India Field Testing of an Integrated Sanitation Platform with Electronic Public Toilet (eToilet) and Off-grid Anaerobic Membrane Bioreactor (NEWgenerator)

Robert Bair & Midhu S.V.,

J. Calabria, O. Ozcan, W. Sutton, P. Zydek, D.H. Yeh

University of South Florida & Eram Scientific Solutions

Slum Sanitation

- Dependence on communal toilets
- High density and land value
- Compact treatment technology needed
- Low infrastructure coverage

Project Goal

Field testing of off-grid sanitation and resource recovery platform

International Faecal Sludge Management Conference

International Convention Centre, Durban, South Africa

29-31 October 2012

Eram Scientific

USF

NEWGENERATOR

Clean water

Fertilizer

FSM4

Front End: eToilet

- Indian company
- Focused on improved sanitation through automation
- Over 2100+ units installed throughout India
- Automated eToilets with remote monitoring capabilities

Back End: NEWgenerator

- Decentralized, onsite
- Safely processes wastes
- Modular & Off-Grid
- Compact design
- Water recycling

Pilot Design

Funding through Reinvent the Toilet Challenge India

- Coupled with 2 eToilets
- Designed for 100 uses/day
- Completely off-grid
- Onsite water recovery

Features of eToilet

- Easy to Install and Service
- Solar Powered System
- Stainless Steel Closet with SS Floor
- Remote monitoring
- Self-cleaning
- Ceiling light & exhaust fan
- Sensor enabled water saving design

