# Changing paradigm for sewage - from treatment to recycle


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# Some issues discussed in the morning

- Sewage- drinking water supply relationship (quantitative mass balance versus quality implications)
- Create market for the treated sewage? Agriculture versus industry
- Modular development of STPs (what happens due to overdesign? Bangkok, Bosch, JK Tyres Kankroli…)
- Design, trouble shooting and augmentation modules

# Some issues discussed in the morning

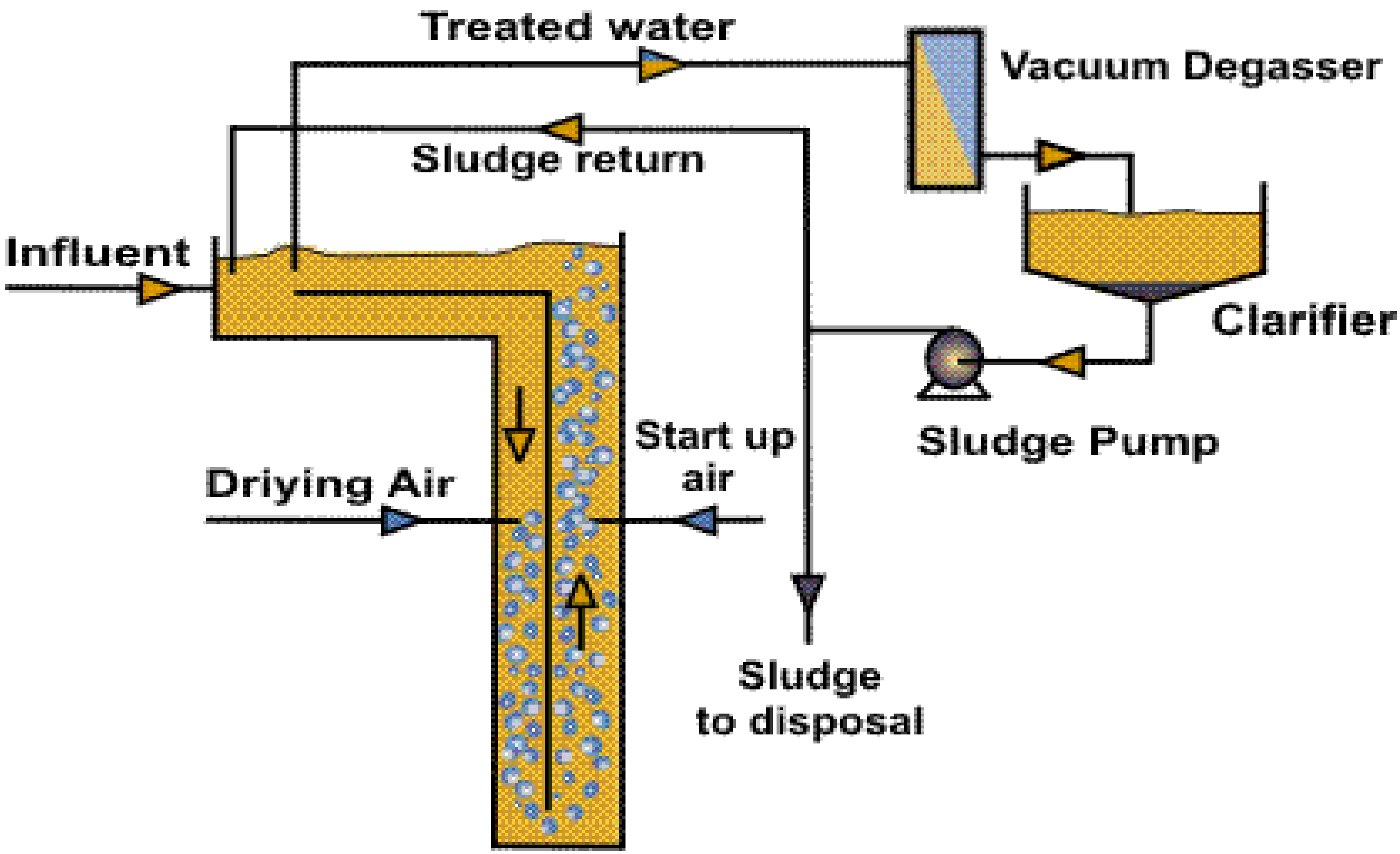
- Minimizing the discharge (Aurobindo and Gargi hostels of MNIT Jaipur)
- Decentralized versus centralized systems
- Energy aspects in STPs – how much to conserve?
- Wetlands - their applications and limitations
- New areas for R&D

# Deep shaft process

- It is a Process having a mechanism of great depth aeration (depth of 40 to 150 m as an aeration tank) and it is practiced where land  is in short supply.

- It can treat the waste water at higher rate.

- It is also known as a space efficient and energy efficient biological process.


