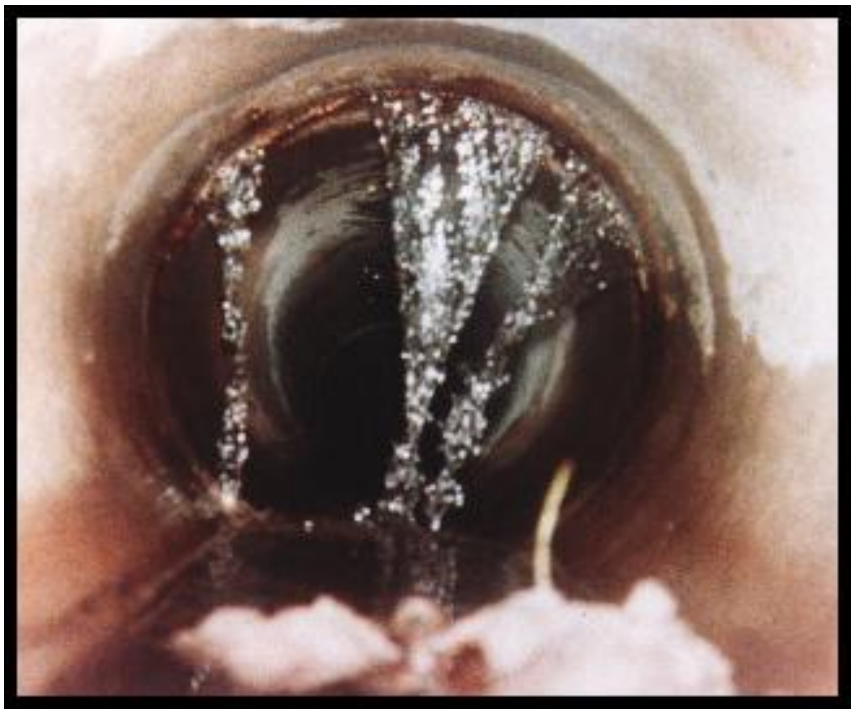
WHAT IS WASTEWATER?

"THE USED WATER AND SOLIDS MIXTURE FROM A HOUSEHOLD, COMMUNITY, OR INDUSTRY"

SOURCES OF WASTEWATER

- DOMESTIC/RESIDENTIAL
- COMMERCIAL
- INDUSTRIAL
- INFILTRATION



- STORM WATER RUNOFF

BEFORE WE CAN EXAMINE THE CONTAMINANTS IN WASTEWATER, WE MUST UNDERSTAND THE TERM "UNITS"

UNITS: *"A SPECIFIED AMOUNT FOR A GIVEN VOLUME, LENGTH, OR TIME*

TERM	UNITS
MILEAGE	MILES PER GALLON
SALARY	DOLLARS PER HOUR
VELOCITY	MILES / HOUR

WHAT "UNITS" ARE USED IN WASTEWATER MEASUREMENTS?

- **THE BRITISH (or ENGLISH) SYSTEM**

  (FEET, GALLONS, POUNDS)

- **THE SYSTEM INTERNATIONAL (SI) or METRIC SYSTEM**

  (METERS, LITERS, GRAMS)

UNITS

CHEMICAL "INGREDIENTS":
WEIGHT per *VOLUME*

such as milligrams per liter
(abbreviated as mg/L)

EXAMPLE: The dissolved oxygen content of the wastewater was 5 mg/L (meaning there was five (5) milligrams of oxygen for each liter of wastewater)

UNITS

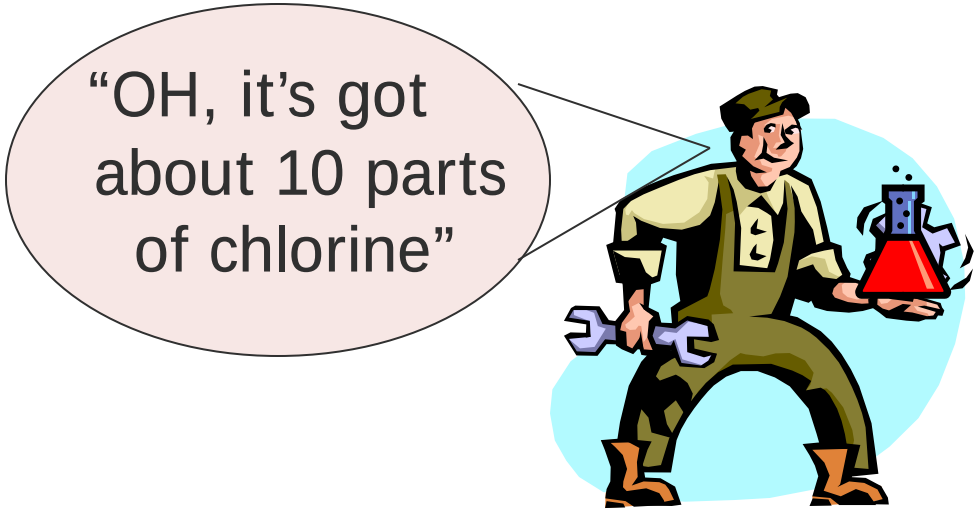
BIOLOGICAL "INGREDIENTS":
NUMBER per VOLUME

such as Colony Forming Units per milliliter (abbreviated as cfu/mL)

