

# SWIM and Horizon 2020 Support Mechanism

Working for a Sustainable Mediterranean, Caring for our Future

## SWIM-H2020 SM Regional Activities 14

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**SWIM and Horizon 2020 SM REG-14: Refugee Emergency: Fast track project Design of wastewater**

26 March 2018, Beirut, Lebanon

This Project is funded by the European Union

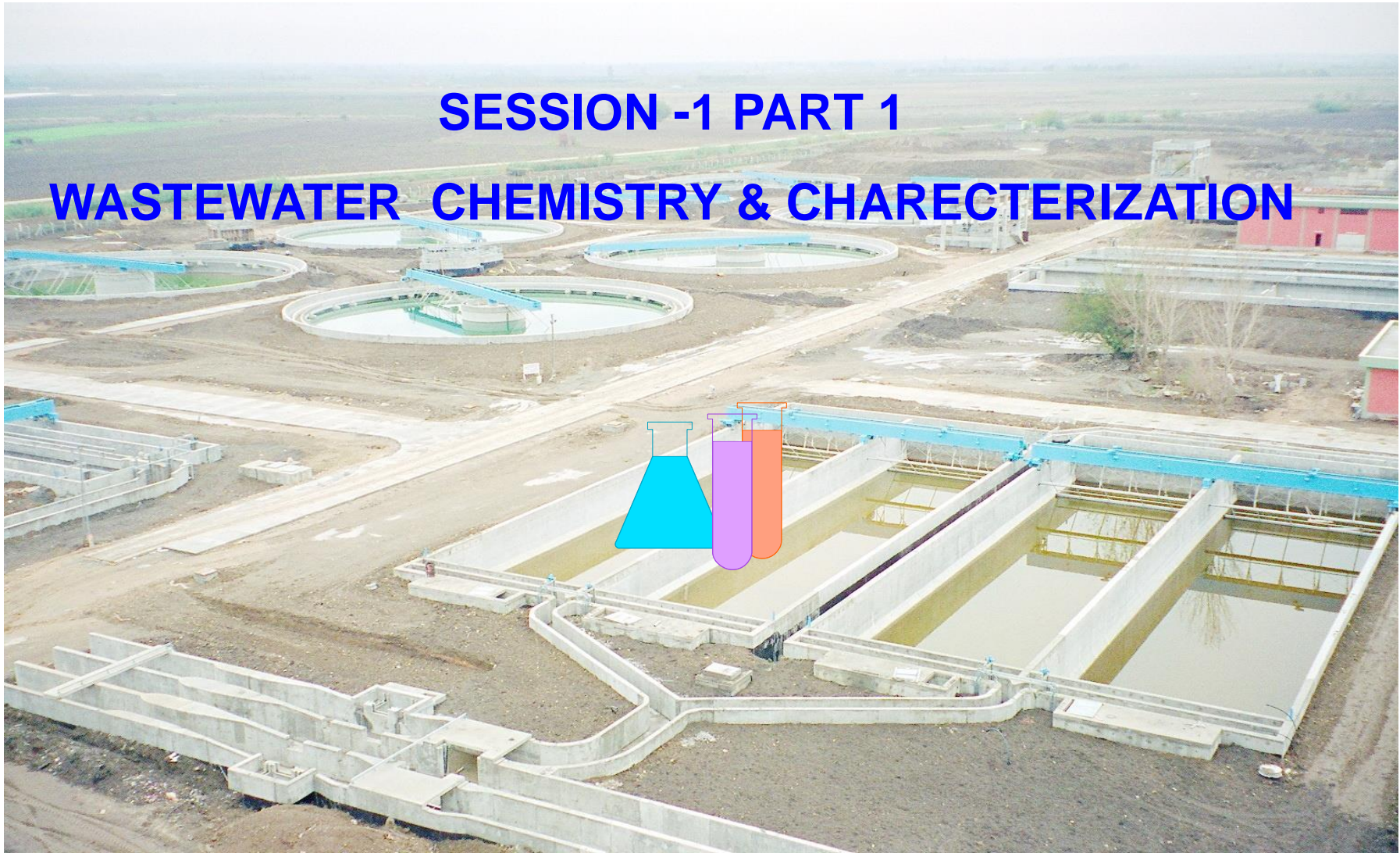


ENVIRONMENT AGENCY AUSTRIA **umweltbundesamt**

**ATKINS**

# SESSION -1 PART 1

## WASTEWATER CHEMISTRY & CHARACTERIZATION



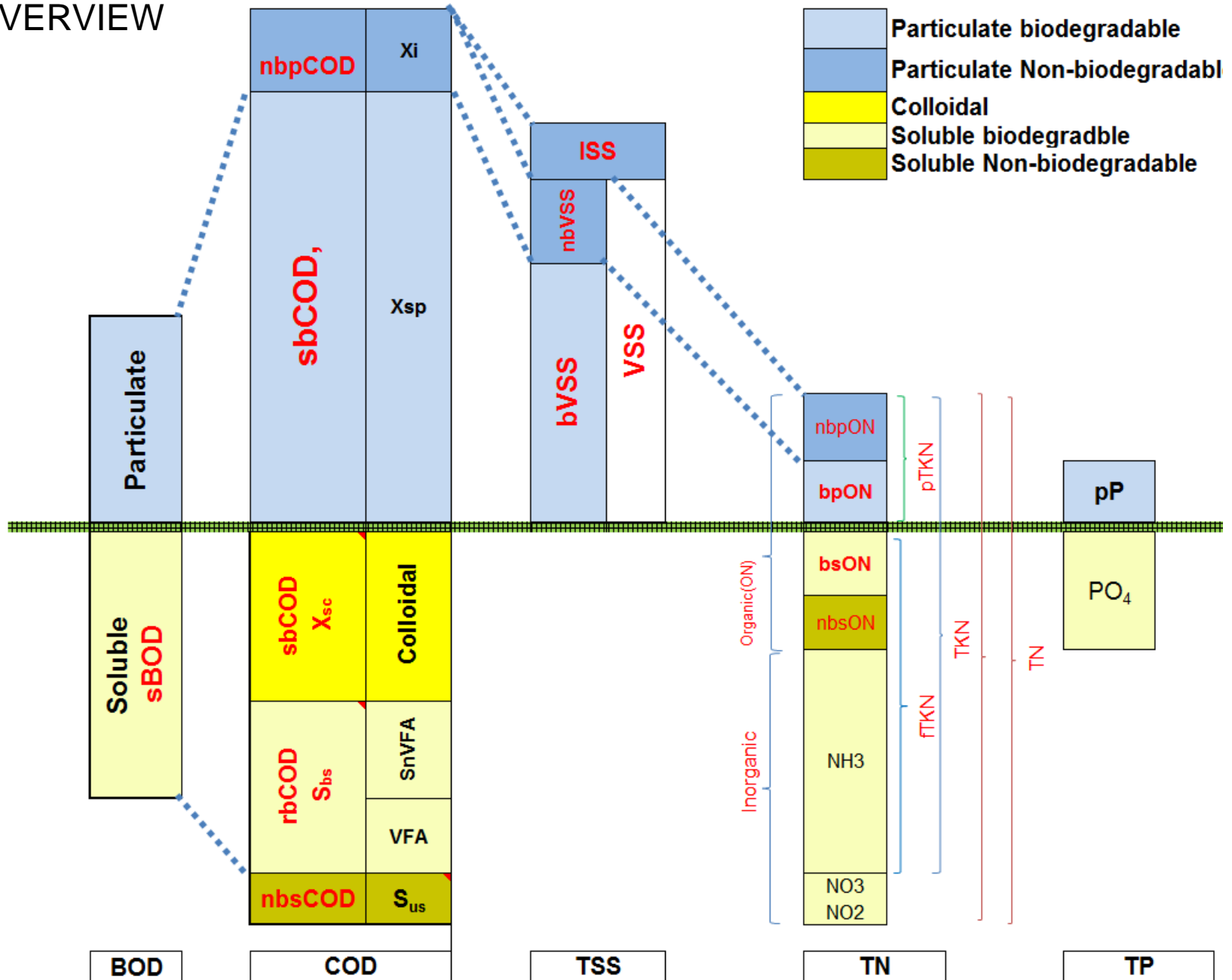
# WASTEWATER CHEMISTRY & CHARACTERIZATION

