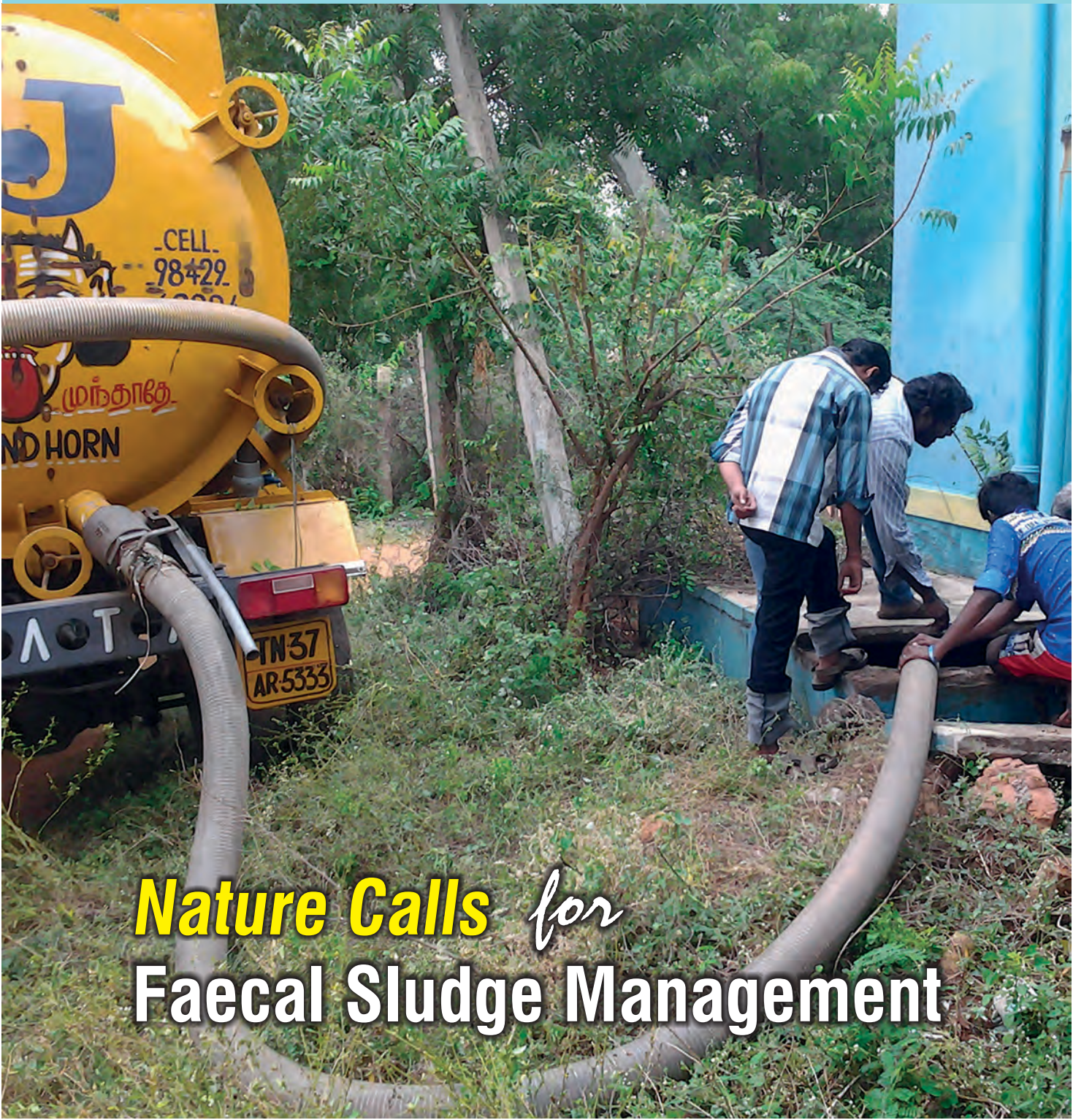




November 2018

# Water *Watch*

Quality Matters



***Nature Calls for***  
**Faecal Sludge Management**



World Toilet Day 2018 is about toilets and nature. The theme of this year is Nature-based solutions (NBS) to the sanitation and water crisis harness the power of ecosystems such as Composting latrines that capture and treat human waste on site, producing a free supply of fertiliser to help grow crops. Human-made wetlands and reed-beds filter wastewater before it is released back into water courses. So from this year, when nature calls, we have to use the nature-based toilets and sanitation systems that work in harmony with our environment. Always remember, the impact of exposure to human faeces on this scale has a devastating impact on public health, living conditions, nutrition, education and economic productivity across the world.



**Centre for Urban Water Resource (CURE)  
Water Knowledge Centre  
DHAN Vayalagam (Tank) Foundation**

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**SIT DOWN  
IF YOU WANT  
TO END  
POVERTY**

One third of humanity is struggling to stay well, keep their children alive and work their way to a better future - all for the want of a toilet.

Make sure everyone has a toilet by 2030.  
[www.worldtoiletday.org](http://www.worldtoiletday.org)

19 November  
**WORLD TOILET DAY**

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# Shit Matters !

‘Shit!’ An exclamatory word to express our irritating state and our psychology also indeed that, shit (Faecal matters) always a neglected solid. This neglected solid creates a social injustice by creating the untouchable community. Even after Indian government enacted ‘The Prohibition of Employment of Manual Scavengers and Their Rehabilitation Act 2013’ regularly our daily newspapers count the death of manual scavengers. Now thanks to urbanization that the problem of the minority is going to become a problem of majority urban citizens. Yes, what we send away through our left hand is coming back through our right hand due to improper faecal sludge management. The research statics of Tamilnadu Water And Drainage Board (TWAD) says some districts like Madurai are having more 15% of drinking water sources are found of faecal contamination. This Biological parameter, faecal coliform creates a great impact on human health. They are the pathway for communicable diseases. World Health Organization (WHO) points out investing one dollar on sanitation will return four dollars on the efficiency of human power. Sanitation system in urban India is of four major types viz. i) urban-specific centralized sewerage systems ii) stand-alone septic tank systems (private or public) iii) water seal compost latrines and iv) simple pits. Those who are not covered by any of the above systems are compelled to choose open defecation. In this scenario, Centre for Urban Water

Resources took efforts to understand the Madurai city on Faecal Sludge Management.

