# **SEPTAGE MANAGEMENT : Application of Pit Life Extender**

# Report Prepared for: Water For People India Trust



Study undertaken

by

### SCHOOL OF WATER RESOURCES ENGINEERING

# JADAVPUR UNIVERSITY

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### **SEPTIC TANK**

- A septic tank is a combined sedimentation and digestion tank where the sewage is held for one to two days.
- During this period, the suspended solids settle down to the bottom. This is accompanied by anaerobic digestion of SS (sludge) and liquid, resulting in reasonable reduction in the volume of sludge, reduction in biodegradable organic matter and release of gases like CO<sub>2</sub>, CH<sub>4</sub>, H<sub>2</sub>S.
- The effluent although clarified to a large extent will still contain appreciable amount of dissolved and suspended organic solids and pathogens.

Thus, septic tank effluent needs to be treated before its final safe disposal.

- The secondary treatment facility can vary from the most conventional land disposal methods like soak pits or dispersion trenches to additional secondary biological treatment systems.
- In general, septic tank is intended to be used only for the water closet and hence, the night soil alone is the causative factor for the organic load.
- As far as the BOD is concerned, the per capita contribution of night soil, flushing water and the volume of ablution water and its frequency per day are relevant. Urine is the factor for nitrogen content.

# <u>SEPTIC TANK</u> <u>Influent Characteristics</u> (Mean and Range)

- Bio-chemical Oxygen Demand (BOD): 1290 mg/l (970-1550 mg/l)
- Chemical Oxygen Demand (COD): 2570 mg/l (1920-3050 mg/l)
- Suspended Solids (SS): 4140 mg/l ( 2550-4860 mg/l )
- Total Kjeldahl Nitrogen (TKN): 170 mg/l (150-185 mg/l)
- Total Phosphorus (Total P): 30 mg/l (24-34 mg/l)
- The above characteristics of influent in septic tank may vary depending on the volume of ablution water, flushing water per use and number of use per day.
- Septic Tank must be associated with Soak Pit.
- No. of users: 10, Length= 2m, Breadth=0.9m, Liquid depth= 1.4m (3yr)
- No. of users: 5, L=1.5m, B=0.75m, LD=1.05m (3yr)
- A provision of 300mm should be kept for free board.
- Soak Pit : To be provided with proper size.

# FAECAL SLUDGE

Faecal sludge is the solid or settled contents of pit latrines and septic tanks. Faecal sludge differs from the sludge produced in municipal waste water treatment plants. The characteristics of faecal sludge differ widely from household to household, from city to city and from country to country. The physical, chemical and biological qualities of faecal sludge are influenced by the duration of storage, temperature, intrusion of ground water or surface water in septic tanks or pits, performance of septic tanks and tank emptying technology and pattern.

Human excreta and the lack of adequate personal and domestic hygiene have been implicated in the transmission of many infectious diseases including cholera, typhoid, hepatitis, polio, cryptosporidiosis, ascariasis, and schistosomiasis. The World Health Organization (WHO) estimates that 2.2 million people die annually from diarrhoeal diseases and that 10% of the population of the developing world are severely infected with intestinal worms related to improper waste and excreta management (Murray and Lopez 1996; WHO 2000a). Human excreta-transmitted diseases predominantly affect children and the poor. Most of the deaths due to diarrhoea occur in children and in developing countries (WHO 1999). Proper excreta disposal and minimum levels of personal and domestic hygiene are essential for protecting public health.

Safe excreta disposal and handling act as the primary barrier for preventing excreted pathogens from entering the environment. Once pathogens have been introduced into the environment they can be transmitted via either the mouth (e.g. through drinking contaminated water or eating contaminated vegetables/food) or the skin (as in the case of the hookworms and schistosomes), although in many cases adequate personal and domestic hygiene can reduce such transmission. Excreta and wastewater generally contain high concentrations of excreted pathogens, especially in countries where diarrhoeal diseases and intestinal parasites are particularly prevalent. For maximum health protection, it is important to treat and contain human excreta as close to the source as possible before it gets introduced into the environment, that's why onsite sanitation facilities like septic tank along with PLE is a good option for this purpose.



### Fig.1: diagram of septic tank





Fig.2: diagram of septic tank



Fig.3: PIT LIFE EXTENDER PROCESS FLOW DIAGRAM

# PIT LIFE EXTENDER (PLE)

- A 17.75 cm (7 inches) diameter pipe that is 183.50 cm (6 feet) long sits in-place within a septic tank the lower 60 cm (2 feet) of pipe is perforated and wrapped with a porous cloth filter. This filter prevents large solids or debris from reaching the centre of the pipe as well as providing additional filtration through the build-up of a sludge blanket.
- Within the pipe a submersible pump provides flow to a cartridge filter which acts as the micro-filter as well as the GAC filter.
- A booster pump is installed after the GAC filter to provide the additional pressure required to push flow through the ultra-filtration membranes.
- All filtration operates in dead-end mode, with no backwashing available within the system.
- Under FSM grant, Water For People along with its partner has developed a device which uses membranes to separate and treat the supernatant part of septic tank and pit latrine sludge.

#### Abbreviation used

**CF-** Cloth filter

MF- micro filter

GAC- granulated activated carbon

**UF-** Ultra filtration

# PLE- Performance: 19/12/2017

Parameter	Cloth filter	Micro filter	GAC Ultrafilter	Ultrafilter
pH	7.27	7.4	7.8	7.70
TDS (mg/l)	1116	1076	968	960
TSS(mg/l)	92	27.5	9	2.7
COD(mg/l)	260	185	110	92
TC(/100ml)	160000	11000	1800	450

#### **Observation**

Flow rate at the final outlet of PLE was found to be varying between 33 lph and 45 lph during continuous 3 hrs running of PLE.

