Waste Water Treatment Technologies
An Overview

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1. INTRODUCTION

- **Sewage is produced out of everyday human activities**
- **The principal objective of sewage treatment is to allow domestic effluents to be disposed of without danger to human health or unacceptable damage to the natural environment**

SEWAGE CHARACTERISTICS

Quantum - 80 % of water used

Water - 99.9%

Solid - 0.1 %

- Floating Material
- Settleable Solids
- Suspended Solids

SEWAGE TREATMENT PROCESS

Combination of:

- Physical Processes
- Chemical Processes
- Biological Processes

SEWAGE TREATMENT PROCESS - contd.

Stages:

- Preliminary Treatment
- Primary Treatment
- Secondary Treatment
- Tertiary (Advanced) Treatment

WASTEWATER TREATMENT PROCESSES

Preliminary Treatment

The objective is to prepare wastewater for subsequent treatment.

- Screening removes coarse solids such as rags that would interfere with mechanical equipment.
- Grit removal, inorganic, sand-like solids.

Removal of these materials is necessary to enhance the operation and maintenance of subsequent treatment units.

WASTEWATER TREATMENT PROCESSES

PRIMARY TREATMENT

The objective is the elimination of suspended solids (S.S.).

Approximately 30 to 45% of the incoming biochemical oxygen demand (BOD5), 45 to 60% of the total suspended solids (SS), and 65% of the oil and grease are removed during primary treatment.

WASTEWATER TREATMENT PROCESSES

SECONDARY TREATMENT

Removal of residual biodegradable dissolved and colloidal organic matter using aerobic biological treatment processes

- The microorganisms biologically flocculate to form settleable particles. This excess biomass is separated in sedimentation tanks as a concentrated suspension called "secondary sludge."
- Secondary treatment can remove between 85 and 95% of the BOD and TSS in raw sanitary sewage

WASTEWATER TREATMENT PROCESSES

TERTIARY (ADVANCED) TREATMENT

- Ultrafiltration is used to achieve higher quality effluent and to remove more than 99% of the pollutants from raw sewage. BOD<5 & SS<5 PPM
- Cost of construction and O&M is very high, sometimes doubling the cost of secondary treatment

TREATED EFFLUENT QUALITY AS PER CPCB NORMS

- **BOD (5 days at 20 °C) -10 mg/l**
- **Total Suspended Solids - 10 mg/l**
- **Ammonical Nitrogen - 2 mg/l**
- **Total Nitrogen - 10 mg/l**
- **Total Phosphorus - 2 mg/l**
- **pH - 6.5 to 8.0**
- **Total coliform - 250 MPN/100 ml**

2. STP – Technology Options

Option 1:	ACTIVATED SLUDGE PROCESS **Extended Aeration**
Option 2 :	MOVING BED BIO REACTOR **(MBBR)** / FIXED AERATED BIOREACTOR **(FAB)**
Option 3:	SEQUENTIAL BATCH REACTOR **(SBR)**
Option 4:	MEMBRANE BIO REACTOR **(MBR)**
Option 5 :	UPFLOW ANAEROBIC SLUDGE BLANKET **(UASB)** REACTOR
Option 6:	TRICKING FILTER **(TF)**

