



Probiotic[®] SOLUTIONS

Wastewater 301

By

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Wastewater 301 Outline

- ***Abbreviations***
- ***Wastewater Overview***
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 - Composition
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 - Nitrogen Cycle
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Wastewater 301 Outline Continued

- ***Biological Treatment with Probiotic Solutions Applications***
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 - Septic Systems
 - Lagoons
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 - Alternate Activated Sludge Technologies
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 - In Place
 - In Motion
- ***Additional Considerations***
 - Odors
 - Vectors
 - Permitting requirements

Abbreviations

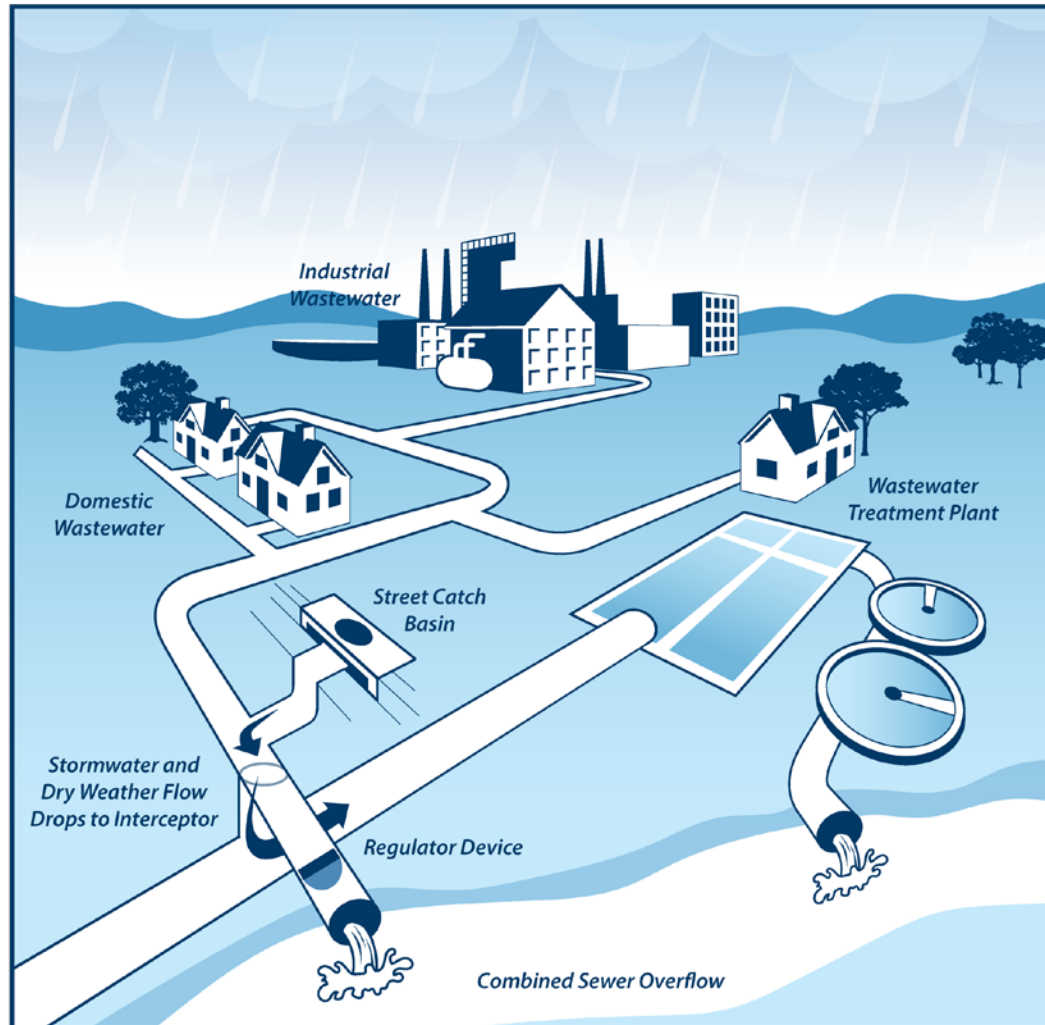
- **BOD** Biochemical oxygen demand
- **COD** Chemical oxygen demand
- **DO** Dissolved oxygen
- **F** Mass loading of BOD per day
- **FOG** Fats, oils and grease
- **F/M** Food to Microorganism ratio
- **gpm** Gallons per minute
- **INF** Influent plant flow
- **M** Mass of MLSS under aeration
- **MCRT** Mean cell residence time
- **MGD** Million gallons per day
- **mg/L** Milligrams per liter
- **MLSS** Mixed liquor suspended solids
- **NH₃** Ammonia
- **ppm** milligrams/10⁶ milligrams
- **SOUR** Specific oxygen uptake rate
- **SV₃₀** Sludge volume time at 30 min.
- **SVI** Sludge volume index
- **TKN** Total Kjeldahl Nitrogen
- **TOC** Total organic carbon
- **TSS** Total suspended solids
- **RAS** Return activated sludge flow
- **WAS** Waste activated sludge flow
- **VSS** Volatile suspended solids
- **TVS** Total volatile solids
- **VOC** Volatile organic carbon

Wastewater Overview

- **Wastewater Sources**

- Typical water use per residential capita is 100 gallons per day (gpd)
- 60-85% of per capita water used becomes wastewater
- Other sources of wastewater are
 - Industrial/Commercial
 - Infiltration/inflow (I/I)
 - Storm run off
- Treatment Systems are sized for average flows with capacity for peak hourly flows

Wastewater Overview Cont.



