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

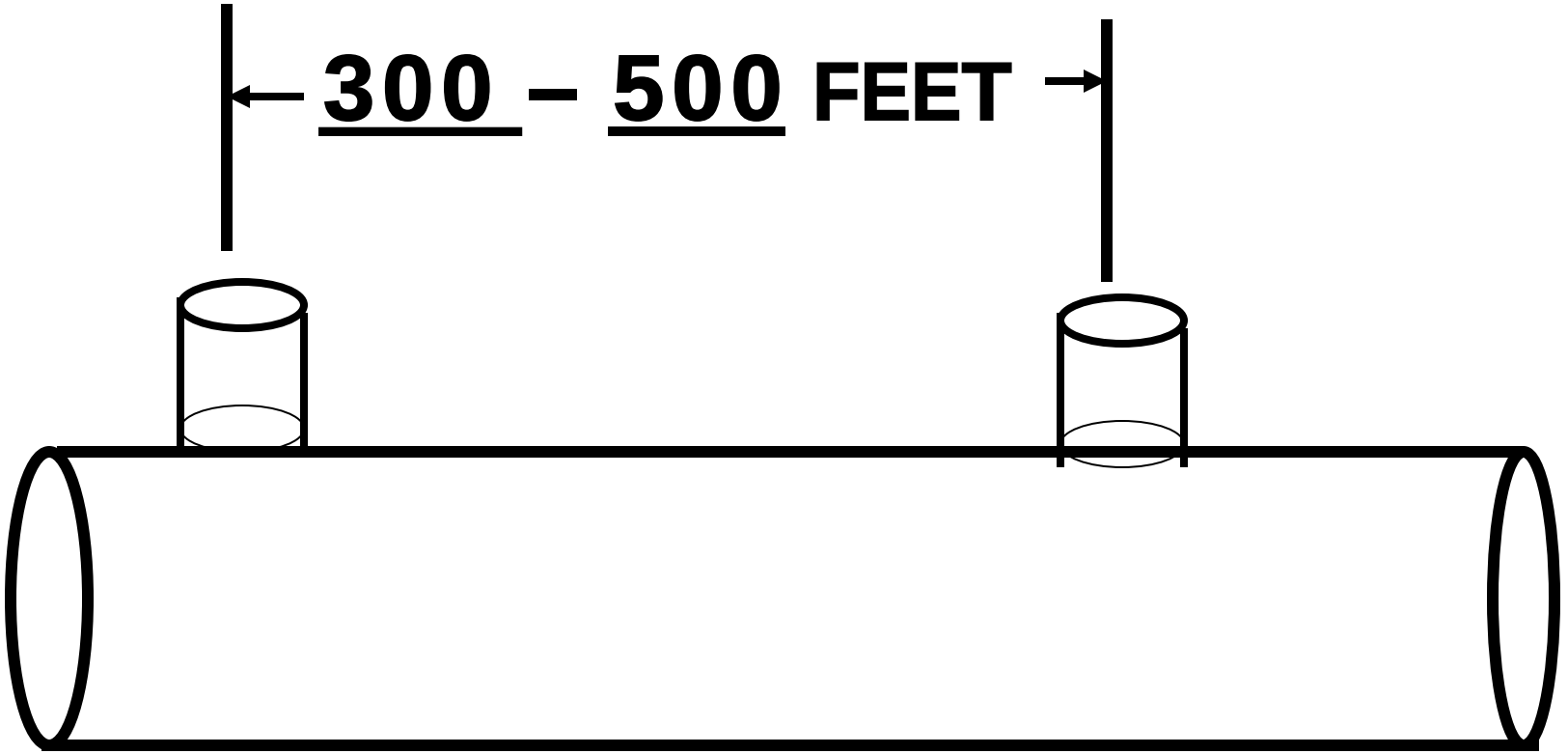
- AVERAGE PERSON GENERATES APPROX 56 gm BOD per DAY or 0.12 lbs BOD/PERSON/DAY

TO COLLECT AND TRANSPORT WASTEWATER FOR TREATMENT WE USE:

