TN US SP

TAMIL NADU URBAN SANITATION SUPPORT PROGRAMME

iihs™

INDIAN INSTITUTE FOR HUMAN SETTLEMENTS

In Association With:

Keystone
A GROUP FOR ECO-DEVELOPMENT INITIATIVES

Gramalaya

CDD Consortium for DEWATS Dissemination Society

Training programme on Fecal Sludge Management for Engineers in Trichy Corporation

Faecal sludge characterisation

Quantity of feaces generated

Humans excrete 200 -350 g of fresh feces per person per day
(low income countries)

Source: https://en.wikipedia.org/wiki/Human_feces

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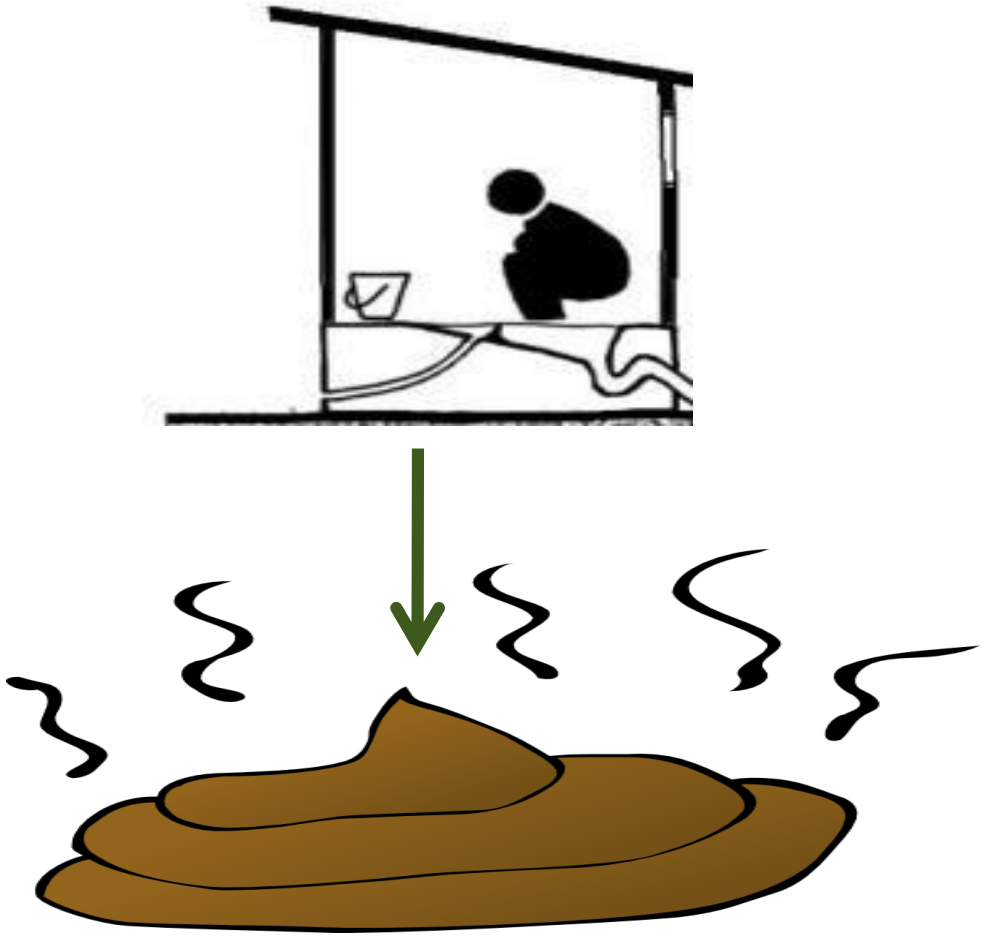
Composition of fresh feces



75 % water

25% of solids

84-93 % of Organic Matter

25-54% bacterial mass
2-25% of proteins
25% carbohydrates
2-15% undigested fat

non-organic solids
calcium iron and phosphates,
dried epithelial cells, and mucus