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2. Wastewater Sampling Methods
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9. Alkalinity
10. Measurement Methods for Wastewater Characterization
11. Recommended typical fractions
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# OVERVIEW



# ADVANTAGE OF WW CHARACTERIZATION TRAINING

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- Understanding of WW analysis reports.
- Assessment of WW quality data.
- Prerequisite for using Simulation Modeling.

BioWin

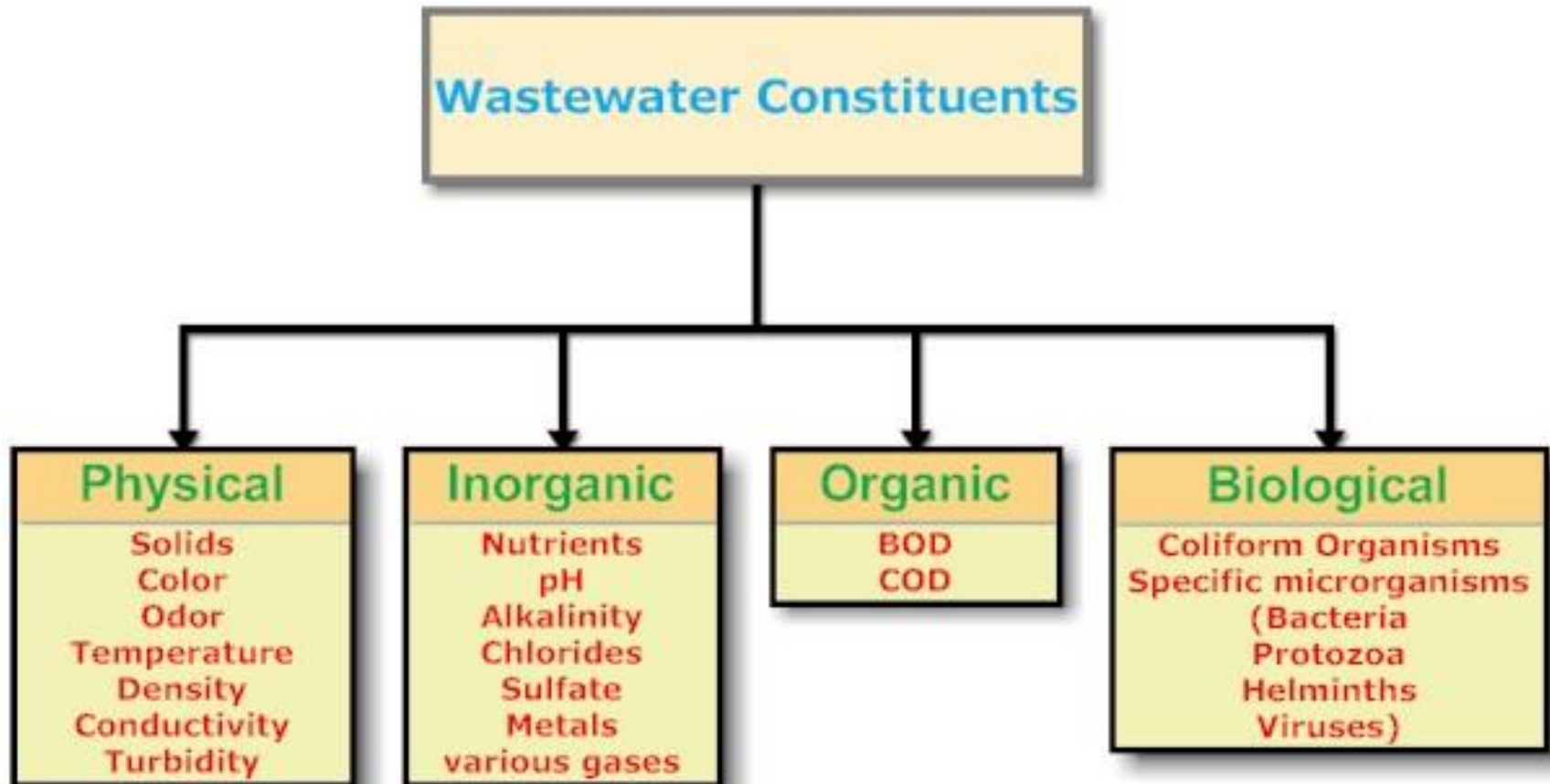
GPS-X





# CONSTITUENTS IN WASTEWATER

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# DISSOLVED Vs PARTICULATE

- **Dissolved Solids(S)**

- The solids contained in the filtrate that passes through a filter paper with nominal pore size of  $2.0 \mu\text{m}$  or less(Standard Methods 1988).

- **Colloidal Matter**

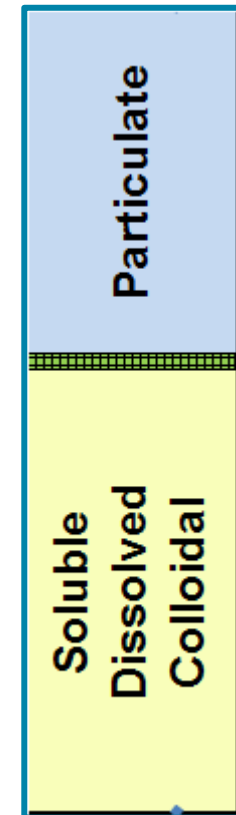
- Dissolved solids.
- The size of the colloidal particles in wastewater is typically in the range from  $0.01$  to  $1.2 \mu\text{m}$ .