- **SANITARY SEWERS**
- **STORM SEWERS**
- **COMBINED SEWERS**

- **IN GENERAL, SEWERS ARE DESIGNED TO FLOW BY <u>GRAVITY</u>**

- **DESIGN FLOW IS <u>2</u> 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 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:

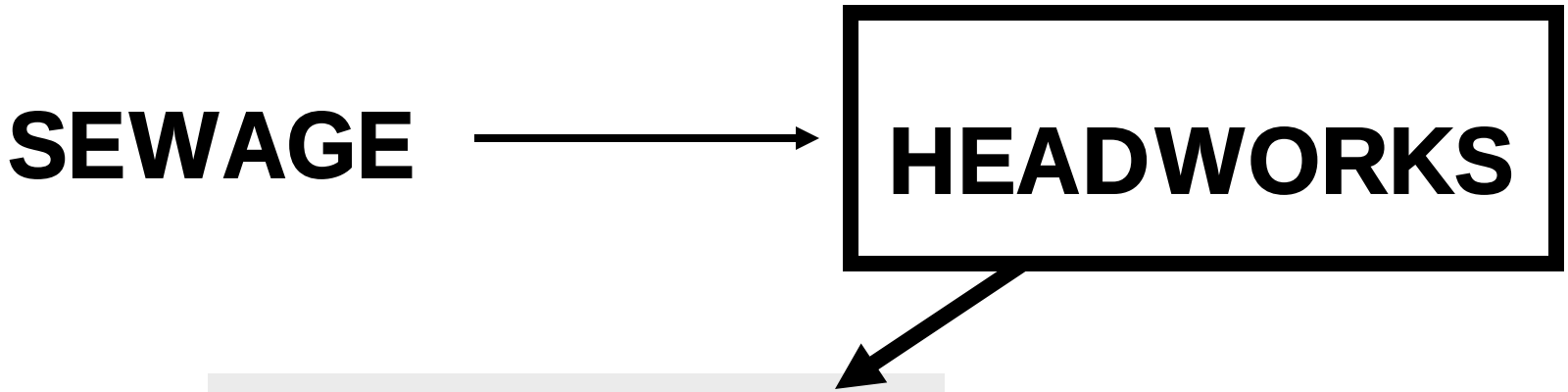
1. PRELIMINARY TREATMENT
2. PRIMARY TREATMENT
3. SECONDARY TREATMENT
4. SOMETIMES…TERTIARY

PRELIMINARY TREATMENT

SEWAGE ----▸ HEADWORKS

- **SCREENING**
- **GRIT REMOVAL**
- **SHREDDING**
- **FLOW MEASUREMENT**

PRELIMINARY TREATMENT



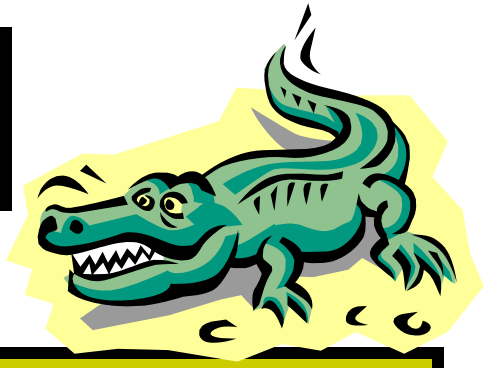
- SCREENING
- SHREDDING
- GRIT REMOVAL
- FLOW MEASUREMENT

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

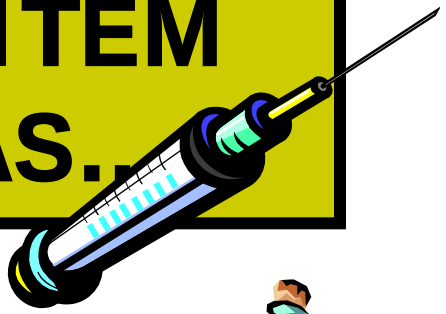
- TO PROTECT THE EQUIPMENT IN THE REST OF THE PLANT and...

