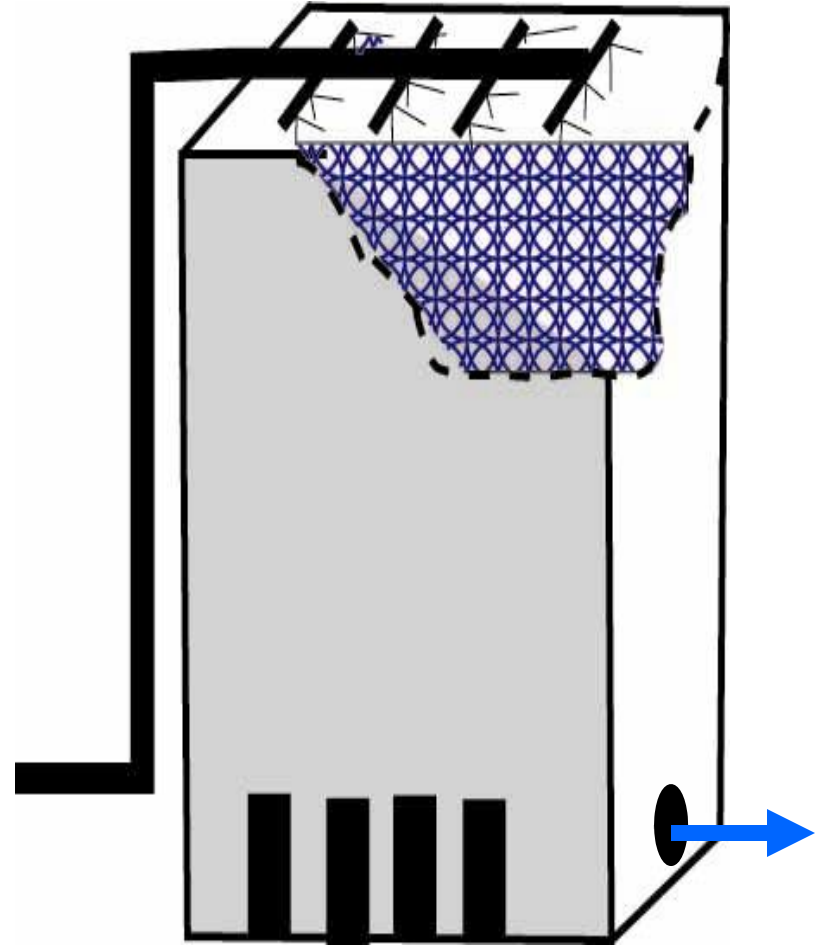


TRICKLING FILTERS



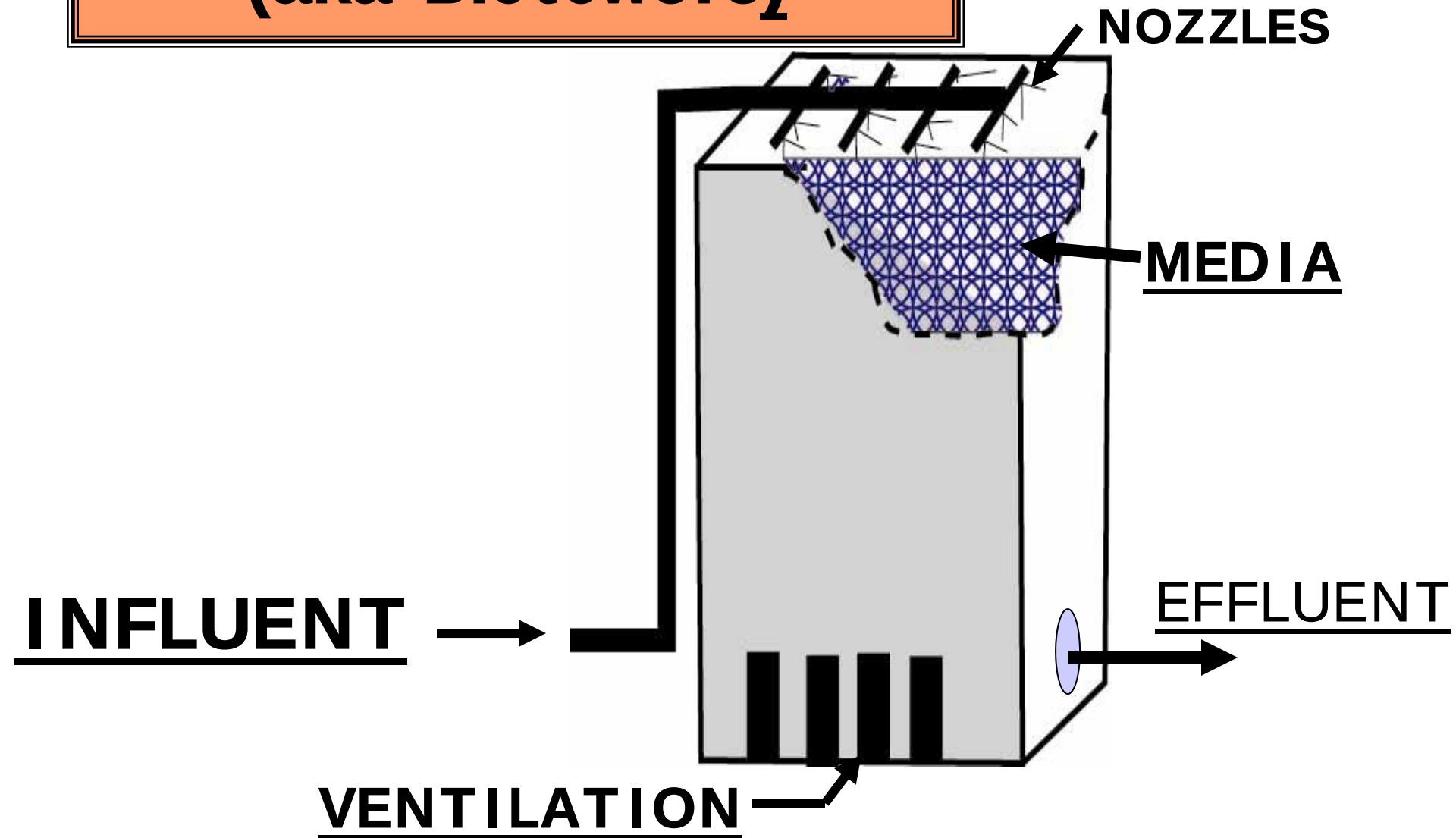
**ROTATING
DISTRIBUTOR**



FILTER TOWER

FILTER TOWERS

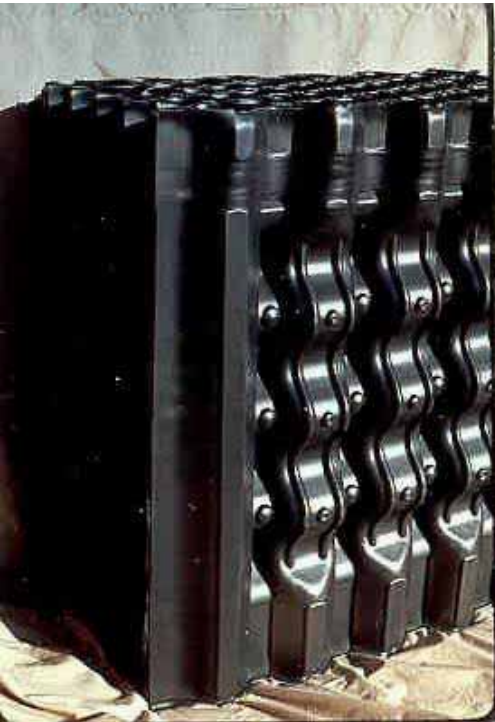
(aka Biotowers)





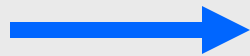


FILTER TOWER MEDIA



PLASTIC
MEDIA

ALL TRICKLING FILTERS CONSIST OF 3 PARTS



- **MEDIA**
- **UNDERDRAIN**
- **DISTRIBUTION
SYSTEM**

**TRICKLING FILTERS
COULD BE CALLED...**

**“ATTACHED
GROWTH
BIOLOGICAL
REACTORS”**

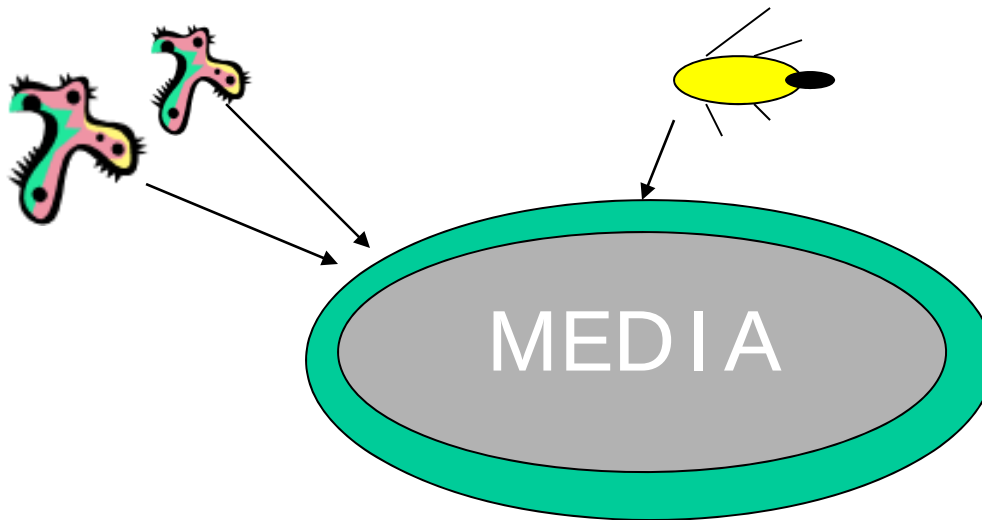
MEDIA

FUNCTION

- **PROVIDES A PLACE FOR BIOLOGICAL SLIME TO DEVELOP**

SLIME: aka ZOOGLEAL FILM
(ZOE - glee - al)