Treated water
Vacuum Degasser
Sludge return
Influent
Clarifier
Sludge Pump
Start up
air
Driying Air
Sludge
to disposal

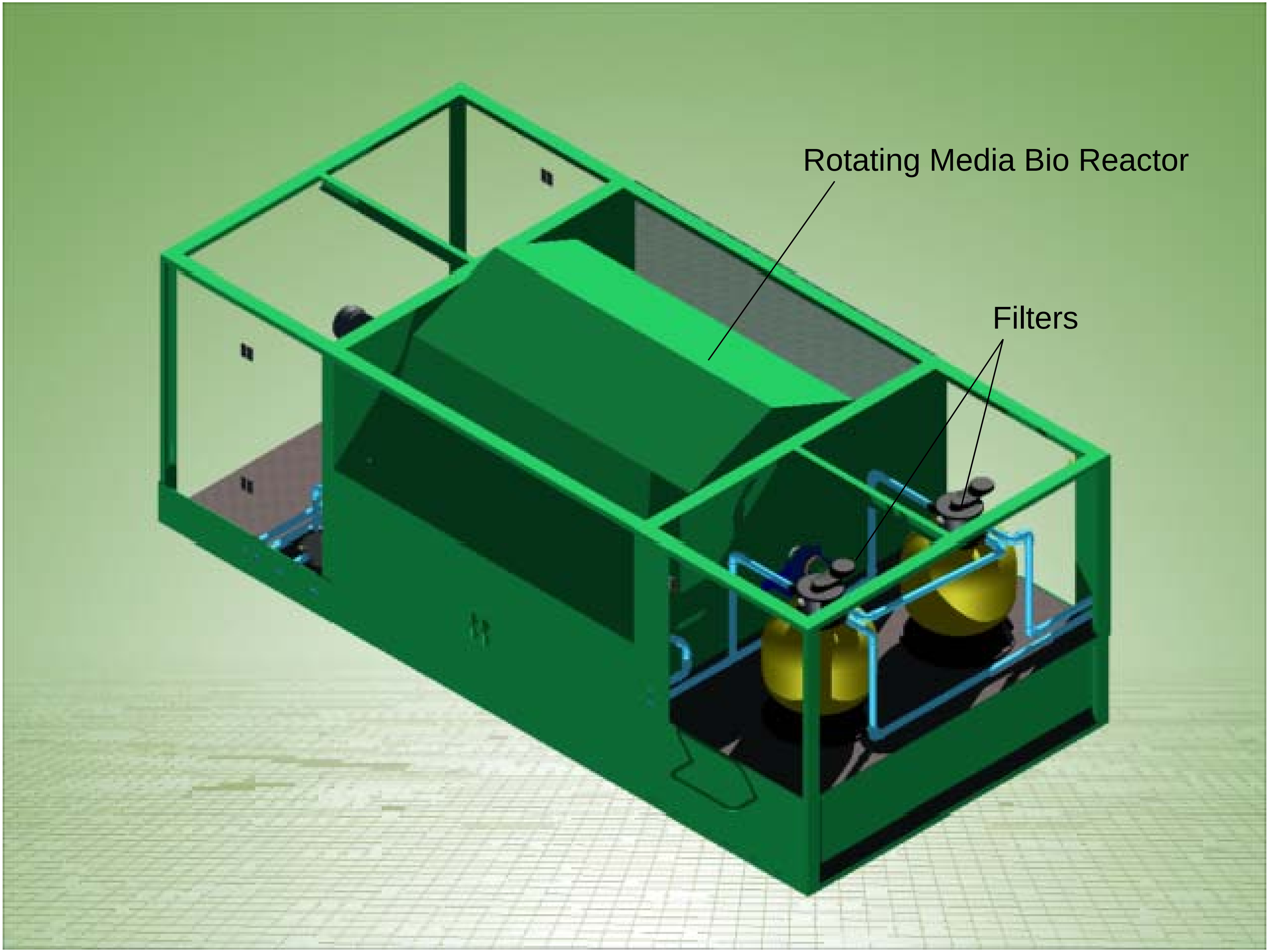
# *Disposal and recycle norms…*

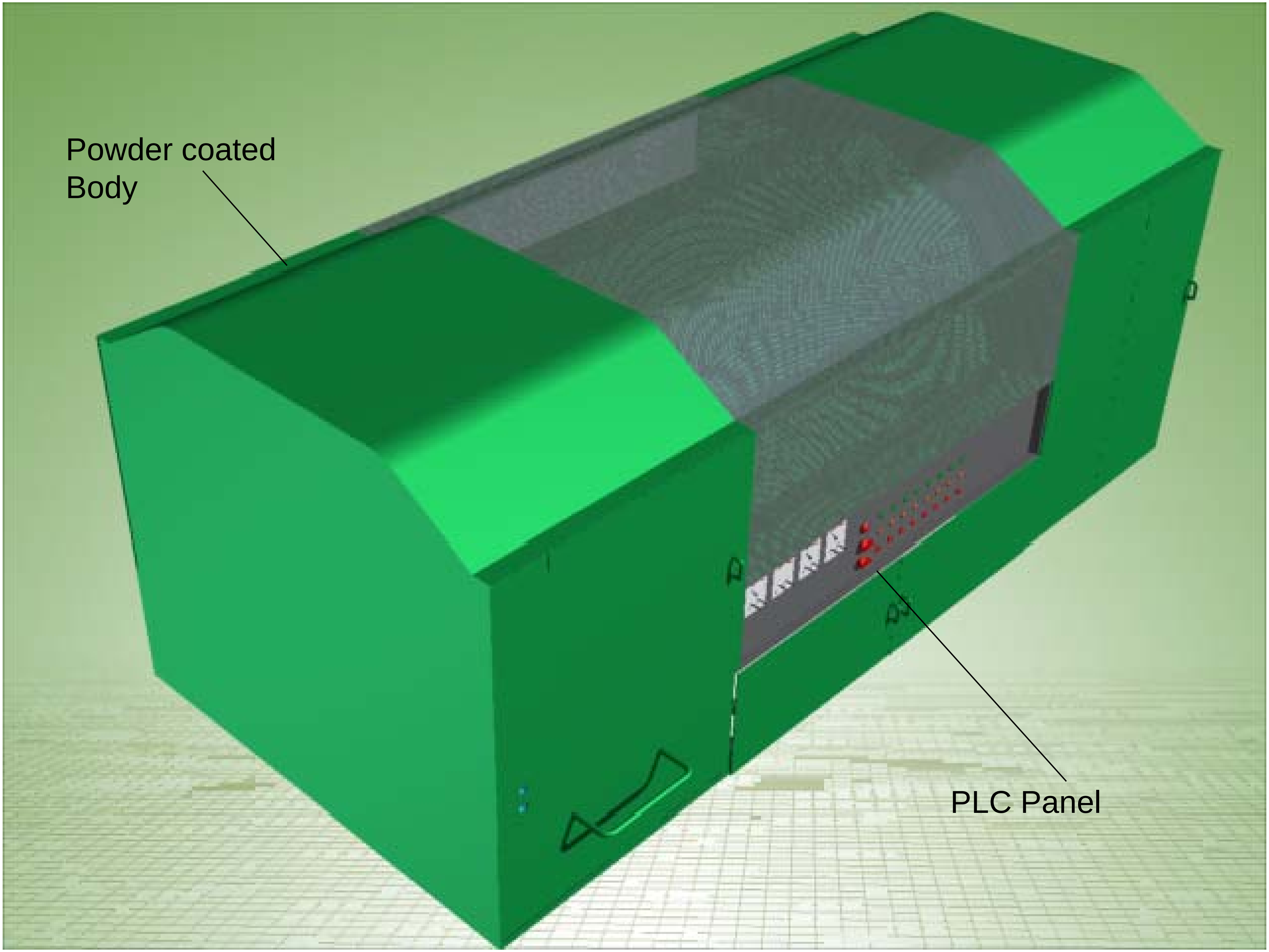
| Parameter | Disposal norms | Recycle norms | |
|---|---|---|---|
| | | Low end reuse | High end reuse |
| TSS | 100 | < 5 | < 1 ntu |