## Faecal Sludge Management

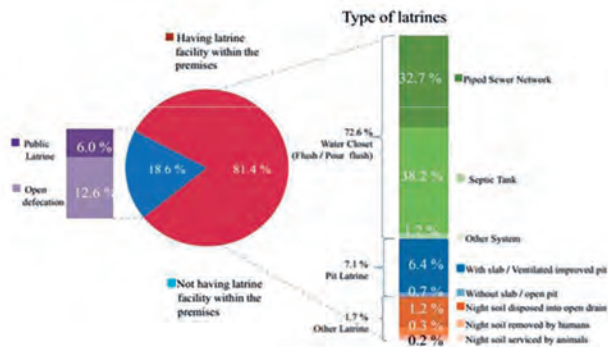
In most urbanized areas in India, human excreta are disposed off to the centralised sewers but most of the time excreta flows on the housing plot itself. Some of them are septic tanks, dry latrines, bucket latrines, communal toilets, or other types, they all accumulate faecal sludge, which needs to be removed periodically. If this sludge is not properly managed, negative impacts on the urban environment and on public health. Generally, Faecal Sludge Management is a missing picture on city sanitation plan through it is a public sector responsibility but it is managed by the informal private sector operators. All these problems can be avoided by proper management of faecal sludge, which may include adequate de-sludging of sanitation facilities, safe handling and transport of sludge, treatment of sludge, and its safe disposal or reuse.

## Shit Flow Diagram

An excreta flow diagram (also often described as a shit flow diagram, SFD) is a tool for engineers, planners and decision-makers. It is used to understand and visualize how excreta physically flow through a city or town. Based on contributing populations and an indication of where their excreta (septage or sewage) goes. It is a representation of public health hazard and an overview from which to develop sanitation priorities

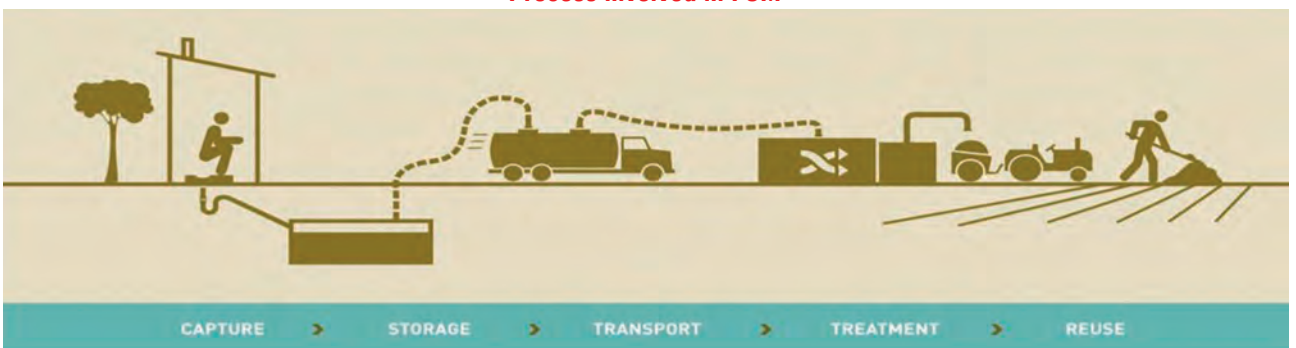
## Global facts

- 62.5% of the world population don't have access to safe sanitation.
- 892 Million Peoples practices open defecation
- 1.8 Billion Peoples drinking water are contaminated by Feces.

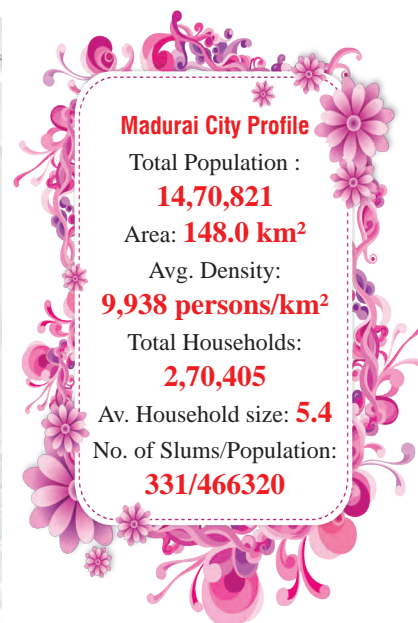
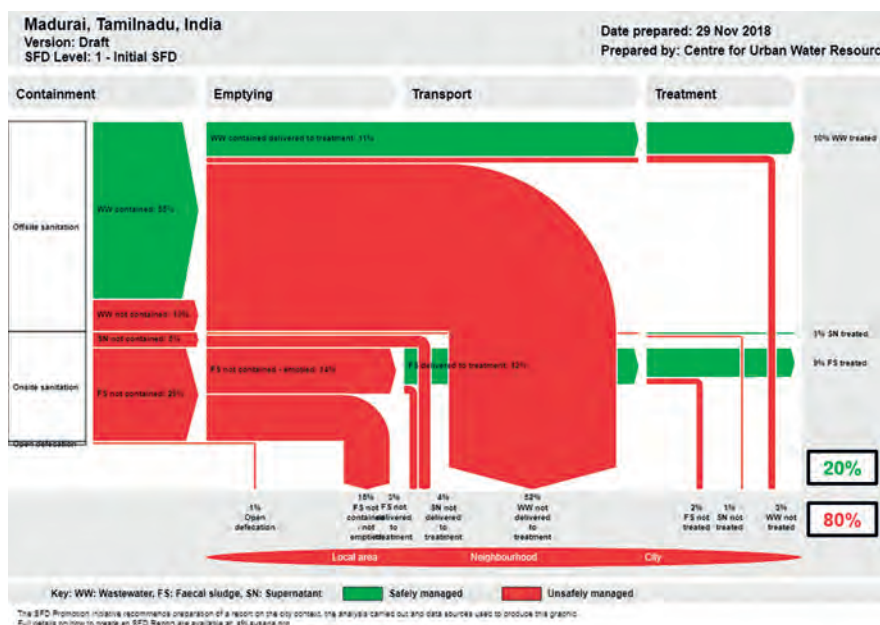


India's sanitation system (Source: Census, 2011)

## Process involved in FSM



# Shit Flow Diagram for Madurai City



## Observation from SFD

The Sanitation priorities are achieved from this Shit Flow Diagram such as

1. In Madurai city, most of the septic tank's design and size are not as per standard. Which simply act like a normal seepage tank which creates a negative impact on primary treatment and contaminates the water resources. Also, awareness about operation and maintenance of septic tanks is sub-optimal.
2. In Madurai city, most of the septic tank operators discharge their sludge's at pumping stations. From a technical perspective, the discharge of faecal sludge in STPs could lead to severe operational problems. Excessive solids accumulation drastically reduces the efficiency and increase the operational costs.
3. The overall efficiency of the existing STPs in Madurai City are having only 14.3% (Source: Operative Guidelines of Septage management-GoTN,2014) which results in 55% of overall faecal sludge to unsafe management.
4. Underground Drainage system reached more than 72 wards of Madurai corporation (Source: Smart City proposal) but there is a major flaw in the transportation of sewage which affects the indigenous water bodies of Madurai city.
5. Faecal Sludge Management is an alarming factor for city sanitation Plan. Results of 80% unsafe disposal refer to the seriousness of public health hazard, Groundwater contamination, hygiene factor. These show a separate Faecal Sludge Treatment Plant (FSTP) is a need of an hour for Madurai city.