ZOOGLEAL FILM

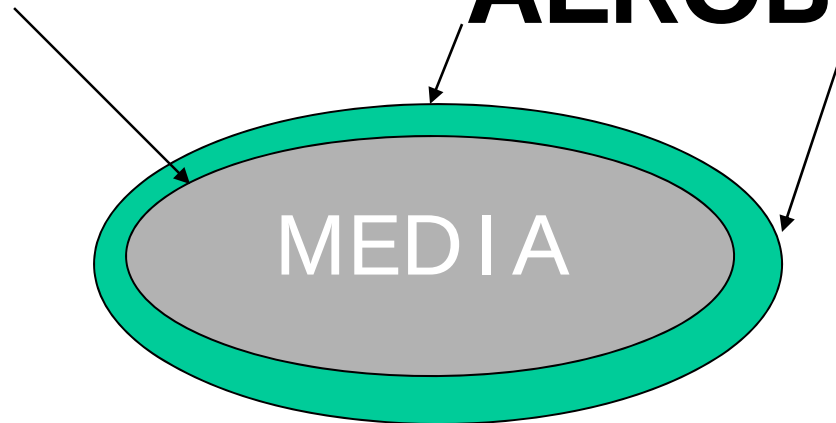


**CONSISTS OF BACTERIA, ALGAE
PROTOZOA, FUNGI, WORMS...+?**

ZOOGLEAL FILM

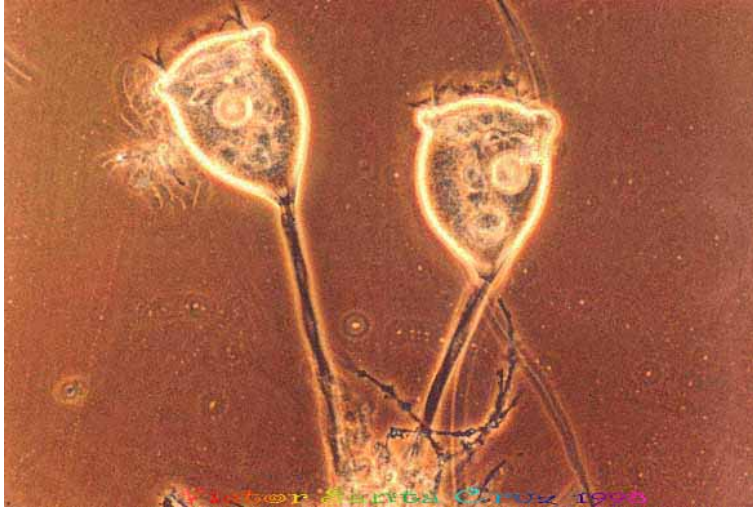
ANAEROBIC

AEROBIC



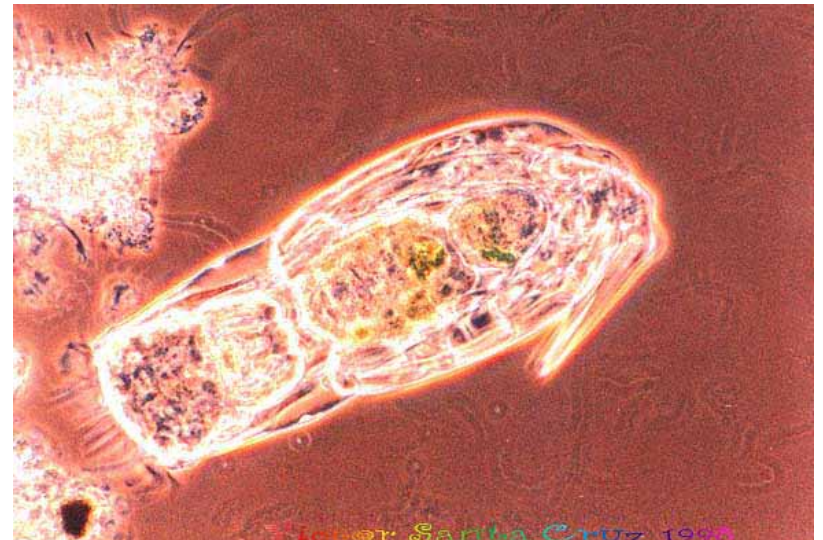
**THE PROCESS IS AEROBIC—
EVEN WITH AN ANAEROBIC
LAYER NEXT TO THE MEDIA**

SOME ZOOGLEAL CRITTERS AT 1000 X

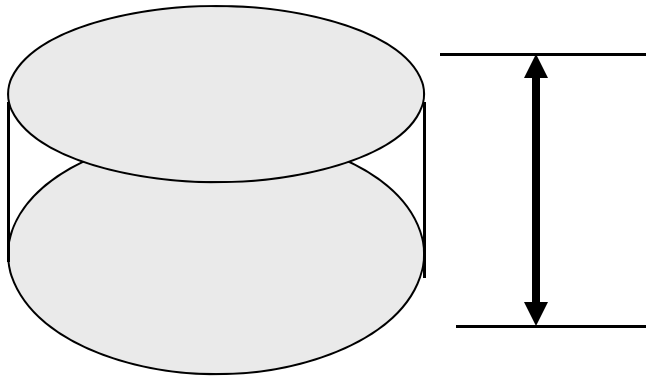


↑
“STALKED”
CILIATES

ROTIFER

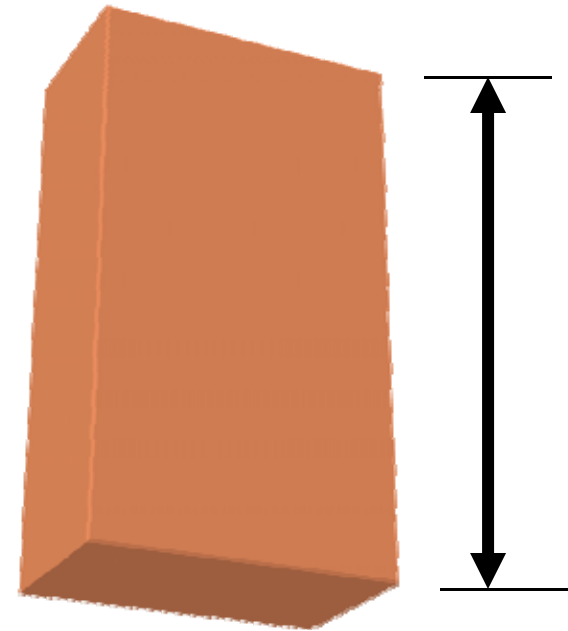


DEPTH OF MEDIA



**3-8 FT FOR
ROCKS**

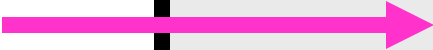
**(DEPTH LIMITED
BECAUSE OF
WEIGHT OF ROCKS)**