Source: https://en.wikipedia.org/wiki/Human_feces

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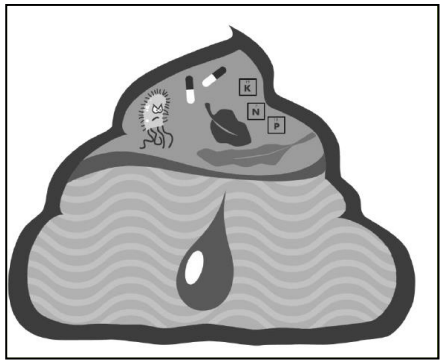
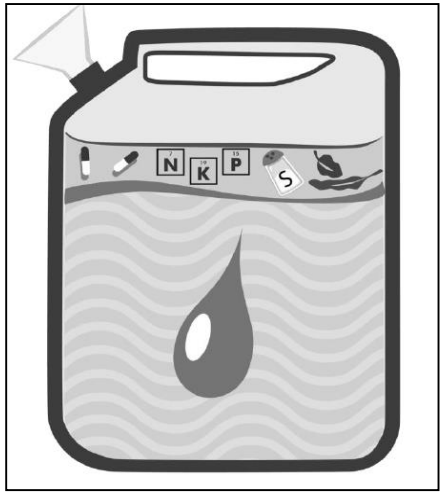
Composition of FS

- **Water**
  - On average 91-96% of urine is water and 75% of faeces are water (Rose et. al. 2015);
  - Liquid content in FS is about 97%.
- **Organic materials**
  - 25% of faeces are solid, of which 84-93% is organic material;
  - 4-9% urine is dissolved and suspended solids, of which 65-85% is organic material;
  - More discussion in later sections



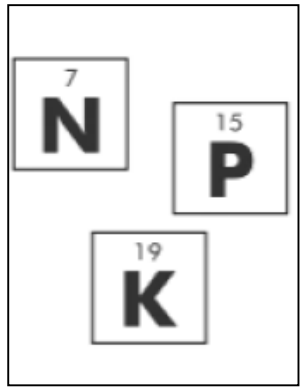


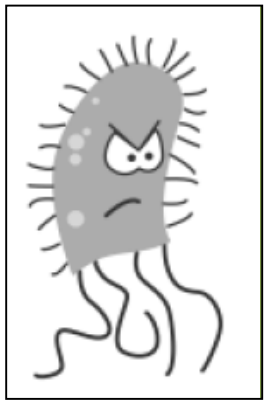
Composition of FS

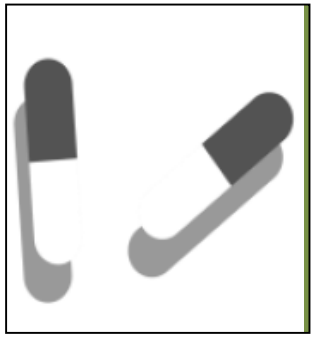
- **Nutrients**
  - Nitrogen (N), Phosphorous (P), Potassium (K)

Nutrients	Urine (%)	Feces (%)
Nitrogen	88	12
Phosphorous	67	33
Potassium	73	27

(Jonsson & Vinneras, 2004)







- **Pathogens**
  - Bacteria, viruses, protozoa, helminths
- **Chemicals**
  - Heavy metals, hormones and pharmaceuticals
  - Usually not a big concern in FSM

Factors influencing FS characteristics

Source (Streams connected)

Frequency of cleaning

Storage duration

Usage of water

Temperature

Type and design of Collection system

Influencing factors

Toilet usage

- Type of toilet dry vs. flush toilet, volume of water flushed, inclusion or exclusion of grey water;
- Fat, oil and grease concentration increases with inclusion of kitchen wastewater – reduces microbial degradation;
- Filling rate increases as more waste streams enter the toilet and the number of people using the toilet;
- Chemical additives can be harmful for digestion process

Influencing factors

Storage duration

- Digestion of organic matter that occurs during storage affects the FS characteristics;
- FS from public toilets – not stabilized and have high BOD and COD concentrations (low storage duration)
- FS from septic tank more stabilized and have low BOD and COD concentrations (high storage duration)

Influencing factors

Inflow and infiltration

- Filling rate of systems will be slower if there is more leaching – resulting in thicker FS;
- FS leaching leads to groundwater pollution;
- Groundwater intrusion may increase the filling rate of systems – resulting in thinner FS;

