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EXAM #2

SHOW ALL CALCULATIONS TO RECEIVE CREDIT. JUSTIFY YOUR ANSWERS. MAKE ASSUMPTIONS WHERE NECESSARY.

A local community has finalized the design of a new water treatment plant that will replace an old facility. The following design information is available:

Design Q = 5 MGD

Sources of water under consideration with their water quality information:

Constituent	**River A**	**River B**	**Groundwater**
Turbidity	Moderate	Moderate	Non Detect
TSS	High	Moderate	Non Detect
Dissolved Organic Matter	High	Very Low	Non detect
Alkalinity (HCO_3^-) as $CaCO_3$	40	56	240
pH	7.2	7.4	7.2
Bacteria	High	High	Non Detect
Nitrate	Low	Low	High
Ammonia	High	Low	Non Detect
Calcium as $CaCO_3$	Levels acceptable for drinking water		275
Magnesium as $CaCO_3$			25
Iron Fe^{+2} as $CaCO_3$			High
Manganese Mn^{+2} as $CaCO_3$			High
Sulfate as $CaCO_3$			60
Strontium			Low

NJDEP requires a chlorine total residual of 0.5 mg/L in treated drinking water.

The community can use the following treatment processes only:

Settling (S), Coagulation Flocculation (CF), Dual Media Filtration (DMF), Disinfection (D), Ozonation (O), UV radiation (UV), Chemical Treatment for Softening (CTS), Ion Exchange (IX), Gas Transfer (GT)

1. Indicate qualitative water treatment flowcharts (a total of 3) for each drinking water source for this community. Indicate what chemical/external agent will be used for treatment.

River A

Ozonation followed by settling and then coagulation/flocculation then filtration and disinfection. Ozone, alum and chlorine –chemical agents

River B

Settling and then coagulation/flocculation then filtration and disinfection. alum and chlorine –chemical

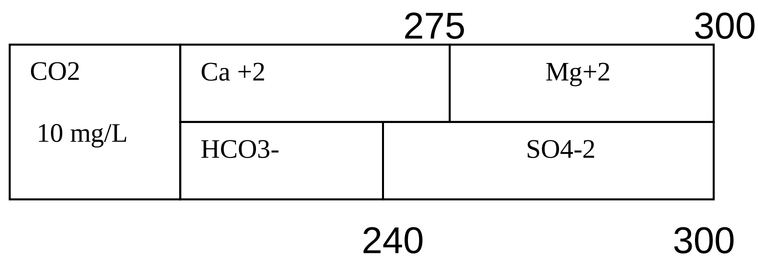
Groundwater

Gas Transfer followed by Ion Exchange then Softening Filtration Disinfection Chemicals – Lime, Soda Ash, Chlorine

2. Indicate which constituents will cause hardness in water.

Iron, Manganese, Calcium, Magnesium, Strontium

Draw a bar chart for the groundwater. Determine the total hardness, carbonate hardness and the non carbonate hardness of the water. . Assume that CO_2 concentration in the water is 10 mg/L as $CaCO_3$.



Total Hardness Ca + Mg = 300 mg/L as CaCO3
Carbonate Hardness 240 mg/L as CaCO3
Non Carbonate = 300-240 = 60 mg/L as CaCO3

Determine the concentrations of the constituents causing hardness in the water as mg/L as CaCO3.Determine the lime and soda ash requirements in mg/L as lime and soda ash

Constituent	Lime	SodaAsh
CO2	10	
$Ca(HCO_3)_2$	240	
Ca SO4		35
MgSO4	25	25
Total	365	60

Lime requirements $\frac{365 * 28}{50} = 204$ mg/L

Soda Ash $= \frac{60*53}{50} = 63.6$ mg/L

3. (a) The old water treatment plant has only **one circular settling basin** for sedimentation after coagulation flocculation for turbidity removal with alum. The basin has the following dimensions:
Diameter=15 m   Depth 3.5 m.

Will this sedimentation tank meet the needs of the new plant? What must you propose as an engineer to meet the demands? Please show calculations to support your answers. Qualitative answers are not acceptable.

Q = 5MGD = 18927m3/day

Basin Area = pi*15^2/4 = 176.71 m^2

Loading for this tank = Q/As = 18927/176 = 107m3/m2-day

This is greater than allowable 40 m3/m2-day Page 281 of book

This tank will be overloaded for current flow.