| BOD | 100 | < 10 | Nil |
| COD | 250 | < 50 | Nil |
| SDI | No limit | No limit | < 3 |
| TKN | 100 | No limit | < 1 |
| T- N | No limit | No limit | < 5 |
| T- P | 5 | No limit | < 1 |
| Bacteria | No limit | No limit | Nil |

# *…Cost Benefit Analysis*

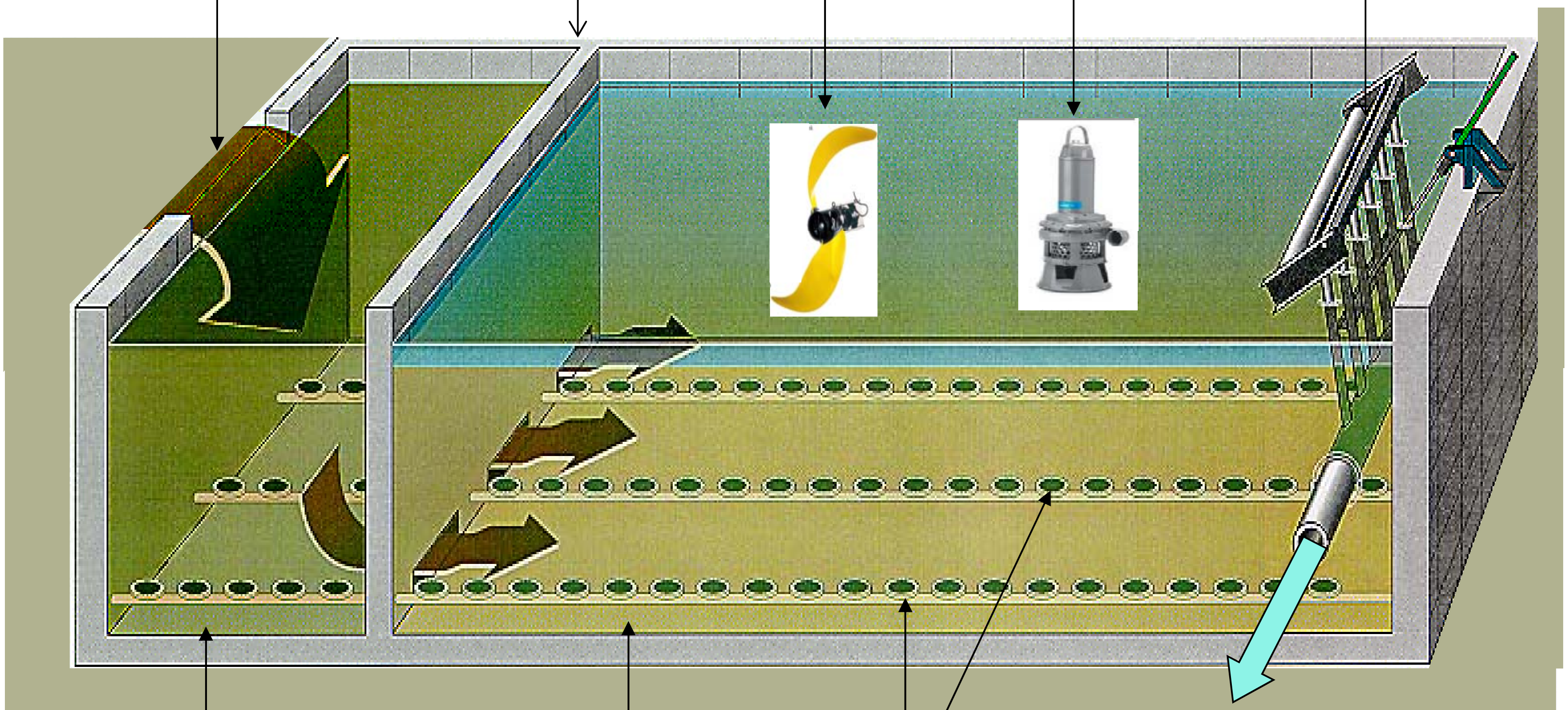
1. *Benefit vs Additional cost*
2. *Payback of Additional cost*
3. *Life cycle analysis*