Typical Composition of Untreated Domestic Wastewater

Contaminants	unit	Concentration		
		Weak	Medium	Strong
Solids, Total (TS)	mg/L	350	720	1200
Dissolved, total (TDS)	mg/L	250	500	850
Fixed	mg/L	145	300	525
Volatile	mg/L	105	200	325
Suspended solids (SS)	mg/L	100	220	350
Fixed	mg/L	20	55	75
Volatile	mg/L	80	165	275
Settleable solids	mL/L	50	10	20
Biochemical oxygen demand (BOD ₅)	mg/L	110	220	400
Total organic carbon (TOC)	mg/L	80	160	290
Chemical oxygen demand (COD)	mg/L	250	500	1000
Nitrogen (total as N)	mg/L	20	40	85
Organic	mg/L	8	15	35
Free ammonia	mg/L	12	25	50
Nitrites	mg/L	0		0
Nitrates	mg/L	0	0	0
Phosphorous (total as P)	mg/L	4	8	15
Organic	mg/L	1	3	5
Inorganic	mg/L	3	5	10
Chlorides	mg/L	30	50	100
Sulfate	mg/L	20	30	50
Alkalinity (CaCO ₃)	mg/L	50	100	200
Grease	mg/L	50	100	150
Total coliform	no/100 mL	10 ⁶ - 10 ⁷	10 ⁷ - 10 ⁸	10 ⁸ - 10 ⁹
Volatile Organic Compounds (VOCs)	µg/L	<100	100 - 400	>400

Metcalf and Eddy, Inc

Wastewater Treatment Monitoring

Influent

- pH
- BOD mg/L
- COD mg/l
- TSS mg/l
- VSS mg/l
- TEMP °C
- NH₃ mg/l
- TKN mg/l

Effluent

- pH ¹ units
- DO mg/l
- BOD mg/l and % removal
- COD mg/l
- TSS mg/l and % removal
- TDS mg/l
- FECAL COLI. /100 ml
- AVG TURB. NTU
- MAX TURB. NTU
- NH₃ mg/l
- TKN mg/l
- Total N mg/l and % removal

Biological Needs

In Addition To Carbon source

Principal Nutrients

- Nitrogen
- Sulfur
- Potassium
- Phosphorus
- Magnesium
- Calcium
- Iron
- Sodium
- Chlorine

Micronutrients

- Zinc
- Manganese
- Molybdenum
- Selenium
- Cobalt
- Copper
- Nickel
- Vanadium
- Tungsten

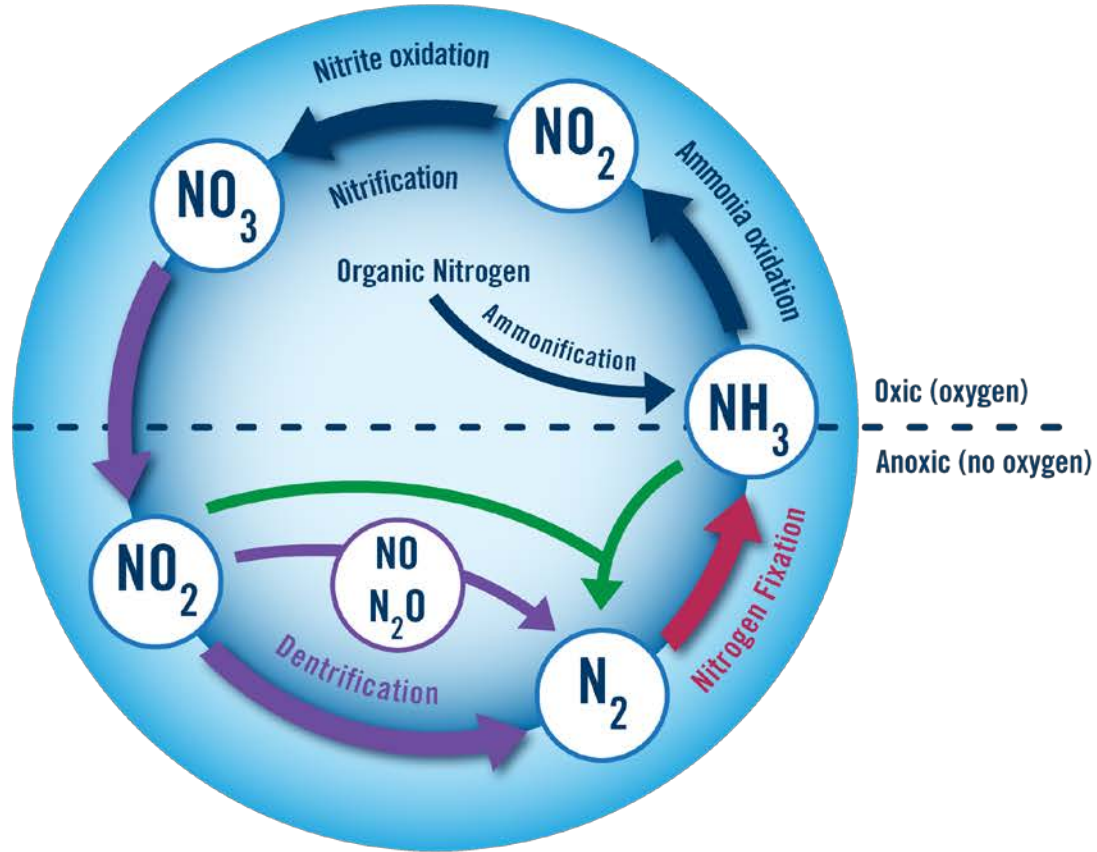
Addtl. growth factors: amino acids, purines and pyrimidines, vitamins

