Co-treatment of Faecal Sludge and Sewage at STPs : India Experience

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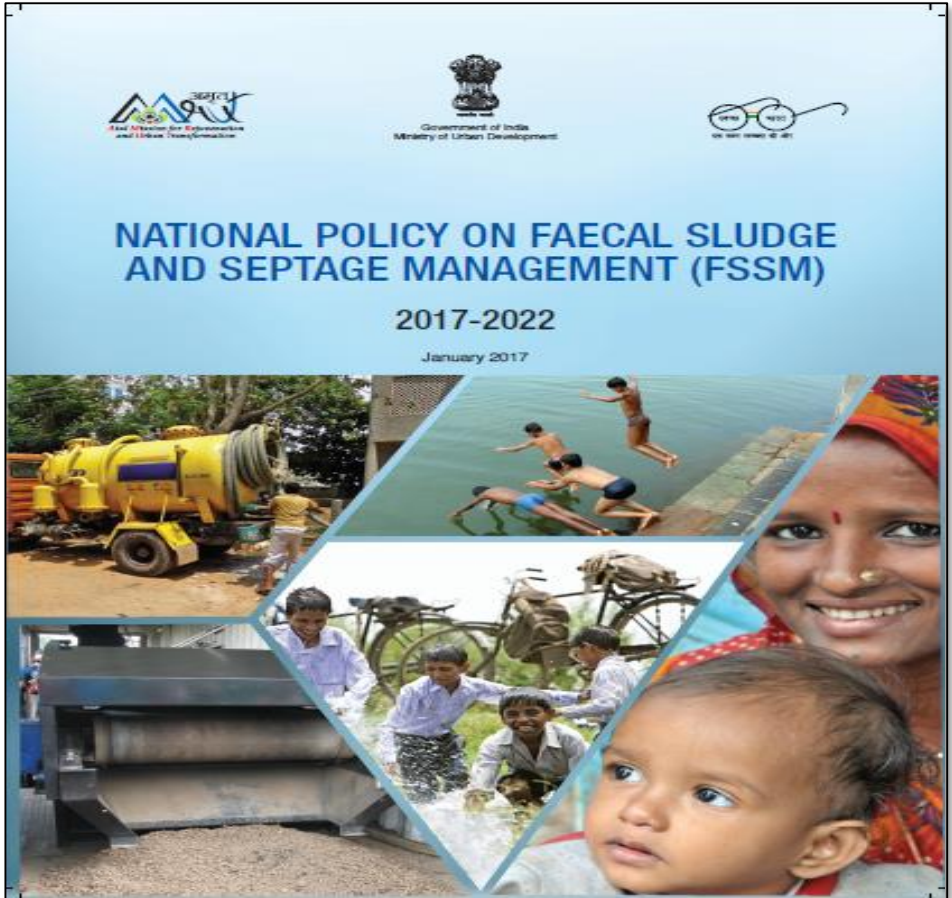
Definition

Combined treatment of faecal sludge at a functional Sewage treatment plant (STP) designed for WW treatment