# RBC at MNIT

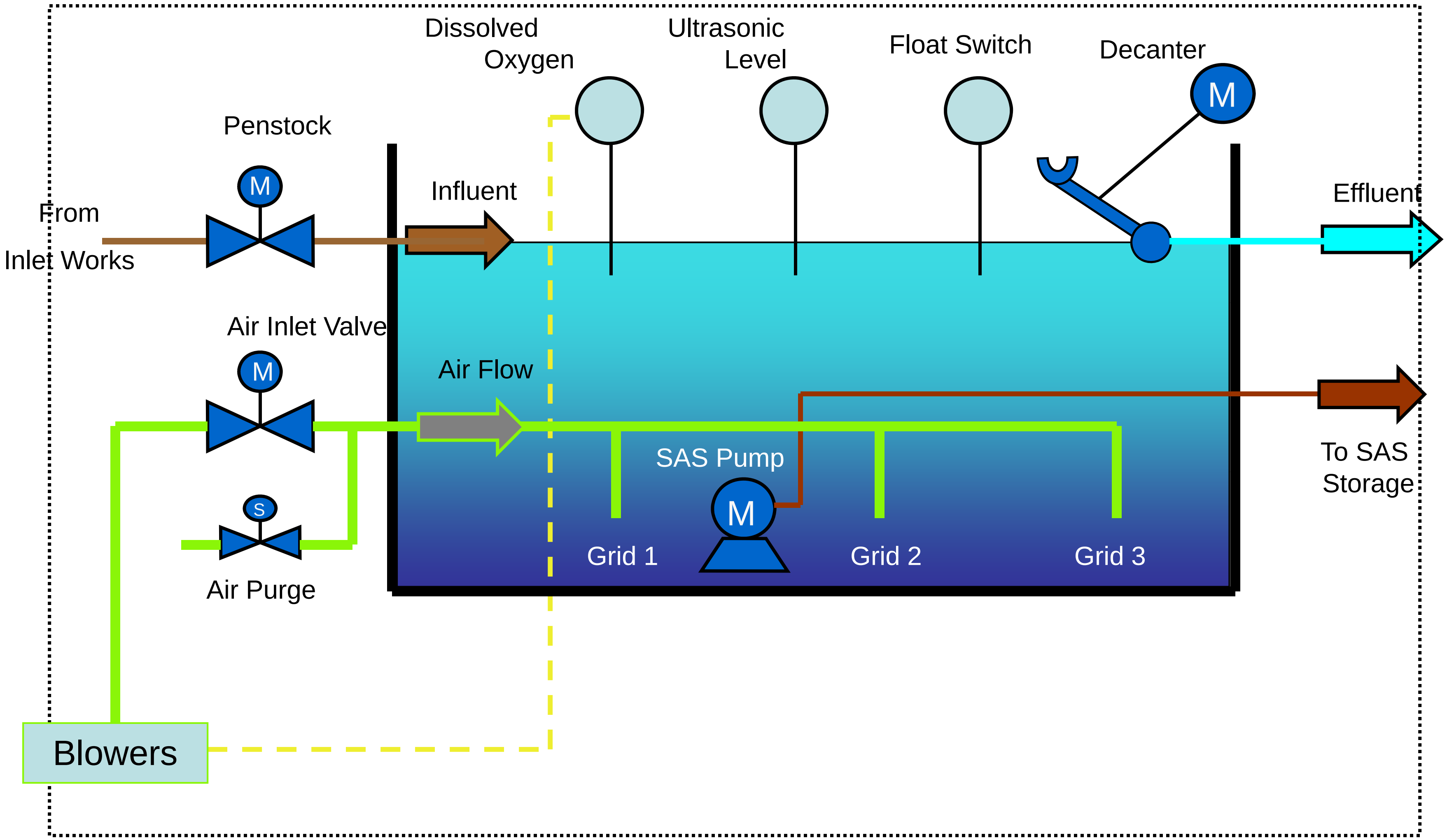

Rotating Media Bio Reactor
Filters


Powder coated
Body
PLC Panel

# SBR


Screened Influent
Baffle Wall
Mixers
SAS
Pumps
Decanter
Pre-react Chamber
Main-react
Chamber
Diffusers
Effluent Discharge