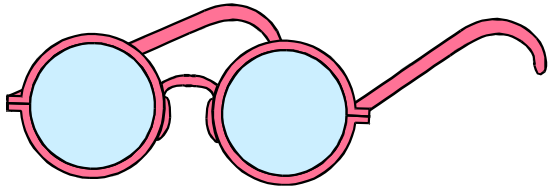
- TO MONITOR THE FLOW

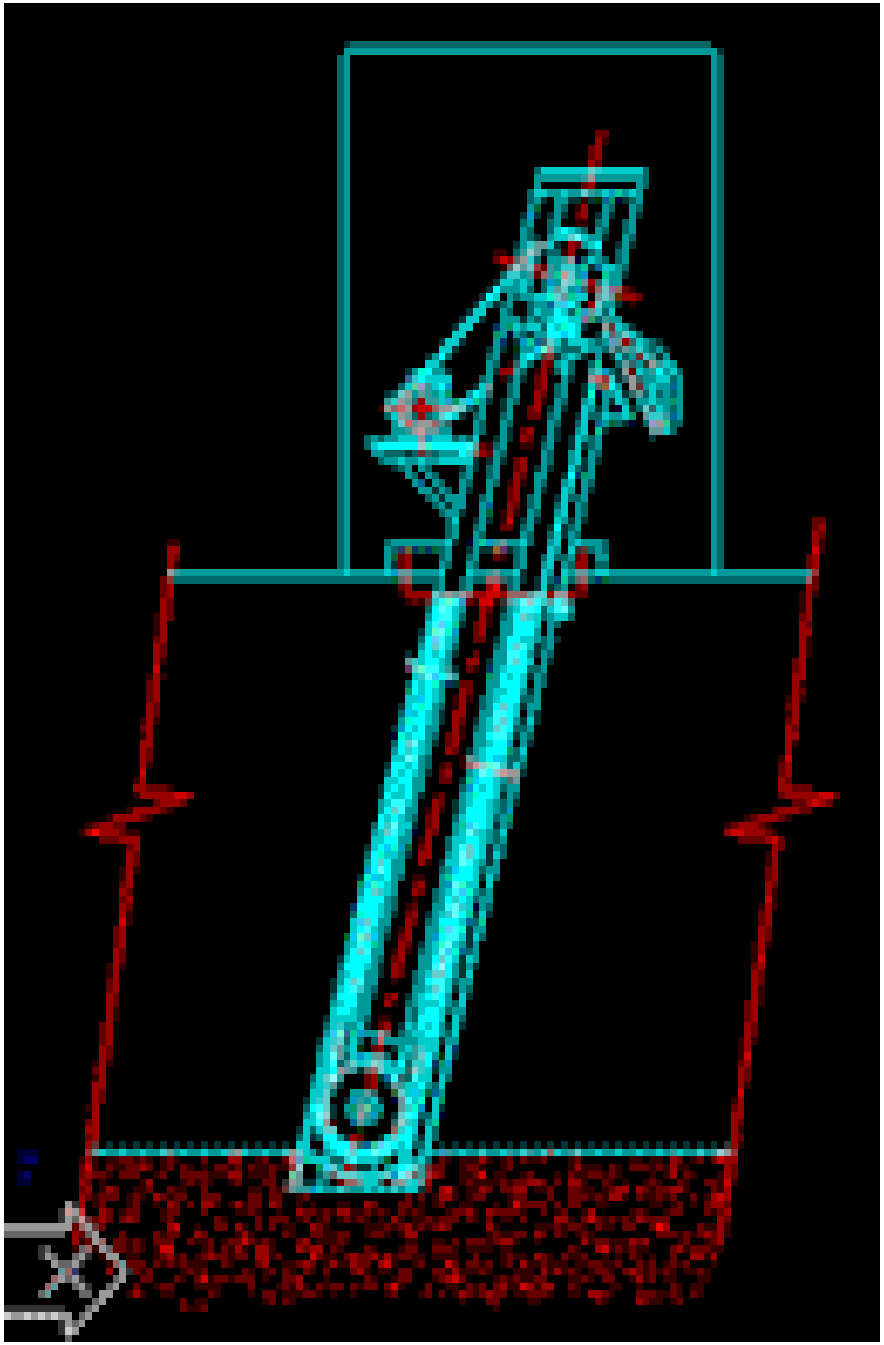
SCREENING



PURPOSE: TO <u>REMOVE</u> LARGE, NON-BIODEGRADABLE ITEM FROM SEWAGE SUCH AS..



