the pit, a cylindrical structure with 3ft diametre is constructed out of pre cast cement rings. The joints are kept open. The cylinder is covered with a removable concrete lid.

Unlike the design from Rajasthan, the upper layer of the pit is kept open to the atmosphere and not covered by any means.

OTHER FEATURES

Capacity	7000 l of grey water per day
Area required	270 sq. ft. (25 sqm)
Population covered by a single unit	100, 20 Household
Capex	INR 170615
Technology is material-intensive or labor-intensive or both	Requires both components equally. Requires only local material. Local skilled workers can do it after some training.
Reuse of treated water	Not applicable
Quality of treated water	Not applicable
Energy (power) required	Not required

OPERATION AND MAINTENANCE REQUIRED

Cleaning of silt chamber	Once or twice a month
Cleaning of cylinder	As and when required
Cleaning of pipes	As and when required
Who does it?	Gram Panchayat

Level of implementation	Semi-centralized – group of houses
Suitability to terrain	Permeable soils. Not suitable in semi-permeable and nonpermeable soils and hard strata
Suitability to climatic conditions	All climatic conditions. In very high rainfall zones the function of a soak pit may hamper during the peak rainfall period
Suitability to housing pattern	Well suited to scattered housing but also possible in houses with limited courtyard
Technical complexity	Low
Scalability	Easily scalable

Community Magic Pit in School at Khiva Khurd, Dist. Mansa, Punjab

Community Magic pit with a connecting chamber (fully underground)

Students enjoying mid-day meal right on the top of the magic pit. No smell

SALIENT FEATURES

This is another form of magic pit that varies according to local conditions and soil strata. The topsoil is semi-permeable while the sandy layer is struck at a depth of 6 feet. Therefore, a dual-size pit is dug.

WORKING PRINCIPLE – A magic pit works on the principle of recharge of groundwater.

COMPONENTS OF THE SYSTEM

Silt Chamber – A small silt chamber (2ft x 1.5ft x 1ft) is constructed. This act more as a junction-cum-inspection chamber.

The Pit – The upper layer of soil is semipermeable whereas a permeable sandy layer is struck at a depth of 6ft. Therefore, a dual-dimension pit is excavated. The total depth of the pit is taken as 10 ft. Out of these lower 4 ft is dug in a circular fashion with a dia. of only 18 inches. The upper 6 ft portion has a dimension of 4 ft x 4 ft. The entire pit is filled with 40mm stone metal or brickbat.

Cement cylinder – A cement cylinder with 3 ft dia and 3 ft depth is kept in the center of the pit in the upper portion. This is sealed at the bottom and has a row of holes (3-inch dia.) in the upper portion. The cylinder arrests the sludge part from entering the pit. Only the water spilled through the holes is drained into the pit. It has a cement concrete lid.

Outlet for overflow – An emergency outlet is provided at the upper level in case of any occasional overflow or pit blockage.

The pit is covered with a gunny sack and closed with earth filling.

OTHER FEATURES

Capacity	3000 l of grey water per day
Area required	16 sq. ft. (1.5 sq. m.)
Population covered by a single unit	140 (students and staff)
Capex	INR 3113
Technology is material-intensive or labor-intensive or both	Requires both components equally. Requires only local material. Local skilled workers can do it after some training.
Reuse of treated water	Not applicable
Quality of treated water	Not applicable
Energy (power) required	Not required

OPERATION AND MAINTENANCE REQUIRED

Cleaning of silt chamber	Once or twice a month
Cleaning of cylinder	As and when required
Cleaning of pipes	As and when required
Who does it?	School staff

Level of implementation	Decentralised – Standalone unit for school
Suitability to terrain	Permeable soils. Not suitable in semi-permeable and non permeable soils and hard strata
Suitability to climatic conditions	All climatic conditions. In very high rainfall zones the function of a soak pit may hamper during the peak rainfall period
Suitability to housing pattern	Suitable for schools
Technical complexity	Low
Scalability	Easily scalable

REFERENCES

Desk Review	SBM Rajasthan, SBM Punjab
Field Visit	Village Ramsinghpura and Jahota, District Jaipur, Rajasthan Village Kheri Bir Singh, District Fatehgarh Sahib, Punjab Village Khiva Khurd, District Mansa, Punjab

8. Community Leach Pit

A community leach pit is a larger version of a domestic leach pit that can be connected to more than one house. It is a very convenient technology for a group of houses where individual grey water management is not possible. In Gram Panchayat level planning for grey water management, it proves to be a very economical and environment friendly option. A community leach pit works on a recharge principle which can significantly increase the groundwater level. Two other important advantages of leach pit technology are the elimination of mosquito infestation and clean and dry environment.

Implementing states – Madhya Pradesh, Maharashtra, Jharkhand, Odisha, Uttar Pradesh, Haryana and Bihar.

Community Leach Pits in Village Halgajiya, District Damoh, Madhya Pradesh

Completed community leach pit

Small size covers also suffice due to corbeling

SALIENT FEATURES

WORKING PRINCIPLE – A community leach pit works on the principle of groundwater recharge. A separate silt chamber prevents physical impurities from entering the leach pit. This increases the cleaning interval of the leach pit. It does not need to be cleaned for at least 5 to 10 years.

COMPONENTS OF THE SYSTEM

Nhani Trap and Primary Silt Chamber – These are located in individual households.

Secondary Silt Chamber – This is located near the leach pit. Grey water from drains or pipelines enters it first. Physical impurities such as solids and floating particles are trapped in the silt chamber. This not only purifies the water but also increases the desilting interval of the leach pit.

Leach Pit - It is a brick-lined circular pit. The effective volume of the leach pit (the volume up to the pipe level) is taken to be twice the expected daily flow of grey water. This helps in steady seepage of grey water into the surrounding soil and the pit does not overflow.

Corbelling – Since the diameter of the leach pit is large, its covers must also be large and heavy. This can be avoided by corbeling, i.e. gradually reducing the diameter of the pit. By doing this the diameter of the topmost layer is only 3 feet and the pit can be covered with small and light covers.

A POSITIVE CHANGE IN THE VILLAGE

- Ten houses are connected to a single community leach pit.
- Every house has a primary silt chamber.
- A secondary silt chamber is constructed near the leach pit
- All the houses are connected by pipelines.
- Volume of the leach pit was calculated according to the grey water generated in all 10 houses.
- Grey water used to flow indiscriminately even on roads in the locality. There is a paradigm change in the environment. There is no filth flowing on the roads or in the surroundings.
- Foul smell and mosquito infestation has reduced.

OTHER FEATURES

Capacity	4000 l grey water per day approx
Area required	110 sq. ft. (10 sq. m.)
Population covered by a single unit	50, 10 Households
Capex	INR 32000, INR 640 per capita (including secondary silt chamber, excluding HH silt chamber and pipeline)
Opex	INR 2500 per year, INR 50 per capita per year
Technology is material-intensive or labor-intensive or both	Requires both components equally. Requires only local material. Local skilled workers can construct it after proper training.
Reuse of treated water	Not applicable
Quality of treated water	Not applicable
Energy (power) required	Not required

OPERATION AND MAINTENANCE REQUIRED

Cleaning of silt chamber	Primary – Once in a month Secondary - Twice a month
Desilting of leach pit	Once in 6 years
Cleaning of pipes	As and when required
Who does it?	Primary- Family members Secondary - Gram Panchayat

Level of implementation	Semi-centralised – group of houses
Suitability to terrain	All terrains except i) hard (impervious) rock and ii) permanently waterlogged areas. Can work in semi-permeable soils/black cotton soils with due modifications
Suitability to climatic conditions	All climatic conditions. In very high rainfall zones the function of a soak pit may hamper during the peak rainfall period
Suitability to housing pattern	Well suited to dense housing where individual interventions are not possible due to space problem.
Technical complexity	Low
Scalability	Easily scalable

Community Leach Pits in Village Horale, District Raigad, Maharashtra

Completed community leach pit

Additional brick-lined border to avoid flooding due to stormwater

SALIENT FEATURES

- Four to five houses are connected to a single community leach pit.
- Every house has a primary silt chamber.
- A secondary silt chamber is constructed near the leach pit.
- At some locations, a brick-lined border is provided to avoid flooding of leach pit due to stormwater.
- All the houses are connected by pipelines.
- Volume of the leach pit was calculated according to the grey water generated in all 5 houses.
- Foul smell and mosquito infestation has reduced.
- Grey water used to flow indiscriminately even on roads in the locality. The scenario has completely changed.

OTHER FEATURES

Capacity	270 to 360 l grey water per day approximately
Area required	43 sq. ft. (4 sq. m.)
Population covered by a single unit	20-25, 4-5 Households
Capex	INR 333644, INR 1682 per capita (including secondary silt chamber, excluding HH silt chamber and pipeline)
Opex	Not done yet
Technology is material-intensive or labor-intensive or both	Requires both components equally. Requires only local material. Local skilled workers can construct it after proper training.
Reuse of treated water	Not applicable
Quality of treated water	Not applicable
Energy (power) required	Not required

OPERATION AND MAINTENANCE REQUIRED

Cleaning of silt chamber	Primary – Once in a month Secondary - Twice a month
Desilting of leach pit	Once in 6 years
Cleaning of pipes	As and when required
Who does it?	Primary- Family members Secondary - Gram Panchayat

Community Leach Pits in village Amanat Diyara, Dist. Sahibganj, Jharkhand

Community leach pit under construction

Community leach pit nearing completion

Community Leach pit near Handpump

SALIENT FEATURES

- Community Leach Pit for 3-4 households constructed.
- Community Leach Pits also constructed near handpump to take care of the spilled water.

OTHER FEATURES

Capacity	1000 to 1500 l grey water per day approximately
Area required	43 sq. ft. (4 sq. m.)
Population covered by a single unit	15-20, 3-4 HH
Capex	INR 75000, INR 3750 per capita (including secondary silt chamber, excluding HH silt chamber and pipeline)
Opex	INR 1000 per year

Technology is material-intensive or labor-intensive or both	Requires both components equally. Requires only local material. Local skilled workers can construct it after proper training.
Reuse of treated water	Not applicable
Quality of treated water	Not applicable
Energy (power) required	Not required

OPERATION AND MAINTENANCE REQUIRED

Cleaning of silt chamber	Primary – Once in a month Secondary - Twice a month
Desilting of leach pit	Once in 6 years
Cleaning of pipes	As and when required
Who does it?	Primary- Family members Secondary - Gram Panchayat

Community Leach Pits in Village Dongali, District Narnaul, Haryana

Community leach pit under the paved road-literally invisible

Junction chambers from individual households joining directly to the Leach Pit

SALIENT FEATURES

- Dongli village has adopted community leach pit technology as early as 2005. The village has a peculiar old housing pattern where there is hardly any space between two houses. To overcome the space constraint the villagers have constructed common leach pits just below the main road. The road is now paved with concrete paver blocks. No part of the leach pit is visible. The only visible part of the Grey water management system is the small junction chambers of individual houses.
- The leach pits are functioning well for the last 17 years. The only maintenance performed by the villagers is the occasional cleaning of chambers and connecting pipes.

OTHER FEATURES

Capacity	600 to 800 l grey water per day approximately
Area required	50 sq. ft. (5 sq. m.)
Population covered by a single unit	15-20, 3-4 Households
Capex	INR 22000, INR 1100 per capita (including secondary silt chamber, excluding HH silt chamber and pipeline)
Opex	Not done yet
Technology is material-intensive or labor-intensive or both	Requires both components equally. Requires only local material. Local skilled workers can construct it after proper training.
Reuse of treated water	Not applicable
Quality of treated water	Not applicable
Energy (power) required	Not required

OPERATION AND MAINTENANCE REQUIRED

Interestingly the leach pits in Dongali haven't required any maintenance in the last 17 years. The household chambers are cleaned by house owners periodically.

REFERENCES

Desk Review	SBM Jharkhand, SBM Haryana, WaterAid India, DDWS website
Field Visit	Halgajiya, District Damoh, Madhya Pradesh Village Horale, District Raigad, Maharashtra Village Amanat Diyara, District Sahibganj, Jharkhand Village Dongali, District Narnaul, Haryana

COMMENTS/REMARKS/OBSERVATIONS

- There is no correlation between the size of the leach pit and number of houses connected or the quantity of grey water drained. The size of the leach pit is almost the same whether the number of houses is 2 or 5 or more.
- Every leach pit has a diameter of 5 ft and a depth of 20 ft. (almost 400 cubic feet). It can easily accommodate about 10000 l of water, whereas it is fed hardly with about 600 to 800 l of grey water.
- Interestingly no one has studied the parameters or tried to optimize the sizes in 17 years.
- Despite the very positive and encouraging experience in Dongli, none of the surrounding villages have come forward to follow this model. This is only for fear of water seeping into the walls of the house.

9. Community Plantation using Grey Water

Reusing grey water in some form or the other can be an ideal way to manage it. This is possible at various scales, from a single house to an entire village. Grey water reuse for growing various plants/crops is not only easy to practice but also requires very simple, low-cost, and technically less complex infrastructure. However, social acceptance and proper management and monitoring at various levels is a pre requisite for such a system.

Implementing states – Maharashtra

Community Plantation using Grey Water at Village Banwadi, District Satara, Maharashtra

Chamber at the end of the drain

Initial plantation of Banana

Mixed plantation of Banana and Drumstick

Indiscriminate growth of vegetation after disruption of the unit

SALIENT FEATURES

- Grey water from 450 households out of 1644 from the village Banwadi is collected at one point through a pipeline.
- The water is used in a plantation on 10 acre land owned by the Gram Panchayat.
- Before entering the plantation, the water is also allowed to soak in a leach pit and only the excess water is used for irrigation.
- Plants grown – Banana, Drumstick and some other plants.
- Method of irrigation – Free flooding.
- Management – The plantation is managed by Swachchhagrahis.
- The project was launched in 2019.

OTHER FEATURES

Capacity	90000 l grey water per day approximately
Area required	10700 sq. ft. (1000 sq. m.)
Population covered by a single unit	1800, 450 Households
Capex	INR 22000, INR 12 per capita
Opex	INR 2500 per year, INR 1.38 per capita per year
Technology is material-intensive or labor-intensive or both	Labor-intensive technology. Initial planning of the plantation and regular monitoring is crucial and need to be done carefully.
Reuse of treated water	Reuse for irrigation
Quality of treated water	Not done
Energy (power) required	Not required

OPERATION AND MAINTENANCE REQUIRED

Monitoring of flow of water, management of excess water	Regularly, as and when required
Management of plantation	Regularly, as and when required
Cleaning of pipes	As and when required
Who does it?	Swachhagrahis and Gram Panchayat

Level of implementation	Semi-centralised – group of houses as well as centralised – for the entire village
Suitability to terrain	All terrains except i) hard (impervious) rock and ii) permanently waterlogged areas.
Suitability to climatic conditions	All climatic conditions. In Monsoon some arrangement for bypassing the grey water is essential since it is not required by the plants.
Suitability to housing pattern	Well suited to dense housing where individual interventions are not possible due to space problem.
Technical complexity	Low
Scalability	Easily scalable

PROBLEMS FACED

At present (2022) the project has some hiccups and is not working. This can be due to the following reasons.