- **Dissolved & Particulate BOD & COD**

- The pore size of the filter paper recommended in Standard Methods for differentiating between dissolved and particulate BOD & COD is  $1.2 \mu\text{m}$ .

- **Particulate Matter(X)/suspended Solids**

- Material that retained in a filter paper of a certain size.





# VOLATILE vs INERT SOLIDS

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- **General**

- If solids are “organic”, the material is carbon-based and will burn. “Inorganic” solids, on the other hand, are mineral based and generally will not burn. Any material that was at one time living (for example: body wastes, starches, sugars, wood, bacteria and cotton) are all organic while limestone, iron and calcium are inorganic.

- **Volatile solids(Organic Solids):**

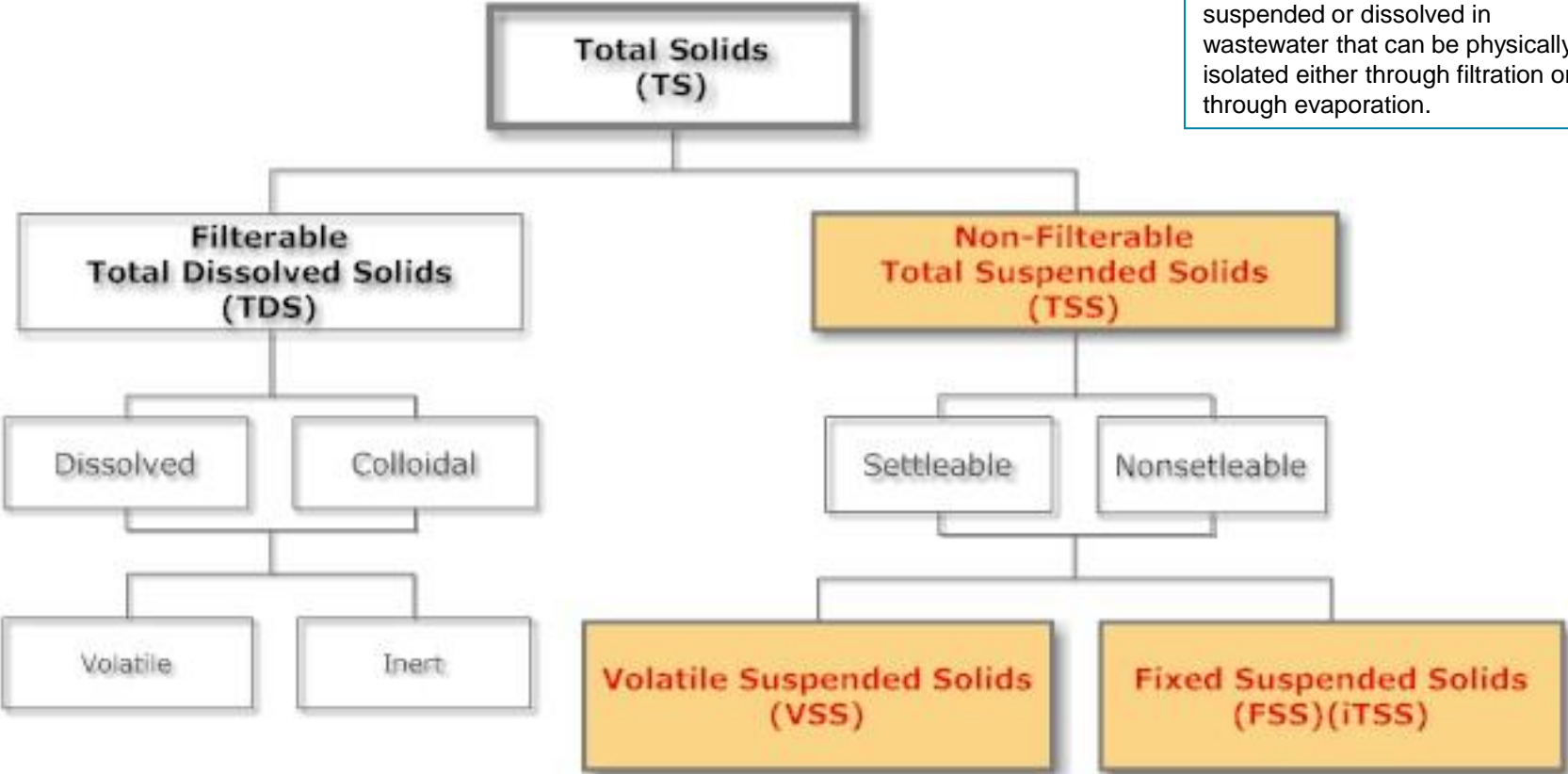
- Those solids which are lost during ignition (by burning) for 15-20 minutes at 550 +/-50°C. In general, volatile solids are made up of organic material.

- **Fixed Solids(Fixed Solids):**

- Those solids (total, suspended or dissolved) which remain after ignition for 15-20 minutes at 550 +/-50°C. These are also commonly referred to as ash. In general, fixed solids are made up of inorganic material.

# SOLIDS

The term “solids” is generally used when referring to any material suspended or dissolved in wastewater that can be physically isolated either through filtration or through evaporation.



# MEASUREMENT OF ORGANIC POLLUTION BIOCHEMICAL OXYGEN DEMAND(BOD)

## • BOD

- It is defined as the potential for removal of oxygen from wastewater by aerobic heterotrophic bacteria which utilizes organic matter for their metabolism and reproduction.
- The BOD<sub>5</sub> values indicate the amount of biodegradable organic material(carbonaceous demand). It may also measure the oxygen used to oxidize nitrogen, unless their oxidation is prevented by inhibitor.