Nitrogen Cycle

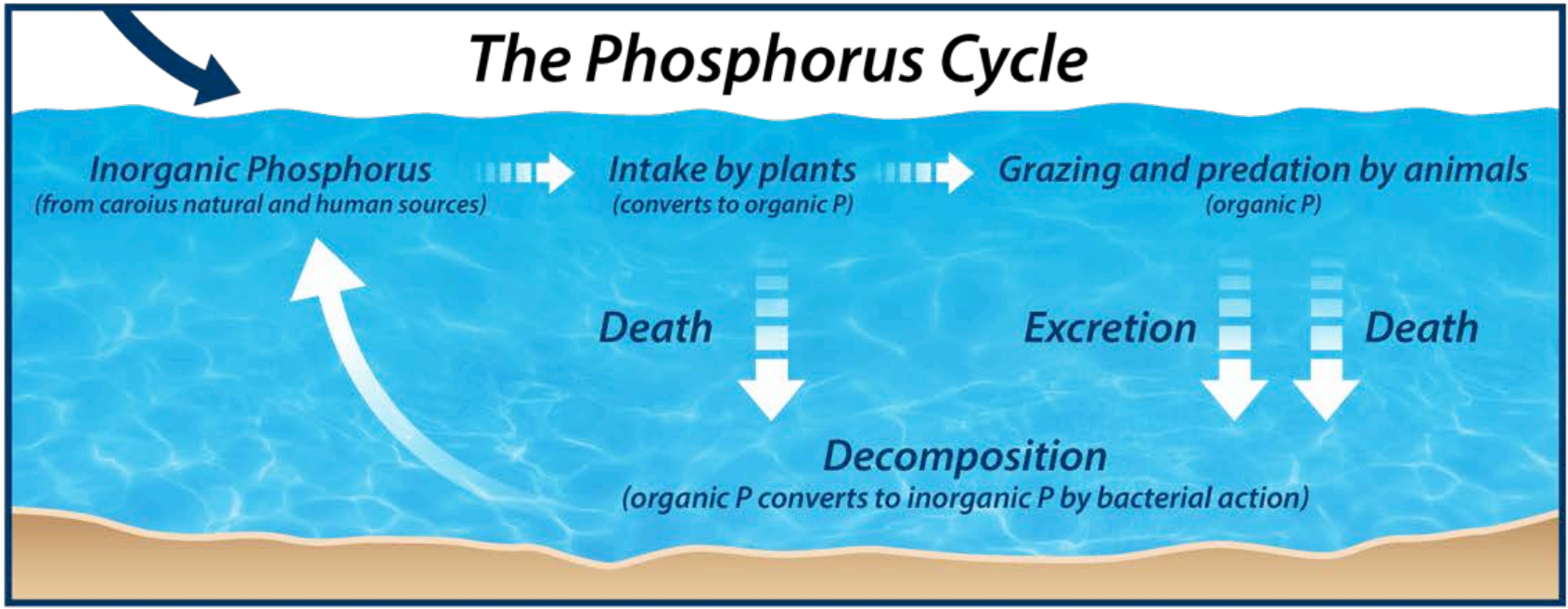
- **Elements**

- Fixation- nitrogen (N_2) in the atmosphere is converted into ammonium (NH_4^+)
- Ammonification- bacteria or fungi convert the organic nitrogen within the solids back into ammonium (NH_4^+)
- Nitrification- oxidation of ammonium (NH_4^+) is performed by bacteria, into nitrates (NO_3^-)
- Denitrification- reduction of nitrates back into the largely inert nitrogen gas (N_2)

Nitrogen Cycle Cont.