- Errors in initial planning - Mismatch between the quantity of water, plantation area, and type of plantation.
- No pre-treatment of incoming grey water before irrigating the crops.
- Lack of proper maintenance and monitoring – Grey water remains stagnant, not channelized as required.
- Low acceptance by the community due to bad smell and stagnant water in the area.

REFERENCES

Desk Review	DDWS website
Field Visit	Village Banwadi, District Satara, Maharashtra

SECTION 1

EXISTING TECHNOLOGIES

C. Centralised Technologies

10. Waste Stabilization Pond
11. DEWATS
12. Sinchewala model of Grey Water Management
13. Seechewal (Sinchewala) Model Modified with TIET Technology
14. Modified Grey Water Management using Typha Plantation

10. Waste Stabilization Pond (WSP)

Waste stabilization pond (WSP) is the most widely adopted technology for the centralised management of wastewater. It is a nature-based technology and does not require any external inputs such as chemicals or energy for the process. A Waste Stabilization Pond (WSP) is a series of three or more interconnected ponds. Grey water flows from one pond to another by gravity. No power is required. Each pond has a specific function in the purification of grey water. The water coming out of a properly designed and properly operated WSP is considered fit for agriculture or pisciculture purposes. However, WSP requires a sizeable piece of land at one location and needs to be critically designed as per norms to achieve the desired results. Likewise, the operation and maintenance of this seemingly simple system must also be significant, otherwise, it may miserably fail to process grey water.

Implementing states – Maharashtra, Madhya Pradesh, Chhattisgarh, Jharkhand, West Bengal, Gujarat, Odisha.

Waste Stabilization Pond at Sultanpur, District Karnal, Haryana

Anaerobic pond

Facultative pond

Maturation pond

Operation & Maintenance of Anaerobic pond

Operation & Maintenance of maturation pond

Operation & Maintenance of Facultative pond

SALIENT FEATURES

- Spread over 2.75 acres of land on the outskirts of village Sultanpur, constructed in 2021, this WSP has the capacity to treat about 84 KLD of grey water per day.
- The original design of a waste stabilization pond has been modified and two more ponds – an additional anaerobic pond and maturation pond each - have been incorporated.
- Two anaerobic ponds are used alternately to facilitate cleaning without disturbing the function of the system.
- The additional maturation pond is provided since there are no takers for the treated water at present and it needs to be properly discharged without any overflow in the nearby areas.

WORKING PRINCIPLE – Purification of grey water through natural processes.

COMPONENTS OF THE SYSTEM

Screen Chamber – It helps in removal of solids (sludge) and some floating physical impurities from the grey water.

Anaerobic pond – First pond of the series. It functions as follows:-

- Settlement of solids at the bottom in the form of sludge
- Digestion of grey water with the help of anaerobic bacteria and primary reduction of BOD
- Supernatant liquid flows forward to the second pond – The facultative pond

Facultative Pond – Second pond of the series. It functions as follows

- Grey water undergoes both anaerobic (in the lower section) and aerobic (in the upper section) digestion
- Further purification of grey water is achieved. Grey water flows to third pond-aerobic pond

Aerobic Pond/Maturation Pond – Third and final pond of the series. It functions as follows

- Mainly aerobic microbial action takes place
- Further purification of grey water is achieved. Grey water flows out of the system for reuse.

OTHER FEATURES

Capacity	84000 l of grey water per day
Area required	2.75 acres
Population covered by a single unit	2000, 450 Households
Capex	INR 3260000
Opex	INR 200000 per year
Technology is material-intensive or labor-intensive or both	Requires less material and more labour. Local skilled and unskilled workers can do the job with proper technical planning, guidance, and supervision
Reuse of treated water	Not done for the present. In future, it is intended to use this water for agriculture or pisciculture.
Quality of treated water	The test reports of Aug 2021 show BOD reduction from 73 to 36 mg/l and COD reduction from 240 to 128 mg/l
Energy (power) required	Not required

OPERATION AND MAINTENANCE REQUIRED

Cleaning of screen chambers, post-Monsoon clearing of embankments, anti-mosquito spraying, etc.	Twice a year
Desilting of the anaerobic pond, Scum removal from all the ponds	As and when required
Cleaning of pipes	As and when required
Who does it?	Gram Panchayat

Level of implementation	Centralized
Suitability to terrain	All terrains except i) hard (impervious) rock and ii) permanently waterlogged areas.
Suitability to climatic conditions	All climatic conditions.
Suitability to housing pattern	Well suited to dense housing where individual interventions are not possible due to space problem.
Technical complexity	Medium
Scalability	Scalable with competent technical assistance

REFERENCES

Desk Review	SBM Punjab, DDWS website
Field Visit	Sultanpur and Kurak Jagir, District Karnal, Haryana

11. DEWATS - Decentralized Waste Water Treatment System

DEWATS is a composite structure combining several components designed according to the specific parameters and pollution levels of the influent wastewater. The treated water is generally used for irrigation or pisciculture however, in the present project the treated water is infiltrated into the ground with the help of a soak pit.

Implementing states – Chhattisgarh, Madhya Pradesh, Karnataka, Tamil Nadu, Maharashtra.

DEWATS for grey Water Management at Ghugva, District Durg, Chhattisgarh

External View of DEWATS system

Internal View of DEWATS system showing Screen chamber, Anaerobic baffled reactors and Soak pit (at the far end)

Soak Pit for groundwater recharge by the treated water

SALIENT FEATURES

WORKING PRINCIPLE – Purification of grey water and infiltration into the ground facilitating recharge of groundwater.

COMPONENTS OF THE SYSTEM

Screening chamber – Waste water from households coming through the open drain first enters this chamber where floating physical impurities are separated with the help of screen bars.

Settler – It is a two-chambered structure that facilitates the settling of solids at the bottom (sludge). Lighter components (oil, grease, peels) float in the upper part (scum layer) and relatively clearer water flows further in the Anaerobic baffled reactor.

Anaerobic Baffled Reactor – ABR is a series of compartments separated by baffles (partitions). These compartments are connected with each other by vertical pipes with an inlet at the upper side and outlet at the bottom. This creates an upward–downward flow of water in the entire ABR. Further settling of solids takes place. This also forces the water to pass through the sludge blanket at the bottom containing microbes resulting in the anaerobic degradation of the organic impurities.

Anaerobic Filter - This is similar in structure to an anaerobic baffled reactor. However, there is an addition of fixed filter media (boulders, broken pipes, etc.). This media provides a huge surface area for microbes to grow. Grey water is forced to flow through the medium and comes in contact with the microbes. Non-settleable and suspended solids get decomposed.

Soak Pit – The effluent from the anaerobic filter enters the soak pit from where the treated water infiltrates the surrounding soil finally recharging the groundwater.

Bypass arrangement for stormwater – The grey water from houses flows to the system through the storm water drain. In order to avoid rainwater entering the system a bypass arrangement is provided at a suitable point.

OTHER FEATURES

Capacity	7000 l of grey water per day
Area required	448 sq. ft. (41.60 sq. m.)
Population covered by a single unit	1078, 159 Households
Capex	INR 551899
Opex	INR 5000 per year
Technology is material-intensive or labor-intensive or both	Requires both components equally. Requires only local material. Local skilled workers can construct it after proper training.
Reuse of treated water	Water is recharged into the ground
Quality of treated water	Not done yet
Energy (power) required	Not required

OPERATION AND MAINTENANCE REQUIRED

Backwashing of filter media	As and when required
Desludging of settler and ABR/AF, Cleaning of all filter media	Once in 2 years
Cleaning of pipes	As and when required
Post-monsoon maintenance – clearing of mud etc	Post Monsoon
Who does it?	Gram Panchayat

Level of implementation	Centralised
Suitability to terrain	All terrains except i) hard (impervious) rock and ii) permanently waterlogged areas.
Suitability to climatic conditions	All climatic conditions.
Suitability to housing pattern	Well suited to dense housing where individual interventions are not possible due to space problem.
Technical complexity	Low
Scalability	Scalable with competent technical assistance

DEWATS for Grey Water Management at Bharasar, District Kutch, Gujarat

Anaerobic Baffled Reactor

Planted Gravel Bed

Final Storage Pond

SALIENT FEATURES

After achieving the goal of providing adequate water supply to every household under the Jal Jeevan Abhiyan, Bharasar village faced the problem of Grey water management. Problems of mosquito infestation and vector-borne diseases also arose. To overcome the same a DEWATS unit was proposed and installed. The project took shape in fast-track mode due to the financial support of an NRI from the village.

WORKING PRINCIPLE – Purification of grey water and reuse in agriculture.

COMPONENTS OF THE SYSTEM

Screening chamber – Physical impurities from wastewater are separated with the help of screen bars.

Settler – It is a two-chambered structure that facilitates the settling of solids at the bottom (sludge). Lighter components (oil, grease, peels) float in the upper part (scum layer) and relatively clearer water flows further in the Anaerobic baffled reactor.

Anaerobic Baffled Reactor – Anaerobic Baffled Reactor is a series of compartments separated by baffles (partitions). These compartments are connected with each other by vertical pipes with an inlet at the upper side and outlet at the bottom. This creates an upward–downward flow of water in the entire Anaerobic Baffled Reactor. Further settling of solids takes place. This also forces the water to pass through the sludge blanket at the bottom containing microbes resulting in the anaerobic degradation of the organic impurities.

Anaerobic Filter - This is similar in structure to an anaerobic baffled reactor. However, there is an addition of fixed filter media (boulders, broken pipes, etc.). This media provides a huge surface area for microbes to grow. Grey water is forced to flow through the medium and comes in contact with the microbes. Non-settleable and suspended solids get decomposed

Planted Gravel Filter – This is a multichambered bed filled with gravel. Plants such as Cana have been planted in this bed. Grey water from the anaerobic filter flows into it. The gravels as well as the roots of plants are always submerged in water. Grey water gets further purified.

Storage Tank – This is the last component of the system. It stores treated water. This water can be supplied to agricultural land. When there is no demand, the water automatically flows into the discharge pit and percolates into the ground.

OTHER FEATURES

Capacity	250 KL of grey water per day
Area required	2400 sq. ft. (225 sq. m.)
Population covered by a single unit	1000, 200 Households
Capex	INR 6000000
Opex	Not done yet
Technology is material-intensive or labor-intensive or both	Requires both components equally. Requires only local material. Local skilled workers can construct it after proper training.
Reuse of treated water	Water is recharged into the ground
Quality of treated water	Not done yet
Energy (power) required	Not required

OPERATION AND MAINTENANCE REQUIRED

Backwashing of filter media	As and when required
Desludging of settler and ABR/AF, Cleaning of all filter media	Once in 2 years
Cleaning of pipes	As and when required
Post-monsoon maintenance – clearing of mud etc	Post Monsoon
Who does it?	Gram Panchayat

Level of implementation	Centralised
Suitability to terrain	All terrains except i) hard (impervious) rock and ii) permanently waterlogged areas.
Suitability to climatic conditions	All climatic conditions.
Suitability to housing pattern	Well suited to dense housing where individual interventions are not possible due to space problem.
Technical complexity	Low
Scalability	Scalable with competent technical assistance

REFERENCES

Desk Review	DDWS website, SBM Chattisgarh, Unicef Gujarat
Field Visit	Ghugva, District Durg, Chhattisgarh Bharasar, District Bhuj, Gujarat

12. Seechewal (Sinchewala) Model of Grey Water Management

Evolved as a part of the social welfare activities of Baba Balbir Singh Seechewal of Kapurthala, Punjab, the Seechewal model of Grey water management is a centralized system of treating grey water. The system works on the spiral movement of water through wells in clockwise and anti-clockwise directions which results in the removal of physical impurities from the water. Finally, the water gets stored in a dug pond where it undergoes mild aerobic digestion as well as settling. This water is then pumped for irrigation.

Implementing states – Punjab, Haryana

Seechewal Model of Grey Water Management at Kheri Bir Singh, District Fatehgarh Sahib, Punjab

Screening chamber (square) and Filtration wells (cylindrical) in series

Final storage pond from where the water is pumped for irrigation

Raised tower for ease in irrigation by gravity

SALIENT FEATURES

WORKING PRINCIPLE – Purification of grey water through a series of wells.

COMPONENTS OF THE SYSTEM

Screening chamber – Wastewater from households coming through the open drain first enters this chamber where floating impurities are separated with the help of screen bars.

Well one – (Approximately 12ft diametre and 20ft deep) Grey water from the screening chamber enters the digestion tank tangentially which aids in the settling of solid material to the bottom of the tank.

Well two – (Approximately 10ft diametre and 20ft deep) The motion of the grey water in this tank is anti-clockwise. Due to this oils and other such impurities get separated and do not enter the further stream.

Well three – (Approxiimately 8ft diametre and 20ft deep) Grey water treated through wells stabilizes here and settleable solids get further settled and separated.

Storage Pond – This is an open dug pond where the treated water is stored. The same is pumped from there to agricultural fields for irrigation.

OTHER FEATURES

Capacity	4500 l of grey water per day
Area required	21500 sq. ft. (2000 sq. m.)
Population covered by a single unit	15-20, 3-4 Households
Capex	INR 682000
Technology is material-intensive or labor-intensive or both	Requires both components equally.
Reuse of treated water	Used in agriculture
Quality of treated water	Not done yet
Energy (power) required	Power required for pumping for irrigation

OPERATION AND MAINTENANCE REQUIRED

Cleaning of screen chambers, Desilting of wells	As and when required
sludge removal from the ponds, post-Monsoon clearing of embankments, anti-mosquito spraying	As and when required
Cleaning of pipes	As and when required
Who does it?	Gram Panchayat

Level of implementation	Centralised
Suitability to terrain	All terrains
Suitability to climatic conditions	All climatic conditions.
Suitability to housing pattern	Well suited to dense housing where individual interventions are not possible due to space problem.
Technical complexity	Medium. However, it is very much crucial to stick to the design parameters such as slopes, angles and directions of flow, etc.
Scalability	Scalable with technical assistance

REFERENCES

Desk Review	DDWS website, SBM Punjab
Field Visit	Kher Bir Singh, District Fatehgarh Sahib, Punjab

COMMENTS/REMARKS/OBSERVATIONS

The working principle and role of different components of the system need to be scientifically verified and vetted. Although the system is capable of removing physical impurities, its ability to tackle biological and chemical contamination needs to be ascertained. The froth at the final discharge point is evidence of the chemical contaminants prevalent in the treated water.

13. Seechewal (Sinchewala) Model Modified with TIET Technology

With a view to overcoming the limitations and some of the shortcomings of the Seechewal model of GWM, the Thapar Institute of Engineering and Technology undertook the study of this model and finally optimized some of the parameters and also made an addition of an oxidation pond.

Implementing states – Punjab

Seechewal Model modified with TIET technology at Hiro Kalan, District Mansa, Punjab

Screening chamber (square)

Digestion tank, Skimming Tank and Stabilization Tank all in series

Oxidation Pond

Final Storage Pond

SALIENT FEATURES

WORKING PRINCIPLE – Purification of grey water + blackwater through a series of wells and oxidation ponds.