**15-30 FT FOR
SYNTHETIC
MEDIA**

**ALL TRICKLING
FILTERS CONSIST OF 3
PARTS...**

•MEDIA

 **•UNDERDRAIN**

**•DISTRIBUTION
SYSTEM**

UNDERDRAIN



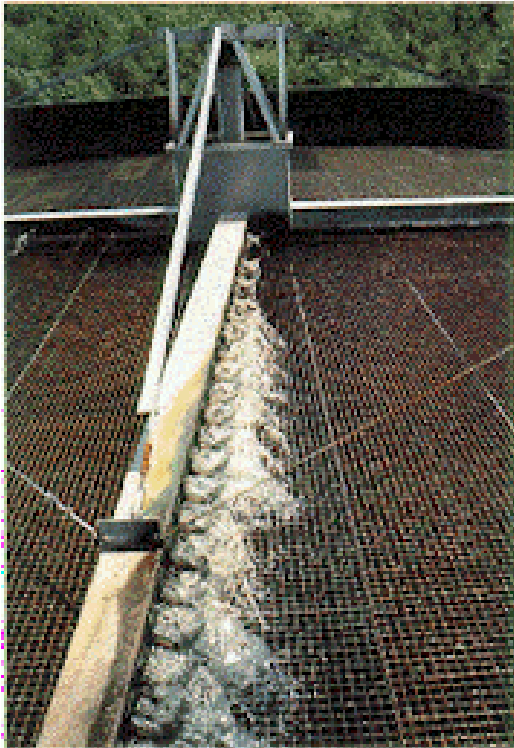
UNDERDRAIN

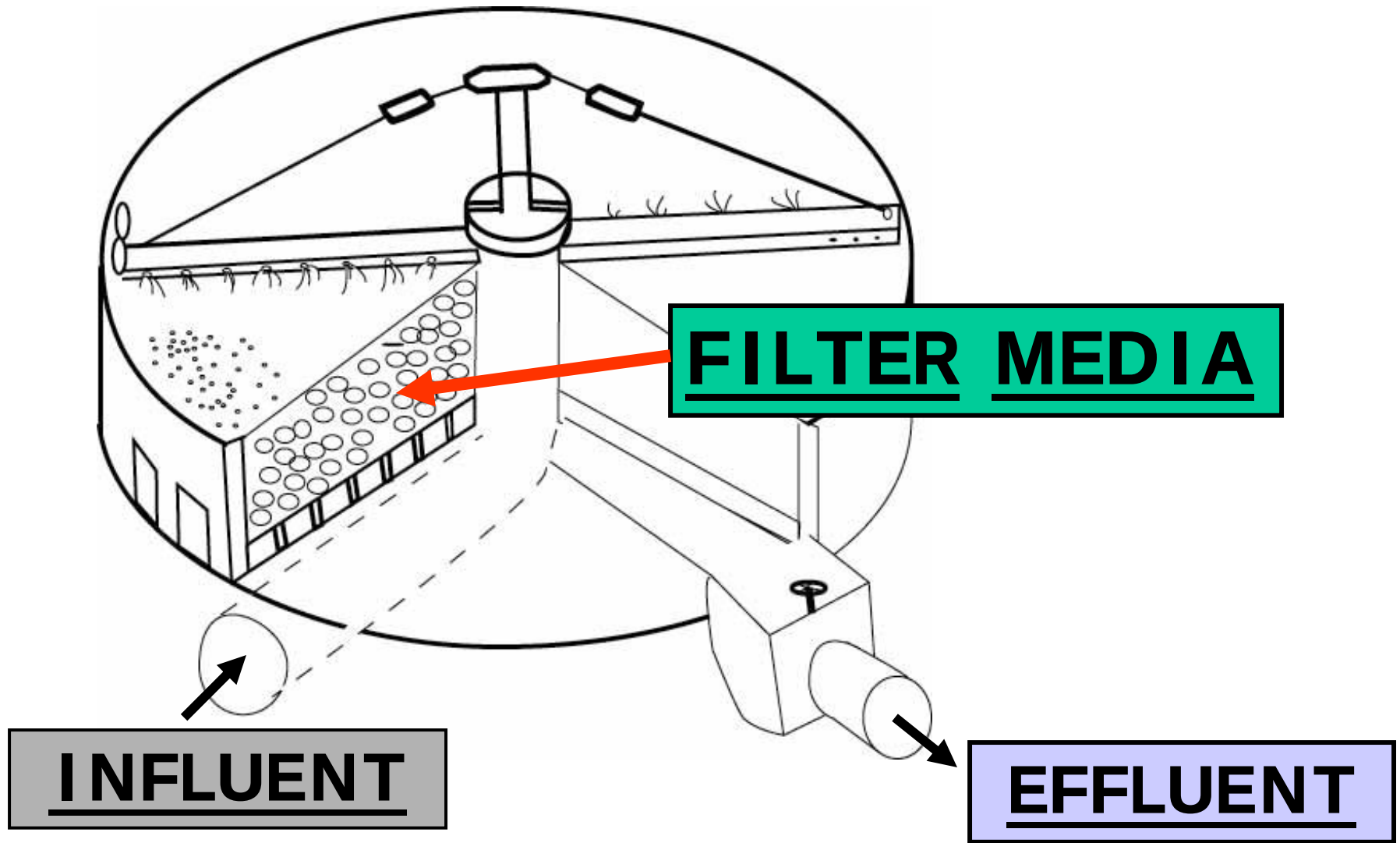


- THESE ARE DESIGNED TO FLOW $\frac{1}{2}$ FULL AT MAXIMUM FLOW RATES

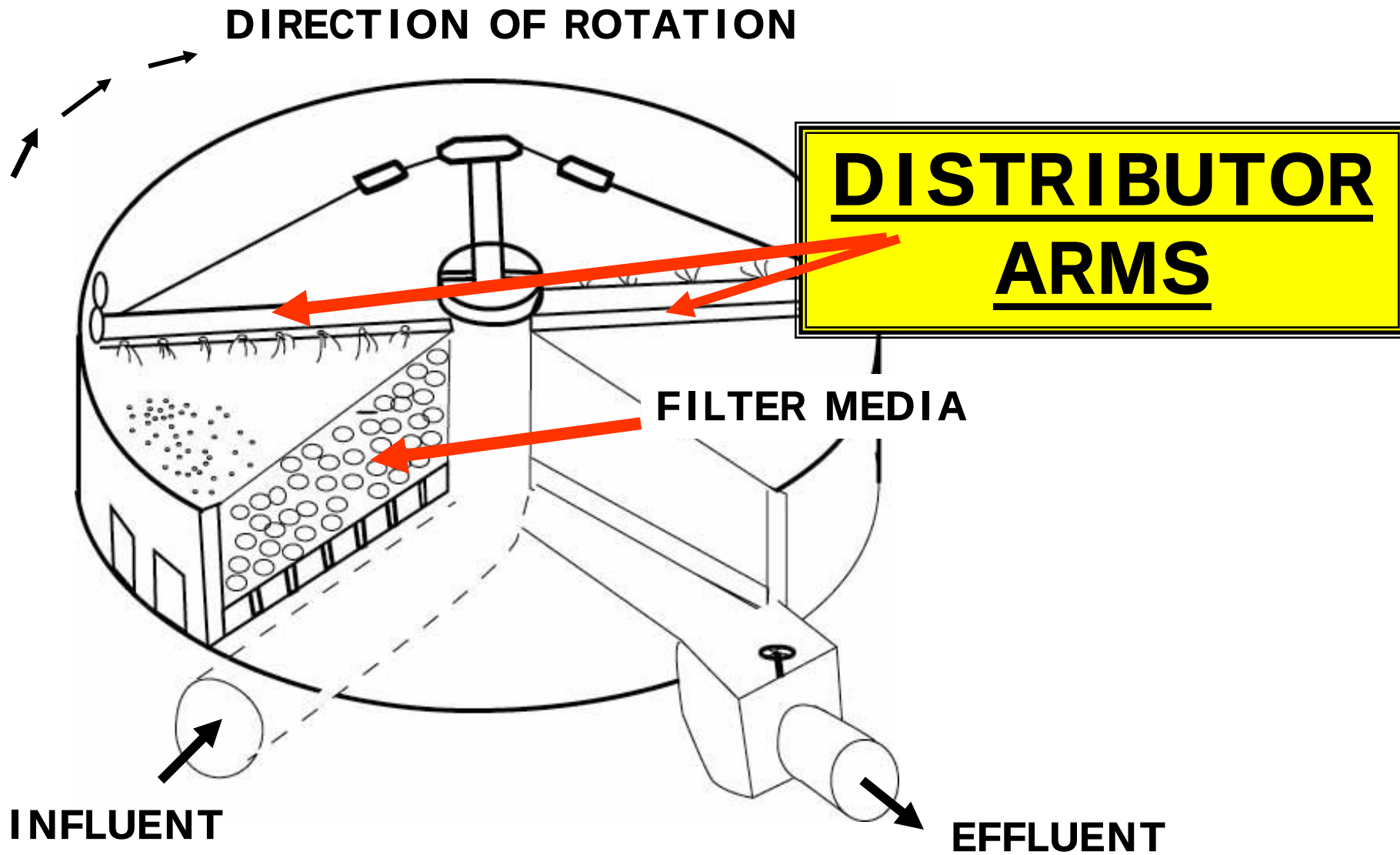
- SLOPED TO DRAIN AT MINIMUM OF 2 fps