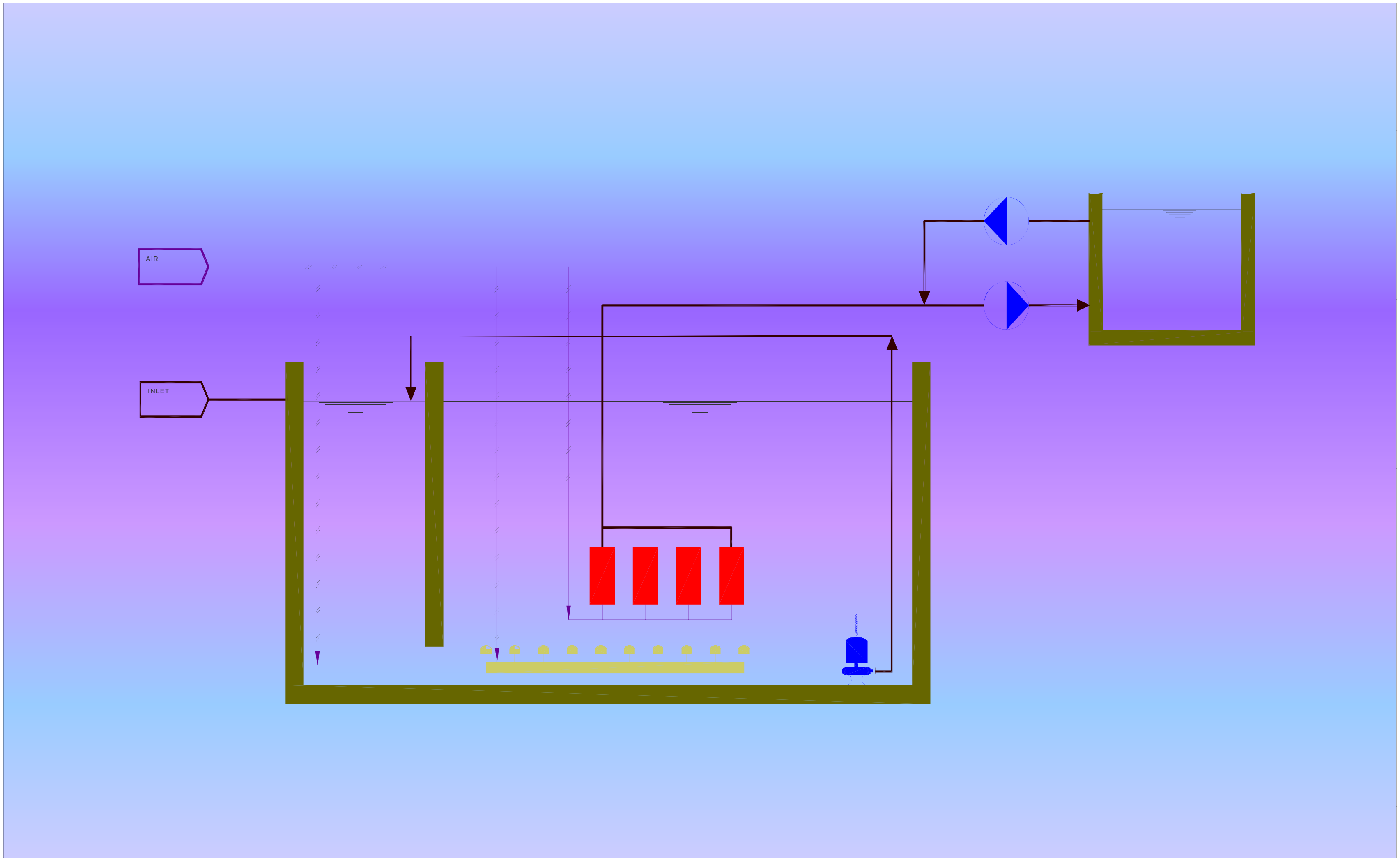
# SBR Basin Equipment



*MBR*

*it is a very high efficiency process with outlet quality as feed to Reverse Osmosis ….*

# MBR System Schematics



# Outlet quality (all units in ppm)

| Srno | Paramete r | SBR | MBR | ASP |
|---|---|---|---|---|
| 1. | BOD | 10 | 5 | 30 |
| 2. | COD | 50 | 25 | 250 – 300 |
| 3. | TSS | 10 | < 0.5 | 100 |
| 4. | TN | <5 | <5 | No change |
| 5. | TP | <1 | <1 | No change |
| 5. | SDI | - | <3 | - |

# Energy considerations

- **ASP STP Jaipur North- 27 MLD- 0.89 kWh/ kg of BOD (ref_ MNIT)**
- **ASP STP Jaipur South- 62.5 MLD- 0.50 kWh/ kg of BOD (ref_ MNIT)**
- **ASP Pune – 17 MLD ASP- 1.75, TF- 0.70 kWh/ kg of BOD (ref_ MNIT)**