COMPONENTS OF THE SYSTEM

Screening chamber – Wastewater from households coming through the open drain first enters this chamber where floating impurities are separated with the help of screen bars.

Digestion tank (well) – The effluent from the screening chamber enters the digestion tank tangentially which aids in the settling of solid material to the bottom of the tank.

Skimming Tank (well) – The motion of the grey water in this tank is anti-clockwise. Due to this oils and other such impurities get separated and do not enter the further stream.

Stabilization Tank (well) – The effluent from the skimming tank enters the stabilization tank. In this tank, all the settleable particles are filtered down resulting in the cleaning of the grey water.

Oxidation-cum-Storage Pond – The effluent from the stabilization tank enters the oxidation pond where due to the action of sunlight, bacteria and algae it is treated further. The treated water is finally transferred to natural storage pond and used for irrigation.

OTHER FEATURES

Capacity	160680 l of grey water per day
Area required	14994 sq. ft. (1392.94 sq. m.)
Population covered by a single unit	2745, 400 Households
Capex	INR 2800000
Opex	INR 1000 per year
Technology is material-intensive or labor-intensive or both	Requires both components equally.
Reuse of treated water	Used for irrigation in agriculture in around 50 to 60 acres
Quality of treated water	Not done yet
Energy (power) required	Power required for pumping from storage pond to fields

OPERATION AND MAINTENANCE REQUIRED

Cleaning of screen chambers, Desilting of wells	As and when required
sludge removal from the ponds, post-Monsoon clearing of embankments, anti-mosquito spraying	As and when required
Cleaning of pipes	As and when required
Who does it?	Gram Panchayat

Level of implementation	Centralised
Suitability to terrain	All terrains
Suitability to climatic conditions	All climatic conditions.
Suitability to housing pattern	Well suited to dense housing where individual interventions are not possible due to space problem.
Technical complexity	Medium. However, it is very much crucial to stick to the design parameters such as slopes, angles and directions of flow, etc.
Scalability	Scalable with technical assistance

REFERENCES

Desk Review	DDWS website, SBM Punjab
Field Visit	Hiro Kalan, District Mansa, Punjab

COMMENTS/REMARKS/OBSERVATIONS

The working principle and role of different components of the system need to be scientifically verified and vetted. Although the system is capable of removing physical impurities, its ability to tackle biological and chemical contamination needs to be ascertained. The froth at the final discharge point is evidence of the chemical contaminants prevalent in the treated water.

14. Modified Waste Stabilization Pond using Typha Plantation

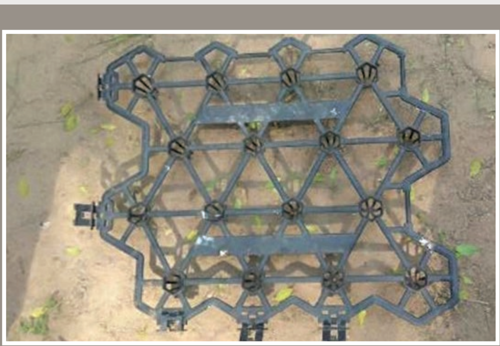
It was originally a waste stabilization pond constructed in 2013. After 6 years, in 2019, to overcome the inefficiencies of the unit, Typha plantation was introduced in one of the ponds. This was done as an experimental exercise to increase the purification potential of the treatment system.

Implementing states – Punjab.

Waste Stabilization Pond using Typha plantation at Village Singhpura, Dist. SAS Nagar, Punjab

Primary Collection tank for grey water

Grey water from the collection tank is pumped into the screening chamber



Specialized floats used for supporting Typha plants

Typha plantation using floats

Fully grown Typha Plantation in the first pond

Other two ponds of the series (Maturation pond I and II)

SALIENT FEATURES

Village Singhpura has a Waste Stabilization Pond Spread over 3 acres of land constructed in 2013. It has a capacity of 1.5 lakh liters per day.

THE ORIGINAL DESIGN COMPONENTS WERE AS UNDER

1. An underground collection tank with a capacity of about 30000 l.
2. A pump for lifting water from the collection tank to the screening chamber.
3. A screening chamber to separate physical impurities from the wastewater.
4. Facultative pond 1.5m deep with HRT as 5.8 days.
5. Maturation Pond 1, 1m deep with HRT as 2.9 days.
6. Maturation Pond 2, 1m deep with HRT as 2.5 days.
7. An open dug pond of about 1.5 acres for storage of treated water.

It was observed that the treated water was not of the expected standard (Final BOD around 90mg/l). This was attributed to reasons such as the growth in population and increase in water consumption. To overcome this problem, in 2018, Typha (*Typha Latifolia*) plantation was introduced in the first pond (facultative pond). Typha plants being macrophytes helped in enhancing the purification process of the system. The final BOD was found to be reduced to 23 mg/l.

WORKING PRINCIPLE – Purification of grey water through natural processes also using Typha plants.

ADDED COMPONENTS

- Floats made of polymers to hold the Typha plants in the pond.
- Typha plants grown in nursery in required quantity
- Typha plants were introduced in the first pond (facultative pond) of the series.

RESULTS OF THE MODIFICATION AFTER INTRODUCTION OF TYPHA IN APRIL 2019

	April 2019		July 2019	
Parameters	**Inlet**	**Outlet**	**Inlet**	**Outlet**
BoD	198 mg/l	90 mg/l	195 mg/l	23 mg/l
CoD	528 mg/l	304 mg/l	382 mg/l	93 mg/l

Source- SBM Punjab

OTHER FEATURES

Capacity	1,50,000 l of grey water per day
Area required	3.0 acres
Population covered by a single unit	1350, 198 Households
Capex	INR 13000000 – Additional cost on Typha Introduction - INR 6000000
Opex	Rs 96000 per year
Technology is material-intensive or labor-intensive or both	Requires both components equally.
Reuse of treated water	Presently there are no takers for the treated water. Since the location of the storage pond is not convenient. The treated water is stored in an open dug pond. In the future, it is intended to use this water for agriculture or pisciculture.
Quality of treated water	The test reports of July 2019 show BOD reduction from 195 to 23 mg/l and COD reduction from 382 to 93 mg/l
Energy (power) required	10 HP pump for 5 hrs. every day

OPERATION AND MAINTENANCE REQUIRED

Cleaning of screen chambers, Desilting of wells	As and when required
sludge removal from the ponds, post-Monsoon clearing of embankments, anti-mosquito spraying	As and when required
Cleaning of pipes	As and when required
Who does it?	Gram Panchayat

Level of implementation	Centralised
Suitability to terrain	All terrains
Suitability to climatic conditions	All climatic conditions.

Suitability to housing pattern	Well suited to dense housing where individual interventions are not possible due to space problem.
Technical complexity	Medium. However, it is very much crucial to stick to the design parameters.
Scalability	Scalable with technical assistance

REFERENCES

Desk Review	DDWS website, SBM Punjab
Field Visit	Sighpura village, District SAS Nagar

COMMENTS/REMARKS/OBSERVATIONS

1. The original WSP design needs to be verified. The design does not show an anaerobic pond. Similarly, the HRTs and depths of all the ponds need to be verified. The root cause of the inefficiency of the plant may be hidden in these erroneous parameters.
2. The cost of introducing Typha appears to be exuberant. There can be indigenous substitutes to these imported plants as well as the floats.

SECTION 2

NEWLY EVOLVED TECHNOLOGIES

15. Vedancha model of Grey Water Management
16. Vermifilter Technology
17. Bioremediation and Phytoremediation
18. Jalopchar
19. Eco STP
20. Inline Treatment of Grey Water

15. Vedancha Model of Grey Water Management

Vedancha model is one of the new upcoming technologies for grey water management. It is a completely over-ground masonry structure with three distinct compartments. Wastewater from households is primarily collected in a natural pond from where it is daily pumped into the treatment unit. Alum and lime dosing is one of the special features of this technology. Similarly, settling and charcoal treatment also form important functions of the treatment unit. Although the operating cost of this unit is high it is easily compensated by the manure produced through silting. The treated water can be used for irrigation.

Implementing states – Gujarat.

Vedancha Model for Grey Water Management at Rooppura, District Banaskantha, Gujarat

A complete view of Vedancha Model of Grey water management

Natural pond for collection of wastewater from households

Granular filter-cum-dozer for alum and lime

Settling Tank no. 1 with pebbles and large size charcoal

Settling tank no. 2 with activated charcoal

Settling tank no.3 with sand and charcoal powder

Manure produced from the plant

SALIENT FEATURES

WORKING PRINCIPLE – The system operates on the principle of settling wastewater at multiple stages in series. The use of certain chemicals for flocculation (alum), disinfection (lime), and purification (charcoal) also forms an important component of the system. Effective settling results in the accumulation of solids at the bottom of each compartment which is a rich soil conditioner and manure. The treated water is discharged into a deep well and infiltrated into the ground. It can be used for agriculture on demand.

COMPONENTS OF THE SYSTEM

Natural Pond for collection wastewater – Wastewater from 350 houses gets collected in this pond.

Pump – From the storage pond, the wastewater is pumped daily into settling tank number 1. While pumping it also passes through a drum filter.

Drum Filter – It is a screening unit for removing physical impurities from wastewater.

Settling agent Dozer – While the wastewater is pumped it is supplemented with alum and lime with the help of a dozer.

Settling tank no. 1 – It contains a mixture of pebbles and large-sized charcoal which facilitates the settling down of impurities at the bottom of the tank. After every 21 days, when the process is halted for cleaning, algal-based fertilizer at the bottom is collected.

Settling tank no. 2 – Similar process is followed in Tank no. 2. Here, the size of activated charcoal is lesser than in tank no. 1. Charcoal powder in this tank needs to be replenished daily (50 kg per day). From this tank also after every 21 days, when the process is halted for cleaning, algal-based fertilizer at the bottom is collected.

Settling Tank no. 3 - Treated water from settling tank no. 2 is then passed on to settling tank no. 3 where a filter bed consisting of Sand, gravel, and charcoal powder purifies the grey water. From this tank also after every 21 days, when the process is halted for cleaning, algal-based fertilizer at the bottom is collected.

Manure production – The manure obtained from three tanks is to the tune of 9000 kg per month.

Storage-cum-discharge well – The final treated water is drained into a 20 ft deep well from where it is infiltrated into the ground. It is also possible to use this for irrigation.

OTHER FEATURES

Capacity	200 KL of grey water per day
Area required	2500 sq. ft. (230 sq. m.)
Population covered by a single unit	1700, 350 Households
Capex	INR 646000
Opex	INR 45000 per month (including manpower and chemicals)
Revenue generated by the sale of manure	INR 500000–INR 550000 per month
Technology is material-intensive or labor-intensive or both	Requires both components equally.
Reuse of treated water	In future treated water will be used for irrigation
Quality of treated water	BOD - Inflow 110, Outflow - 11
Energy (power) required	The system requires a pump for lifting wastewater from the collection pond to the treatment unit

OPERATION AND MAINTENANCE REQUIRED

Pumping of wastewater into the system	Everyday
Dosing with alum and lime	Everyday
Collection of manure	After every 21 days
General Cleaning of the plant	As and when required
Who does it?	Contractor/Service Provider

Level of implementation	Centralised
Suitability to terrain	All terrains
Suitability to climatic conditions	All climatic conditions.
Suitability to housing pattern	Well suited to dense housing where individual interventions are not possible due to space problem.
Technical complexity	Medium. However, it is very much crucial to stick to the design parameters
Scalability	Scalable with technical assistance

REFERENCES

Desk Review	Unicef Gujarat
Field Visit	Village Rooppura, District Banaskantha, Gujarat

COMMENTS/REMARKS/OBSERVATIONS

The only thing to be careful about is the primary collection of wastewater from natural ponds. Since it is an unlined and unregulated lake, it is bound to have all the negative characteristics like mosquito breeding, flooding during monsoons, ground water contamination due to natural seepage, etc. Likewise, not all wastewater from the pond can be pumped into the system. Leftover water can cause the above problems.

16. Vermifilter Technology for Grey Water Management

Wastewater treatment using earthworms is a new upcoming technology. Earthworms act as 'biofilters' and remove impurities including total suspended solids from wastewater in addition to reducing BOD and COD. Earthworms carry out this process by 'ingestion' and biodegradation of organic wastes, heavy metals, and solids from wastewater and also by their 'absorption' through body walls. The peculiarity of this technology is that no sludge is generated in the process which requires additional system and disposal costs. The process is completely odor-free, another property of earthworms. The outcoming treated water is clean enough to be reused for irrigation or in parks and gardens. The wood chips eventually get converted into good-quality compost and soil conditioner- an additional by-product of the system.

Implementing states – Delhi, Madhya Pradesh.

Vermifilter-based Sewage Treatment Plant at Technical University Delhi

Primary Bar Screen chamber, storage tank and pumps

A biofilter/vermifilter unit consisting of crates filled with wood chips filled with earthworms. Effluent is sprinkled through sprinklers

Final storage tank for treated water

Visual difference between inflow and outflow

SALIENT FEATURES

WORKING PRINCIPLE – The system works on the principle of vermi-filtration where earthworms of particular species and a mix of microbes act on the suspended and dissolved solids in the raw sewage and biologically degrade in an environmentally safe manner. This is a continuous process and the treated water keeps flowing through a drain at the floor of the bio-filter into the treated water tank which can be used for further treatment or irrigation/horticulture etc.

COMPONENTS OF THE SYSTEM

Sewage Diverting Channel with Bar Screening

These screens allow removing major large-size particles and silts from grey water up to 6mm in size manually by simple gravity screening. The suspended solids (TSS) drop by 25 - 30% under this process thereby supporting the further process.

Strainer or Silt Removal System

The wastewater is then pumped from the collection tank via the Strainer system. The strainer is a nonelectric physical filtration system composed of rings and a mesh of 450 microns in size. The sewage passing through it becomes free from silt. The overall removal of TSS is about 70 - 90% and BOD, and COD reduction by 10 – 15%. Straining supports in non-clogging of Vermi or Bio-filtration sewage treatment system.

Pump – From the storage tank, the wastewater is continuously pumped to the vermifilter units.

Vermifilter unit – This is the main treatment unit of this system. It consists of multiple plastic crates stacked in a special fashion. The crates are filled with wood chips and earthworms once a year. Sprinklers are fitted over the top of the crates. Wastewater is continuously sprinkled over the wood chips. Wastewater trickles down the staked crates and flows through a drain below the crates. The complete unit is installed in a shed, protected from direct sunlight.

Storage Tank – Treated wastewater is collected in a storage tank outside the vermifilter unit. From here it can be used as and when needed.

Ozonation Unit (Optional) – Ozonation is done to increase the purity of water.

Manure production – The media (wood chips) in the crates in the vermilifter unit is replaced annually. By the time it's due to be replaced, it turns into a high-quality soil conditioner. It is the revenue generating element of the system.