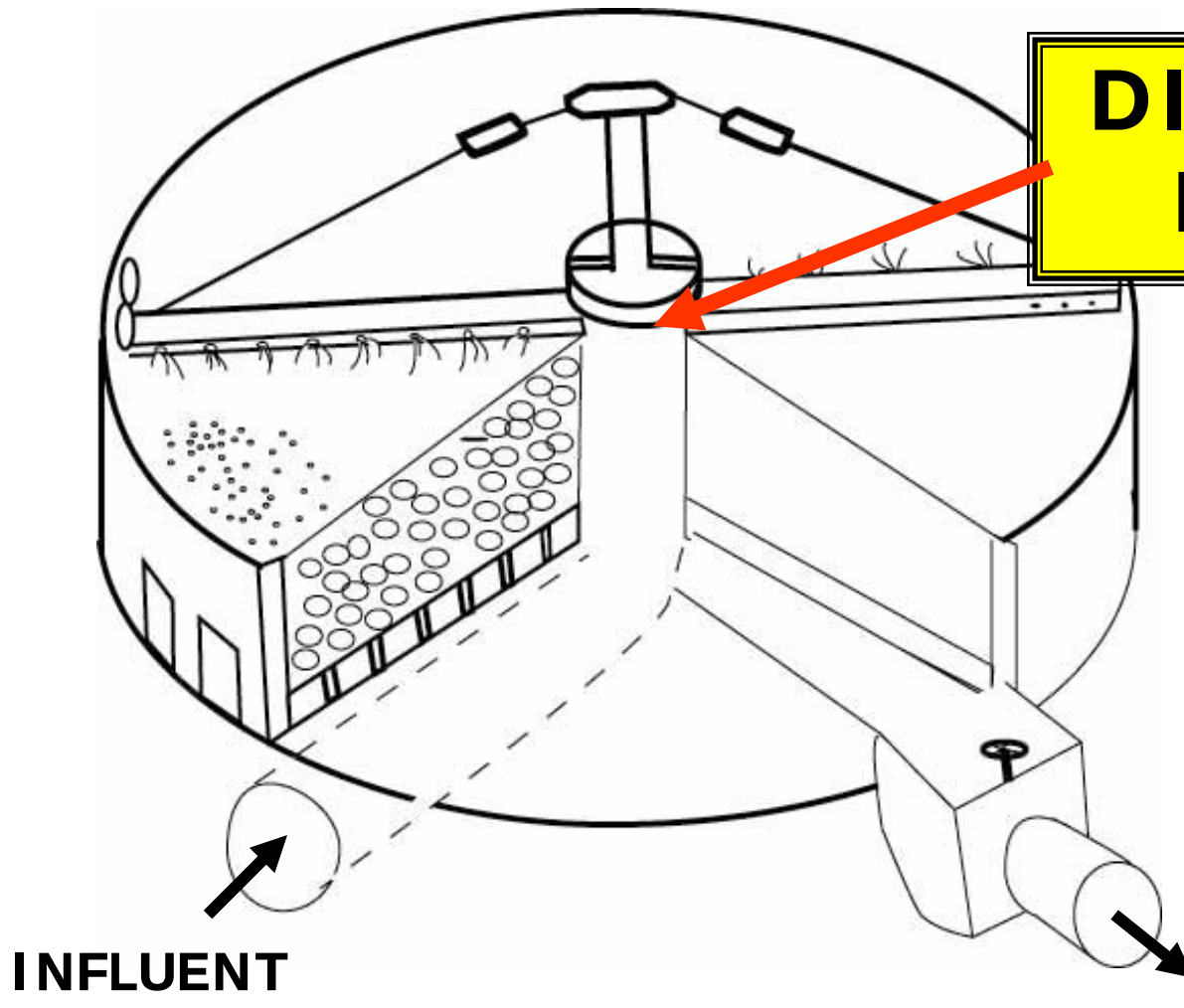
DISTRIBUTION SYSTEM





TRICKLING FILTER

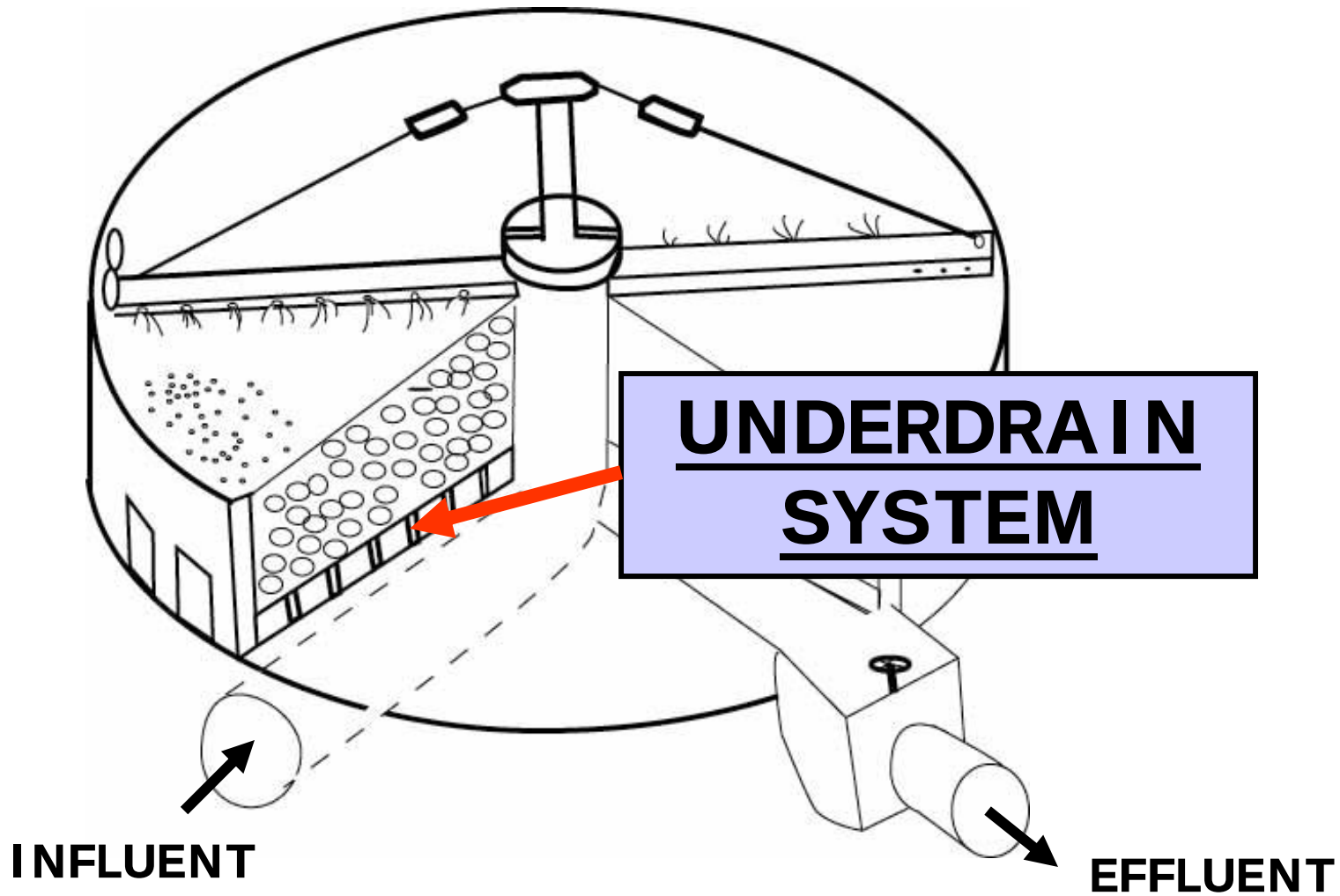




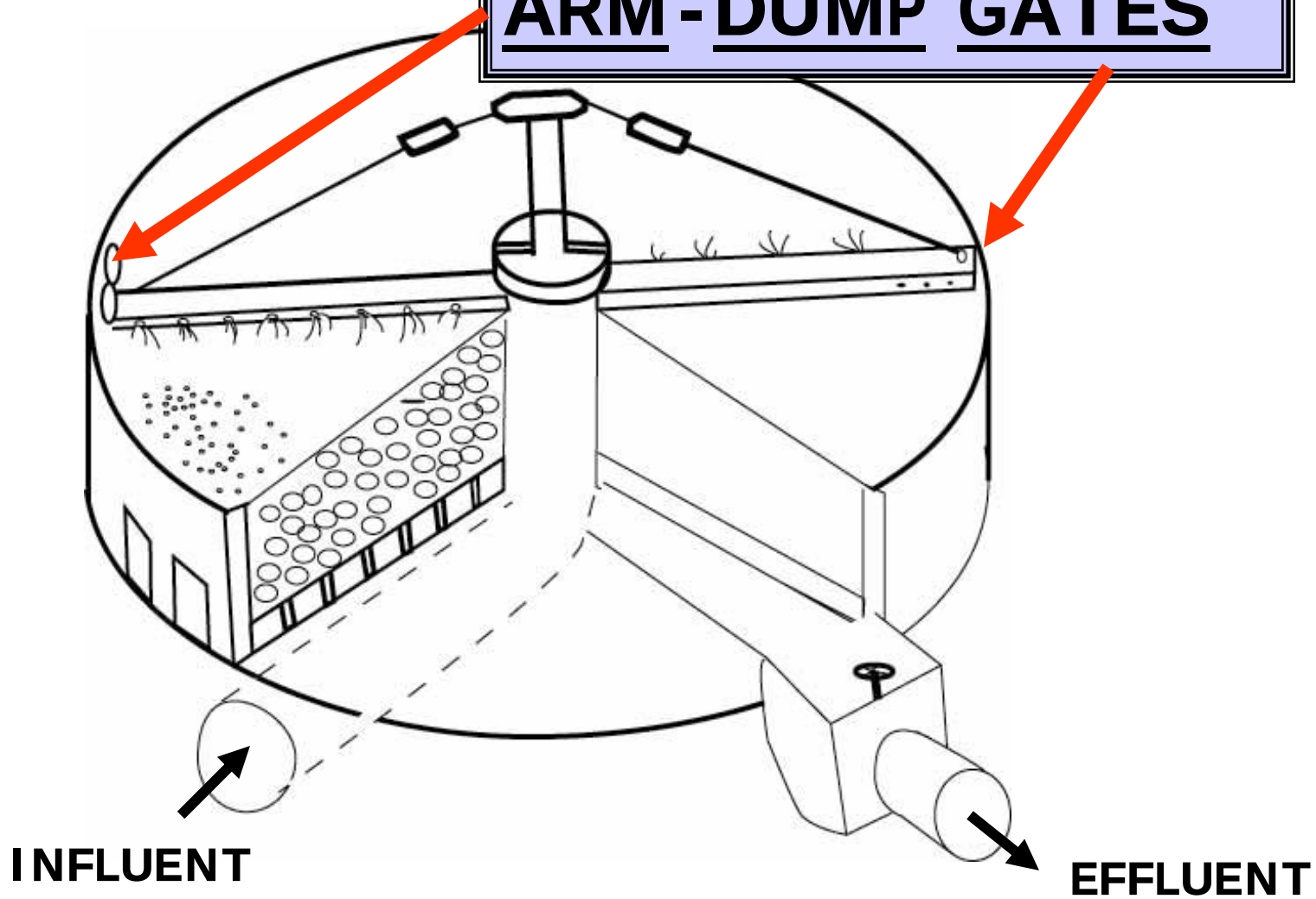
**DISTRIBUTOR
BEARINGS**



**WATCH
OUT FOR
MERCURY**



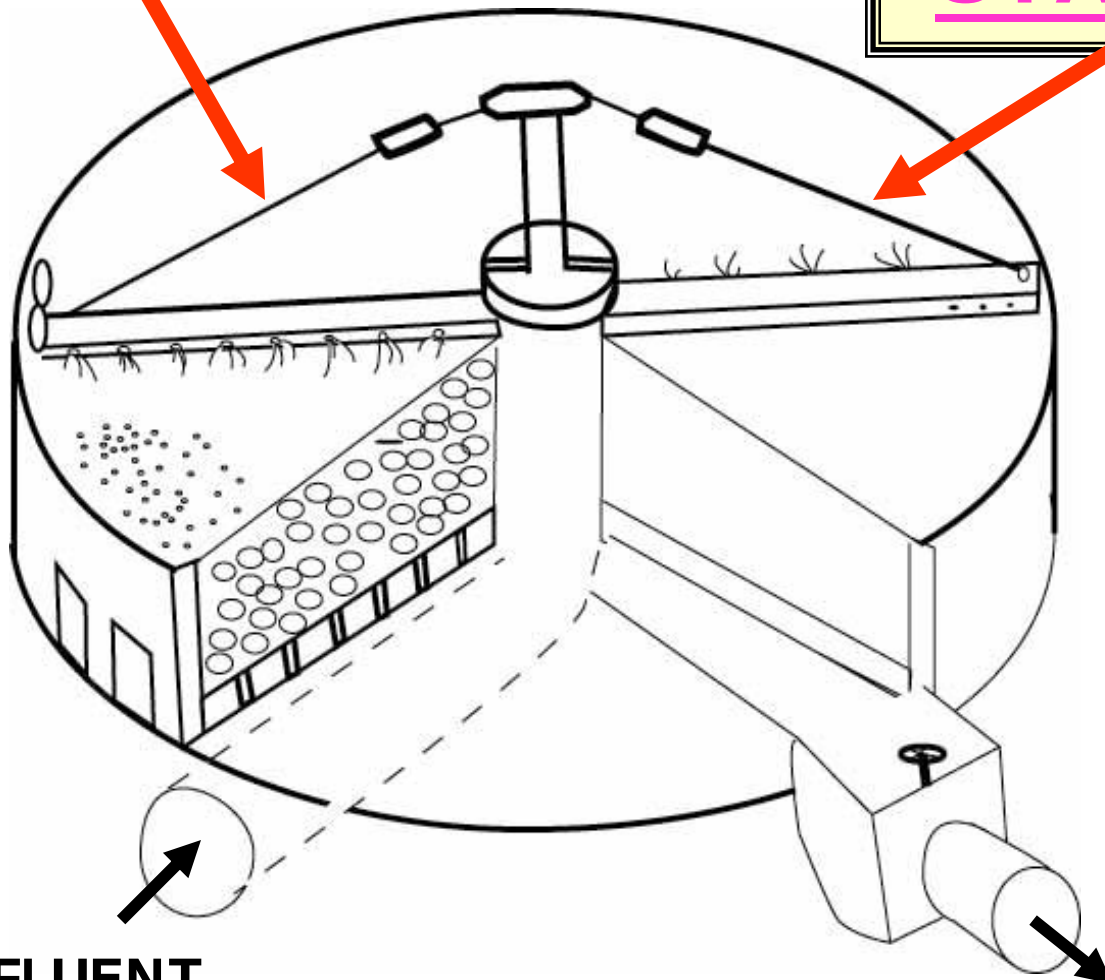
ARM - DUMP GATES

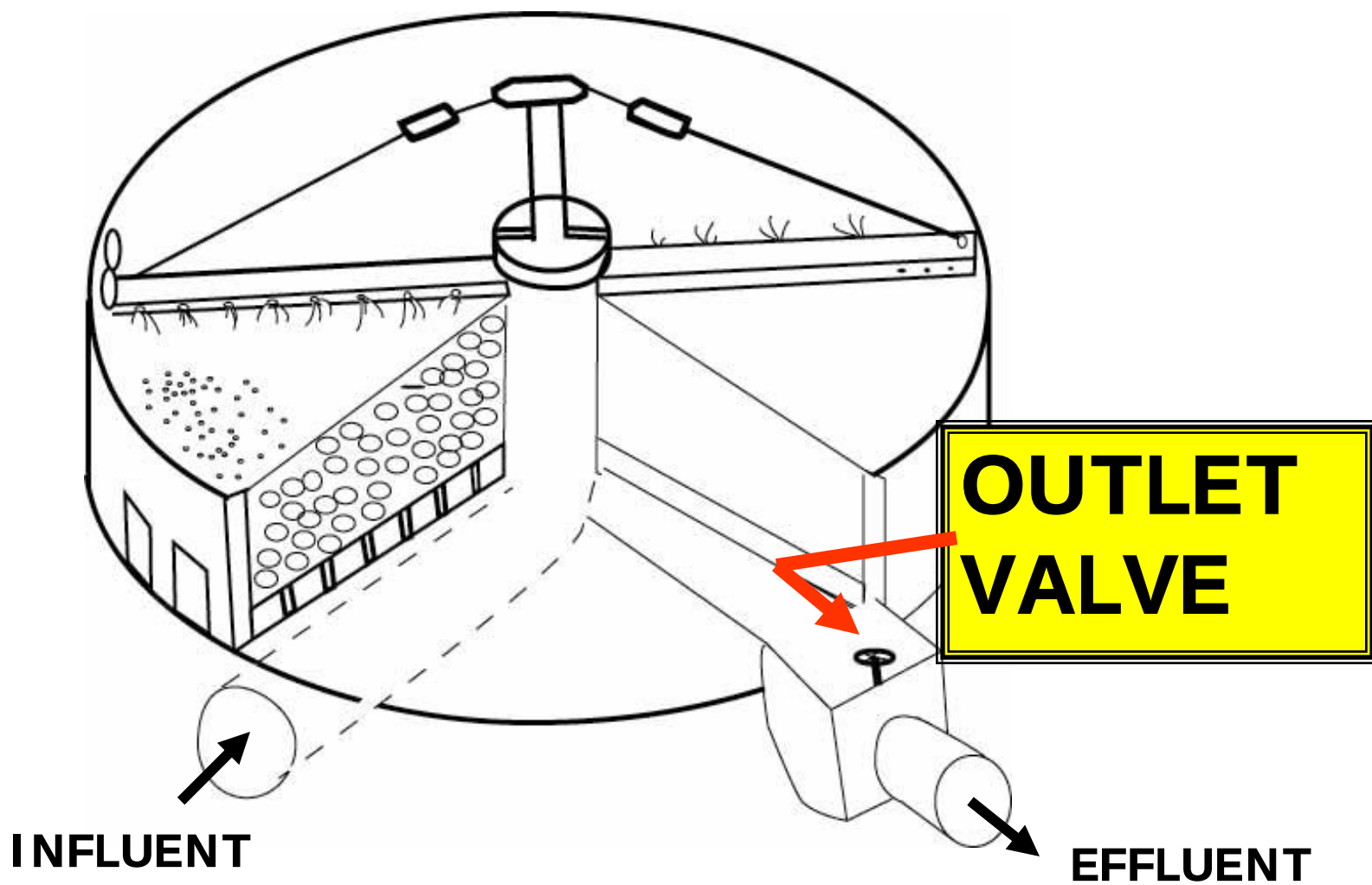


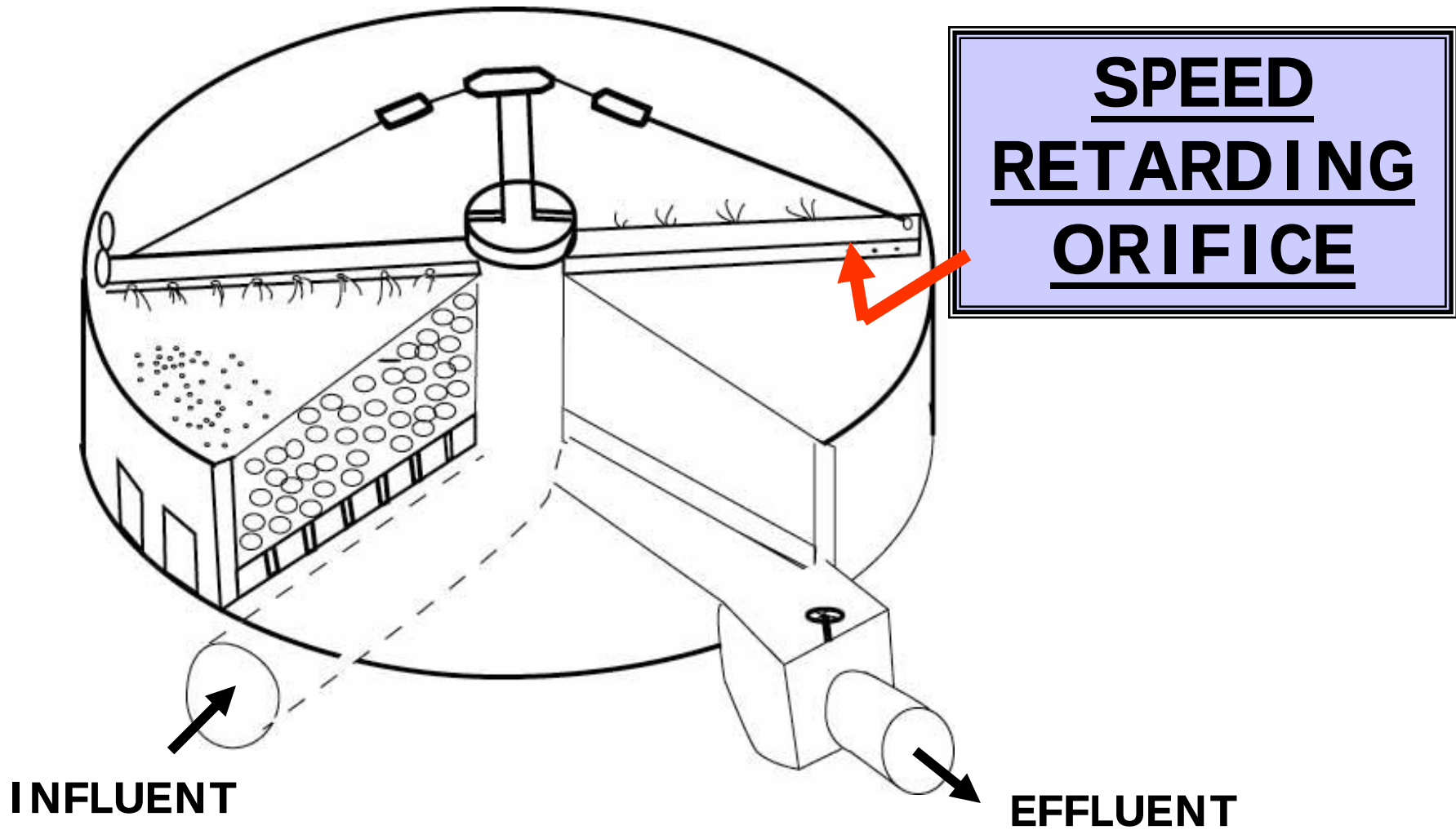
STAY RODS