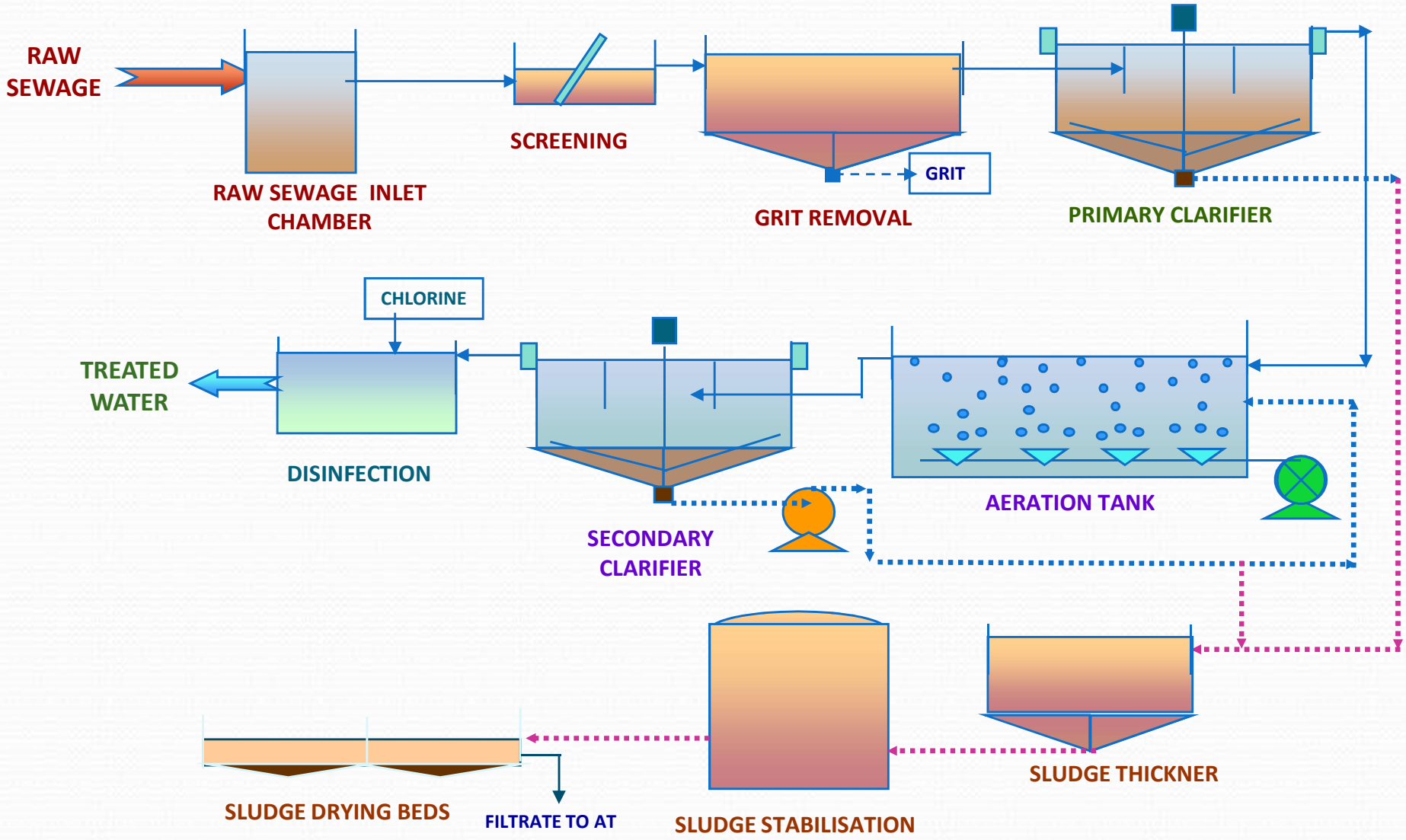
ACTIVATED SLUDGE PROCESS (ASP)

In addition to the basic preliminary and Primary treatment, three basic components:

- Biological treatment unit - A reactor in which the microorganisms responsible for treatment are kept in suspension and aerated.
- Liquid solids separation, usually in a sedimentation tank, and finally separation of sludge from effluent

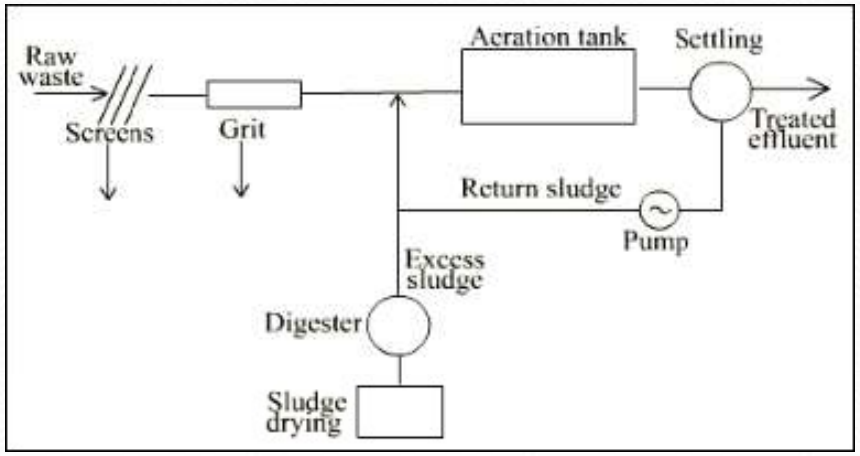
This is the basic treatment process, and most of the other technologies are only modifications in the biological treatment unit.

ASP - Flow Diagram



EXTENDED AERATION

- It is same as ASP with the elimination of anaerobic reaction i.e. primary sedimentation tank & Digesters/ Gas holders are not constructed, but aeration time is prolonged.