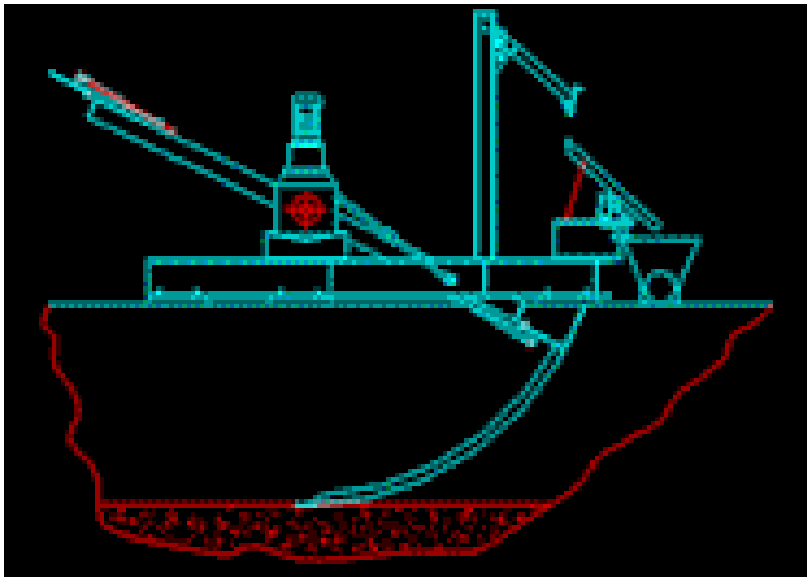




BAR SCREENS:

SPACING =

3/8” to 2”



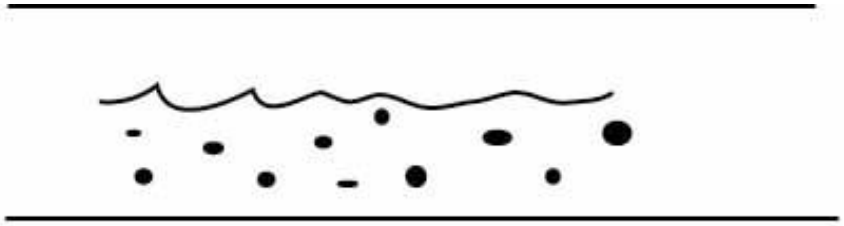
GRIT REMOVAL

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

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

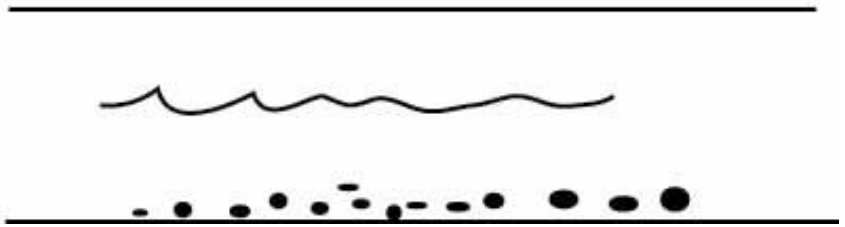
HOW IS GRIT REMOVED?