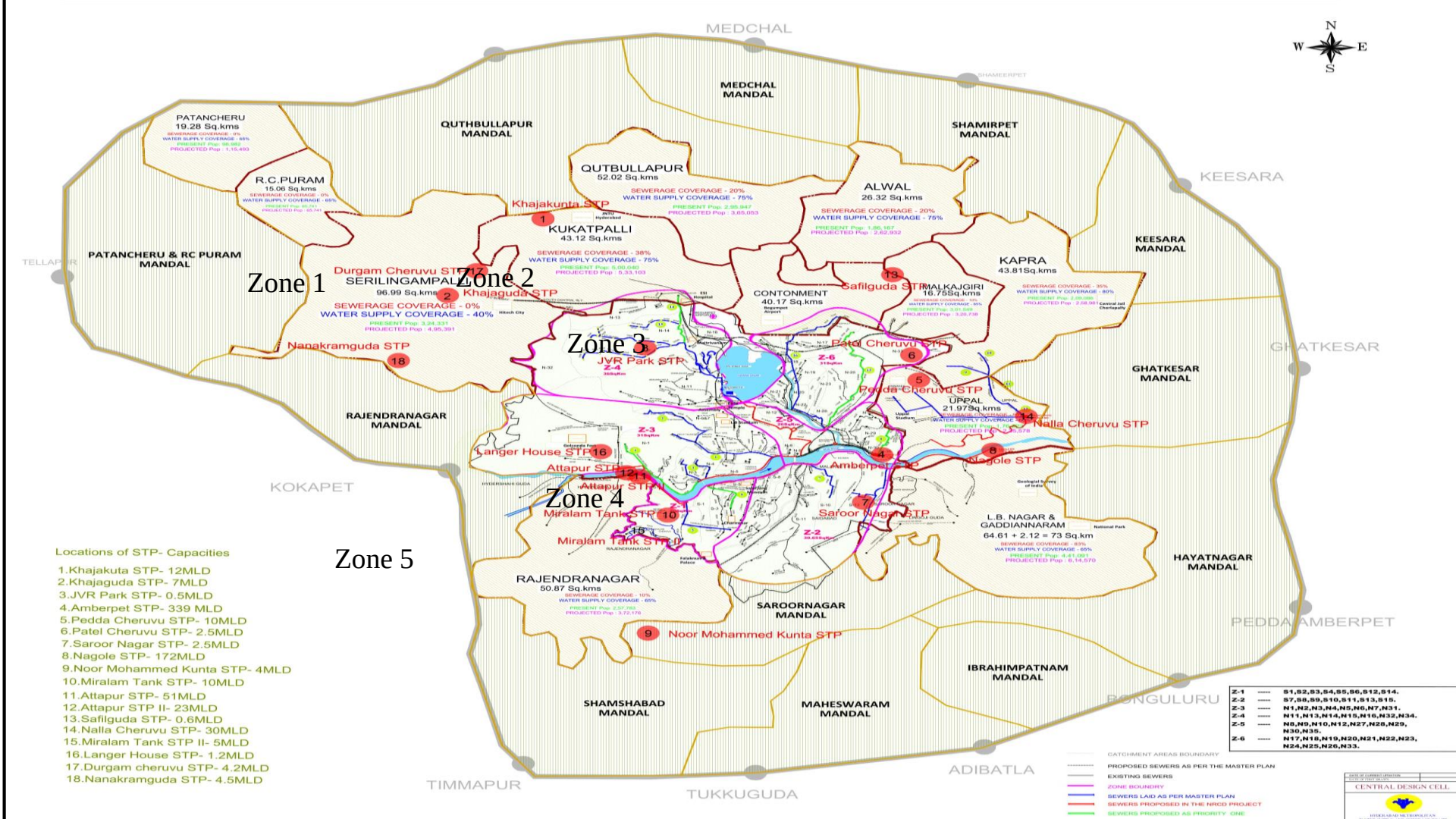
Policy context

- Policy on FSSM of GOI encourages co-treatment
- CPHEEO manual on sewerage and sewage treatment provides broad guidance on co-treatment



Why Cities are considering co-treatment as an option?

- Under utilization of existing STP infrastructure in major cities
  - Over 800 functional STPs in major cities in India
- Non availability of network
- Challenges in procuring land for FSTPs
- Additional cost for establishing FSTPs
- Urgency in addressing public health and environmental incidents


MEDCHAL
MEDCHAL MANDAL
QUTHBULLAPUR MANDAL
SHAMIRPET MANDAL
KEESARA
PATANCHERU
19.28 Sq.kms
R.C.PURAM
15.06 Sq.kms
QUTBULLAPUR
52.02 Sq.kms
SEWERAGE COVERAGE - 20%
WATER SUPPLY COVERAGE - 75%
ALWAL
26.32 Sq.kms
SEWERAGE COVERAGE - 20%
WATER SUPPLY COVERAGE - 75%
Khajakunta STP
1
KUKATPALLI
43.12 Sq.kms
KEESARA MANDAL
PATANCHERU & RC PURAM MANDAL
Zone 1
Zone 2
Durgam Cheruvu STP
SERILINGAMPALLY
96.99 Sq.kms
2
Khajaguda STP
SEWERAGE COVERAGE - 0%
WATER SUPPLY COVERAGE - 40%
CONTONMENT
40.17 Sq.kms
13
Safilguda STP
MALKAJGIRI
16.75Sq.kms
KAPRA
43.81Sq.kms
Nanakramguda STP
18
Zone 3
JVR Park STP
Z-4
Patel Cheruvu STP
6
Z-6
GHATKESAR
GHATKESAR MANDAL
Pedda Cheruvu STP
5
UPPAL
21.97Sq.kms
14
Nalla Cheruvu STP
RAJENDRANAGAR MANDAL
Z-3
Z-5
Langer House STP
16
Attapur STP
12
11
Attapur STP II
Amberpet STP
4
8
Nagole STP
KOKAPET
Zone 4
Miralam Tank STP
10
Saroor Nagar STP
7
L.B. NAGAR & GADDIANNARAM
64.61 + 2.12 = 73 Sq.km
Z-2
Miralam Tank STP II
15
HAYATNAGAR MANDAL
RAJENDRANAGAR
50.87 Sq.kms
SAROORNAGAR MANDAL
PEDDA AMBERPET
9
Noor Mohammed Kunta STP
IBRAHIMPATNAM MANDAL
Zone 5
SHAMSHABAD MANDAL
MAHESWARAM MANDAL
RANGULURU
ADIBATLA
TIMMAPUR
TUKKUGUDA
N
W
E
S
Locations of STP- Capacities
1.Khajakuta STP- 12MLD
2.Khajaguda STP- 7MLD
3.JVR Park STP- 0.5MLD
4.Amberpet STP- 339 MLD
5.Pedda Cheruvu STP- 10MLD
6.Patel Cheruvu STP- 2.5MLD
7.Saroor Nagar STP- 2.5MLD
8.Nagole STP- 172MLD
9.Noor Mohammed Kunta STP- 4MLD
10.Miralam Tank STP- 10MLD
11.Attapur STP- 51MLD
12.Attapur STP II- 23MLD
13.Safilguda STP- 0.6MLD
14.Nalla Cheruvu STP- 30MLD
15.Miralam Tank STP II- 5MLD
16.Langer House STP- 1.2MLD
17.Durgam cheruvu STP- 4.2MLD
18.Nanakramguda STP- 4.5MLD
Z-1 ----- S1,S2,S3,S4,S5,S6,S12,S14.
Z-2 ----- S7,S8,S9,S10,S11,S13,S15.
Z-3 ----- N1,N2,N3,N4,N5,N6,N7,N31.
Z-4 ----- N11,N13,N14,N15,N16,N32,N34.
Z-5 ----- N8,N9,N10,N12,N27,N28,N29, N30,N35.
Z-6 ----- N17,N18,N19,N20,N21,N22,N23, N24,N25,N26,N33.
CATCHMENT AREAS BOUNDARY
PROPOSED SEWERS AS PER THE MASTER PLAN
EXISTING SEWERS
ZONE BOUNDRY
SEWERS LAID AS PER MASTER PLAN
SEWERS PROPOSED IN THE NRCD PROJECT
SEWERS PROPOSED AS PRIORITY ONE
CENTRAL DESIGN CELL

Unsafe disposal practices

Why Cities are considering co-treatment as an option?