OTHER FEATURES

Capacity	1 million l of grey water per day
Area required	8400 sq. ft. (780 sq. m.)
Population covered by a single unit	15000
Capex	INR 1.90 crore
Opex	INR 1.2 lakh (including manpower and change of media)
Technology is material-intensive or labor-intensive or both	Requires both components equally. The system requires some specialized proprietary components.
Reuse of treated water	Treated water is used for construction, toilet flushing, gardening, etc.
Quality of treated water	BOD 9, COD 41
Energy (power) required	The system requires 2 pumps to run alternately for 20 hours a day for lifting wastewater from the collection tank to the sprinkler unit

OPERATION AND MAINTENANCE REQUIRED

Pumping of wastewater into the system	Everyday
Monitoring the working of sprinklers	Everyday
Changing of wood chips and earthworms	Once a year
Who does it?	Contractor/Service provider

Level of implementation	Centralised
Suitability to terrain	All terrains
Suitability to climatic conditions	All climatic conditions.
Suitability to housing pattern	Well suited to dense housing where individual interventions are not possible due to space problem.
Technical complexity	Medium. However, it is very much crucial to stick to the design parameters
Scalability	Scalable with technical assistance

A similar system of 30 KLD capacity is under construction at Datoda, Dist, Indore, Madhya Pradesh for 100 households. The estimated cost of the project is INR 2630000 and the recurring expenses are estimated to be INR 20000 per month.

REFERENCES

Desk Review	Unicef Gujarat
Field Visit	Technical University, Delhi

17. Bioremediation and Phytoremediation Technology for Grey Water Management

Bioremediation and phytoremediation technology of grey water management is a system that uses a combination of microbial culture and physical filters. The plant was established in 2018 at Gargoti village in the Kolhapur district of Maharashtra. The technology was provided and the plant was installed by M/s Shashwat Organic Farming Associates.

Implementing states – Maharashtra.

Bioremediation and Phytoremediation Technology for GWM at Village Gargoti, District Kolhapur, Maharashtra

Bioremediation and Phytoremediation unit showing 1) Feeding channel 2) Collection-cum-settling tank 3) Bio Tower and 4) Bio-filter in a series

SALIENT FEATURES

Gargoti village has a network of drains to collect grey water from all households. All the drains connect to the main drain which ends in the Vedganga river. A Bioremediation and phytoremediation plant has been set up to prevent river pollution. The plant treats about 3 lakh liters (25%) of the total grey water produced in the village. The use of specialized microbial culture is the major treatment component of the system.

WORKING PRINCIPLE – Purification of grey water through microbial process and physical filtration.

Component of the system

1) **Collection-cum-settling Tank –** This tank has multiple functions. A screen installed at the beginning prevents larger physical impurities. The tank also acts as collection-cum-equalization tank. It also facilitates sedimentation of suspended solids. The capacity of this tank is 10000 l.

2) **Bio-Tower –** This part is filled with gravel and also inoculated with microbial culture. Water percolates through both these layers which results in the reduction of BOD and COD. The capacity of this tank is around 10000 l.

3) **Bio-Filter –** This is an underground tank filled with gravel and sand. It is also inoculated with microbial culture.

OTHER FEATURES

Capacity	3,00,000 l of grey water per day
Area required	1076 sq. ft. (100 sq. m.)
Population covered by a single unit	4500, 900 Households
Capex	INR 700000 – INR 156 per capita
Opex	INR 250000 per year
Technology is material-intensive or labor-intensive or both	Requires both components equally.
Reuse of treated water	The water treated through the unit is drained into river Vedganga
Quality of treated water	Not available
Energy (power) required	No power required

Level of implementation	Centralised
Suitability to terrain	All terrains
Suitability to climatic conditions	All climatic conditions
Suitability to housing pattern	Well suited to dense housing where individual interventions are not possible due to space problem.
Technical complexity	Medium. However, it is very much crucial to stick to the design parameters
Scalability	Scalable with technical assistance

REFERENCES

Desk Review	DDWS website, SBM Kolhapur
Field Visit	Gargoti village, District Kolhapur

COMMENTS/REMARKS/OBSERVATIONS

Presently (2022) the plant has become inoperable due to a lack of finance to meet recurring expenditures mainly on procurement of culture and also due to some managerial problems.

18. Jalopchar Grey Water Management System

Designed and developed by IARI, Delhi, Jalopchar technology is a single-stage treatment system that utilizes the interaction between plants, microbes and media (gravel) for the purification of wastewater.

In nature, some species of plants (macrophytes) grow naturally in wetlands. They play a role in purifying the water they come into contact with, especially their root systems. The same environment is artificially created in jalophar. This can be described as a modified version of constructed wetland.

Implementing states – Haryana, Uttar Pradesh

Jalopchar at Javahar Navoday Vidyalay, Rasalpur, District Palwal, Haryana

Central collection tank for wastewater

Wastewater is pumped into the planted bed

Distribution system with perforated PVC pipes

Planted bed with macrophyte plants

SALIENT FEATURES

WORKING PRINCIPLE – Jalopchar system works on the principle of bio-filtration i.e.; synergistic functioning of macrophyte plants, microbes and gravel media. Macrophyte plants play a major role as they grow profusely and produce maximum biomass in the system. These plants play multiple roles – uptake of pollutants from wastewater, and transport of oxygen from the atmosphere to the rhizosphere (root system), which in turn is made available to microorganisms that purify the wastewater. Gravel media facilitates the proper distribution of wastewater and pollutants throughout the planter bed and also supports the growth microbial as well as plant growth. Microorganisms harboring on media as well as plant roots degrade organic pollutants in wastewater. Unlike DEWATS or other similar systems, this does not include components such as anaerobic filters or anaerobic baffled reactors.

COMPONENTS OF THE SYSTEM

Collection tank – Entire wastewater from the campus is collected in this tank

Pump and distribution chamber – Effluent from the collection tank is pumped daily into this chamber and further into the planted beds (7.5 HP pump for 1 hr.)

Planted Bed – This is the main treatment unit where macrophyte plants are planted. It is a masonry unit built in a trapezoidal shape. The effluent is distributed through perforated PVC pipes of 6 inch diametre.

Discharge chamber – This is the final point from which treated water exits the system. At present it is discharged into natural drains. It can be used for irrigation.

OTHER FEATURES

Capacity	100000 l of grey water per day
Area required	7800 sq. ft (724 sq. m.)
Population covered by a single unit	350, 1 school
Capex	Not available
Opex	No available
Technology is material-intensive or labor-intensive or both	Requires both components equally.
Reuse of treated water	Can be used in agriculture. Presently goes to a natural stream
Revenue generation	After harvesting the macrophyte plants can be used for several type of artefacts and handicrafts.
Quality of treated water	Not available
Energy (power) required	7.5 HP pump operates for 1 hr daily.

OPERATION AND MAINTENANCE REQUIRED

Pumping of effluent into planter bed	Everyday
Desilting of collection tank	As and when required
Cleaning of distribution pipes and removing occasional blockages	As and when required
Harvesting of plants from planter bed	Once a year
Who does it?	Primary- Family members Secondary - Gram Panchayat

Level of implementation	Decentralised – Standalone unit for school
Suitability to climatic conditions	All climatic conditions. In very high rainfall zones the function may hamper during the peak rainfall period
Suitability to housing pattern	Suitable for residential schools having adequate space/ for dense housing where individual interventions are not possible due to space problem.
Technical complexity	Medium. However, as it is an engineered structure, need to be planned and implemented very scrupulously.
Scalability	Scalable with technical assistance

REFERENCES

Field Visit	Javahar Navoday Vidyalay, Rasalpur, District Palwal, Haryana

19. ECO STP for Grey Water Management

The ECOSTP technology offers a state-of-the-art sewage treatment solution taking maximum advantage of natural processes including anaerobic digestion to achieve a long-life, reliable and eco-friendly sewage treatment system. The system is a biomimicry of the cow's digestive system. Requires no power, no chemicals and no moving mechanical parts as well. The treated water meets the required standards for agricultural or other similar non-potable uses. ECOSTP solution is a 'Bad Water in Good Water out' system with no moving parts.

Implementing states – Madhya Pradesh, Odisha

Eco- STP at Barman Kalan, District Narsinghpur, Madhya Pradesh

SALIENT FEATURES

WORKING PRINCIPLE – ECOSTP is a combination of different wastewater treatment technologies cascaded in modules to a full-blown system, to achieve the required effluent quality for reuse purpose/s. At micro level, the anaerobic sludge digestion process is carried out by microbes under anaerobic conditions (i.e.; oxygen is not used in the degradation process reactions). This makes it different from aerobic digestion wherein oxygen is used. Anaerobic digestion is more economical than aerobic treatment as the aeration process is not required for anaerobic digestion.

COMPONENTS OF THE SYSTEM

Stage I - The first stage involves liquefying of the solid material in the sludge. This process is called hydrolysis.

Stage II – The second stage is rapid and involves the digestion of the soluble solids that resulted from the previous stage. This process is carried out at the molecular level by acid (primarily acetic, propionic, butyric acid, etc.) producing anaerobic bacteria.

Stage III – At the final stage which is called the gasification stage, the organic acid produced in the previous stage is used by certain microbes as substrate, and methane and carbon dioxide gases are producedas a result. This stage is slower and is also called methanogenesis.

Stage IV - PBF (Plant Bio Filter) –filtration and aerobic treatment.

Sand Filter –filtration and aids natural disinfection.

OTHER FEATURES

Capacity	110 KL of grey water per day
Area required	Not available
Population covered by a single unit	1389, 273 Households
Capex	INR 6050000
Opex	INR 40000 per year
Technology is material-intensive or labor-intensive or both	Requires both components equally.
Reuse of treated water	Groundwater recharge
Quality of treated water	Not available
Energy (power) required	Not required

OPERATION AND MAINTENANCE REQUIRED

Clean up PBF area for any dead leaves / waste materials	Weekly
Trim any plants which has grown really big / drying up / falling down	Weekly
Open the final collection tank manholes and check for any backflow issues	Monthly
Sand filter - top layer of the sand to be removed, remaining sand to be churned and replaced with new sand. And-complete sand replacement	Annually
Open the manholes and check for any blockage in the STP chambers	Regularly
Check sludge level using Sludge Judge Tool for proper assessment of sludge and desludging timeline	Annually
Desludging done for Stage 1 chambers	Once in 2 years

Level of implementation	Centralised
Suitability to terrain	All terrains except i) hard (impervious) rock and ii) permanently waterlogged areas.
Suitability to climatic conditions	All climatic conditions.
Suitability to housing pattern	Well suited to dense housing where individual interventions are not possible due to space problem.
Technical complexity	High. It is an engineered structure. Need to be planned and implemented very scrupulously.
Scalability	Scalable with technical assistance

REFERENCES

Desk Review	WaterAid Madhya Pradesh
Field Visit	Village Barman Kalan, District Narsingpur, Madhya Pradesh

COMMENTS/REMARKS/OBSERVATIONS

The construction of this plant is in progress. A similar plant of 10 KLD is under construction at Motto Slum Chandbali Block, District Bhadrak, Odisha.

20. Inline Treatment for Grey Water Management

The system consists of a horizontal subsurface flow constructed wetland that is dependent on the treatment target and the amount and quality of the influent. The removal efficiency of the wetland and the maximum possible flow are determined by the surface area and cross-sectional area of the wetland. Generally, a surface area of about 3 square metre per cubic metre of pre and secondary-treated effluent is required. Settler and Anaerobic Baffle Reactor (ABR)/Sedimentation tanks/Sedimentation drain/Sedimentation ponds etc., can be used as primary treatment modules.

Implementing States – Karnataka

Inline Treatment for Grey Water Management, Rampura, District Chitradurga, Karnataka

Screening and velocity baffle walls with pit

In-line convey channel to settler tank

Settler tank with aerobic ventilation

Storage tank

SALIENT FEATURES

Inline treatment generally uses natural canals, natural drains and low-lying sections of the channel to accommodate different components of the system such as settling tanks, planted beds, aerobic treatment units, etc.

Pre-Treatment – This unit is a screening unit typically characterized by a screening bars to prevent physical impurities from entering the grey water flowing through the drain.

Sedimentation pond – This facilitates further separation of solids in the form of sludge by way of sedimentation.

Wetland through open channels – Natural channels are modified to act as wetland. Any native plant with deep, wide roots that can grow in a wet, nutrient-rich environment is appropriate. Phragmites australis (reed) is a common choice because it forms horizontal rhizomes that penetrate the entire filter depth. These plants play multiple roles – uptake of pollutants from wastewater, and transport of oxygen from the atmosphere to the rhizosphere (root system), which in turn is made available to microorganisms that purify the wastewater.

Gravel media - Most commonly, angular-graded gravel is used to fill the bed to a depth of 0.5m. To limit clogging, the gravel should be clean and free of fines. As for the water level in the wetland, it is maintained at 5 to 15 cm below the gravel surface to ensure subsurface flow. Gravel bed facilitates the proper distribution of wastewater and pollutants throughout the planter bed and also supports the growth microbial as well as plant growth. Microorganisms harboring on media as well as plant roots degrade organic pollutants in wastewater.

Storage Tank- It is an open excavated or natural pond at the end of the system that stores treated water. The treated water from here either seeps into the ground or can be used to irrigate nearby agriculture.

OTHER FEATURES

Capacity	4,00,000 l of grey water per day
Area required	Not availble
Population covered by a single unit	2600, 450 Households
Capex	INR 1200000, INR 461.54 per capita
Opex	INR 15600 per month. INR 6 per capita
Technology is material-intensive or labor-intensive or both	Requires both components equally.
Reuse of treated water	Groundwater recharge partially for agriculture.
Quality of treated water	Not done
Energy (power) required	Not required

OPERATION AND MAINTENANCE REQUIRED

Cleaning of screen chambers, post-Monsoon clearing of embankments, anti-mosquito spraying, etc.	As and when required
Desilting of the sedimentation pond, Scum removal from all the ponds	As and when required
Cleaning of channels	As and when required
Who does it?	Gram Panchayat

Level of implementation	Centralised
Suitability to terrain	All terrains except i) hard (impervious) rock and ii) permanently waterlogged areas.
Suitability to climatic conditions	All climatic conditions.
Suitability to housing pattern	Suited to dense housing where individual interventions are not possible due to space problem.
Technical complexity	High. It is an engineered structure. Need to be planned and implemented very scrupulously.
Scalability	Scalable with technical assistance

REFERENCES

Desk Review	DDWS
Field Visit	Rampura, District Chitradurga, Karnataka

SECTION 3

INNOVATIVE TECHNOLOGIES

21. Nehveen Model of Grey Water Management

The Nehveen model (named after the local SBM officials who developed the concept) is a newly evolved technology for grey water management. Tried and tested in Bhiwani district of Haryana, it is a modified version of the community leach pit. Accurate measurement and actual calculation of grey water generated, proper screening and silt removal from the grey water prior to the main treatment are some of the key features of the system. A favorable soil stratum is a prerequisite of this model (Bhiwani district is characterized by sandy soil which is highly permeable)

Implementing states – Haryana.