Sewer

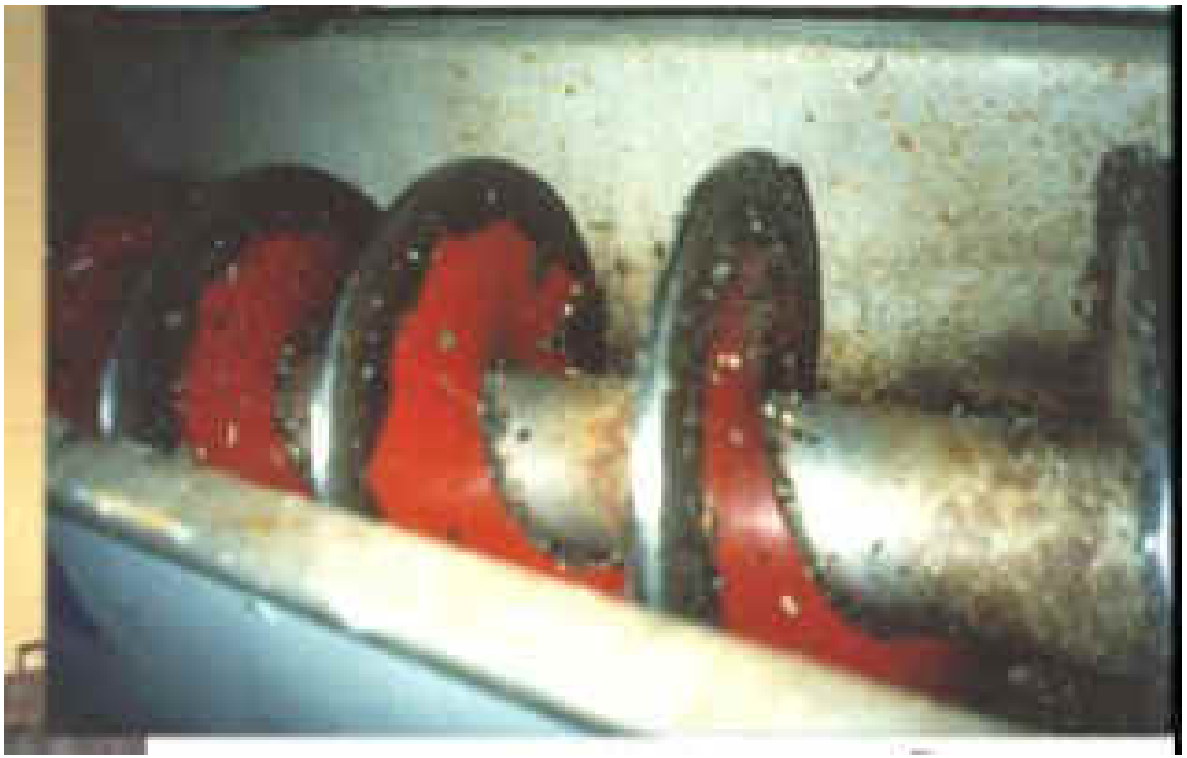


VELOCITY = 2 ft/sec

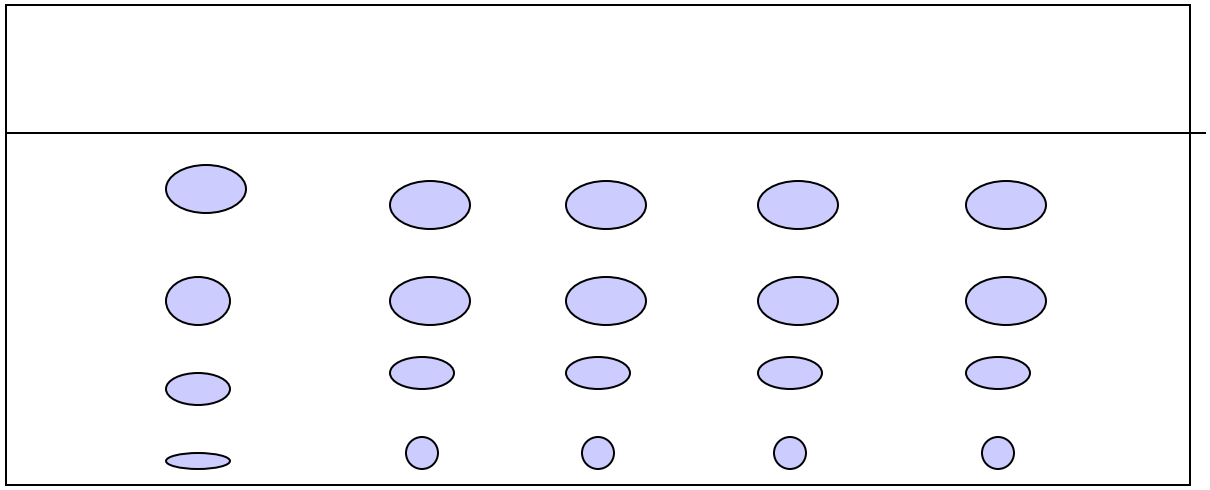
Grit Chamber



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

SHREDDING

PURPOSE: TO <u>REDUCE</u> IN SIZE, CUT UP AND SHRED "STUFF" NOT REMOVED ON THE SCREENS. (TO ABOUT ¼")