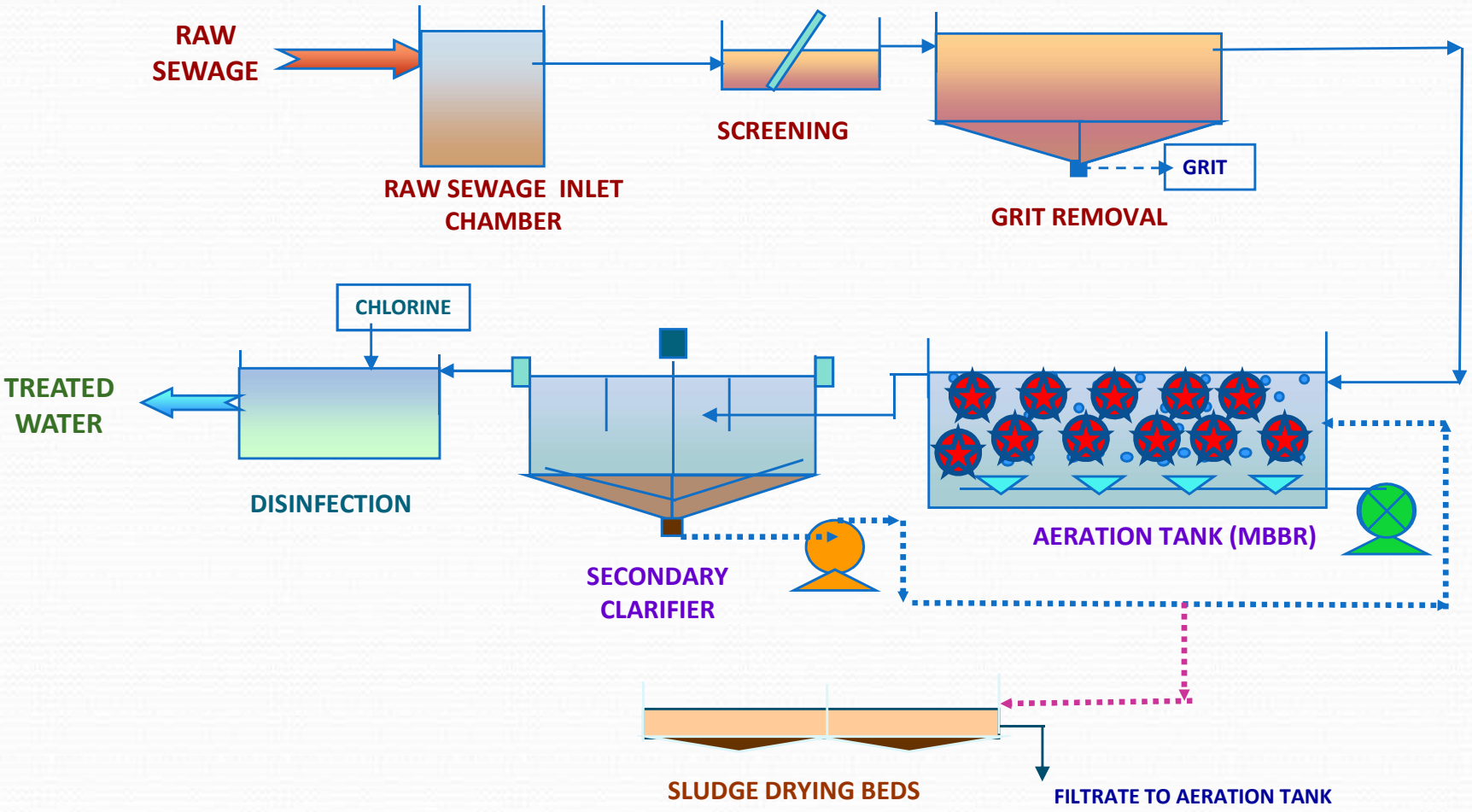


MOVING BED BIO REACTOR (MBBR)

- Invented by Prof Hallvard Odegaard at the Norwegian University of Science & Technology in the late 1980s
- Moving Bed Bio reactor consists of a tank with submerged but floating plastic (usually HDPE, polyethylene, or polypropylene with a density of 0.95 g/cm3 close to water) porous media that is ideally suited for immobilization of microorganisms essential for degradation of environmental pollutants. The large surface area of the plastics provides an abundant surface for bacterial growth. Biomass grows on the surface as a thin film. This continuous bio film is on a continuous rotating mass, which does not clog and does not require recirculation of sludge as required in ASP. Medium or coarse bubble diffusers uniformly placed at the bottom of the reactor maintain a dissolved oxygen (DO) concentration of > 2.5-3 mg/L for BOD removal. No sludge recycling is required for this process.

