

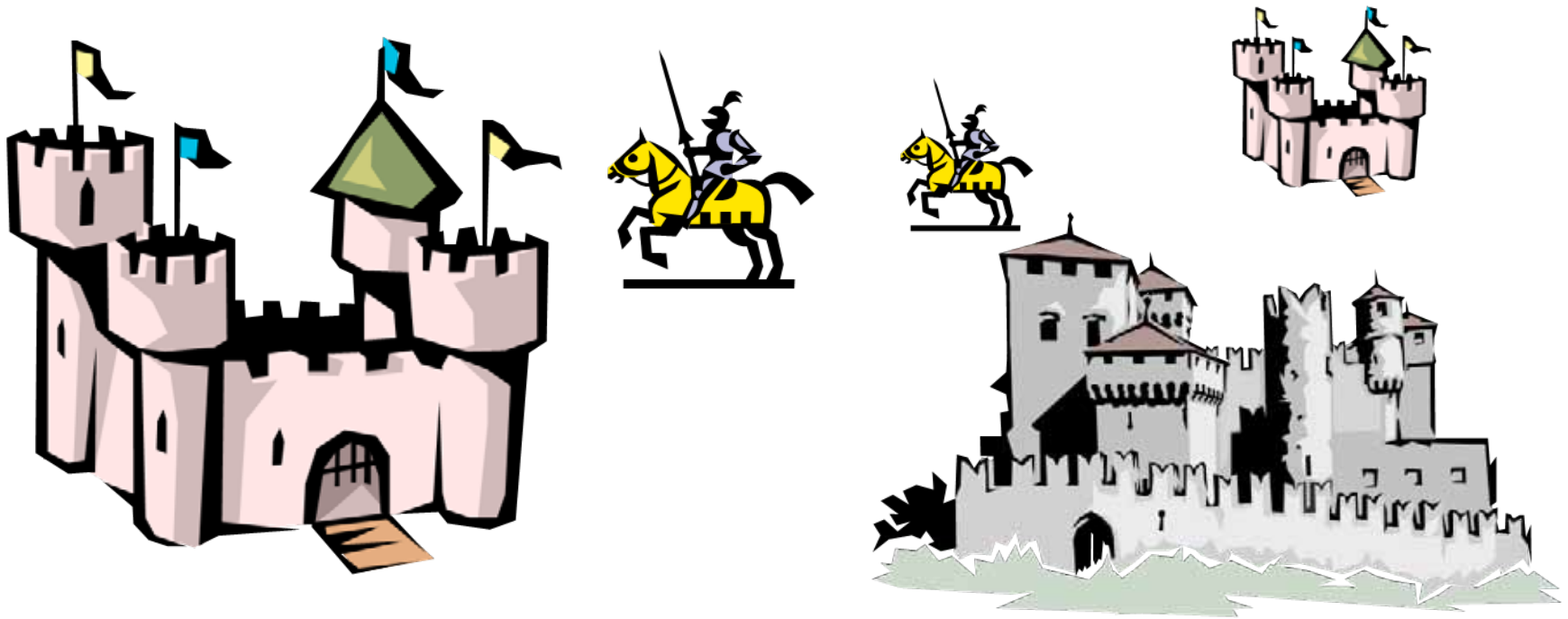
OVERVIEW OF WASTEWATER TREATMENT

- **GENERATION**
- **COLLECTION / TRANSPORT**
- **TREATMENT**
- **DISPOSAL**

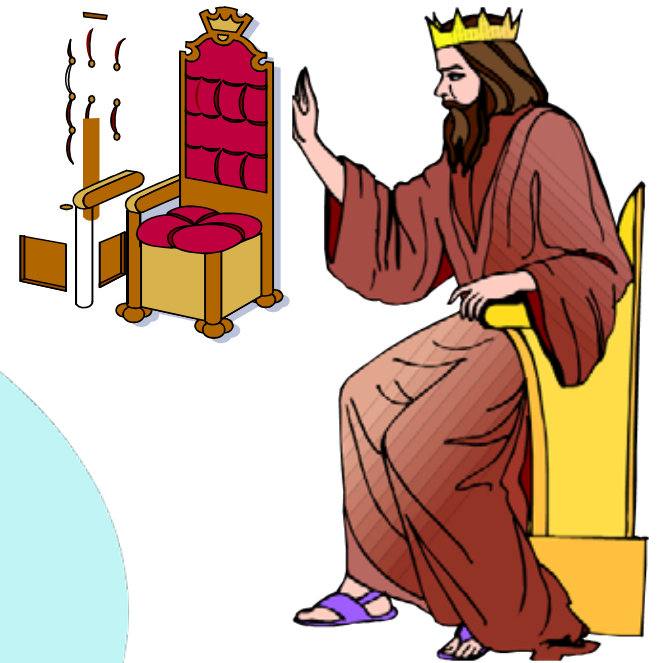
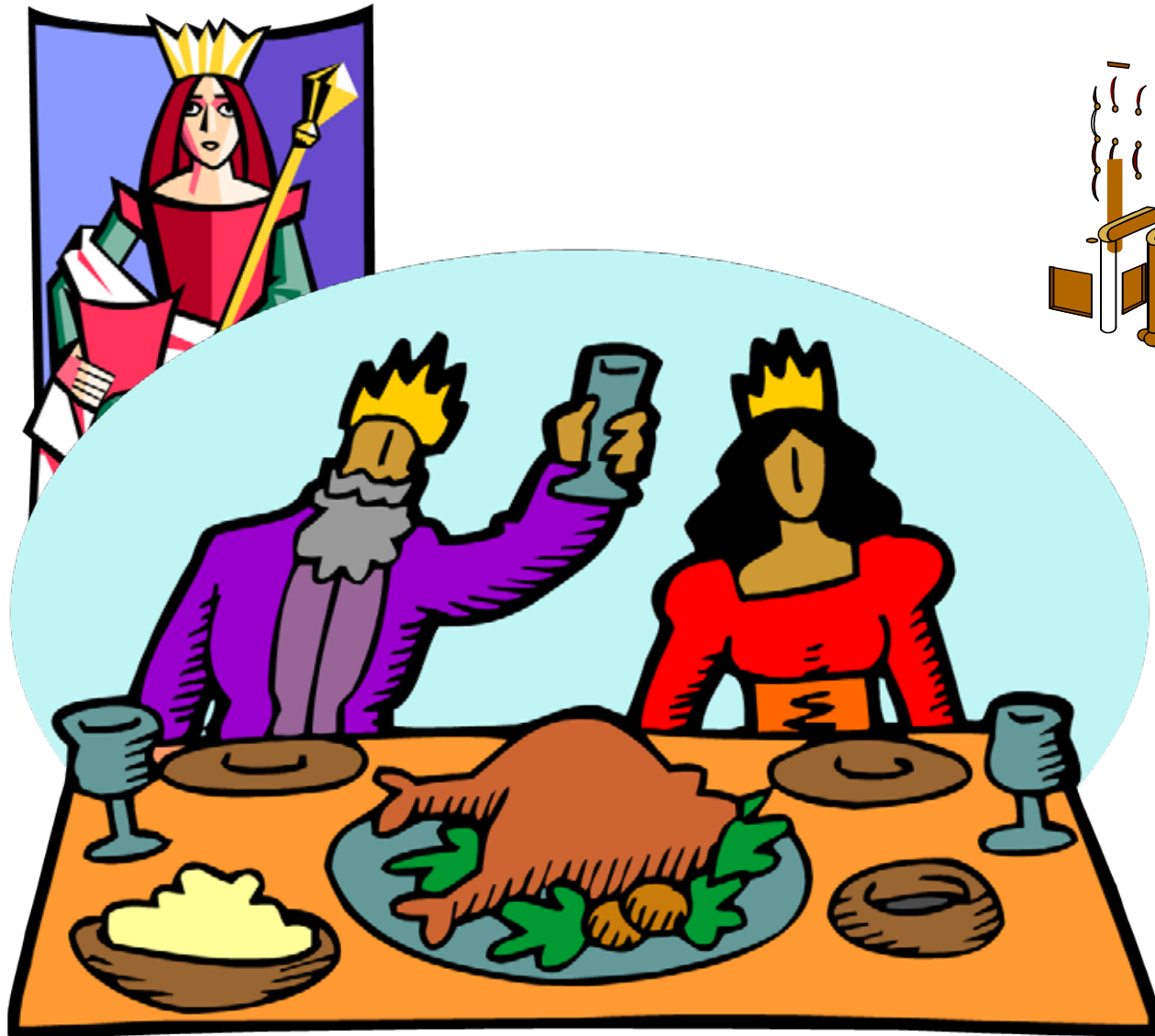
GENERATION OF WASTES