<u>SEVERAL BRANDS</u>:
BARMINUTOR, COMMINUTOR, DIMMINUTOR, MACERATOR

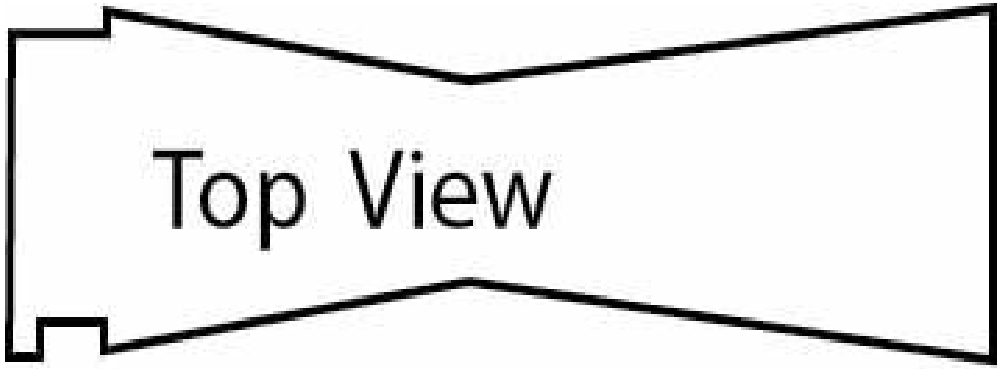
FLOW MEASUREMENT

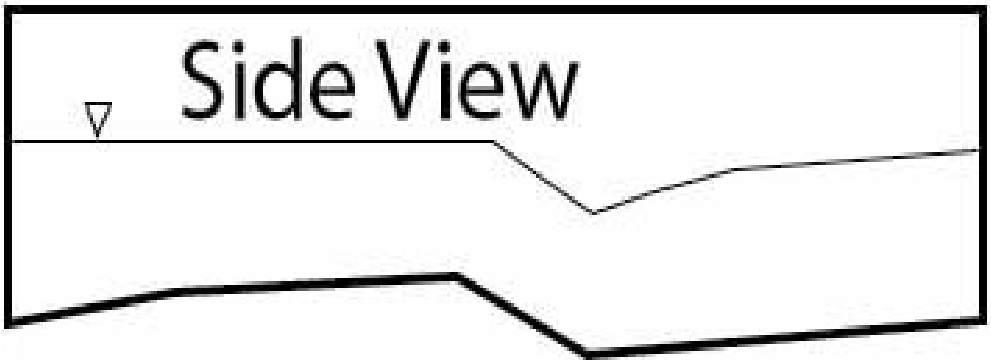
PURPOSE: TO LET YOU KNOW HOW MUCH WASTE WATER YOU ARE GETTING...

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

PARSHALL FLUME

FLOW →





PARSHALL FLUME

- MOST POPULAR DEVICE IS THE PARSHALL FLUME.

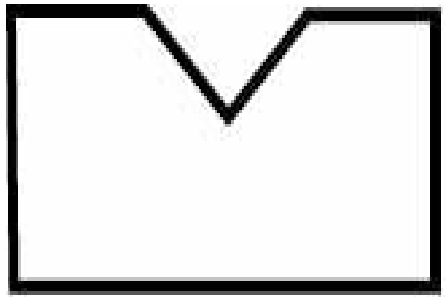
- DEVELOPED IN 1922 TO MEASURE IRRIGATION FLOW

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

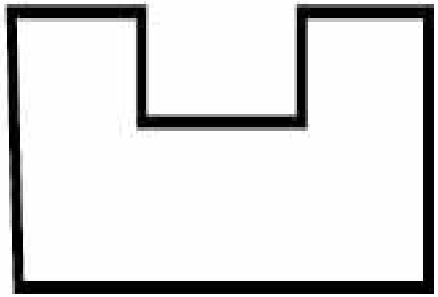
- WORKS WELL FOR SEWAGE BECAUSE NO SHARP EDGES