Nehveen Model of Grey Water Management at Jitanwas, District Bhiwani, Haryana

Main incoming drain from households (measurement of flow is crucial)

Branched silt chamber-cum-grease trap to arrest physical impurities and oil and grease

Leach pit with a honeycombed partition wall. One part is filled with brickbat/boulders

No. of leach pit ranges from 2 to 6 as per the quantity of grey water to be treated

Leach pit under construction

Branching and connection of drains with Leach pit

Completed unit

SALIENT FEATURES

WORKING PRINCIPLE – The system operates on the principle of recharge of groundwater with grey water. A silt-cum-grease chamber is an integral part of the system which prevents the physical impurities from entering the leach pit. The system does not require any power or mechanical components or chemicals.

COMPONENTS OF THE SYSTEM

Well-constructed and managed drain – This facilitates transportation of Grey water from households to treatment sites. It is also necessary to keep drains clean and free of debris along their entire length. Cleaner the water, more efficient the system works

Screen chamber – Grey water from the drain first passes through this chamber. This has an iron mesh for screening of physical impurities like plastic, trash, etc.

Sedimentation chamber-cum-grease trap – This is a 5ft deep square shaped chamber. From this originate the pipes that convey the filtered grey water received from the first chamber to the leach pits. The depths of pipes are adjusted to facilitate deposition of sludge up to about three feet. The pipes are connected to the leach pit with bends. This prevents floating impurities including oils and greases from entering the leach pit.

Two compartment leach Pit – Leach Pits constructed in honeycomb masonry are the main components of this system. The leach pit is divided into two parts with the help of a partition wall also constructed in honeycomb fashion. The first part (to which the inlet pipe is connected) is filled with boulders/brickbat. Stones are also filled around the entire leach pit up to 1 ft. It is assumed that grey water coming to the leach pit flows to the filled part first and then to the hollow part. The number of leach pits ranges from 2 to 6 depending upon the grey water to be treated.

Bypass arrangement for storm water – This is an important component of the system. In order to avoid flooding of the leach pits and prevent shutdown, the peak flow of grey water in the drain is properly calculated and an arrangement is made at the entry point to the system so that the excess water passes to some natural canal or pond nearby.

OTHER FEATURES

Capacity	24000 l of grey water per day
Area required	1200 sq. ft. (110 sq. m.)
Population covered by a single unit	1000, 200 Households
Capex	INR 149000
Opex	INR 8000 per month (Salary of general safai karmachari who also maintains this unit)
Technology is material-intensive or labor-intensive or both	Requires both components equally.
Reuse of treated water	24000 l of water per day. Groundwater level found increased by 2ft in 1 year.
Quality of treated water	Not tested. But incidence of water borne diseases reduced in the Gram Panchayat.
Energy (power) required	Not required

OPERATION AND MAINTENANCE REQUIRED

Delisting of screen chambers and Junction chambers	As and when required
Desilting of leach pit	Once in 6 years (Not done yet)
Monitoring of drains	As per general cleaning schedule of the Gram Panchayat
Who does it?	Gram Panchayat

Level of implementation	Centralised
Suitability to terrain	Highly permeable soils most favorable. Not suitable in i) hard (impervious) rock and ii) permanently waterlogged areas.
Suitability to climatic conditions	All climatic conditions. In very high rainfall zones the function of a soak pit may hamper during the peak rainfall period
Suitability to housing pattern	Well suited to dense housing where individual interventions are not possible due to space problem.
Technical complexity	Medium. The district-level engineers can very well design the unit and get it constructed as per technical norms. However, it is very much crucial to stick to the design parameters.
Scalability	Scalable with technical assistance.

REFERENCES

Desk Review	DDWS website, SBM Haryana
Field Visit	Village Jitanwas, Village Kairu, District Bhiwani, Haryana

COMMENTS/REMARKS/OBSERVATIONS

System needs to be tried in different soil conditions.

22. Community-based Grey Water Management in Uttarakhand

Beerpur, Dunda block, Dist. Uttarkashi, in Uttarakhand, is a Namami Gange Gram Panchayat, situated at the banks of river Bhagirathi. It's traditionally a wool-producing village. Villagers used to discharge grey water generated from raw wool washing and other household activities directly into the river through two main drains. Two grey water treatment units were constructed at the end of both main existing drains. This resulted in an overflow of water, stagnation in certain areas, and pollution of river water, leading to health concerns. Having been selected under the Namami Gange program, efforts were made by the district administration of Uttarkashi to stop the discharge of grey water into the river and find a permanent solution to this problem. The present project is the outcome of these efforts.

Implementing states – Uttarakhand.

Community-based Grey water management in Beerpur, District Uttarkashi, in Uttarakhand

SALIENT FEATURES

WORKING PRINCIPLE – The system operates on

1. Proper drain lines connecting all houses
2. Screening of grey water at the end of the drains but before the treatment unit
3. Draining the grey water into two leach pits for natural seepage.

COMPONENTS OF THE SYSTEM

Repairs of existing drains – As a first step in grey water management, existing drains were repaired, especially the leakages were closed. The result was that the grey water from all the houses could be diverted to a single point.

Screen/Filtration chamber – There are three major community drains in the Gram Panchayat through which grey water was directly discharged along the banks of the Bhagirathi River. The drains carry approximately 42000 l of grey water from 425 households. To prevent physical impurities, from entering the system iron meshes are fixed at exit points (intake point of leaching pit) of all three community drains. The grey water is channeled into a big chamber or leach pit that was divided into two sub-chambers which again were covered by iron mesh.

Sedimentation chamber – From the filtration chamber, grey water passes to the sedimentation chamber where the sludge potion settles at the bottom in filteration gallery.

Infiltration gallery – This is filled with boulders. Through this the water slowly percolates into the ground.

Safety Wall - In addition, a safety wall was constructed along the riverbank. This safety wall was situated 5 to 6m away from the main course of the river while the treatment chambers were constructed approximately 15m from the main river.

OTHER FEATURES

Capacity	42000 l of grey water per day
Area required	Not available
Population covered by a single unit	Around 2100, 425 Households
Capex	INR 1700000
Opex	INR 15000 per year
Technology is material-intensive or labor-intensive or both	Requires both components equally.
Reuse of treated water	Not applicable
Quality of treated water	Not available
Energy (power) required	Not required

OPERATION AND MAINTENANCE REQUIRED

Cleaning of silt chamber and sedimentation tank	As and when required
Monitoring of drains	Regularly as per GP schedule
Who does it?	Gram Panchayat

Level of implementation	Centralised
Suitability to terrain	This unit is planned for a specific location
Suitability to climatic conditions	This unit is planned for a specific location
Suitability to housing pattern	Well suited to dense housing where individual interventions are not possible due to space problem.
Technical complexity	Medium
Scalability	Scalable in similar situations with proper technical assistance

REFERENCES

Desk Review	SBM Uttarakhand
Field Visit	Village Birpur, District Uttarkashi, Uttarakhand

23. Community Soak Pit-cum-Reed Bed for Grey Water Management

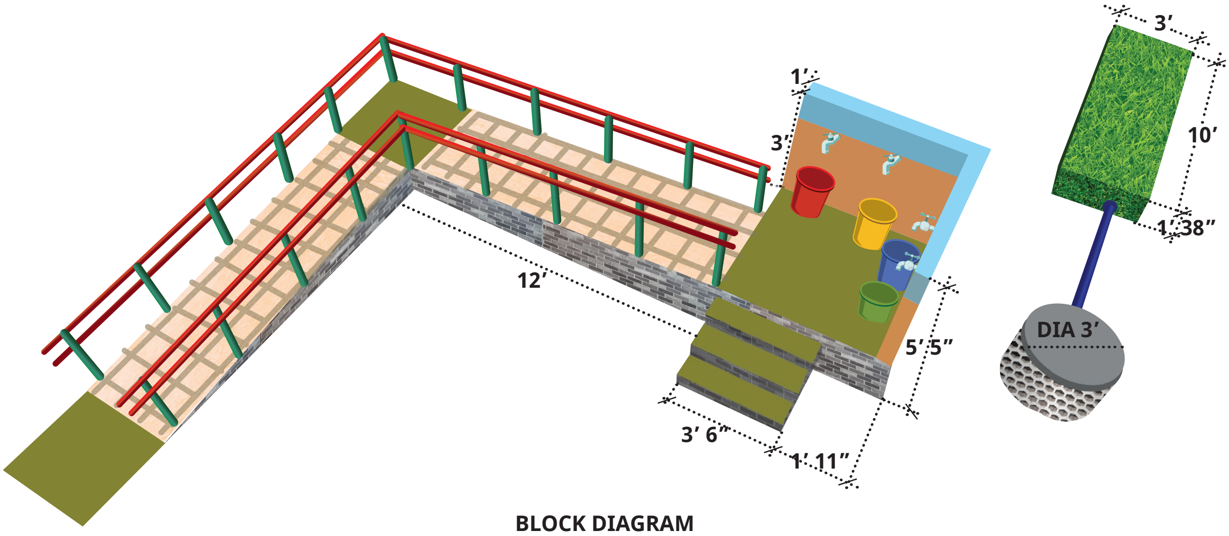
This is an experimental technology being tried in village Chandbali, District Bhadrak in Odisha. The village is a typical coastal village, with high rainfall and hard strata at low depth. Grey water management with conventional methods is a bit challenging so a combination of the two technologies is suggested and tried.

Implementing states – Odisha.

Community Soak Pit-cum-Reed Bed for Grey Water Management in village Chandbali, District Bhadrak, Odisha

Raised washing platform, Soak Pit and a Reed Bed

Raised washing platform, Soak Pit and a Reed Bed



BLOCK DIAGRAM

SALIENT FEATURES

WORKING PRINCIPLE – This system works on the principles of recharge, purification, and reuse of grey water. Grey water first enters the soak pit and soaks into the soil. An overflow pipe from the soak pit leads to a reed bed (planted with water-loving plants). Excess grey water not absorbed by the soak pit automatically flows into the reed bed and is absorbed as well as purified. If the treated water comes out of the reed beds, it can be used for gardening.

COMPONENTS OF THE SYSTEM

Raised washing platform – To be used by the community for various washing purposes.

Drain pipe – Four-inch diametre. PVC pipe from the platform to the soak pit

Soak pit – Made of 3ft diametre cement rings placed in an excavated pit. 3 rings are placed over each other without cement mortar (open joints). The pit is filled with brickbat up to 2/3rd height and closed with a cement lid. An overflow pipe from the pit leads to the reed bed.

Reed Bed – This is a brick-lined bed with dimensions of 10ft x 6ft x 2ft depth. It is filled with gravel or brickbat. Plants such as Cana are planted in the bed. The reed bed has an outlet pipe for occasional overflow. This water can be used for gardening.

OTHER FEATURES

Capacity	500 to 1000 l of grey water per day
Area required	Not available
Population covered by a single unit	178, 30 Households
Capex	INR 8000
Opex	INR 200 to INR 500 per year
Technology is material-intensive or labor-intensive or both	Requires both components equally.
Reuse of treated water	Groundwater recharge
Quality of treated water	Not tested.
Energy (power) required	Not required

OPERATION AND MAINTENANCE REQUIRED

Desludging of the entire system	Once in 6 months
Who does it?	Community (users of the facility)

Level of implementation	Semi-Centralised
Suitability to terrain	Semi-permeable soils, coastal areas, and high-water table areas.
Suitability to climatic conditions	All climatic conditions.
Suitability to housing pattern	Well suited to dense housing dependent on common facilities for cloth and utensil washing.
Technical complexity	Low (Nature-based wastewater treatment process with less maintenance cost and technical knowledge for the functioning of the system)
Scalability	Scalable.

REFERENCES

Desk Review	WaterAid
Field Visit	Village Chandbali, District Bhadrak, Odisha

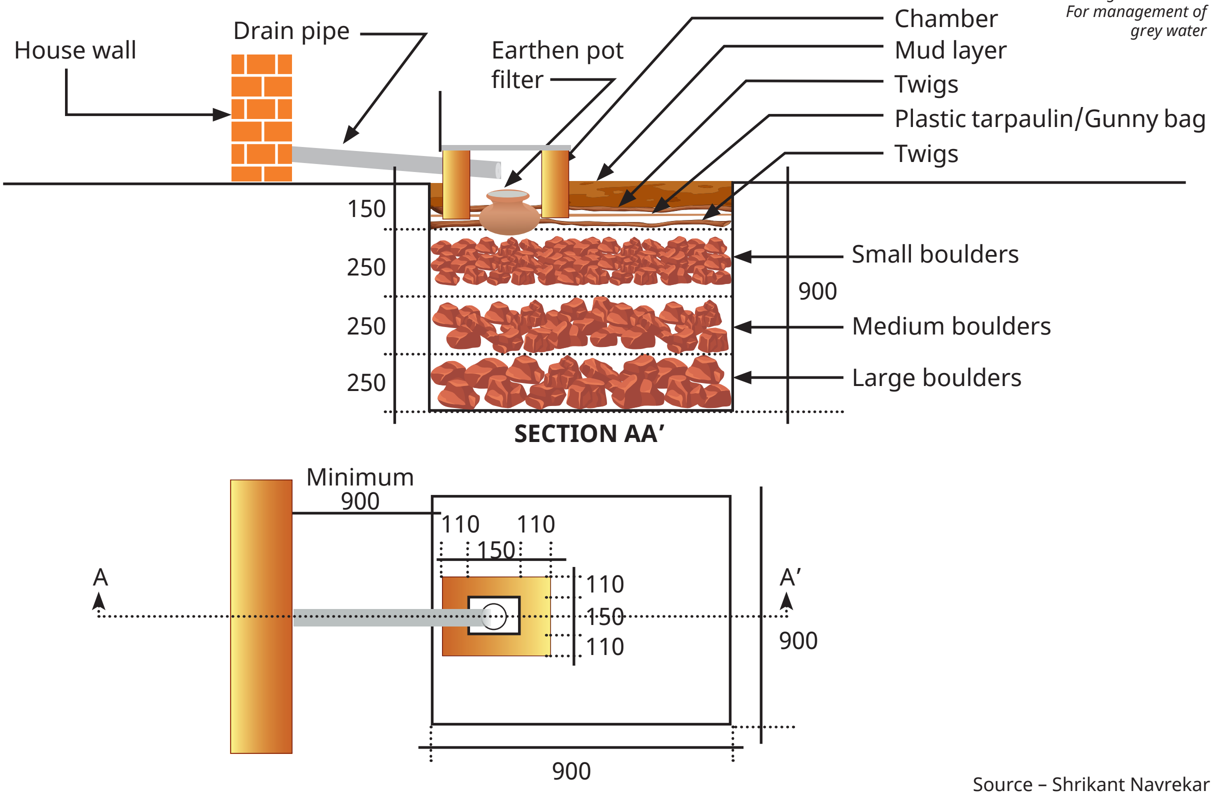
COMMENTS/REMARKS/OBSERVATIONS

This is an experimental technology. More tests are underway. Many parameters like water quality, response to different climates and soil conditions, etc. are still to be checked.