- Parameters of Faecal sludge and sewage are more or less same
  - Solids, COD, BOD, VOC, Nutrients, Pathogens etc

- High concentration – FS is 10 to 100 times concentrated (Median – 60)
  - Especially suspended /dissolved solids

Table 1: Characteristics of faecal sludge and comparison with tropical sewage. (Adapted from: Heinss et al., 1998, p. 4)

	Public Toilet Sludge	Septage	Sewage
Characterisation	Highly Concentrated, mostly fresh; stored for days or weeks only.	FS of low concentration; usually stored for several years; more stabilised that public toilet sludge.	Tropical sewage
COD (mg/l)	20 – 50,000	<10,000	500 – 2,500
COD/BOD	2:1 .....5:1	5:1 – 10:1	2:1
NH_4-N (mg/l)	2, - 5,000	< 1,000	30 – 70
TS	≥3.5%	< 3%	< 1%
SS (mg/l)	≥ 30,000	≈7,000	200 -700
Helminth eggs (no./litre)	20, - 60,000	≈4,000	300 – 2,000

Source : CDD Document on co-treatment – draft

Methods

- Dilution method
- Solid liquid separation method

Dilution method – schematic

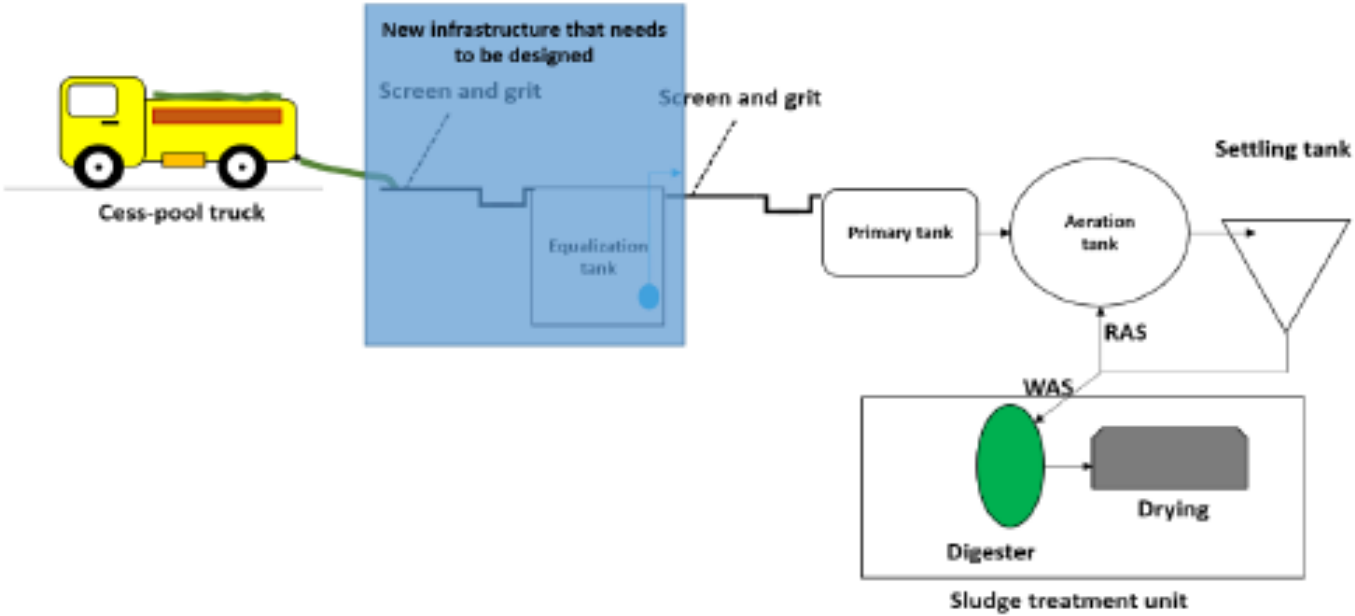


Figure 5: Cotreatment using dilution method at the STP, for illustration only

Source : CDD document on co-treatment – draft

Solid-liquid separation

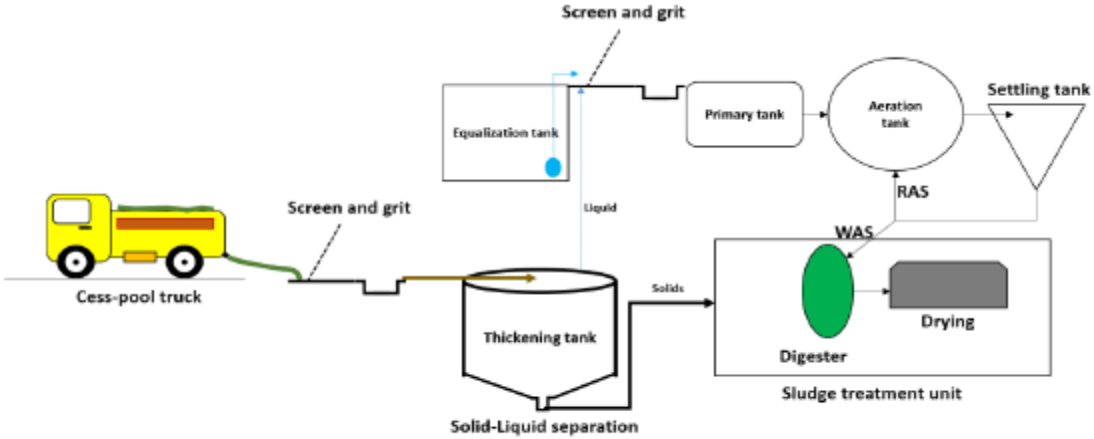


Figure 6: Cotreatment option using solid-liquid separation method, for illustration only