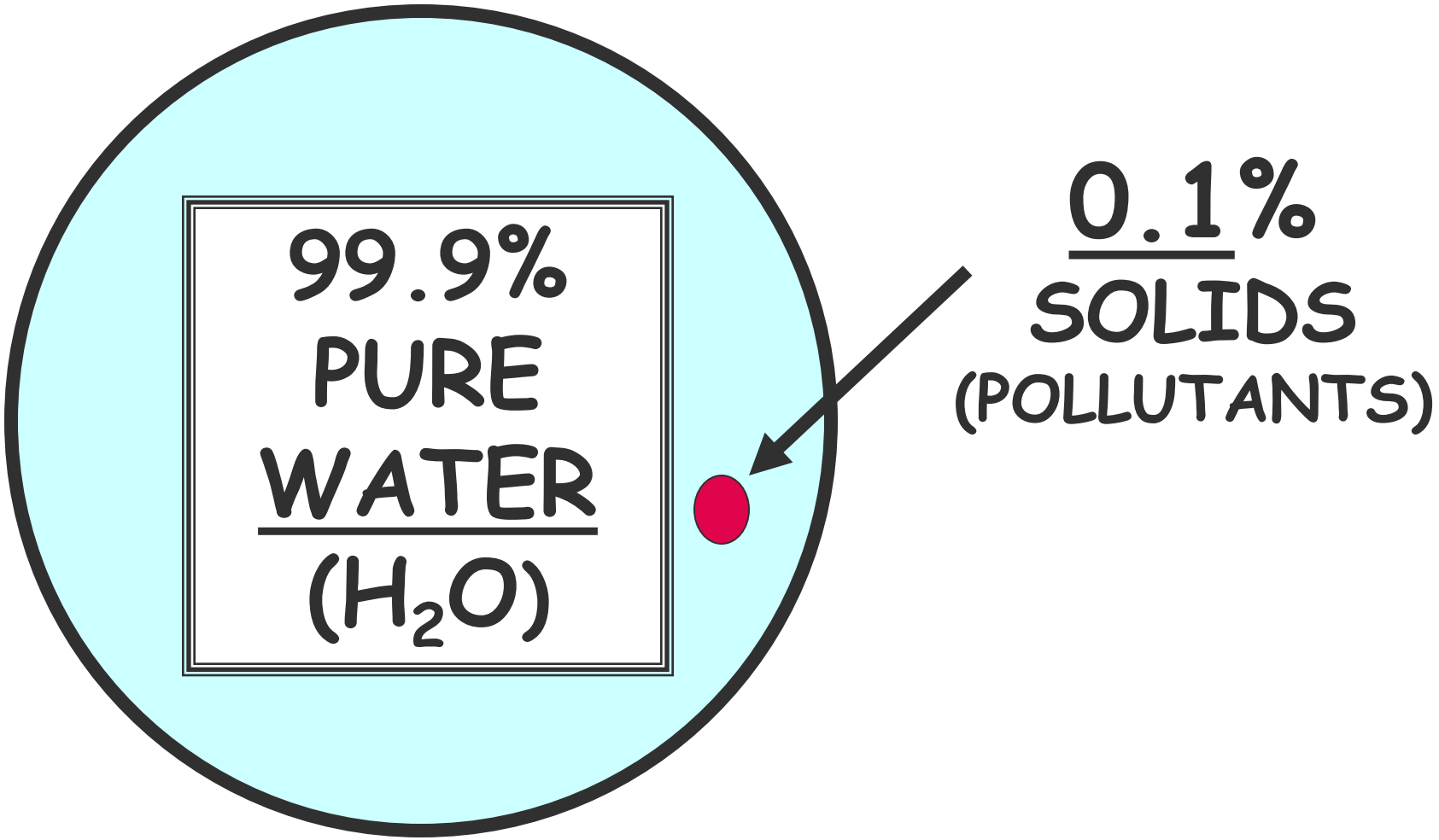
EXAMPLE: The bacteria concentration in the wastewater was 25 cfu/ 100 mL (meaning there were twenty five (25) colonies of bacteria in each 100 milliliters of wastewater)

MILLIGRAMS PER LITER or PARTS PER MILLION ???

ONE LITER OF WATER WEIGHS 1000 GRAMS (or ONE MILLION MILLIGRAMS). THEREFORE, ONE MILLIGRAM OF A CONTAMINANT, IN ONE LITER OF WATER WOULD BE "*ONE PART PER MILLION*" (ppm).



WHAT'S IN WASTEWATER?