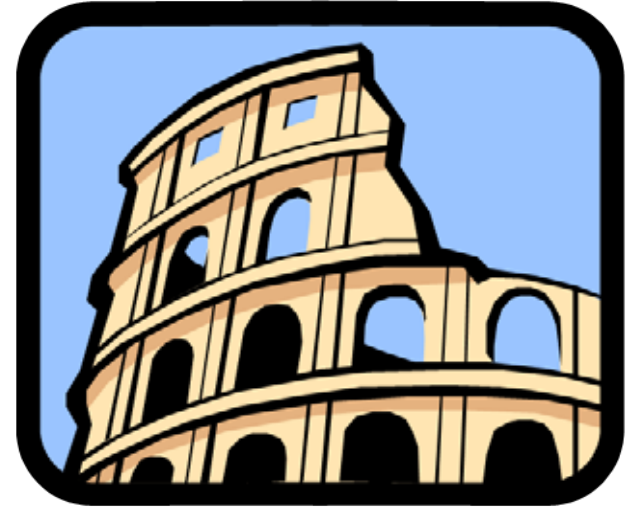
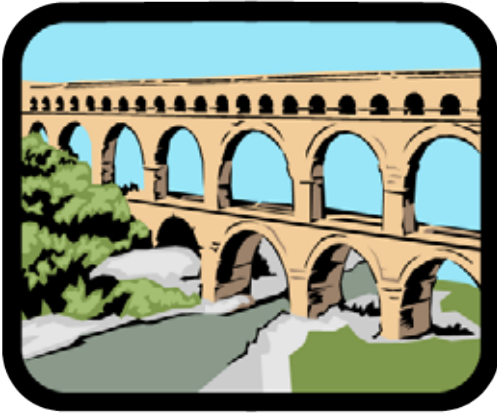
- **IN THE USA, AVERAGE PERSON GENERATES 70 to 100 GALLONS OF WASTEWATER per DAY**