Source : CDD document on co-treatment – draft

Design criteria

- Quantity of FS received in a day
- No of trucks arriving at the WWTP for discharging
- FS characteristics
- Design capacity and criteria of WWTP (peak flow, low flow etc)
- Current operational capacity of the WWTP
- Characteristics of WW influent
- Effluent discharge standards
- Combined influent characteristics of the WW & FS

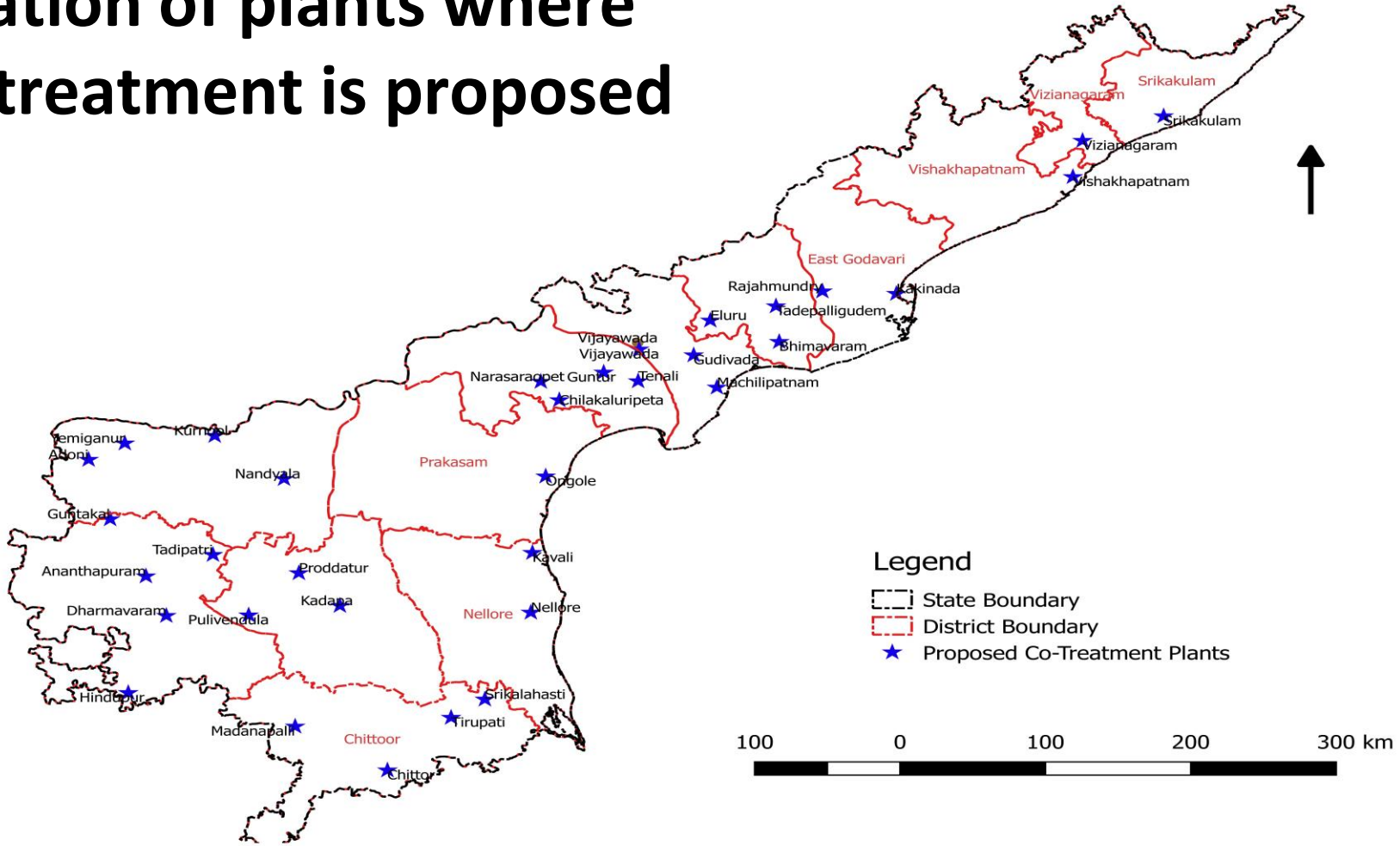
About Andhra Pradesh

- 8th largest state in India
- Urban population of **14.6 million** (29.6%) residing in **110 towns**
- All towns declared Open Defecation Free **(ODF)** in October 2016 and sustained
- Faecal Sludge and Septage Management **(FSSM)** prioritized

FSSM in Andhra Pradesh

- State **policy** and operative guidelines for FSSM issued
- Multi-pronged approach for **treatment facilities** in all towns:
  - 22 New **combined treatment STPs** in 22 towns
  - Conversion of 27 existing functional STPs (spread over 7 towns) to co-treatment facilities
  - **Stand-alone Faecal Sludge Treatment Plants (FSTPs)** piloted in 2 towns and scaled up to 76 towns through innovative Public Private Partnership (PPP) based on Hybrid Annuity Model (HAM)

Location of plants where co- treatment is proposed



Assessment of Feasibility of conversion of existing STPs into combined treatment facilities

