

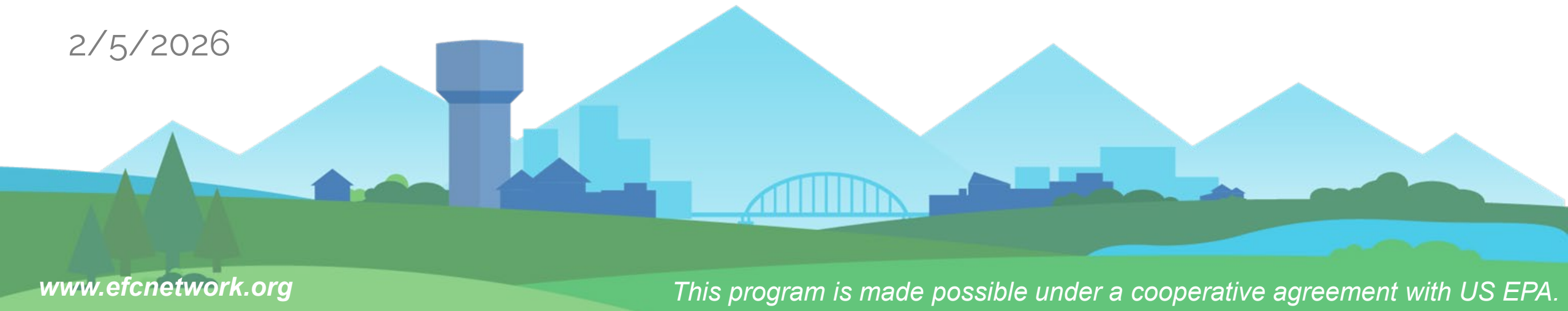


SOUTHWEST
ENVIRONMENTAL
FINANCE CENTER

US Territories Water Operator Training Series

Session 15: Drinking Water Treatment Math

2/5/2026



Your trainer for today

Matt Ziegler
Program Director



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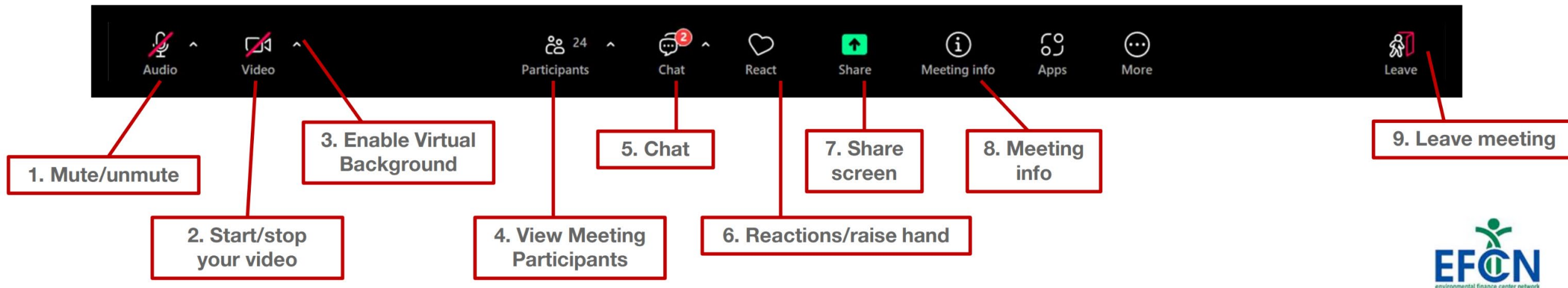
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This training series is funded by the US EPA

Attendee Meeting Controls

- Locate your control bar
- All attendees will see a black horizontal bar on their screen
- If your control bar is not visible, it may be hidden
 - Move your cursor to the screen's bottom (or top) to reveal this control bar.