NEWgenerator Construction

USF

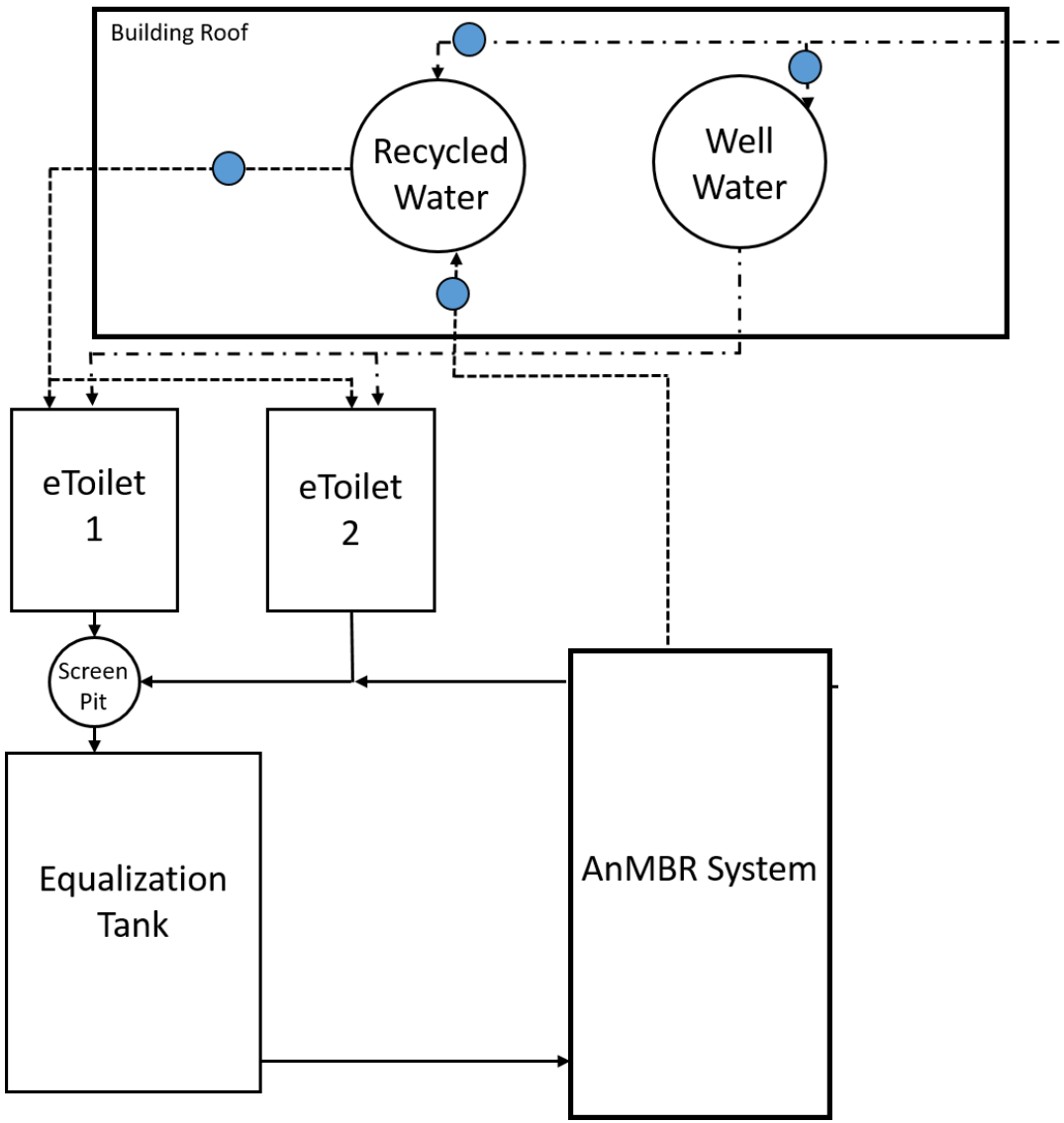
FSM4

Location

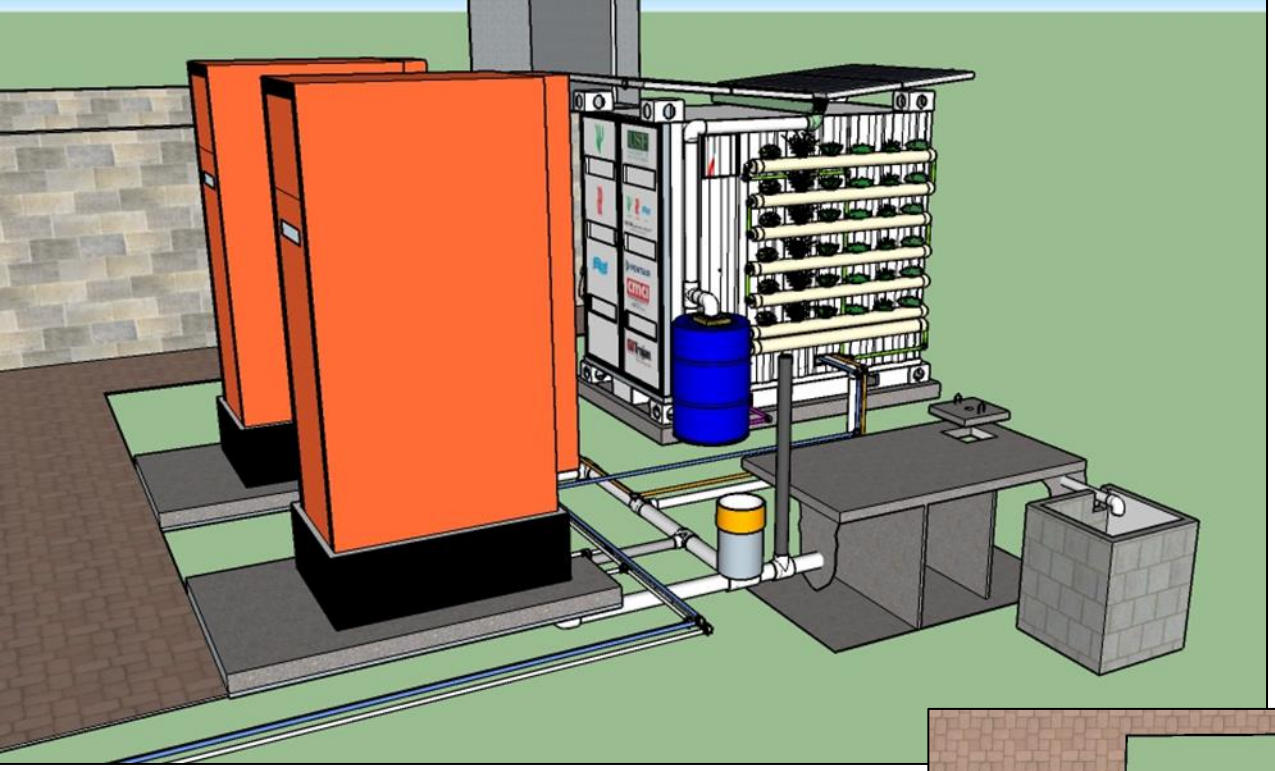
- Pulluvila, Kerala (South India)
- Coastal community
- School with approx. 1500 students