1. Analysis of pollution parameters at the inlet and outlet points of STP

2. Measurement of hydraulic flow at different times of day at the inlet of STP

3. Analysis of septage characteristics

Pilot projects undertaken- Tirupati and Ankapalli

STP In Tirupati

- Design capacity of 50 MLD
- Facultative Oxidation Process

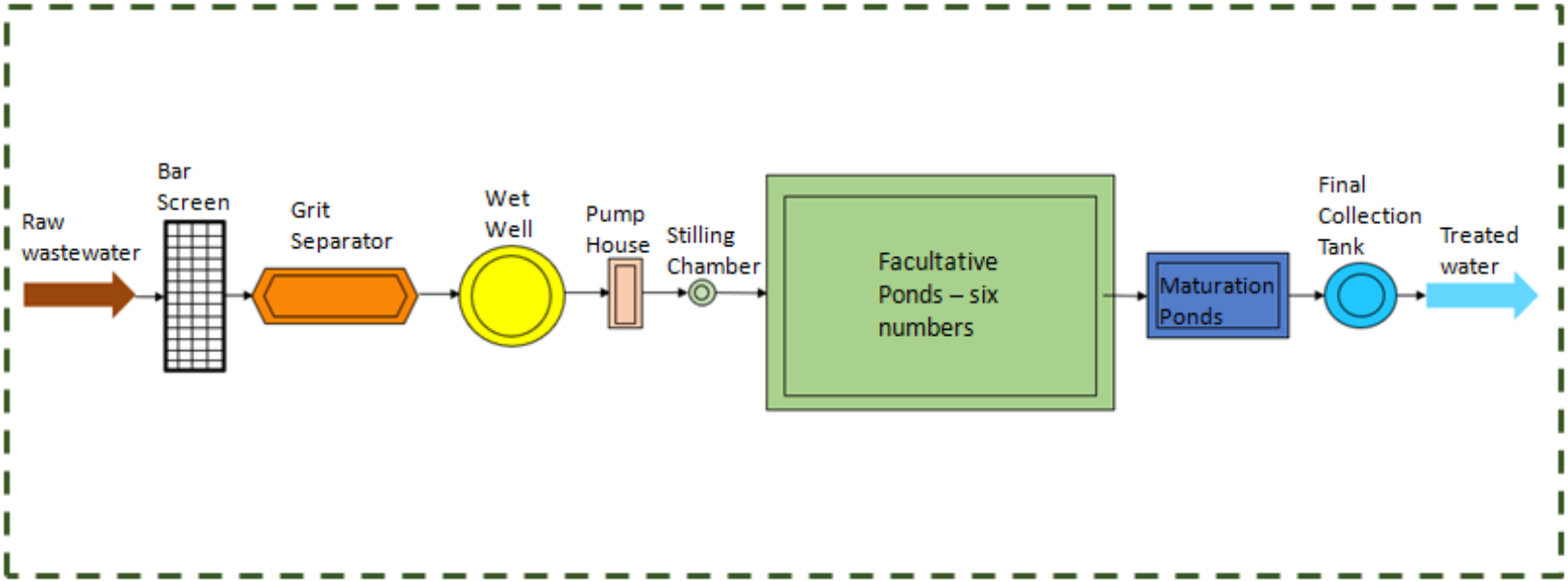
STP in Ankapalli

- Design capacity of 15 MLD
- Activated Sludge Process

Salient Features

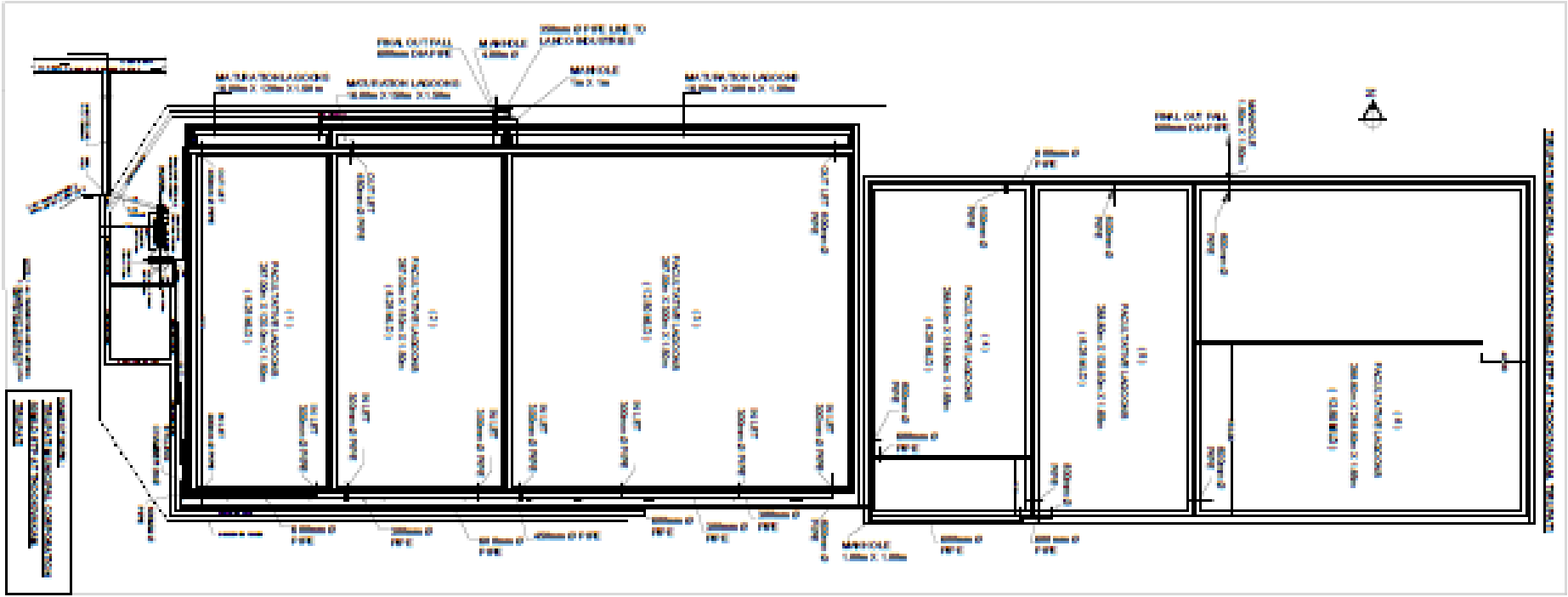
- Population (2011 census): 3,74,260
- Number of House (2017): 62642 (Houses)
- Households with septic tanks (2017): 38290 (Houses)
- Households connected to sewage system (2017): 24012 (Houses)
- Length of main sewer: 70.46 kms
- Length of sub main sewer, branch sewer, lateral sewer: 189.57 kms
- Total length of sewer line: 260.03 kms
- **Capacity sewage treatment plant: 50 MLD**
- Site available at STP: 299.50 Acres
- Commissioning of the UGD scheme: 1999
- Commissioning of 1st stage of STP: 2004