TECHNICAL DRAWINGS

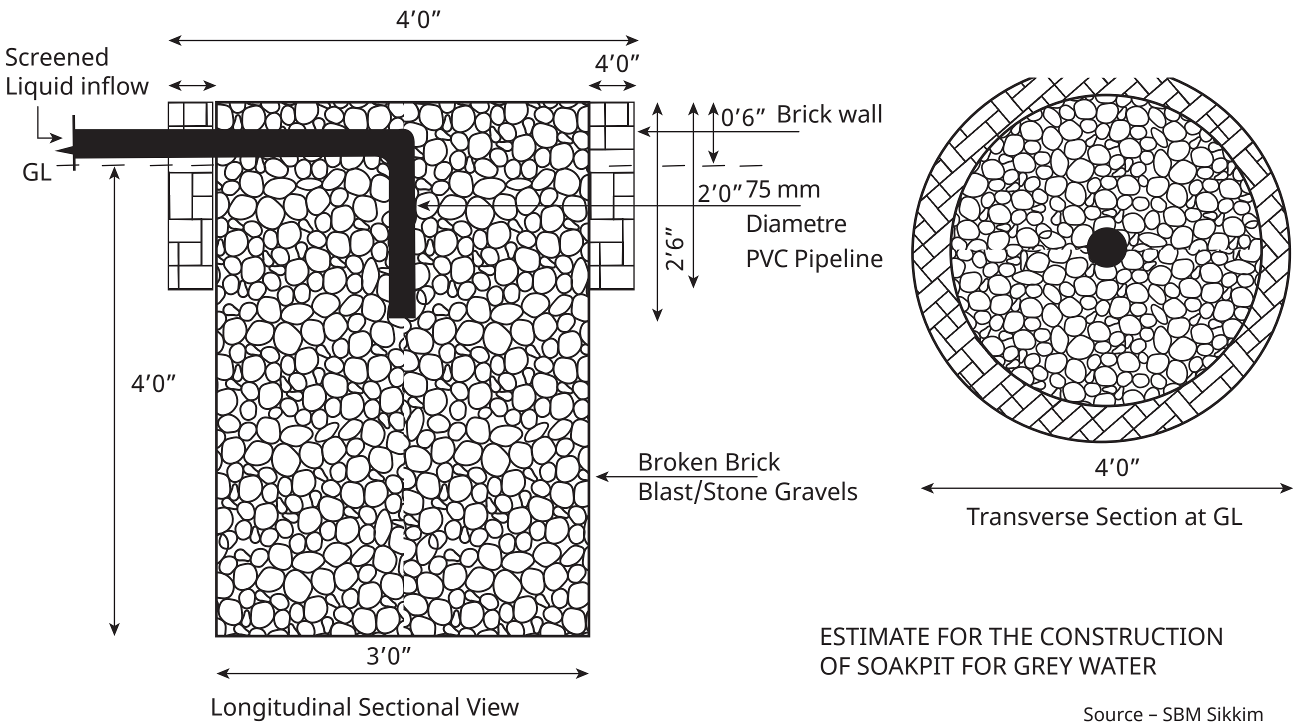
1. HOUSEHOLD SOAK PIT – GENERAL DESIGN

For single household
For management of grey water



Source – Shrikant Navrekar

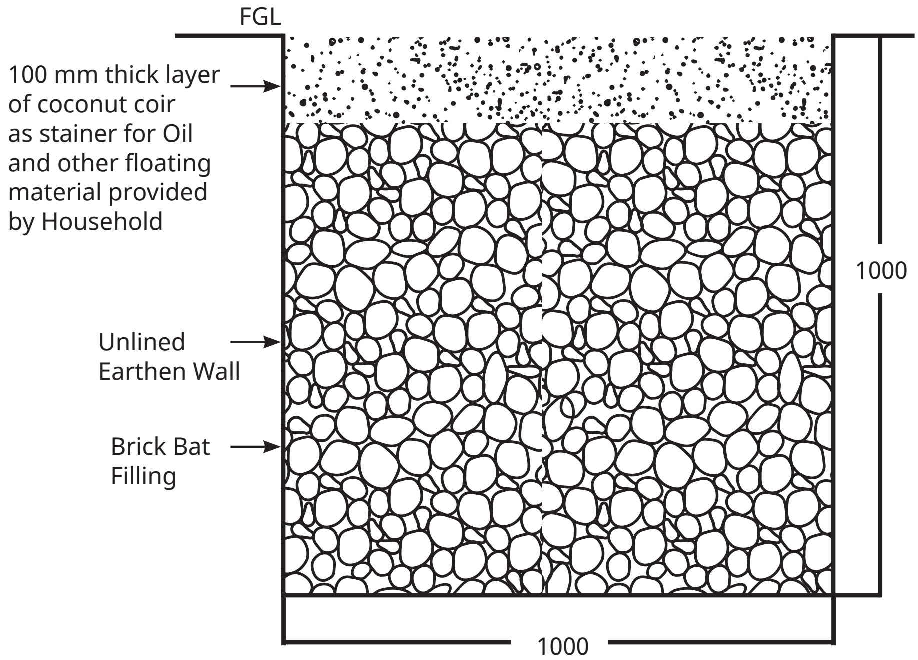
2. HOUSEHOLD SOAK PIT – SIKKIM



ESTIMATE FOR THE CONSTRUCTION OF SOAKPIT FOR GREY WATER

Source – SBM Sikkim

3. HOUSEHOLD SOAK PIT – ODISHA



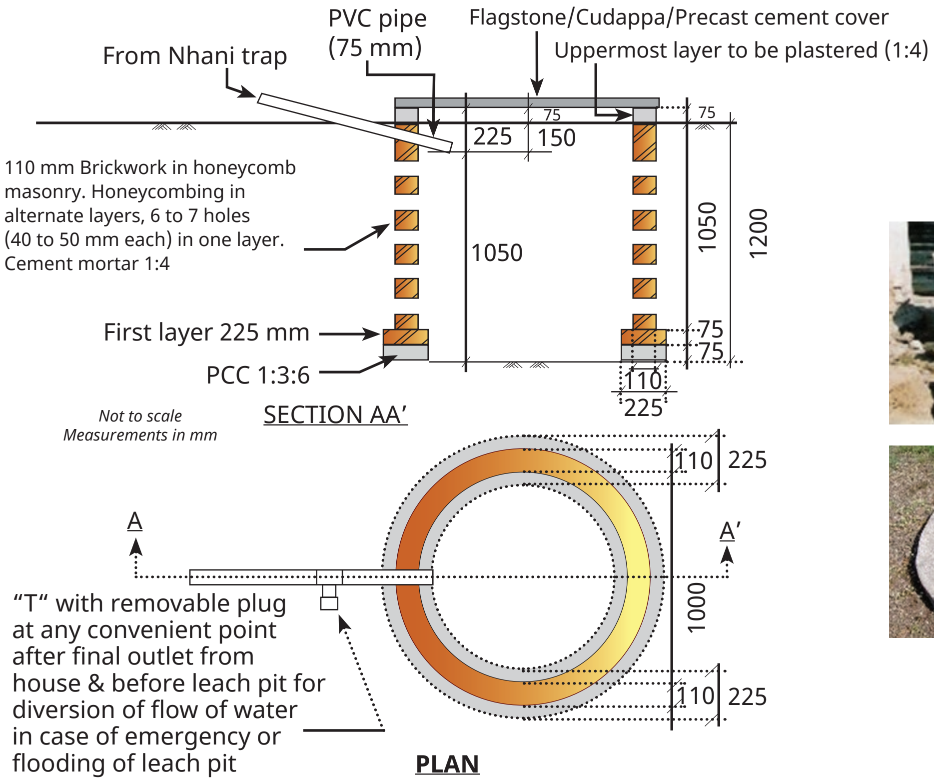
Section at BB'

All dimension are in mm

Source- Unicef Odisha

4. HOUSEHOLD LEACH PIT – GENERAL DESIGN

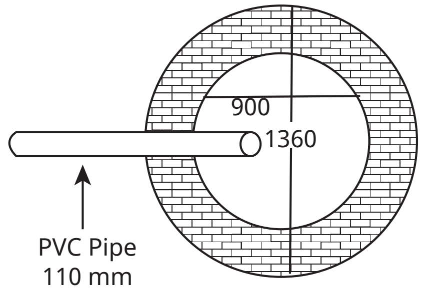
BB masonry
(For a single household: Capacity 250-300 lit per day)



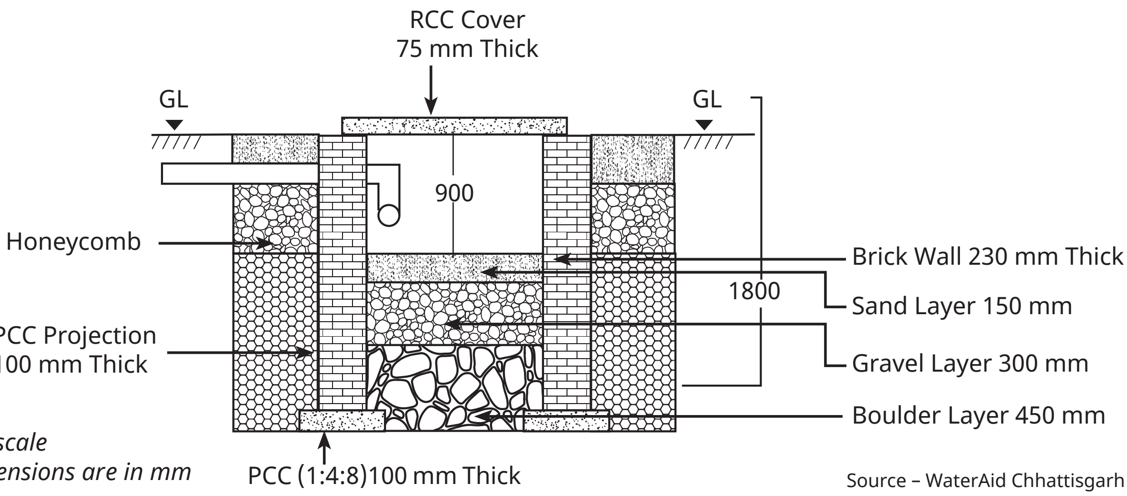
Source – Shrikant Navrekar

5. HOUSEHOLD LEACH PIT – CHHATTISGARH

SOAK PIT



PLAN

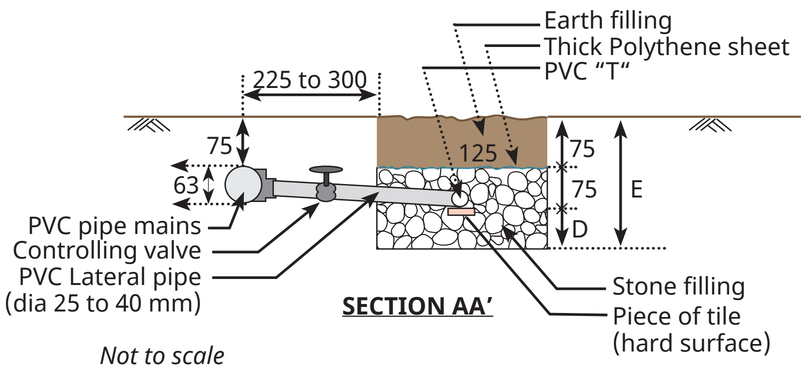


Not to scale
All dimensions are in mm

Source – WaterAid Chhattisgarh

SECTION

6. KITCHEN GARDEN WITH PIPED ROOT ZONE TREATMENT

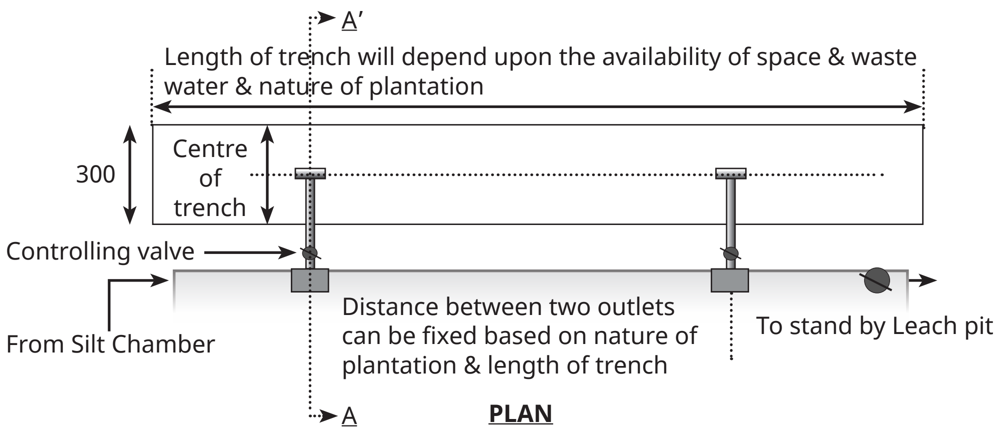


SECTION AA'

Not to scale
Measurements in mm

Reuse of Grey water in Kitchen Garden/ Garden with Piped Root Zone treatment

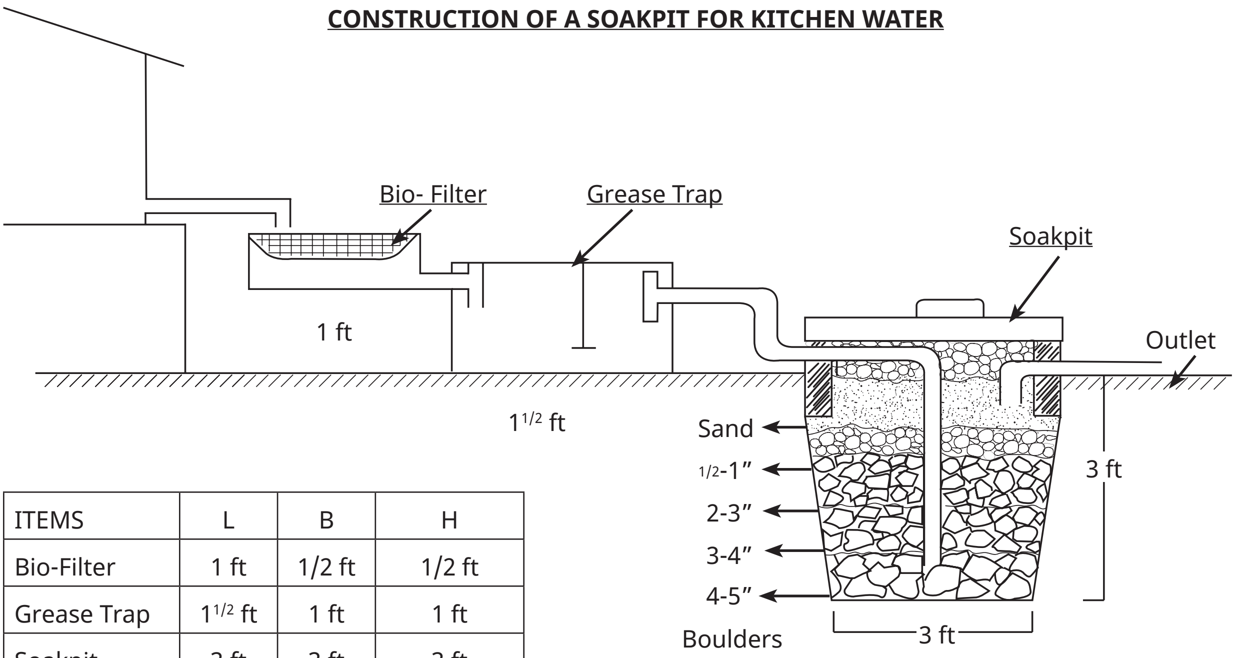
Flow of water	Variable Dimensions		
	D	E	Diameter of lateral pipe
Low	75	225	25
Medium	150	300	40
High	225	450	40



