

A stylized sun graphic on the left side of the slide. It features a solid yellow circle at the bottom left, with several yellow curved lines above it representing rays. The background is a gradient from orange to white, with a large white semi-circle on the right side.

Soil Treatment 101

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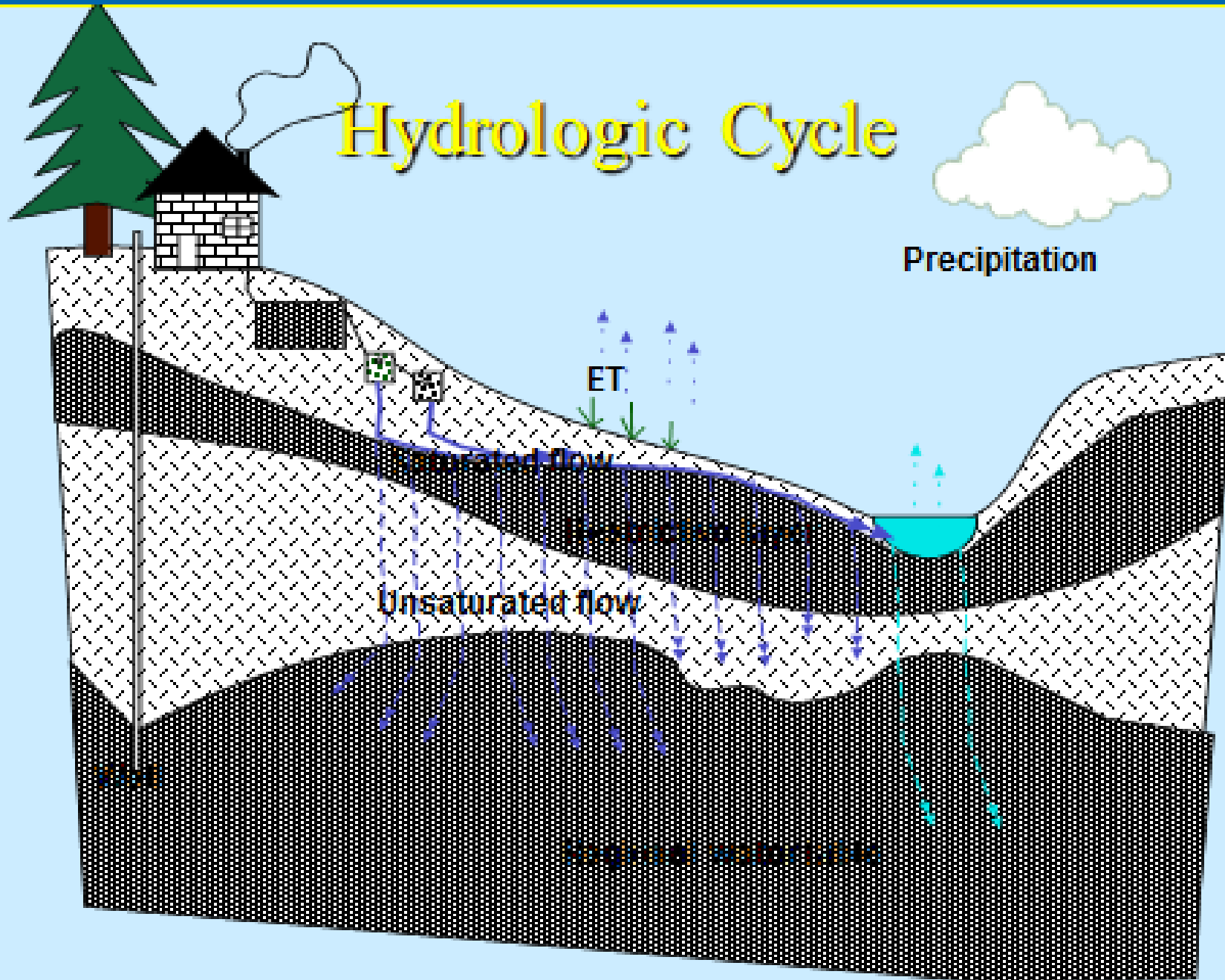
Presentation Agenda

- Why is understanding soil treatment important?
- Saturated vs unsaturated conditions
- Biomat development
- Soil treatment



Hydrologic Cycle

Precipitation





What's in Wastewater?



- Organic compounds
- Dissolved oxygen
- Oxygen demand
- Solids
- Nutrients
- Microbial organisms (Pathogens)
- Fats, Oils, & Grease
- Inorganic compounds



What does a
wastewater
treatment system
need to do?





Treat sewage

Public health concerns
Environmental quality
concerns



Disperse treated sewage



Provide acceptable level of risk – put the “odds” on our side



Join hydrologic cycle

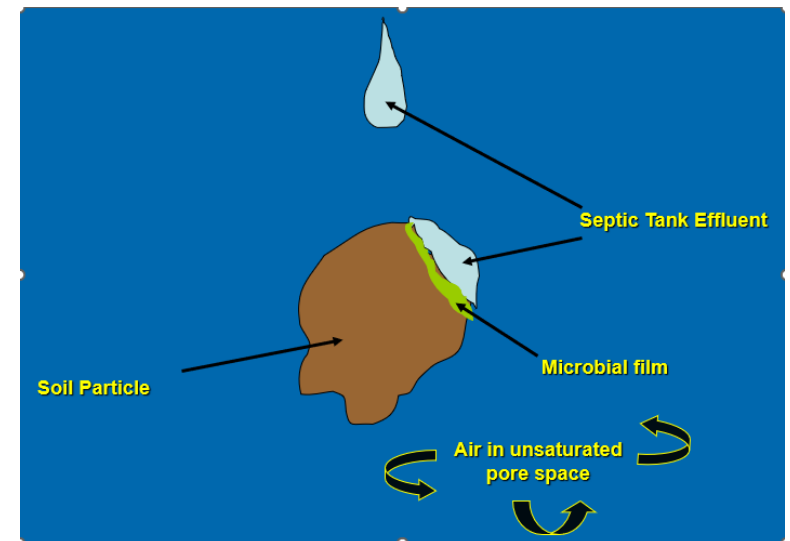


Which Treatment
Environment:

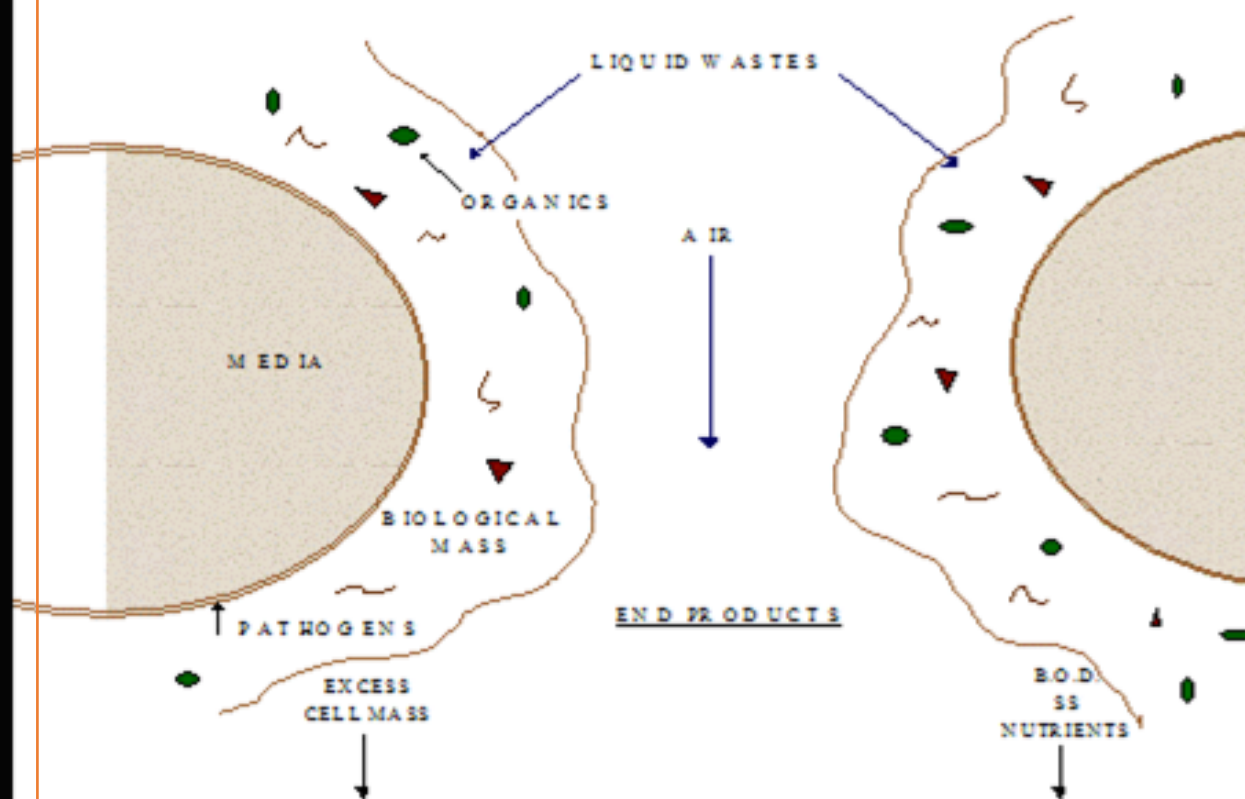
Anaerobic or Aerobic?