0.1% = ? ppm

100% = 1,000,000 ppm

10% = 100,000 ppm

1% = 10,000 ppm

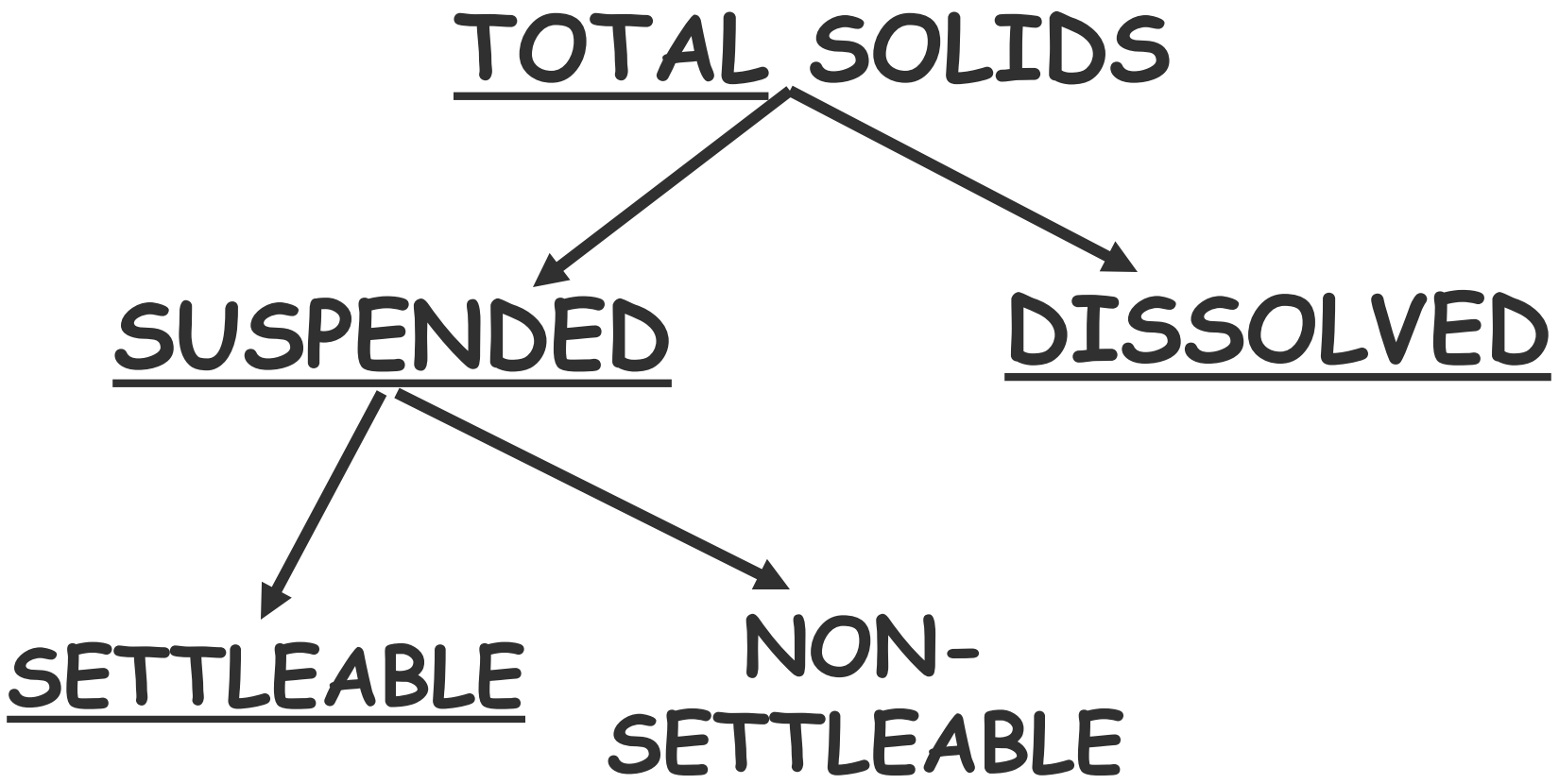
0.1% = 1,000 ppm or 1,000 mg/L

1000 mg/L of SOLIDS MEANS:

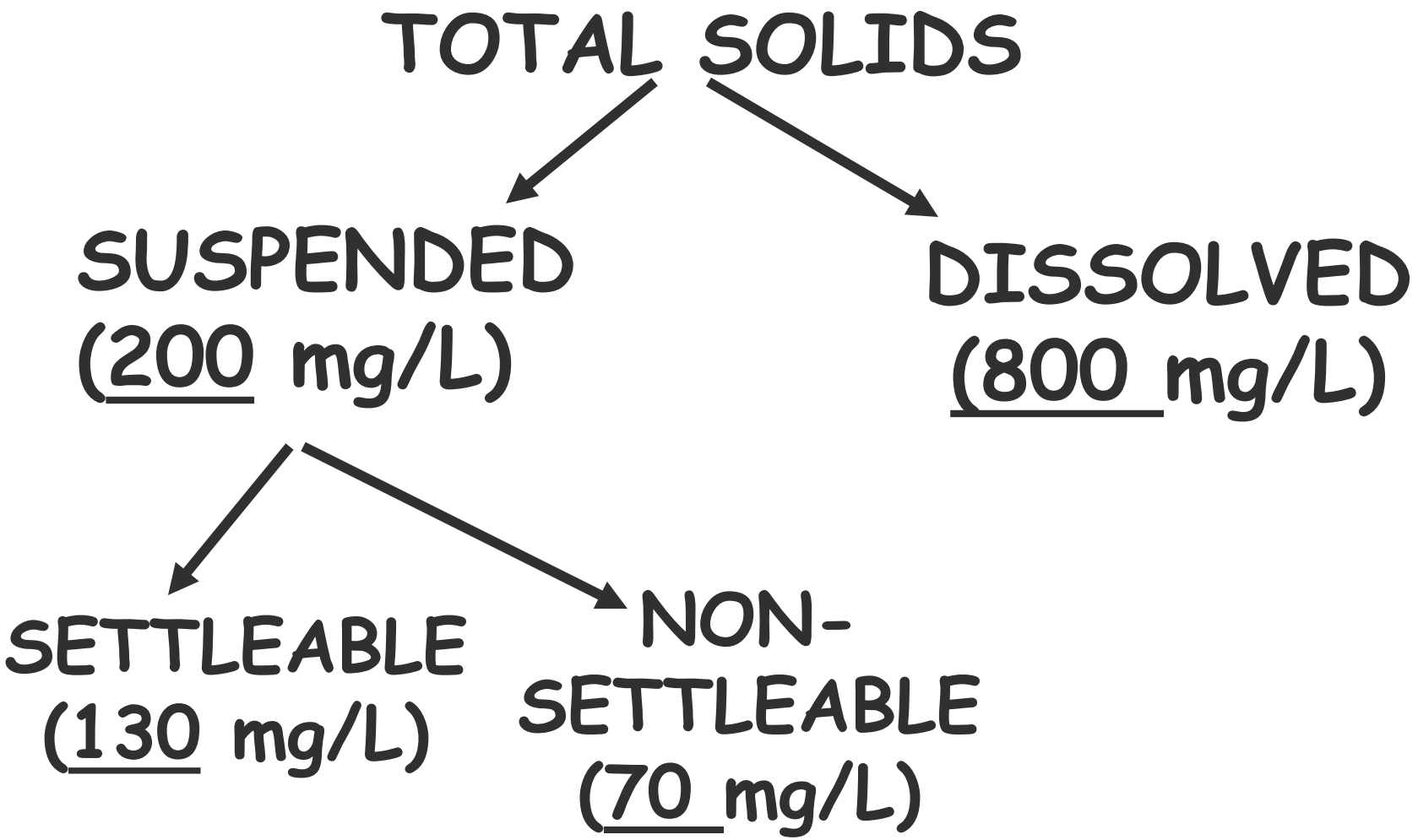
AN AVERAGE DOMESTIC WASTEWATER (SEWAGE) CONTAINS:

ONE THOUSAND (1,000) MILLIGRAMS OF SOLIDS IN EACH LITER OF WASTEWATER

SOLIDS


TOTAL SOLIDS
SUSPENDED
DISSOLVED
SETTLEABLE
NON-
SETTLEABLE

SOLIDS


TOTAL SOLIDS
SUSPENDED
(200 mg/L)
DISSOLVED
(800 mg/L)
SETTLEABLE
(130 mg/L)
NON-
SETTLEABLE
(70 mg/L)

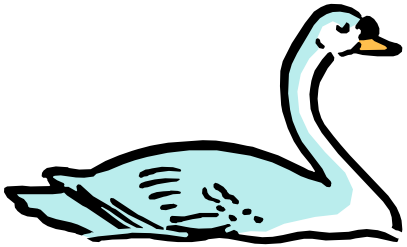
WASTEWATER CONTAINS SOME SOLIDS THAT WILL NEITHER SINK NOR FLOAT!

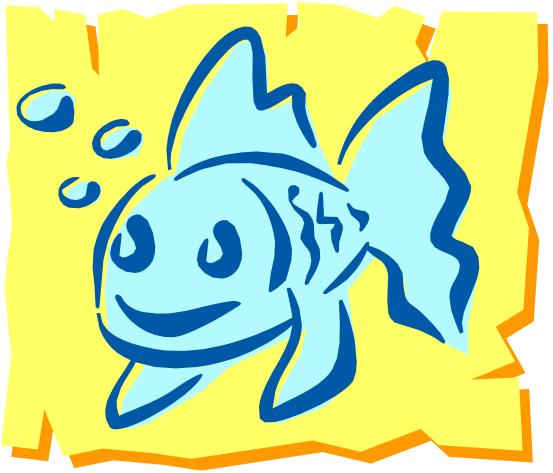
- COLLOIDS = FINELY DIVIDED DISPERSED SOLIDS
- EMULSIONS =LIQUIDS THAT WILL NOT DISSOLVE IN EACH OTHER (GREASE, FATS, OIL in WATER)

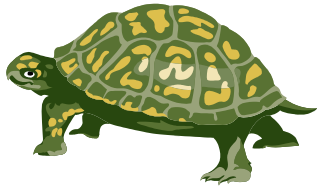
FLOATATION PROCESS

AIR IS PUMPED INTO THE WASTEWATER THEN REMOVED BY VACUUM OR RELEASED UNDER PRESSURE TO REMOVE COLLOIDS and EMULSIONS

WHY TREAT WASTEWATER?