- **AVERAGE PERSON GENERATES APPROX 56 gm BOD per DAY or 0.12 lbs BOD / PERSON / DAY**

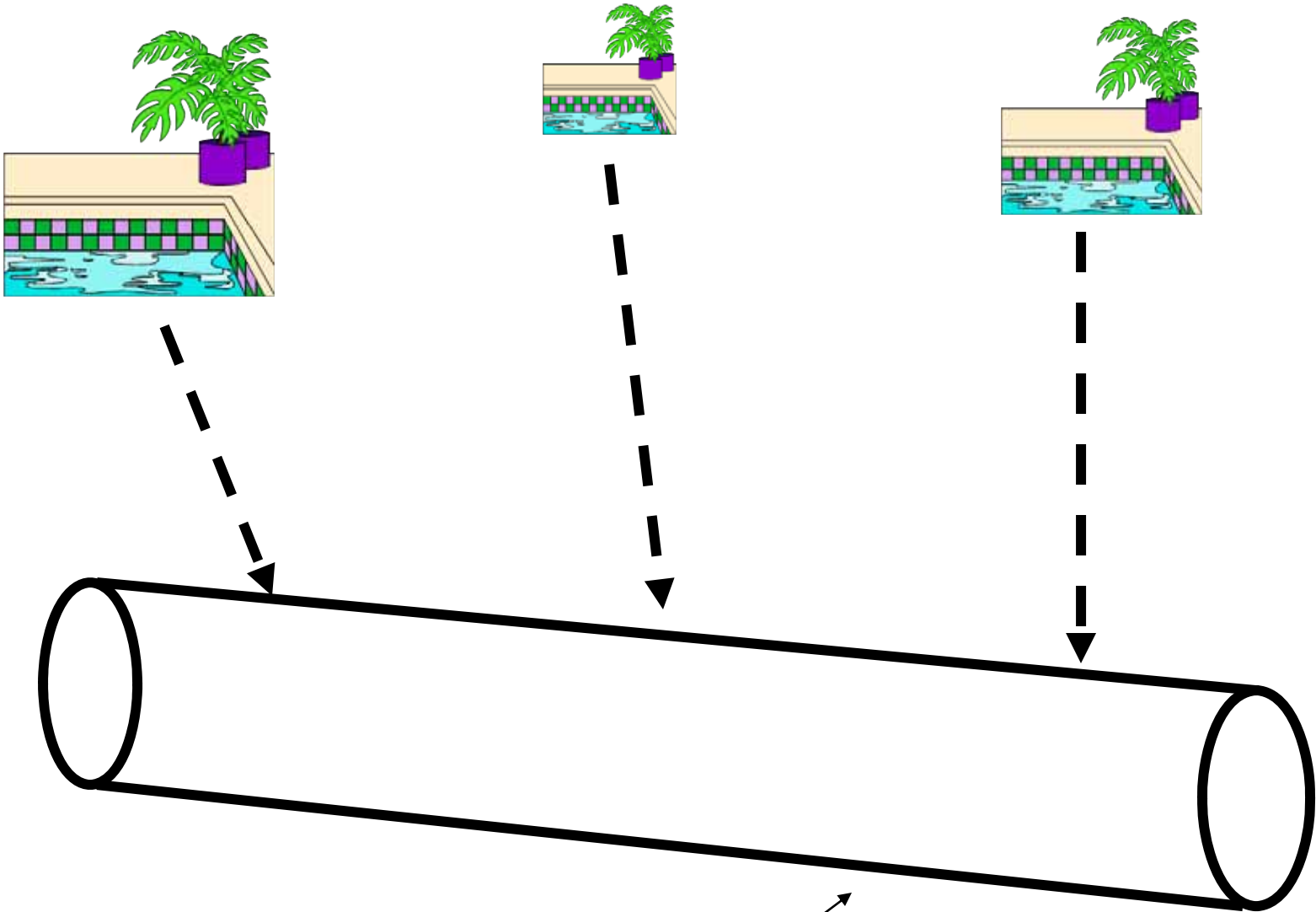


**IN MEDIEVAL TIMES, WASTES
WERE SIMPLY DUMPED OVER
THE WALLS!**





**IN ROME AROUND 600 AD,
ROMANS BUILT THE CLOACA
MAXIMA TO DRAIN A SWAMP**



CLOACA MAXIMA



**PIT PRIVIES (OUTHOUSES)
WIDELY USED IN THIS COUNTRY
IN THE 1960's and 1970's.**

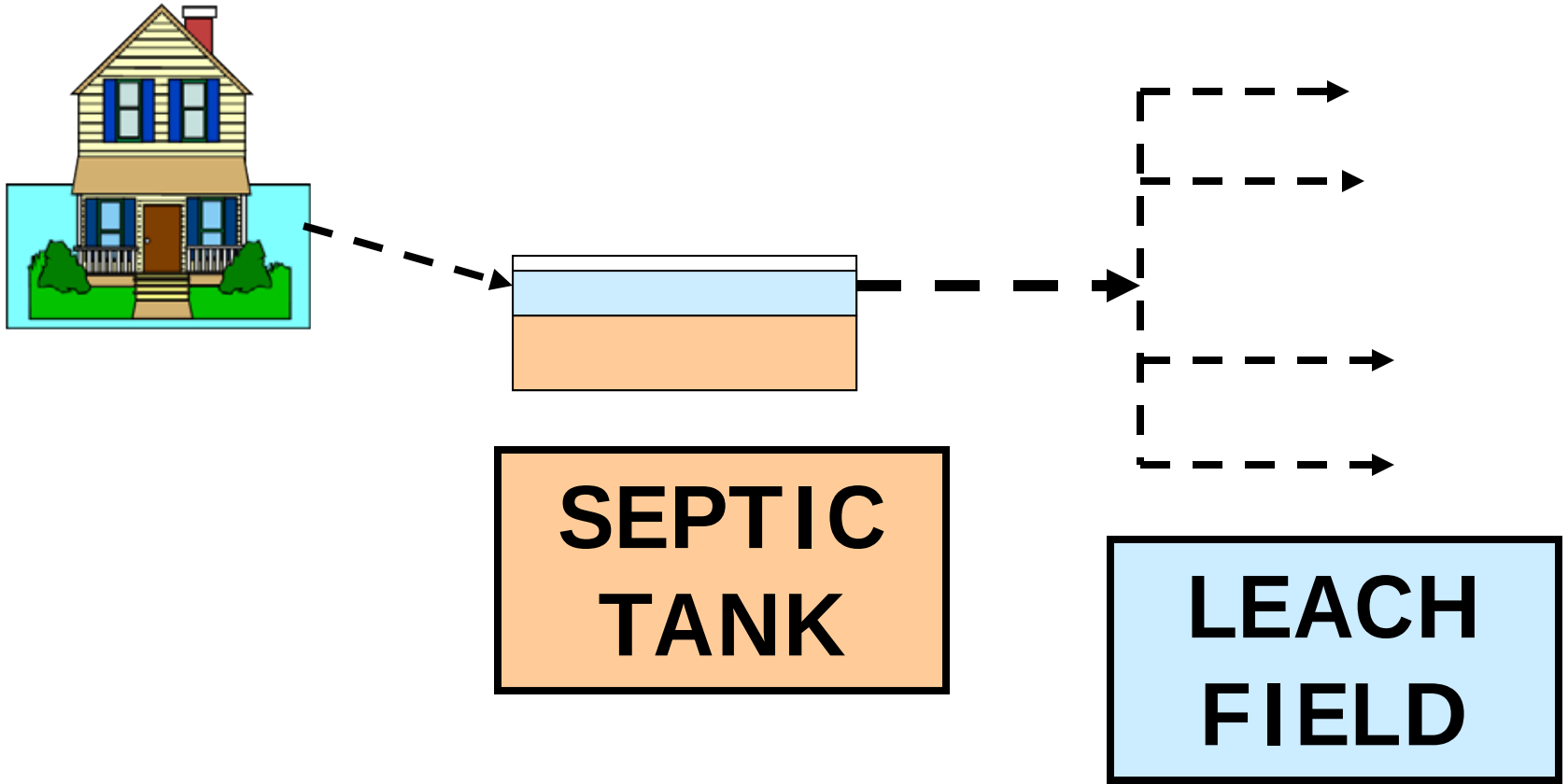
**CURRENTLY, WIDELY USED IN
REMOTE ALASKA**



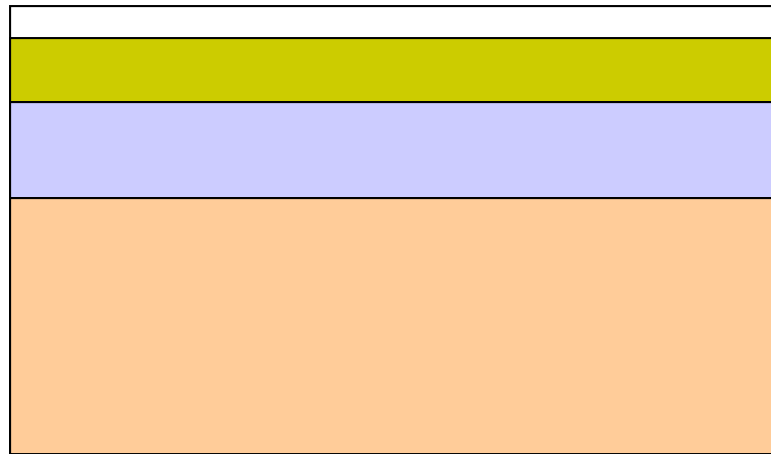
- IN 1980, 85 MILLION PEOPLE SERVED BY POTWs

- NOW, OVER 175 MILLION SERVED BY POTWs

**POTW = PUBLICLY OWNED
TREATMENT WORKS**



INDIVIDUAL HOME DISPOSAL



SCUM LAYER

LIQUID

SOLIDS

**ANAEROBIC CONDITIONS
IN THE SEPTIC TANK,
AEROBIC CONDITIONS IN
THE LEACH FIELD**

**IN PRINCIPLE, INDIVIDUAL
SYSTEMS ARE SIMILAR TO
LARGE SCALE SYSTEMS—
WASTE MUST BE
TRANSPORTED, SOLIDS
REMOVED, THEN PROPERLY
DISPOSED OF**