MBBR - Flow Diagram

MBBR-SC-CHL

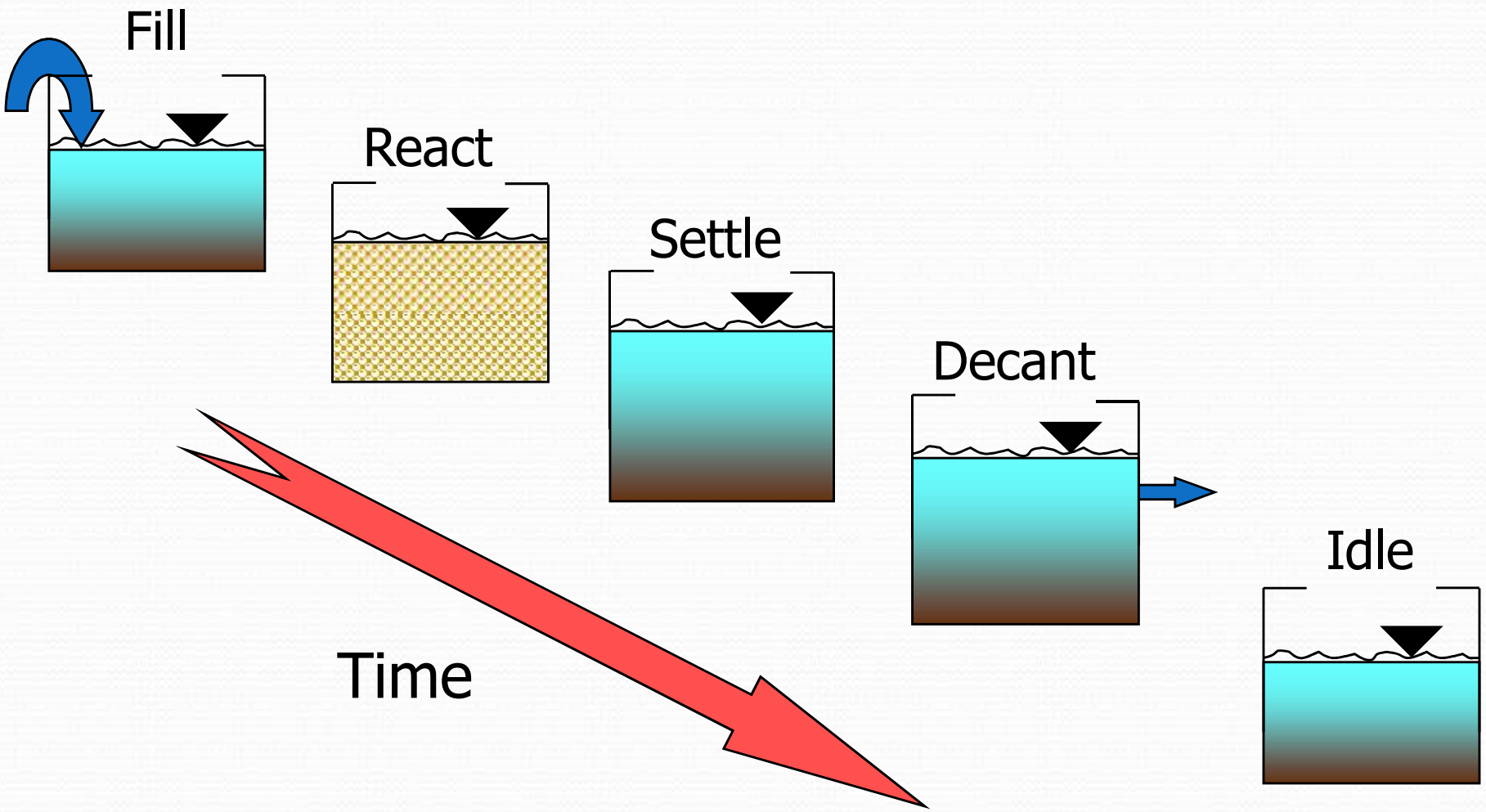


SEQUENCING BATCH REACTOR

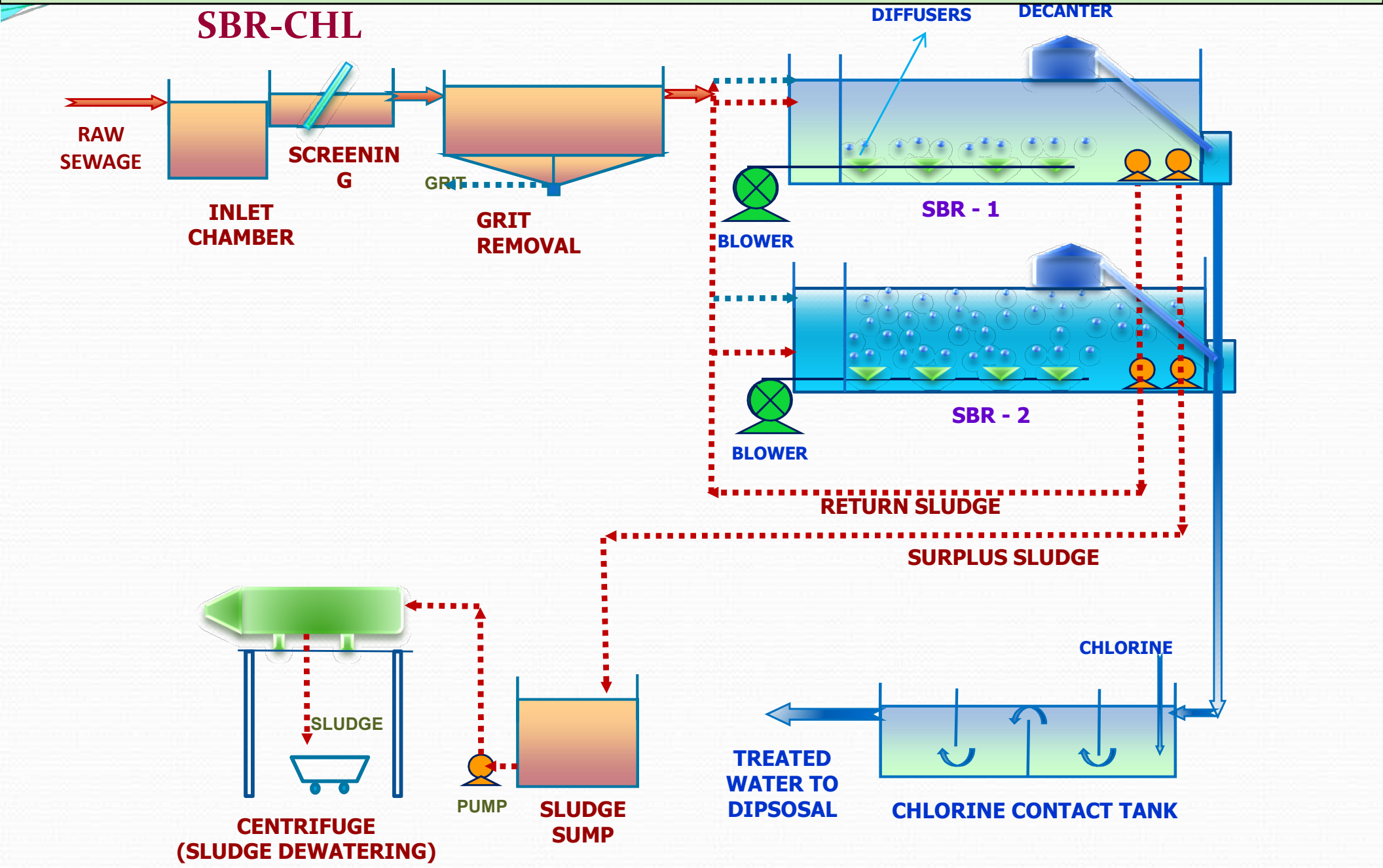
- SBR is a fill and flow type of reactor system involving a single complete mix reactor in which all steps of the activated sludge process occur.
- All SBR systems have five steps in common, which are carried out in sequence as follows:

  1. Fill
  2. React (aeration)
  3. Settle (sedimentation/clarification)
  4. Draw (decant)
  5. Idle.

Sequencing Batch Reactor



SBR - Flow Diagram



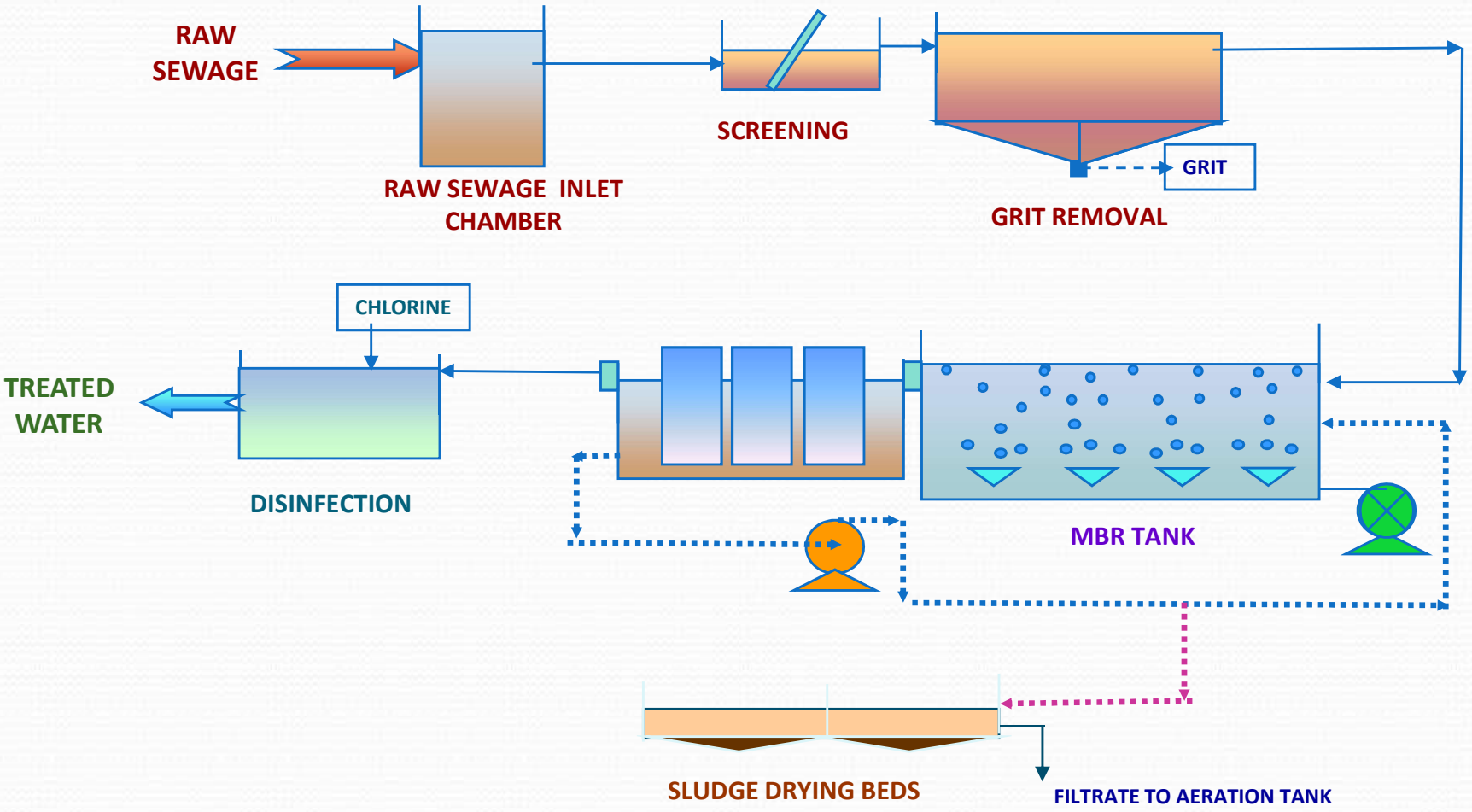
SBR

(MBR)MEMBRANE BIO REACTOR

1. It involves the removal of particulate and colloidal matter from a liquid. In membrane filtration, the range of particle sizes is extended to include dissolved constituents (typically 0.0001 to 1.0 µm).
2. It is based on Biological Treatment followed by membrane separation, a system comprising an intense activated sludge process with the biomass separation stage carried out by membrane cassettes located in a separate membrane tank.