Adding one more similar tank and splitting the flow into half will provide a loading of 54 which is close to 40.

4. A jar test was conducted on the river water B with alum. The optimum alum dose was determined to be 15 mg/L. Does the water have adequate alkalinity for the alum reaction to occur?
What is the name of the precipitate that alum will form in the water and indicate how many pounds of precipitate per year will be generated in the facility? What is the fate of this precipitate?

Alum dose 15 mg/L

Each mole of alum consumes 6 moles of alkalinity

So alkalinity required $\frac{15 \text{mg/l alum} \quad * \quad 6 * 61 \text{ g/mole Alkalinity}}{594 \text{ g/mole alum}} =$

$= 9.24$ mg/l of HCO3- $= \frac{9.24*50 \text{ (eq wt of } CaCO_3)}{61 \text{ (eq wt of } HCO_3)} =$

=7.57 mg/L as $CaCO_3$ Water has much higher alkalinity so OK

5. A dual media (sand and anthracite) filter will be used for rapid filtration of the river water. What is the total number of filters that will be needed and what is their **individual** surface area in m^2? Why is anthracite used in filtration?

Q= 5MGD

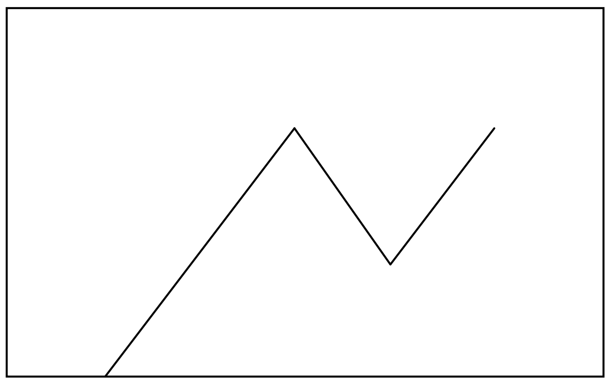
Loading for rapid dual media filtration is 300 m3/m2-day Page 284

Area required = 18927m3/day /300 m3/m2-day 63.09 m2

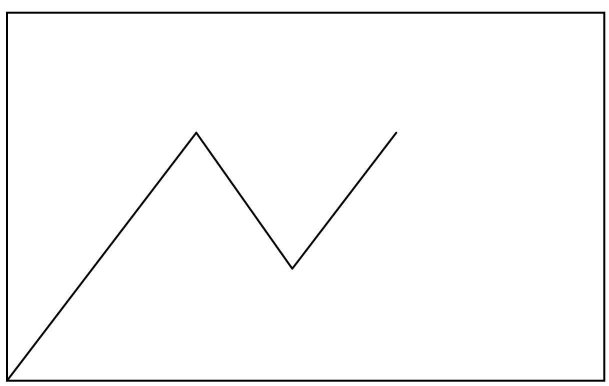
At a minimum two filters should be used

6. Draw qualitative Breakpoint chlorination graphs for the three types of water sources being assessed by the community. Justify the shapes of your curve. Which water will pose problems during disinfection with chlorine? Why? What technical measures can you take to remove the problem?

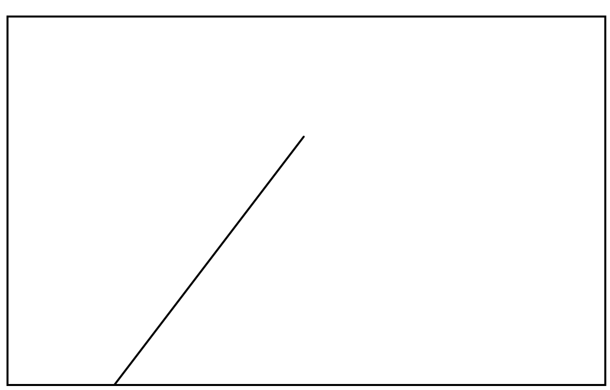
River A



River B



Groundwater



7. A poor community needs drinking water from a nearby river that is primarily high in TSS and bacteria. Assuming the water meets all other WHO water quality criteria, what type of treatment do you recommend for this community if no pumping equipment is available? Available resources include forests, sand, charcoal.

First let water settle to remove TSS Then filter

Make a sand filter with sand and charcoal

and then boil water.