INFLUENT

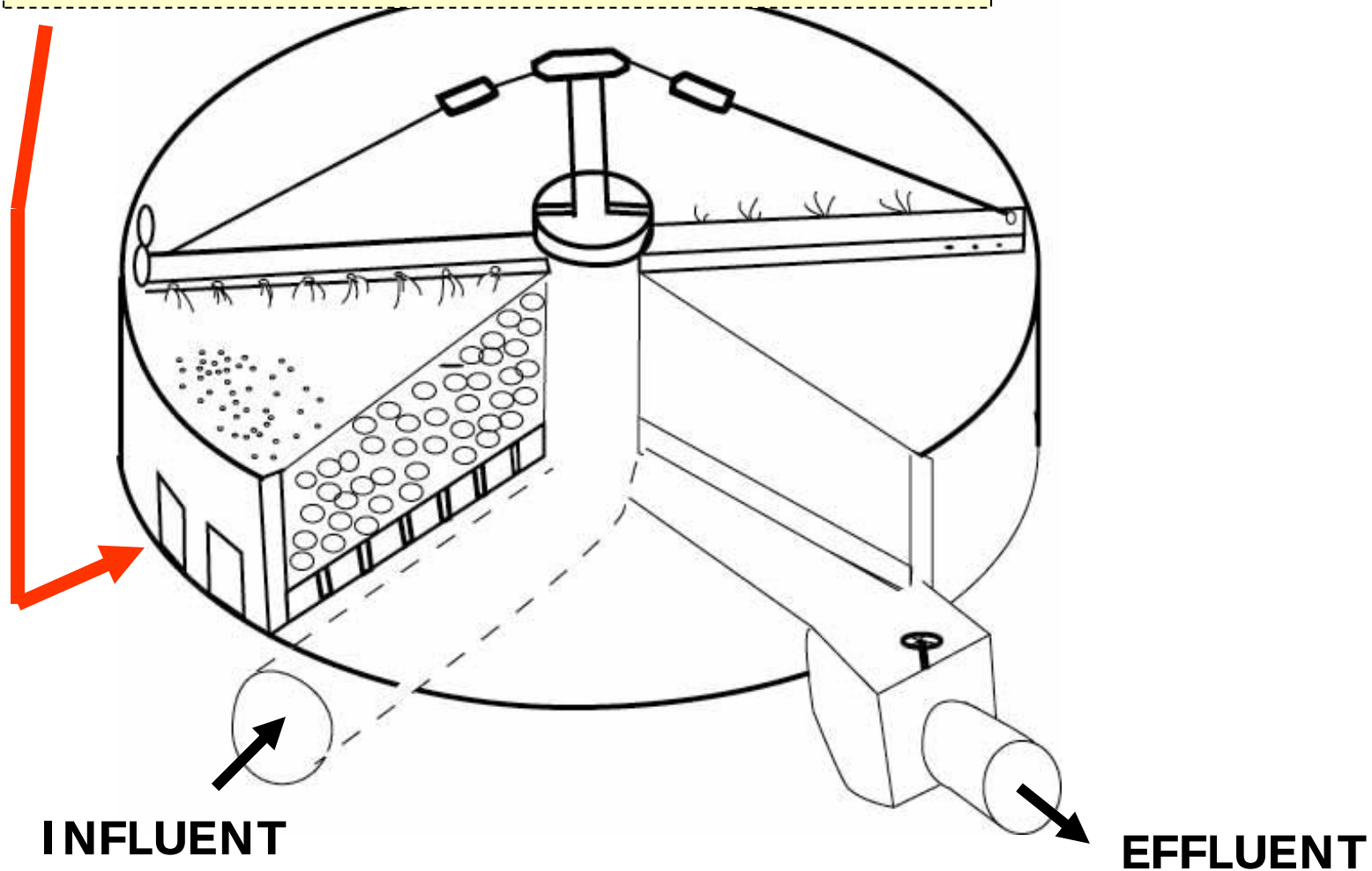
EFFLUENT







VENTILATION PORTS



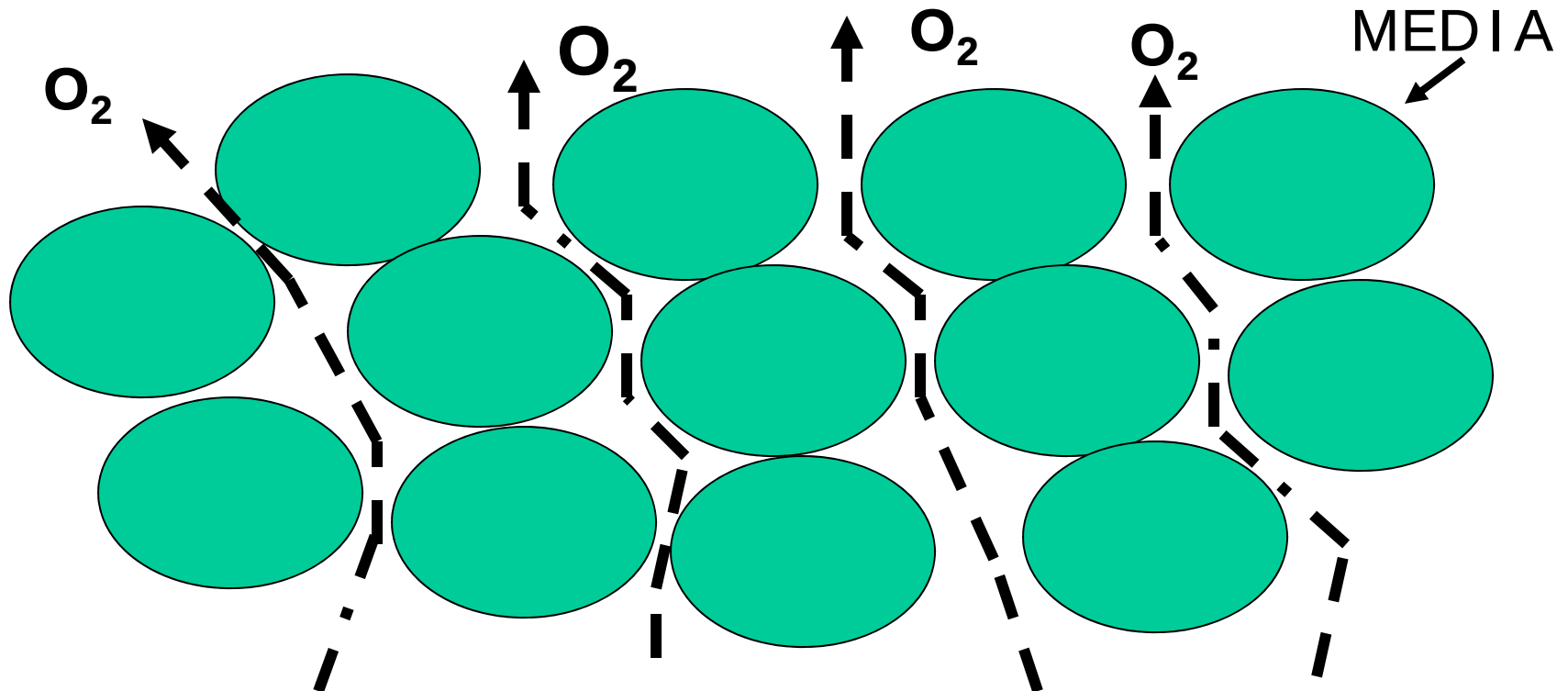
PRINCIPLES OF OPERATION

**A TRICKLING FILTER IS NOT
A FILTER...(NO STRAINING ACTION)**

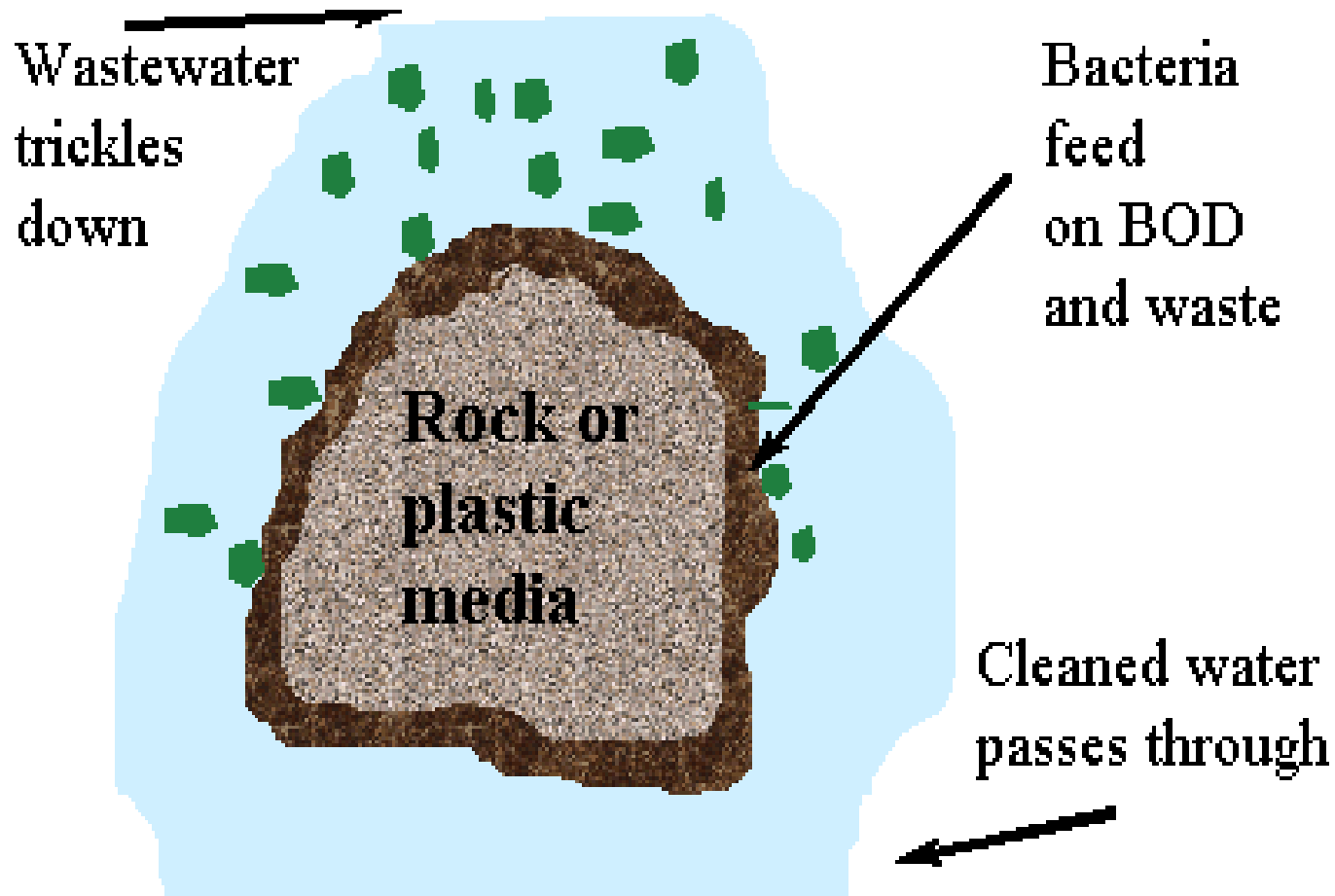
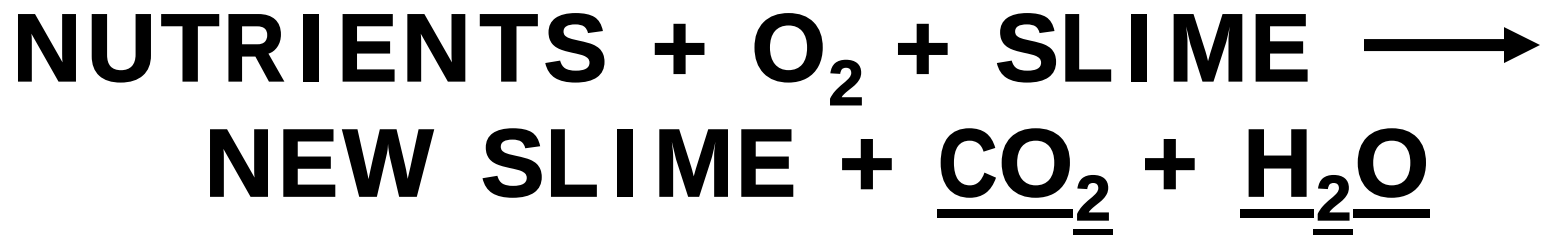
**THE “JELLY-LIKE” COATING
ON THE MEDIA USES THE
ORGANICS IN THE WASTE-
WATER AS NUTRIENTS**