PLAN

Source – Shrikant Navrekar

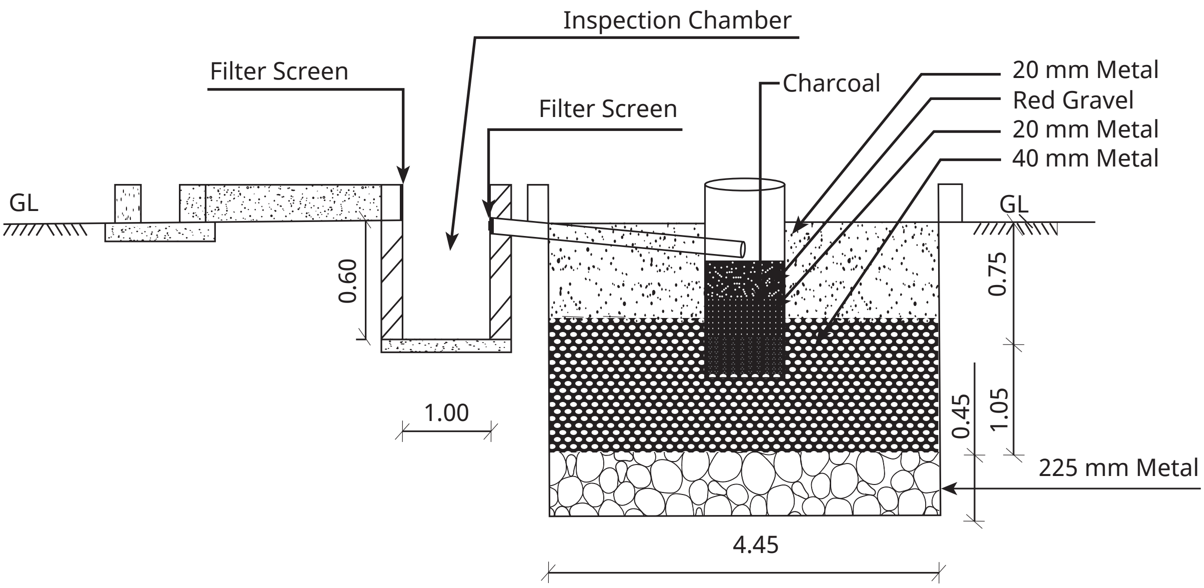
7. MODIFIED SOAK PIT WITH GREASE TRAP - MEGHALAYA



ITEMS	L	B	H
Bio-Filter	1 ft	1/2 ft	1/2 ft
Grease Trap	1 1/2 ft	1 ft	1 ft
Soakpit	3 ft	3 ft	3 ft

Source – SBM Meghalaya

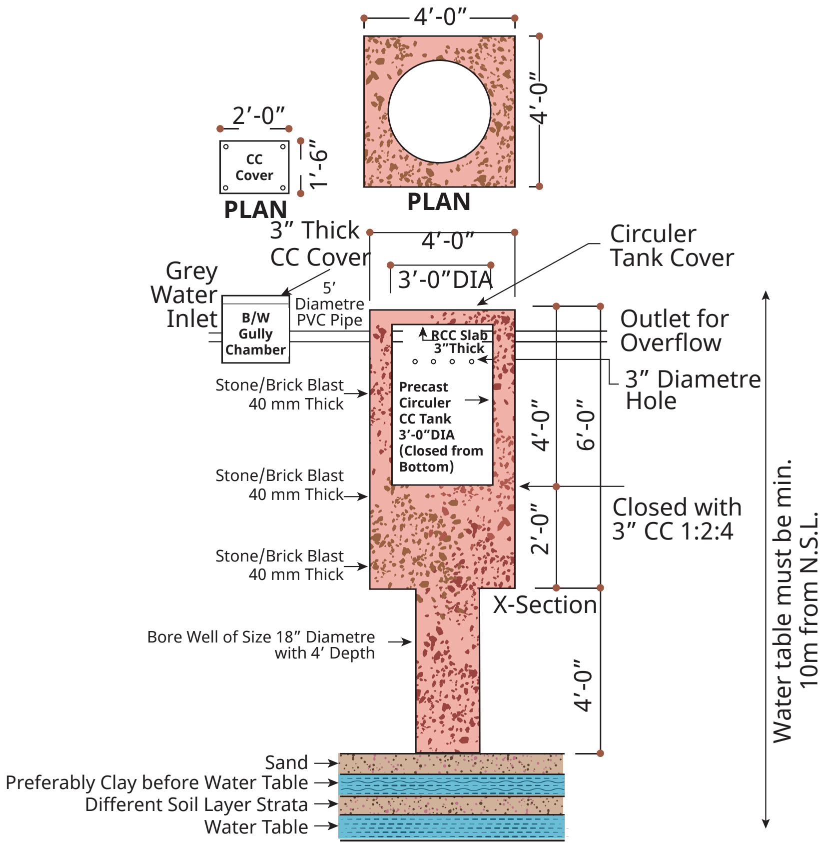
8. COMMUNITY MAGIC PIT – PUNJAB



Source – SBM Punjab

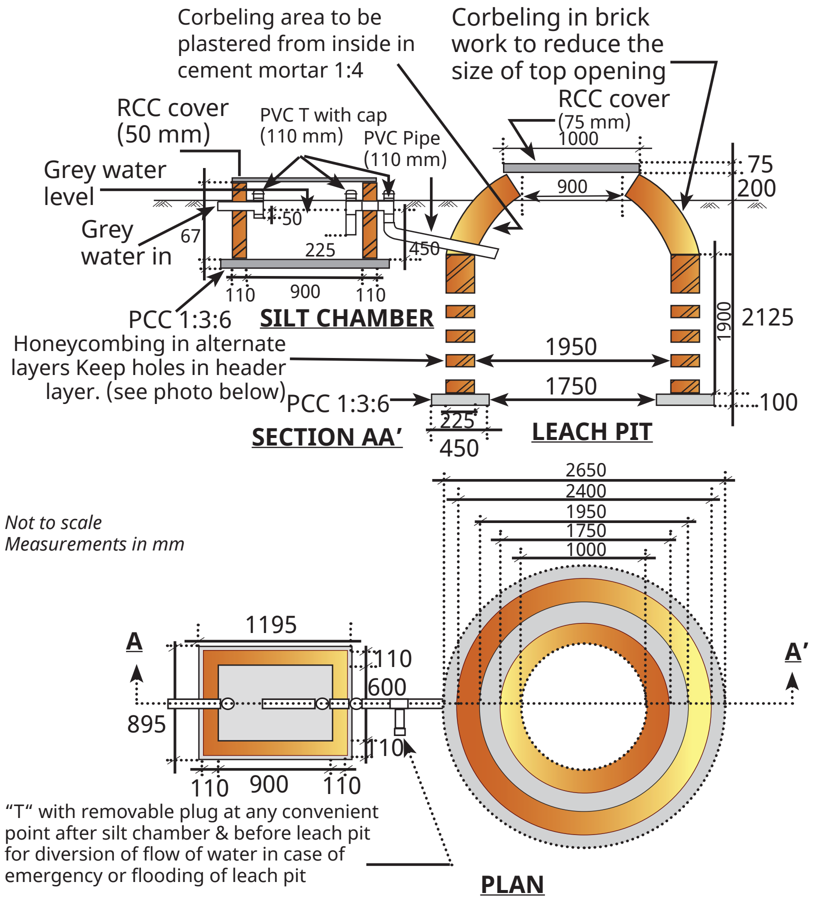
CROSS SECTION

9. MAGIC PIT FOR SCHOOLS – PUNJAB



Source – SBM Punjab

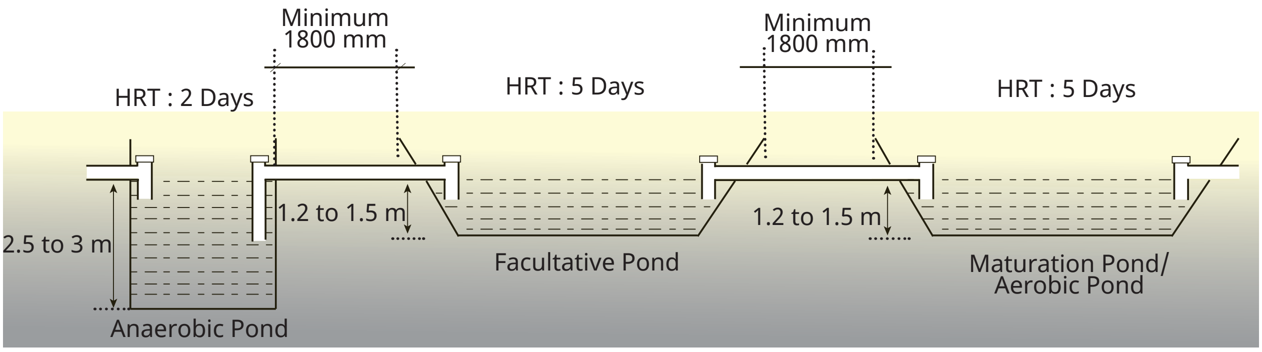
10. COMMUNITY LEACH PIT – GENERAL DESIGN



Community Leach Pit with Silt Chamber
(For a group Households. Maximum no. of houses=10 Qty of grey water per day per HH: 300 l Also useful for community water points)

Source – Shrikant Navrekar

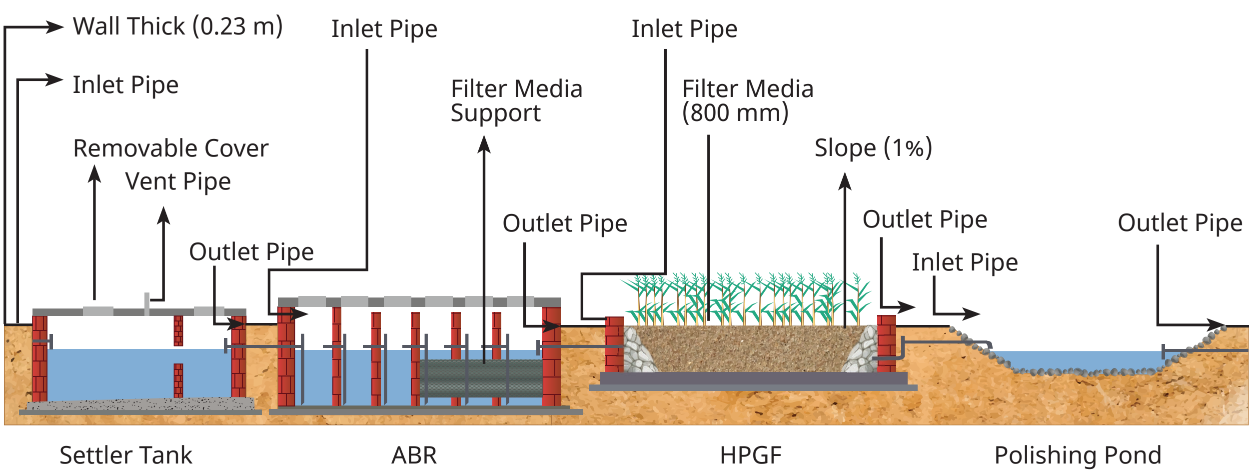
11. WASTE STABILIZATION POND – GENERAL DESIGN



DESIGN OF GREY WATER STABILIZATION POND (SCHEMATIC)