**Ref-Compendium..IIT Kanpur prepared for NRCD- MOEF 2009**

- **Conventional ASP based STPs under YAP- Allahabd 60-80 MLD- 180-225 KWH/MLD**
- **TF under YAP- 180 KWH/MLD**
- **UASB under YAP- 10-15 KWH/MLD**
- **Facultative aerated lagoon under YAP 18 KWH/MLD**

**How to save and how much??**

**How much energy can be generated?**

# Decentralized Treatment Systems
## **WHERE** to consider (according to USEPA)?

- Where the operation and management of existing onsite systems must be improved
- Where the community or facility is remote from existing sewers
- Where localized water reuse opportunities are available
- Where fresh water for domestic supply is in short supply
- Where existing wastewater treatment plant capacity is limited and financing is not easily available for expansion
- Where, for environmental reasons, the quantity of effluent discharged to the environment must be limited
- Where the expansion of the existing wastewater conveyance from treatment facilities would involve unnecessary disruption to the community
- Where specific wastewater constituents are of environmental concern.

# The case study of Jaipur

- Two scenarios considered
  - First, centralized treatment at STP Delawas and supply treated sewage through a pipeline to the major green belts- data derived mainly from PHED report
  - Second, isolated RBCs for the desired capacities to be constructed at individual locations with and without automation
- Estimates made for a period of 10 years

# Economic Justification of Decentralized System

**Table-1: Demand Estimates and No. of Proposed Plants**

| S.No. | AREA | Tentative Demand in MLD | No. of Plants | |
|---|---|---|---|---|
| | | | 1 MLD | 0.5 MLD |
| **Zone I** | | | | |
| 1 | Ram Niwas Bagh | 1.2 | 1 | 1 |
| 2 | Central Park | 1 | 3 | |
| 3 | Polo Ground1.0/ Golf Course | 0.45 | Central Park plant may Cater | |
| 4 | SMS Stadium | 0.6 | | |
| 5 | Jawahar Nagar | 1.56 | 1 | 1 |
| 6 | Jawahar Nagar Forest Area | 5 | 5 | |
| 7 | Amrita Devi Udyan | 3 | 3 | |
| 8 | University Campus | 1 | 1 | |
| 9 | Saras Sankul | 0.3 | | 1 |
| 10 | MNIT | 0.7 | 1 | 1 |
| 11 | OTS | 0.3 | 1 | |
| 12 | Smrity Van | 0.3 | OTS Plant may cater | |
| 13 | Malviya Nagar sector 1 | 0.7 | 2 | |
| 14 | Malviya Nagar Ind. Area | 0.95 | | |
| 15 | Malviya Nagar sector 9 | 0.7 | | |
| 16 | Jawahar Circle | 0.55 | | |
| 17 | Jagatpura | 5 | 5 | |
| 18 | Pratap Nagar | 3.85 | 4 | |
| | **SUBTOTAL** | **27.16** | **26** | **4** |

## Table-1: Demand Estimates and No. of Proposed Plants

| S.No. | AREA | Tentative Demand in MLD | No. of Plants | |
|---|---|---|---|---|
| | | | 1 MLD | 0.5 MLD |
| **Zone II** | | | | |
| 1 | Inter State Bus Terminus | 0.25 | | 1 |
| 2 | Mansarovar (Sec 1 to 6) | 1 | 1 | |
| 3 | Mansarover Sector SFS &Sec 7-12 | 1.2 | 1 | 1 |
| 4 | Mansarover Industrial Area | 1.2 | 1 | 1 |
| | **SUBTOTAL** | **3.65** | **3** | **3** |
| **Zone III** | | | | |
| 1 | Sitapura Ind. Area | 2 | 2 | |
| 2 | Tonk Road | 8 | 8 | |
| | **SUBTOTAL** | **10** | **10** | **0** |
| **Zone IV** | | | | |
| 1 | Sez | 22.5 | 23 | |
| 2 | Bagru Industrial Area | 5 | 5 | |
| 3 | Ajmer Road Colonioes | 5 | 5 | |
| | **SUBTOTAL** | **32.5** | **33** | **0** |
| | **Total No. of Plants** | | **72** | **7** |
| | ***Total Capacity*** | ***73.3*** | ***72*** | ***3.5*** |

| Unit Costs for various options | | | | | |
|---|---|---|---|---|---|
| | **Plant Size** | **Capital Cost** | **Power Cost for 10 Yrs** | **10 Yrs O & M Cost** | **No. of Proposed Units** |
| **Treatment System without Tertiary Treatment** | **1 MLD** | 7,875,000 | 3,966,564 | 3,212,394 | 72 |
| | **0.5 MLD** | 6,900,000 | 1,983,282 | 3,121,833 | 7 |
| | | | | | |
| **Treatment System with Tertiary Treatment** | **1 MLD** | 8,400,000 | 5,949,846 | 3,212,394 | 72 |
| | **0.5 MLD** | 7,485,000 | 2,974,923 | 3,121,833 | 7 |
| | | | | | |
| **Treatment System with Fully Automatic Plant** | **1 MLD** | 8,925,000 | 5,949,846 | 586,130 | 72 |
| | **0.5 MLD** | 8,070,000 | 2,974,923 | 495,569 | 7 |