Unit Operations of the existing STP



Aerial view of STP

Layout of STP



STP Design Parameters

Parameter	Inlet	Outlet
pH	7.1 – 7.8	5.5 – 9.0
TSS (mg/l)	260 - 390	≤ 100
TDS (mg/l)	950 - 1250	≤ 2100
COD (mg/l)	500 - 600	------
BOD (mg/l)	280 - 305	≤ 100

Field Study

Hydraulic Flow Measurement of inlet to the STP

S. No	Time	Flow in MLD
1	7:50 A.M	25.88
2	9:45 A.M	35.27
3	11:35 A.M	40.61
4	4:15 P.M	12.81

Monitored Values

Parameter	UOM	STP Inlet	STP Outlet-1	STP Outlet-2	General Standards	New Standards
pH	---	7.35	8.02	7.61	5.5 to 9.0	6.5 to 9.0
COD	mg/l	756	52.6	94.7	250	---
BOD	mg/l	181	11	18	30	30
TSS	mg/l	178	70	78	100	100
TDS	mg/l	994	861	890	---	---

Note:

- The reasons for high value COD in the inlet is to be reviewed.
- The BOD values of the treated sewage at outlet 1 and 2 are meeting the norms. To be monitored periodically for establishing the performance of STP on continual basis

Septage Characteristics

Parameter	UOM	Septage T-1	Septage-2
pH	---	7.49	7.43
COD	mg/l	11572	25353
BOD	mg/l	3997	9780
TSS	mg/l	332	954
O&G	mg/l	9	8
Ammonical Nitrogen	mg/l	216.4	84.3
Total Kjeldahl Nitrogen	mg/l	262.8	102.3
Phosphorus as PO4	mg/l	37.56	20.24
Total Solids	mg/l	18694	33328
Volatile Solids	mg/l	9566	14482
Alkalinity	mg/l	1349.9	659.7

Key parameters

Hydraulic load, COD/BOD, N, P

Lagoon Design Matrix with Co-Treatment

A. BOD load as per design and without septage
   - Hydraulic Load: 50 MLD
   - Inlet BOD concentration: 300 mg/l
   - Inlet BOD load: 15000 kg/day

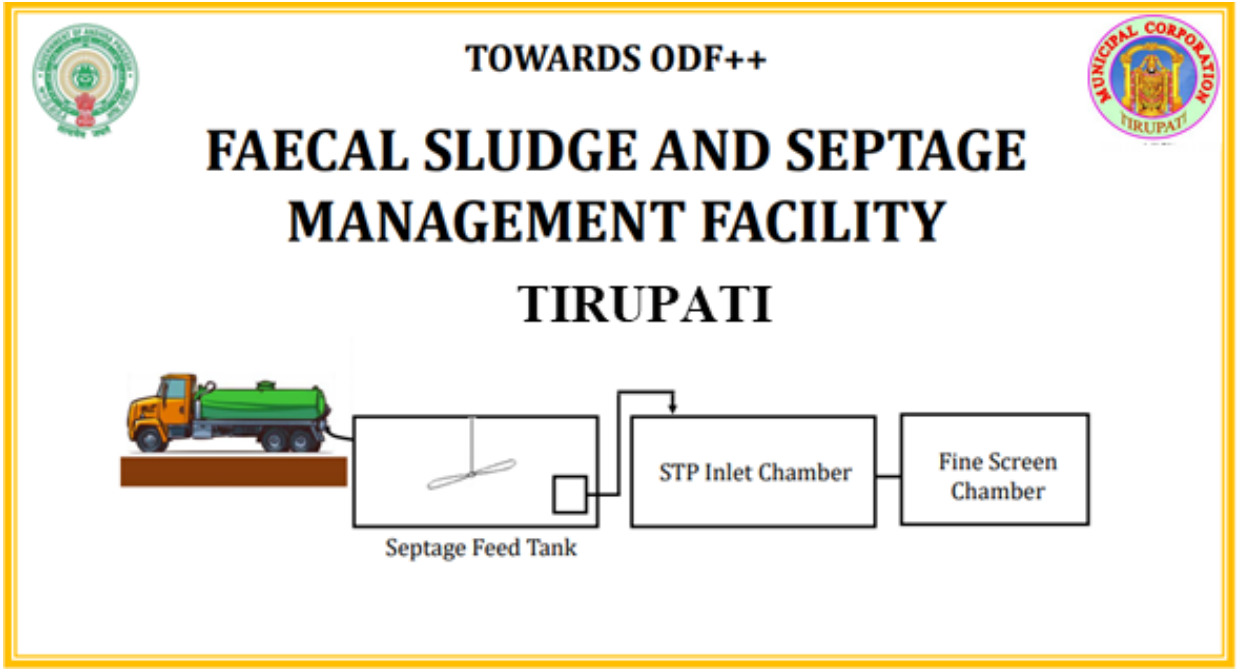
B. Septage load
   - Measured BOD value: 3997 mg/l and 9780 mg/l
   - Considering BOD concentration of 10,000mg/l and hydraulic load of 100KLD
   - Estimated BOD load due to septage: 1000 kg/d

C. Equivalent hydraulic load of sewage of 1000 kg/d: 3.33 MLD (say 4 MLD)

D. The capacity of STP when adopted co-treatment will be 46 MLD of sewage plus 100 KLD of septage

Tirupati

- To ensure safe mixing of septage, a septage reception facility consisting of a Septage Collection cum Feed Tank prior to bar screen.