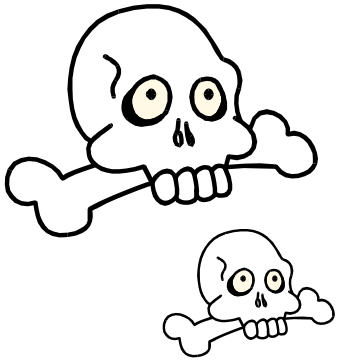


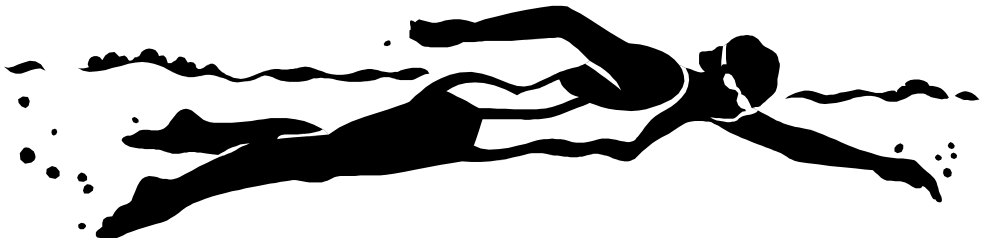


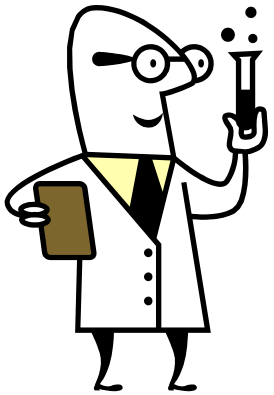


UNTREATED WASTEWATER WILL CAUSE <u>OXYGEN</u> DEPLETION IN THE RECEIVING WATER

WHY TREAT WASTEWATER?



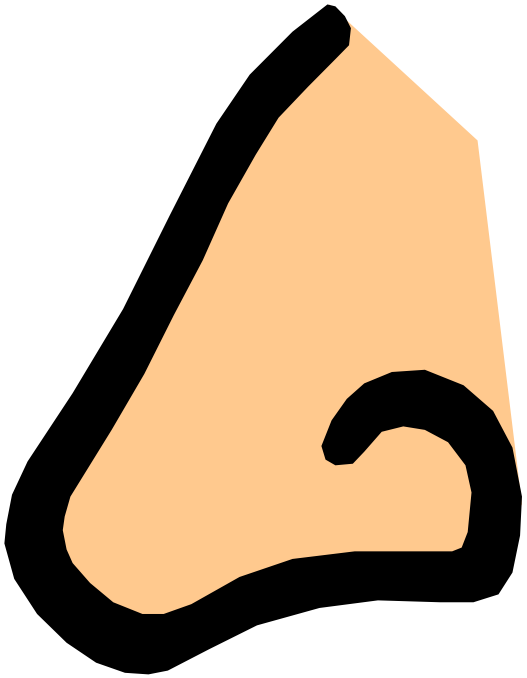




WASTEWATER CONTAINS PATHOGENS AND CHEMICALS

WHY TREAT WASTEWATER?

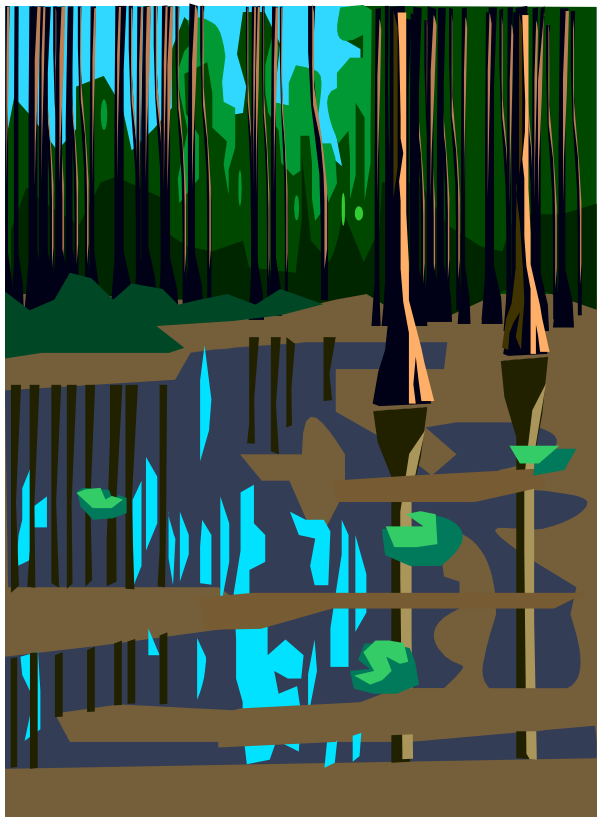
WASTEWATER CAN BE UNSIGHTLY AND SMELLY!



Why Treat Wastewater?

- Causes oxygen depletion in receiving stream
- Contains pathogens and/or chemicals
- Unsightly and smelly
- Contributes to eutrophication

WHY TREAT WASTEWATER?