**TO COLLECT AND TRANSPORT
WASTEWATER FOR TREATMENT
WE USE:**

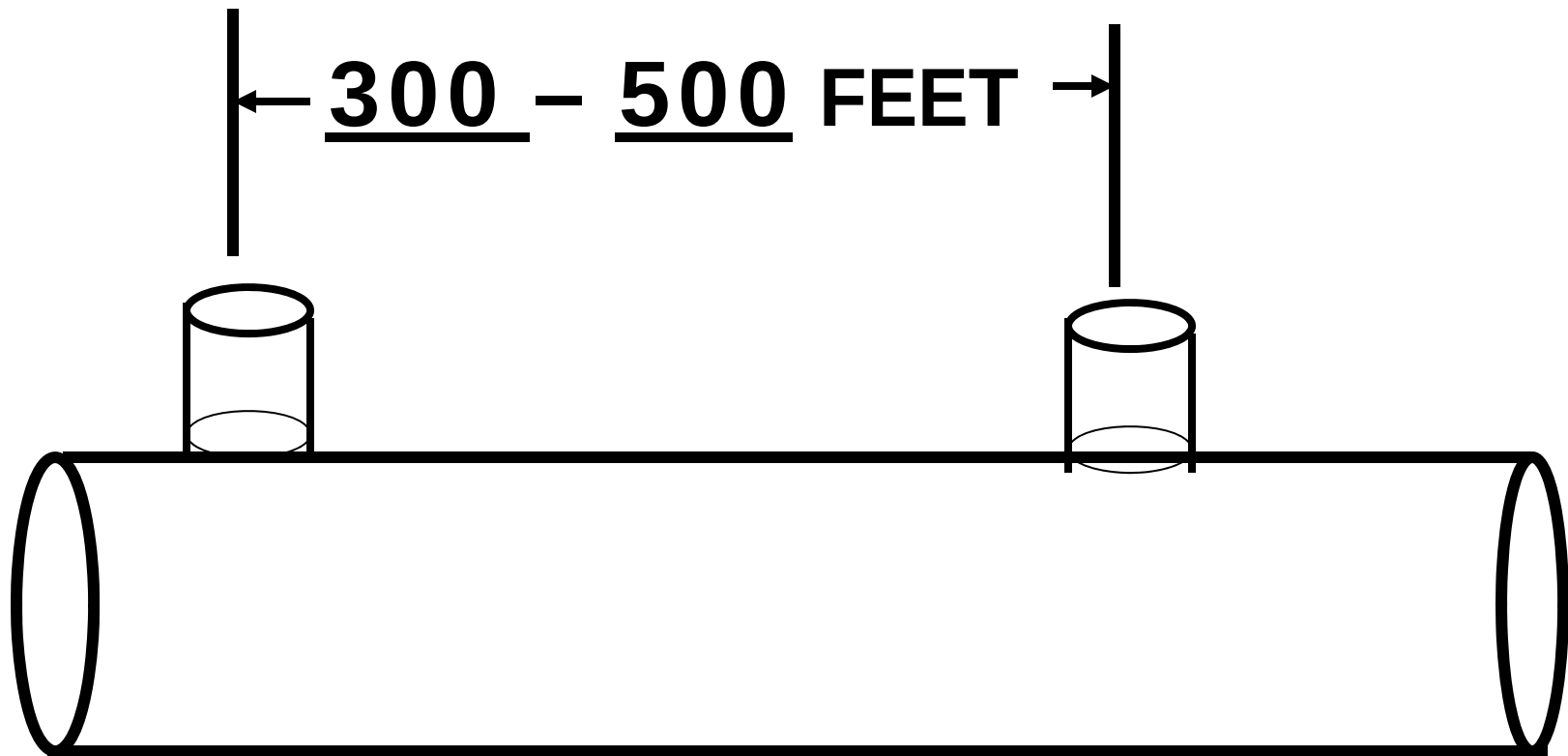
- **SANITARY SEWERS**

- **STORM SEWERS**

- **COMBINED SEWERS**

- **IN GENERAL, SEWERS ARE
DESIGNED TO FLOW BY
GRAVITY**

- **DESIGN FLOW IS 2 FEET per
SECOND (fps) to prevent
settling and septic conditions**



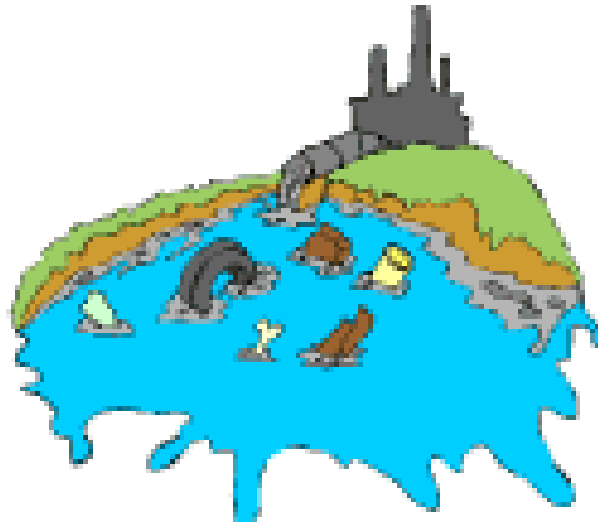
**MANHOLE PLACEMENT ON
SEWERS**



**WHY ARE
MANHOLE
COVERS
ROUND?**







IF UNTREATED WASTE IS DISCHARGED INTO A RIVER...

- SOLIDS SETTLE OUT
- DEMAND FOR $\underline{\underline{O_2}}$
- HOPEFULLY, RECOVERY



**WASTEWATER
TREATMENT TAKES
WHAT WOULD
HAPPEN IN MILES
OF RIVER...**

**...AND DUPLICATES IT IN A
FEW ACRES OF TANKS AND
EQUIPMENT**

**IN THE WASTEWATER
TREATMENT PLANT, THE
STAGES OF TREATMENT ARE:**

1. PRELIMINARY TREATMENT

2. PRIMARY TREATMENT

3. SECONDARY TREATMENT

4. SOMETIMES...TERTIARY

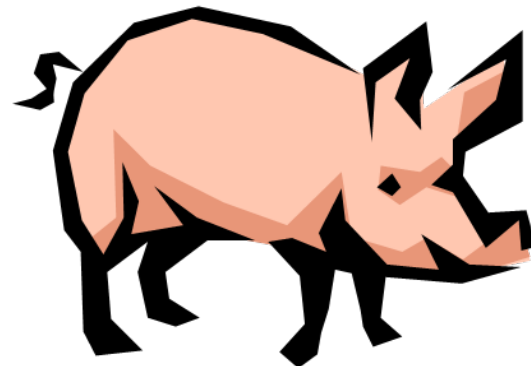
PRELIMINARY TREATMENT

SEWAGE - - - -> HEADWORKS

- SCREENING
- SHREDDING
- GRIT REMOVAL
- FLOW MEASUREMENT

MNEMONIC (nee – MON – ic)
from Greek...to improve memory

**KING PHILLIP CAME OVER
FROM G GRANADA SPAIN**

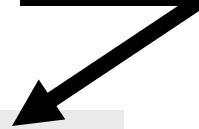


PRELIMINARY TREATMENT

SEWAGE



HEADWORKS



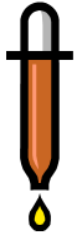
- SCREENING
- SHREDDING
- GRIT REMOVAL
- FLOW MEASUREMENT

MUST LEARN AND REMEMBER!