Requirements for Aerobic Treatment in Soil

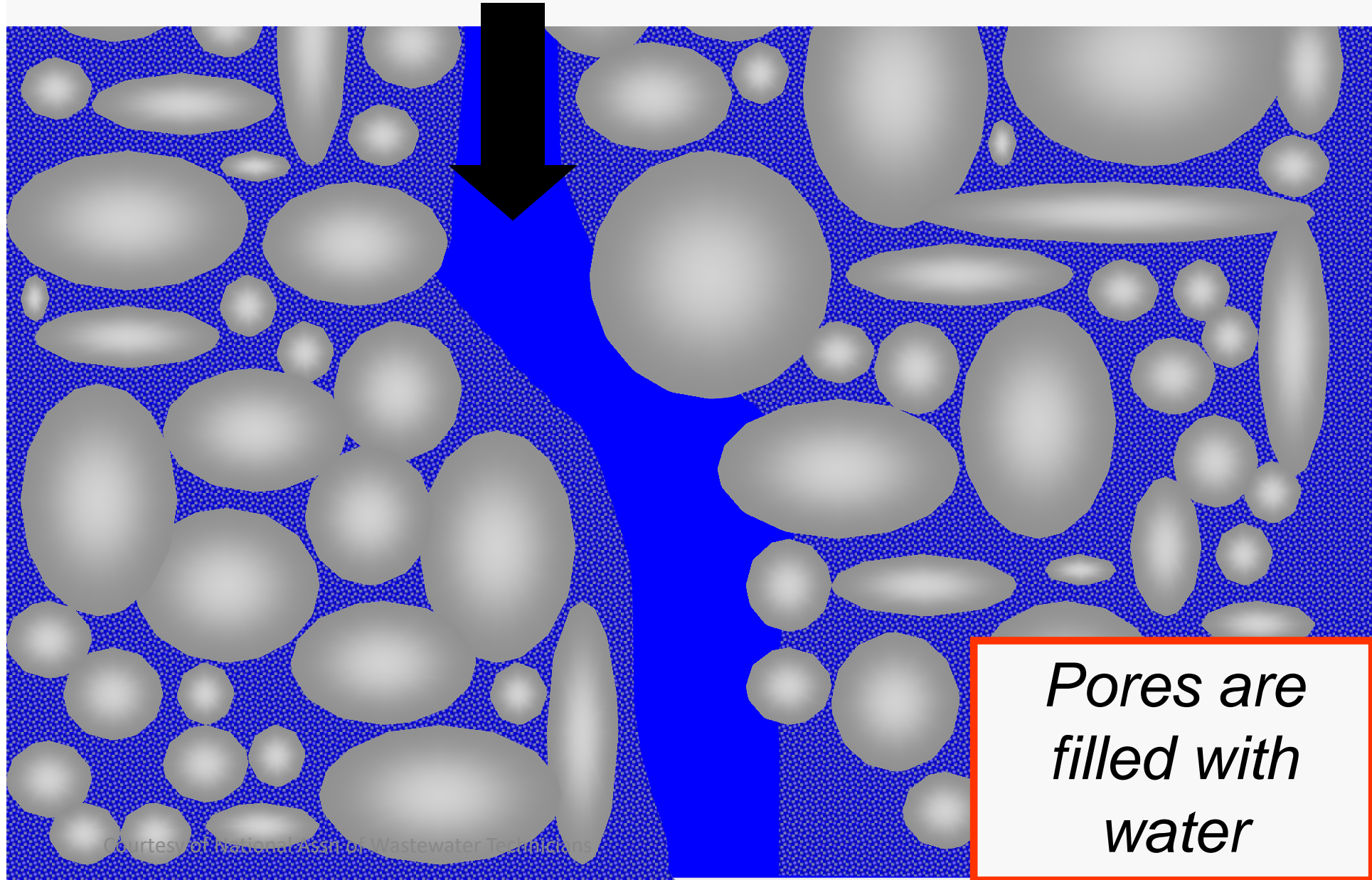
- Aerobic Soil
 - Must have air/oxygen (not just merely gasses)
 - Water
- Unsaturated Flow
 - Water moves around the surface of the soil particles



PROCESSES AT WORK

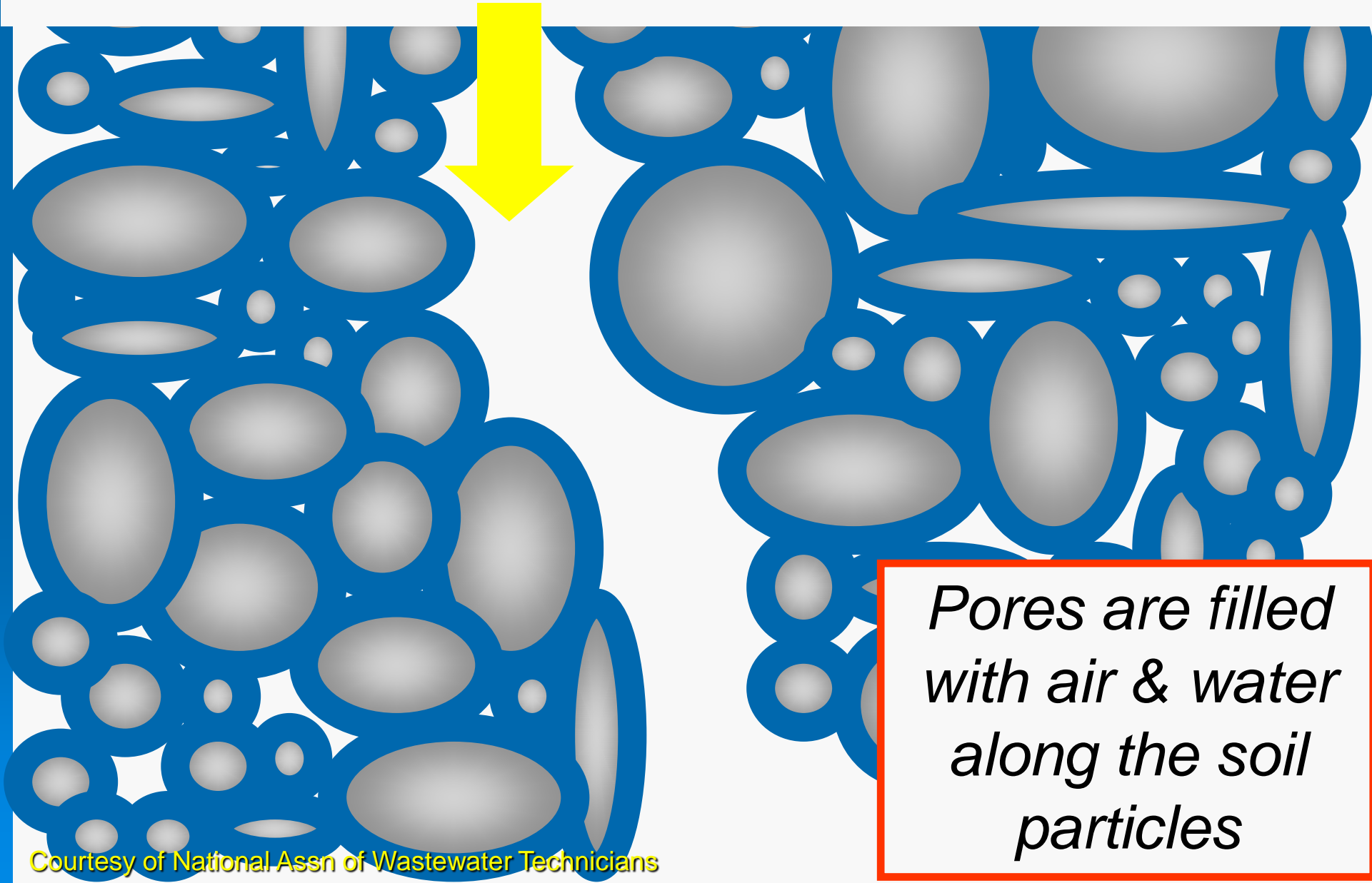


Saturated Conditions



*Pores are
filled with
water*

Unsaturated Conditions



*Pores are filled
with air & water
along the soil
particles*

Unsaturated vs. Saturated flow

Unsaturated

- Pores: Air-filled
- Mov't next to particles
- Aerobic
- Controlled by
 - Soil wetness
 - Soil pore size