Schedule for 2026:

Date	Topic
1/22/26	Alternative Treatment Processes (e.g. flouridation, ion exchange, RO...)
2/5/26	Drinking Water Treatment Math & Concept Review
2/19/26	Safety Program Basics (including personal safety, equipment safety, facility safety)
3/5/26	Lead & Copper Rule, Corrosion Control
3/19/26	Distribution Systems 1: Hydraulics, Pipe Types, Selection, Installation, and Water Quality
4/2/26	Distribution Systems 2: Valves, Hydrants, Meters, and Service Connections
4/16/26	Distribution Systems 3: Storage and Booster Pumping
4/30/26	O&M: Pumps, Main, and Appurtenance Maintenance (including pressure monitoring, valve exercising, and flushing)
5/14/26	O&M: Cross Connection Control
5/28/26	O&M: Distribution System Math and Concept Review
6/11/26	Sampling & Lab Procedures/Analysis/Interpretation
6/25/26	Management Overview (including organization, communication, PR & record keeping)
7/9/26	Drinking Water Practice Exam and Review

Links to recordings and material are available on our website at <https://swefc.unm.edu/home/op-cert-trainings/>

Pacific Island Territories Operator Certification Trainings

This page is a repository of Wastewater and Drinking Water Operator Certification (Op Cert) Training Webinars offered by the SW EFC for systems in the Pacific Territories. Below you will find the **training webinar schedules (wastewater, then drinking water)** followed by a **training webinar recordings library**.

[Jump to Wastewater Trainings](#) ↓

[Jump to Drinking Water Trainings](#) ↓

Wastewater Training Schedule

Please note all times are local to CNMI and Guam. The times in American Samoa are one day earlier at 11 am.

Session	Date	Training Topic & Link to Recording (click to view)	Supporting Materials (click to download)
1	6/25/2025	Program Overview, Test Format, Study & Test Tips	PPT slides
2	7/9/2025	Treatment Overview	PPT slides
3	7/23/2025	WW Math Part 1 (Areas & Volumes)	PPT slides
4	8/6/2025	WW Math Part 2 (Flow Rates & Detention Times)	PPT slides
5	8/20/2025	Collection Systems – Gravity systems	PPT Slides

Sign in for every session to ensure you get credit for attending



**US Territories Water & Wastewater Operator Certification
Virtual Training Series Group Attendance Sheet**

Session Title: _____

Session Date: _____

Training Location: _____

Attendee Name	Attendee Signature	Arrival Time	Departure Time

I hereby certify that the individuals listed above attended the referenced training session.

Name: _____

Signature: _____

Title: _____

Date: _____

Please scan this sheet after each training session and email it to swefc@unm.edu with the subject line: "US Territories Op Cert Attendance Sheet"

Feed Rate Chemicals That Are Not Chlorine

Cardinal
CONTAINER SERVICES
210 WALSER ROAD, LEXINGTON, NC 27295
34-7040-0444-8
FOR FAST RESPONSE 1-800-227-6816
• Empty container • Rinse and drain • Replace lids, rings plugs

PraestoTM 186 KH polymer

NOTICE: WHILE THIS MATERIAL HAS A LOW LEVEL OF TOXICITY, GOOD INDUSTRIAL HYGIENE PRACTICES ARE ENCOURAGED TO MINIMIZE EXPOSURE.

FIRST AID:
If in contact with eyes, flush eyes with water. Call a physician if irritation persists. If in contact with skin, wash with water. Call a physician if irritation persists. If SWALLOWED, move person to fresh air. IF SWALLOWED, DO NOT induce vomiting. Give nothing by mouth to an unconscious person. Call a physician.

FOR INDUSTRIAL USE ONLY. BEFORE USE, REVIEW MATERIAL SAFETY DATA SHEET FOR FURTHER INFORMATION INCLUDING CHRONIC HEALTH EFFECTS.

PRECAUTIONARY MEASURES:
Wash thoroughly after handling. Do not transfer to unmarked container. Keep container closed when not in use. Loosen closure carefully. Do not use pressure to empty. Empty containers may contain hazardous product residues. Use or store with adequate ventilation. Circumstances could require use of respiratory protection. Refer to applicable OSHA regulations. Avoid contact with eyes. Wear appropriate eye protection. Avoid contact with skin and clothing. Wear appropriate skin protection. Do not taste or swallow.