**OVERALL PURPOSE OF THE
HEADWORKS IS ...???**

**• TO PROTECT THE
EQUIPMENT IN THE REST
OF THE PLANT and...**

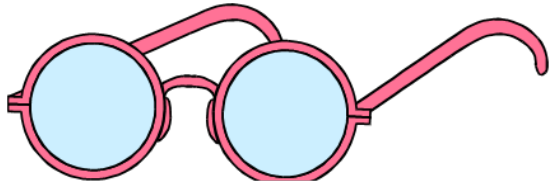
• TO MONITOR THE FLOW



SCREENING



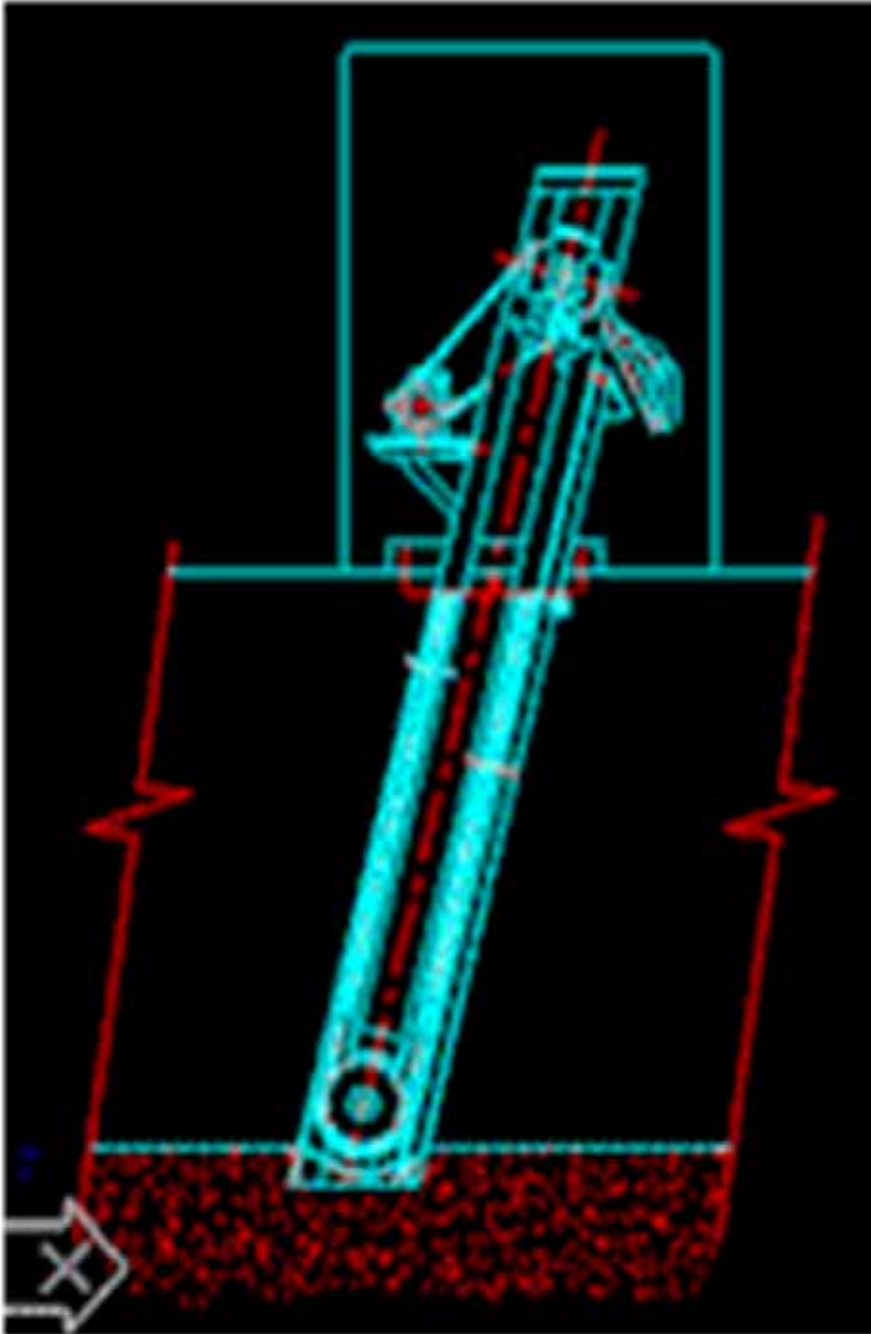
**PURPOSE: TO REMOVE LARGE,
NON-BIODEGRADABLE ITEM
FROM SEWAGE SUCH AS..**



_BAR SCREENS:

SPACING =

3 / 8" to 2"



SHREDDING

PURPOSE: TO REDUCE IN SIZE, CUT UP AND SHRED “STUFF” NOT REMOVED ON THE SCREENS. (TO ABOUT $\frac{1}{4}$ ”)



**SEVERAL BRANDS:
BARMINUTOR, COMMINUTOR,
DIMMINUTOR, MACERATOR**

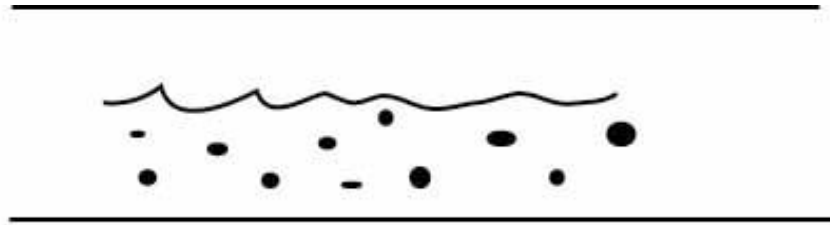
GRIT REMOVAL

**PURPOSE: TO PROTECT THE
MECHANICAL EQUIPMENT IN
THE REST OF THE PLANT**

**WHAT'S GRIT? SAND, GRAVEL,
EGG SHELLS, COFFEE GROUNDS,
SEEDS, etc.**

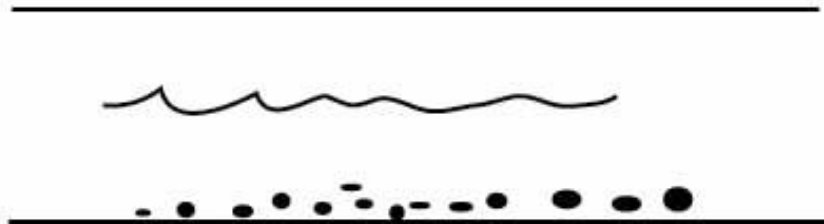
HOW IS GRIT REMOVED?