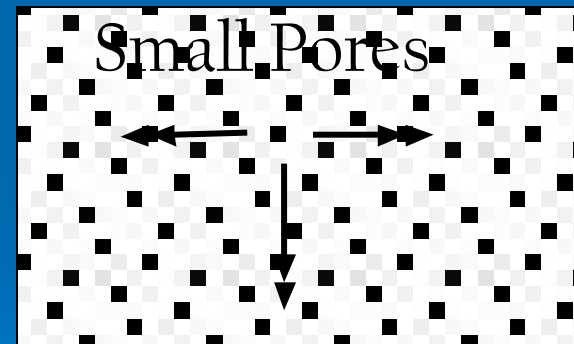
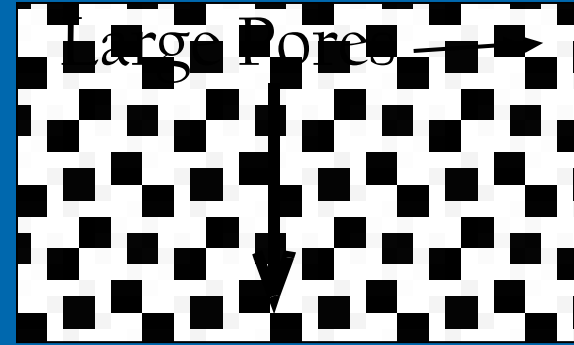
Saturated

- Pores: Water-filled
- Mov't in large pores
- Non-aerobic
- Controlled by
 - Slope
 - Soil (K_{sat})



Pore size & unsaturated flow

- Large pores water will be pulled predominantly by gravity
- Small pores water will move in all directions better & further





Distribution Matters

Gravity vs. Pressure

Gravity Distribution Forms Biomat

Biomat = mixture of solids from effluent, biomass (old cells) from microorganisms, and excretions from the microorganisms

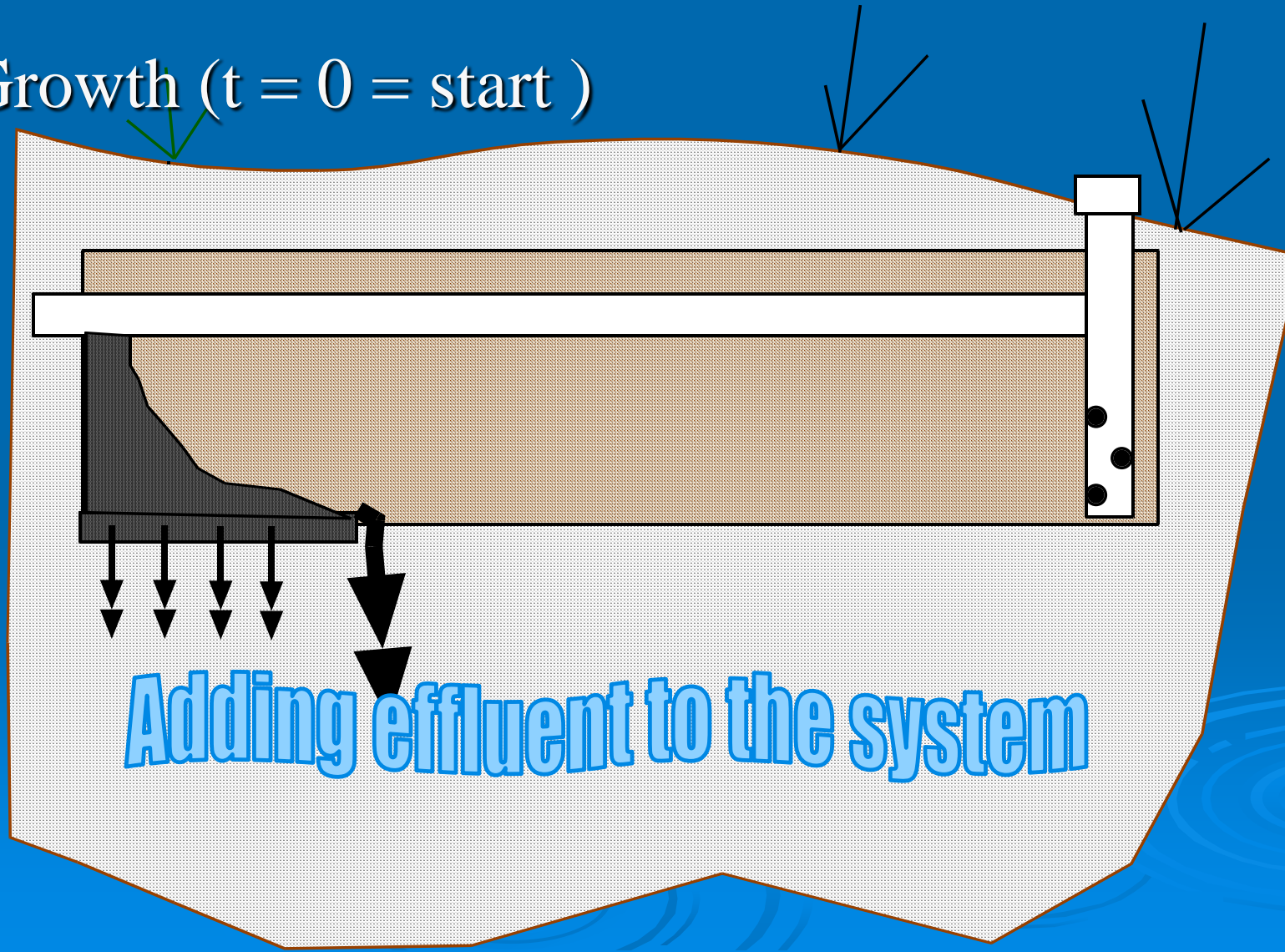
Biomat is highly effective in removing organic material and pathogens AND detain viruses

Biomat slows down the infiltration of effluent into underlying soil (research indicates a rate of 0.5 ft/d)

As biomat developed over the entire trench surface, ponding will occur.

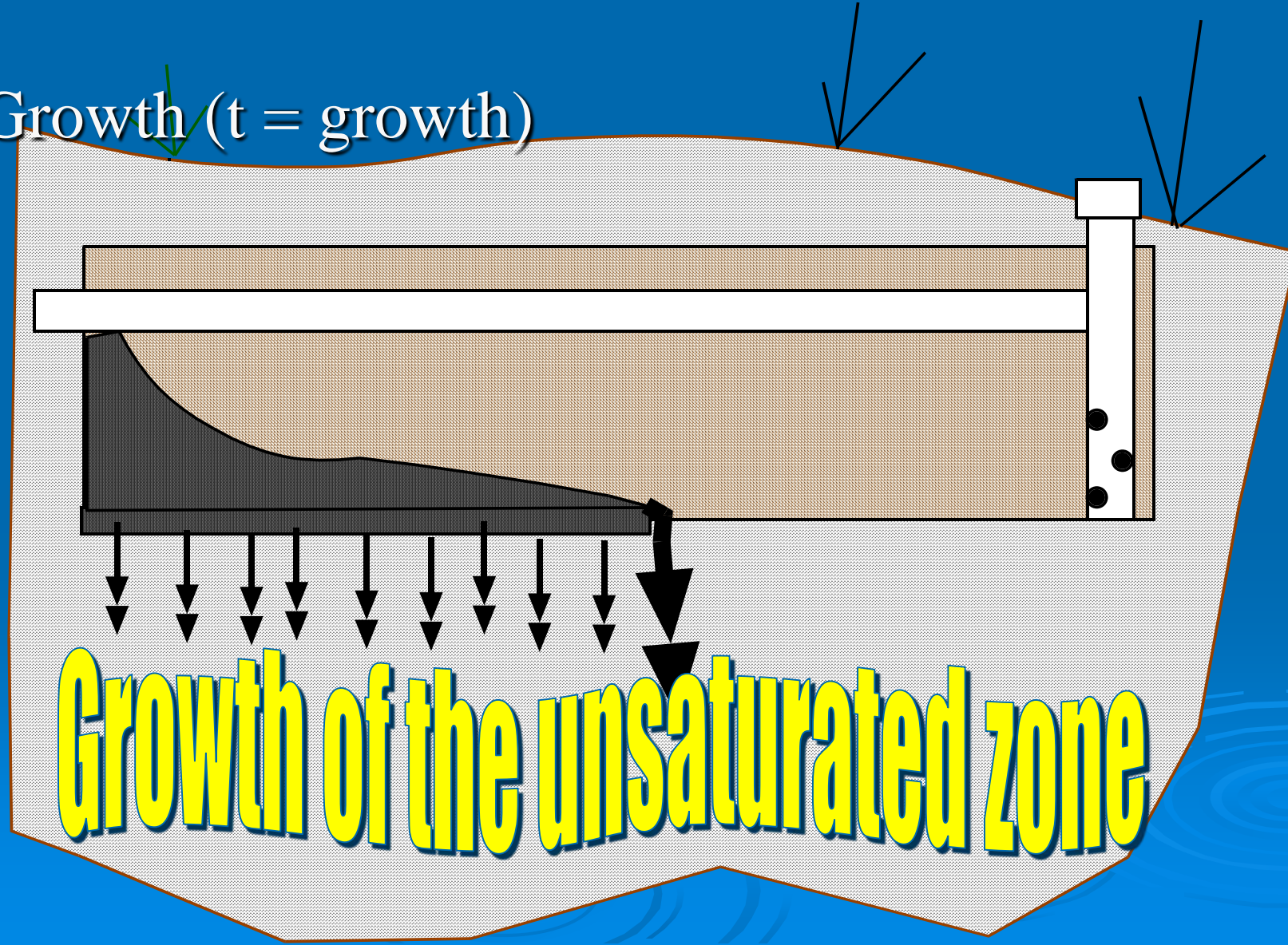
Flow pattern in a gravity trench

- Biomat Growth ($t = 0 = \text{start}$)