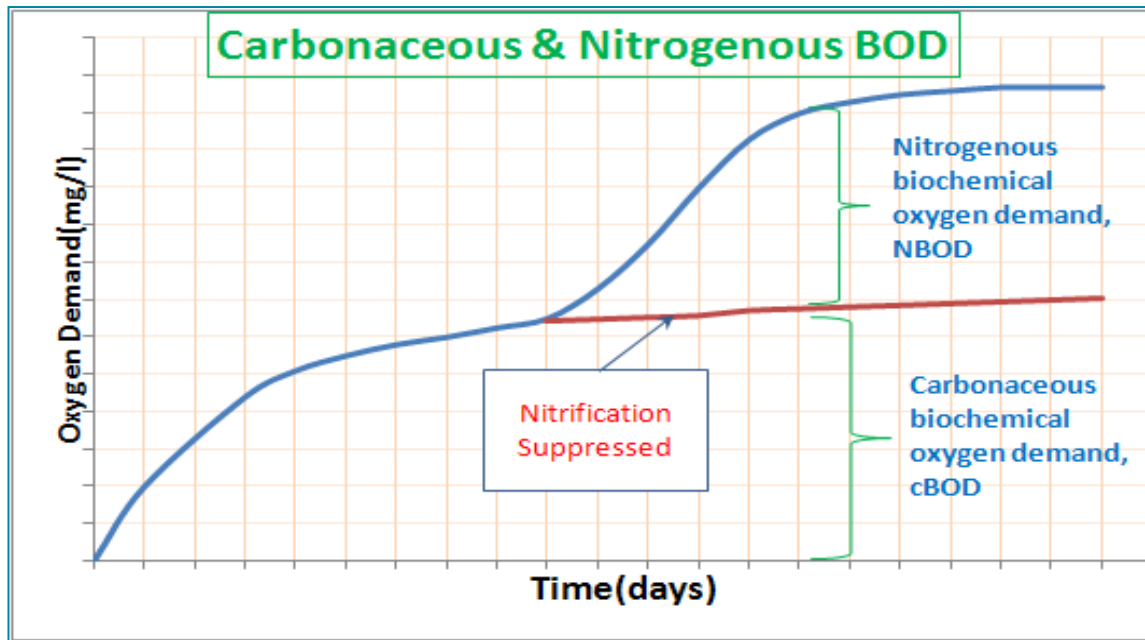


# ULTIMATE BOD

## CARBONACEOUS BOD(cBOD)

### • uBOD

- BOD test are typically conducted over 5 days; UBOD can go on for weeks – it's until the rate of oxygen utilization by organisms is zero.



Rule of thumb

$$\frac{BOD_5}{uBOD} = 0.68$$

$$\frac{uBOD}{BOD_5} = 1.47$$

Why 5 day BOD?



# MEASUREMENT OF ORGANIC POLLUTION

## COD

- **COD**

- COD evaluates everything that is oxidizable – either biologically or chemically. dichromate in an acid solution is usually used for oxidation.

For conversion between BOD & COD, it is sometimes assumed that ultimate BOD is equal to COD. Because not all of the COD is biodegradable , uBOD is actually less than COD.

A blue square icon with a white document symbol and the text "Standard Methods" inside.

Standard  
Methods

# WASTEWATER SAMPLING METHODS

- Grab Sampling
  - Given instantaneously a volume of wastewater in one spot.
- Automatic Sampling
  - Full Sequential Sampling Mode
    - Sampling at regular time interval of a given volume collected in one flask. After one sample , the system moves to fill the next flask.
  - Composite Sequential Sampling Mode
    - Samples are collected at regular intervals in one large flask for a single composite sample or in several flasks for hourly or bi-hourly composite samples.
    - Good for higher sampling frequency.
  - Integrated Sampling Mode
    - Good if Knowledge of daily load is required.
    - The volume of sample is proportional to the flow.





# WASTEWATER CHARACTERIZATION

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- Aim is to determine typical wastewater fractions relationship between various constituents.
- Flow and concentration vary with time, but the fractions and relationships can be assumed to remain constant.
- Most critical step in process design.
- Important in evaluation existing WWTPs

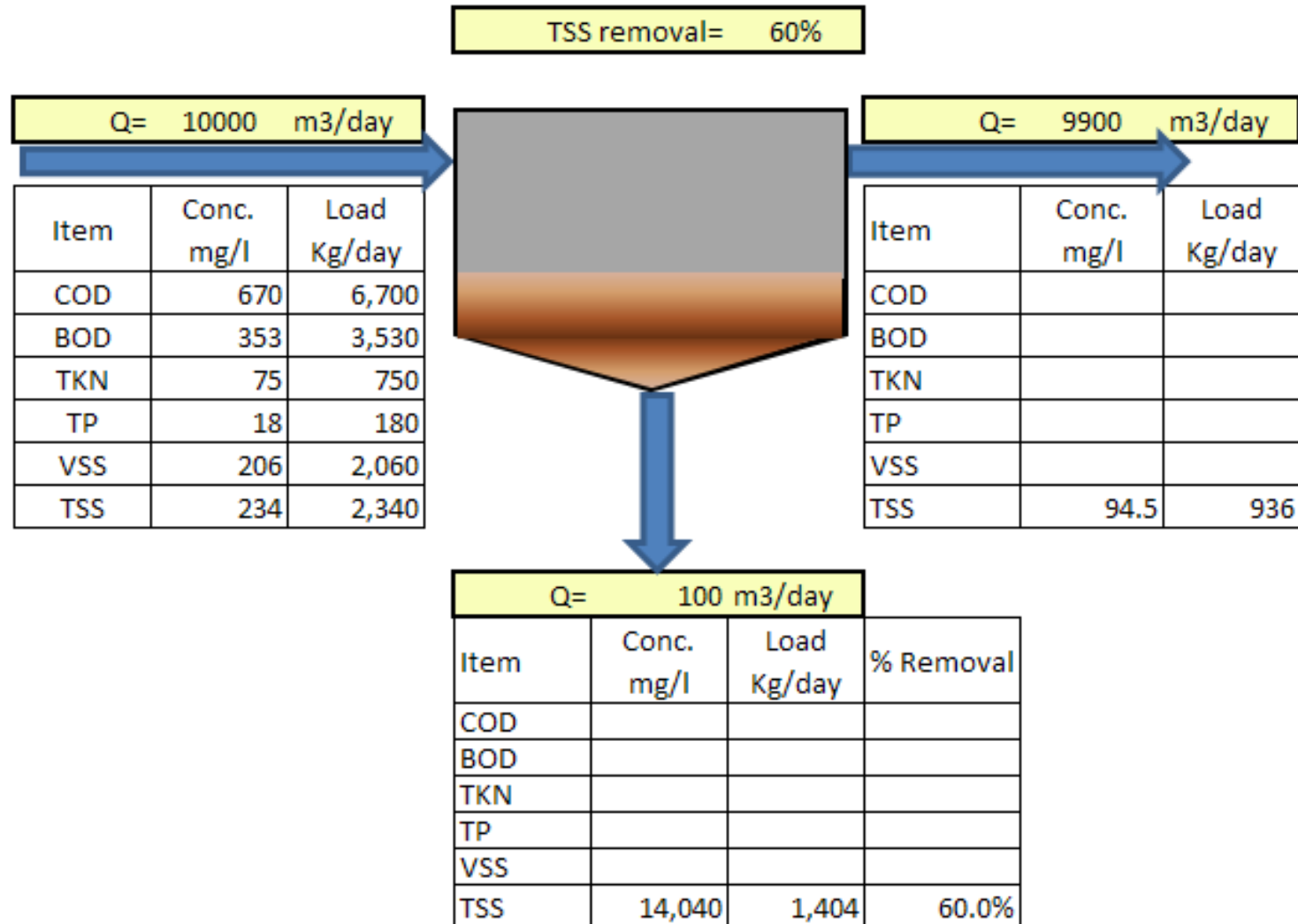
## Wastewater Characteristics Categories:

- Carbonaceous Substrate (BOD,COD).
- Nitrogen Compounds.
- Phosphorus Compounds
- Total & Volatile Suspended Solids.
- Alkalinity

# DEFINITION OF TERMS USED TO CHARACTERIZE BOD,COD,N,SS,& P

Parameter			Definition		Fraction Name	Parameter			Definition		Fraction Name
<b>BOD</b>						<b>Nitrogen</b>					
	BOD	tBOD	Total 5-d biochemical oxygen demand				TKN	Total Kjeldahl nitrogen			
	sBOD	fBOD	Soluble BOD				NH3	Ammonia			Fna
	uBOD		Ultimate BOD				bTKN	Biodegradable TKN			
<b>COD</b>							sTKN	Soluble TKN			
	COD	tCOD	Total chemical oxygen demand				ON	Organic nitrogen			
	bCOD		Biodegradable COD				bON	Biodegradable organic nitrogen			
	pCOD		Particulate COD				nbON	Non-biodegradable organic nitrogen			
	sCOD	fCOD	Soluble COD				pON	particulate organic nitrogen			Fnox
	nbCOD		Non-biodegradable COD				nbpON	Non-biodegradable particulate organic nitrogen			
	rbCOD	Sbs	Readily biodegradable COD		Fbs		sON	Soluble organic nitrogen			
	bsCOD		biodegradable soluble COD				bsON	Biodegradable soluble organic nitrogen			
	sbCOD	Xs	Slowly biodegradable COD		Fxs		nbsON	Non-biodegradable soluble organic nitrogen			Fnus
	csbCOD	Xsc	Colloidal slowly biodegradable COD		Fxc	<b>Suspended solids</b>					
	psbCOD	Xsp	Particulate slowly biodegradable COD		Fxsp		TSS	Total suspended solids			
	bpCOD		Biodegradable Particulate COD				VSS	Volatile suspended solids			
	nbpCOD	Xi	Non-biodegradable particulate		Fup		bVSS	Biodegradable VSS			
	nbsCOD	Sus	Non-biodegradable soluble COD		Fus		nbVSS	Non-biodegradable VSS			
	ffCOD		Floculated & filtered COD				iTSS	Inert total suspended solids			
<b>P:COD &amp; N:COD ratios</b>						<b>Phosphorus</b>					
			nbpON:nbpCOD		FupN		TP	Total Phosphorus			
			NbpP:nbpCOD		FupP		PO4	Orthophosphate			Fpo4

# PRIMARY SEDIMENTATION TANK(PST) MASS BALANCE & CHARECTERIZATION



# REQUIRED WASTEWATER ANALYSIS FOR CHARECTERIZATION

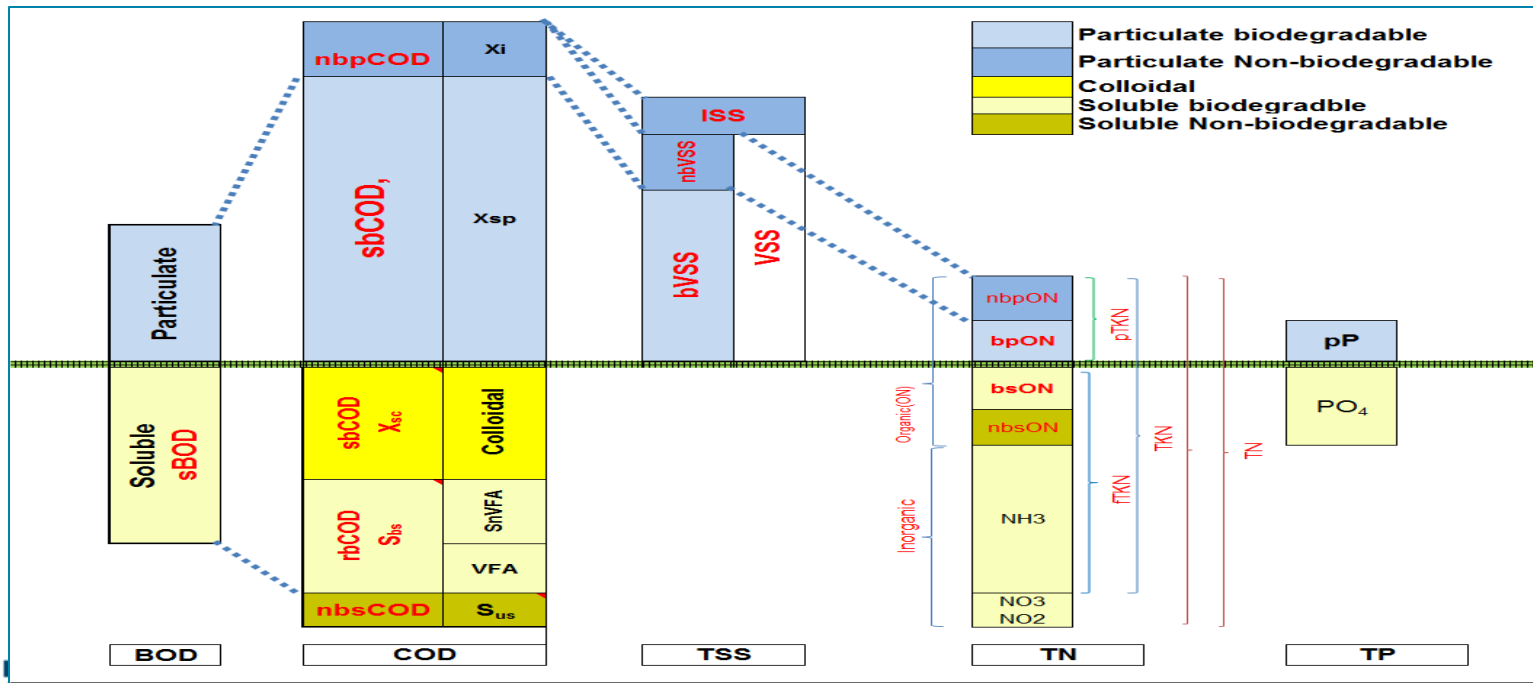
No.	Parameter		Influent	Effluent
1	Total COD	<b>COD</b>	√	√
2	Filtered COD(1.2 um glass fiber filter)	<b>sCOD</b>	√	√
3	Flocculated & filteredCOD(0.45 um filter)	<b>ffCOD</b>	√	
4	BOD <sub>5</sub>	<b>BOD<sub>5</sub></b>	√	√
5	Filtered BOD <sub>5</sub> (1.2 um glass fiber filter)	<b>sBOD<sub>5</sub></b>	√	√
6	Total Suspended Solids	<b>TSS</b>	√	√
7	Volatile Suspended Solids	<b>VSS</b>	√	
8	Total Phosphurus	<b>TP</b>	√	
9	Orthophosphate	<b>PO<sub>4</sub></b>	√	√
10	Total Kjeldhal Nitrogen	<b>TKN</b>	√	√
11	Filtered TKN	<b>fTKN</b>	√	√
12	Ammonia	<b>NH<sub>3</sub></b>	√	√
13	Nitrate	<b>NO<sub>3</sub></b>		√
14	Nitrite	<b>NO<sub>2</sub></b>		√
15	Alkalinity as CaCO <sub>3</sub>		√	