Phosphorus Cycle

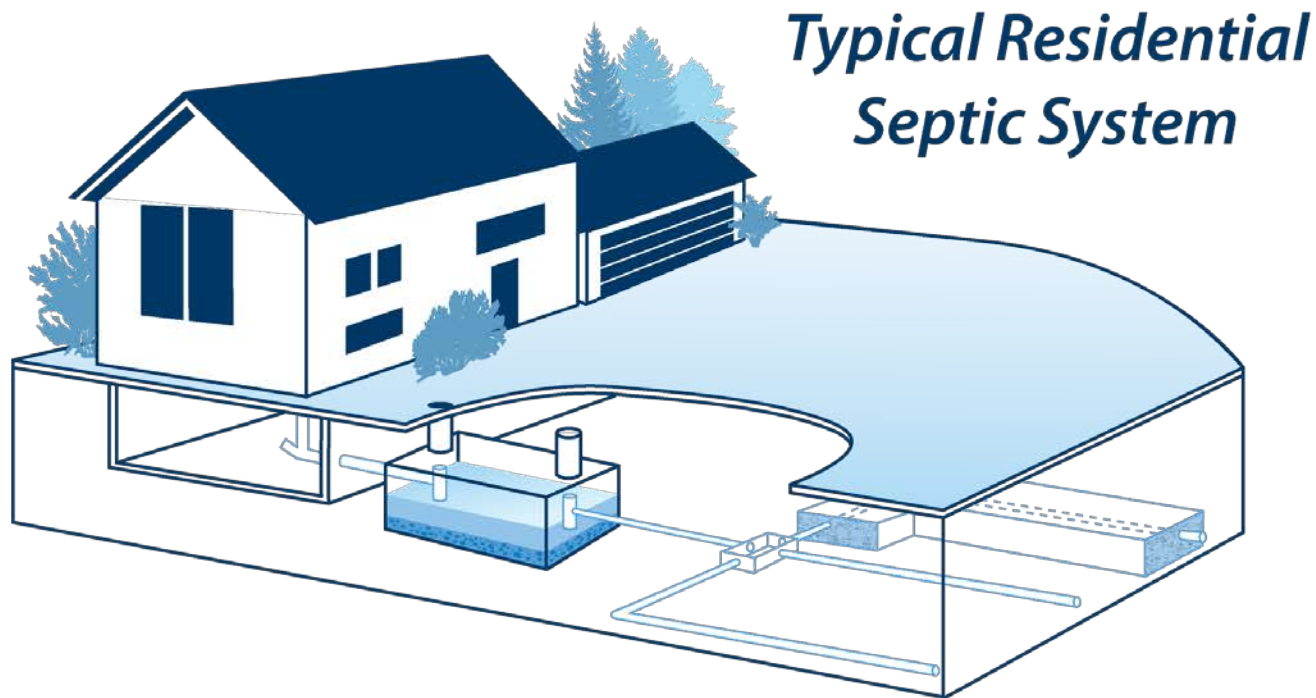


Biological Treatment

- ***Suspended Growth Biological Treatment***
 - Activated Sludge Treatment
 - Conventional
 - Alternate Technology
 - Sequencing Batch Reactor
 - Membrane biological reactors
 - Oxidation Ditches
- ***Attached Growth Biological Treatment***
 - Medium
 - In place
 - In motion

Septic Systems

- **Septic**- application points are at influent (toilet) and discharge box to leach field



Lagoon Treatment

- ***Collection System***
 - Sewer, storm drain, pump stations
- ***Preliminary treatment*** (Headworks)
 - Bar screens, grit removal, sometimes odor control
- ***Primary treatment/Lagoons***
 - Aerobic
 - Anaerobic
 - Facultative

Lagoon Treatment Cont.

- ***Disinfection***
 - Ultraviolet (UV) light
 - Chlorine/contact basin
- ***Water Use***
 - Irrigation
 - Recharge underground
 - Discharge to body of water
- ***Biosolids/Dredging***
 - Landfill or land application

Lagoon Treatment Cont.