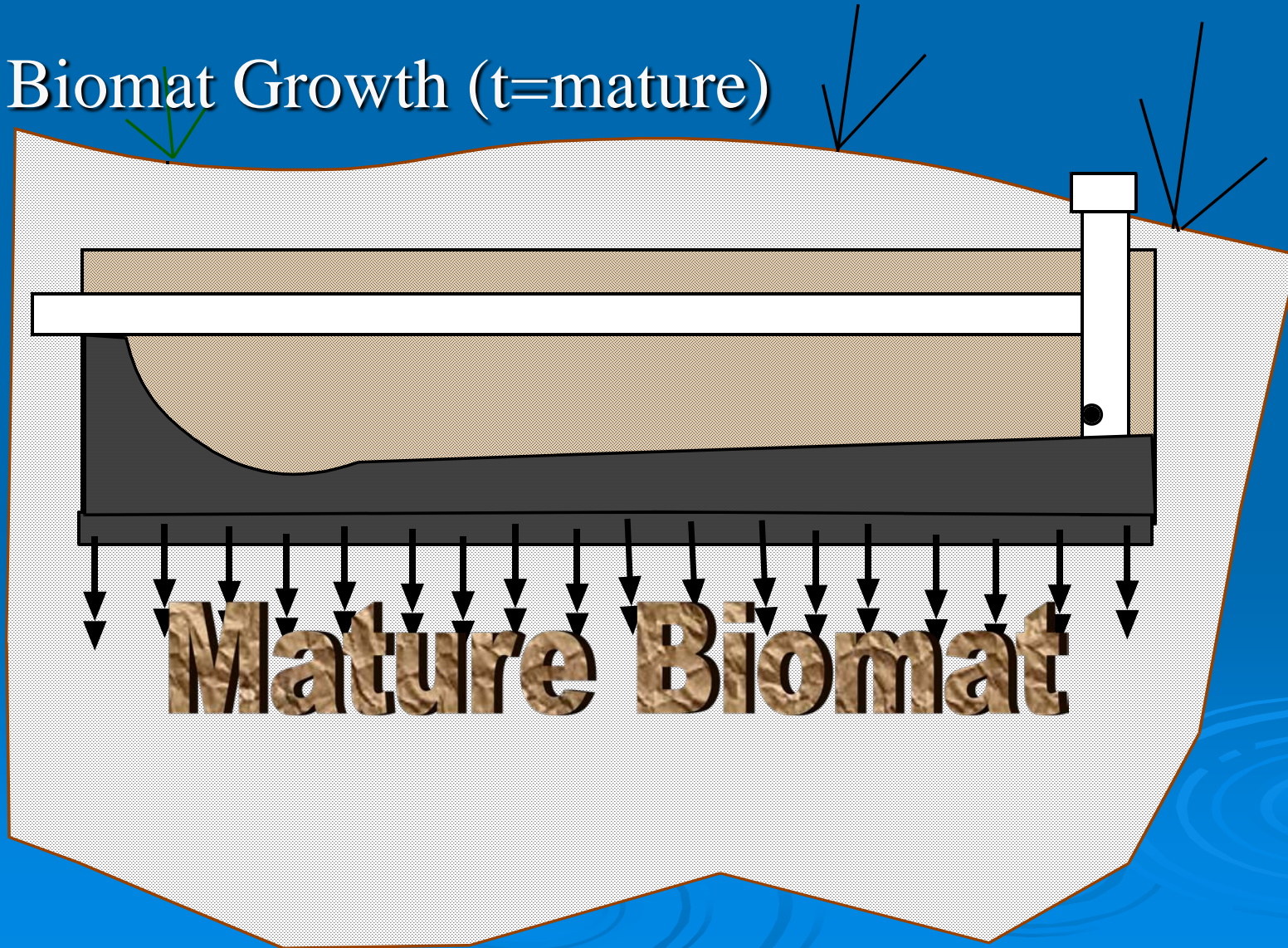
Flow pattern in a gravity trench

➤ Biomat Growth (t = growth)



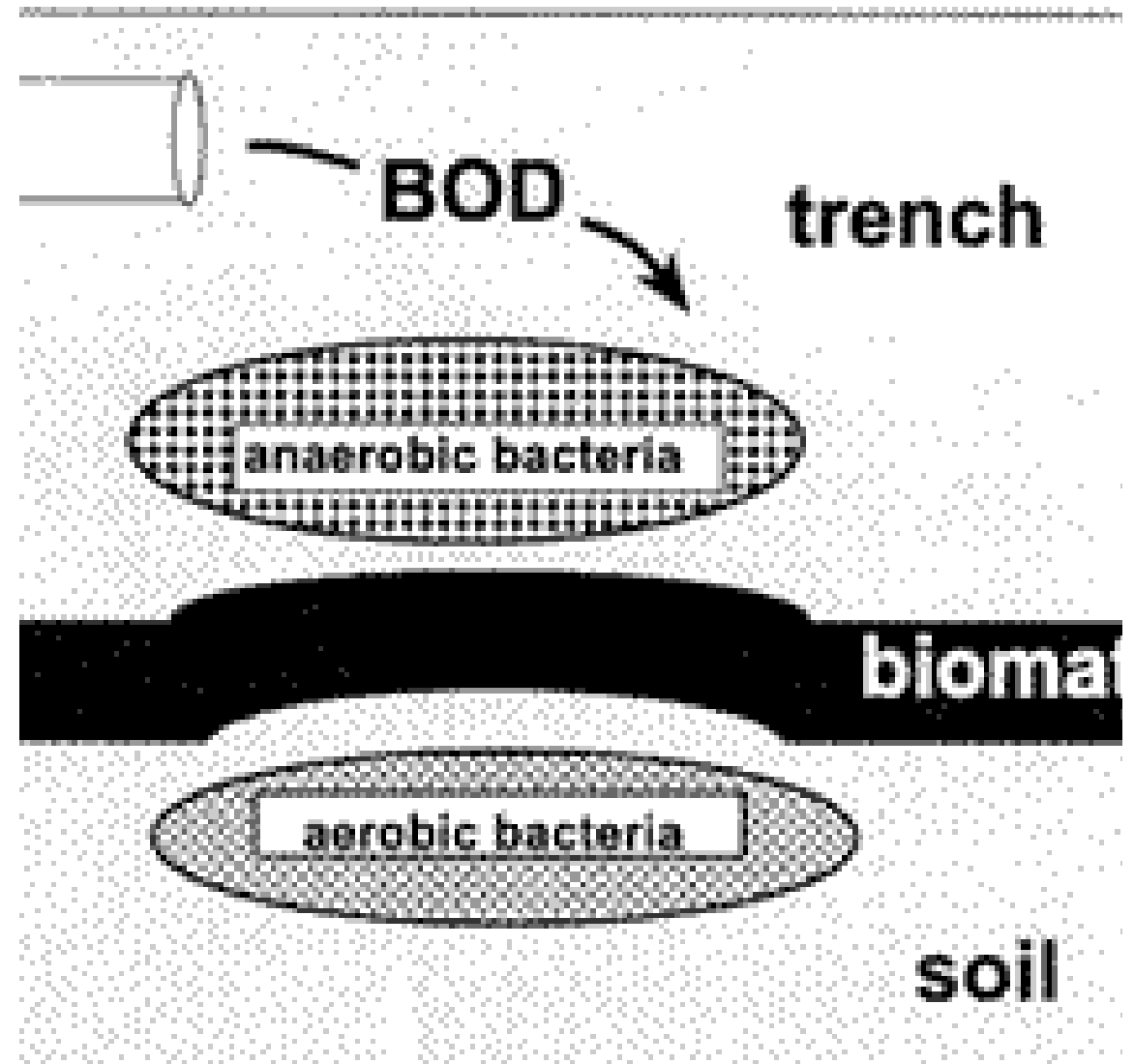
Flow pattern in a gravity trench

- Biomat Growth (t=mature)



Push-me, Pull-you Action

- **Within the trench**, the organic materials in the wastewater feed the anaerobic microorganisms, which grow and multiply, increasing the thickness and decreasing the permeability of the biomat.
- **On the soil side** of the biomat beneath the trench, oxygen is present so that conditions allow aerobic soil bacteria to feed on and continuously break down the biomat.