Influencing factors

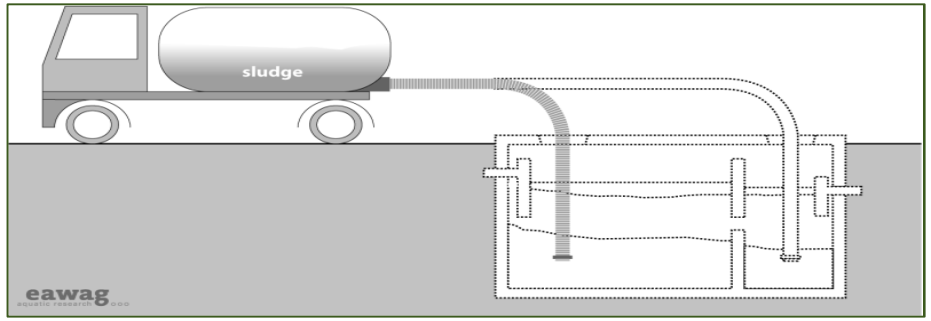
Climate

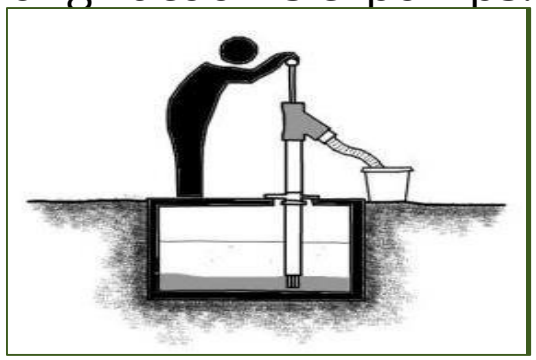
- Temperature and moisture has influence on FS characteristics;
- Heavy rainfalls result in overflowing and flooding of onsite systems, demanding for frequent desludging;
- FS mixed with rainwater is less viscous;
- Rates of biological degradation increase with warmer temperature;
- Hotter the temperature, the faster pathogens are killed.