FIRE PROCEDURE:
In case of fire, use water spray (fog), foam, dry chemical or carbon dioxide.

SPILL PROCEDURE:
Contain and/or absorb spill with inert material (e.g. sand, vermiculite), then place in suitable container. Do not flush to sewer or allow to enter waterways. Use appropriate personal protective equipment. Dispose of wastes in accordance with applicable federal, state and local regulations.

DO NOT FREEZE.

NET WT. 450.00 LB 204.12 KG

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How many pounds per day of alum, is needed to treat 8.2 MGD to a dosage of 12 mg/L? The purity of the alum is 49%.

$$\text{Feed Rate, lb/day}^* = \frac{(\text{Dosage, mg/L})(\text{Flow, MGD})(8.34 \text{ lb/gal})}{\text{Purity, \% expressed as a decimal}}$$

- Flow rate = 8.2 MGD
- Dosage = 12 mg/L
- Purity = 49% = 0.49

$$\text{Feed Rate, lb/day} = \frac{(12 \text{ mg/L})(8.2 \text{ MGD})(8.34 \text{ lb/gal})}{0.49} = 1,675 \text{ lb/day}$$

1,675 pounds/day of 49% alum are required to treat 8.2 MGD to a dosage of 12 mg/L.

If **16.34 lbs/day** of zinc orthophosphate has been fed into a **1 MGD** water system, determine the average dose in mg/L.



- Feed rate = 16.34 lb/day
- Flow rate = 1.0 MGD
- Purity = 100% = 1

$$\text{Feed Rate, lb/day}^* = \frac{(\text{Dosage, mg/L})(\text{Flow, MGD})(8.34 \text{ lb/gal})}{\text{Purity, \% expressed as a decimal}}$$

$$\text{Dosage, mg/L} = \frac{(\text{Feed Rate, lb/day})(\text{Purity})}{(8.34 \text{ lb/gal})(\text{Flow, MGD})}$$

$$\text{Dosage, mg/L} = \frac{(16.34 \text{ lb/day})(1)}{(8.34 \text{ lb/gal})(1.0 \text{ MGD})} = \mathbf{1.96 \text{ mg/L}}$$

2.0 mg/L is the average dose of zinc orthophosphate when 1 MGD of water is treated with 16.34 lbs/day.



Surface Area Application of Chemicals

Copper sulfate is used for algae control. Your reservoir is 1,200 ft long and 600 ft wide. At an application rate of 5.5 lb per surface acre, how much copper sulfate is required?

- Reservoir length = 1,200'
- Reservoir width = 600'
- Application rate = 5.5 lb/acre

No Equation on
Formula Sheet

1 acre.....	= 43,560 ft ²
	= 4,046.9 m ²

$$\text{Reservoir area, } ft^2 = 1,200 \text{ ft} \times 600 \text{ ft} = 720,000 \text{ ft}^2$$

$$\text{Reservoir area, acres} = 720,000 \cancel{ft^2} \times \frac{1 \text{ acre}}{43,560 \cancel{ft^2}} = 16.5 \text{ acres}$$

$$\text{Copper Sulfate, lb} = 16.5 \cancel{\text{ acres}} \times \frac{5.5 \text{ lb}}{\cancel{\text{acre}}} = 91 \text{ lb}$$

91 lbs of copper sulfate are needed to treat a 1,200' x 600' reservoir at an application rate of 5.5 lb per surface acre.

Filter Loading Rate

Filter Loading Rate

- Also known as the Filtration Rate.
- Measured in gpm/ft².
- Allows comparison of actual conditions with design specifications.

$$\text{Filter Loading Rate, gpm/ft}^2 = \frac{\text{Flow, gpm}}{\text{Filter area, ft}^2}$$

A filter has a surface area of 920 sq ft. What is the filtration rate in gallons per minute per square foot, if it receives a flow of 4,875 gpm?

$$\text{Filter Loading Rate, gpm/ft}^2 = \frac{\text{Flow, gpm}}{\text{Filter area, ft}^2}$$

▪ Filter surface area = 920 ft²

▪ Flow = 4,875 gpm

$$\text{Filtration Rate, gpm/ft}^2 = \frac{4,875 \text{ gpm}}{920 \text{ ft}^2} = 5.3 \text{ gpm/ft}^2$$

5.3 gpm/ft² is the filtration rate for this filter at a flow rate of 4,875 gpm.