# **Initial Performance Study of PLE**

- A model PLE was fitted in a septic tank in Baranagar Municipal Area. The unit was designed and fabricated by Kolkata unit of Water for People.
- The PLE consisted of cloth-filter (placed at the bottom zone near the outlet of Septic Tank), submersible pump, Micro-filter, Granular Activated Carbon Filter, booster pump and ultra-filter. Double pumping arrangement was considered in the design.
- The unit operations of PLE had function on only forward flow of liquid. There was no arrangement of reverse movement of liquid and as a result filters could not be cleaned by backwashing.
- The design of PLE consisted of different types of filtration system in stages. Hence physical process for removal of contaminants (organic and pathogenic organisms) was considered in PLE. There was no biological process in PLE. Basically liquid-solid separation by membranes including odor removal by GAC was considered in the design of PLE.
- A septic tank is a combined sedimentation and digester tank where sewage is held for certain period. During this period the suspended solids settle down to the bottom. This is accompanied by anaerobic digestion of settled solid (sludge) and liquid, resulting in reasonable reduction in the volume of sludge, reduction in biodegradable organic matter and release of gases like carbon dioxide, methane and hydrogen sulphide. The effluent although clarified to large extent will still contain appreciable amount of dissolved and suspended putrescible organic solids and pathogens.
- Septic tank is an on-site sanitation system recommended only for individual homes, institutions and small communities in un-sewered areas. The effluent from septic tank needs further treatment for disposal. Soak pits are recommended as one of the method for disposal of septic tank effluent. But in most of the septic tanks one could find absence of soak pit and instead the septic tank effluents are discharged in surface drain.
- In the model PLE pipe diameter for conveying liquid after micro filtration was inadequate compared to pipe diameter between cloth filter and MF. Rate of flow after cloth filter was higher compared to final discharge flow. This could be due to head loss as well as reduced pipe diameter after micro-filter.

# **Initial Performance Study of PLE(contd.)**

- Flow rate at the final outlet of PLE was found to be varying between 33 lph and 45 lph during continuous 3hr operation of PLE.
- While suspended solids were found to be 230 mg/L at a depth of 1.05 m of septic tank (near cloth filter), the same after cloth filter was detected as 23 mg/l indicating reduction of suspended solids due to sludge blanket as well as cloth filter. However, at the bottom zone the cloth filter is getting clogged due to presence of sludge resulting in reduction of flow. Alternatively, the cloth filter can be placed at upper zone where influence of sludge will be much less.
- The volume of septic tank (where PLE was fitted) was measured as 5 m<sup>3</sup> which seems to be of higher size compared to the number of users. Normally volume of septic tank (as per design) should be around 2.5 m<sup>3</sup> for 10 users and interval of S.T. cleaning as 3 years. In the septic tank where PLE was installed, it was observed that the black water generated by 5 persons was getting disposed. Again toilet flushing was practiced after passing urine also. Thus, BOD, COD and FC were found to be comparatively of lower concentration.
- During the study at least 2 hours pumping was considered for taking samples from different locations.
- The study indicated that the cloth filter needs to be changed at a certain interval depending upon the cumulative flow through PLE. As micro-filter functioning depends on specification of membrane as well as cleaning arrangement, so replacement of MF will be generally guided by the volume of waste water treated. The granular Activated Carbon Filter replacement will depend on the BOD/COD, odor and volume of waste water treated.

### **Proposed Study**

Meeting held on 9<sup>th</sup> January, 2018 between Water for People and SWRE, Jadavpur University further study on the performance of PLE need to be carried out with modified methodology as well as modified design of PLE.

# Salient points considered for the proposed study

- At least eight (8) septic tanks in different places will be identified and qualitative analysis will be carried out for assessing the characteristics of liquid in-site septic tank as well as effluent coming out from the septic tank.
- Three septic tanks will be selected (including initially selected septic tank for the study) for installation of PLE.
- PLE will be designed and fabricated as per joint discussion between Water for People and SWRE, Jadavpur University. Fabrication and installation cost will be borne by Water for People directly.
- Performance of PLE will be monitored continuously for 72 hours by taking samples from different identified location at selected interval of time. Such continuous pumping will be carried out in four occasions for each septic tank during the study.
- Instant flow as well as cumulative flow will be monitored by installing specific type of flow meter (electromagnetic flow meter) and the same will be procured and installed by Water for People. In addition pressure gauge at suitable location will be installed and accordingly the same will be procured by Water for People.
- Parameters such as pH, COD, BOD, Suspended Solids, Turbidity, Total Coliform and Faecal Coliform will be analysed for the samples to be collected during the study.
- All samples will be stored in the ice-box to maintain lower temperature.
- The samples will be transported within 12 and 18 hours to the laboratory of SWRE, Jadavpur University for analysis.
- The operational life of each unit e.g. cloth filter, MF and UF will be assessed during the study in terms of quantity of liquid treated.

# **Objectives of previously operated various sites**

- Performance of PLE will be monitored continuously for 72 hours by taking samples from different identified location at selected interval of time.
- Flow will be measured at specified interval of time. In addition pressure gauge at suitable location will be installed.
- Parameters such as pH, COD, BOD, Suspended Solids, Turbidity, Total Coliform and Faecal Coliform will be analysed for the samples to be collected during the study.
- All samples will be stored in the ice-box to maintain lower temperature.
- The samples will be transported within 12 and 18 hours to the laboratory for analysis.
- The operational life of each unit e.g. cloth filter, MF and UF will be assessed during the study in terms of quantity of liquid treated.

#### Sampling During Continuous Pumping-next phase

Continuous pumping of septic tank effluent will be carried out (max 72 hrs) on three occasions for monitoring different parameters.

Sampling Protocols during continuous monitoring for 72 hrs will be as follows:

### Location of sampling:

- (a) After Cloth-filter –(1)
- (b) After Micro-filter –(2)
- (c) After Granular Activated Carbon –(3)
- (d) After Ultra-filter –(4)

#### Parameters to be analyzed

#### **Location Parameters**

### (a) pH, COD, BOD, SS/Turbidity, TC, FC

- (b) pH, COD, BOD, SS/Turbidity
- (c) pH, COD, BOD
- (d) pH, COD, BOD, TC, FC

# Sampling & Analysis: Cycle

Time	CODBODTC/FCLocationLocationLocation		TC/FC Location	Pressure Location
0 hr	a, b, c, d	a,d	a, d	1, 2, 3, 4
2 hrs	a, b, c, d	d	d	1, 2, 3, 4
4 hrs	a, b, c, d	d	d	1, 2, 3, 4
6 hrs	c, d	d	d	1, 2, 3, 4
12 hrs	c, d	d	d	1, 2, 3, 4
24 hrs	c, d	d	d	1, 2, 3, 4
36 hrs	c, d	d	d	1, 2, 3, 4
48 hrs	c, d	d	d	1, 2, 3, 4
72 hrs	c, d	d	d	1, 2, 3, 4

### Previous Study carried out by SWRE, JU

#### Filter Specifications-

#### Micro Filter:-

Material – Polypropylene

Pore Size – 5 Micron

Max Flow - 7.57 LPM

#### GAC (Granular Activated Carbon) :-

Max Flow – 26 LPM

Max Pressure – 125 psi

### **Pump Specification-**

- Type of Pump Submersible
- Power 40 Watt.
- Max Head 2.5 M (Approx.)
- Discharge of the pump 26 LPH(avg.)