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

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

40,000 gal/450 gal/min = 89 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**

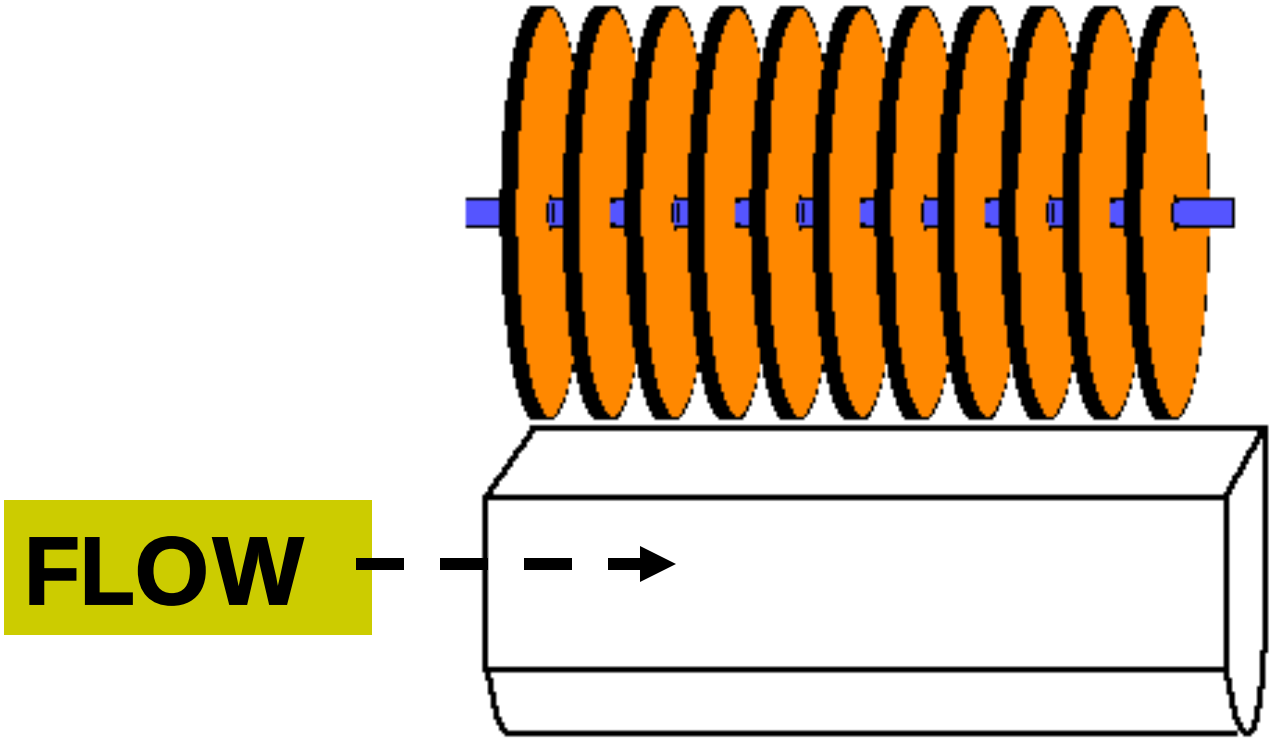
- **THE SLOUGHED MATERIAL IS CALLED "HUMUS" AND REQUIRES A SECONDARY CLARIFIER**

- **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 - 95% 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 CO_2

2. GAS FORMERS—BREAK DOWN THE ORGANIC ACIDS TO PRODUCE METHANE (CH_4)

SLUDGE (con't)

- THE $\underline{CH_4}$ GAS HEATS THE DIGESTER (95°F) & RUNS ENGINES

- THE LIQUID ABOVE THE SETTLED SOLIDS IS CALLED "<u>SUPERNATANT</u>"

- DIGESTERS CAN BE VERY DANGEROUS IF <u>AIR</u> 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 O_2