**SUSPENDED, COLLOIDAL, & DISSOLVED
ORGANICS**

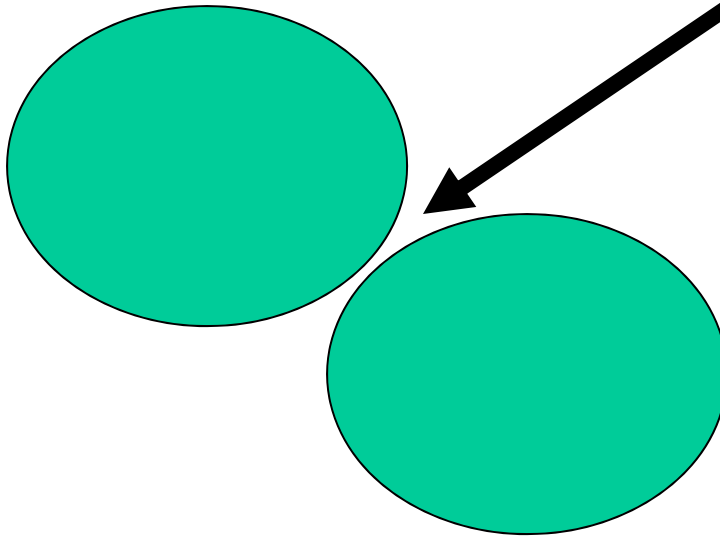


AIR FROM VENTILATORS

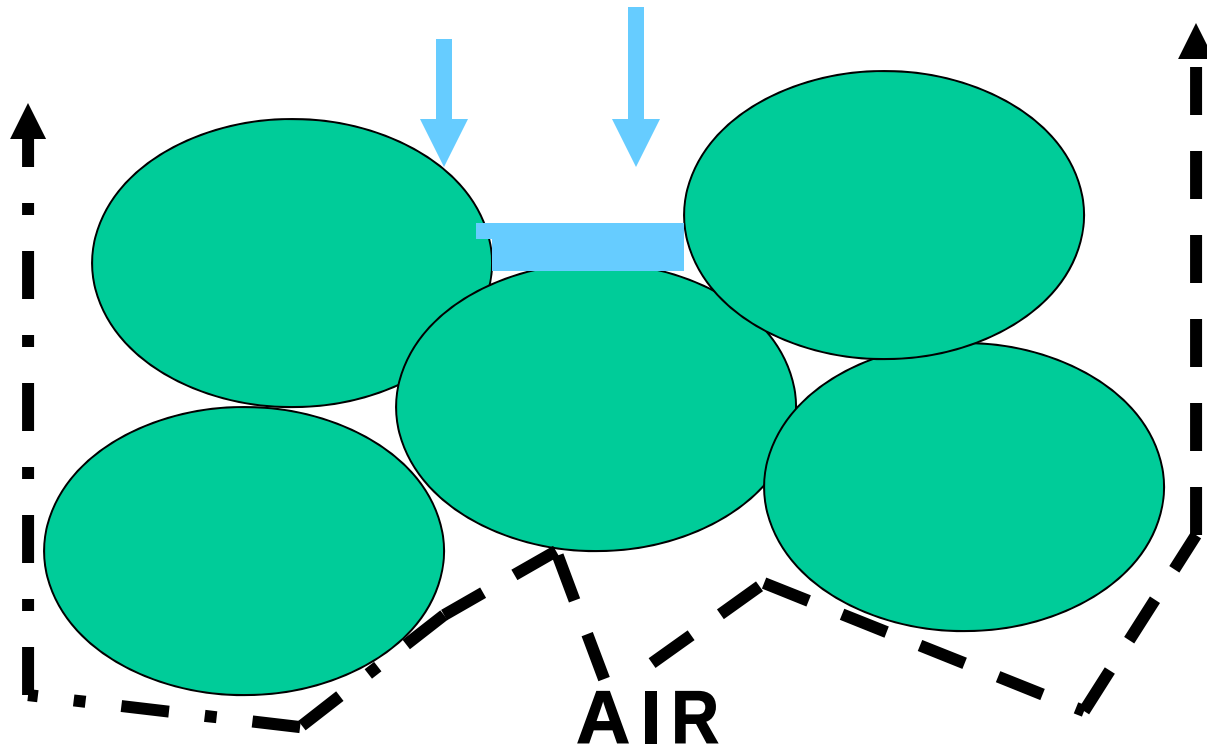


**ROCKS PROVIDE
ABOUT 35% VOID
SPACE**

**SYNTHETIC
MEDIA
PROVIDE
ABOUT 95%
VOID SPACE**



PONDING **(CLOGGED VOID** **SPACES**

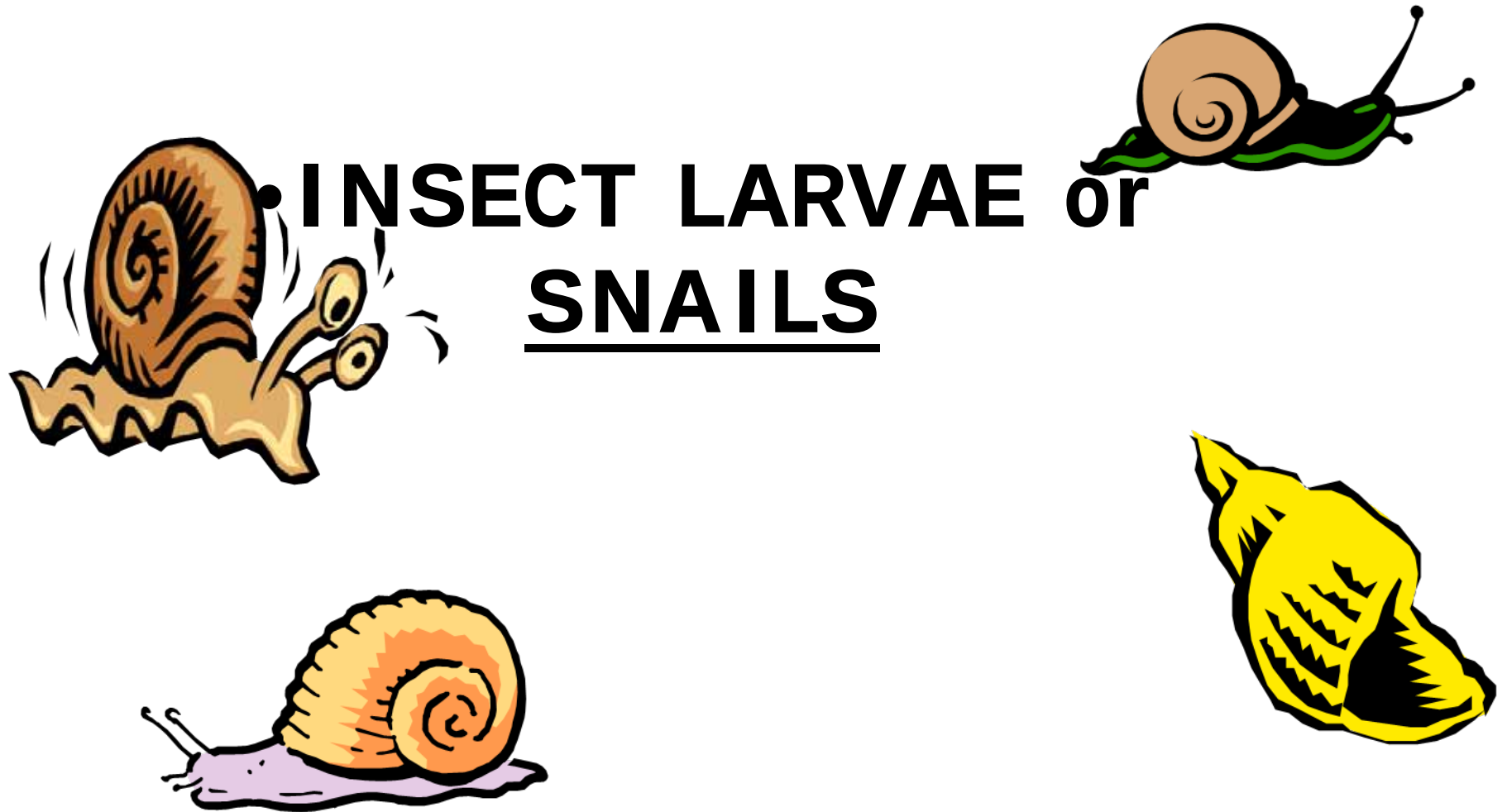


PONDING IS CAUSED BY:

- **EXCESSIVE ORGANIC LOADING**
- **POOR PRIMARY CLARIFICATION**
- **MEDIA IS TOO SMALL or NOT
UNIFORM IN SIZE**

(non-uniform media will allow the smaller to fit between the larger and block the void space)

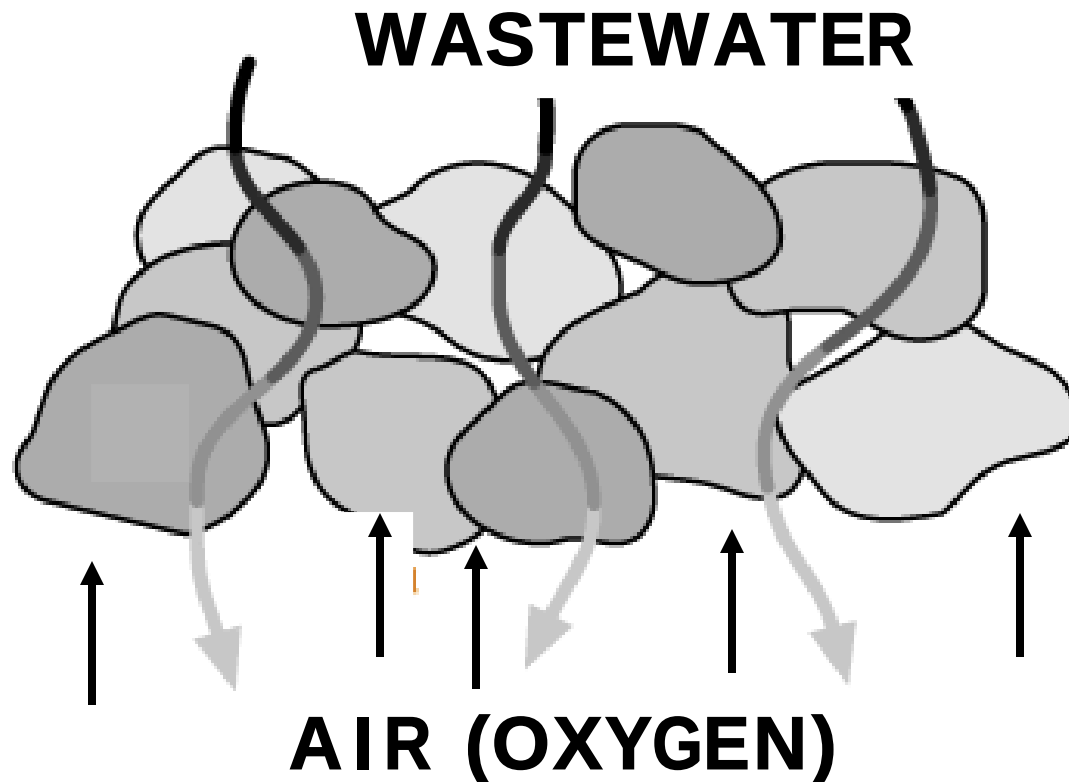
PONDING IS CAUSED BY:



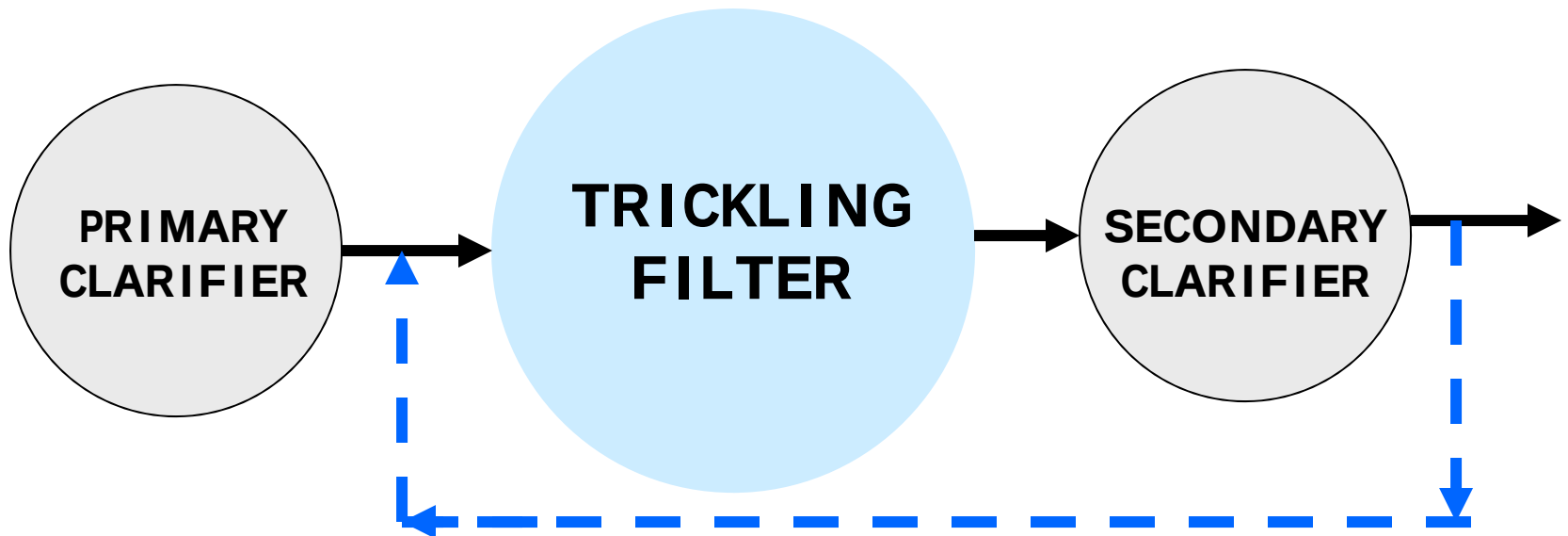
PROBLEM WITH PONDING

**PONDING PREVENTS
AIR CIRCULATION
THAT IS VITAL TO
MAINTAINING AN
ACTIVE SLIME LAYER**

POOR AIR CIRCULATION MEANS POOR BOD REMOVAL



RECIRCULATION



RECYCLING TREATED EFFLUENT

RICIRCULATION:

- **MAY BE CONSTANT OR
INTERMITTENT**
- **MAY BE ONLY DURING LOW
FLOWS TO KEEP THE
DISTRIBUTORS MOVING**
- **IMPROVES BOD REMOVAL
BECAUSE OF LONGER
CONTACT TIMES**

RECIRCULATION...

- **PRODUCES MORE CONTINUOUS AND UNIFORM SLOUGHING**

➤ **WHICH PREVENTS PONDING AND IMPROVES VENTILATION**

➤ **PRESENTS A MORE AGGRESSIVE SURFACE FOR NEW SLIME GROWTH**

➤ **DECREASES THE PROBLEMS WITH PESTS—FILTER FLIES AND SNAILS**



**FLOW TO A TRICKLING
FILTER IS GENERALLY
REGULATED THRU A WET
WELL or DOSING CHAMBER**

**TRICKLING FILTERS CAN
SUCCESSFULLY TREAT
ALMOST ANY WASTE—EXCEPT
THOSE WITH HIGH
CONCENTRATIONS OF...**

- **TOXIC WASTES**
- **PESTICIDES**
- **HEAVY METALS or EXTREME pH
WASTES**

FOR MAXIMUM EFFICIENCY, TRICKLING FILTERS SHOULD BE KEPT AEROBIC BY...

- **A PROPERLY DESIGNED
COLLECTION SYSTEM (i.e. good
flow to prevent septic conditions)**
- **PROPER OPERATION OF THE
PRIMARY CLARIFIERS**
- **PRETREATMENT WITH AIR OR
RECYCLED FILTER EFFLUENT**

TRICKLING FILTERS ARE ALSO AFFECTED BY:

- **TEMPERATURE OF THE
WASTEWATER - -**

**IN GENERAL, THE
ORGANISMS INCREASE
AS THE TEMPERATURE
RISES**



CLASSIFICATIONS OF TRICKLING FILTERS

**BASED ON HYDRAULIC AND BOD
LOADING...**

HYDRAULIC LOADING:

GPD/SQ-FT

BOD LOADING:

Lbs BOD per day / 1000 cu-ft

CLASSIFICATIONS OF TRICKLING FILTERS

**BASED ON HYDRAULIC AND BOD
LOADING...**

- **STANDARD-RATE**
- **HIGH-RATE**
- **ROUGHING FILTERS**

STANDARD-RATE

PARAMETER

VALUE

- **FLOW** **25 - 100 gpd/sq - ft**
- **BOD** **5 - 25 lbs BOD/
1000 cu - ft**
- **%BOD removal** **90 - 95 %**

HIGH-RATE TRICKLING FILTER

PARAMETER

VALUE

- **FLOW** (ROCK) **100 - 1000** gpd/

sq - ft

- **FLOW** (SYNTHETIC) **350 - 2100** “

HIGH-RATE TRICKLING FILTER

<u>PARAMETER</u>	<u>VALUE</u>
• BOD (rock)	<u>25</u> - 100 lbsBOD / 1000 cu - ft
• BOD (synthetic)	<u>50</u> - 300 “
• BOD removal	<u>90 - 95</u> %

ROUGHING FILTER

PARAMETER	VALUE
------------------	--------------

- **FLOW** (same as high - rate)
- **BOD** 100 – 300 lbs BOD
/ 1000 cu - ft
- **BOD removal** 80 – 85 %

COMPARISON OF HYDRAULIC LOADINGS—gpd/sq - ft

Standard Rate	25 to 100
----------------------	------------------

High Rate (rock)	100 to 1000
(synthetic media)	350 to 2100

Roughing	100 to 2100
-----------------	--------------------

COMPARISON OF ORGANIC LOADING: lbs BOD/ 1000 cu-ft

Standard Rate	5 to 25
High Rate (rock)	25 to 100
(synthetic)	50 to 300
Roughing	100 to 300