Fig.4: filter arrangements

# **All Previous Designated Sites**

Site Location - JU Hostel – 3 Storied Building. Each floor containapprox 12 rooms and per room two persons. Floating students- 10-12 Total = 84(Approx)

Site.1:-



Fig 5: Septic tank at JU hostel

# All Designated Sites(Contd.)

Site Location - JU Staff Complex – 20-19 units. each unit contain 3-4 person. Total = 80(Approx).





Fig.6:Staff complex septic tank



Fig.7: Staff Complex inspection pit

### Characteristics of Five Septic Tanks Raw Sample

Raw Sample	BOD	COD	pН	Turbidity	TDS	TSS	TC	FC
	(mg/l)	(mg/l)		(NTU)	(ppm)	(mg/l)	(MPN per 100 ml)	(MPN per 100 ml)
JU Hostel	967	2135	6.78	794	2360	250	33x10 <sup>4</sup>	27x10 <sup>4</sup>
JU Staff Complex	254	545	6.84	214	2410	76	29x10 <sup>4</sup>	11x10 <sup>4</sup>
JU Staff Complex-2 <sup>nd</sup>	245	489	6.74	204	2310	67	$24 \times 10^4$	11x10 <sup>4</sup>

12/12	50	172	7.38	42	1040	20	1.6x10 <sup>5</sup>	$3.3 \times 10^{3}$
Brideshwar Dhole Lane Baranagar								
Garfa 5 <sup>th</sup> Lane	216	384	6.71	194	2180	50	26x10 <sup>4</sup>	17x10 <sup>4</sup>

### After Filter Water Quality

Effluent		COD	лU	Turbidity	TDC	тсс	тс	EC
Enluent	BOD	COD	рн	Turbially	TDS	155	IC	FC
sample	(mg/l)	(mg/l)		(NTU)	(ppm)	(mg/l)	(MPN	(MPN
							per 100	per 100
							ml)	ml)
JU Hostel	856	1863	6.67	230	2169	89	17x10 <sup>4</sup>	$17 \times 10^{4}$
JU Staff Complex	213	268	6.52	69.3	2136	16	21x10 <sup>4</sup>	9x10 <sup>4</sup>
JU Staff Complex Ins. Pit	210	233	6.87	70.1	1963	14	21x10 <sup>4</sup>	9x10 <sup>4</sup>
12/12 Brideshwar Dhole Lane Baranagar	43.37	82	7.41	12	1032	4	9x10 <sup>2</sup>	34

# **Recent studies of PLE at various locations**

1<sup>st</sup> cycle of operation at 12/12 bireswar dhol lane

Site.1:-

Installation date:-28.08.18



### **Objective of all the recent studies:**

• Performance of PLE will be monitored continuously for 72 hours by taking samples from different identified location at selected interval of time.

- Flow will be measured at specified interval of time. In addition pressure gauge at suitable location will be installed.
- Parameters such as pH, COD, BOD, Suspended Solids, Turbidity, Total Coliform and Faecal Coliform will be analysed for the samples to be collected during the study.
- All samples will be stored in the ice-box to maintain lower temperature.
- The samples will be transported within 12 and 18 hours to the laboratory for analysis.
- The operational life of each unit e.g. cloth filter, MF and UF will be assessed during the study in terms of quantity of liquid treated.

# Arrangements of PLE at BireswarDhol Lane for 1<sup>st</sup> cycle

• A perforated pipe of 20.32cm (8 inch) diameter and 1.82m (6 ft) height is installed in the septic tank, it rests on the bottom of the septic tank. Submersible pump is placed inside the pipe rests on a plate previously attached to the pipe. 40.64cm (16 inch) from the bottom of the perforated pipe is not perforated because it would have

caused accumulation of the sludge. Above this part has perforation of diameter of 4mm for a length of 76cm ( 2 ft 6inch).

- Septic tank has user of 4 to 5 persons.
- Water extracted from the pit enters to the micron filter of size 5micron. Then it passes through activated carbon and finally through ultrafiltration.
- This pattern flow of water (MF to GAC to UF) continues for 2cycles in same location with minute improvisations.

### **Material specifications**

#### Submersible pump

Voltage= 165-240V, Frequency= 50Hz, Maximum head=2.5M, Output=3500L/hr

#### **Booster pump**

Voltage=48VDC, Nominal flow rate=1.8LPM

#### Micro filter

Pore size = 5micron.

### Perforated pipe

A pipe of diameter20.32cm(8inch) is used having total length of 1.82m(6ft),perforated for a length for 76cm(2ft 6inch) and keep bottom 1ft 4inch is blocked.



Fig.8: Various part of PLE machine

### **Parameters measured**

- A- Raw sample.
- **B** Sample after cloth filter.
- C- Sample after micro filter.
- **D** Sample after activated carbon.
- **E-** Sample after ultra filtration.

BOD, COD, pH, total suspended solids(TSS) measured in mg/litre.

Turbidity measured in <u>NTU</u>.

Number of Total Coliform (TC) & Feacal Coliform (FC) are in the order of <u>1000 per 100</u> <u>ml.</u>

Pressure Gauge reading is in <u>kg/sq.cm</u>.

Flow measured in litre per hour.

Location Bireswardhol	BOD	COD	рН	TSS	TURBIDITY	TC*1000	FC*1000	PRESS.	FLOW (lph)		
02:35pm on 28.08.18											
1A	60	97	7.91	57	39	30	21				
1B	56	88	7.88	48	28.4	28	20.5		140.4		
1C	43	77	7.8	39	14.1	25	19.5				
1E	34	62	8.19	13	4.0	22	17		156.6		
04:35pm on 2	8.08.18	1	ı	ı	1	1			1		
2B	50	85	7.88	37	13	25	22		121.5		
2E	44	80	7.96	15	4.9	22	21		69.22		
06:35pm on 2	8.08.18										
3E	32	64	7.86	8	4.6	21	18		111.1		
08:35pm on 28.08.18											
4E	43	79	7.93	12	4.5	25	21		111		
02:35am on 2	02:35am on 29.0818										
5E	64	105	8.07	32	12.4	27	22		0.72		



Comparative analysis BOD & COD of samples collected from different outlet at initial time (0 hr).



Comparative analysis pH, TSS, turbidity of samples collected from different outlet at initial time (0 hr).



Comparative analysis TC & FC of samples collected from different outlet at initial time (0 hr).