## FSM Terms

**Yellow water:** Wastewater generated from the urinals.

**Brown water:** Wastewater refers to faeces mixed with water, but not urine

**Greywater / Sullage:** Wastewater generated from domestic activities except for faeces, Urine.

**Blackwater:** Wastewater generated from toilets i.e., urine and faeces.

**Excreta:** Feces and urine

**Night soil:** Untreated excreta

**Onsite sanitation:** A Sanitation System in which Excreta (referred to as Faecal Sludge) are collected and contained at the plot where they are generated.

**Offsite sanitation:** A Sanitation System in which Excreta (referred to as Wastewater) are connected to the Centralized or network-based sanitation like Under Ground Drainage (UGD).

**Faecal sludge:** Anything comes out of any onsite system acts fresh

**Septage:** Anything comes out of the septic tank which is partially digested.



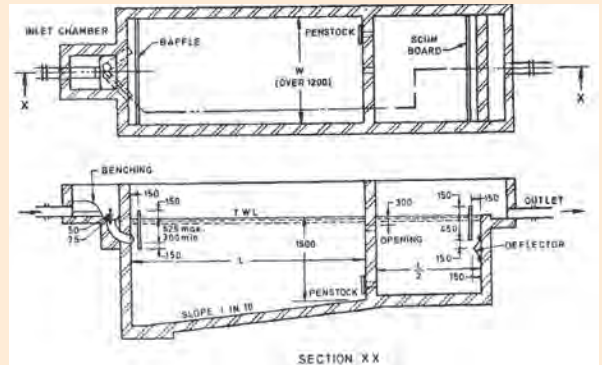
# Containment

Containment decides quality, effectiveness and functionality of the range of reported offsite and onsite sanitation technologies and systems. **Septic tanks** are most common sanitation option in the households of tier one cities (with a population of more than a million), tier two and tier three towns in India.

Madurai city results in mostly improper containment at several areas. Due to the Underground drainage system, most of the faecal sludge is collected through the sewer. But in onsite sanitation, operation and maintenance of septic tanks are sub-optimal. The sizes and designs of septic tank vary from one place to another. Type and size of septic tanks are largely influenced by i) space availability ii) cost iii) local construction standards and iv) skill levels of masons.

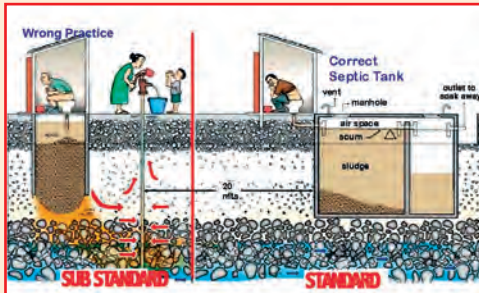
## What is an Ideal septic tank?

A well-designed unit is a watertight tank in which sewage is retained sufficiently long to permit sedimentation and digestion. It generally has two chambers then the discharge of septic tank must go through secondary treatment or should be connected to the soak pit.



Typical design of Septic Tank  
(Source: IS2470)

Containment types  
in Madurai City



Semipermeable open bottom tank at Pudur



Lined Tank at Vaigai vilas nagar



SBM tank at Thiruparakundram

# Emptying

Emptying is the manual or motorized removal of faecal sludge or septage from onsite sanitation systems. Desludging tankers are available in various sizes and are deployed to carry out the emptying process. In the periphery of Madurai city, due to less availability and affordability of tankers, the sludge is cleared manually using buckets or gulpers. When tanks are emptied, septage from septic tanks is disposed to the pumping stations but sometimes they dispose indiscriminately into water bodies, drains, landfills, and vacant lands due to the lack of enforcement and lack of septage treatment plants.



Emptying process at Tirunagar, Madurai (Ward 97)

In Madurai City, Most of the septic tanks are not emptied at regular frequencies. Emptying process happens only due to overflowing or unpleasant odours. The emptying trucks or tractors play the role of a “mobile sewer network” for onsite sanitation systems. Septage is then let out in the environment either in low lying areas, vacant plots or water bodies



Application for Emptying from Madurai Corporation

# Transportation

Transport impacts on quality, effectiveness and functionality of transport infrastructure, including sewers (centralised and decentralised), motorized tankers, manual emptying arrangements.

For Offsite Sanitation transport refers to the conveyance of wastewater through sewer network.

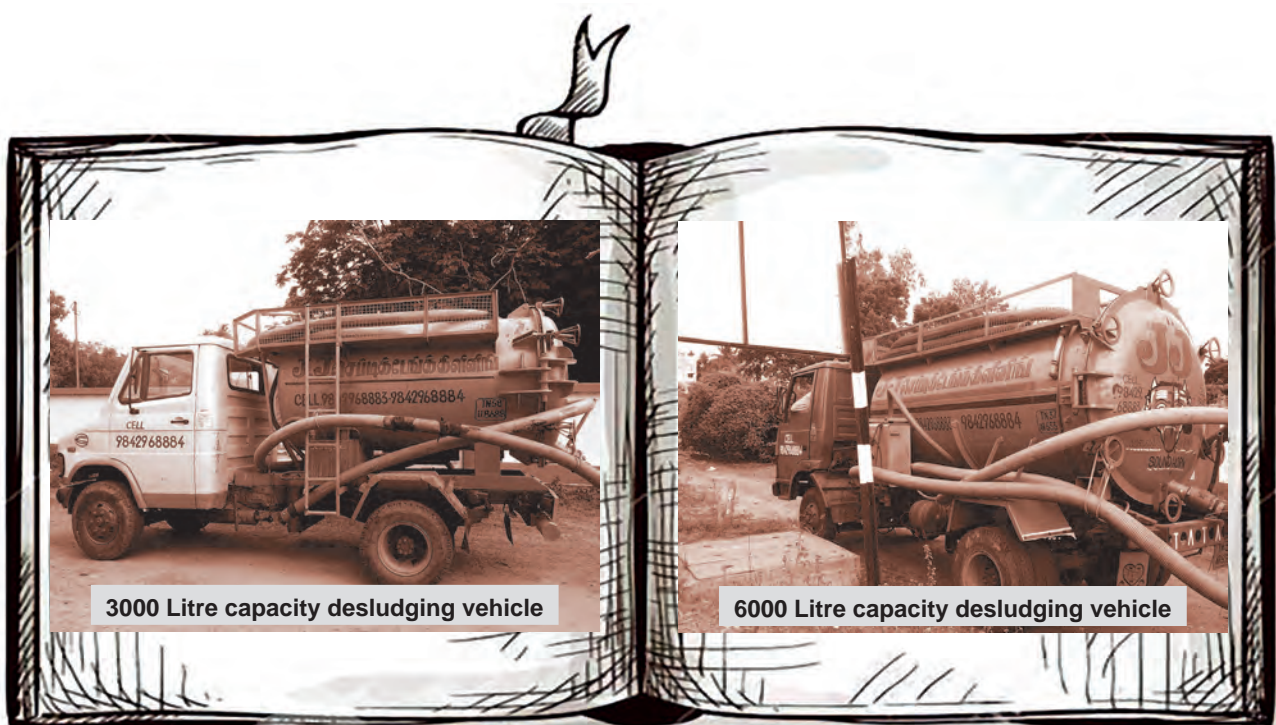
For Onsite Sanitation transport refers to the Manual or Motorized conveyance to load the sludge.