## Total Cost Estimates

| | No. of Proposed Units | Capital Cost | Power Cost for 10 Yrs | 10 Yrs O & M Cost | Total |
|---|---|---|---|---|---|
| **Without Tertiary Treatment** | 72 | 567,000,000 | 285,592,622 | 231,292,350 | 1,083,884,972 |
| | 7 | 48,300,000 | 13,882,975 | 21,852,830 | 84,035,805 |
| | | **615,300,000** | **299,475,596** | **253,145,181** | **1,167,920,777** |
| | | | | | |
| **With Tertiary Treatment** | 72 | 604,800,000 | 428,388,933 | 231,292,350 | 1,264,481,283 |
| | 7 | 52,395,000 | 20,824,462 | 21,852,830 | 95,072,292 |
| | | **657,195,000** | **449,213,395** | **253,145,181** | **1,359,553,575** |
| | | | | | |
| **Fully Automatic Plant** | 72 | 642,600,000 | 428,388,933 | 42,201,345 | 1,113,190,278 |
| | 7 | 56,490,000 | 20,824,462 | 3,468,983 | 80,783,445 |
| | | **699,090,000** | **449,213,395** | **45,670,328** | **1,193,973,722** |
| | | | | | |
| **Centralized System** | | **1,050,000,000** | **989,600,000** | **236,400,000** | **2,276,000,000** |

# Advantages

- Cost of additional Sewerage system, Transport of sewage and its pumping reduced
- In the earlier scenario contamination due to dye wastes made it difficult to treat sewage
- High end technology introduced at lesser cost and possibility for modular development
- Recharging the local water table
- Disposal on greens gives further polish thus safe for GW recharge (Natural treatment system introduced)

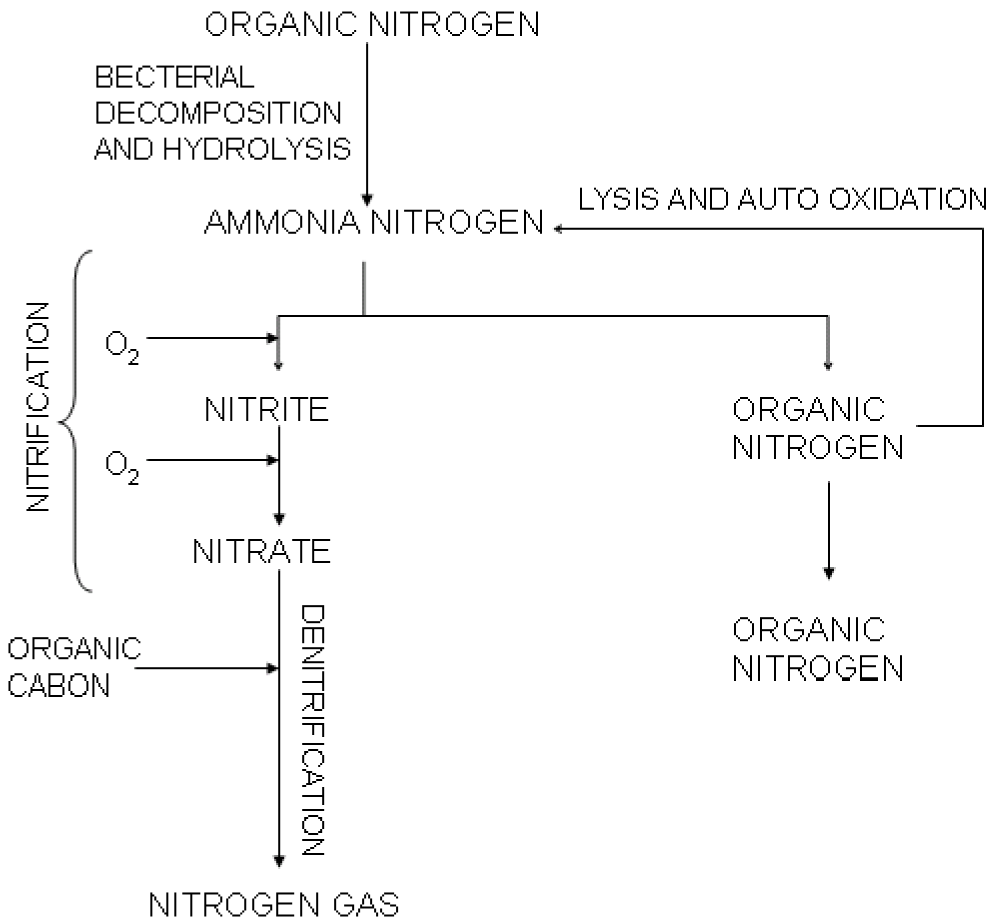
## Technologies for the Treatment of Wastewater
## an analysis...

- Each situation is different and needs to be given dual consideration, different alternatives exist for each system from small scale households to large scale centralized one.

- More attention to properly designed lower-cost, simpler to operate processes as well as to decentralized technologies. These should be adopted depending on the influent wastewater and on the desired effluent quality.