Suspended Conventional Treatment

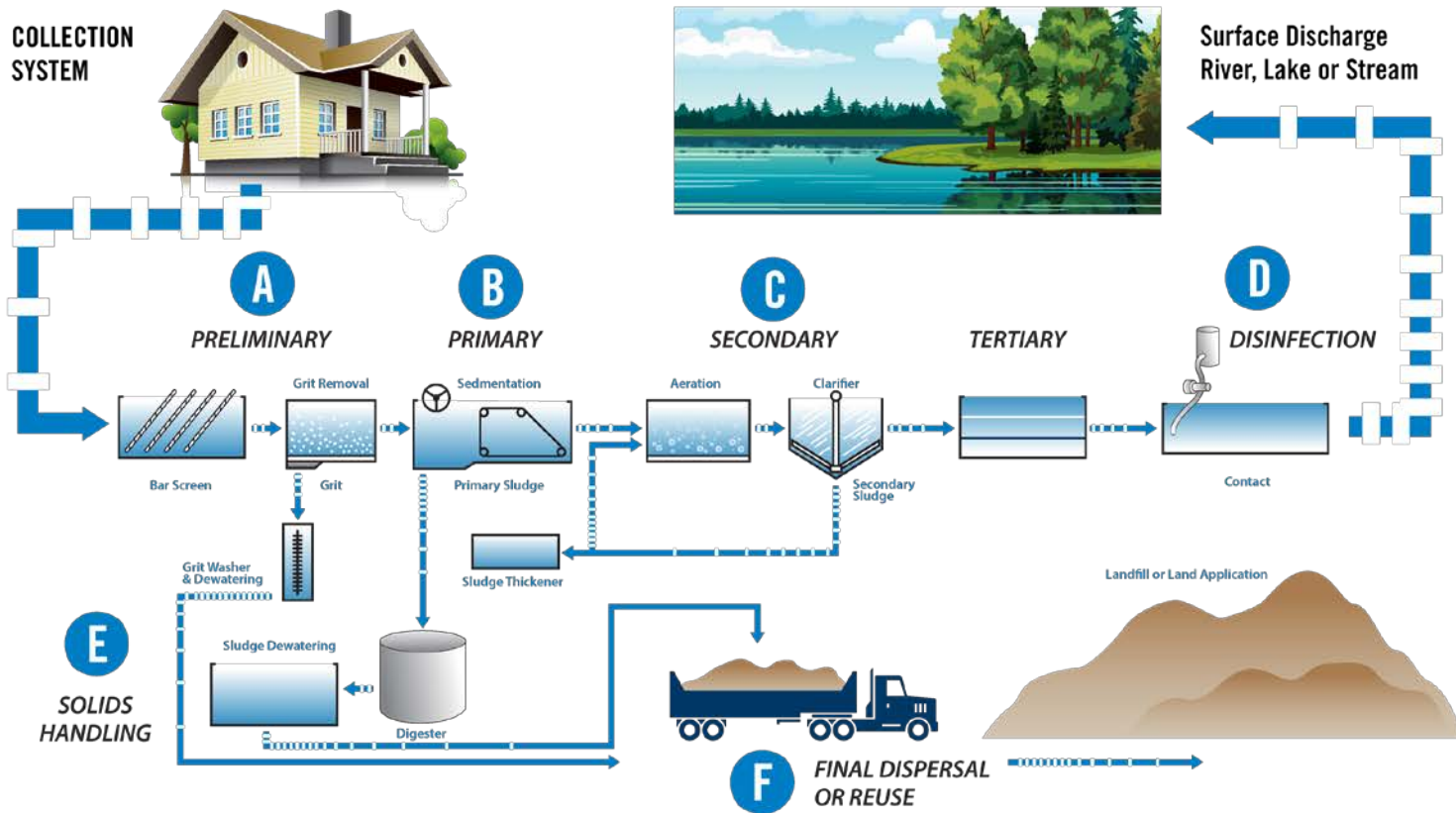
- ***Collection System***
 - Sewer, storm drain, pump stations
- ***Preliminary treatment*** (Headworks)
 - Bar screens, grit removal, odor control (H₂S)
- ***Primary treatment***
 - Primary clarifiers, settling tanks
 - Chemicals used for sedimentation include alum, lime, ferric chloride, ferric sulfate
- ***Secondary treatment*** (Biological)
 - Aerobic or anaerobic treatment,
 - Activated sludge returned in system and wasted for biosolids handling (RAS/WAS)

Suspended Conventional Treatment Cont.

- ***Tertiary treatment***
 - Coagulation sedimentation (polymer)
 - Filtration- sand or activated carbon
 - Reverse osmosis
- ***Disinfection***
 - Ultraviolet (UV) light
 - Chlorine/contact basin, breakpoint chlorination
- ***Effluent Use***
 - Irrigation
 - Recharge underground
 - Discharge to body of water
- ***Biosolids handling***
 - Landfill or land application

Suspended Conventional Treatment Cont.