THE NUTRIENTS IN WASTEWATER CONTRIBUTE TO EUTROPHICATION

EUTROPHICATION

Pronounced: YOU -tro-fa-kay-shun

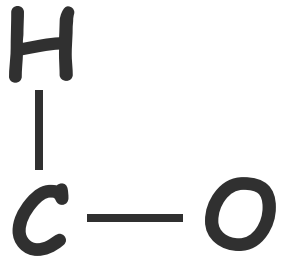
EU – from Greek meaning "**large amount**"

TROPHIC – from Greek meaning "**nutrients**"

Current meaning: "the results of having an overabundance of nutrients in the receiving water"

LET'S LOOK AT SOME GENERAL IMPURITIES

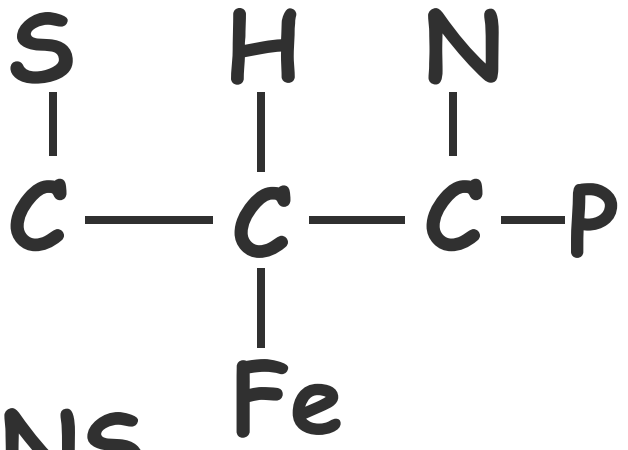
- ORGANICS



ALWAYS CONTAINS CARBON, and usually HYDROGEN and OXYGEN

LET'S LOOK AT SOME GENERAL IMPURITIES

- ORGANICS



SOMETIMES CONTAINS SULFUR (S), NITROGEN (N), IRON (Fe), & PHOSPHORUS (P)

Organics (cont.)

- Carbohydrates and alcohol
- Lipids (fats and oils)
- Proteins
- Nucleic acids (DNA and RNA)
- Pesticides

LET'S LOOK AT SOME GENERAL IMPURITIES

- ORGANICS
- INORGANICS

INORGANIC COMPONENTS

- Minerals / Salts / Metals

-Calcium (Ca^{++}), Magnesium (Mg^{++}), Sodium (Na^{+}), Potassium (K^{+}), Chloride (Cl^{-}), Nitrate (NO_3^{-})

Inorganic (cont.)

- Carbonates (CO_3)
- Phosphates (PO_4)
- Hydrogen sulfide (H_2S)
- Ammonia or Ammonium (NH_3 / NH_4^+)
- Nitrites and/or nitrates (NO_2 / NO_3)

Inorganic (cont.)

- Dissolved
- Suspended (particulate)
- Fixed/inert

LET'S LOOK AT SOME GENERAL IMPURITIES

- ORGANICS
- INORGANICS
- GASSES

Gases

- Ammonia (NH_3)
- Hydrogen Sulfide (H_2S)
- Methane (CH_4)
- Oxygen (O_2)

LET'S LOOK AT SOME GENERAL IMPURITIES

- ORGANICS
- INORGANICS
- GASSES
- MICROORGANISMS

Microorganisms

- Viruses
- Bacteria
- Protozoa
- Metazoa
- Pathogens

Viruses

- Either DNA or RNA encapsulated in protein coat
- Enterovirus: Polio
- Adenovirus
- Infectious Hepatitis

Bacteria

- Used to stabilize wastewater
- Procaryote (pronounced pro-CARRY-oat)
  - No true nucleus
  - Reproduces by fission

Bacteria - waterborne

- Salmonella (salmonellosis)
- Shigella (bacillary dysentery)
- Bacillus typhosus (typhoid fever)
- Vibrio cholera (cholera)
- Salmonella paratyphi (paratyphoid)

Protozoa

- Eucaryote

(pronounced you-CARRY- oat)

  - True membrane bound nucleus
  - Divides by mitosis
- Single cells or a group of more or less identical cells
- Amoeba, flagellates, ciliates

Metazoa

- Eucaryotes
- Worms or worm-like animals (frequently parasitic)
- Nematodes, other helminths, rotifers

MNEMONIC (nee – MON – ic)

from Greek…to improve memory

KING PHILLIP CAME OVER
FROM GRANADA SPAIN

BIOCHEMICAL OXYGEN DEMAND (BOD)