A filter has a surface area of 350 sq ft. What is the filtration rate in gallons per minute per square foot, if it receives a flow of 1,200 gpm?

$$\text{Filter Loading Rate, gpm/ft}^2 = \frac{\text{Flow, gpm}}{\text{Filter area, ft}^2}$$



■ Filter surface area = 350 ft²

■ Flow = 1,200 gpm

$$\text{Filtration Rate, gpm/ft}^2 = \frac{1,200 \text{ gpm}}{350 \text{ ft}^2} = 3.4 \text{ gpm/ft}^2$$

3.4 gpm/ft² is the filtration rate for this filter at a flow rate of 1,200 gpm.



Surface Loading Rate

Surface Loading Rate

- The amount of water per day (gpd) passing over 1 square foot (ft²) of a treatment process.
- Allows comparison of actual conditions with design specifications.
- AKA – Surface Settling Rate or Surface Overflow Rate

$$\text{Surface Loading Rate or Surface Overflow Rate, gpd/ft}^2 = \frac{\text{Flow, gpd}}{\text{Area, ft}^2}$$

What is the surface loading rate for a circular clarifier that is 90 feet in diameter, if it is treating an instantaneous flow rate of 5 cfs?

$$\text{Surface Loading Rate or Surface Overflow Rate, gpd/ft}^2 = \frac{\text{Flow, gpd}}{\text{Area, ft}^2}$$

▪ Clarifier = 90 ft diameter

▪ Flow rate = 5 cfs

**Need flow in gpd &
Need area in ft²**

1 cubic foot per second = 0.646 MGD
= 448.8 gpm

$$\text{Area of Circle} = (3.14)(\text{Radius}^2)$$

$$\text{Area of Circle}^* = (0.785)(\text{Diameter}^2)$$

What is the surface loading rate for a circular clarifier that is 90 feet in diameter, if it is treating an instantaneous flow rate of 5 cfs?

- **Flow rate = 5 cfs (convert to gpd)**

$$\begin{aligned} 1 \text{ cubic foot per second} &= 0.646 \text{ MGD} \\ &= 448.8 \text{ gpm} \end{aligned}$$

$$\text{Flow Rate, } gpd = 5 \cancel{cfs} \times \frac{0.646 \text{ MGD}}{1 \cancel{cfs}} = 3.23 \text{ MGD} = 3,230,000 \text{ } gpd$$

- **Clarifier = 90 ft diameter (calculate area)**

$$\text{Area of Circle} = (3.14)(\text{Radius}^2)$$

$$\text{Area of Circle}^* = (0.785)(\text{Diameter}^2)$$

$$\text{Clarifier Area, } ft^2 = 0.785 \times (90 \text{ } ft)^2 = 6,359 \text{ } ft^2$$

What is the surface loading rate for a circular clarifier that is 90 feet in diameter, if it is treating an instantaneous flow rate of 5 cfs?

$$\text{Surface Loading Rate or Surface Overflow Rate, gpd/ft}^2 = \frac{\text{Flow, gpd}}{\text{Area, ft}^2}$$

- Flow rate = 3,230,000 gpd
- Clarifier area = 6,359 ft²

$$\text{Surface Loading Rate, gpd/ft}^2 = \frac{3,230,000 \text{ gpd}}{6,359 \text{ ft}^2} = 508 \text{ gpd/ft}^2$$