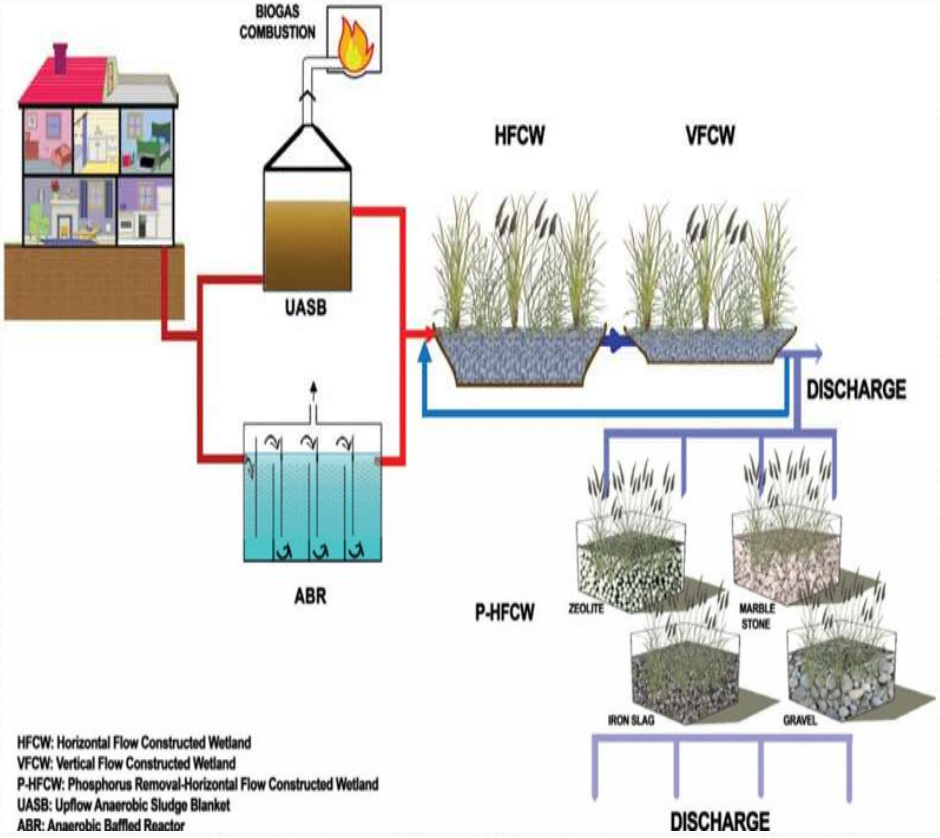
MBR- Flow Diagram

MBR-CHL

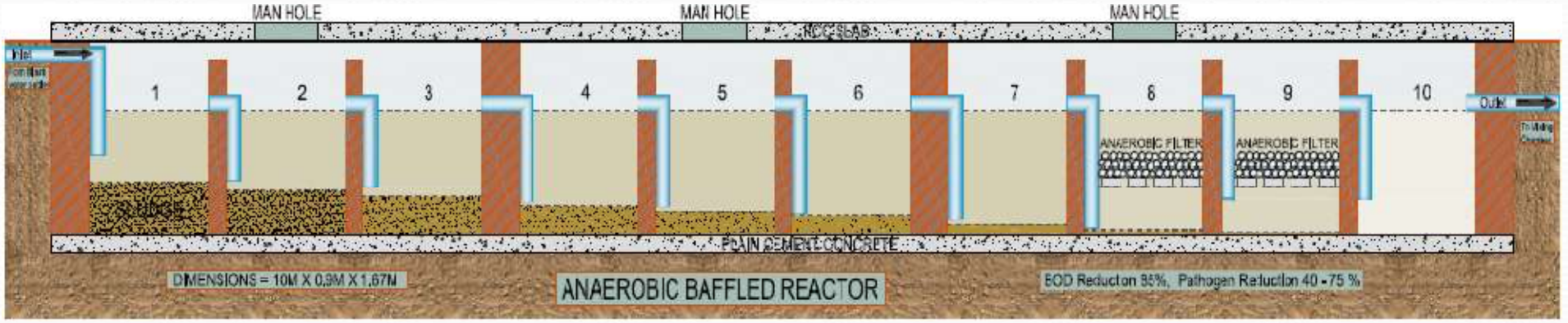


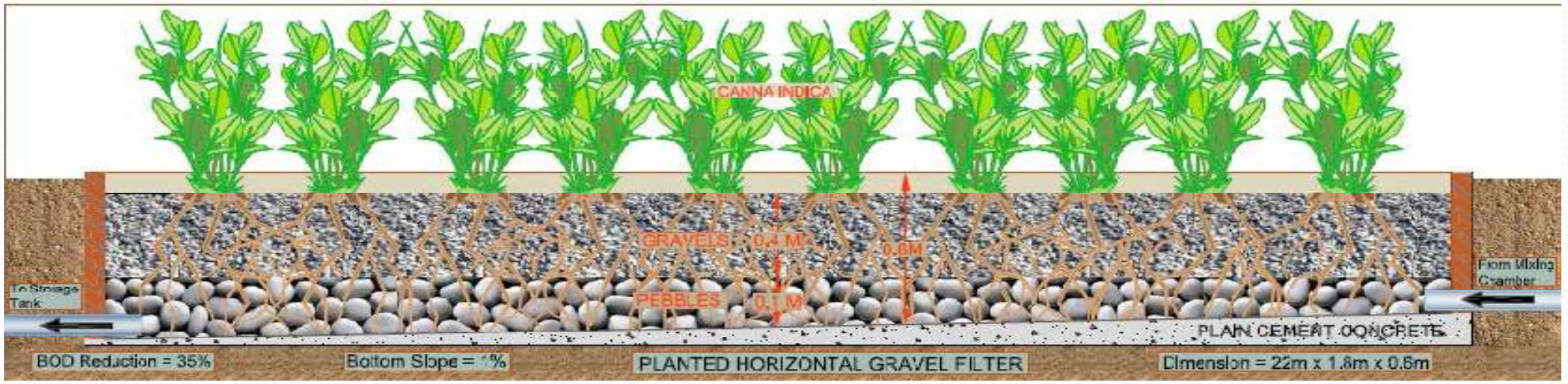
3. New Developments in Technologies

1. Activated Sludge Process with
   - Power Generation.
   - Composting of sludge
   - Tertiary treatment for high high-quality standard of treated effluent
2. Improved S.B.R.: In SBR technology, only the Aerobic process
3. Constructed Wetland system: Natural Bioremediation followed by Root Zone treatment process reduces the cost of maintenance.



A pilot Plant constructed at DJB H.Q. (35 KLD)





Eleocharis palustris, softstem burus, sweet flag, Narrow leaf cattail, Broad leaf arrowhead, Green Ash, Red Maple, Green arrow arum, Spartina altemiflora etc.

New Development in Technologies

4. Compact Sewage Treatment Plant:

5. Hydro Electrolysis

6. STPs based on Soil Biotechnology:

ROTATING BIOLOGICAL CONTACTOR (RBC)

7. RBC consists of a series of closely spaced circular disks of polystyrene or polyvinyl chloride. The cylindrical plastic disks are attached to a horizontal shaft.

The RBC unit is partially submerged in a tank containing the wastewater, and the disks rotate slowly. As the RBC discs rotate out of the wastewater, aeration is accomplished by exposure to the atmosphere. Microbes are also attached and multiply on the disc, which accelerates the process

Integrated Fixed Film Activated Sludge Process

8. IFFAS:

1. **Combination of activated sludge** with **attached-growth** biofilm processes.
2. It involves adding media carriers (usually made of plastic or synthetic materials) to the aeration tanks of existing wastewater treatment systems. These carriers provide a surface for microbial biofilms to grow, supplementing the suspended microbial population in the sludge. It is widely used to upgrade plants to meet **tertiary treatment standards.**
3. It enhances treatment capacity and efficiency, reduces sludge production, and requires a low capital cost for retrofitting existing plants

4. Selection of Technology.....?

1. **Centralized or Decentralized..?**
2. **Selection of technology**: Oxidation ponds, ASP, Extended Aeration, SBR, MBBR, MBR, BCR(Seoul), Bioremediation /Constructed Wetland: Phytorid..?, Bio-technica, DEWAT..? Or any others

4. Selection of Technology.....?

Cost-Benefit Analysis:

CAPEX

Vs

Power Generation

If Power Generation: Additional CAPEX on Primary Clarifiers, Biodigesters, Gas holders, Scrubbers, Biogas Engine, Alternators, etc., and operational cost on these infrastructures

Vs

Cost of power produced

End Use.....?