### Madurai’s faecal sludge transportation in numbers

- There are 48 No. of Private Pumping Lorries available.
- Each Tanker Lorry takes 8 to 10 trips in a day.
- Around 60,000 litres of faecal sludge cum septage are being removed every day.
- It is proposed by Madurai Corporation to collect fees Rs. 10,000/- from each tanker lorry per year.
- Private operators are charging Rs.2,500 for septic tank desludging.
- Even though manual scavenging are prohibited they charge 500-1000 for desludging the septic tank.

*Source: Septage Management Presentation by Madurai Corporation\_24.11.2014*





3000 Litre capacity desludging vehicle

6000 Litre capacity desludging vehicle

### Off-site transport system

S. No.	Name	Length
1	Length of Under Ground Drainage	206.09 km
2	Length of Open Drainage	165 km

Source: Madurai Corporation official website

The quantity of faecal sludge generated in Madurai City.

Zone	Suction Lorries available	Location of the Pumping Station to Discharge	Expected Quantity
Zone 1	10	Ponmeni, Thathaneri & S.S. Colony	12 KL
Zone 2	15	Munthiri Thoppu, Sellur & Karpaga Ngr	18 KL
Zone 3	9	Anuppanady, Keeraithurai, Anuppanady HB, Villapuram HB & Santhaipeitai	11 KL
Zone 4	14	Muthupatti & Palanganatham	16 KL
<b>TOTAL</b>	<b>48</b>		<b>57 KLD</b>

Source: Septage Management Presentation by Madurai Corporation\_24.11.2014

In average 57 KLD of faecal sludge to be collected from the onsite sanitation. Even after Madurai Corporation channelized the transport by discharging in the Pumping stations. There are no records are maintained on both sides. This creates an unaccountability state on faecal sludge management.

### Experience

#### Round table workshop on Faecal Sludge Management

Date: February 3, 2017

Organized by:  
*City Resource Centre (CRC) of  
DHAN Foundation*

Venue: **Madurai Corporation**

#### Action points

- Identification of pockets for implementing pilot projects on Faecal Sludge Management at Madurai City.
- Conducting special camps for the UGD Connection and Toilet Construction
- Creating policy for implementing DEWATS or other alternate system as a onsite treatment with contribution of corporation in periphery of city where UGD is not available.
- Creation of Task force on urban water resources for the further action and follow up and which needs to be interact at regular intervals.

# Treatment

It is a process that changes the physical, chemical and biological characteristic or composition of Faecal Sludge or Wastewater so that it is converted into a product that is safe for End-Use.



Discharging at Pumping station



Raw septage is discharged to the pumping tank

**Why discharging faecal sludge to the existing STP are technically not feasible**



## Comparison of domestic sewage and faecal sludge

Parameter	Municipal wastewater (sewage)	faecal sludge
BOD	200-300	440 - 78,600
COD	400-500	1,500 - 703,000
TSS	200-300	1,132 - 130,745
PH	7-9	1.5 - 12.6
OIL & GREASE	15	-

*Source: Advisory note on septage management in Urban India, Govt. of India, 2013*

Compare to the municipal wastewater, Faecal sludge load is very heavy. The most common problems are the overloading of solids, COD or nitrogen compounds. They can lead to serious operational problems ranging from incomplete removal of organics to the cessation of nitrification, which can take several weeks to recover. Also, the excessive solids accumulation may lead to heavy sludge generation that can compromise the efficiency of the plant and increase the operational costs.

## Status of offsite sanitation in Madurai City

Name of the ULB	Year of Commissioning	Capacity (MLD)	Technology	Present flow	Efficiency
Madurai (2 Nos)	2011	172.00	SBR	25.00	14.53%

*Source: Operative Guidelines for Septage Management for Local Bodies of TN Municipal Administration & Water Supply Department*

## Disposal

When the pathogens are removed from the excreta, then it is the manure for agriculture. The design like Twin pit was encouraged by the Swachh Bharat mission to yield the manure out of excreta.



# Action Plan

S.No	Action Plan for Madurai City	Executed by
1.	To regularize the faecal Sludge Management a Steering committee to be formed.	<b>Chair:</b> Madurai Corporation <b>Supported by:</b> City Resource Centre of DHAN Foundation
2.	To ensure the safe discharge, Public Social Private Partnership is to be encouraged	<b>Partners:</b> Madurai Corporation, City Resource Centre of DHAN Foundation, Desludging operators and Academia
3.	The Awareness of drinking water contamination due to faecal matters to be established	<b>For SHGs:</b> City Resources Centre will provide training. <b>For Public:</b> Waterwatch Magazine by Centre for Urban Water Resources
4.	In concern to occupational hazard, the safe workmanship to be trained for the desludging workers	<b>Chair:</b> Madurai Corporation <b>Supported by:</b> City Resource Centre of DHAN Foundation