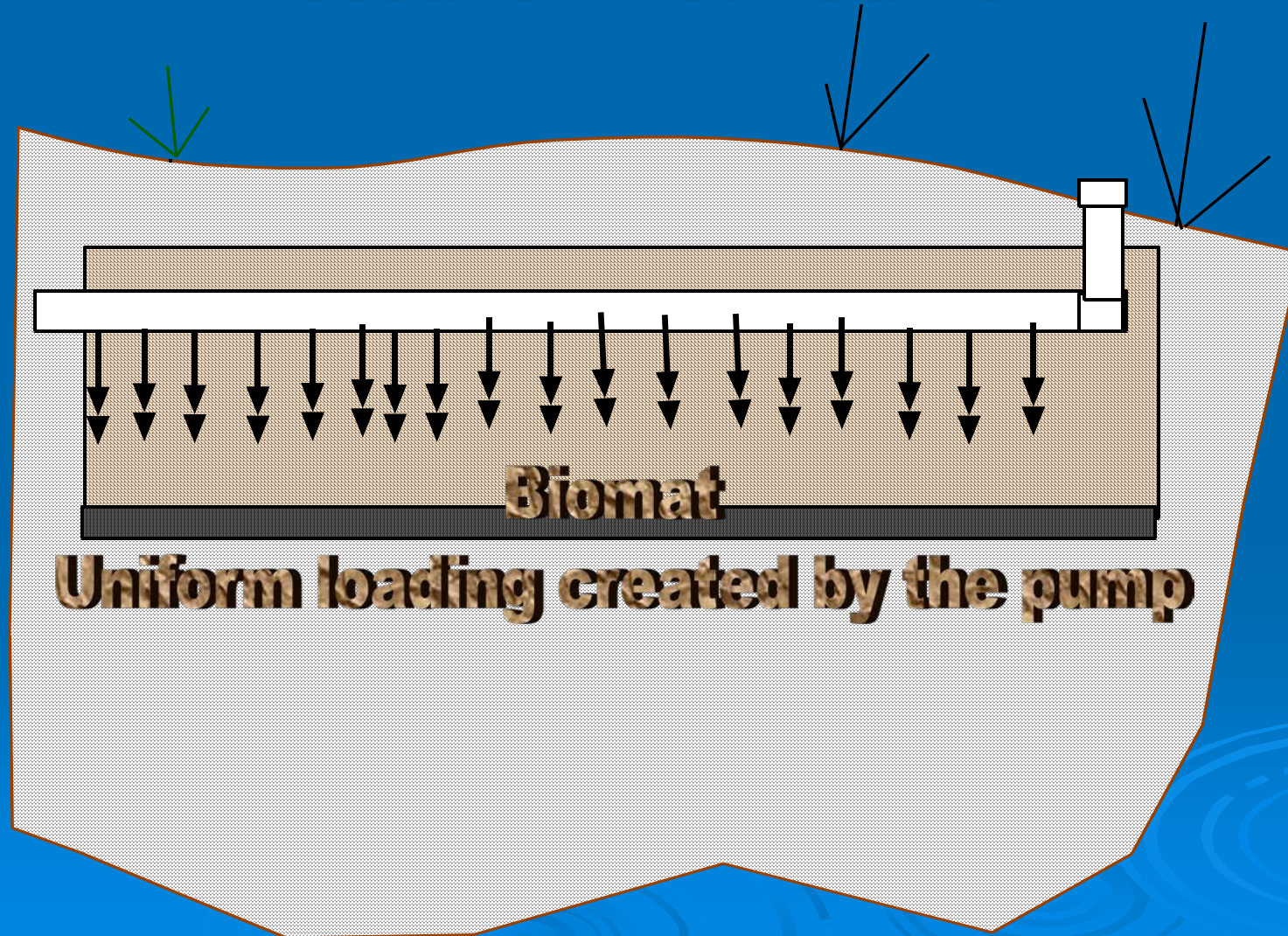




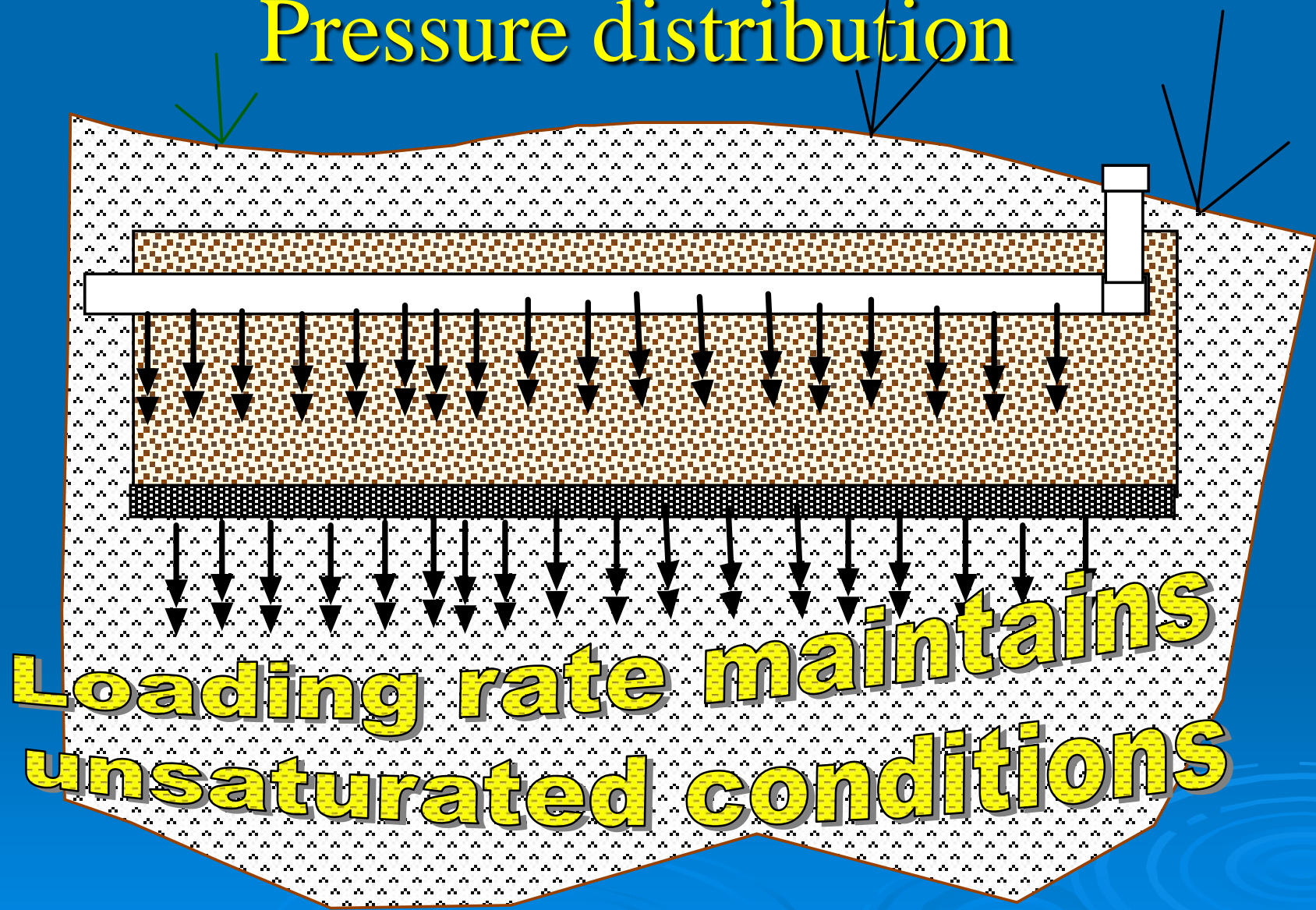
Pressure Distribution forms Little to NO Biomat

- Pressure distribution applies a small amount of effluent equally over the entire surface of the trench.
 - Maintains aerobic, unsaturated soil beneath the excavation.
-

Flow pattern with Pressure Distribution



Pressure distribution



Loading rate maintains unsaturated conditions

NOW Soil Treatment Can Begin – At Last!!

Treatment provided by



soil texture



presence of electrical
charges



soil biological
community



Treatment Mechanisms



Physical filtration of larger particles and adsorption (attachment/binding)



Soil particles are negatively charged → they can attract and hold positively-charged pollutants



Soils contain minerals that bind with some pollutants and immobilize them



Aerobic microbes (bacteria, fungi, actinomycetes, and protozoa) feed on organic material in wastewater