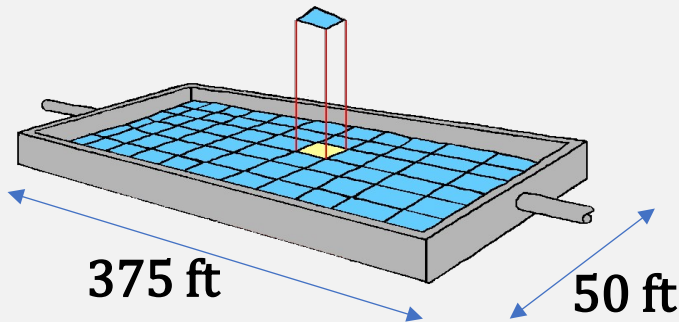
508 gpd/ft² is the surface loading rate for this circular clarifier at a flow rate of 5 cfs.

A rectangular sedimentation basin measures 375 ft by 50 ft, what is the surface loading rate if it is treating an instantaneous flow rate of 17 cfs?

$$\text{Surface Loading Rate or Surface Overflow Rate, gpd/ft}^2 = \frac{\text{Flow, gpd}}{\text{Area, ft}^2}$$

■ Sedimentation basin = 375 ft x 50 ft

■ Flow rate = 17 cfs



Need flow in gpd &
Need area in ft²

A rectangular sedimentation basin measures 375 ft by 50 ft, what is the surface loading rate if it is treating an instantaneous flow rate of 17 cfs?

- Flow rate = 17 cfs (convert to gpd)

$$\begin{aligned} 1 \text{ cubic foot per second} &= 0.646 \text{ MGD} \\ &= 448.8 \text{ gpm} \end{aligned}$$



$$\text{Flow Rate, } gpd = 17 \cancel{\text{ cfs}} \times \frac{0.646 \text{ MGD}}{1 \cancel{\text{ cfs}}} = 10.982 \text{ MGD} = \mathbf{10,982,000 \text{ gpd}}$$

- Sedimentation basin = 375 ft x 50 ft (calculate area)

$$\mathbf{\text{Area of Rectangle}^* = (\text{Length})(\text{Width})}$$



$$\text{Sedimentation Basin Area, } ft^2 = 375 \text{ ft} \times 50 \text{ ft} = \mathbf{18,750 \text{ ft}^2}$$

A rectangular sedimentation basin measures 375 ft by 50 ft, what is the surface loading rate if it is treating an instantaneous flow rate of 17 cfs?



$$\text{Surface Loading Rate or Surface Overflow Rate, gpd/ft}^2 = \frac{\text{Flow, gpd}}{\text{Area, ft}^2}$$

- Flow rate = 10,982,000 gpd
- Sedimentation basin area = 18,750 ft²

$$\text{Surface Loading Rate, gpd/ft}^2 = \frac{10,982,000 \text{ gpd}}{18,750 \text{ ft}^2} = 586 \text{ gpd/ft}^2$$

586 gpd/ft² is the surface loading rate for this sedimentation basin at a flow rate of 17 cfs.



Backwash Rate & Backwash Rise Rate

Backwash Rate

- Backwash rate is the movement of water in the opposite direction of filtration to clean and remove filtered solids.
- Measured in gpm/ft².
- Allows comparison of actual conditions with design specifications.
- No direct formula on the ABC formula sheet.

$$\text{Filter Loading Rate, gpm/ft}^2 = \frac{\text{Flow, gpm}}{\text{Filter area, ft}^2}$$

$$\text{Backwash Rate, gpm/ft}^2 = \frac{\text{Flow, gpm}}{\text{Filter area, ft}^2}$$



**Can Adapt
Formula**

A filter has an area of 840 sq ft with a backwash pumping rate of 20 cfs. What is the backwash rate in gallons per minute per square foot?

$$\text{Backwash Rate, gpm/ft}^2 = \frac{\text{Flow, gpm}}{\text{Filter area, ft}^2}$$

▪ Filter area = 840 ft²

▪ Flow rate = 20 cfs

Need flow in gpm

$$\begin{aligned} 1 \text{ cubic foot per second} &= 0.646 \text{ MGD} \\ &= 448.8 \text{ gpm} \end{aligned}$$

$$\text{Flow Rate, gpd} = 20 \cancel{\text{ cfs}} \times \frac{448.8 \text{ gpm}}{1 \cancel{\text{ cfs}}} = 8,976 \text{ gpm}$$