## Constraints Vs Recommendation

Area	Constraints	Recommendation
Containment	<ul style="list-style-type: none"> <li>Space constraints</li> <li>Lack of skilled manpower</li> <li>High cost</li> <li>Lack of monitoring and enforcement</li> </ul>	<p>Educate people on sanitation benefits through examples</p> <p>ULB to disseminate appropriate design on containment suiting local conditions</p>
Emptying	<ul style="list-style-type: none"> <li>Lack of manuals(SOP) for Desludging</li> <li>Absence of protective gears and protective equipment</li> <li>Health hazards: Lack of information</li> <li>Safety of workers</li> </ul>	<p>Ward wise allocation and Reasonable fixed tariff for Desludging trucks</p> <p>Creation of MIS and GIS : Database of Septic tanks</p>
Transportation	<ul style="list-style-type: none"> <li>No regulatory body for monitoring</li> <li>Lack of UGD connection</li> <li>Dependence on Private Sector</li> <li>No control on desludging process</li> </ul>	<p>GPS Technology</p> <p>Licensing and Registering the Truck operators</p> <p>Institutional mechanisms for enforcement with Byelaws</p> <p>Capacity building for Desludge operators</p>
Treatment	<ul style="list-style-type: none"> <li>High BOD and COD of Septage</li> <li>Operation and Maintenance fund</li> <li>Lack of monitoring</li> <li>Lack of coordination among departments</li> </ul>	<p>Looking for hybrid solution includes both centralized and decentralized treatment</p> <p>Knowledge partner selection</p>
Reuse	<ul style="list-style-type: none"> <li>Resistance for reuse</li> <li>Lack of public awareness</li> <li>Mindset against reuse</li> </ul>	<p>Policy intervention for treatment</p> <p>Revenue generation</p> <p>Reuse for agriculture</p>

These overall social discriminations are started from the faecal matters. Now, these social problems are marching towards the scientific sanitation problem in the Urban Context. This scientific decimation is retrieved only through the interdisciplinary action.

Now this is a time to think, Shit always a matter! both socially and scientifically.



## Vandiyur Dreams

The project **REVIVAL**, is a new initiative of CURE in Collaboration with HCL Foundation.

**REVIVAL**, Revitalizing Vandiyur Lake is focusing on restoring the tank system by redefining the purpose of it for the future through collective planning and action. Vandiyur tank, the biggest tank of Madurai city, once irrigated more than 640 acres has lost its irrigation purpose and continuously subjected to predation. Two major components of the project are redesigning Vandiyur tank based on purpose and bringing safe water to the tank system. This project would be a model on 'Water security' of the ground water based urban communities through revitalizing traditional surface water bodies. The first phase focuses on developing an inclusive 'Detailed Project plan Report (DPR)'.

In this aspect, the first meeting was organized to create a space for associations, community volunteers and other stakeholders to share their thoughts, dreams and efforts to implement their dreams on 'Reviving the Vandiyur Tank'. The meeting took place at 4 pm on 24.11.2018 at the Vandiyur Walkers Club. There were 35 participants from various resident welfare associations, Vandiyur Restoration Committee, the Vandiyur traders Association and volunteers.

### **Following are the glimpse of discussion,**

- Phase of Urbanization of Madurai accelerated post 1988. Land use of tank command area shifted from cultivation to constructions. Farmers sold their farm lands for real estates, farm labourers were pushed out as masons, carpenters, construction labourers, scavengers, etc. Tank cascade system which served predominantly for irrigation incrementally lost its purpose to serve. People started to ignore tank, pond and started using bore wells.



Subsequently, surface based civilization was replaced by ground water based civilization. In 1990s, the ground water table was within 30 feet.

- In 1993, there was a heavy flood in Madurai. Poor maintenance of tank cascade system was one of the major reasons for flooding. Residential space of Vandiyur Tank Command area was inundated and severely affected. Three sluice gates were constructed adjacent to Vandiyur Tank surplus weir.
- In 1995, the Vandiyur tank was desilted at an expense of 5 crores, Vandiyur Tank Walkers Club played critical role in this initiative. People realized that desilting of tank improved the ground water level of neighborhoods. Post this initiative, initiatives such as creation of island inside Vandiyur Tank, boating in Vandiyur Tank were planned and piloted but nothing sustained in long run.
- In 2010s, urban sprawl exploited ground water table deep down to more than 450 feet. Residents of Gomathipuram and neighborhoods started to move away in search of domestic water, rented houses remained 'To-let'. The inhabitants had to buy water for Rs.2,000 per month.
- At this point, the resident welfare associations in the surrounding area formed a 'Vandiyur Tank Restoration Confederation'. In 2013, the Confederation decided to create percolation pits for a kilometer long in tank water spread area. Despite of continuous effort the work was stopped due to political interference. This confederation learned how important it is to be in a compatible environment with political systems.
- In 2011, a study conducted by Ornithologists revealed that Vandiyur Tank and Kunnathoor Tank, the twin tanks serve as a bio reserve for more than 5,000 birds that includes both native and migratory birds. But now the ecosystem has been drastically changed due to sewage disposals, solid waste disposals and invasive species infestation. It is important to restore the ecosystem by creating an island in center of the tank.
- It is important to form a confederation by bring 'tank associations and residential associations' in







Vandiyur Tank Cascade system together. This confederation should put continuous effort for reviving the cascade system. It should actively interact and act along with public administration and PWD for address encroachments along tank and channels, solid waste disposals in channels, sewage flowing in the tank system.

The extract from sharing reflects that people who had 'Bigger dreams' about Vandiyur Tank in their past and no more with them. Failure despite continuous efforts faded away their 'Bigger dreams'. But people still have a strong hope that 'small step of success in reality will bring 'Bigger-Wider and Smarter Dreams' back to them. Let the Vandiyur dreams come true...

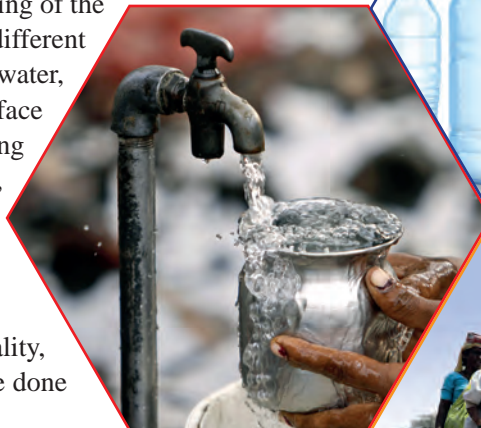
## Baseline Assessment Water and Scenario Analysis

A spatial temporal assessment of the Madurai urban water quality to provide an understanding of the relative condition of water quality in different sources of water supplies such as Lorry water, Corporation water, Groundwater, Surface water which are all utilised for drinking purpose. In order to cover all four zones, we collected the drinking water sample in the each zone under corporation boundary.