- THE AMOUNT OF OXYGEN NEEDED TO STABILIZE THE WASTEWATER

USED AS A MEASURE OF THE **ORGANIC** STRENGTH OF WASTES IN WATER

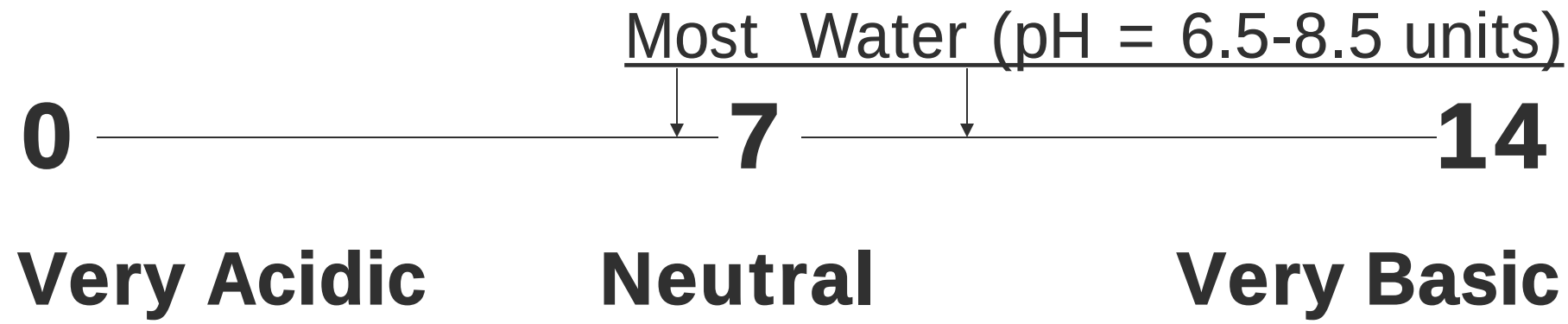
MICROBIAL RESPIRATION

"AEROBIC ORGANISM"
REQUIRES FREE AVAILABLE OXYGEN (DISSOLVED O_2) TO LIVE AND REPRODUCE

"ANAEROBIC ORGANISM" IS ABLE TO LIVE AND REPRODUCE WITHOUT DISSOLVED OXYGEN (breaks down chemicals like SO_4 to get oxygen)

pH

A MEASURE OF HOW ACIDIC OR BASIC A MATERIAL OR SOLUTION IS.



Fresh vs. Septic Sewage

- Fresh
  - Grey
  - Musty odor
  - Floatable solids visible
  - No apparent gas bubbles
- Septic
  - Black
  - Offensive odor
  - No floatable solids visible
  - Apparent gas bubbles

Treatment Advantages of Fresh Wastewater

- Fresh
  - Smells better
  - Solids settle better in downstream treatment units
  - Grease and oil separate better
  - Reduces possibility of septic conditions in primary clarifier

Why Treat Wastewater?

- Contains pathogens and/or chemicals
- Unsightly and smelly
- Contributes to eutrophication
- Causes oxygen depletion in receiving stream

AND... WE DO IT FOR THE $$$$$$!!

National Pollutant Discharge Elimination System

Protecting the Environment and Public Health

- Regulates discharges of pollutants to navigable waters of the United States

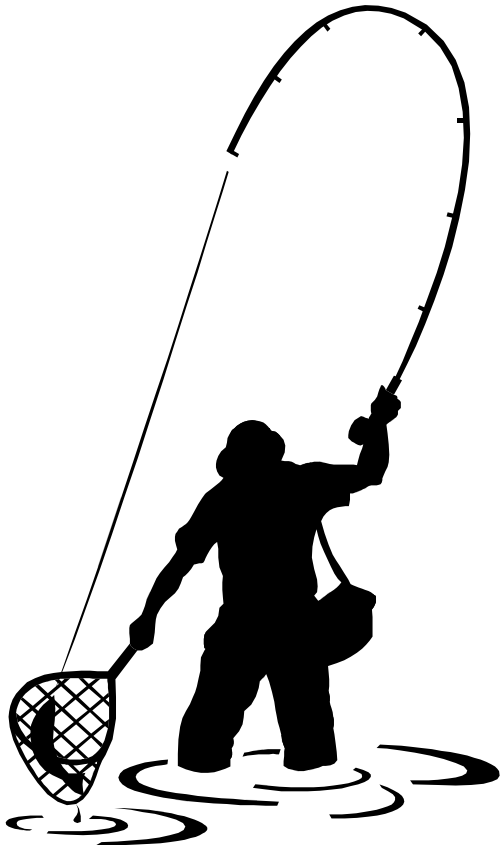
  - The Environmental Protection Agency (EPA) sets effluent standards.

PRINCIPLES OF THE "LAW"

- DISCHARGING POLLUTANTS **IS NOT A <u>RIGHT</u>**
- A DISCHARGE PERMIT IS REQUIRED
- WASTEWATER **MUST BE <u>TREATED</u>** REGARDLESS OF THE RECEIVING WATER
- LIMITS BASED ON <u>TECHNOLOGY</u> AND SCIENCE

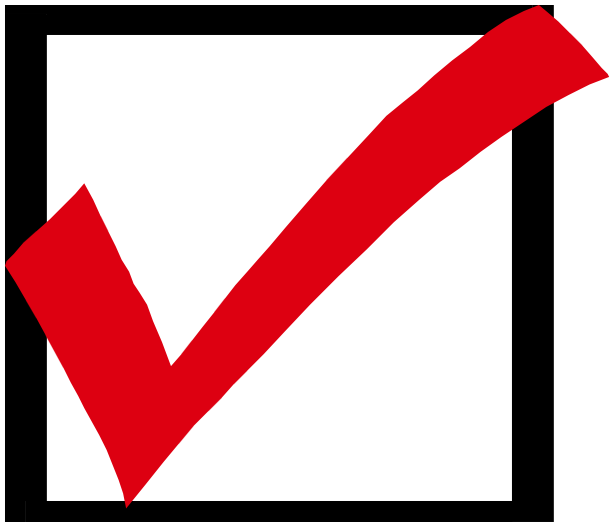
- Discharge of any pollutant into navigable waters without a NPDES permit is unlawful
  - Point source pollution