Variation of flow rate with respect to the time of operation

### Few observation of PLE at Bireswar Dhol Lane for 1st cycle:-

- Pressure gauges were not working properly, too much fluctuation.
- Pressure at the ultra filtration at 06:35pm was between 0.3kg/sq.cm to 0.8kg/sq.cm.
- No flow comes out of GAC.
- Flow from micro filter at 0hr was not measured. After that no flow was came through micro filter.
- At 2am on 29.08.18 perforated pipe was moved upward from previous position, very little flow has coming from outlet in a very inconsistent manner such as, 500ml in 42min and 140ml in 1hr4min.
- At 07:30am on 29.08.18 flow was completely stopped.
- BOD and COD of raw water are found to be reduced to around 50% and 60% of its original value at 0 hr after Ultra filtration.

- After ultra-filtration pH is found to be almost uniform with tedious variations, TSS & Turbidity is found to be reduced to around 20% & 10% respectively of its original value at 0hr after Ultra filtration.
- TC & FC counts are found to be reduced to 73% & 80% respectively of its original value at 0hr after Ultra filtration.

#### Expected cause of the upward movement

It may have happened that flow of water in the perforated pipe get reduced significantly resulting in less water accumulation in the pipe. So downward weight of the pipe gets reduced and as per the law of buoyancy displaced water gives upward force to perforated pipe results in floatation of the pipe system.



Fig.9: Micro filter after three days of running previously it was white



Fig.10: Perforated pipe



Fig.11: Brick is placed upon the pipe to resist its upward movement



Fig.12: Flexible Pipe connecting perforated pipe and PLE machine is subjected to tension due to upward movement the perforated pipe

**Recent studies of PLE at various locations(contd.)** 

<u>2<sup>nd</sup> cycle in 12/12 bireswardhol lane</u>

Site.1:-

Installation date:-10.09.18



### Few improvisation of PLE at Bireswar Dhol Lane for 2nd cycle:-

- Due to the incident of floatation of the perforated pipe some modifications have done to reduce the chances of clogging of the pipe.
- Apart from changes in the booster pump (given in detail in next slide), we changes the cloth filter and covered the perforated pipe with double layer of 10micron cloth filter.
- Drilling of diameter 13mm is done apart from previous 4mm and previous accumulation of solids surrounding the pipe is brushed off using steel rod.
- Apart from above mentioned modifications everything remains same as previous cycle on 28.08.18.

### Material specifications

#### Submersible pump

Voltage= 165-240V, Frequency= 50Hz, Maximum head=2.5M, Output=3500L/hr
#### Booster pump

Voltage=48VDC, Nominal flow rate=1.8LPM

#### **Micro filter**

Pore size = 5 micron.

#### **Perforated pipe**

A pipe of diameter 8inch is used having total length of 1.82m(6ft),perforated for a length for 76.2cm(2ft 6inch) and keep bottom 40.64cm(1ft 4inch) is blocked.

#### **Parameters measured**

- **A-** Raw sample.
- **B** Sample after cloth filter.
- **C** Sample after micro filter.
- **D** Sample after activated carbon.
- **E-** Sample after ultra-filtration.

BOD, COD, pH, total suspended solids (TSS) measured in mg/litre.

Turbidity measured in <u>NTU</u>.

Number of Total Coliform (TC) & Feacal Coliform (FC) are in the order of  $\underline{100}$ 

Pressure Gauge reading is in kg/cm<sup>2</sup>

Flow measured in <u>litre per hour</u>

LOCATION	BOD	COD	pН	TSS	TURBIDITY	TC*100	FC*100	PRESS.	FLOW
BIRESWAR DHOL LANE									(LPH)
2 <sup>ND</sup> CYCLE									
04:50pm on 1	0.09.18								

1A	105	174	7.88	42	18	28	22		
1B	96	165	7.84	38	16	26	21	0	324
1C	90	120	7.89	20	12	24	19	0	216
1D	82	115	7.94	24	10	21	17	0	117
1E	68	103	7.97	17	7	18	16	0	95.25
06:50pm on 1	0.09.18								
2B	91	135	7.9	27	15	28	22	0	312
2C	82	126	8.05	25	12	26	21	0	230
2D	79	110	7.94	18	8	22	18	0	114.4
2E	62	98	7.91	15	4.5	17	15.5	0.4-0.5	114.26
08:50pm on 1	0.09.18	-							
3B	80	126	8.02	23	9	28	22	0	5.02
3C	61	108	8.01	14	8.2	16.5	20	0	2.91
3D									
3Е	45	91	8.06	12	3.8	16.5	15	2	14.86

LOCATION	BOD	COD	pН	TSS	TURBIDITY	TC*100	FC*100	PRESS.	FLOW			
Bireswardhol lane2 <sup>nd</sup> cycle												
10:50pm on 10.09.18												

4E	40	85	8.21	12	3.7	18	16	0.5	5.4					
04:50am on 11	04:50am on 11.09.18													
5E	37	73	8.34	10	3	15	13	0	4.18					
04:50pm on 11	.09.18	-												
6E	34	70	7.9	9.2	2.8	14	12.5	0.5	8					
04:50am on 12.09.18														
7E	32	64	8.09	8	2.5	14	12	0	2.5					
04:50pm on 12	.09.18	-												
8E	28	53	8.77	7.4	2.2	13	11	0	2.48					
12:44pm on 13	.09.18													
9E	19	40	8.16	6	1.9	12	10	0.5	4.4					



Comparative analysis BOD & COD of samples collected from different outlet at initial time (0 hr).



Comparative analysis pH, TSS, turbidity of samples collected from different outlet at initial time (0 hr).



Comparative analysis TC & FC of samples collected from different outlet at initial time (0 hr).



## Variation of flow rate with respect to the time of operation

## Few observations of PLE at Bireswar Dhol Lane for 2nd cycle:-

- Pump runs for 68 hours uninterruptedly.
- This time no such problem like upward movement of pipe is occurred, which indicates that less number of perforation may have caused this problem in the 1<sup>st</sup> cycle.
- Samples are collected in proper time and iced.
- Suddenly at 5:20am on 11.09.18 pressure at ultra-filtration rises to 5kg/sq.cm.
- BOD and COD of raw water are found to be reduced to 64% and 60% of its original value at 0hr after Ultra filtration.
- After 72hrs of operation BOD & COD are found to be reduced to 18% & 23% respectively of its original value after Ultra filtration.
- After ultra-filtration pH is found to be almost uniform with tedious variations. TSS & turbidity are found to be reduced to around 40% & 38% respectively of its original value at 0hr after Ultra filtration.
- After 72hrs of operation TSS & turbidity are found to be reduced to 15% & 10% respectively of its original value after Ultra filtration.
- TC & FC counts are found to be reduced to 64% & 72% respectively of its original value at 0hr after Ultra filtration.
- After 72hrs of operation TC & FC are found to be reduced to 42% & 45% respectively of its original value after Ultra filtration.