To understand the trend of the water quality, we sampled the same location what we done on June,2018. The Locations are

1. Sellur - Zone-I;
2. Pudhur - Zone-II;
3. Thepakulam - Zone-III;
4. Arapalayam - Zone-IV

Packaged drinking water-  
CAN water Supply



Water supply through Pipe Network-  
Corporation Supply



Bore well water-  
Ground water





# Zone 1 - Corporation Water

<b>TOTAL DISSOLVED SOLIDS</b> 182 mg/l 	<b>TURBIDITY</b> 0 NTU 	<b>pH</b> 7.5 	<b>TOTAL ALKALINITY as CaCO<sub>3</sub></b> 80 mg/l 
<b>TOTAL HARDNESS as CaCO<sub>3</sub></b> 80 mg/l 	<b>CALCIUM (Ca)</b> 15 mg/l 	<b>MAGNESIUM (Mg)</b> 10 mg/l 	<b>IRON (Fe)</b> 0 mg/l 
<b>FREE AMMONIA (NH<sub>3</sub>)</b> 0 mg/l 	<b>NITRITE (NO<sub>2</sub>)</b> 0 mg/l 	<b>NITRATE (NO<sub>3</sub>)</b> 2 mg/l 	<b>CHLORIDE (Cl)</b> 24 mg/l 
<b>FLUORIDE (F)</b> 0.4 mg/l 	<b>SULPHATE (SO<sub>4</sub>)</b> 7 mg/l 	<b>PHOSPHATE (PO<sub>4</sub>)</b> 0 mg/l 	<b>WATER IS CRYSTAL CLEAR &amp; FREE OF ODOUR</b>
<p>All the drinking water parameters are within the acceptable limits. Therefore the water is recommended as safe for drinking.</p>			



# Zone 1 - Ground Water

<b>TOTAL DISSOLVED SOLIDS</b> 1568 mg/l 	<b>TURBIDITY</b> 0.3 NTU 	<b>pH</b> 7.4 	<b>TOTAL ALKALINITY as CaCO<sub>3</sub></b> 500 mg/l 
<b>TOTAL HARDNESS as CaCO<sub>3</sub></b> 540 mg/l 	<b>CALCIUM (Ca)</b> 96 mg/l 	<b>MAGNESIUM (Mg)</b> 72 mg/l 	<b>IRON (Fe)</b> 0 mg/l 
<b>FREE AMMONIA (NH<sub>3</sub>)</b> 0.24 mg/l 	<b>NITRITE (NO<sub>2</sub>)</b> 0 mg/l 	<b>NITRATE (NO<sub>3</sub>)</b> 12 mg/l 	<b>CHLORIDE (Cl)</b> 280 mg/l 
<b>FLUORIDE (F)</b> 1.2 mg/l 	<b>SULPHATE (SO<sub>4</sub>)</b> 100 mg/l 	<b>PHOSPHATE (PO<sub>4</sub>)</b> 0mg/l 	<b>WATER IS CRYSTAL CLEAR &amp; FREE OF ODOUR</b>
<p>It is observed that water is hard because of the presence of Calcium and Magnesium. Total dissolved solids(TDS) exceeds acceptable limit. It does not have direct health effects but solids which cause higher 'TDS' may be harmful to human health. Higher level of fluoride in drinking water may cause bone diseases and dental Fluorosis. This hard water is <b>not</b> recommended for drinking. If there is no other source of drinking water, then it shall be consumed.</p>			

■ Within acceptable limits     
 ■ Within Permissible limits     
 ■ Exceeds permissible limits

\*Permissible limit are acceptable in the absence of alternate sources.  
 Bureau of Indian Standards recommends that acceptable limits to be implemented.



## Zone 1 - Packaged Can Water

<b>TOTAL DISSOLVED SOLIDS</b> 49 mg/l 	<b>TURBIDITY</b> 0 NTU 	<b>pH</b> 7.6 	<b>TOTAL ALKALINITY as CaCO<sub>3</sub></b> 16 mg/l 
<b>TOTAL HARDNESS as CaCO<sub>3</sub></b> 20 mg/l 	<b>CALCIUM (Ca)</b> 5 mg/l 	<b>MAGNESIUM (Mg)</b> 2 mg/l 	<b>IRON (Fe)</b> 0 mg/l 
<b>FREE AMMONIA (NH<sub>3</sub>)</b> 0 mg/l 	<b>NITRITE (NO<sub>2</sub>)</b> 0 mg/l 	<b>NITRATE (NO<sub>3</sub>)</b> 1 mg/l 	<b>CHLORIDE (Cl)</b> 12 mg/l 
<b>FLUORIDE (F)</b> 0.2 mg/l 	<b>SULPHATE (SO<sub>4</sub>)</b> 1 mg/l 	<b>PHOSPHATE (PO<sub>4</sub>)</b> 0 mg/l 	<b>WATER IS CRYSTAL CLEAR &amp; FREE OF ODOUR</b>

All the drinking water parameters are within the acceptable limits. Therefore the water is recommended as safe for drinking.



## Zone 2 - Corporation Water

<b>TOTAL DISSOLVED SOLIDS</b> 210 mg/l 	<b>TURBIDITY</b> 0 NTU 	<b>pH</b> 7.2 	<b>TOTAL ALKALINITY as CaCO<sub>3</sub></b> 80 mg/l 
<b>TOTAL HARDNESS as CaCO<sub>3</sub></b> 80 mg/l 	<b>CALCIUM (Ca)</b> 16 mg/l 	<b>MAGNESIUM (Mg)</b> 10 mg/l 	<b>IRON (Fe)</b> 0 mg/l 
<b>FREE AMMONIA (NH<sub>3</sub>)</b> 0 mg/l 	<b>NITRITE (NO<sub>2</sub>)</b> 0 mg/l 	<b>NITRATE (NO<sub>3</sub>)</b> 2 mg/l 	<b>CHLORIDE (Cl)</b> 40 mg/l 
<b>FLUORIDE (F)</b> 0.4 mg/l 	<b>SULPHATE (SO<sub>4</sub>)</b> 9 mg/l 	<b>PHOSPHATE (PO<sub>4</sub>)</b> 0 mg/l 	<b>WATER IS CRYSTAL CLEAR &amp; FREE OF ODOUR</b>

All the drinking water parameters are within the acceptable limits. Therefore the water is recommended as safe for drinking.