- ORGANISMS USE THE OXYGEN AND PRODUCE CO_2 WHICH CAUSES ALGAE TO FLOURISH

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"

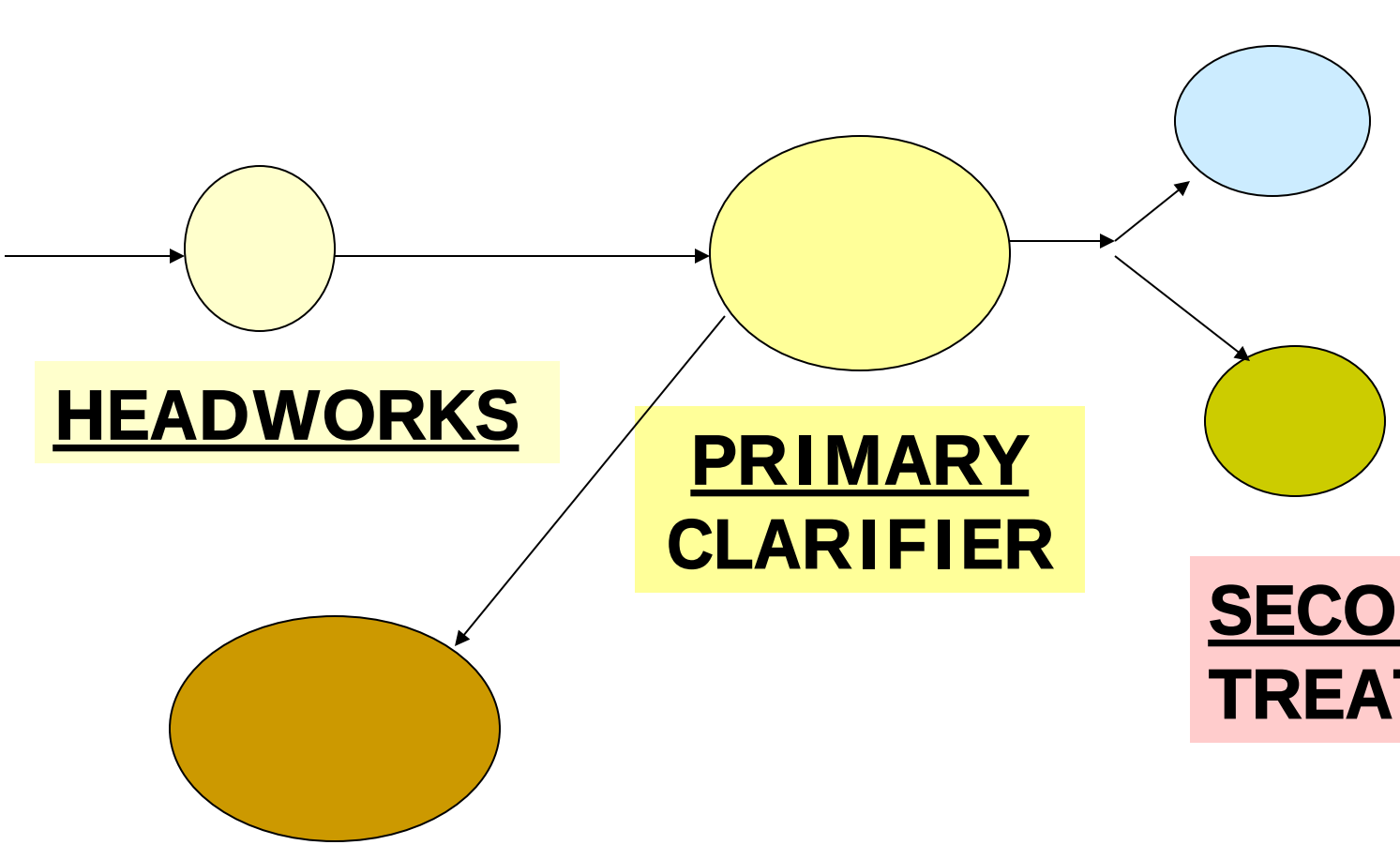
DISINFECTION (con't)

- 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)