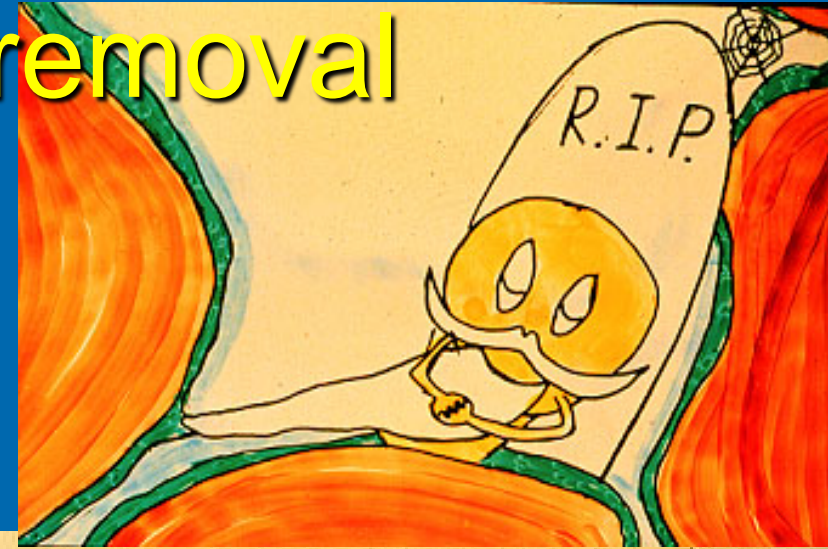


Chemical reactions occurring on soil particle's surface

Pathogen capture



Pathogen removal



NUTRIENTS

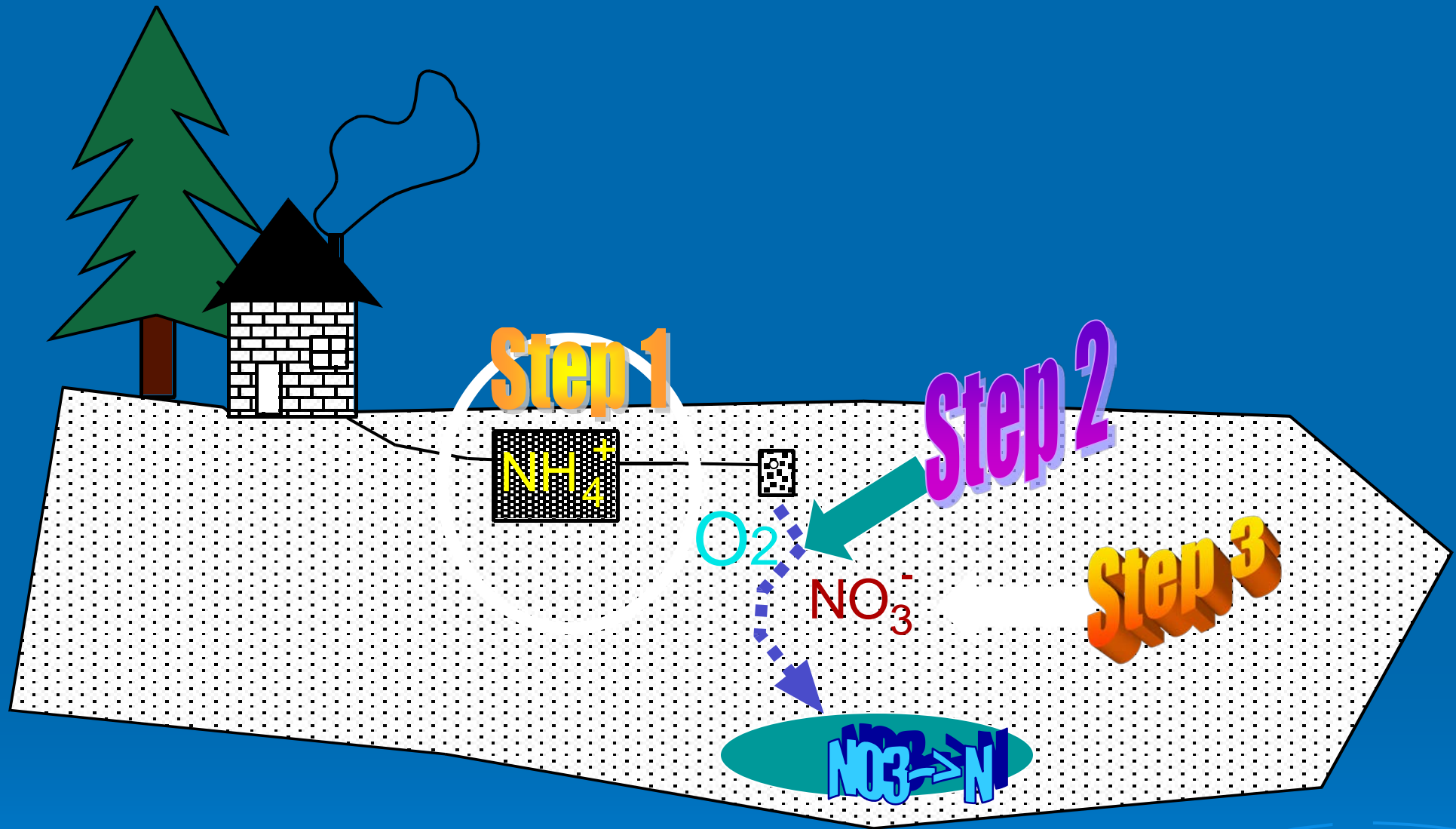
- Phosphorus
 - Surface water
- Nitrogen
 - Groundwater
- Treatment
 - Precipitation
 - Dilution
 - Denitrification



P

Phosphorus is held in the soil

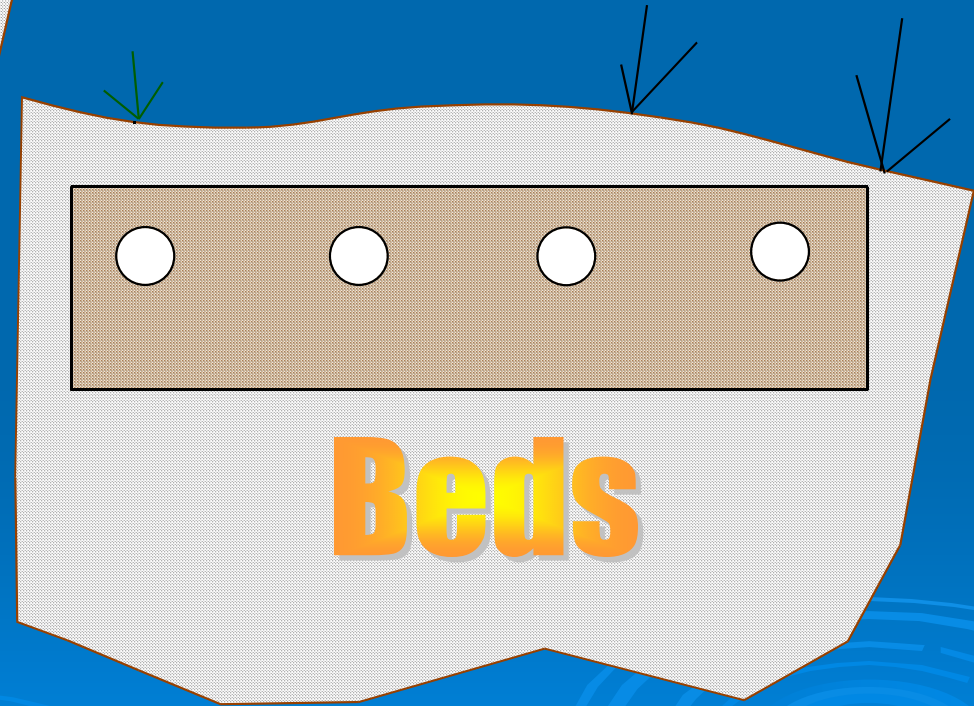
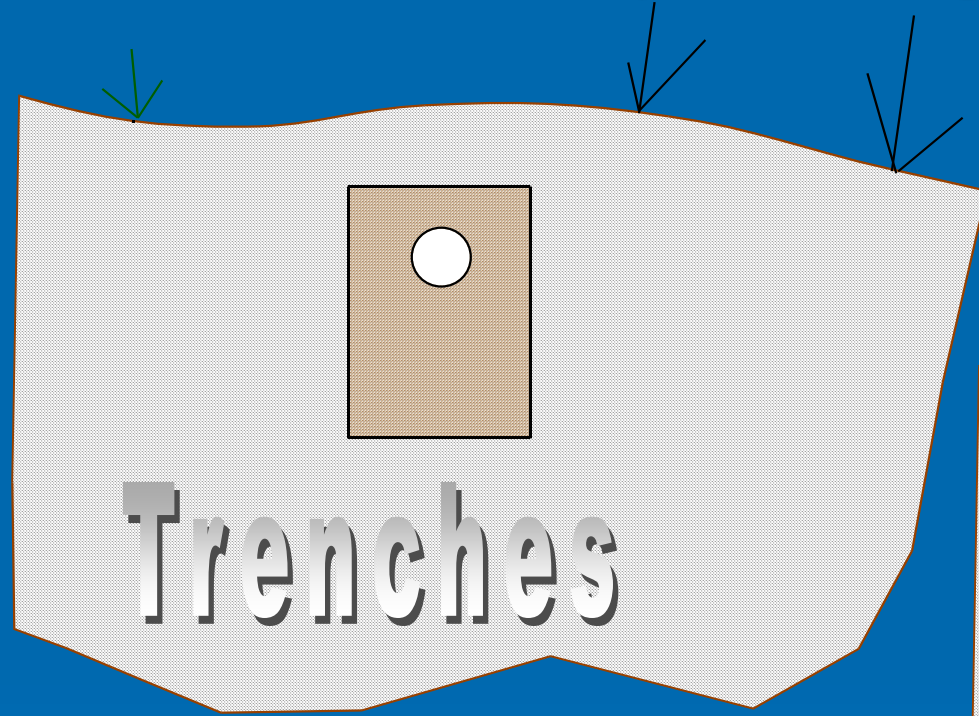
Courtesy of National Assn of Wastewater Technicians