Within acceptable limits



Within Permissible limits



Exceeds permissible limits





## Zone 2 - Ground Water

<b>TOTAL DISSOLVED SOLIDS</b> 822 mg/l 	<b>TURBIDITY</b> 0.2 NTU 	<b>pH</b> 7.8 	<b>TOTAL ALKALINITY as CaCO<sub>3</sub></b> 340 mg/l 
<b>TOTAL HARDNESS as CaCO<sub>3</sub></b> 120 mg/l 	<b>CALCIUM (Ca)</b> 24 mg/l 	<b>MAGNESIUM (Mg)</b> 14 mg/l 	<b>IRON (Fe)</b> 0 mg/l 
<b>FREE AMMONIA (NH<sub>3</sub>)</b> 0.16 mg/l 	<b>NITRITE (NO<sub>2</sub>)</b> 0 mg/l 	<b>NITRATE (NO<sub>3</sub>)</b> 3 mg/l 	<b>CHLORIDE (Cl)</b> 112 mg/l 
<b>FLUORIDE (F)</b> 0.8 mg/l 	<b>SULPHATE (SO<sub>4</sub>)</b> 31 mg/l 	<b>PHOSPHATE (PO<sub>4</sub>)</b> 0mg/l 	<b>WATER IS CRYSTAL CLEAR &amp; FREE OF ODOUR</b>

It is observed that water is hard because of the presence of Calcium and Magnesium. Total dissolved solids(TDS) exceeds acceptable limit. It does not have direct health effects but solids which cause higher 'TDS' may be harmful to human health. Higher level of chloride in drinking water gives a unpleasant taste. This hard water is **not** recommended for drinking. If there is no other source of drinking water, then it shall be consumed.



## Zone 2 - Packaged Can Water

<b>TOTAL DISSOLVED SOLIDS</b> 56 mg/l 	<b>TURBIDITY</b> 0 NTU 	<b>pH</b> 7.5 	<b>TOTAL ALKALINITY as CaCO<sub>3</sub></b> 20 mg/l 
<b>TOTAL HARDNESS as CaCO<sub>3</sub></b> 20 mg/l 	<b>CALCIUM (Ca)</b> 5 mg/l 	<b>MAGNESIUM (Mg)</b> 2 mg/l 	<b>IRON (Fe)</b> 0 mg/l 
<b>FREE AMMONIA (NH<sub>3</sub>)</b> 0 mg/l 	<b>NITRITE (NO<sub>2</sub>)</b> 0 mg/l 	<b>NITRATE (NO<sub>3</sub>)</b> 1 mg/l 	<b>CHLORIDE (Cl)</b> 12 mg/l 
<b>FLUORIDE (F)</b> 0.2 mg/l 	<b>SULPHATE (SO<sub>4</sub>)</b> 1 mg/l 	<b>PHOSPHATE (PO<sub>4</sub>)</b> 0 mg/l 	<b>WATER IS CRYSTAL CLEAR &amp; FREE OF ODOUR</b>

All the drinking water parameters are within the acceptable limits. Therefore the water is recommended as safe for drinking.



Within acceptable limits



Within Permissible limits



Exceeds permissible limits



## Zone 3 - Corporation Water

<b>TOTAL DISSOLVED SOLIDS</b> 171 mg/l 	<b>TURBIDITY</b> 0.3 NTU 	<b>pH</b> 7.4 	<b>TOTAL ALKALINITY as CaCO<sub>3</sub></b> 72 mg/l 
<b>TOTAL HARDNESS as CaCO<sub>3</sub></b> 32 mg/l 	<b>CALCIUM (Ca)</b> 6 mg/l 	<b>MAGNESIUM (Mg)</b> 4 mg/l 	<b>IRON (Fe)</b> 0 mg/l 
<b>FREE AMMONIA (NH<sub>3</sub>)</b> 0 mg/l 	<b>NITRITE (NO<sub>2</sub>)</b> 0 mg/l 	<b>NITRATE (NO<sub>3</sub>)</b> 1 mg/l 	<b>CHLORIDE (Cl)</b> 40 mg/l 
<b>FLUORIDE (F)</b> 0.2 mg/l 	<b>SULPHATE (SO<sub>4</sub>)</b> 1 mg/l 	<b>PHOSPHATE (PO<sub>4</sub>)</b> 0 mg/l 	<b>WATER IS CRYSTAL CLEAR &amp; FREE OF ODOUR</b>
<p>All the drinking water parameters are within the acceptable limits. Therefore the water is recommended as safe for drinking.</p>			



## Zone 3 - Ground Water

<b>TOTAL DISSOLVED SOLIDS</b> 1288 mg/l 	<b>TURBIDITY</b> 0.5 NTU 	<b>pH</b> 7.3 	<b>TOTAL ALKALINITY as CaCO<sub>3</sub></b> 560 mg/l 
<b>TOTAL HARDNESS as CaCO<sub>3</sub></b> 360 mg/l 	<b>CALCIUM (Ca)</b> 80 mg/l 	<b>MAGNESIUM (Mg)</b> 38 mg/l 	<b>IRON (Fe)</b> 0 mg/l 
<b>FREE AMMONIA (NH<sub>3</sub>)</b> 0.32 mg/l 	<b>NITRITE (NO<sub>2</sub>)</b> 0 mg/l 	<b>NITRATE (NO<sub>3</sub>)</b> 6 mg/l 	<b>CHLORIDE (Cl)</b> 180 mg/l 
<b>FLUORIDE (F)</b> 0.6 mg/l 	<b>SULPHATE (SO<sub>4</sub>)</b> 77 mg/l 	<b>PHOSPHATE (PO<sub>4</sub>)</b> 0 mg/l 	<b>WATER IS CRYSTAL CLEAR &amp; FREE OF ODOUR</b>
<p>It is observed that water is hard because of the presence of Calcium and Magnesium. Total dissolved solids(TDS) exceeds acceptable limit. It does not have direct health effects but solids which cause higher 'TDS' may be harmful to human health. This hard water is <b>not</b> recommended for drinking. If there is no other source of drinking water, then it shall be consumed.</p>			

Within acceptable limits

Within Permissible limits

Exceeds permissible limits





## Zone 3 - Packaged Can Water

<b>TOTAL DISSOLVED SOLIDS</b> 77 mg/l 	<b>TURBIDITY</b> 0 NTU 	<b>pH</b> 6.7 	<b>TOTAL ALKALINITY as CaCO<sub>3</sub></b> 24 mg/l 
<b>TOTAL HARDNESS as CaCO<sub>3</sub></b> 32 mg/l 	<b>CALCIUM (Ca)</b> 8 mg/l 	<b>MAGNESIUM (Mg)</b> 3 mg/l 	<b>IRON (Fe)</b> 0 mg/l 
<b>FREE AMMONIA (NH<sub>3</sub>)</b> 0 mg/l 	<b>NITRITE (NO<sub>2</sub>)</b> 0 mg/l 	<b>NITRATE (NO<sub>3</sub>)</b> 1 mg/l 	<b>CHLORIDE (Cl)</b> 17 mg/l 
<b>FLUORIDE (F)</b> 0.2 mg/l 	<b>SULPHATE (SO<sub>4</sub>)</b> 1 mg/l 	<b>PHOSPHATE (PO<sub>4</sub>)</b> 0 mg/l 	<b>WATER IS CRYSTAL CLEAR &amp; FREE OF ODOUR</b>

All the drinking water parameters are within the acceptable limits. Therefore the water is recommended as safe for drinking.