Sewer



VELOCITY = 2 ft/sec

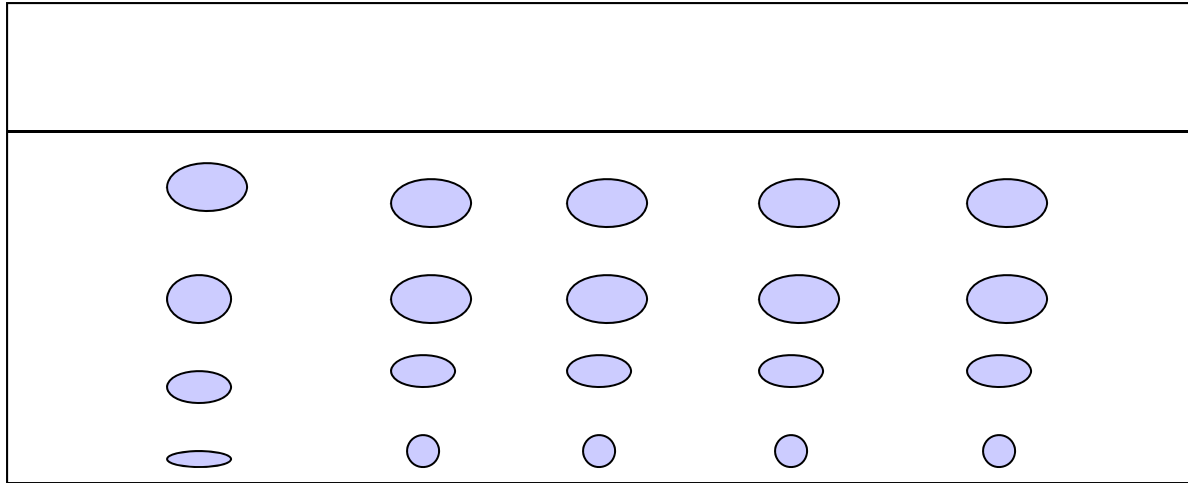
**Grit
Chamber**



VELOCITY = 1.5 ft/sec



**ONCE SETTLED, THE GRIT CAN
BE REMOVED AND DISPOSED OF**



**SOME GRIT CHAMBERS HAVE
AIR DIFFUSERS TO REMOVE
ATTACHED ORGANICS AND
“FRESHEN” THE SEWAGE**

FLOW MEASUREMENT

**PURPOSE: TO LET YOU
KNOW HOW MUCH WASTE
WATER YOU ARE
GETTING...**

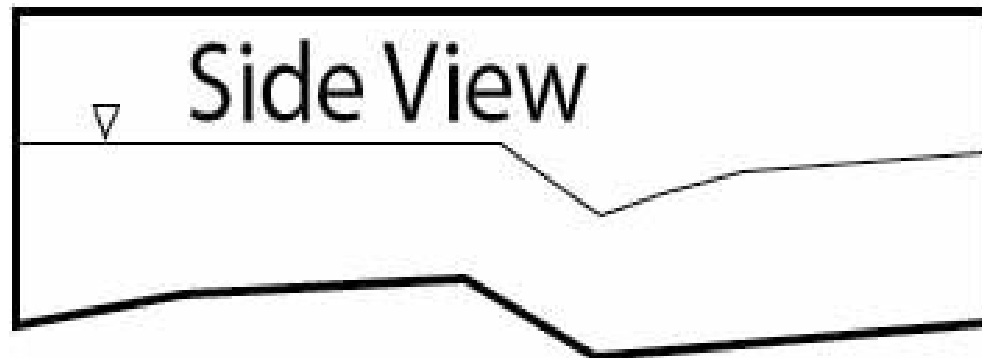
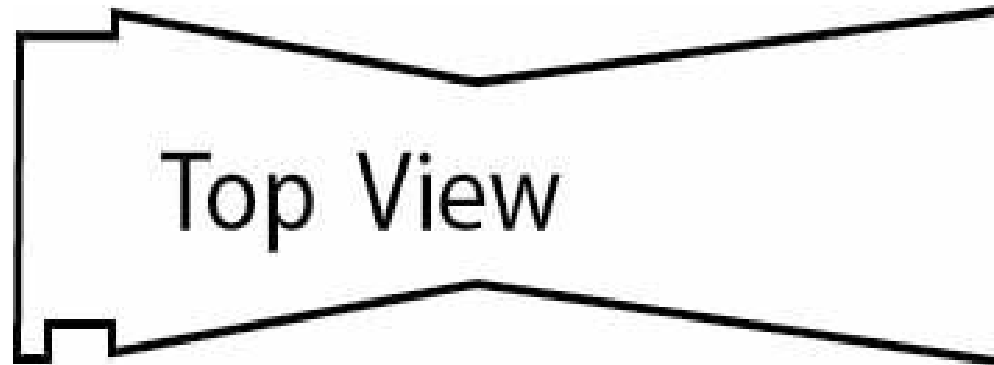
**SO, YOU CAN ADJUST PUMP,
AERATION, AND DISINFECTION
RATES, SLUDGE WITHDRAWAL,**



PARSHALL FLUME



FLOW →



PARSHALL FLUME

- MOST POPULAR DEVICE IS THE PARSHALL FLUME.

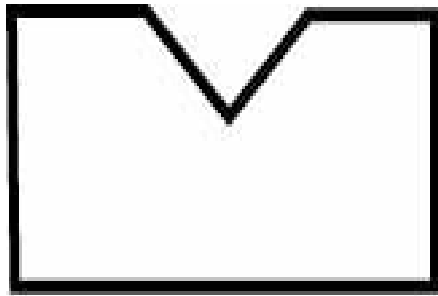
- DEVELOPED IN 1922 TO MEASURE IRRIGATION FLOW

- WORKS BY CONSTRICTING THE FLOW AND MEASURING THE DEPT OF WATER

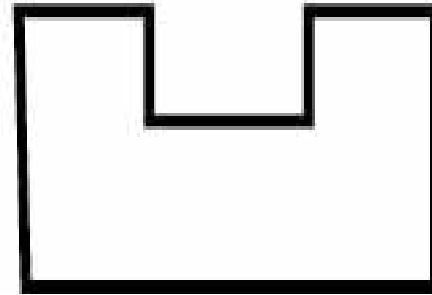
- WORKS WELL FOR SEWAGE BECAUSE NO SHARP EDGES

OTHER FLOW MEASURING DEVICES

WEIRS



V-NOTCH



RECTANGULAR

**PROBLEM WITH WEIRS IS
SEWAGE WILL BEGIN SETTLING**

PRIMARY TREATMENT

- A “PHYSICAL” PROCESS
- FLOW IS SLOWED DOWN TO
ALLOW SETTLING
- FLOATABLE SOLIDS CAN BE
SKIMMED OFF

PRIMARY TREATMENT (con't)

- SAME PRINCIPLE AS THE IMHOFF CONE

- THE SETTLING TANKS ARE CALLED SEDIMENTATION TANKS (or BASINS) or CLARIFIERS



**MANY OLDER CLARIFIERS
ARE RECTANGULAR IN
SHAPE. MOST NEWER ONES
ARE CIRCULAR**

**THE FIRST CLARIFIERS
FOLLOWING THE
HEADWORKS ARE
CALLED THE PRIMARY
CLARIFIERS**

DETENTION TIME

- THE TIME FOR A GIVEN FLOW TO PASS THROUGH A TANK

EXAMPLE: IF THE FLOW IS 450 gal/min AND THE TANK SIZE IS 40,000 gal, the DETENTION TIME IS

$$\underline{40,000} / 450 = 89 \text{ min (1.5 hours)}$$

DETENTION TIME con't

- **PRIMARY CLARIFIERS ARE DESIGNED FOR 1.5 – 2 HOURS DETENTION TIME**

THIS PROVIDES:

- **60 % REMOVAL of SUSPENDED SOLIDS**
- **30 % REMOVAL OF BOD**

DETENTION TIME con't

CALCULATED DETENTION TIME IS THEORETICAL. IN PRACTICE, SOME FLOW COMES THRU RIGHT AWAY— CALLED “SHORT-CIRCUITING”

OPERATORS MAY HAVE TO DETERMINE THE ACTUAL “DT” USING DYES

SECONDARY TREATMENT

- A “BIOLOGICAL” PROCESS WHERE LIVING ORGANISMS “MUNCH” ON THE ORGANICS IN THE DISSOLVED AND NON-SETTLEABLE SOLIDS

MOST COMMON PROCESS ARE:

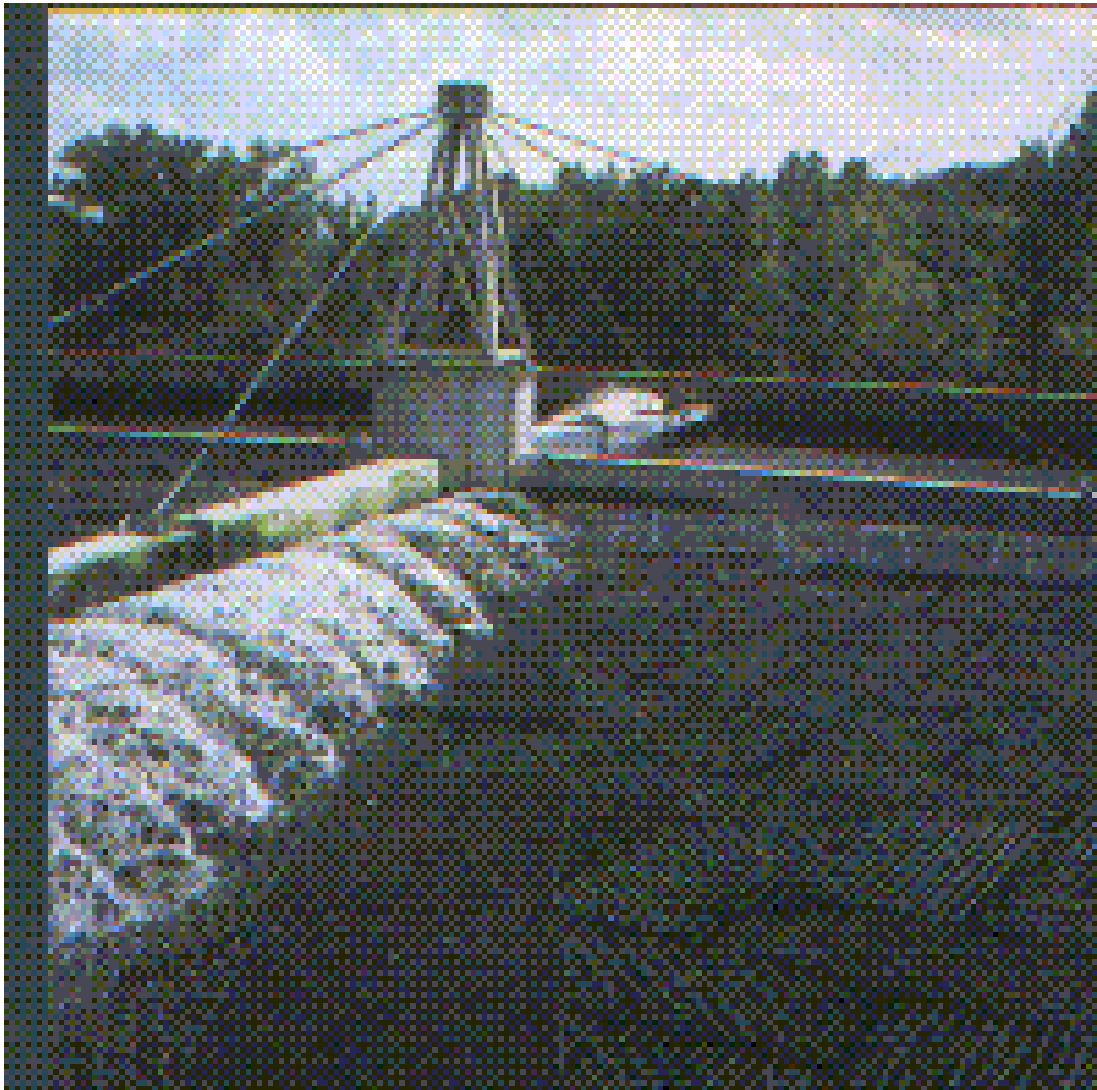
- TRICKLING FILTERS
- ACTIVATED SLUDGE

TRICKLING FILTERS

- NOT REALLY A FILTER

- EFFLUENT FROM THE PRIMARY CLARIFIER IS SPRINKLED OVER A BED OF 1.5-5 inch ROCKS (or plastic)

- AEROBIC ORGANISMS ATTACH TO THE ROCKS. AIR IS AVAILABLE BETWEEN THE ROCKS.



A TRICKLING FILTER

TRICKLING FILTERS (con't)

- **WHEN BIOLOGICAL GROWTH ON THE ROCK GETS TOO THICK, IT BREAKS OFF—CALLED SLOUGHING**

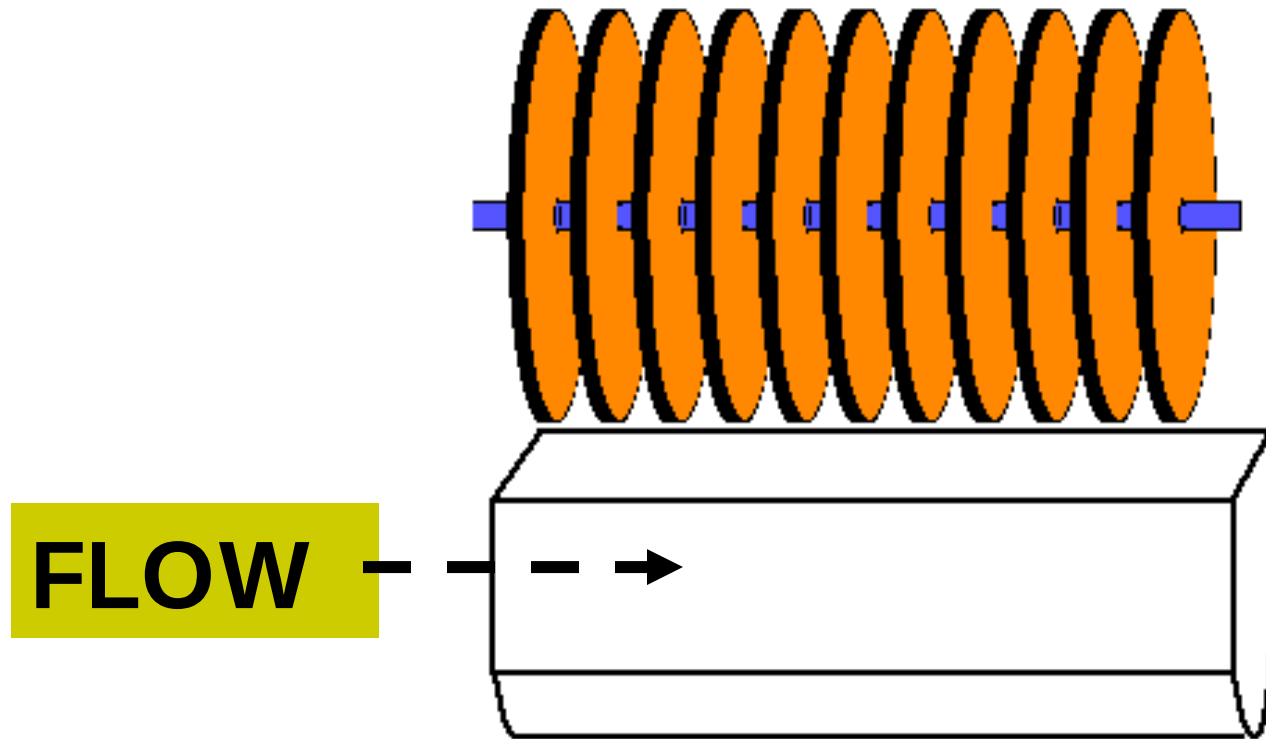
- **THE SLOUGHED MATERIAL IS CALLED “HUMUS” AND REQUIRES A SECONDARY CLARIFIER**

- **REMOVES 70 - 85 % OF THE BOD AND SUSPENDED SOLIDS**

ROTATING BIOLOGICAL CONTACTORS

- **CALLED “RBCs”**

- **SPECIAL DISCS ARE ROTATED
THRU THE SEWAGE AND
BIOLOGICAL GROWTH
DEVELOPS ON THE DISCS (just
like on the rocks)**



**ROTATING BIOLOGICAL
CONTACTOR**

ACTIVATED SLUDGE

- CONSISTS OF AN AERATION TANK FOLLOWING THE PRIMARY CLARIFIER

- O_2 IS SUPPLIED BY DIFFUSERS OR MECHANICAL DEVICES

- DETENTION TIME OF 4 - 8 hours
PRODUCE RAPID AEROBIC GROWTH

ACTIVATED SLUDGE (con't)

- EFFLUENT FROM THE AERATION TANK IS CALLED “MIXED LIQUOR”

- THE ORGANISMS THAT SETTLE IN THE SECONDARY CLARIFIER ARE CALLED “ACTIVATED SLUDGE”