## **Recent studies of PLE at various locations(contd.)**

# 1<sup>st</sup> cycle in JU campus besides mechanical building



Site.2:-

Installation date:- 11<sup>th</sup> December 2018

## Arrangements of PLE at JU campus for 1<sup>st</sup>cycle of operation

- Perforated pipe is not used this time, sludge pumping pump is used as submersible pump. It is placed 30.48cm (1ft) above the bottom portion of the tank of depth 1.82m (6ft) which is filled up to 1.52m (5ft) with sewage.
- Septic is of dimension of length 6.1m( 20ft) and breath1.82m( 6ft) and depth 1.82( 6ft). This tank has a volume of 20.20m<sup>3</sup>.
- This septic tank is associated with a building used for educational purposes only. So this tank has a regular user of around three to four persons.
- Water extracted from the pit enters in to the activated carbon membrane. Then it passes through micro filter and finally through ultrafiltration. This is a difference between previous course of action where extracted water enters micro filter first then activated carbon membrane.
- This pattern flow of water (GAC to MF to UF) continues for 2cycles (72hr+72hr) at same location with small improvisations.

# Material specifications

ITEM	SPEC
Micro filter spec	0.45 Micron
Ultra filter spec	0.01 Micron
GAC	600 IV
Booster pump spec	0.25 HP, 220 V
Submersible pump spec	1HP, 220 V

# Submersible pump

					Eterna	SW							
Dump	Del Dine	Denner		Discharge (LPM)									
Model	Size (mm)	Rating	3	4	5	6	7	8	9	Solid	Min		
		(kW/HP)	(W/HP) Total Head in meters							Size	From		
750SW	40	0.75/1.0		150	120	95	60			15	370		

## **Booster pump**

PUMP	POT	VER	PIPE SIZE (mm)		FULL LOAD CURRENT	RATED VOLTAGE	TOTAL HEAD IN METRES					
MODEL	1-UV	HP	SUC	DEL	(in amps.)	(voits)	3	6	9	12	15	
				50C. DEL.			DISCH	LARGE	IN LITR	ES PER	HOUR	
TINY	0.18	0.25	19	19	2	230	1600	1300	1100	800	600	

# MATERIAL OF CONSTRUCTION Pump Body : Stainless Steel for SW CI FG 200 for BW Impeller : Noryl for SW CI for BW Shaft : Stainless Steel Cable Length : 10 meters Class Insulation : F

Ingress Protection: IP 68



Fig.13: Submersible pump



Fig.14: PLE machine after complete installation

## **Parameters measured**

- A- Raw sample.
- **B** Sample after activated carbon.
- **C** Sample after micro filter.
- **D-** Sample after ultra-filtration.

BOD, COD, pH, total suspended solids (TSS) measured in mg/litre.

Turbidity measured in <u>NTU</u>.

Number of Total Coliform (TC) & Feacal Coliform (FC) are in the order of 100.

Pressure Gauge reading is in <u>kg/sq.cm</u>.

Flow measured in <u>litre per hour</u>

LOCATION	BOD	COD	pН	TSS	TURBIDITY	TC*100	FC*100	PRESS.	FLOW				
Beside mechanical building JU													
03:30pm on 11.12.18													
1A 39 88 7.72 46 26 130 79 0.7													
1B	26	67	7.64	38	15	108	72	0.6					
1C	21	58	7.86	29	14	90	54	0.55					
1D	15	38	7.83	18	12	79	49	2.4	30.34				
05:30pm on 11.12.18													
2A	20	61	7.79	25	16.2	150	90	0.5					
2B	19	49	7.81	15	12.0	94	70	0.6					
2C	16	43	7.93	12	11.5	90	94	0					
2D	12	32	7.92	12	10.4	69	35	2.1	14.58				
				07:	30pm on 11.12.1	.8							
3A	40	94	7.54	24	16	120	70	0.6					
3B	26	46	7.80	15	20	84	63	0.6					
3C	17	32	7.86	14	16.5	94	70	0					
3D	5	24	7.97	10	8.5	63	26	1.9	11.34				

LOCATION	BOD	COD	ΡН	TSS	TURBIDITY	TC*100	FC*100	PRESS.	FLOW
Beside mechanical building JU									
09:30pm on	11.12.18								
4B	18	32	7.77	22	16.5	63	26	0.5	
4D	7	26	7.91	8	3.7	55	30	1.5	8.64
03:30am on	12.12.18								
5B	19	40	7.93	27	19	94	32	0.5	
5D	11	27	7.93	6	3	74	43	1-1.5	5.25
03:30pm on	12.12.18								
6A	11	44	7.74	18	9.4	120	70	0.5	
6B	17	32	7.93	16	9.3	63	26	0.5	
6D	12	29	8.01	9	2.8	41	27	1	4.57
03:30am on	13.12.18								
7A	8	38	7.81	18	9.3	84	26	0.6	
7B	7	38	7.97	15	8	40	27	0.6	
7D	4.5	22	8.02	5	2.5	38	32	1.1	3.8

Location Beside mechanical building JU	BOD	COD	рН	TSS	TURBIDITY	TC*100	FC*100	PRESS.	FLOW					
03:30pm on 13.12.18														
8A	7	38	7.76	12	9	94	49	0.6						
8B	8	39	7.95	9	4.6	49	22	0.6						
8D	5	27	7.97	4.2	2.2	31	23	1.1	1.87					
				03:30	)pm on 14.12.18									
9A	7	34	7.83	19	10.8	84	42	0.55						
9B	8	37	7.75	26	14.6	38	20	0.6						
9D	3	12	7.95	3	1.9	24	19	1.5	3.6					

# <u>Observations of PLE at JU campus besides Mechanical building for 1<sup>st</sup> cycle:-</u>

- The unit has operated with pumping for 72hrs.
- Samples are collected and iced in proper time.
- BOD and COD of raw water are found to be reduced to 38% and 43% of its original value at 0hr after Ultra filtration.
- After 72hrs of operation BOD &COD are found to be reduced to 7% &13% respectively of its original value after Ultra filtration.
- After ultra-filtration pH is found to be almost uniform with tedious variations. TSS & turbidity are found to be reduced to around 39% &41% respectively of its original value at 0hr after Ultra filtration.
- After 72hrs of operation TSS & turbidity are found to be reduced to 6% &7.30% respectively of its original value after Ultra filtration.
- TC & FC counts are found to be reduced to 60% &62% respectively of its at original value at 0hr after Ultra filtration.
- After 72hrs of operation TC & FC are found to be reduced to 18.4% &24% respectively of its original value after Ultra filtration.