  + usage by local community

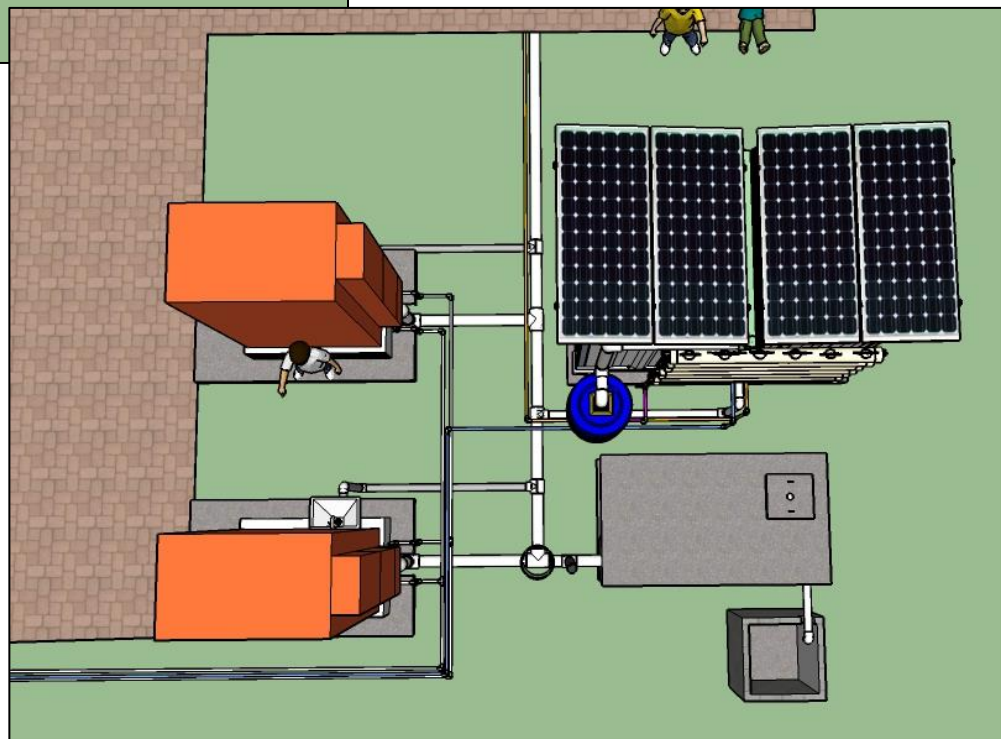
Installation and Interfacing

Site Layout


Building Roof
School Well
Recycled Water
Well Water
eToilet 1
eToilet 2
Screen Pit
Equalization Tank
AnMBR System