Denitrification needs

- Low DO
- Food {BOD or organic matter}
- Bacteria

System geometry



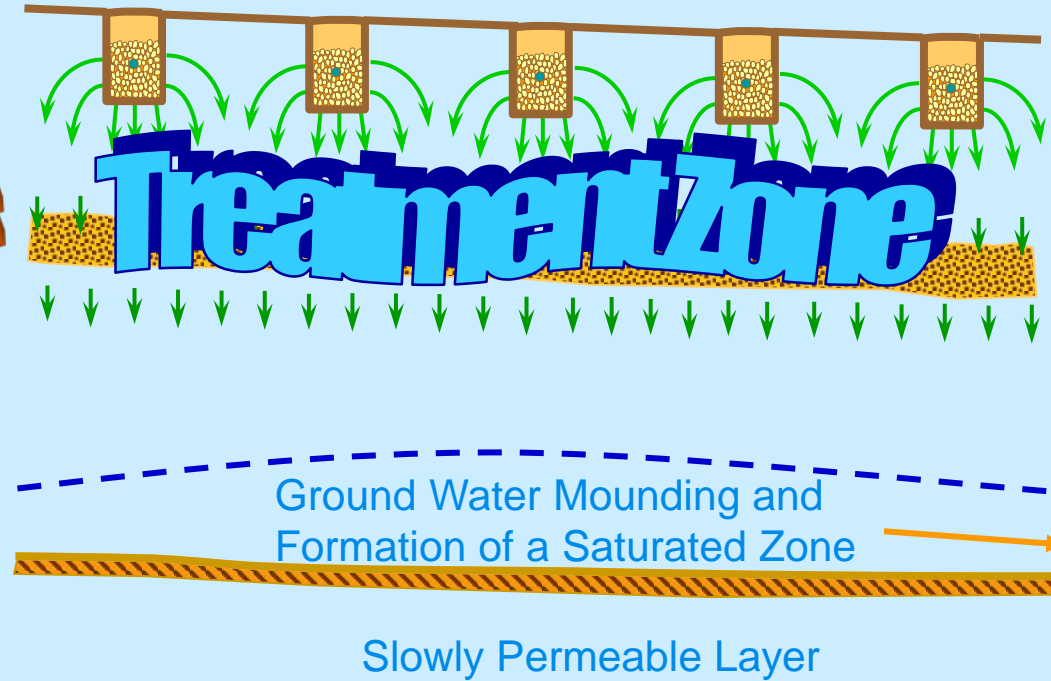
HYDROLOGY OF A SEPTIC SYSTEM

Infiltration from
Trenches

Vertical Movement
through the
Saturated Zone

Late Stage
in the Saturated Zone

Improved by:
Long
Narrow
Shallow



LTAR/SAR

➤ Texture/Structure

- Soil evaluation method

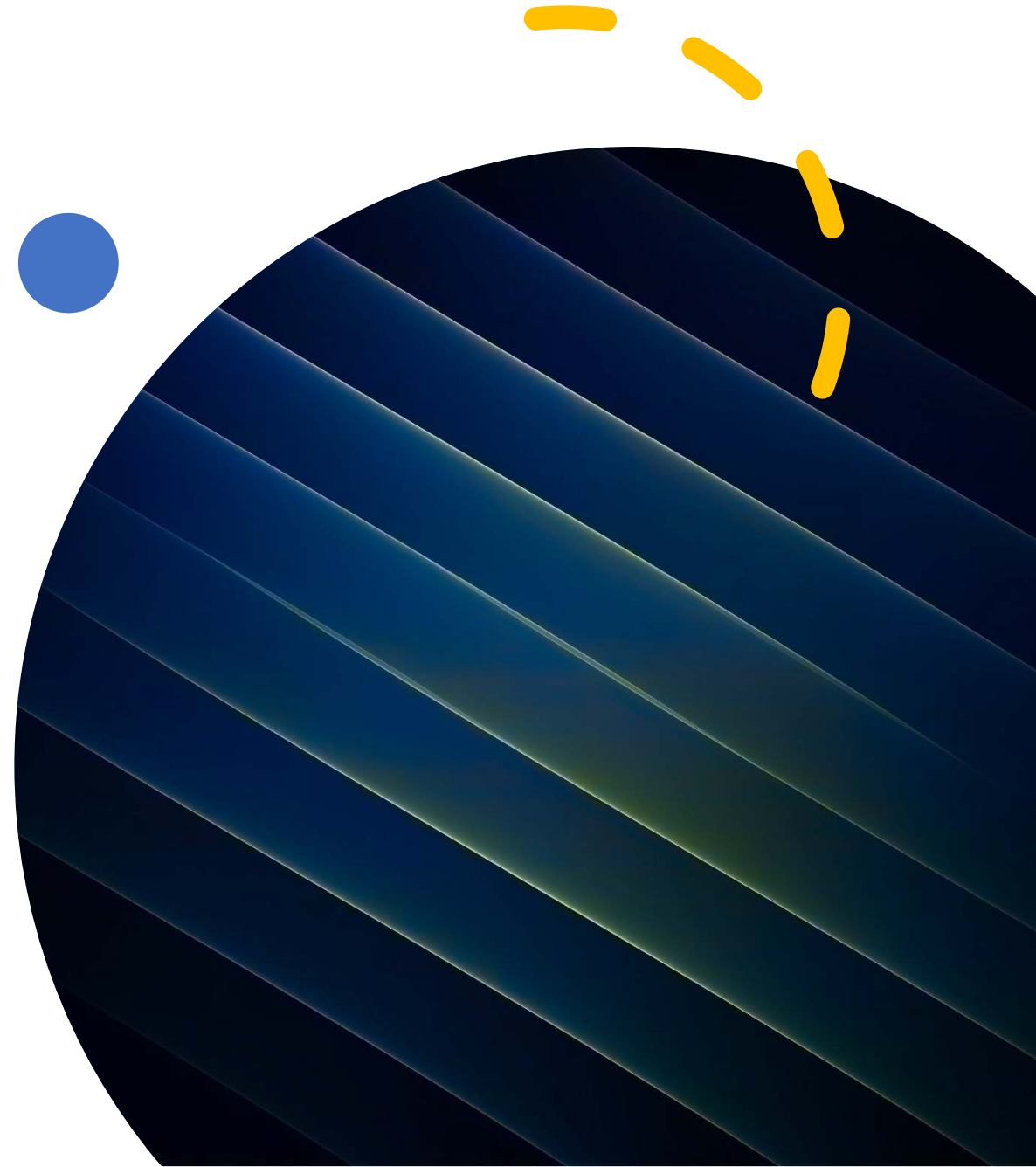
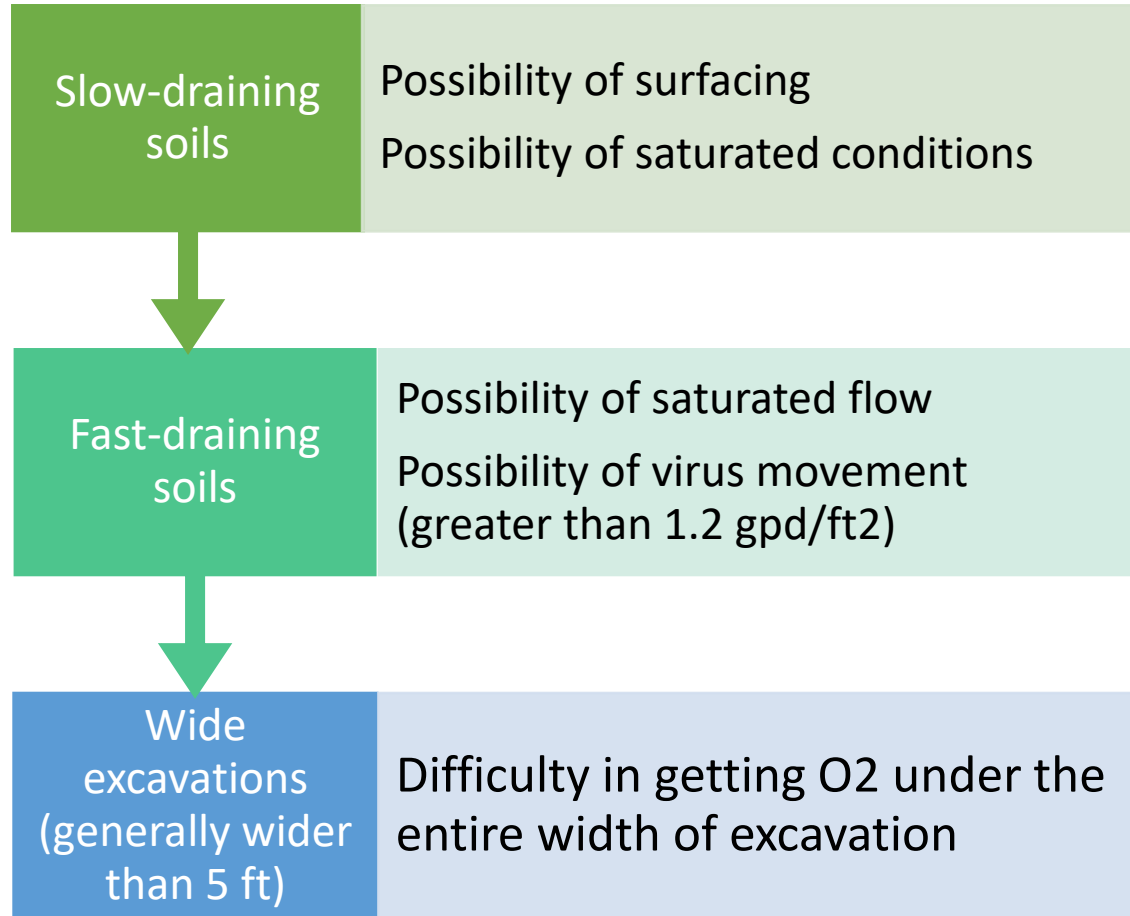
➤ Other tests