Comparative analysis BOD & COD of samples collected from different outlet at initial time (0 hr).



Comparative analysis pH, TSS, turbidity of samples collected from different outlet at initial time (0 hr).



Comparative analysis TC & FC of samples collected from different outlet at initial time (0 hr).



Variation of flow rate with respect to the time of operation



Fig.15:- installation of perforated pipe



Fig.16: Condition of micro filter & ultra-filter after 3 days



Fig.17: Granulated activated carbon



Fig.18: Pressure gauge

## **Recent studies of PLE at various locations (contd.)**

## 2<sup>nd</sup>cycle in JU campus besides mechanical building

#### Site.2:-

Installation date:-18th December 2018



## **Improvisation**

This time we used perforated pipe of diameter 61cm (2ft) with perforation for a depth of 15.24cm (6 inch) at the bottom and we covered it with cloth paper. All the other conditions remain same as previous cycle on 11<sup>th</sup> December 2018.

All other conditions and instrument specifications remain same as per previous operation on 18<sup>th</sup> December 2018 to 21<sup>st</sup> December 2018.

LOCATION	BOD	COD	pН	TSS	TURBIDITY	TC*100	FC*100	PRESS.	FLOW
2 <sup>nd</sup> cycle at JU									(LPH)
				01:4	15pm on 18.12.1	.8			
1A	35	102	7.91	19	11	120	70		
1B	10	42	7.6	14	9	94	64	0.5	
1C	9	39	7.84	13	8.9	85	49	0.25	
1D	8.5	32	7.9	11	8.3	63	33	0	
1E	7	27	7.94	8	4.3	58	26	1.5	32.4
				03:4	l5pm on 18.12.1	.8			
2B	11	44	7.84	15	13.5	84	62	0.5	
2C	10.5	38	7.83	12	9	72	51	0.25	
2D	9.4	32	7.83	9	4.1	64	34	0	
2E	7	15	7.98	7	3.5	52	25	1	15.84
				05:4	l5pm on 18.12.1	.8			
3B	17	34	7.87	14	12.1	94	70	0.55	
3C	16	28	6.95	11	8.6	84	58	0.6	
3D	15	22	7.9	10	6.3	79	55	0	
3E	9	18	7.88	6		45	23	0.8	3.71

LOCATION	BOD	COD	ΡН	TSS	TURBIDITY	TC*100	FC*100	PRESS.	FLOW
2 <sup>nd</sup> cycle at JU									(LPH)
		1	1	07.45pm on	18.12.18	1	1		L
4C	11	29	7.89	16	9.8	74	42	0.6	
4E	8.4	26	7.95	6	2.9	37	16	0	2.62
				1:45am on 1	9.12.18				
5C	10	35	7.78	17	12	46	33	0.6	
5E	8.6	28	8.09	4.2	2.4	41	22	0	1
				1:45pm on 1	9.12.18				
6A	12	52	7.85	14	8.8	63	34		
6C	9	44	7.85	12	4.9	60	32	0.6	
6E	7	32	7.9	4.2	2.3	37	23	0	1
				01:45am on 1	20.12.18				
7A	9.5	42	7.21	13	8.6	64	43		
7C	10	46	7.18	12	4.9	49	38	0.7	
7E	5	22	7.81	4	2.1	33	19	0	0.94

Location	BOD	COD	pН	TSS	TURBIDITY	TC*100	FC*100	PRESS.	FLOW
2 <sup>nd</sup> cycle at									(LPH)
30									
01:45pm on 20.12.18									
8A	10	25	7.23	14	5	59	38		
8C	7.6	22	7.27	10	4	48	32	0.6	
8E	5.4	20	7.75	3.5	1.9	30	16	0-0.5	1.1
01:45pm on 21.12.18									
9A	11	27	7.41	11	3.7	52	33		
9C	8	21	7.2	8	2.2	27	21	0.7	
9E	3	14	7.53	2	1.2	24	14	0.4-0.6	3.17

# <u>Observation of PLE at JU campus besides Mechanical building for 2<sup>nd</sup> cycle:-</u>

- The unit has operated with pumping for 72hrs.
- Samples are taken at proper time and iced.
- In the 1<sup>st</sup> cycle on 11<sup>th</sup> December 2018 perforated pipe covered with cloth paper wasn't used, instead we used a pump with sludge pumping feature.
- In the 2<sup>nd</sup> cycle on 18<sup>th</sup> December 2018 we change the process and included perforated pipe and cloth filter.
- BOD and COD of raw water are found to be reduced to 20% and 26% of its original value at 0hr after Ultra filtration.
- After 72hrs of operation BOD & COD are found to be reduced to 8.57% & 13.7% respectively of its original value after Ultra filtration.
- After ultra-filtration pH is found to be almost uniform with tedious variations. TSS & turbidity are found to be reduced to around 42% & 39% respectively of its original value at 0hr after Ultra filtration.
- After 72hrs of operation TSS & turbidity are found to be reduced to 10.5% &11% respectively of its original value after Ultra filtration.
- TC & FC counts are found to be reduced to 49% &37% respectively of its at original value at 0hr after Ultra filtration.
- After 72hrs of operation TC & FC both are found to be reduced to 20% of its original value after Ultra filtration.
- As we used a pump of huge capacity nearly giving a discharge of 1400 lph, we have to bypass large volume water all the time to protect the filters from high pressure. This is indeed uneconomical. So next time we decided to use pumps with such a power so that no flow is bypassed.



Comparative analysis BOD & COD of samples collected from different outlet at initial time (0 hr).



Comparative analysis pH, TSS, turbidity of samples collected from different outlet at initial time (0 hr).



Comparative analysis TC & FC of samples collected from different outlet at initial time (0 hr).