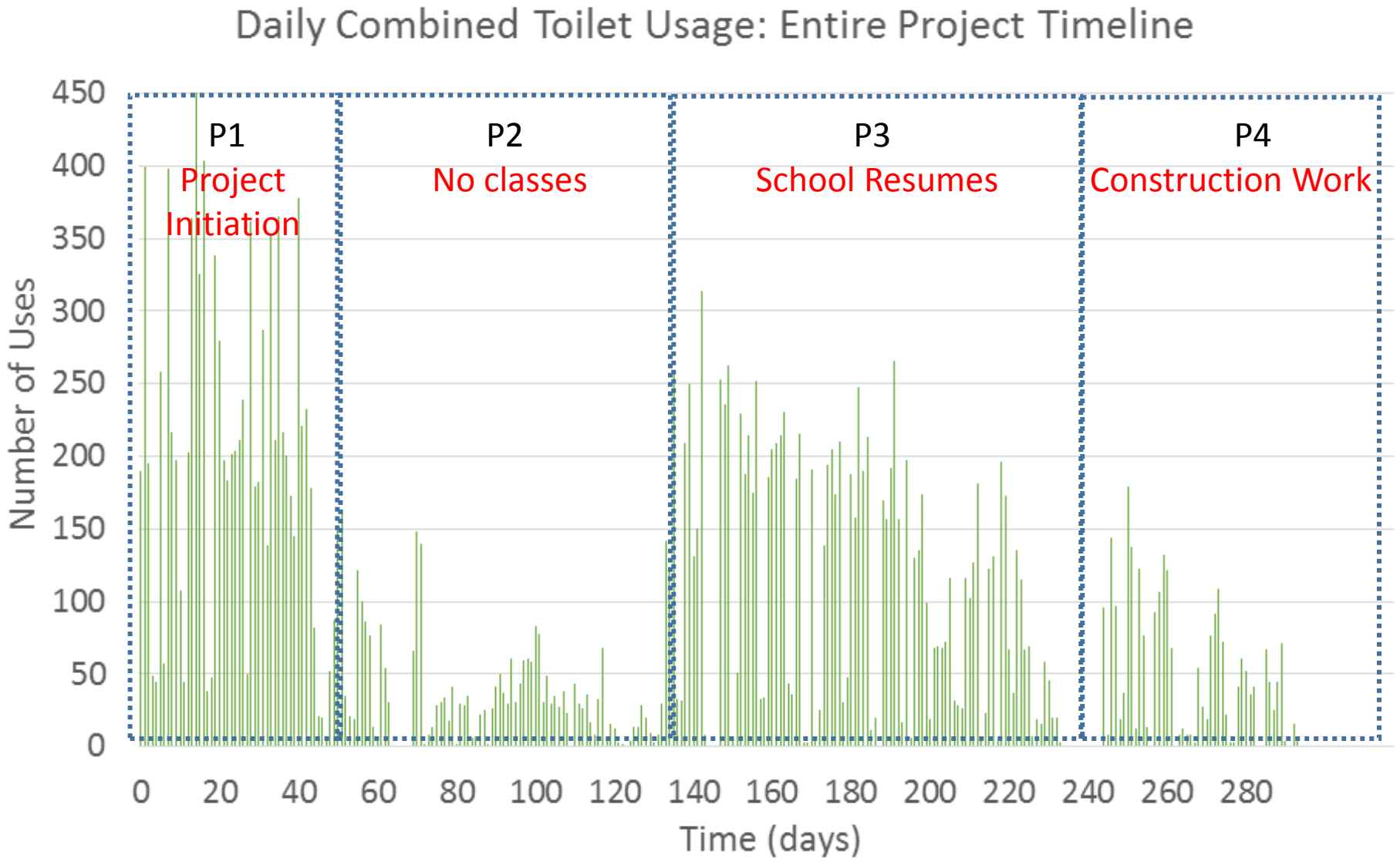
Eram Scientific
eToilet



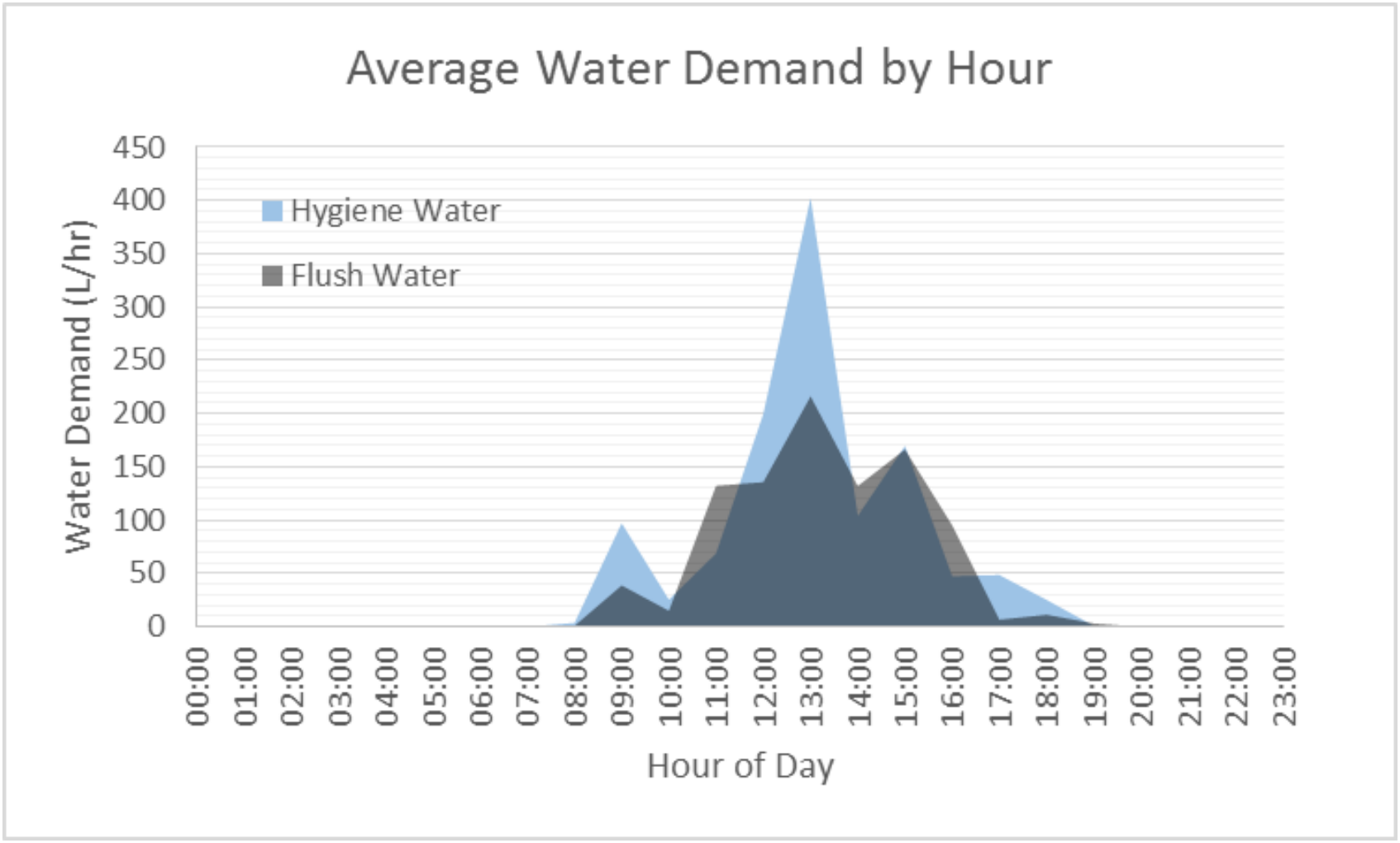


System Usage

#Uses	P1	P2	P3	P4
Avg.	220	47	120	40
Max	454	163	314	179

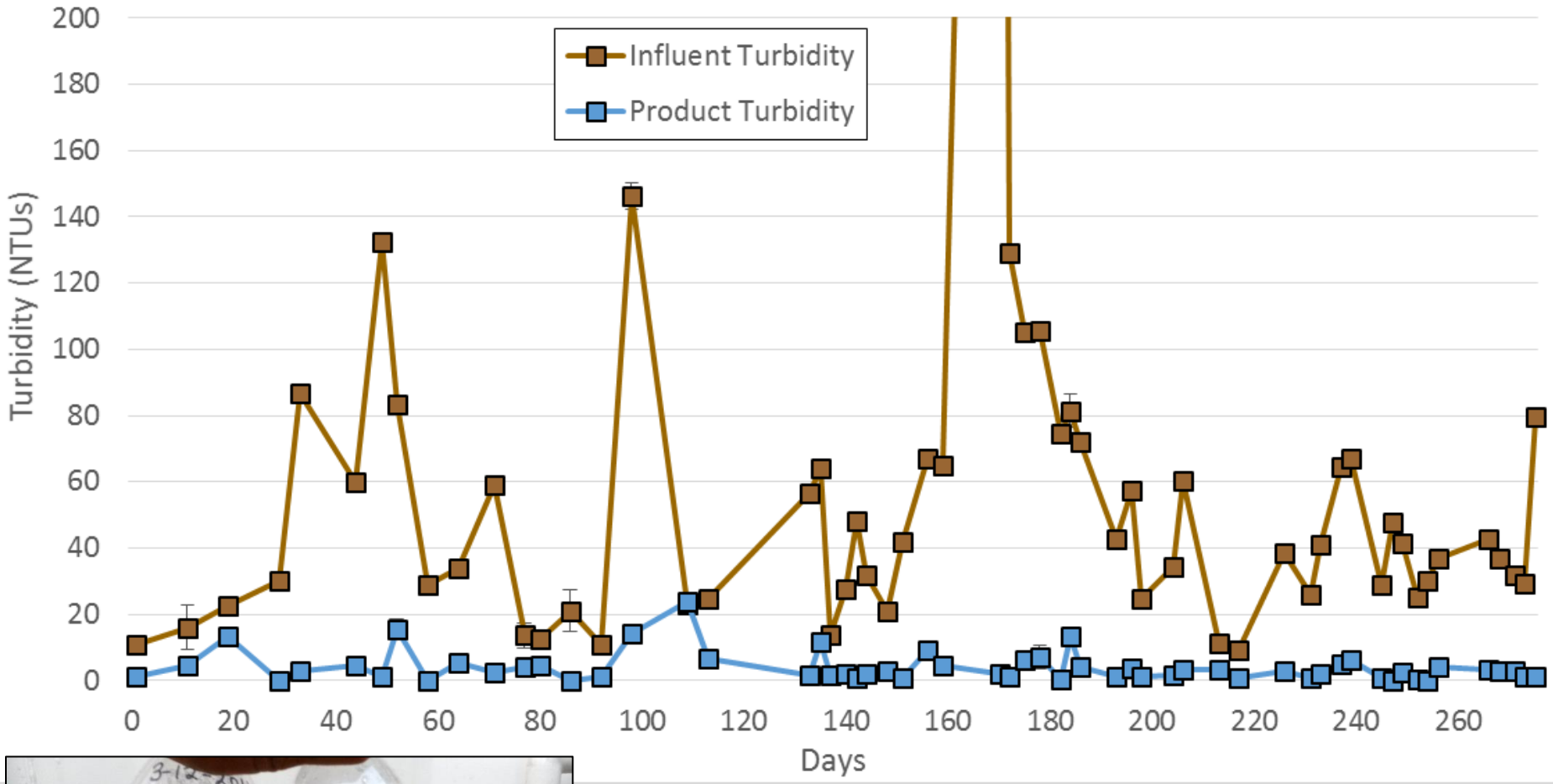


Flow Data

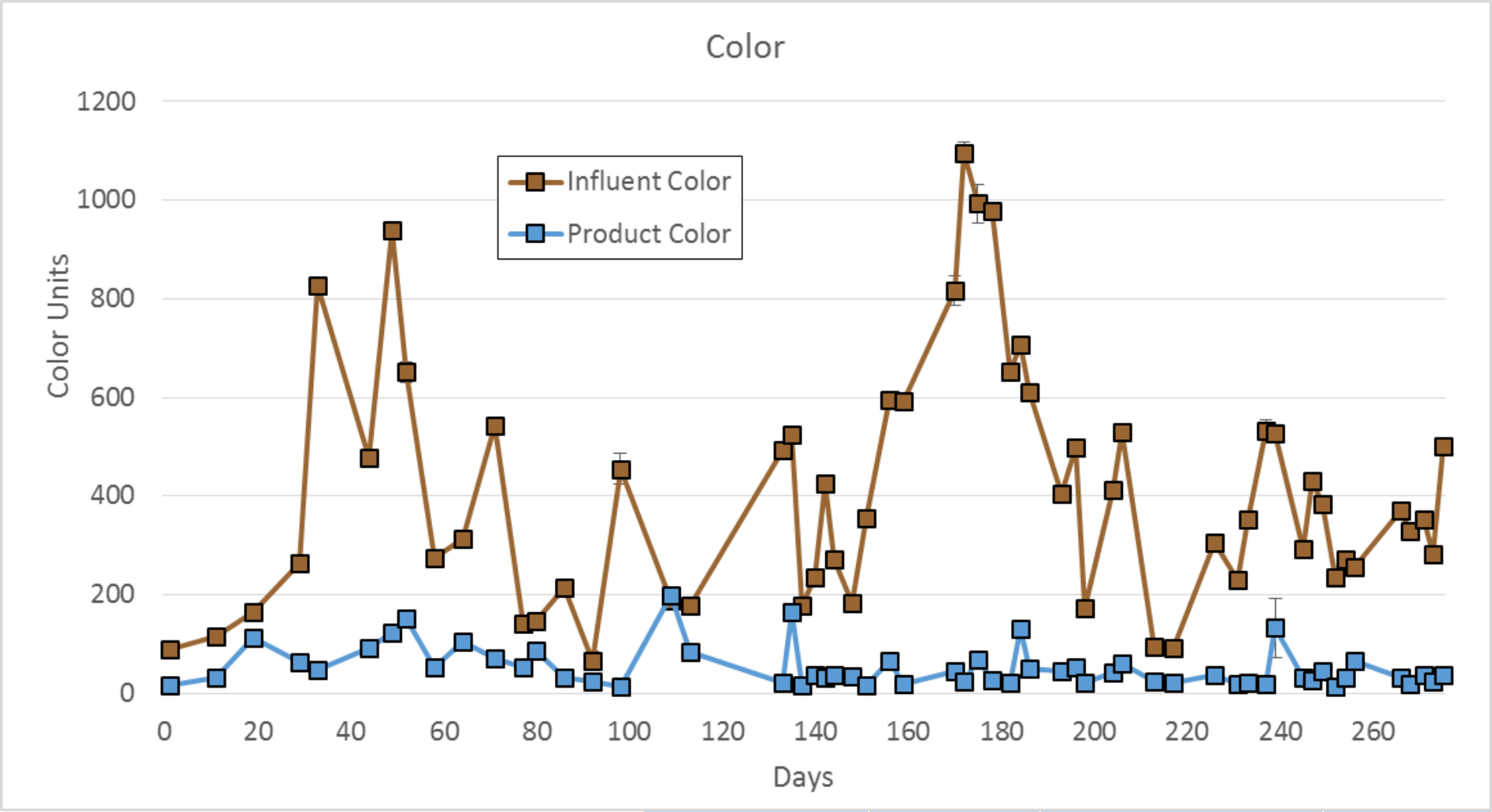


34% of avg. daily hygiene water demand in 1 hr

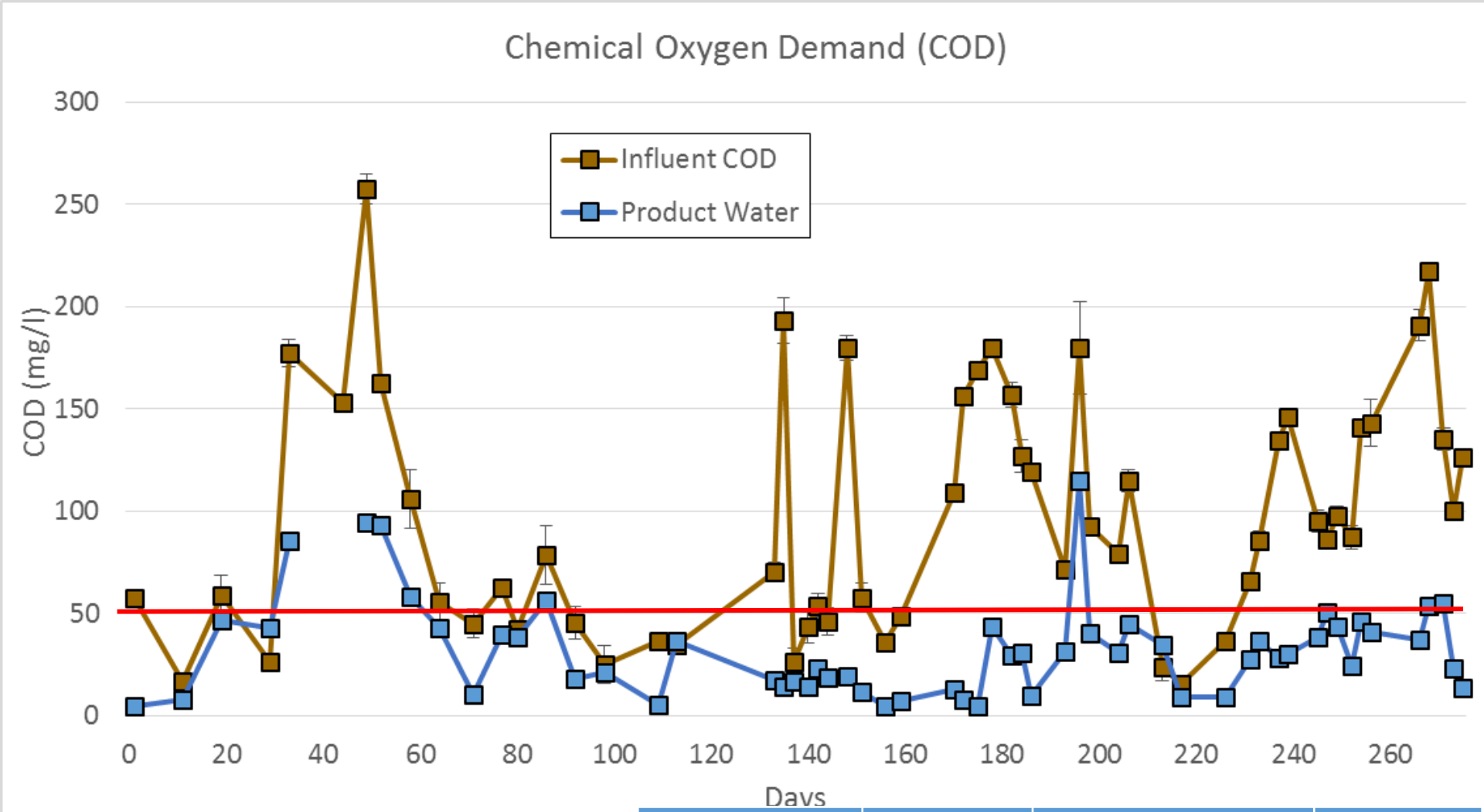
23% of avg. daily flush demand during in 1 hr



Parameter	Influent	Post Membrane	Product
Avg.	60	14	4
% Removal			**91**
Max	725	80	24



Parameter	Influent	Post Membrane	Product
Avg.	407	132	52
% Removal			**85**
Max	1096	479	197



*Average removal throughout trial period. When influent COD increases above 100 mg/L – the removal increases to 86%

Parameter	Influent	Post Membrane	Product
Avg.	98	38	32
% Removal			**72%***
Max	258	86	107

System Pilot: Pulluvila, Kerala

- Operated in 2016
- Successful integration of two technologies
- Off-grid operation
- Water recycling

Lessons Learned

- High seasonal and flow variability
- Low strength wastewater in institutional settings
- Integrated system capable of operating off-grid
- High quality water production from integrated system
- System meets many of the criteria for slum implementation

Acknowledgements:

BILL & MELINDA GATES foundation

birac
Ignite Innovate Incubate

Additional Contact Info:

Robert Bair
USF, Technical Lead
rbair@mail.usf.edu

Midhu S.V.
ESS, R&D Manager
midhu@eramscientific.com

FSM4

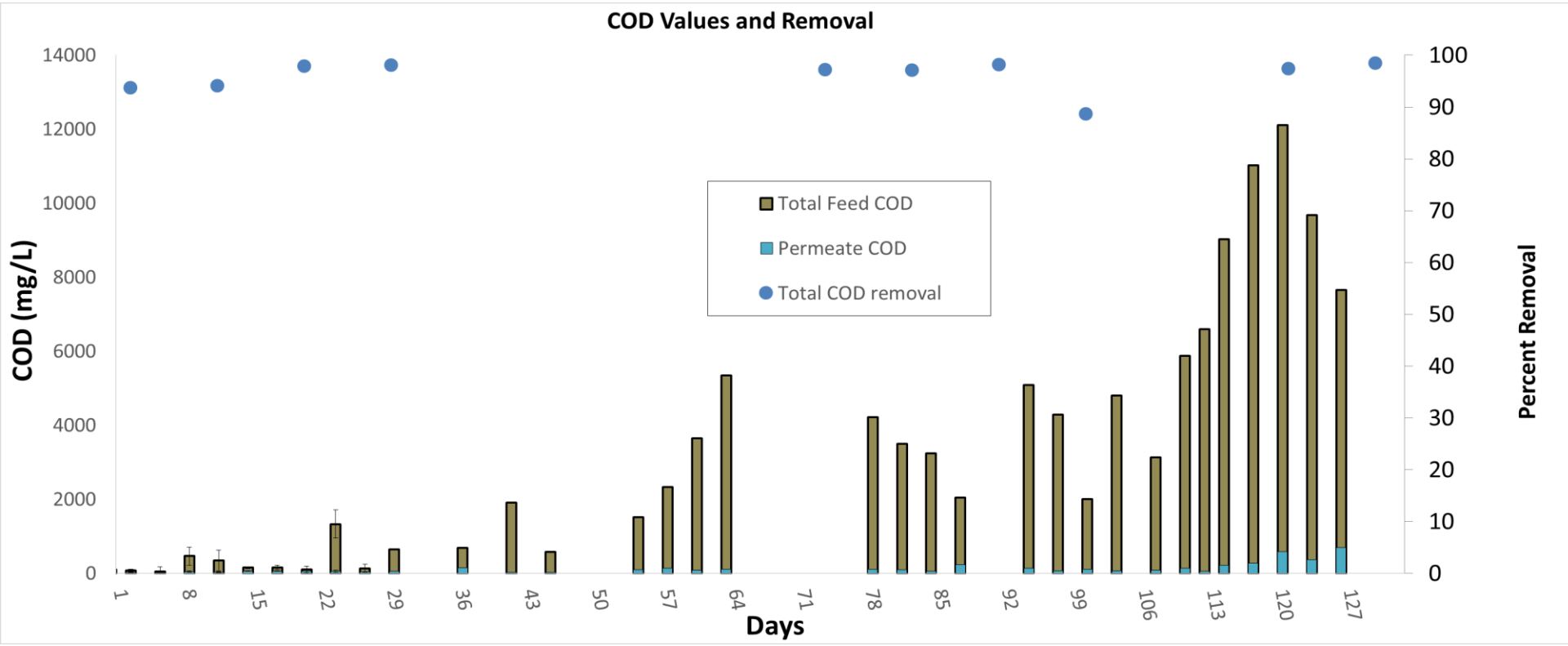
FSM4

Highlighted Challenges: Anaerobic MBR

Remaining Challenges:

- Enhancing permeate polishing for optimized ammonium and residual organics removal (improve energy and performance)
- Further miniaturization / process intensification– footprint reduction
- Beneficial small-scale biogas utilization (e.g., fuel cell for direct conversion to electricity)
- Testing over wide range of conditions (wastewater and fecal sludge characteristics, cultural and site conditions)

COD: Comparisons



COD Ramp up in a smaller-scale unit in Tampa, Fl. 150 mg/l – 12,000 mg/l COD

External Testing

Testing conducted by the Dept. of Environmental Technology, CSIR-NIIST.

Date	Fecal Coliforms (CFU/ml)		BOD (mg/l)	
	Influent	Product	Influent	Product
6/4/2016	$1.12*10^4$	ND[1]	N/A	N/A
22/4/2016	$2.98*10^4$	ND[1]	26	ND[1]
13/5/2016	$7.1*10^2$	ND[1]	37	ND[1]
22/6/ 2016	$1.2*10^2$	ND[1]	41	ND[1]
29/6/2016	$1.8*10^4$	ND[1]	28	ND[1]
13/7/2016	$1.9*10^3$	ND[1]	28	2.2
29/7/2016	$2.2*10^2$	ND[1]	26	ND[1]
12/8/2016	$2.11*10^4$	ND[1]	26	ND[1]
19/8/2016	$7.1*10^3$	ND[1]	18	ND[1]
30/8/2016	$4.92*10^3$	ND[1]	17	ND[1]
21/9/2016	$2.61*10^3$	ND[1]	38	ND[1]
5/10/2016	$1.28*10^5$	ND[1]	N/A	N/A
14/10/2016	$7.88*10^3$	ND[1]	24	ND[1]
21/10/2016	8.7*103	ND1	36	ND[1]

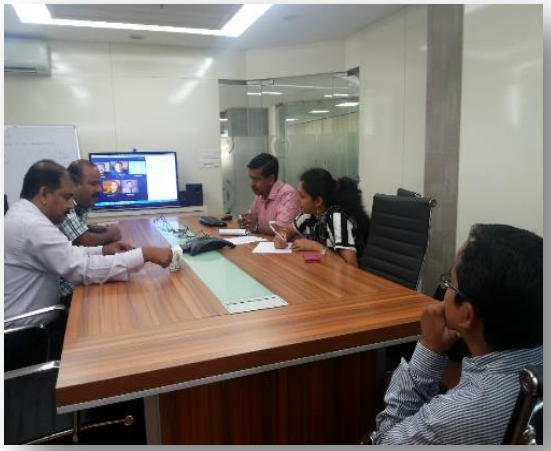
ND1: Non detection – Parameters were below the detection limit of the respective test.