Source – Shrikant Navrekar

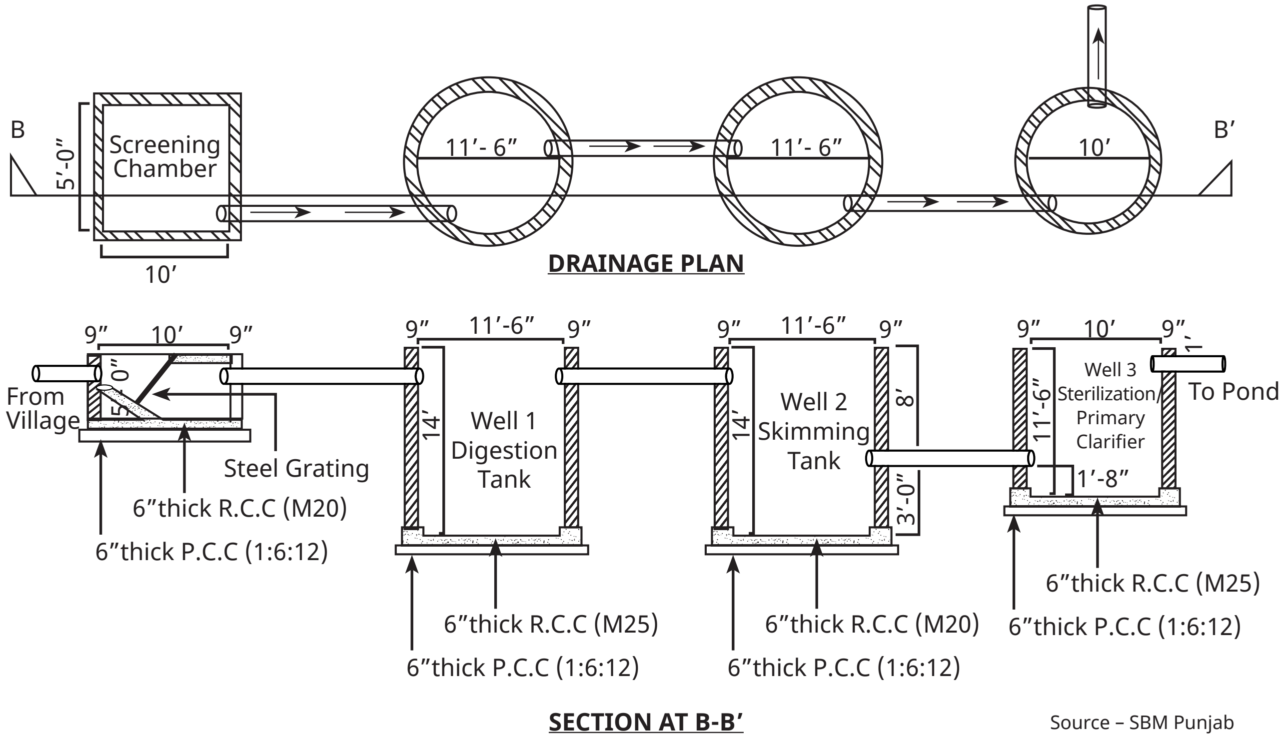
12. DEWATS – GENERAL DESIGN



Source – DDWS

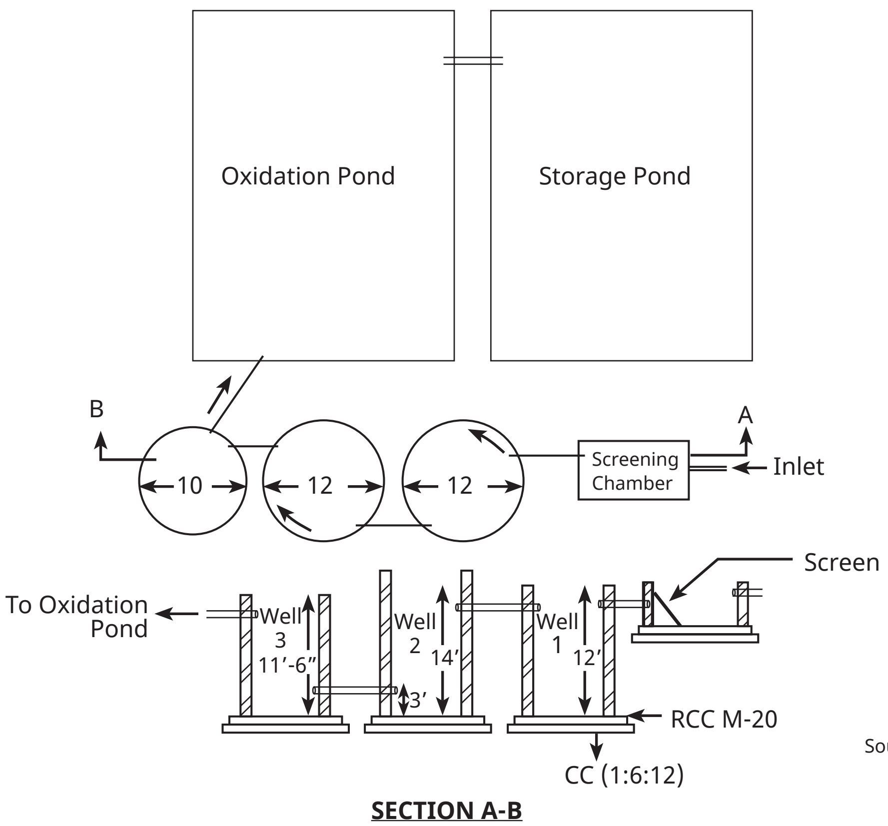
13. SEECHEWAL MODEL GWM – GENERAL DESIGN - PUNJAB

DEPARTMENT OF RURAL DEVELOPMENT & PANCHAYAT'S (ENGINEERING WING)



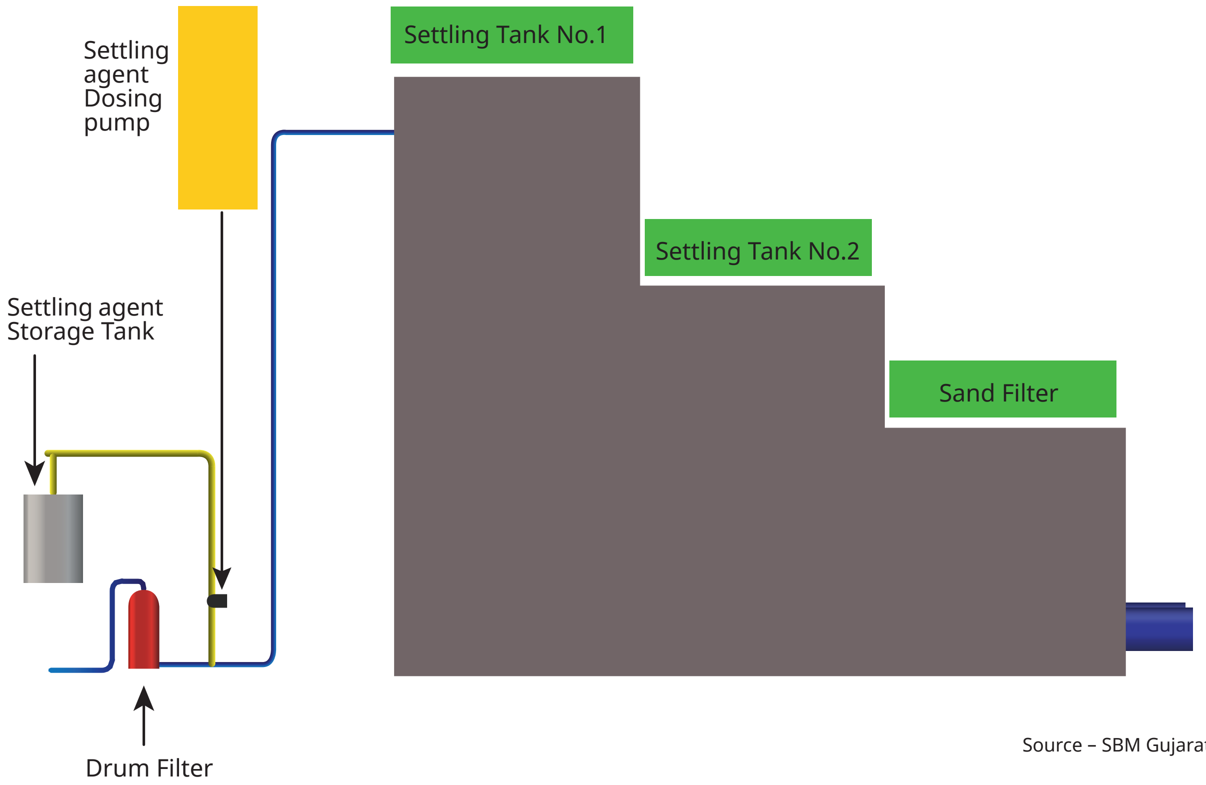
Source – SBM Punjab

14. SEECHEWAL MODEL MODIFIED WITH TIET TECHNOLOGY – GENERAL DESIGN - PUNJAB



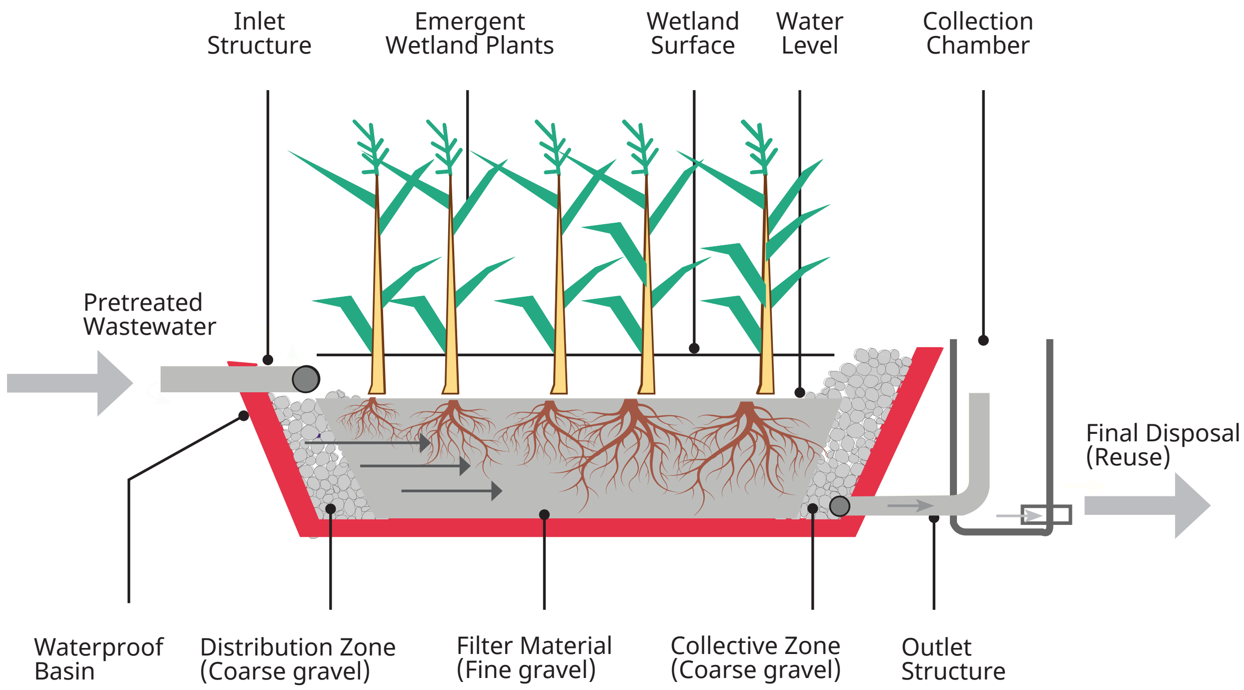
Source – SBM Punjab

15. VEDANCHA MODEL GWM – GENERAL DESIGN – GUJARAT



Source – SBM Gujarat

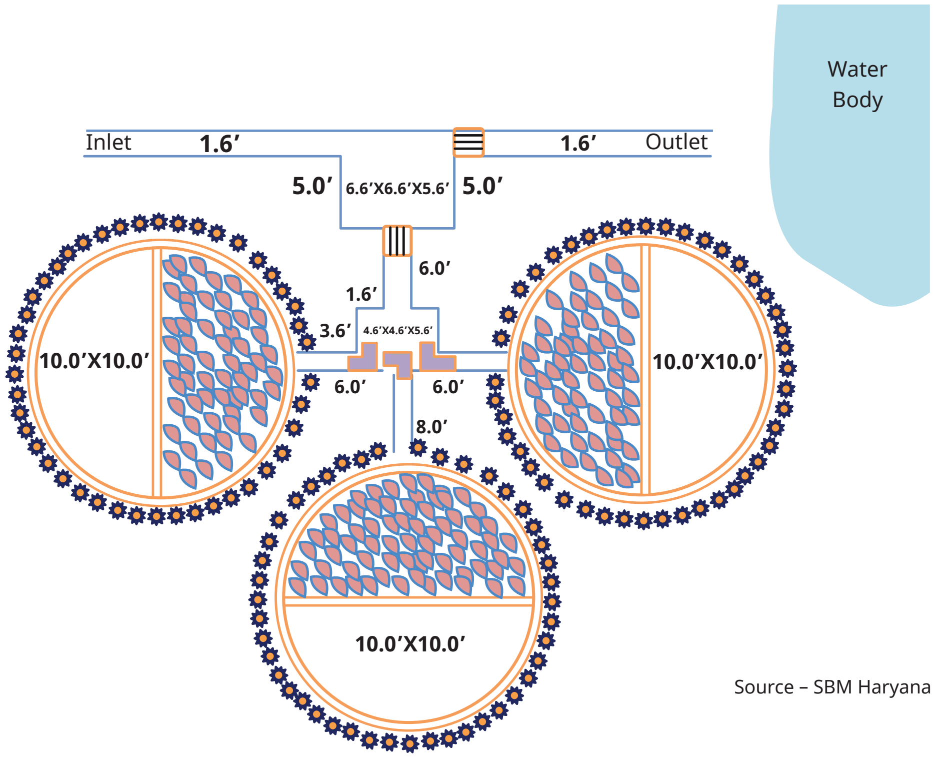
16. JALOPCHAR– GENERAL DESIGN – HARYANA



Source – Jawahar Novoday Vidyalay, Palwal

17. NEHVEEN MODEL OF GREY WATER MANAGEMENT – HARYANA

(upto 450 Household 36000 l water management per day)



Source – SBM Haryana

CONCLUSION

Grey water management is an important component of Swachh Bharat Mission Phase II and has been duly embraced by states implementing the program. It has been observed that implementing agencies at the state and district level are trying to adopt the best possible solutions for the grey water problem. It naturally varies from state to state or region due to differences in climate, terrain, economic status, and lifestyle of communities. The result is a varied picture across the country in terms of grey water management technologies. Through this compilation, a successful attempt has been made to review as many possible case studies from across the country. It should be noted that the focus of this study has obviously been on SBMG and the technologies adopted or developed in this program. There may be many examples outside the scope of the government program where some other technology may have been tried and implemented. Efforts will be made in future to consolidate all such successful case studies by expanding the scope of this study.

Nothing is ultimate in science and technology. The same is true of grey water management. Research and development are never-ending processes. What appears ultimate today may become obsolete tomorrow. Readers are therefore advised to keep themselves abreast of recent developments and keep up to date with current developments in the field. “Success story” is a buzzword in the development field. It is customary to highlight such stories as part of IEC campaigns. It helps in many ways, especially in encouraging communities to adopt good practices. However, it is equally important to study “failure stories”. This is not to blame the developers of the concept or technology but to learn from their experience and try to avoid the mistakes they made. Any technology should always be evaluated with eyes open before adopting it.

WaterAid believes that the compendium is structured to generate lessons and practical knowledge gained from the interventions and outcomes, and for application in the future work. The case studies and reviews will support programme quality and efficiency, and strengthen learning. Analysis will contribute for better planning and technology selection, the future interventions and enhance qualitative aspects. We aim to unblock bottleneck for local government, NGOs, wash practitioners to ensure effective and inclusive delivery through continuous analysis, research, documentation and learning from grassroot models and demonstrations, allowing practitioners to deliver sustainable solutions which are affordable, acceptable and are feasible.

It is hoped that the users of this compendium will be encouraged & enlightened to follow the path of various successful case studies in their respective fields. At the same time, they are advised to study the technologies in depth, contact the respective innovator & understand the essential features critically & thoughtfully adopt the new technologies thoughtfully.

ANNEXURES

Annexures I

Desk Review References

Technology	Source of Information
Household Soak pits	Nirmal Gram Nirman Kendra, Shrikant Navrekar, SBM Sikkim, Unicef Odisha
Household Magic Pit	WaterAid, DDWS website, The World Bank, SBM Rajasthan, SBM Tamil Nadu
Household Leach Pit	WaterAid, SBM Haryana, SBM Chhattisgarh, Nirmal Gram Nirman Kendra
Household Kitchen Garden	SBM Mizoram, DDWS
Household Kitchen Garden with Piped Root Zone System	SBM Chhattisgarh, Water Aid, Nirmal Gram Nirman Kendra
Modified household Soak Pit (Grease trap)	SBM Meghalya
Community Magic Pit	SBM Rajasthan, SBM Punjab, SBM Tamil Nadu, SBM Telangana, DDWS
Community Leach Pit	SBM Jharkhand, SBM Haryana, WaterAid India, DDWS website, SBM Jharkhand
Community Plantation	Gram Panchayat Banwadi, District Satara, Maharashtra
Waste Stabilization Pond	DDWS, SBM Punjab, SBM Haryana
DEWATS	WaterAid, SBM Chhattisgarh
Sinchewala model of GWM	SBM Punjab, DDWS
Seechewal (Sinchewala) model Modified with TIET Technology	SBM Punjab, DDWS
Modified GWM using Typha plantation	SBM Punjab, DDWS
Vedancha model of GWM	Unicef Gujarat
Vermifilter Technology	DDWS, WaterAid
Bioremediation & Phyto remediation	DDWS
Jalopchar	WaterAid
Eco STP	WaterAid
Inline treatment of grey water	DDWS
Nehveen Model of GWM	SBM Haryana
Community-based Grey water management	DDWS
Community soak pit-cum-Reed Bed for Grey water management.	WaterAid