A filter has an area of 840 sq ft with a backwash pumping rate of 20 cfs. What is the backwash rate in gallons per minute per square foot?

$$\text{Backwash Rate, gpm/ft}^2 = \frac{\text{Flow, gpm}}{\text{Filter area, ft}^2}$$

▪ Filter area = 840 ft²

▪ Flow rate = 8,976 gpm

$$\text{Backwash Rate, gpm/ft}^2 = \frac{8,976 \text{ gpm}}{840 \text{ ft}^2} = 10.7 \text{ gpm/ft}^2$$

10.7 gpm/ft² is the backwash rate for this filter at a flow of 20 cfs.

Based on your calculation of the filter backwash rate in Question Ex3, what is the filter backwash rise rate for this filter in inches/minute?

$$\text{Filter Backwash Rise Rate, in/min} = \frac{(\text{Backwash Rate, gpm/ft}^2)(12 \text{ in/ft})}{7.48 \text{ gal/ft}^3}$$

▪ Filter backwash rate = 10.7 gpm/ft²

$$\text{Filter Backwash Rise Rate, in/min} = \frac{(10.7 \text{ gpm/ft}^2)12 \text{ in/ft}}{7.48 \text{ gal/ft}^3} = 17.2 \text{ in/min}$$

17.2 in/min is the filter backwash rise rate for this filter if it is backwashed at a rate of 10.7 gpm/ft².

A filter has an area of 50 sq ft with a backwash pumping rate of 1.7 cfs. What is the backwash rate in gallons per minute per square foot?

$$\text{Backwash Rate, gpm/ft}^2 = \frac{\text{Flow, gpm}}{\text{Filter area, ft}^2}$$

▪ Filter area = 50 ft²

▪ Flow rate = 1.7 cfs

Need flow in gpm

$$\begin{aligned} 1 \text{ cubic foot per second} &= 0.646 \text{ MGD} \\ &= 448.8 \text{ gpm} \end{aligned}$$

$$\text{Flow Rate, gpd} = 1.7 \cancel{\text{ cfs}} \times \frac{448.8 \cancel{\text{ gpm}}}{1 \cancel{\text{ cfs}}} = 763 \text{ gpm}$$



A filter has an area of 50 sq ft with a backwash pumping rate of 1.7 cfs. What is the backwash rate in gallons per minute per square foot?

$$\text{Backwash Rate, gpm/ft}^2 = \frac{\text{Flow, gpm}}{\text{Filter area, ft}^2}$$



▪ Filter area = 50 ft²

▪ Flow rate = 763 gpm

$$\text{Backwash Rate, } \frac{\text{gpm}}{\text{ft}^2} = \frac{763 \text{ gpm}}{50 \text{ ft}^2} = 15.3 \text{ gpm/ft}^2$$

15.3 gpm/ft² is the backwash rate for this filter at a flow of 1.7 cfs.

Based on your calculation of the filter backwash rate in Question 7, what is the filter backwash rise rate for this filter in inches/minute?



$$\text{Filter Backwash Rise Rate, in/min} = \frac{(\text{Backwash Rate, gpm/ft}^2)(12 \text{ in/ft})}{7.48 \text{ gal/ft}^3}$$

▪ Filter backwash rate = 15.3 gpm/ft²

$$\text{Filter Backwash Rise Rate, in/min} = \frac{(15.3 \text{ gpm/ft}^2)12 \text{ in/ft}}{7.48 \text{ gal/ft}^3} = 24.5 \text{ in/min}$$

24.5 in/min is the filter backwash rise rate for this filter if it is backwashed at a rate of 15.3 gpm/ft².