# STATE & COMPOSITE VARIABLES

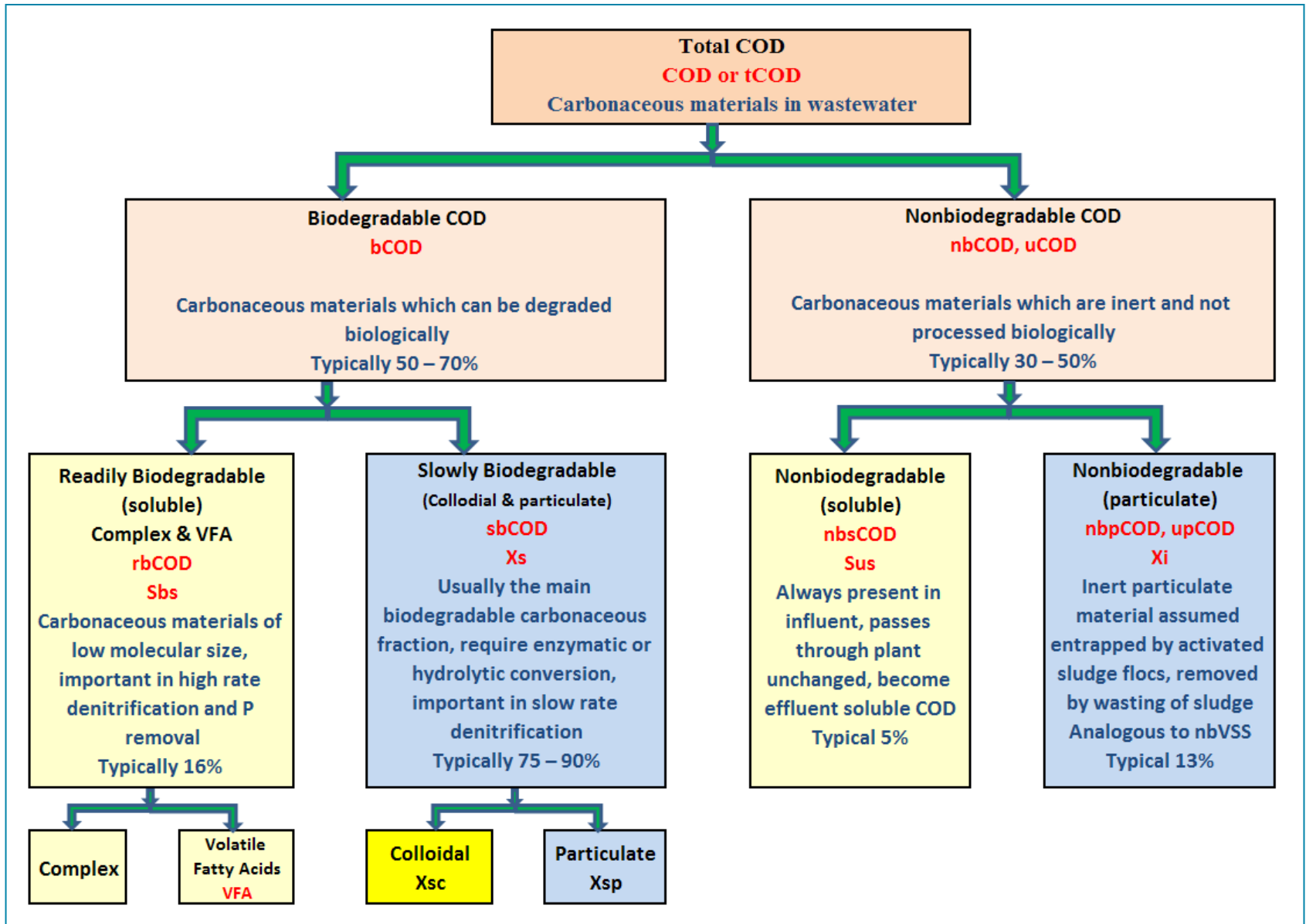
## ➤ State Variables , basic wastewater components:

- ❑ Soluble(S), rbCOD, Ammonia-N, PO<sub>4</sub>-P..etc.
- ❑ Particulate(X), pBOD,pCOD,pN.