**ROUGHING FILTER
PRECEEDS SOME OTHER
FORM OF SECONDARY
TREATMENT (SUCH AS
ACTIVATED SLUDGE)**

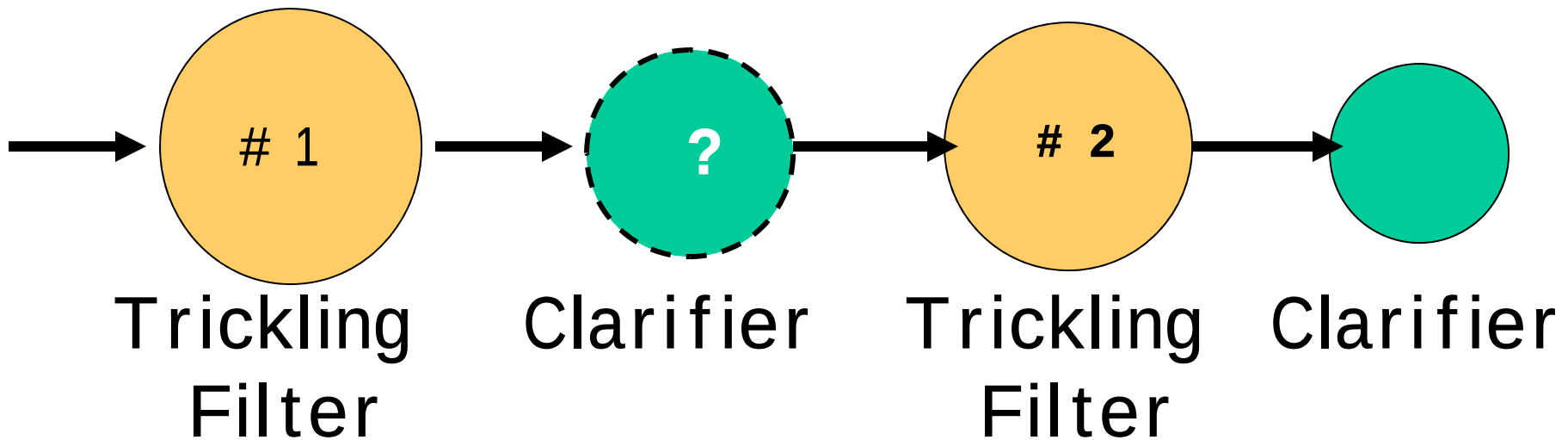




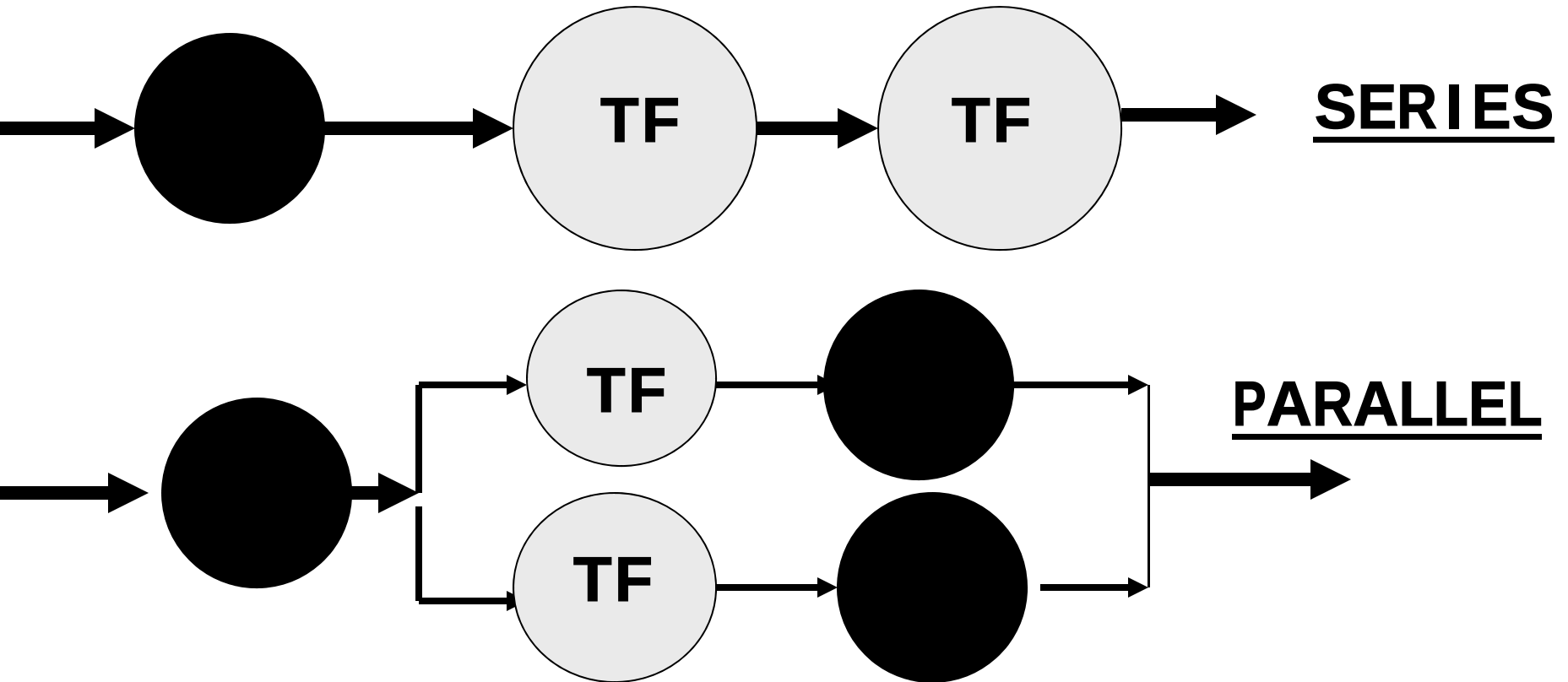
**WOULD
YOU
EXPECT
YOUR
BEST BOD
REMOVAL
DURING
WINTER
OR
SUMMER?**

TWO-STAGE TRICKLING FILTER

(LOTS OF OPTIONS FOR
RECIRCULATION)



TRICKLING FILTERS CAN BE OPERATED...

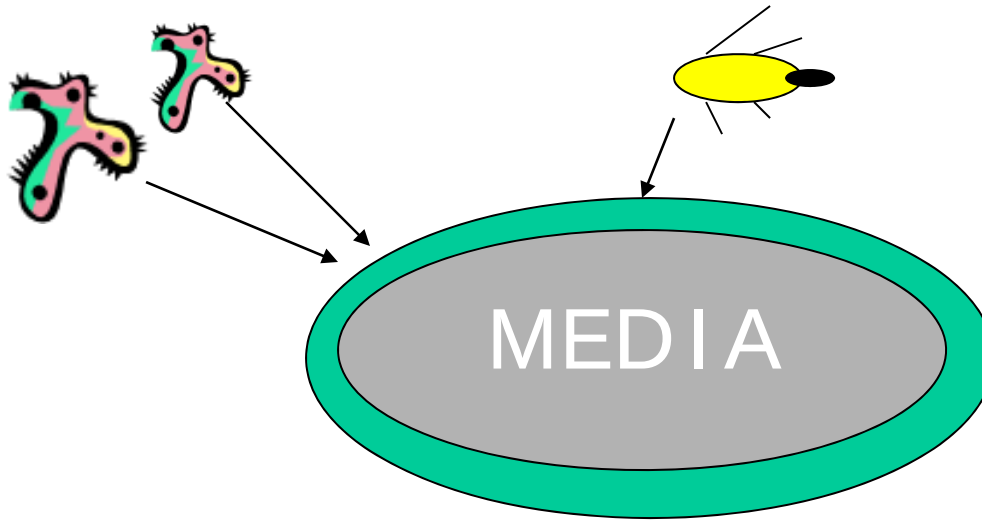


TRICKLING FILTER START-UP

**BEST TO START-UP IN
SPRING TO EARLY SUMMER.**

**TAKES SEVERAL WEEKS FOR
GROWTH TO FULLY
DEVELOP.**

GROWTH = ZOOGLEAL FILM



**CONSISTS OF BACTERIA, ALGAE
PROTOZOA, FUNGI, WORMS...+?**



**ROTATOR
ARMS TURN
ABOUT
1 RPM**

**NEVER STAND
IN FRONT OF
A TURNING
ARM!**

POOR FILTER PERFORMANCE

HIGH SUSPENDED SOLIDS:

- **HEAVY SLOUGHING** (weather changes)
- **FLOW TOO HIGH?**
- **SOLIDS CARRY-OVER FROM
CLARIFIERS (PRIMARY, SECONDARY,
OR BOTH)**
- **SHOCK LOAD**

DAILY OPERATION

- **VERY LITTLE ROUTINE CONTROL NEEDED—VERY RELIABLE PROCESS**

- **CHECK FOR PONDING, FILTER FLIES, ODORS, PLUGGED ORIFICES, AND SEAL LEAKAGES**

DAILY OPERATION (CON'T)

RECIRCULATION

- **USE MINIMUM RECIRCULATION**
(MEET NPDES LIMITS W/O PROBLEMS)
THAT WILL PROVIDE DISSOLVED OXYGEN
CONCENTRATIONS OF 3-6 mg/L (for rocks)
and 4-8 mg/L (synthetic media)

DAILY OPERATION (CON'T)

PONDING (LOSS OF OPEN
AREA IN THE FILTER)

- **CHECK PRIMARY CLARIFIER**

- **HIGH PRESSURE SPRAY ON
ROCKS; HAND-TURN THE
MEDIA; CHLORINATION;
FILTER FLOODING; SHUT-
DOWN AND LET DRY**



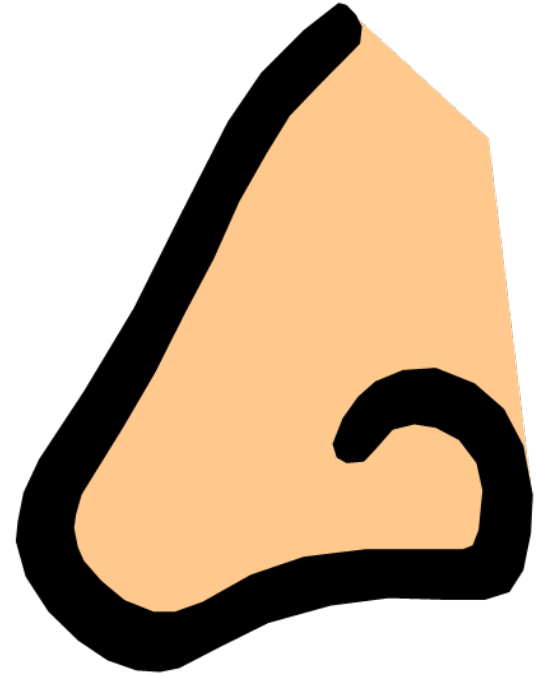
ODOR CONTROL

- **SHOULDN'T BE ODORS IF KEPT
AEROBIC**

- **INCREASE RECIRCULATION RATE
OR USE "MASKING AGENT"**

MASKING AGENT

**MATERIAL USED
TO COVER UP OR
DISGUISE
UNPLEASANT
ODORS**





FILTER FLIES



PSYCHODA (sigh - COAT - AH)

NON-BITING PESTS CONTROLLED BY:

- **INCREASING RECIRCULATION**
- **FLOODING FILTERS FOR 24 hrs**
- **GOOD HOUSE-KEEPING** (CUT
WEEDS, SHRUBBERY, TALL GRASS)
- **PESTICIDES** (GROWTH REGULATORS)



ANOTHER PROBLEM PEST - -

SNAILS



A photograph showing a large, dark, textured pile of snails, likely a pest infestation, being removed from a drainage system. The snails are piled up in a large, rectangular, green-painted metal channel. In the background, a white pipe is visible, and a red hose is coiled on the right. The scene is outdoors, with a concrete wall and some debris visible on the left.

SNAIL REMOVAL

UNCONTROLLED SLOUGHING



**ONE OF THE MOST COMMON
PROBLEMS GENERALLY SOLVED
BY INCREASING RECIRCULATION**

COLD WEATHER PROBLEMS

- **SOMETIMES FREEZING OCCURS
NEAR THE DISTRIBUTOR
NOZZLES**

- **CUT BACK ON RECIRCULATION
(RECIRCULATED WATER IS GENERALLY COLDER
THAN THAT FROM THE PRIMARY CLARIFIER)**

- **GO FROM A SERIES TO A
PARALLEL OPERATION**

IN EXTREME COLD WEATHER...



**MIGHT HAVE
TO ENCLOSE
TRICKLING
FILTERS**

VENTILATION

**NEED A TEMPERATURE
DIFFERENCE OF AT LEAST
3°F BETWEEN THE AIR
AND THE WATER THROUGH
THE FILTER TO GET GOOD
NATURAL CIRCULATION**

PLANT INFLOW VARIATIONS

**(DUE TO STORMS, INFILTRATION, OR
INDUSTRIAL DISCHARGES)**

3 OPTIONS:

- **VARY THE NUMBER OF FILTERS ON
LINE**
- **ADJUST THE RECIRCULATION RATE**
- **SWITCH FROM SERIES TO PARALLEL
(OR VISA - VERSA)**

MAINTENANCE

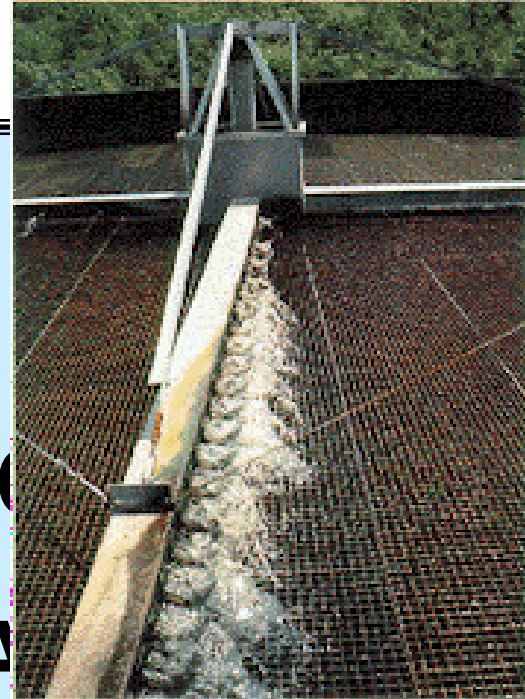
- SEALS: OLD UNITS HAD MERCURY SEALS. NEW UNITS HAVE OIL-BATH SEALS THAT SHOULD BE CHECKED WEEKLY