Influencing factors

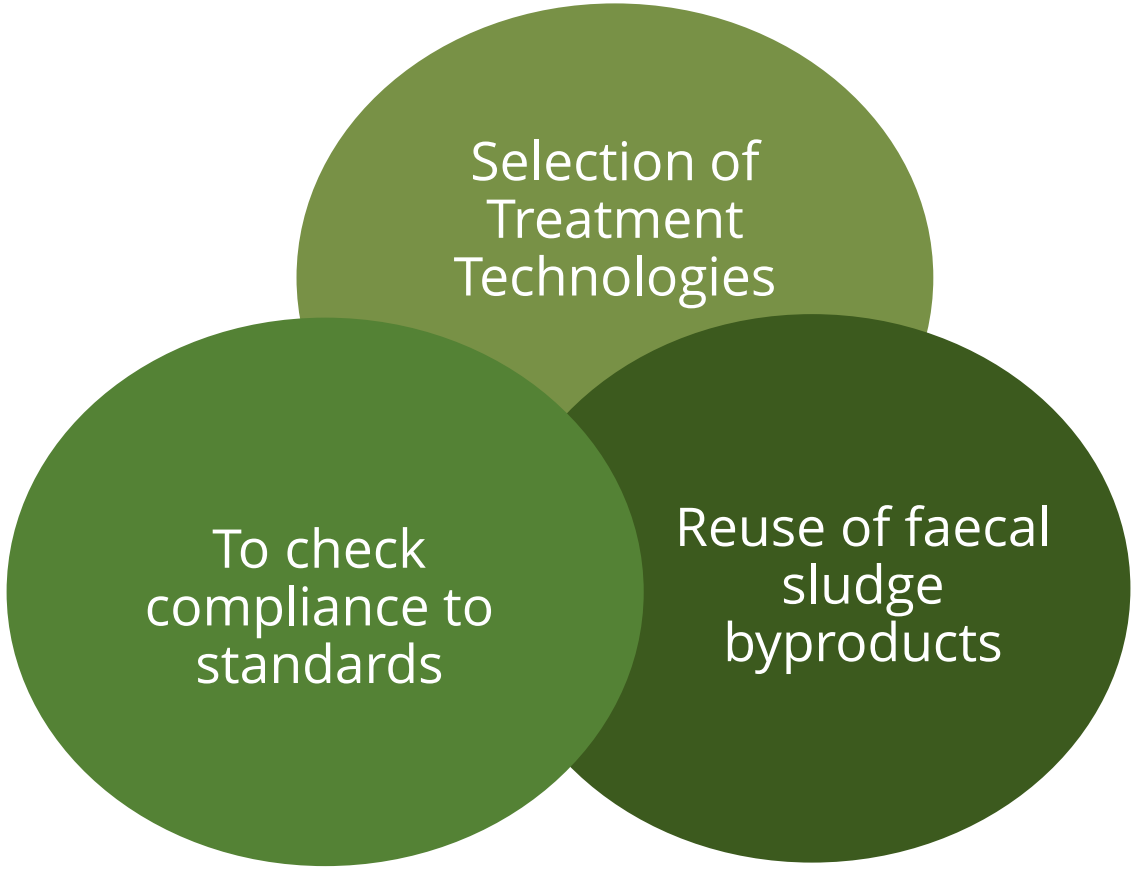
Collection method/desludging

- Addition of chemicals/Kerosene/phenyl
- FS at bottom is too thick to pump mechanically;
- FS removed by pumping is generally more dilute and less viscous than FS emptied manually;
- FS emptied from septic tanks is more dilute if more supernatant that sludge is collected, which is very common due to absence of strong vacuums & pumps.





Importance of FS Characteristics



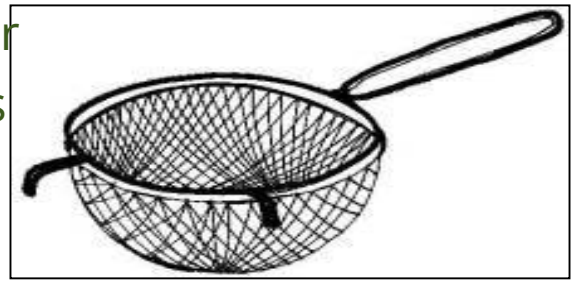
FS Characteristics

1. Physical Characteristics

Color

Odour

Solids



2. Chemical Characteristics

pH

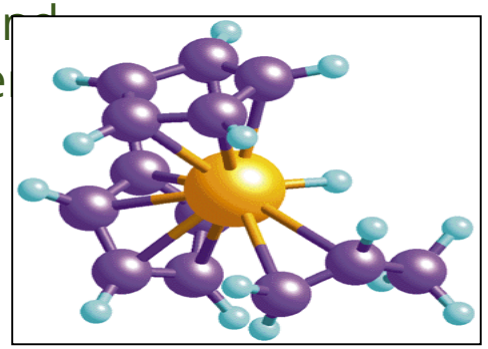
Chemical Oxygen Demand

Biochemical Oxygen Demand

Nitrogen Compounds

Phosphates

Sulfates



3. Biological Characteristics

Viruses

Bacteria

Worms

Physical Characteristics

Color

Yellowish/Greenish

Black

- Color of Faecal Sludge determines the freshness of faecal sludge
- If the color is black or dark brown, it represents old faecal sludge
- If color is Yellow/ greenish, it represents fresh faecal sludge

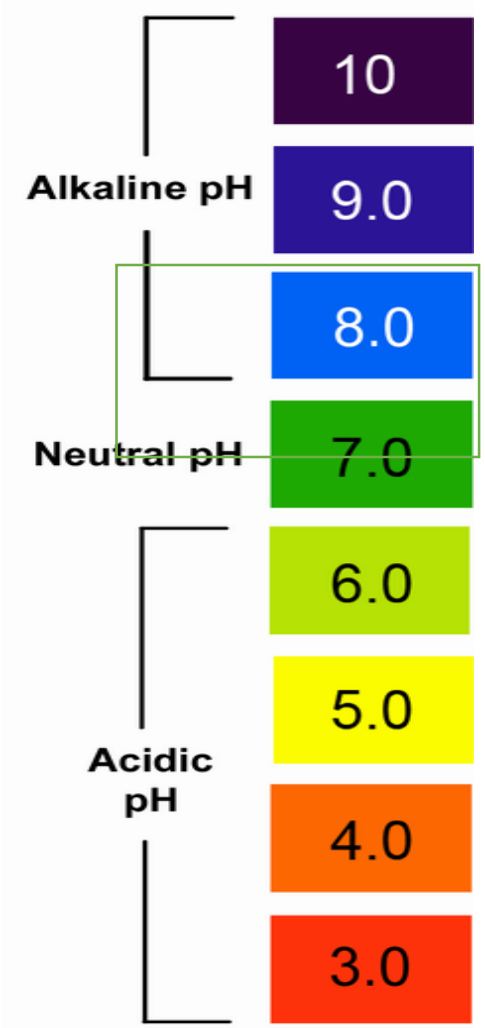
Physical Characteristics

Solids

- Total suspended solids (TSS)
- Total dissolved solids (TDS)
- Total solids (TS)