## ➤ Composite variables, combination of several state variables, BOD,COD,TSS,TKN,TP.



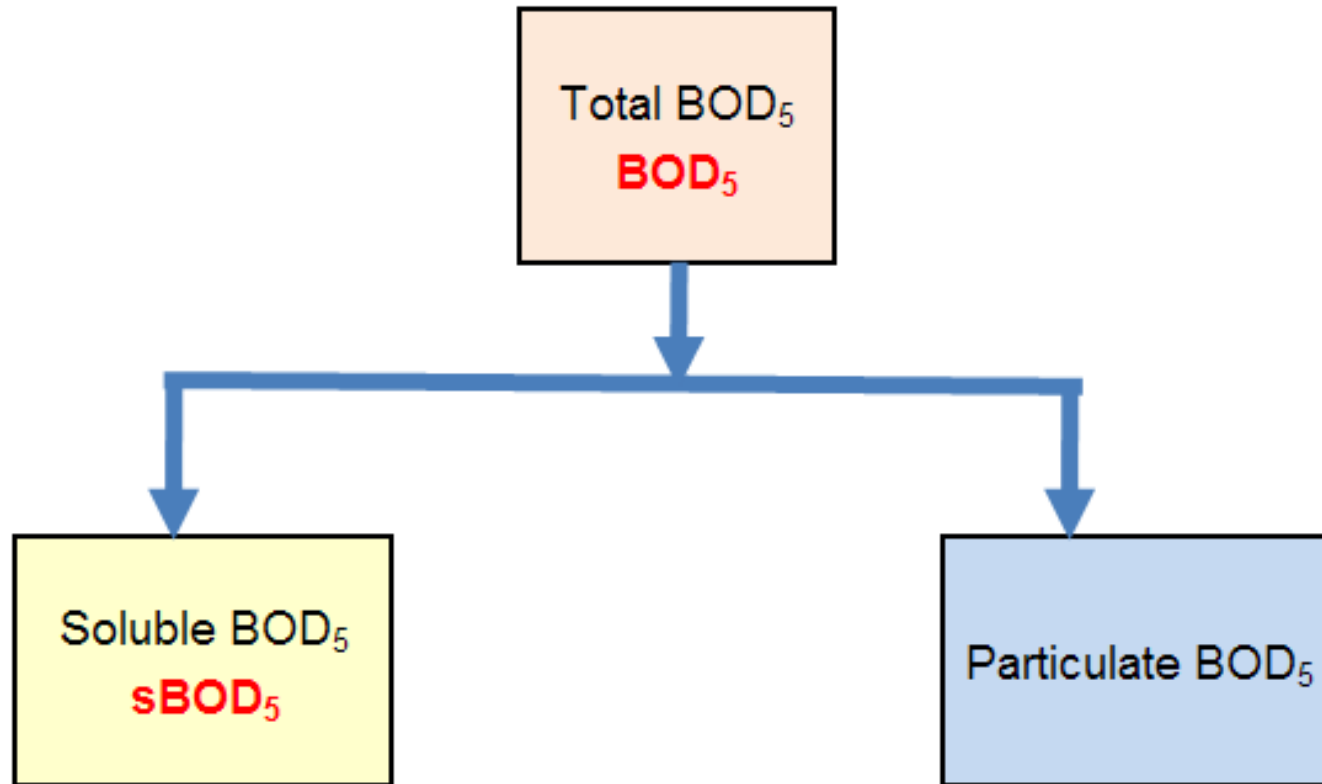
# COD FRACTIONS



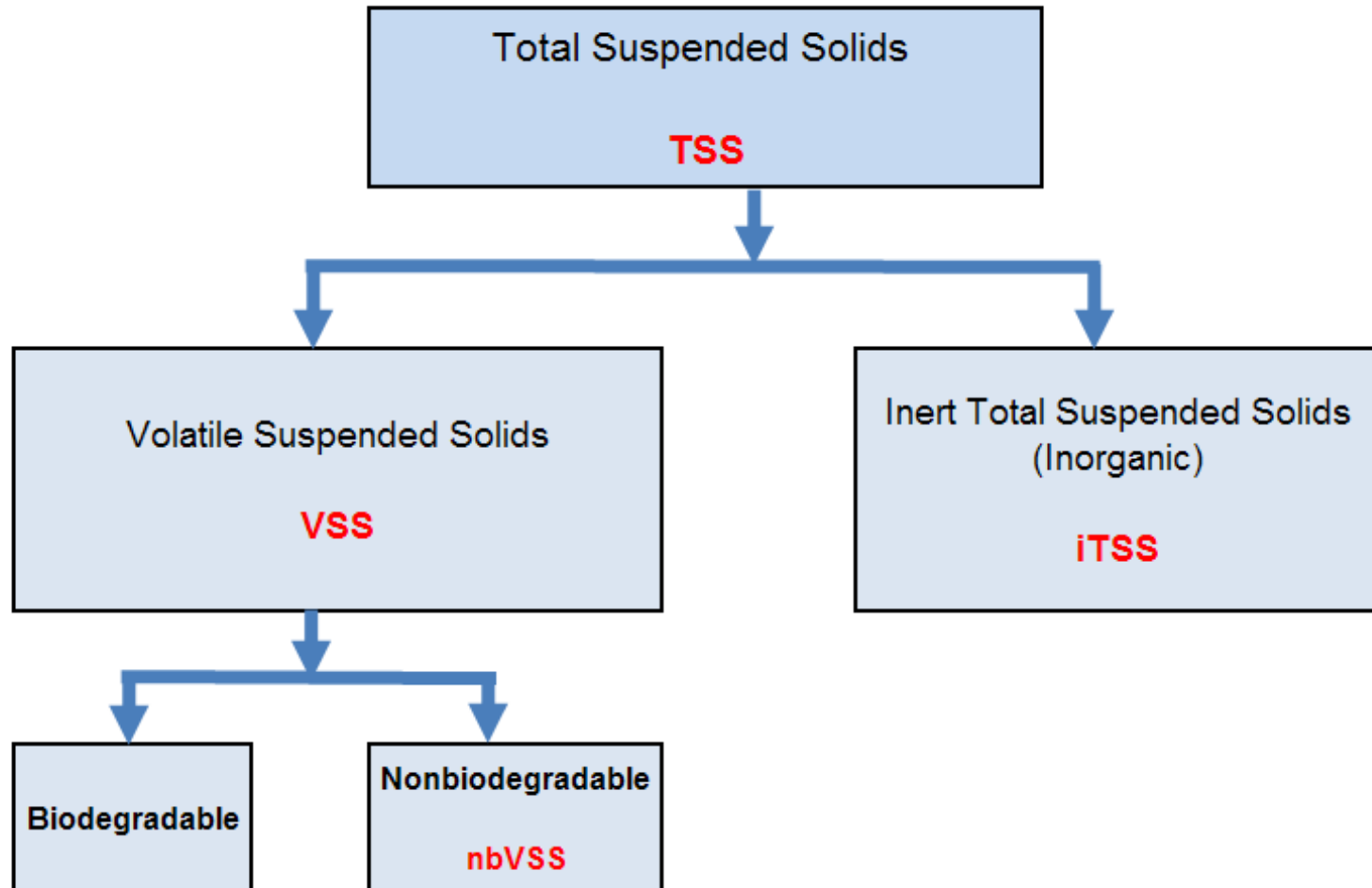


# BOD FRACTIONS

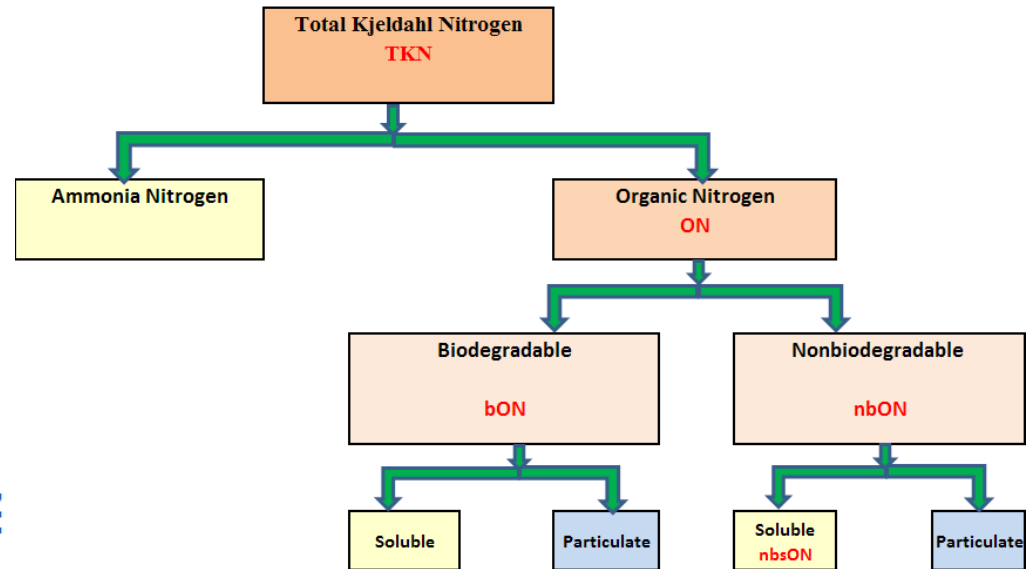
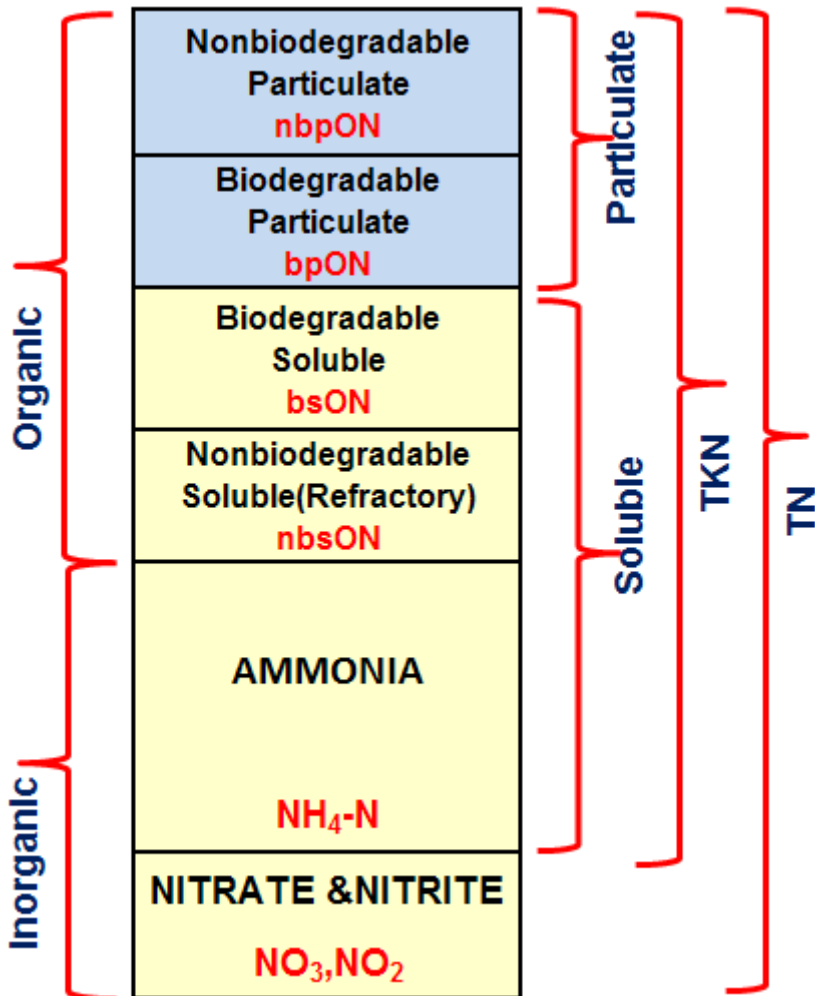
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# TSS FRACTIONS



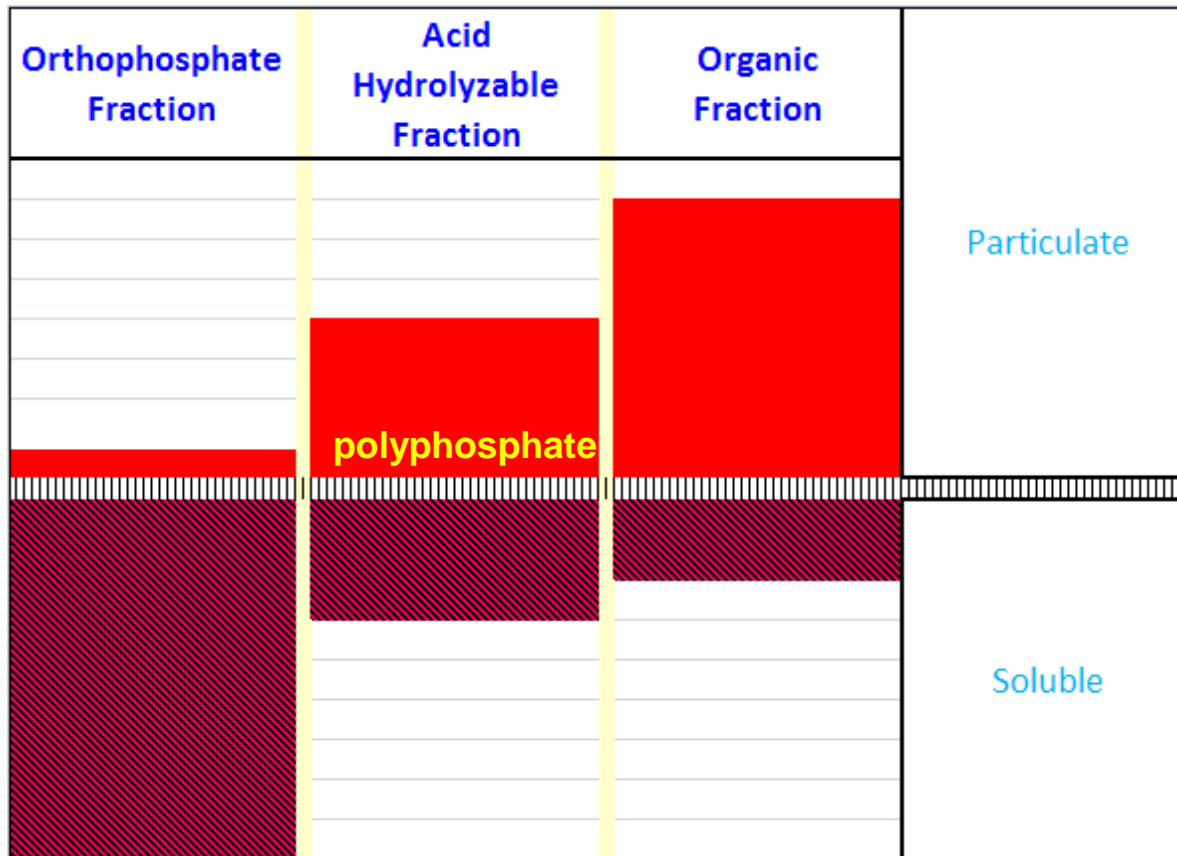
# NITROGEN FRACTIONS



# TOTAL PHOSPHORUS(TP) FRACTIONS

Phosphorus in wastewater is one of three forms

- a) Phosphate(Orthophosphate)
- b) Polyphosphate
- c) Organic phosphorus



# ALKALINITY

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- Alkalinity is a measure of the capacity of water to neutralize acids. It measures the presence of CO<sub>2</sub>, bicarbonate, carbonate and hydroxide ions that are naturally present in water.
- The pH is a measure of how acidic or basic is the wastewater. It is related to the hydrogen ions in wastewater.
- Adequate alkalinity is needed to achieve complete nitrification