### Variation of flow rate with respect to the time of operation



Fig.19: Perforated pipe covered with cloth filter



Fig.20: Collecting of raw sample from 1<sup>st</sup> compartment



Fig.21: Taking sample of cloth filter



Fig.22: PLE machine

## Installation at JU staff quarter

## Arrangements of PLE at JU staff quarter

- Perforated pipe covered with cloth filter is used. Submersible pump is kept inside the perforated pipe. It is rested on 1ft (30.48 cm) above the bottom portion of the tank of depth 1.82 m (6ft) which is filled up to 0.92 m (3ft) with sewage water.
- Septic tank is of dimension of length 6.1m (20ft), breath 1.82 m (6ft) and depth 1.82m(6ft)

It has a volume of 20.20 m<sup>3</sup> and has user of 70 persons (approx).

- Water extracted from the pit enters in to the micro filter. Then it passes through activated carbon and finally through ultrafiltration.
- This pattern flow of water (Micro filter to Activated Carbon to Ultra filter) continues.

## **Material specification**

#### Submersible pump:

220V, 40Watt, 3m head, flow-2000lph

#### **Booster pump:**

Flow-75 GPD, 220V

### Micro filter:

0.45 micron pore size, length-50.8cm (20 inch)

### GAC:

Iodine value- 600IV, length-50.8cm (20inch)

### Ultrafilter:

Flow-25lph, 0.01 micron pore size, length- 25.4cm (10inch)



Fig.23: Submersible pump



Fig.24: Booster pump

## **Parameters measured**

A- Raw sample.
B-Sample after cloth filter
C- Sample after micro filter.
D-Sample after GAC
E-Sample after ultrafiltration
BOD, COD, pH, total suspended solids (TSS) measured in <u>mg/litre.</u>
Turbidity measured in <u>NTU.</u>
Number of Total Coliform (TC) & Faecal Coliform (FC) are in the order of <u>100.</u>
Pressure Gauge reading is in <u>kg/cm<sup>2</sup></u>
Flow measured in litre per hour



Fig.25: JU staff quarter



Fig.26: Installation of PLE


Fig.27: Perforated pipe



Fig.28: Pressure gauge



Fig.29: Perforated pipe after 3days of operation



Fig.30: Sampling at night

LOCATION	BOD	COD	pН	TSS	TURBIDITY	TC*100	FC*100	PRESS.	FLOW		
JU staff quarter									(LPH)		
02:00pm(0hr) on 14.02.19											
1A	132	281	7.31	137	146	940	700				
1B	125	266	7.41	67	118	630	330	0	108		
1C								0	1.38		
1E	48	98	7.75	19	30.9	79	27		12.8		
04:00pm(2hr) on 14.02.19											
2B	130	276	7.55	135	142	700	260	0	105.5		
2C	101	252	7.84	114	62	390	220	0	3.84		
2E	39	88	7.55	15	12	34	22		12		
06:00pm(4hr) on 14.02.19											
3B	143	205	7.51	117	123.2	400	240	0	104.34		
3C	97	145	7.62	75	8.7	250	130	0	4.14		
3E	28	77	7.43	12	6.4	17	11		10.2		

LOCATION	BOD	COD	ΡН	TSS	TURBIDITY	TC*100	FC*100	PRESS.	FLOW			
JU STAFF QUARTER									(LPH)			
08:00pm(6hr) 14.02.19												
4E	35	87	7.57	21	16.1	20	17		9.25			
02:00am(12hr) 15.02.19												
5E	20	55	7.45	12	12.5	34	27		8.82			
			02	2:00pm	(24hr) on 15.0	2.19						
6A	122	230	7.48	152	44.3	940	700					
6E	20	58	7.56	12	10.5	21	21 13		4.37			
			02	2:00am	(36hr) on 16.0	2.19						
7A	114	233	7.56	139	110	170	110					
7E	25	64	4 7.6 12		14	21	14		3.6			
				02:00p	m(48hr) 16.02	.19						
8A	94	150	7.54	116	88	330	270					
8E	33 87 7.52		7.52	22	9.2	54	36		2.82			
	•	•		02:00p	m(72hr) 17.02	.19						
9A	95	95 192 7.51		97	21.7	340 270						
9E	19 54		7.59	25	7.7	21	17		2.5			

## **Observation of PLE at JU staff quarter location:-**

- The unit has operated with pumping for 72hrs.
- Micro filtration unit got choked after 8hrsof operation and hence could not function beyond that.
- There was no flow through GAC from the beginning.
- Pressure gauge fitted after booster pump was found to be fluctuating during the operation.
- BOD and COD of raw water are found to be reduced to 36% and 35% of its original value at 0hr after Ultra filtration.
- After 72hrs of operation BOD & COD are found to be reduced to 14.4% & 19.2% respectively of its original value after Ultra filtration.
- After ultra-filtration pH is found to be almost uniform with tedious variations. TSS & turbidity are found to be reduced to around 13.8% & 21.1% respectively of its original value at 0hr after Ultra filtration.
- After 72hrs of operation TSS & turbidity are found to be reduced to 18.5% & 5.25% respectively of its original value after Ultra filtration.
- TC & FC counts are found to be reduced to 8.4% & 3.8% respectively of its at original value at 0hr after Ultra filtration.
- After 72hrs of operation TC & FC are found to be reduced to 2.20% and 2.4% respectively of its original value after Ultra filtration.



Comparative analysis BOD & COD of samples collected from different outlet at initial time (0 hr).



Comparative analysis pH, TSS, turbidity of samples collected from different outlet at initial time (0 hr).



Comparative analysis TC & FC of samples collected from different outlet at initial time (0 hr).



Variation of flow rate with respect to the time of operation

## Installation at Survey park

#### Arrangements of PLE at Survey park

- Perforated pipe covered with cloth filter is used. Submersible pump is kept inside the perforated pipe. It is rested on 20cmabove the bottom portion of the tank of depth 1.2m (4ft) which is filled up to 0.91m (3ft) with sewage water.
- Septic tank is of dimension length 3m(10ft),breath 1.35m (4.5ft) and depth 1.2m(4ft).It has a volume of 4.86m<sup>3</sup> and has a user of five.
- Water extracted from the pit enters into the micro filter. Then it passes through activated carbon and finally through ultra-filter.
- This pattern flow of water (Micro filter to Activated Carbon to Ultra filter) continues.

### **Material specification**

#### Submersible pump:

220V, 40 Watt, 3 m head, flow-2000 lph

#### **Booster pump:**

Flow-75 GPD, 220V

#### Micro filter:

0.45 micron pore size, length- 50.8cm (20 inches)

#### GAC:

Iodine value- 600 IV, length-50.8 cm (20 inch)

#### Ultra-filter:

Flow-25 lph, 0.01 micron pore size, length- 25.4 cm (10 inch)



Fig.31: Submersible pump



Fig.32: Booster pump

## **Parameters measured**

A- Raw sample.
B-Sample after cloth filter
C- Sample after micro filter.
D-Sample after GAC
E-Sample after ultrafiltration
BOD, COD, pH, total suspended solids (TSS) measured in mg/litre.
Turbidity measured in NTU.
Number of Total Coliform (TC) & Faecal Coliform (FC) are in the order of 100.
Pressure Gauge reading is in kg/cm<sup>2</sup>
Flow measured litre per hour.