## Zone 4 - Corporation Water

<b>TOTAL DISSOLVED SOLIDS</b> 140 mg/l 	<b>TURBIDITY</b> 0 NTU 	<b>pH</b> 7.1 	<b>TOTAL ALKALINITY as CaCO<sub>3</sub></b> 60 mg/l 
<b>TOTAL HARDNESS as CaCO<sub>3</sub></b> 40 mg/l 	<b>CALCIUM (Ca)</b> 16 mg/l 	<b>MAGNESIUM (Mg)</b> 5 mg/l 	<b>IRON (Fe)</b> 0 mg/l 
<b>FREE AMMONIA (NH<sub>3</sub>)</b> 0.08 mg/l 	<b>NITRITE (NO<sub>2</sub>)</b> 0 mg/l 	<b>NITRATE (NO<sub>3</sub>)</b> 1 mg/l 	<b>CHLORIDE (Cl)</b> 24 mg/l 
<b>FLUORIDE (F)</b> 0.2 mg/l 	<b>SULPHATE (SO<sub>4</sub>)</b> 1 mg/l 	<b>PHOSPHATE (PO<sub>4</sub>)</b> 0 mg/l 	<b>WATER IS CRYSTAL CLEAR &amp; FREE OF ODOUR</b>

All the drinking water parameters are within the acceptable limits. Therefore the water is recommended as safe for drinking.



WITHIN ACCEPTABLE LIMITS



WITHIN PERMISSIBLE LIMITS



EXCEEDS PERMISSIBLE LIMITS



## Zone 4 - Ground Water

<b>TOTAL DISSOLVED SOLIDS</b> 791 mg/l 	<b>TURBIDITY</b> 0.4 NTU 	<b>pH</b> 7.2 	<b>TOTAL ALKALINITY as CaCO<sub>3</sub></b> 340 mg/l 
<b>TOTAL HARDNESS as CaCO<sub>3</sub></b> 300 mg/l 	<b>CALCIUM (Ca)</b> 72 mg/l 	<b>MAGNESIUM (Mg)</b> 29 mg/l 	<b>IRON (Fe)</b> 0 mg/l 
<b>FREE AMMONIA (NH<sub>3</sub>)</b> 0.16 mg/l 	<b>NITRITE (NO<sub>2</sub>)</b> 0 mg/l 	<b>NITRATE (NO<sub>3</sub>)</b> 3 mg/l 	<b>CHLORIDE (Cl)</b> 120 mg/l 
<b>FLUORIDE (F)</b> 0.6 mg/l 	<b>SULPHATE (SO<sub>4</sub>)</b> 34 mg/l 	<b>PHOSPHATE (PO<sub>4</sub>)</b> 0 mg/l 	<b>WATER IS CRYSTAL CLEAR &amp; FREE OF ODOUR</b>
<p>It is observed that water is hard because of the presence of Calcium and Magnesium. Total dissolved solids(TDS) exceeds permissible limit. It does not have direct health effects but solids which cause higher 'TDS' may be harmful to human health. This water is <b>not</b> recommended for drinking.</p>			



## Zone 4 - Packaged Can Water

<b>TOTAL DISSOLVED SOLIDS</b> 101 mg/l 	<b>TURBIDITY</b> 0 NTU 	<b>pH</b> 7.4 	<b>TOTAL ALKALINITY as CaCO<sub>3</sub></b> 40 mg/l 
<b>TOTAL HARDNESS as CaCO<sub>3</sub></b> 40 mg/l 	<b>CALCIUM (Ca)</b> 8 mg/l 	<b>MAGNESIUM (Mg)</b> 5 mg/l 	<b>IRON (Fe)</b> 0 mg/l 
<b>FREE AMMONIA (NH<sub>3</sub>)</b> 0 mg/l 	<b>NITRITE (NO<sub>2</sub>)</b> 0 mg/l 	<b>NITRATE (NO<sub>3</sub>)</b> 1 mg/l 	<b>CHLORIDE (Cl)</b> 20 mg/l 
<b>FLUORIDE (F)</b> 0.2 mg/l 	<b>SULPHATE (SO<sub>4</sub>)</b> 0 mg/l 	<b>PHOSPHATE (PO<sub>4</sub>)</b> 0 mg/l 	<b>WATER IS CRYSTAL CLEAR &amp; FREE OF ODOUR</b>
<p>All the drinking water parameters are within the acceptable limits. Therefore the water is recommended as safe for drinking.</p>			



Within acceptable limits



Within Permissible limits



Exceeds permissible limits



## When nature calls, nature recycles

We call our poo and pee bodily waste. But in nature there is no such thing as waste, only resources that need to be recycled. By mimicking natural processes we can transform our poo and pee from waste **into a resource**.

A **constructed wetland** is a low-tech, cost-effective nature-based solution for recycling the water and nutrients we flush down our toilets.



Poo and pee must be deposited into a hygienic toilet separated from human contact.



Wetland plants collect valuable nutrients, such as nitrogen and phosphorus from our poo and pee.

Effluent can then be used safely for irrigation.

Millions of tiny organisms break down the organic matter and germs.

Heavier particles settle to the ground, removing attached nutrients and germs.



# Meteorological Updates

## Rainfall Data

**Station Name:** DHAN Central Office, Madurai

**Device:** Automated rain gauge.

**Average Annual rainfall for Madurai:** 840mm

### November 2018- Rainy days

Date	Intensity(mm/d)
16/11/2018	39
17/11/2018	1
18/11/2018	1
19/11/2018	4
20/11/2018	10
28/11/2018	8
<b>Total rainfall</b>	<b>96 mm</b>



## Temperature Data

	Temperature	Humidity
High	33 °C (13 Nov, 14:30)	97% (24 Nov, 02:30)
Low	21 °C (27 Nov, 05:30)	38% (14 Nov, 14:30)
Average	27 °C	79%



\* Reported 1 Nov 02:30 — 30 Nov 23:30, Madurai. Source: CustomWeather, © 2018

We sincerely acknowledge the Laboratory

**Water Quality Testing Laboratory**  
*The Institution of Engineers (India)*  
*Madurai Local Centre,*  
*Surveyor colony, Madurai- 625007*

*For Suggestion/Comments please write us on*



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