Wastewater Treatment Cycle

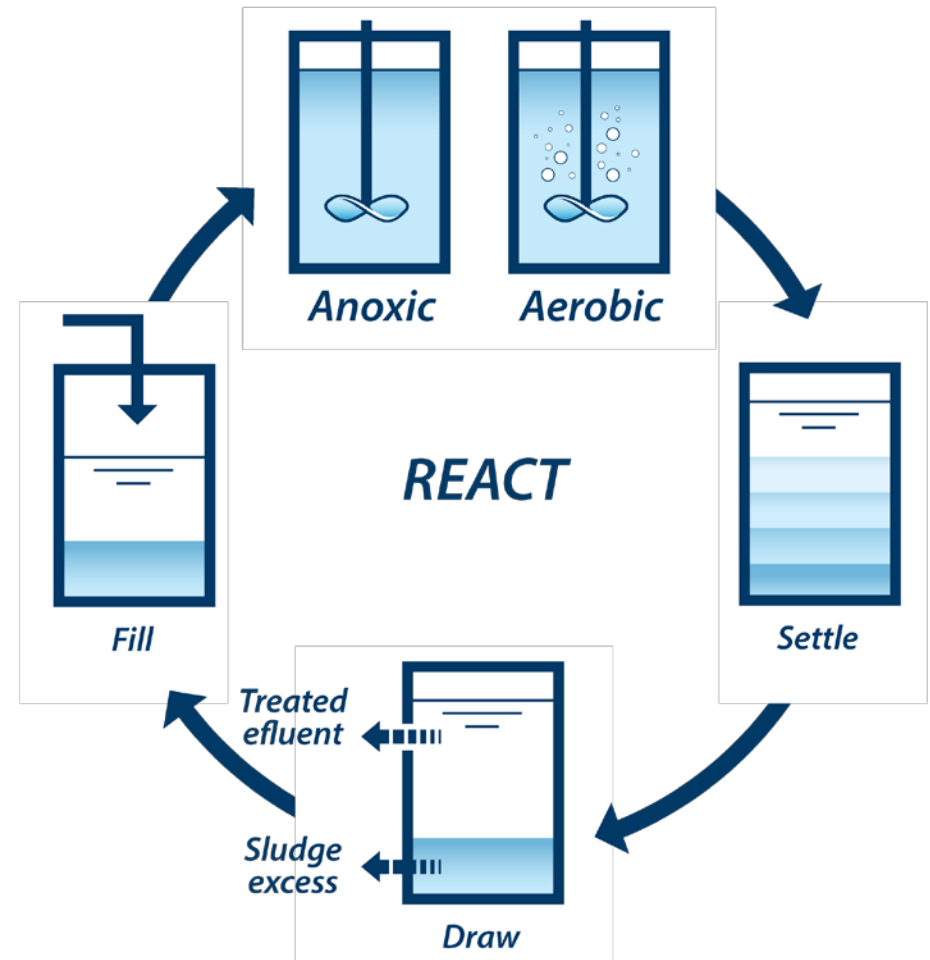


Suspended Conventional Treatment Cont.



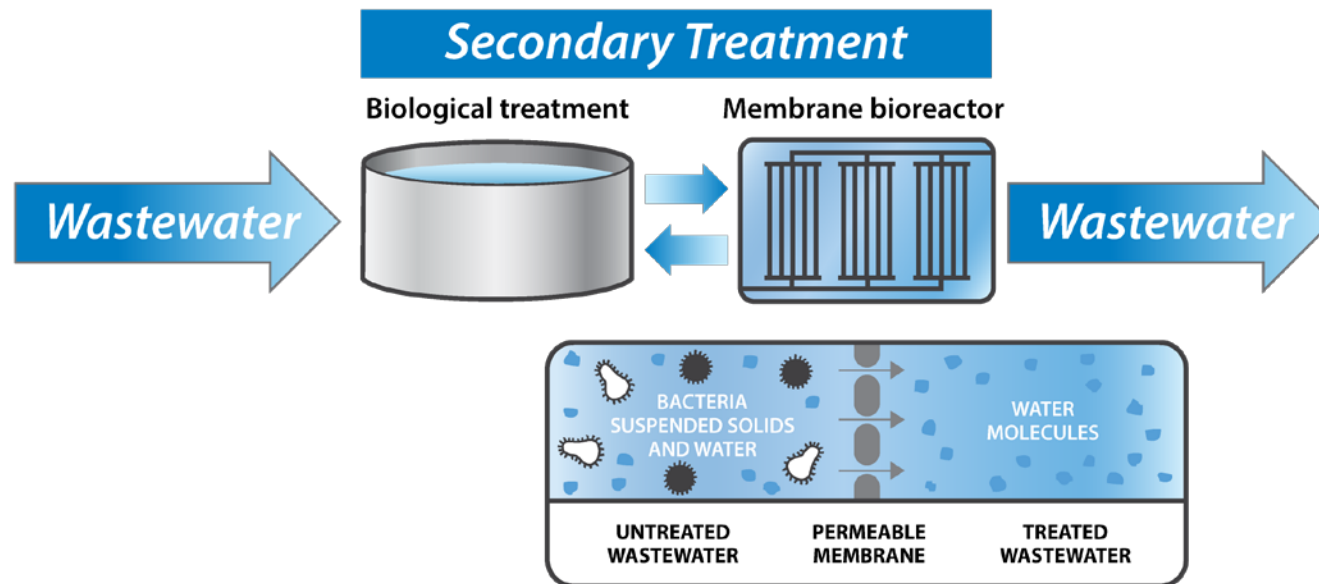
Suspended Alternate Technologies

- A sequencing batch reactor (SBR) uses one tank for the entire treatment process