LOCATION	BOD	COD	pН	TSS	TURBIDITY	TC*100	FC*100	PRESS.	FLOW		
Survey park									(LPH)		
08:00am(0hr) on 25.02.19											
1A	96	208	7.42	112	128	420	330				
1B	82	187	7.77	80	82	380	310	0	540		
1C	70	146	7.62	57	67	210	180	0	495		
1D	44	97	7.53	49	54	36	21	0	8.18		
1E	34	72	7.84	23	25	31	19	1.6	13.71		
10:00am(2hr) on 25.02.19											
2B	78	167	7.34	63	98	390	240	0	350		
2C	62	146	7.68	51	74	320	180	0	310		
2D	58	125	7.72	43	63	52	41	0	2.32		
2E	36	47	7.45	20	28	32	25	1.6	11.3		
12:00pm(4hr) on 25.02.19											
3B	82	174	7.66	58	97	390	230	0	326		
3C	69	143	7.43	48	69	310	190	0	272		
3D	60	138	7.49	40	52	51	42	0	1.46		
3Е	40	82	7.82	33	25	40	31	2.5	8.6		

LOCATION	BOD	COD	рН	TSS	TURBIDITY	TC*100	FC*100	PRESS.	FLOW
SURVEY PARK									LPH
	<u> </u>	I		02:00p	om(6hr) on 25.02.	19	I	I	
4D	56	119	7.19	33	50	32	20	0	0.6
4E	36	80	7.36	14	25	27	18		7.81
08:00pm(12hr) on 25.02.19									
5D	NO FLOW THROUGH GAC								
5E	35	61	7.34	21	22	26	15		3.4
	-		(	)8:00ai	m(24hr) on 26.02.	.19			
6E	32	70	7.68	19	26	27	19		3.13
			0	)8:00pi	m(36hr) on 26.02.	.19			
7E	32	62	7.58	14	22	27	18		2.73
08:00am(48hr) on 27.02.19									
8E	30	72	7.82	19	22	24	19		2.68
			(	)8:00ai	m(72hr) on 28.02.	.19	-		
9E	28	64	7.41	17	20	18	11		2.4

## **Observation of PLE at Survey park location**

- The unit has operated with pumping for 72hrs.
- Micro filtration unit got choked after 48hrsof operation and hence could not function beyond that.
- GAC unit got choked after 7hrs of operation and hence could not function beyond that.
- Pressure gauge fitted after booster pump was found to be fluctuating during the operation.
- BOD and COD of raw water are found to be reduced to 35% and 34% of its original value at 0hr after Ultra filtration.
- After 72hrs of operation BOD & COD are found to be reduced to 29.1% & 30.7% respectively of its original value after Ultra filtration.
- After ultra-filtration pH is found to be almost uniform with tedious variations. TSS & turbidity are found to be reduced to around 20.5% & 19.5% respectively of its original value at 0hr after Ultra filtration.
- After 72hrs of operation TSS & turbidity are found to be reduced to 15% & 15.6% respectively of its original value after Ultra filtration.
- TC & FC counts are found to be reduced to 7.3% & 5.75% respectively of its at original value at 0hr after Ultra filtration.
- After 72hrs of operation TC & FC are found to be reduced to 4.30% and 3.3% respectively of its original value after Ultra filtration.



Comparative analysis BOD & COD of samples collected from different outlet at initial time (0 hr).



Comparative analysis pH, TSS, turbidity of samples collected from different outlet at initial time (0 hr).



Comparative analysis TC & FC of samples collected from different outlet at initial time (0 hr).



Variation of flow rate with respect to the time of operation of



Fig.33: Ultra filter



Fig.34: Perforated pipe & cloth filter after three days of operation



Fig.35: Removing old GAC after three days of operation



Fig.36: Installing new GAC



Fig.37: Micro filter



Fig.38: Old ultra-filter after three days of operation



Fig.39: covering new cloth filter on perforated pipe



Perforated pipe covered with cloth filter

Fig.40:



Fig.41: Installing machine at Survey park



Fig.42: Machine was covered due to heavy rain



Fig.43: Sampling at night



Fig.44: Perforated pipe after three days of operation

Raw Sample	BOD	COD	pН	TSS	Turbidity	TC	FC
	(mg/l)	(mg/l)		(mg/l)	(NTU)	(MPN per 100 ml)	(MPN per 100 ml)
1 <sup>st</sup> cycle at 12/12 bireswardhol lane baranagar	60	97	7.91	57	39	30000	210000
2 <sup>nd</sup> cycle at 12/12 bireswardhol lane baranagar	105	174	7.88	42	18	2800	2200
1 <sup>st</sup> cycle at JU campus	39	88	7.72	46	26	13000	7900
2 <sup>nd</sup> cycle at JU campus	35	102	7.91	19	11	12000	7000
Operation at JU staff quarter	132	281	7.31	137	146	94000	70000
Operation at survey park	96	208	7.42	112	128	42000	33000

Characteristics of raw samples of septic tanks

Treated	BOD	COD	pН	TSS	Turbidity	TC	FC
effluent	(mg/l)	(mg/l)		(mg/l)	(NTU)	(MPN per 100 ml)	(MPN per 100 ml)
1 <sup>st</sup> cycle at 12/12 bireswardhol lane baranagar	64	105	8.07	32	12.4	27000	22000
2 <sup>nd</sup> cycle at 12/12 bireswardhol lane baranagar	19	40	8.16	6	1.9	1200	1000
1 <sup>st</sup> cycle at JU campus	3	12	7.95	3	1.9	2400	1900
2 <sup>nd</sup> cycle at JU campus	3	14	7.53	2	1.2	2400	1400
Operation at JU staff quarter	19	54	7.59	25	7.7	2100	1700
Operation at Survey park	28	64	7.41	17	20	1800	1100

# Characteristics of effluents after filtration

## **STUDY TEAM**

- Prof (Dr) Asis Mazumdar.
- Prof (Dr)Arunabha Majumder.
- Prof(Dr) Pankaj Kumar Roy.
- Dr. ArunKanti Biswas.
- Dr. Gourab Banerjee .
- Mr. Anirban Ghosh.