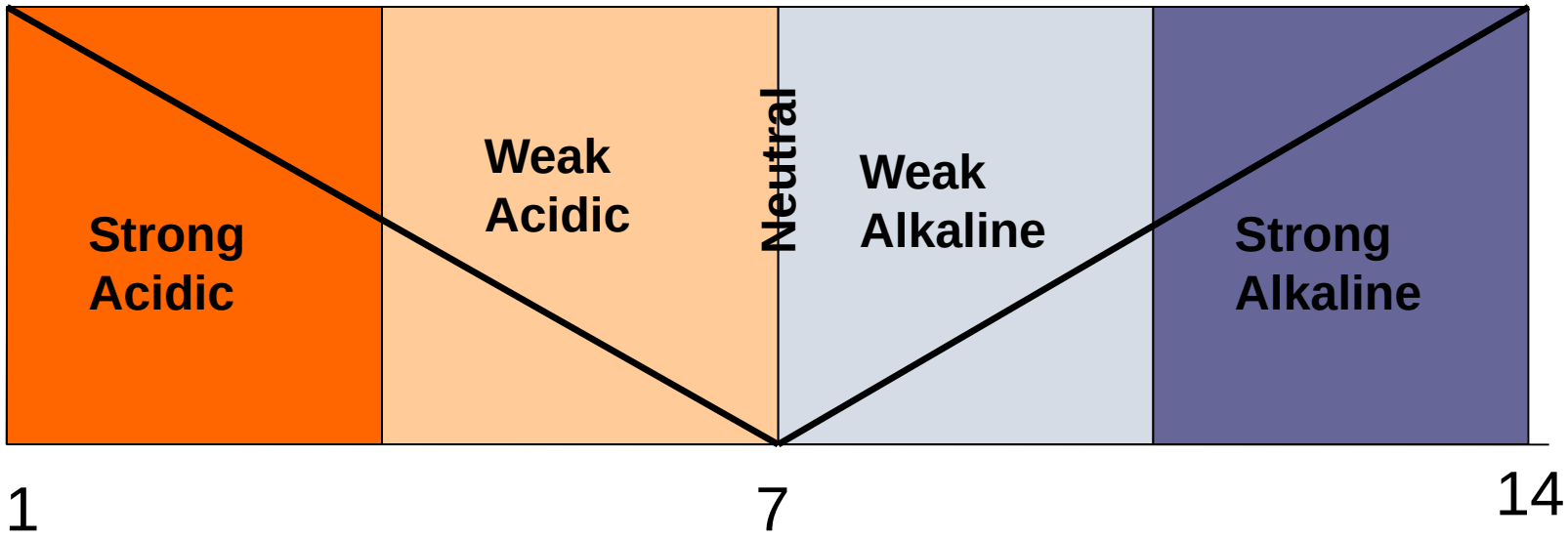
  (TS= TSS + TDS)
- Total Settleable Solids
- Volatile Solids
- Fixed Solids