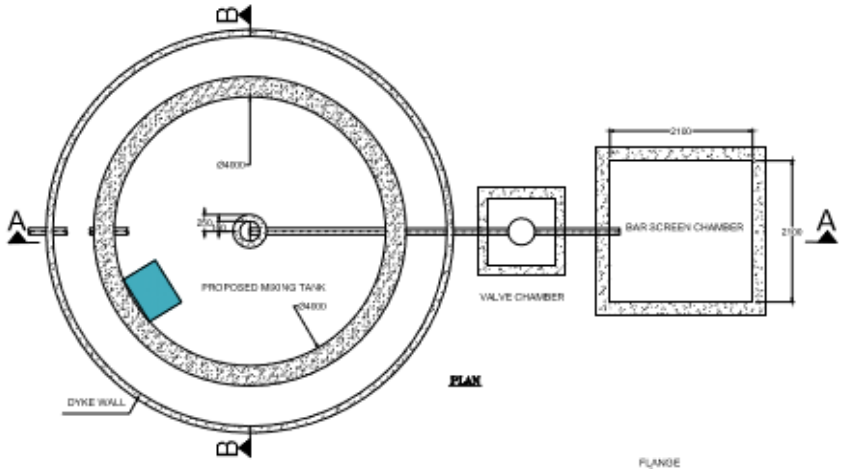
Septage Reception Facility

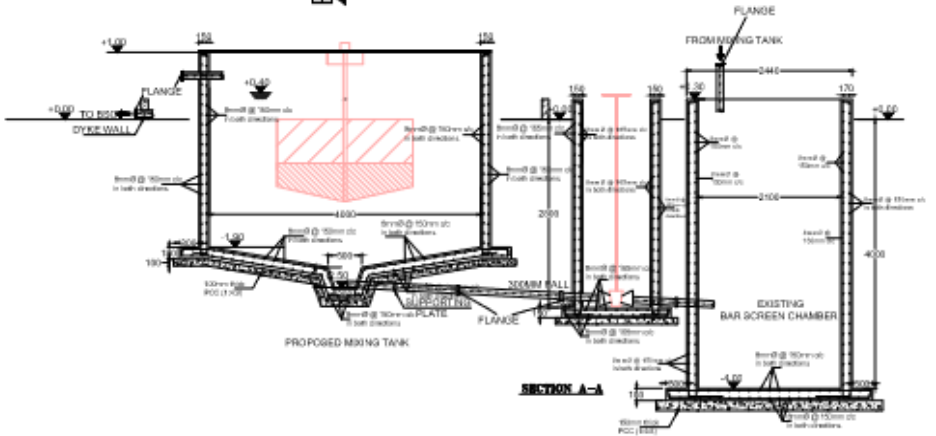
Civil Works:

- Septage Collection cum Feed Tank,
- Valve Chamber

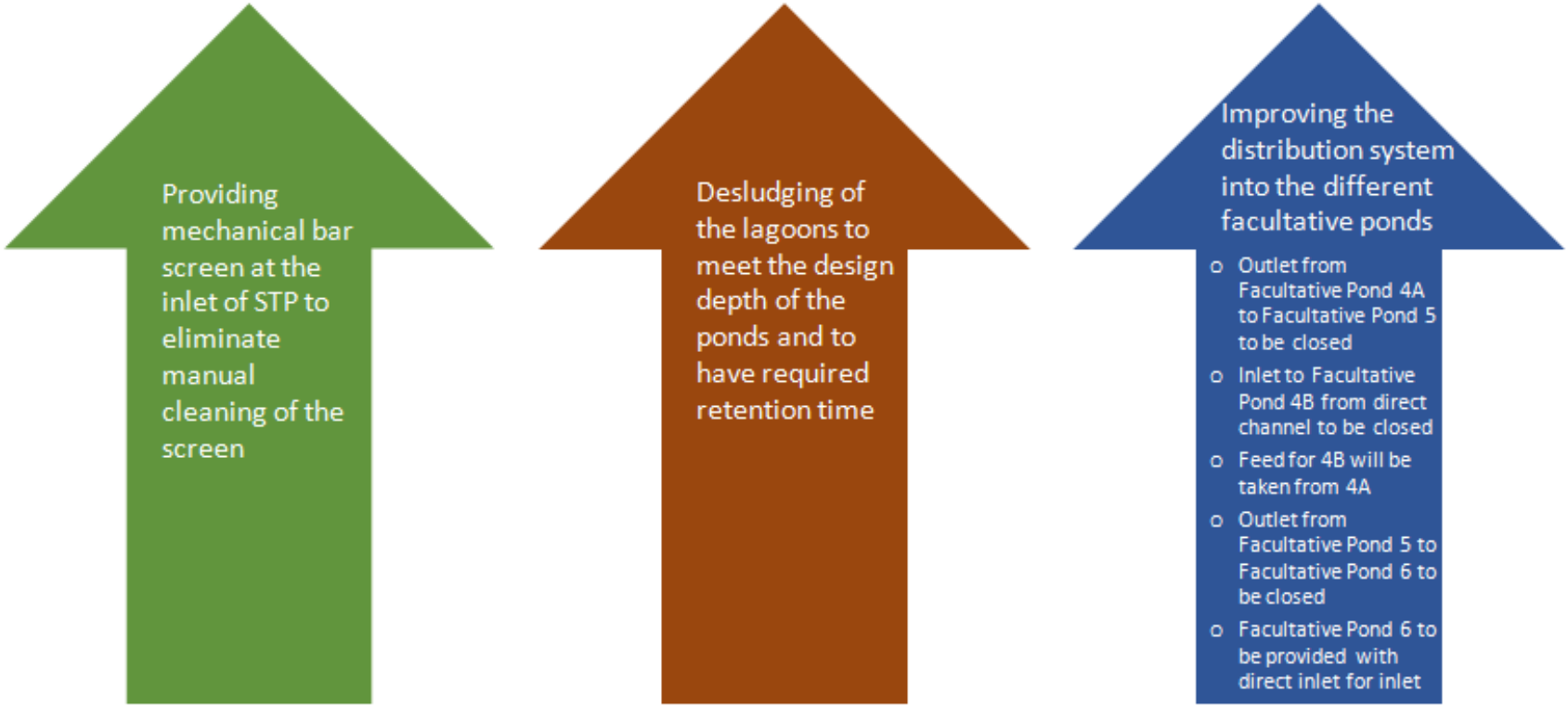
Mechanical Works:

- Mixer for Collection Tank,
- Plug Valve,
- Basket Type Screen,
- Puddle Flanges,
- MCC Panel,
- Power Cables,
- Earth Pit and Earthing





Improvements for enhancing the performance of STP

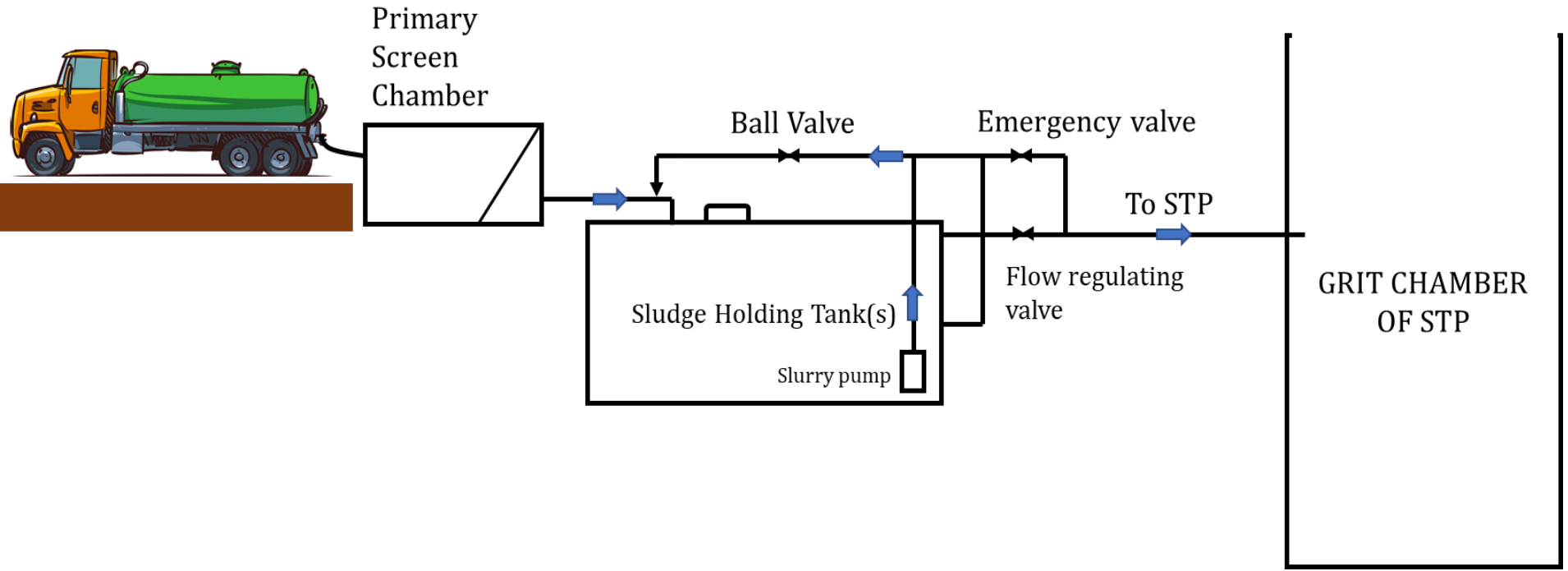



asci
TIRUPATI
TOWARDS ODF ++
FAECAL SLUDGE AND SEPTAGE
MANAGEMENT FACILITY
TIRUPATI
STP INLET CHAMBER
FINE SCREEN CHAMBER
Septage Feed Tank

Results

- All parameters below the standards
- 0.5-2 % loading practiced

Package systems




HOLDING TANK
SCREENING CHAMBER

Lessons and Implications

- Co-treatment of Septage following scientific analysis and design improvements is a unique approach experimented
- The unique model lends itself for replication.
- The approach is easy to implement, low on capex and opex
- It can be situated at STP site thereby avoiding land and manpower requirements for establishing new facilities

Lessons and Implications

- India has over 522 functional STPs and additional 215 under at advanced level of construction.
- The STPs are mostly in metropolitan cities and Class 1 towns (> 100,000 population)
- Study by Central Pollution Control Board (CPCB) in 2015, indicated presence of significant spare capacity at STPs (in the order of 45 %)
- This situation provides a good opportunity to treat septage through co-treatment at these STPs through scientific analysis and implementation of design and process improvements.