S. No.	Purpose of utilization	Treated effluent standard	Remarks
1.	Agriculture/Horticulture	Secondary treated	BOD<30 SS<50 PPM
2.	Cooling in thermal plants	Tertiary treated	BOD<5 SS<5 PPM
3.	Groundwater recharge	Tertiary treated	MPN<250 PPM
4.	Flushing & washing	Tertiary treated	MPN<250 PPM
5.	Firefighting	Secondary treated	BOD<30 SS<50 PPM
6.	Construction	Tertiary treated as per BIS	As per BIS: 456:2000
7.	Industries	Depending upon use	Depending upon type of use in processing

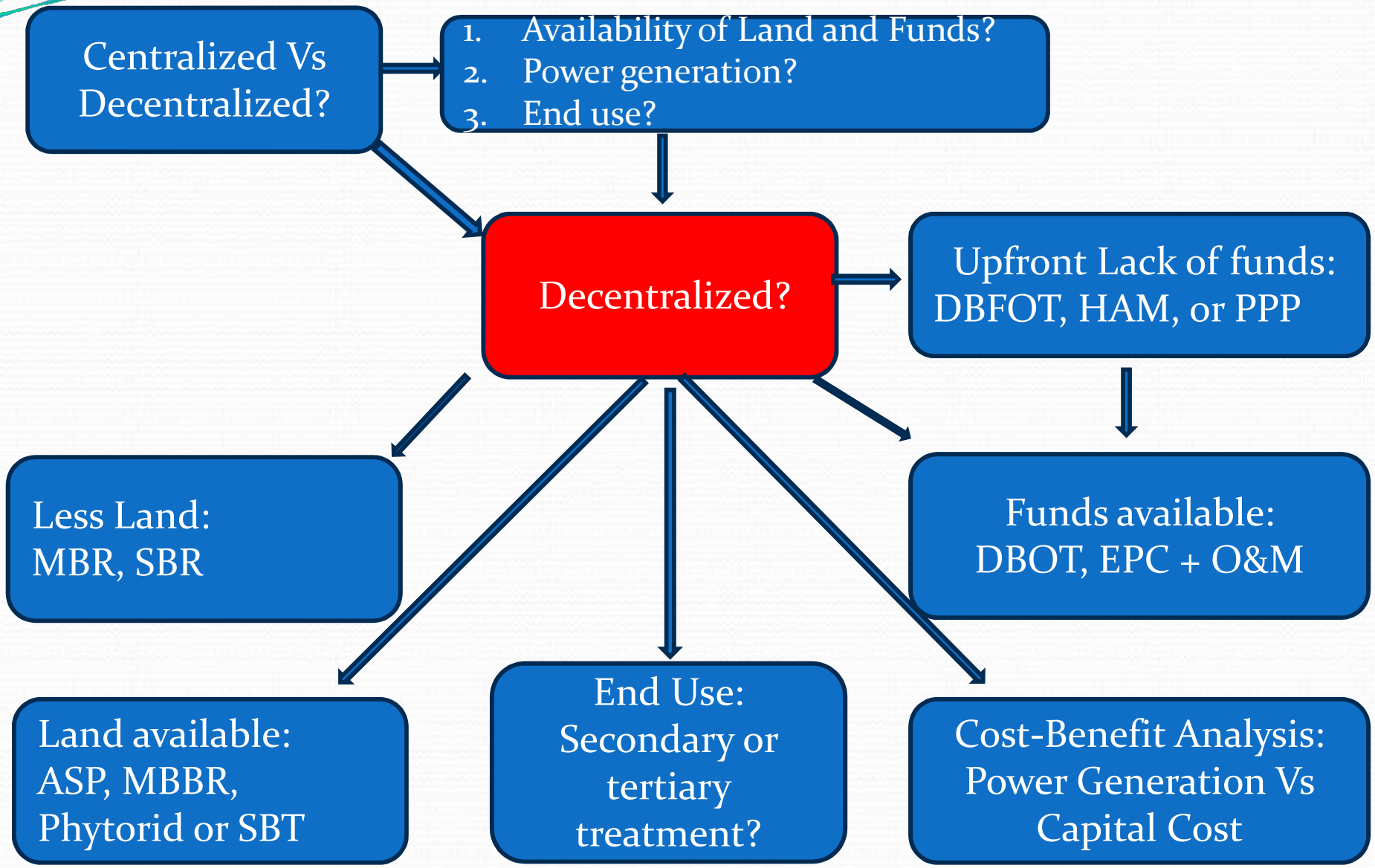
Selection of Business Model

1. EPC: Engineering, Procurement, and Construction
2. DBOT: Design, Build, Operate, and Transfer.
3. DFBOT: Design, Finance, Build, Operate, and Transfer.
4. HAM: Hybrid Annuity Model
5. PPP: Public-Private Partnership Model

Technology Comparison

Parameter	UASB+EA	ASP	MBBR	MBR	SBR
BOD, mg/l	<30	<30	<20-30	<3-<5	<5
COD, mg/l	<250	<250	<250	<100	<100
TSS, mg/l	<100	<100	<100	<5	<10
TKN &P, mg/l	No Treatment	No Treatment	No Treatment	No Treatment	<10 <2
Area, Acres	15.6	10.9	5.5	5	6.3
Capital Cost, Rs. Lac (100MLD)	6500	6000	7000	25000	8000
Power cost, Rs/m3	1.11	1.71	1.8	3.0	1.14
Chemical Cost	0.07	0.07	0.07	0.50	0.06
Maintenance cost, Rs./m3	0.22	0.22	0.25	1.1	0.27
Power generation	Yes	Yes/ Nil	Nil	Nil	Nil

Selection of Technology and Business Model



Thank You !

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