Percent Removal



Percent Removal

- The amount of a contaminant removed in percent form.
- Helps determine if meet some SDWA regulatory requirements.
- Helps inform if treatment plant is doing its job.
- Allows comparison of actual conditions with design specifications.

$$\text{Removal, \%} = \frac{\text{In} - \text{Out}}{\text{In}} \times 100\%$$

The iron content of a raw water is 1.81mg/L. What is the percent removal if the finished water contains 0.11 mg/L iron?

$$\text{Removal, \%} = \frac{\text{In} - \text{Out}}{\text{In}} \times 100\%$$

- Raw water iron (In) = 1.81 mg/L
- Finished water iron (Out) = 0.11 mg/L

$$\text{Removal \%} = \frac{1.81 \text{ mg/L} - 0.11 \text{ mg/L}}{1.81 \text{ mg/L}} \times 100\% = 93.9\%$$

94% is the percent removal of iron in the finished water.



You operate a surface water treatment plant and one of the SDWA requirements as part of the DBPR is to remove a certain percentage of Total Organic Carbon. If your raw water TOC is 3.2 mg/L and your finished water TOC is 0.9 mg/L, calculate the percent removal for TOC.

$$\text{Removal, \%} = \frac{\text{In} - \text{Out}}{\text{In}} \times 100\%$$

▪ Raw water TOC (In) = 3.2 mg/L

▪ Finished water TOC (Out) = 0.9 mg/L

$$\text{Removal \%} = \frac{3.2 \text{ mg/L} - 0.9 \text{ mg/L}}{3.2 \text{ mg/L}} \times 100\% = 71.9\%$$

72% is the percent removal of TOC in the finished water.

A stack of several brown paper bags, likely containing granulated salt. The bags are labeled with "CMF® Granulated Salt Sol Granulada" and "50 lb". Some bags also have a green circular logo with the word "Untreated" inside. The bags are stacked in a way that shows multiple layers, with some bags slightly offset from others. The text "Ordering Treatment Material" is overlaid in the center of the image.

Ordering Treatment Material

It is time to submit an order so that you can do a maintenance on your filter to keep it operating and removing contaminants. You must add 8 inches of coal to one of the 12 ft by 8 ft filters in your treatment plant. If each bag holds 3.5 ft³, how many bags do you need to order?

- Height of coal = 8 inches
- Filter Size = 12 ft x 8 ft
- Bag size = 3.5 ft³

Need to determine volume of coal adding to filter in ft³

$$\text{Volume of Coal, } ft^3 = \left(8 \cancel{\text{in}} \times \frac{1 \text{ ft}}{12 \cancel{\text{in}}} \right) \times 12 \text{ ft} \times 8 \text{ ft} = 64 \text{ ft}^3$$

$$\# \text{ of Bags} = 64 \cancel{\text{ft}^3} \times \left(\frac{1 \text{ bag}}{3.5 \cancel{\text{ft}^3}} \right) = 18.3 \text{ bags}$$

19 bags of coal should be ordered to add 8 inches to the filter.

Next time:

Date	Topic
1/22/26	Alternative Treatment Processes (e.g. fluoridation, ion exchange, RO...)
2/5/26	Drinking Water Treatment Math & Concept Review
2/19/26	Safety Program Basics (including personal safety, equipment safety, facility safety)
3/5/26	Lead & Copper Rule, Corrosion Control
3/19/26	Distribution Systems 1: Hydraulics, Pipe Types, Selection, Installation, and Water Quality
4/2/26	Distribution Systems 2: Valves, Hydrants, Meters, and Service Connections
4/16/26	Distribution Systems 3: Storage and Booster Pumping
4/30/26	O&M: Pumps, Main, and Appurtenance Maintenance (including pressure monitoring, valve exercising, and flushing)
5/14/26	O&M: Cross Connection Control
5/28/26	O&M: Distribution System Math and Concept Review
6/11/26	Sampling & Lab Procedures/Analysis/Interpretation
6/25/26	Management Overview (including organization, communication, PR & record keeping)
7/9/26	Drinking Water Practice Exam and Review

Links to recordings and material are available on our website at <https://swefc.unm.edu/home/op-cert-trainings/>

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