Chemical Characteristics



pH

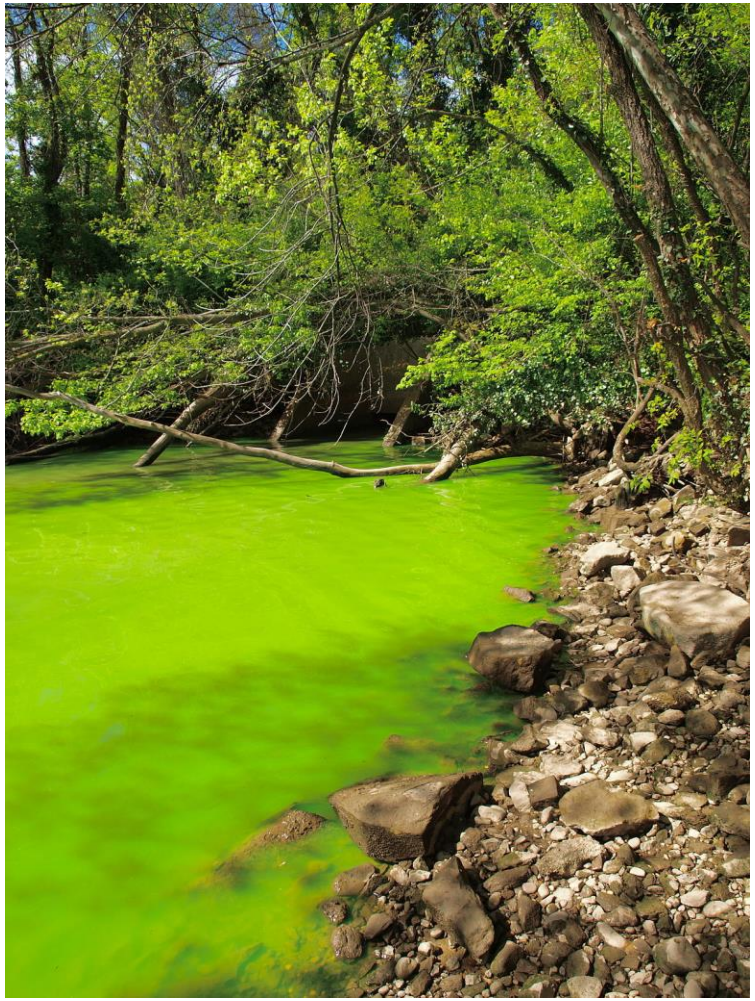
- It varies from 6.5 - 8



Chemical Characteristics

Organic compounds

- Organic degradable compounds are utilised by aerobic bacteria (oxygen using) for aquatic life. High organic concentrations in open water bodies can lead to oxygen scarcity
- Organic compound in wastewater are measured by
  - Biological Oxygen Demand (BOD)
  - Chemical Oxygen Demand (COD)
- Organic compounds can be soluble or suspended. Latter one can be removed by sedimentation.



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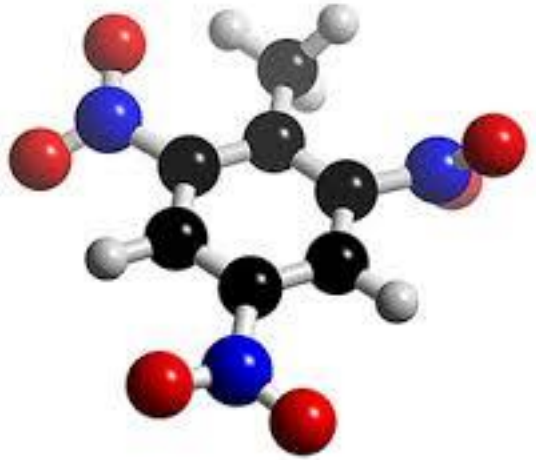
Chemical Characteristics

Organic compounds

- The COD/BOD ratio indicate the biodegradability of a wastewater sample. Values are always > 1 and the higher the ratio the worse the biodegradability



- COD:BOD5 of 1.43 - 3.0 for feacal sludge from septic tanks
- COD:BOD5 is 2- 2.5 for sewage

Chemical Characteristics

Nutrients

- Faecal sludge contains high amount of nutrients
- The nitrogen content in faeces is about 20% as ammonia, 17% as organic nitrogen in the cells of living bacteria, and the remainder as organic nitrogen (e.g. proteins)
- Phosphorus in FS will be present as phosphate, the acid or base form of orthophosphoric acid (H3PO4 / PO4-P), or as organically bound phosphate (e.g. nucleic acids, phospholipids and phosphorylated proteins).

Nutrients	Urine (%)	Feces (%)
Nitrogen	88	12
Phosphorous	67	33
Potassium	73	27

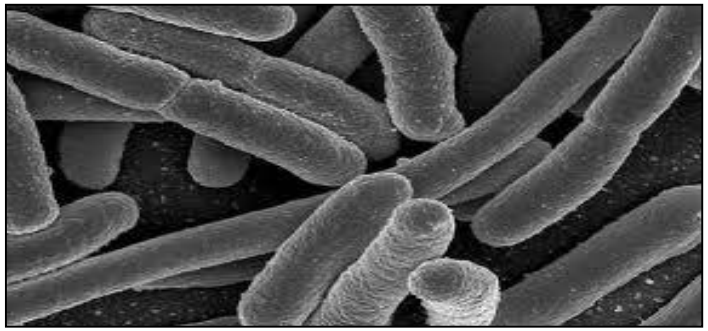
(Jonsson & Vinneras, 2004)