- CHECK OIL FOR CLEANLINESS AND REPLACE WHEN DIRTY

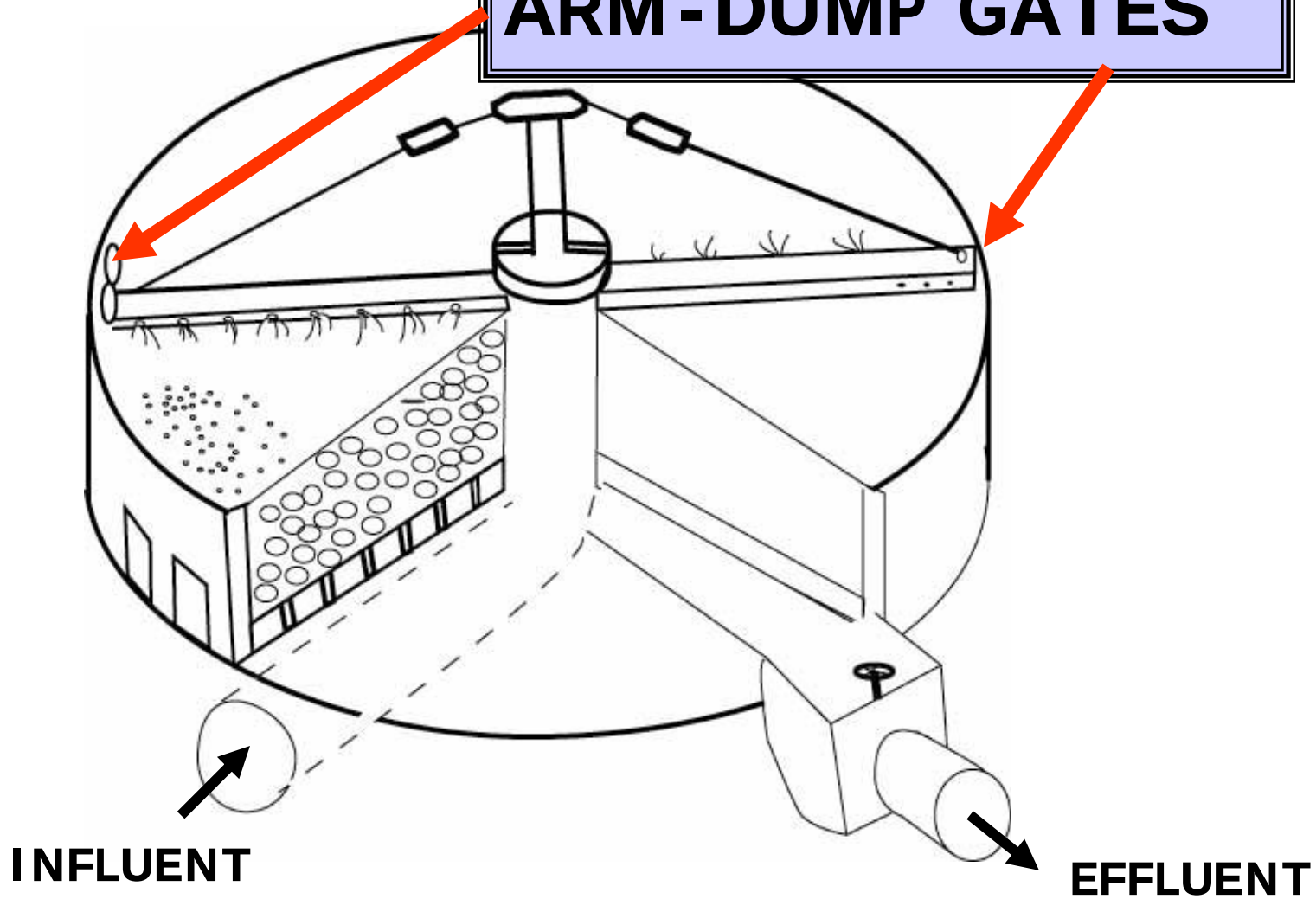
MAINTENANCE

DISTRIBUTOR ARMS:

- FLUSH ARMS WEEKLY BY OPENING THE END FLUSH
- SPEED OF THE ROTATOR A IS GOVERNED BY FLOW FROM THE ORFICES



ARM-DUMP GATES





**ROTATOR
ARMS TURN
ABOUT 1
RPM**

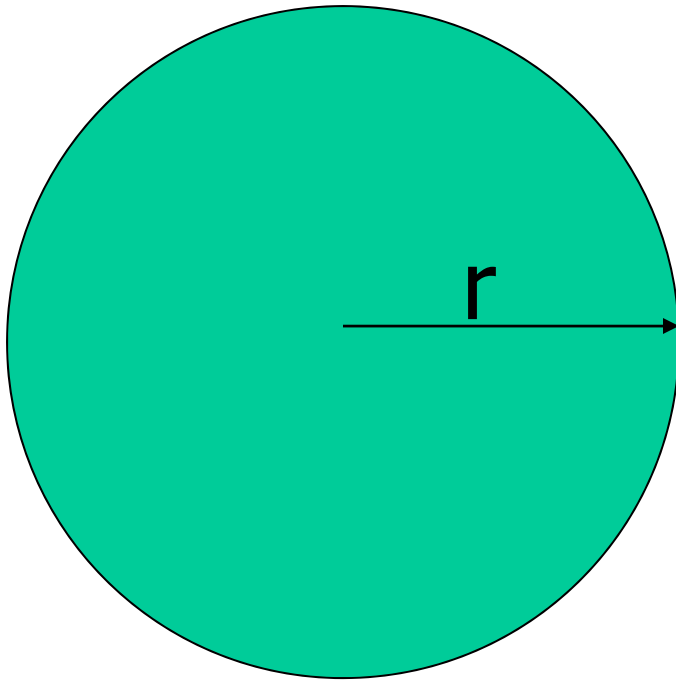
**NEVER STAND
IN FRONT OF
A TURNING
ARM!**

UNDERDRAIN MAINTENANCE

**BEST WAY
TO CLEAN IS
TO USE
CITY'S HIGH
VELOCITY
SEWER LINE
CLEANER
EVERY 6 MO.**



REVIEW OF ARITHMETIC

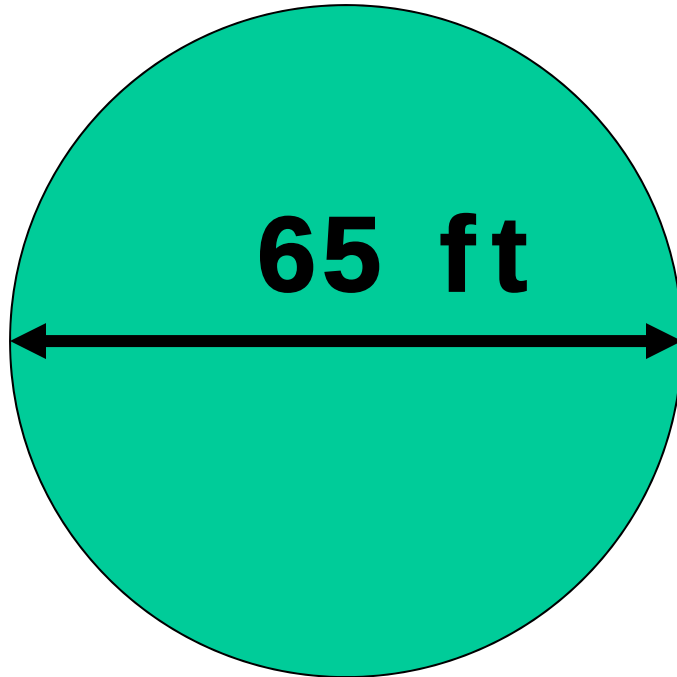


SURFACE AREA
OF A
CIRCLE = πr^2

Or: $\pi D^2 / 4$

Or: $.785 \times D^2$

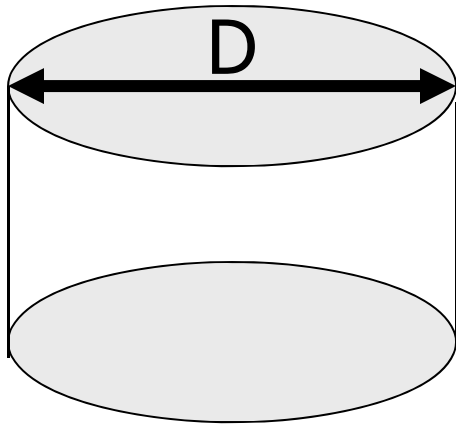
REVIEW OF ARITHMETIC



Example: What is the surface area of a trickling filter that is 65' in diameter:

$$\text{SA} = .785 \times \underline{65} \times \underline{65} = \underline{3317} \text{ sq-ft}$$

REVIEW OF ARITHMETIC



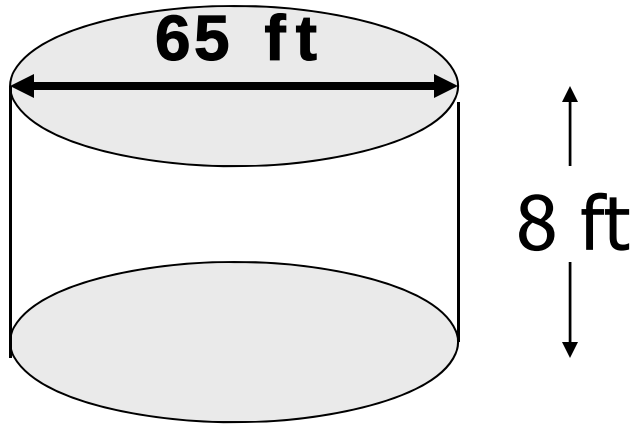
DEPTH

**VOLUME = Surface
Area x Depth**

Or; $\pi D^2/4$ x depth

Or: $.785 \times D^2 \times \text{depth}$

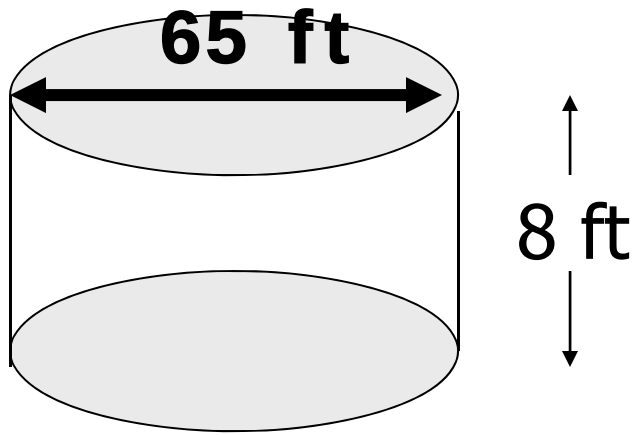
REVIEW OF ARITHMETIC



**EXAMPLE: WHAT IS THE
VOLUME of a 65'
diameter trickling
filter with 8 ft of
media?**

$$\text{VOLUME} = .785 \times 65 \times 65 \times 8 =$$
$$\underline{26,533} \text{ cu-ft}$$

REVIEW OF ARITHMETIC



**HOW MANY 1000 cu ft
ARE THERE IN THIS
FILTER?**

$$26,533 \text{ cu-ft} / 1000 = \underline{26.533}$$

REMEMBER...

- 1 GALLON OF WATER
WEIGHTS 8.3 POUNDS

- 1 CUBIC FOOT HOLDS
7.5 GALLONS

**A TRICKLING FILTER PLANT
RECEIVES 300,000 gal/day,
with a BOD = 230 mg/L**

**The trickling filter is 65 ft in
diameter with 8 ft of rock
media. Is this plant a standard
rate or high rate trickling
filter?**

Hydraulic loading = gpd/sq - ft

$$= 300,000 / .785 \times 65^2$$

$$= \underline{90.4} \text{ gpd/sq - ft}$$

**Organic Loading = lbs BOD/
1000 cu - ft**

$$= 230 \times .3 \times 8.34$$

$$= 576 / 26.3$$

$$= \underline{22} \text{ lbs BOD/1000 cu - ft}$$

COMPARISON OF HYDRAULIC LOADINGS—gpd/sq - ft

Standard Rate	25 to 100
----------------------	------------------

High Rate (rock)	100 to 1000
-------------------------	--------------------

(synthetic media)	350 to 2100
--------------------------	--------------------

COMPARISON OF ORGANIC

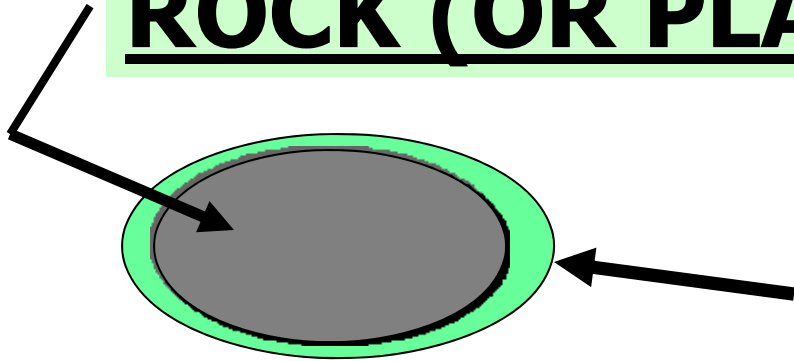
LOADING: lbs BOD/ 1000 cu-ft

<u>Standard Rate</u>	5 to 25
-----------------------------	----------------

<u>High Rate</u> (rock)	25 to 100
--------------------------------	------------------

TRICKLING FILTER

ROCK (OR PLASTIC)



HUMUS

**HUMUS (SLOUGHING
BIOMASS) GOES TO
THE CLARIFIER**

TRICKLING FILTER CLARIFIER

- **HUMUS IS HIGH IN BOD AND MUST BE REMOVED**

- **EXPECT TO PUMP 30-40% MORE SLUDGE FROM A SECONDARY CLARIFIER (THAN A PRIMARY CLARIFIER)**