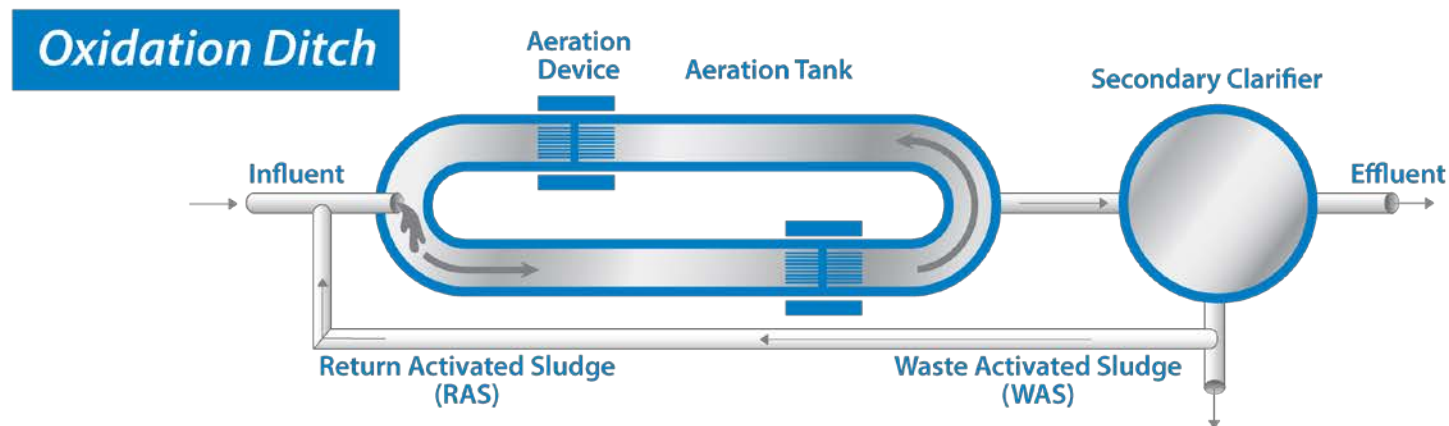
Suspended Alternate Technologies Cont.

- Membrane biological reactors (MBR) instead of a clarifier, the system has a membrane filter – microfiltration or ultrafiltration



Suspended Alternate Technologies Cont.

- The oxidation ditch is a variation of the activated sludge process.
 - ring or oval-shaped channel equipped with mechanical aeration devices, such as brush rotors or disc aerators.



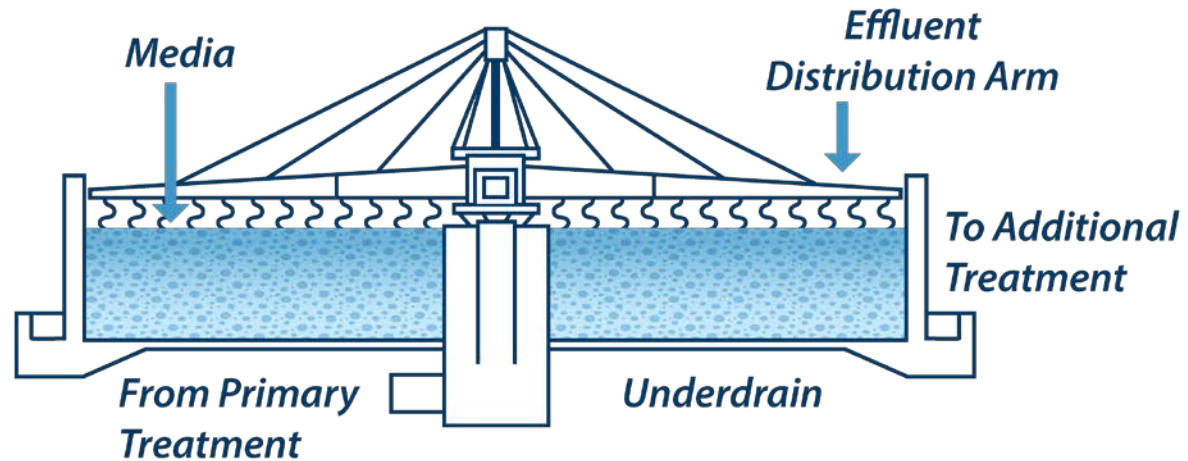
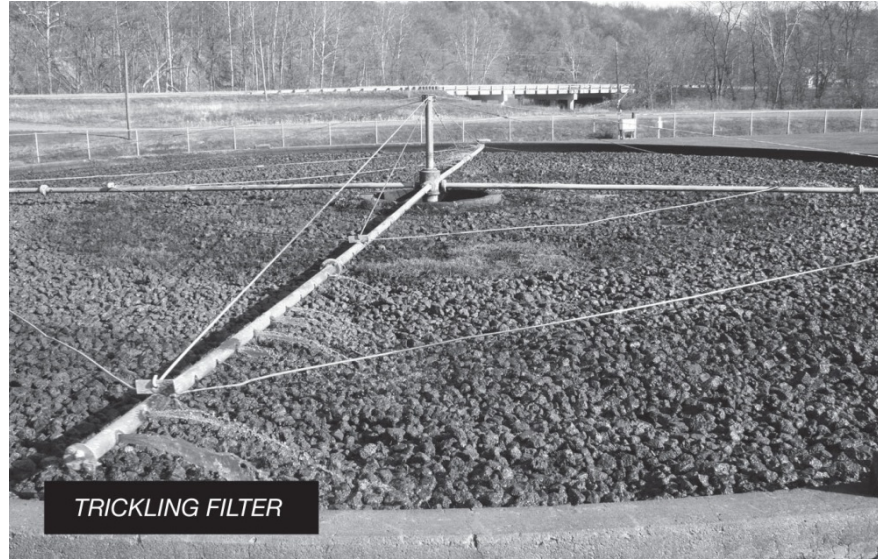
Suspended Alternate Technologies Cont.