Biological Characteristics

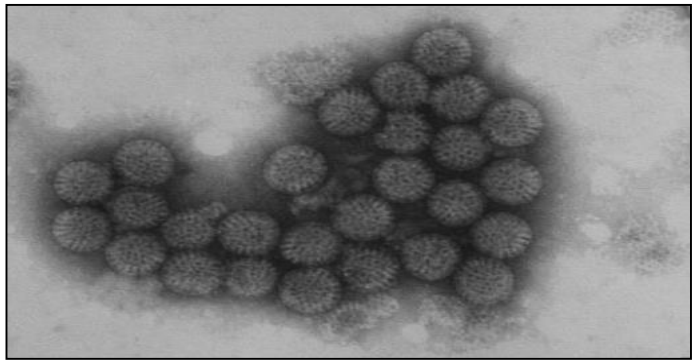
Group	Pathogen	Count
Bacteria	Escherichia coli , Salmonella typhi, Shigella spp. Vibrio cholera	$1x10^5$ CFU/ml
Viruses	Hepatitis A, Hepatitis E, Rotavirus, Poliovirus, Adenovirus	
Protozoa	Cryptosporidium parvum, Entamoeba histolytica	
Helminthes	Ascaris lumbricoides, Trichuris trichura, Hookworm	20,000- 60,000 Nos/Lit

(Jonsson & Vinneras, 2004)

Biological Characteristics

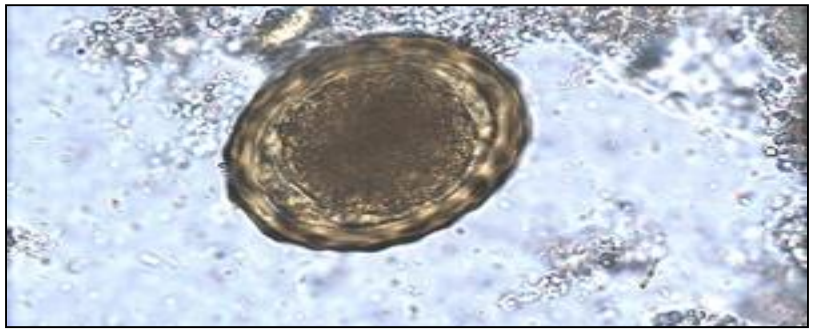


E.Coli



Rota Virus

Protozoa



Ascaris lumbricoides

Trichuris trichura

Hook worm

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Faecal sludge characteristics

Parameter	Type “A” strength	Type “B” low strength
Example	Public toilet or bucket latrine sludge	Septage
Characterisation	• Highly concentrated, mostly fresh FS • stored for days or weeks only	• FS of low concentration • usually stored for several years • more stabilised that Type “A”
COD (mg/l)	20 – 50,000	< 15,000
COD/BOD	5:1 to 10:1	5:1 to 10:1
Ammonium-Nitrogen (mg/l)	up to 5,000	< 1000
Total Solids (%)	> 3%	< 3%
Suspended Solids (mg/l)	>30,000	ca. 7000

FS characteristics from TN baseline survey

pH	Temperature (°C)	Conductivity (ms)	Ammonium (mg/l)	Phosphate (mg/l)	COD(mg/l)	TS (mg/l)	VS (mg/l)
7.02	24.96	3.50	1433.33	1616.84	29454.34	18121.86	5618.84

Current standards for disposal of treated water from STP

Parameter	Standards	
Effluent discharge standards (applicable to all mode of disposal)		
	Location	Concentration not to exceed
	(a)	(b)
pH	Anywhere in the country	6.5-9.0
Bio-Chemical Oxygen Demand (BOD)	Type A	20 mg/L
	Type B	30 mg/L
Total Suspended Solids (TSS)	Type A	<50 mg/L
	Type B	<100
Fecal Coliform (FC) (Most Probable Number per 100 milliliter, MPN/100ml	Anywhere in the country	<1000

Type A: Metro Cities*, all State Capitals except in the State of Arunachal Pradesh, Assam, Manipur, Meghalaya Mizoram, Nagaland, Tripura Sikkim, Himachal Pradesh, Uttarakhand, Jammu and Kashmir and Union territory of Andaman and Nicobar Islands, Dadar and Nagar Haveli Daman and Diu and Lakshadweep

Type B: Areas/regions other than mentioned above

**Metro Cities are Mumbai, Delhi, Kolkata, Chennai, Bengaluru, Hyderabad, Ahmedaba*

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Thank You