N/A: Not applicable – Parameter was not tested for that particular sample date.

Pending: Awaiting values from external lab

Project Phases

Site Prep and Project Initiation



2. eToilet Design and Development-Data analysis, requirement specification finalization, Feasibility study design and development, modules procurement and testing, design validation, approval for production.

6.Integrated System Testing Using Real Wastewater and Ambient Conditions-Integrated system testing using recycling of treated water, testing of product water with all necessary parameters , eToilet functional study and refinements.

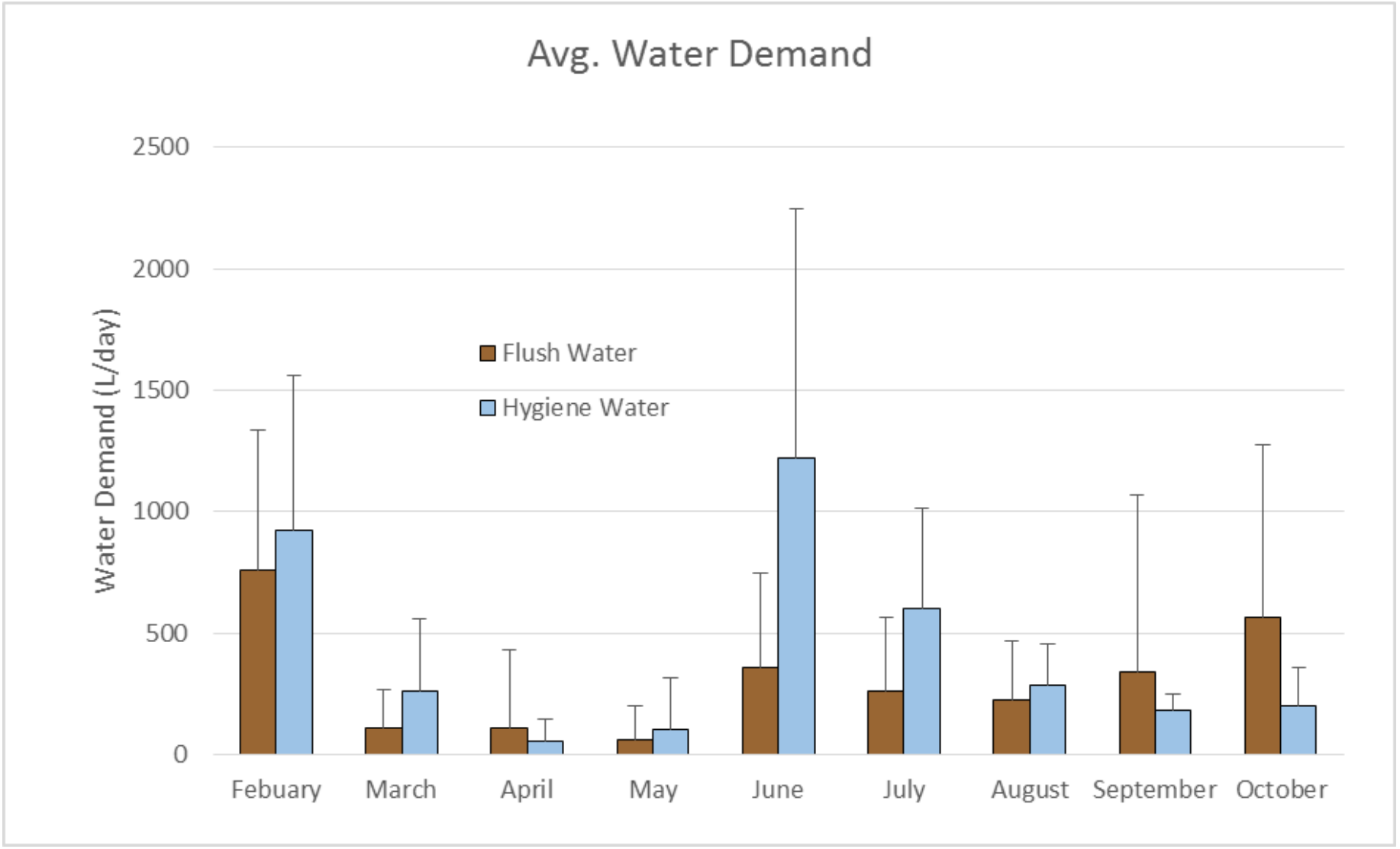
7.User Feedback and Education

8.Lifecycle Cost Analysis of Membrane System- In progress

9.Design Improvement and Manufacturing Docs-Improvements and refinements in eToilet and NEWgenerator- In progress

10.Completion of final report-Documentation in various data collection and testing reports – in progress

Flow Data


Avg. Water Demand
Water Demand (L/day)
2500
2000
1500
1000
500
0
Flush Water
Hygiene Water
Febuary
March
April
May
June
July
August
September
October