- 90 - 99 % REMOVAL OF BOD & SS

SECONDARY CLARIFIERS

- **SOLIDS FROM TRICKLING FILTERS, RBCs, AND ACTIVATED SLUDGE MUST BE REMOVED BEFORE SEWAGE IS DISCHARGED**

- **SLUDGE (or BIOSOLIDS) ARE USUALLY RETURNED TO THE PRIMARY CLARIFIER OR THE DIGESTER.**

SLUDGE (BIO-SOLIDS) HANDLING AND DISPOSAL

- **SOLIDS SENT TO A LARGE SEALED
TANK CALLED A DIGESTER**

- **AFTER 30 DAYS UNDER
ANAEROBIC CONDITIONS, SLUDGE
CAN BE DEWATERED, BURNED, OR
USED AS A SOIL CONDITIONER**

SLUDGE (con't)

- **2 MAJOR TYPES OF BACTERIA IN AN ANAEROBIC DIGESTER**

1. ACID FORMERS—PRODUCE ORGANIC ACIDS AND CO₂

2. GAS FORMERS—BREAK DOWN THE ORGANIC ACIDS TO PRODUCE METHANE (CH₄)

SLUDGE (con't)

- THE CH₄ GAS HEATS THE DIGESTER (95°F) & RUNS ENGINES

- THE LIQUID ABOVE THE SETTLED SOLIDS IS CALLED “SUPERNATANT”

- DIGESTERS CAN BE VERY DANGEROUS IF AIR BECOMES MIXED WITH THE METHANE

SLUDGE (con't)

**SOME ACTIVATED SLUDGE
PLANTS USE AEROBIC DIGESTERS**

- **THESE ARE OPEN TANKS
WHERE COMPRESSED AIR IS
BLOWN THRU THE SLUDGE**

WASTE TREATMENT PONDS

**ALSO CALLED: STABILIZATION
PONDS, OXIDATION PONDS,
BIO-OXIDATION PONDS,
SEWAGE LAGOONS...**

- AEROBIC PONDS RANGE
FROM 3 – 6 FEET DEEP,
ANAEROBIC, 8-12 FEET DEEP**

PONDS (con't)

- **PONDS THAT ARE AEROBIC ON TOP AND ANAEROBIC ON BOTTOM ARE CALLED “FACULTATIVE PONDS” (MOST COMMON)**

HOW DO PONDS WORK?

- WASTEWATER ENTERS THE POND

- SETTLEABLE SOLIDS DECOMPOSE AND USE $\underline{\underline{O_2}}$

- ORGANISMS USE THE OXYGEN AND PRODUCE $\underline{\underline{CO_2}}$ WHICH CAUSES ALGAE TO FLUORISH

HOW DO PONDS WORK?

- THROUGH PHOTOSYNTHESIS THE ALGAE UTILIZE CO_2 TO PRODUCE OXYGEN (O_2)

- ORGANISMS USE THE OXYGEN TO STABILIZE THE WASTEWATER

PONDS (con't)

- **PONDS CAN BE OPERATED IN SERIES OR IN PARALLEL**

- **HAVE A DETENTION TIME OF 30 DAYS OR MORE**

- **“OXIDATION PONDS” FOLLOW PRIMARY TREATMENT; “WASTE STABILIZATION PONDS” RECEIVE UNTREATED WASTE**

DISINFECTION

- MUST KILL REMAINING PATHOGENS
- CHLORINE GAS (Cl_2) IS THE MOST USED DISINFECTANT
- MUST HAVE 20-30 MINUTES OF “CONTACT TIME”

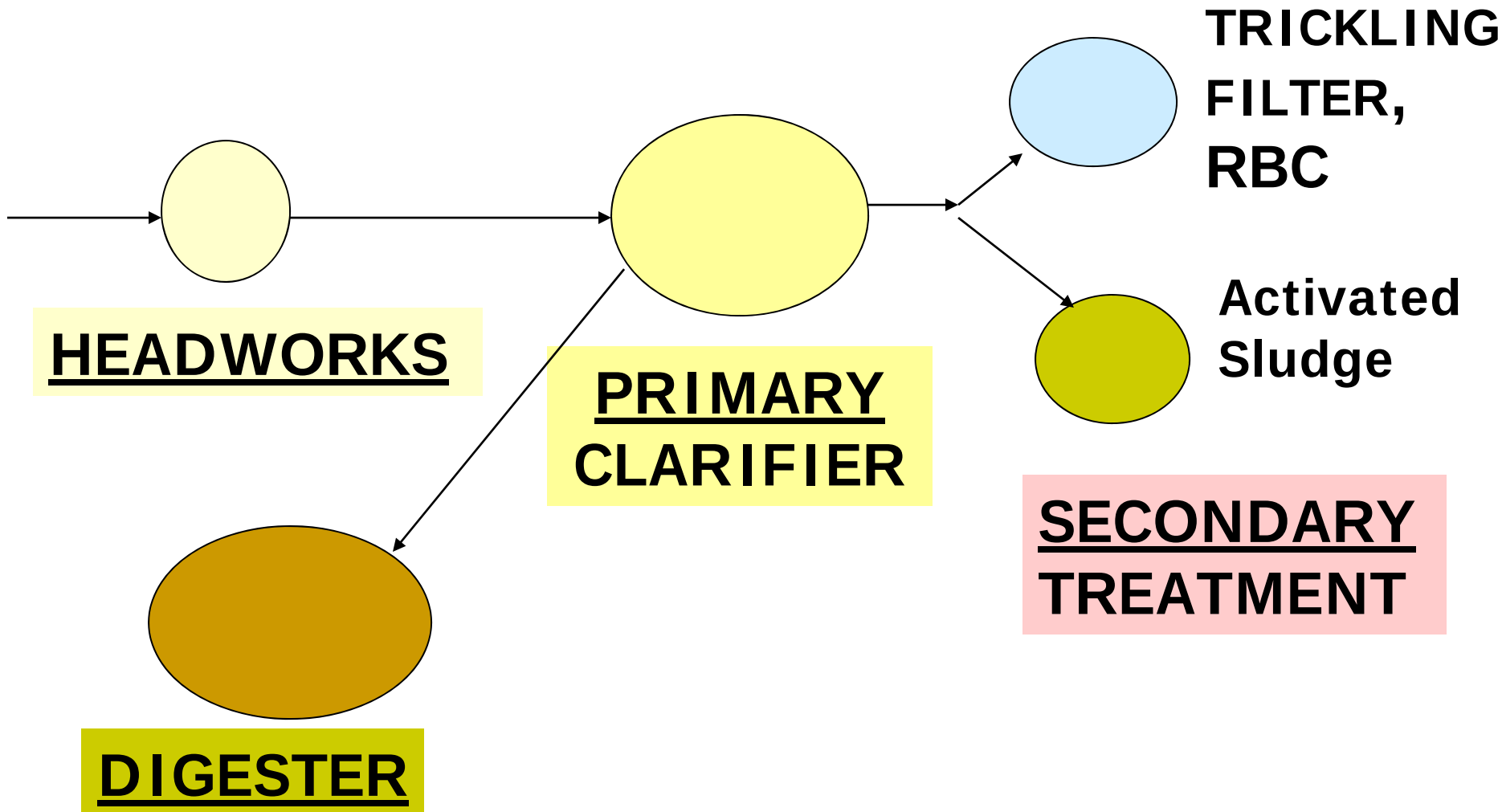
DISINFECTION (con't)

- SOME EFFLUENTS MUST BE “DECHLORINATED” WITH SULFUR DIOXIDE (SO_2)

- CHLORINE CAN BE DANGEROUS

- SOME PLANTS USE ULTRAVIOLET LIGHT AND OTHER DISINFECTANTS

TREATMENT PLANT



TREATMENT PLANT (con't)