Attached Growth

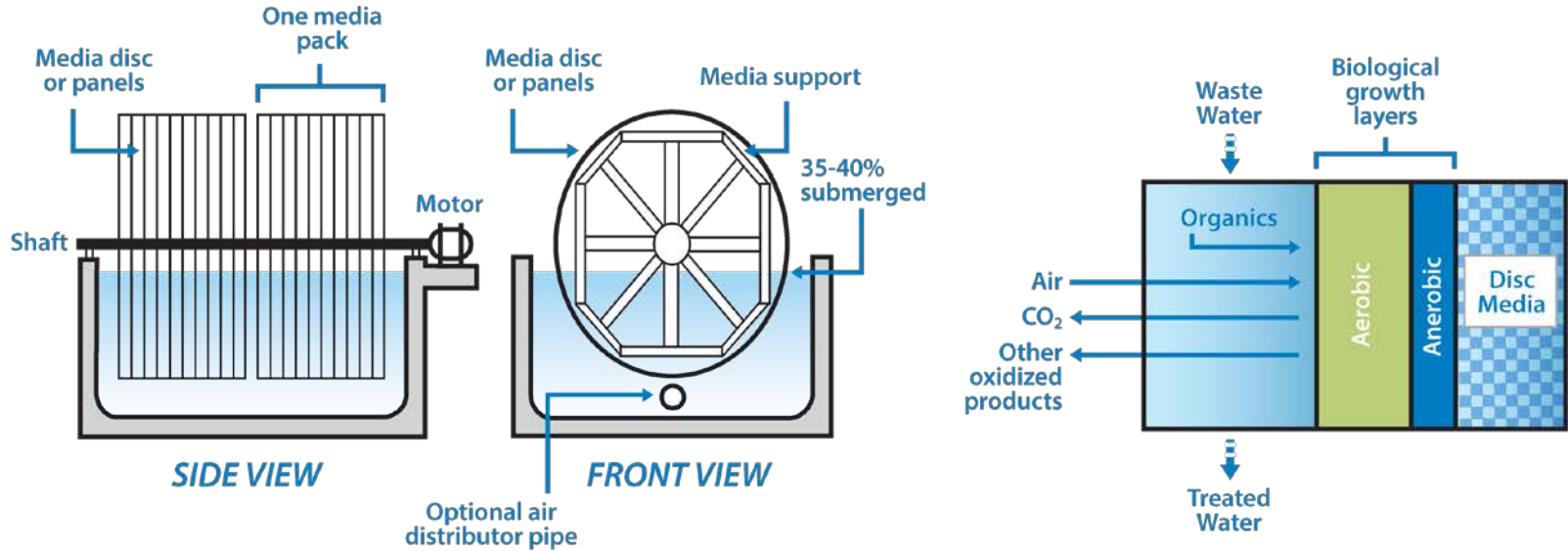
- Attached growth or fixed film systems make use of organisms that are attached to a medium or substrate.
- ***Two basic designs***
 - Media in place, allowing the wastewater to flow over the bed
 - trickling filters, wastewater percolates through slime covered media
 - Media is in motion, relative to the wastewater
 - Rotating Biological Contactors (RBCs) consist of a series of closely spaced, circular, plastic disks mounted on a shaft.

Attached Growth Cont.



Attached Growth Cont.

Rotating Biological Contactor



- Primary causes of odors are due to inefficiencies in solid reduction caused by
 - Lack of nutrients
 - Insufficient aeration
 - Reduction or death of microbial population

Odorous Compound	Quality
Amines	Fishy
Ammonia	Ammoniacal
Diamines	Decayed Flesh
Hydrogen sulfide	Rotten eggs
Mercaptans	Decayed cabbage or skunk
Organic sulfides	Rotten cabbage
Skatole	Fecal matter

Vectors

- ***Vectors***- transmit the causative agent of human disease, or capable of producing human discomfort or injury.
- ***Examples***
 - Midge flies
 - Mosquitos
 - Flies

Permitting Requirements

- State dependent
- Arizona Pollutant Discharge Elimination System (AZPDES) Permit Program,
 - all facilities that discharge pollutants from any point source into waters of the United States (navigable waters)
 - Includes classification of treated wastewater quality
- Aquifer Protection Permit (APP),
 - discharges a pollutant either directly to an aquifer or to the land surface or the vadose zone that will reach an aquifer.
- Reclaimed Water Classifications

References

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Thank You