- Percolation rates
- Saturated conductivity

Sequence of Soil Characteristics Questions	SAR, Trench, Chamber, and Pit gal/day/ft ²
A. Is the horizon gravelly coarse sand or coarser?	A site-specific SAR is required
B. Is the structure of the horizon moderate or strongly platy?	A site-specific SAR is required
C. Is the texture of the horizon sandy clay loam, clay loam, silty clay loam, or finer and the soil structure weak platy?	A site-specific SAR is required
D. Is the moist consistency stronger than firm or any cemented class?	A site-specific SAR is required
E. Is the texture sandy clay, clay, or silty clay of high clay content and the structure massive or weak?	A site-specific SAR is required
F. Is the texture sandy clay loam, clay loam, silty clay loam, or silty loam and the structure massive?	A site-specific SAR is required
G. Is the texture of the horizon loam or sandy loam and the structure massive?	0.20
H. Is the texture sandy clay, clay, or silty clay of low clay content and the structure moderate or strong?	0.20
I. Is the texture sandy clay loam, clay loam, or silty clay loam and the structure weak?	0.20
J. Is the texture sandy clay loam, clay loam, or silty clay loam and the structure moderate or strong?	0.40

Percolation Rate from Percolation Test (minutes per inch)	SAR, Trench, Chamber, and Pit (gal/day/ft ²)	SAR, Bed (gal/day/ft ²)
Less than 1.00	A site-specific SAR is required	A site-specific SAR is required
1.00 to less than 3.00	1.20	0.93
3.00	1.10	0.73
4.00	1.00	0.67
5.00	0.90	0.60
7.00	0.75	0.50

Risky Conditions



Risky Conditions



Deep excavations (generally deeper than 80 inches)

- Lack of existing oxygen
- Lack of oxygen transfer
- Lack of soil structure
- Dwindling numbers of aerobic bacteria to remove pathogens
- Increasing likelihood of encountering limiting soil conditions

Exceeding long-term acceptance or soil absorption rate

- Possibility of saturated flow
- Possibility of virus movement, particularly in sandy soils

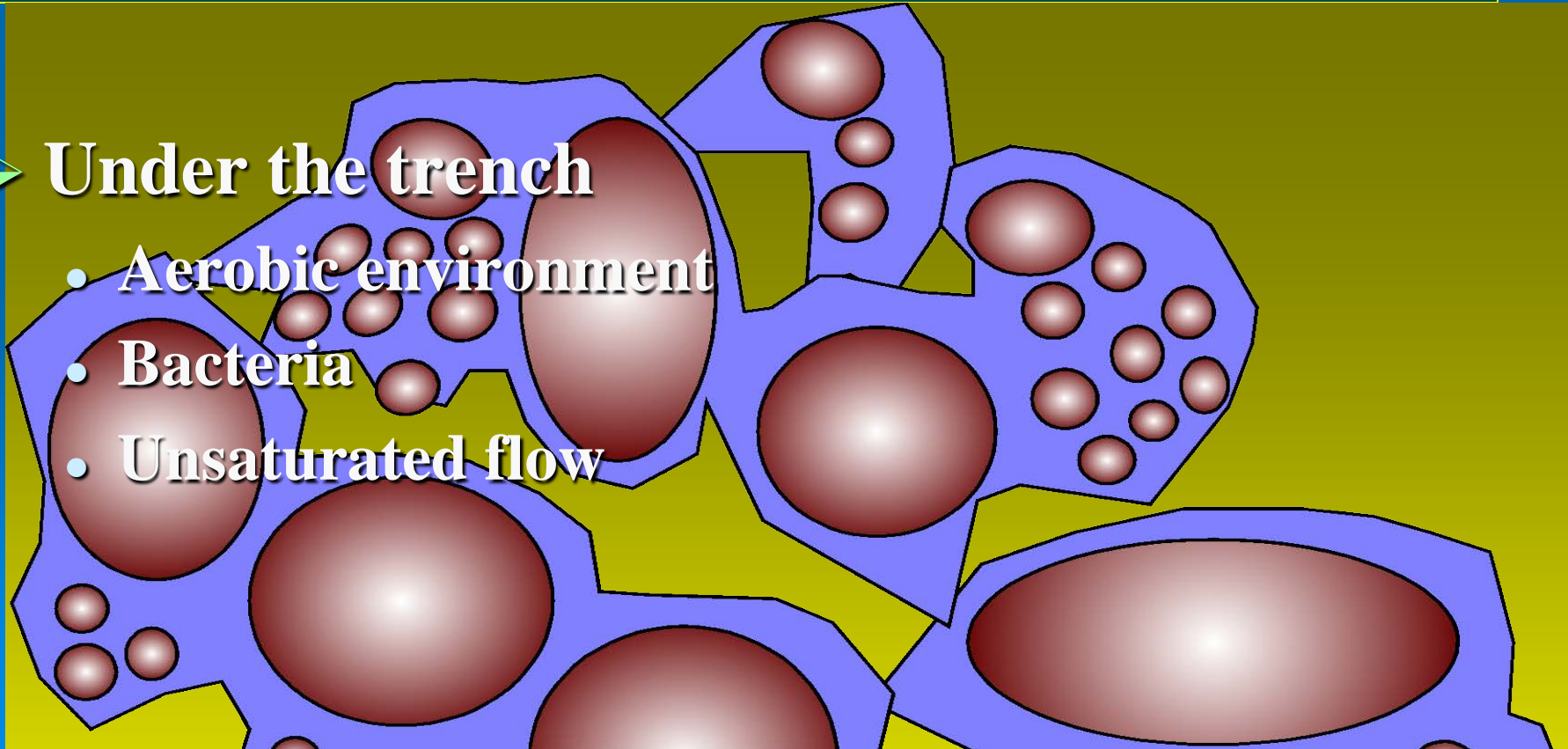
Summary

➤ Inside the trench

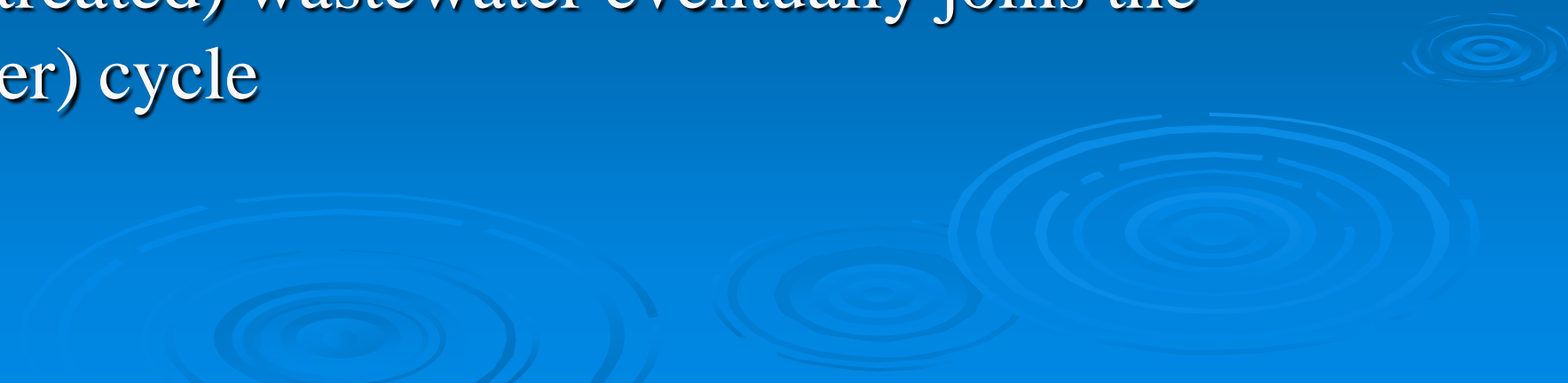
- Conditions are typically anaerobic
- Develops a biomat

➤ Under the trench

- Aerobic environment
- Bacteria
- Unsaturated flow



Summary, continued

- Under gravity distribution, biomat reduces & controls the flow from a soil treatment system
 - Biomat changes with time, wastewater quality and quantity
 - For treatment, flow from *excavation* needs to be aerobic & unsaturated
 - Treated (and untreated) wastewater eventually joins the hydrologic (water) cycle
- 
- The background of the slide features a blue gradient with several concentric white circles of varying sizes, resembling ripples on water, located primarily in the lower half of the image.

Soil is a **very effective**
treatment media &
Treatment is the name
of the **GAME**

The background of the slide is a solid blue color. In the lower half, there are several faint, light blue concentric circles that resemble ripples on water, scattered across the bottom of the frame.