- Also, whenever feasible, a reuse component should be included for all new wastewater treatment projects

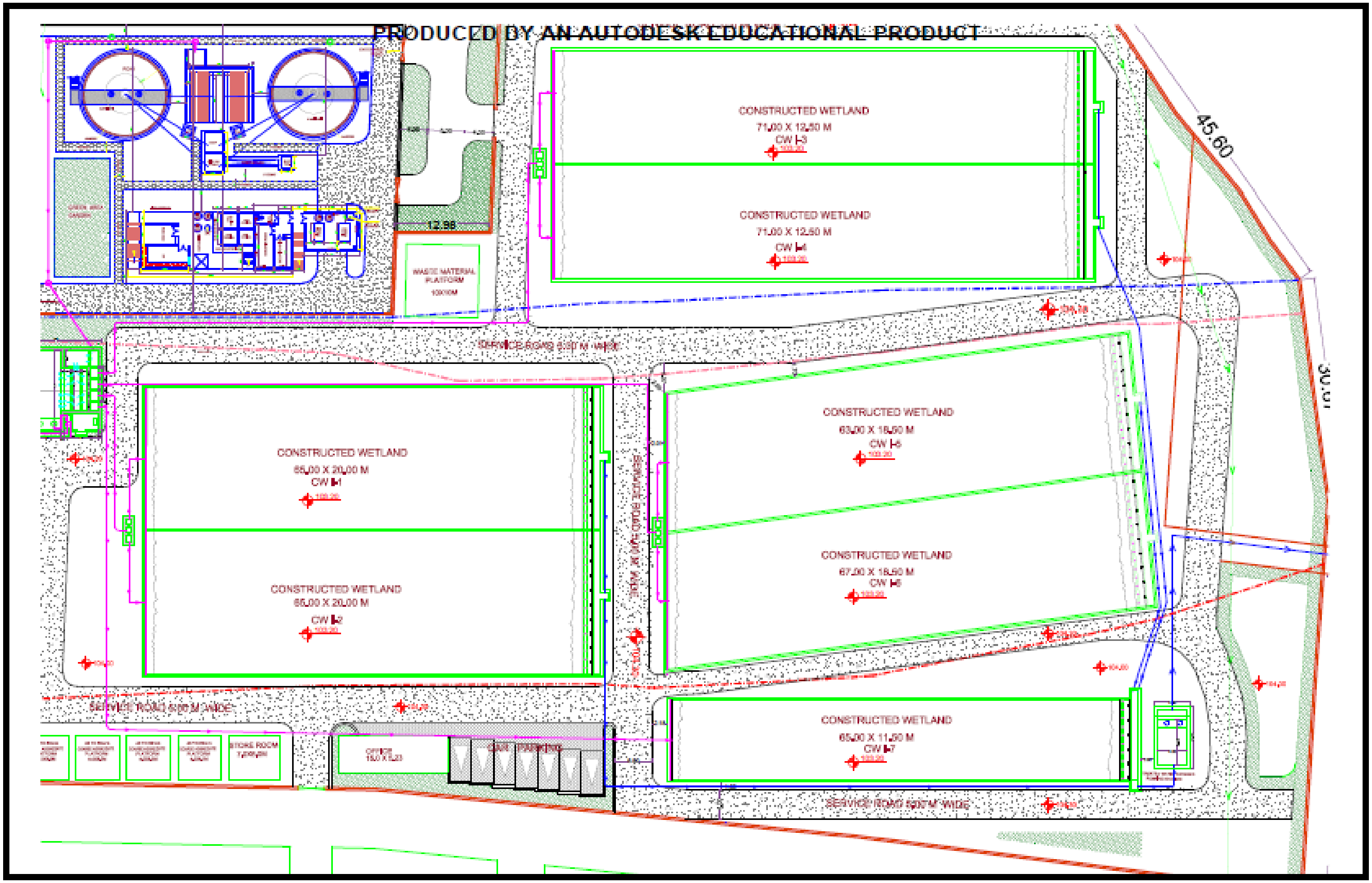
# Biological Nitrogen removal



# Advances in Biological N- removal

- Application of *Thiosphaera pantotropha, a heterotrophic nitrifier and aerobic denitrifier,* in mixed bacterial cultures for simultaneous carbon removal, nitrification and denitrification
- Two important points to note about TP
- i) The specific nitrifying activity of TP is 10 – $10^3$ times lower than that of autotrophs much higher compared to those of other het nitrifiers ($10^3$ - $10^4$ times lower).
- Growth of TP as heterotroph is much higher than that for the autotrophs (the $\mu_{max}$ for *Nitrosomonas europea* 0.03 - 0.05 $h^{-1}$, that of *TP* approx 0.4 $h^{-1}$)
- The aerobic denitrification rates were much higher than het nitrification rates of TP- extra capacity to take nitrate or nitrite coming from other routes

# LAYOUT OF BRAHMPURI WETLAND



# Inferences on wetland study

- Unvegetated wetland is performing better than the vegetated ones for organics removal (??)
- Only N- removal was better in vegetated wetlands suggesting that removal of nitrogen is mostly by plant uptake.
- Plant litter is contributing back to phosphorous in vegetated wetlands giving unexpectedly higher phosphorous at outlet.
- Though the wetland systems were highly under-designed as per design equations they performed satisfactorily -need our own design equations.
- Harvesting being easier compared to ponds..have future

# Conclusion

- *The selected strategy needs to be developed through careful planning and detailing and may be public consultation.*
- *The decentralized option has a definite edge over the centralized option economically, and the flexibility of modular development can always allow stage wise development and obtaining feedback to refine the system.*
- *The future is for the advanced technologies and the life cycle analysis of the treatment options*