- Importance
  - Drinking water supplies
  - Recreation
  - Fish and Wildlife



DISCHARGERS MUST MEET NPDES LIMITS ON THE FOLLOWING:

- BIOCHEMICAL OXYGEN DEMAND (BOD)
- TOTAL SUSPENDED SOLIDS (TSS)
- pH
- FECAL COLIFORM
- CHLORINE RESIDUAL



- Effluent Limits
  - Wastewater Treatment Facilities

Biochemical Oxygen Demand (BOD)

30 day avg. - 30 mg/L

7 day max. avg.- 45 mg/L

Minimum 85% removal

- Effluent Limits (cont.)

Total Suspended Solids

30 day average - 30 mg/L

7 day max. average - 45 mg/L

Minimum 85% removal

- Effluent Limits (cont.)

pH

6-9 S. U.

Report <u>maximum</u> and minimum pH values for month

- Effluent Limits (cont.)

Fecal coliform

30 day average - 200 cfu/100ml

7 day max. average - 500 cfu/100 ml

- **Effluent Limits (cont.)**

Chlorine	No measurable amount
	0.01 mg/L

Other Requirements

- Flow
  - Report only

Biomonitoring

Stream standards may result in more stringent effluent limits

Total Maximum Daily Load, TMDL

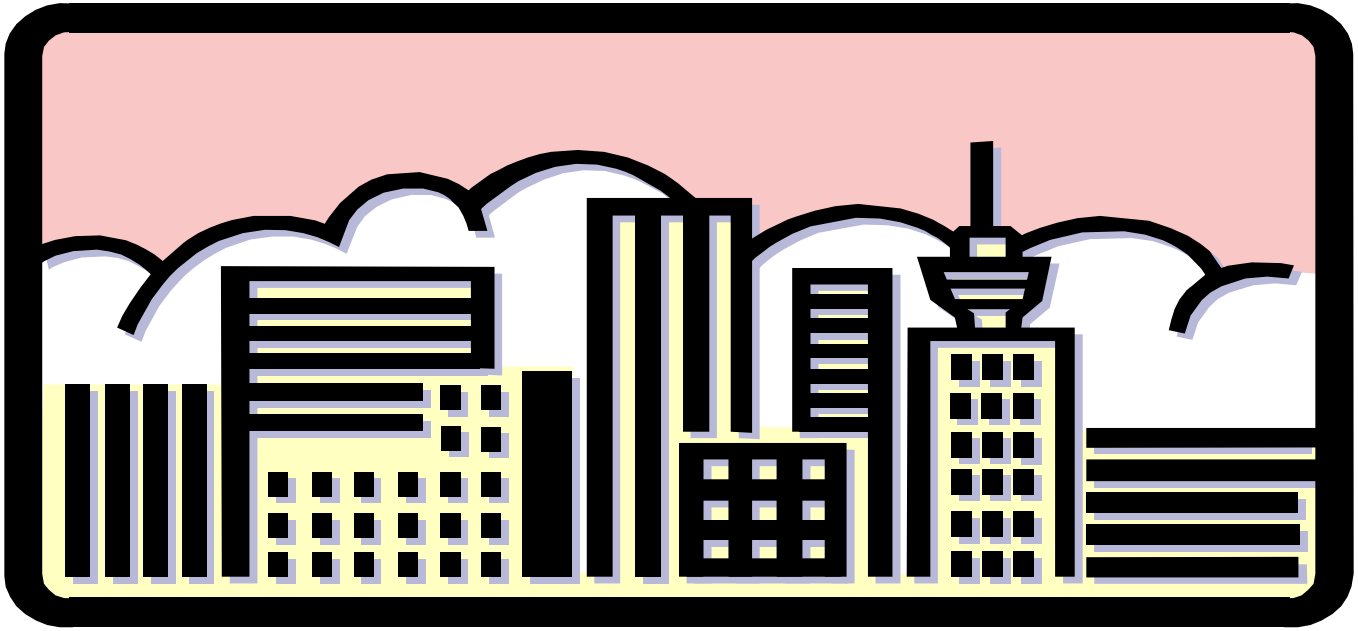
- Regulatory term
- Shift from point source to non-point source
- Increased stakeholders responsible for water quality
  - Agriculture, DOT, septics

Mass Loading Calculations

- Flow
- BOD & TSS concentrations
- Dosage Formula
  - Q, MGD x Conc, mg/L x 8.34 #/gal

Sampling Frequency

- Depends on size of facility



Reporting

- Discharge Monitoring Report – DMR
  - Frequency depends on size of facility