Optimization of Backwash Recycle & Sludge Settling Bozeman WTP

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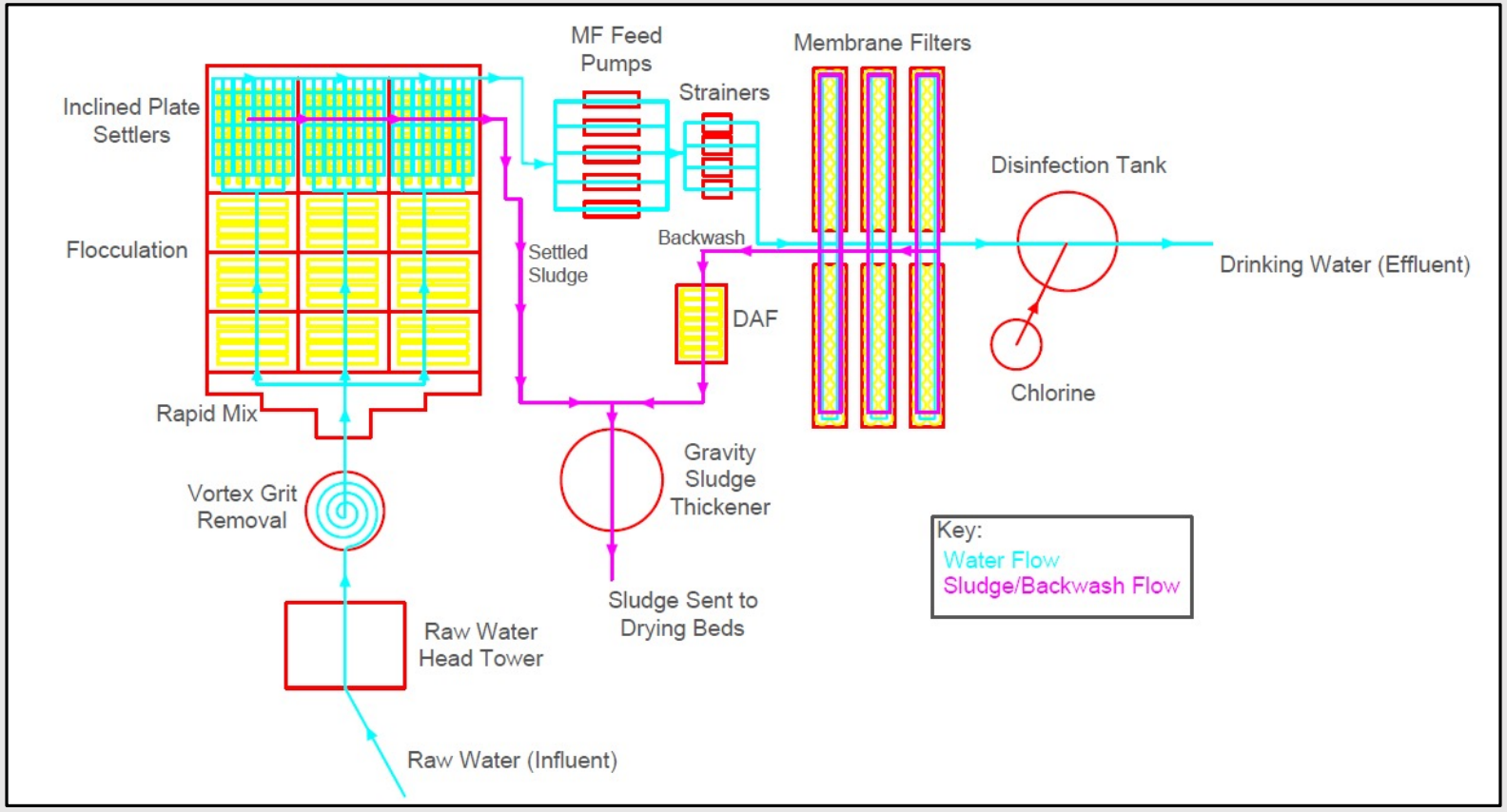
Background

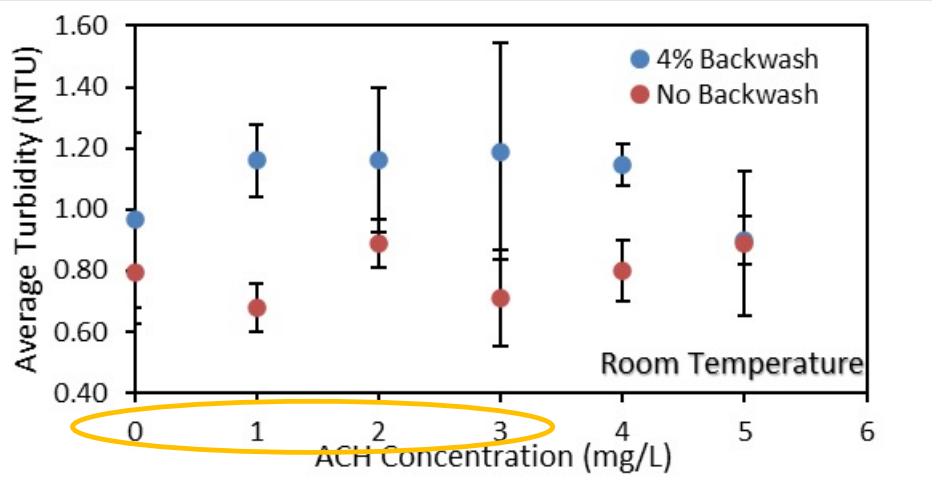
- Filter backwash accounts for ~2-4% of total available water for Bozeman
- Filter Backwash Recycle Rule (EPA)
- Climate change
- Growing population in Bozeman.
- Chemical addition is significant part of operating costs.

Background


MF Feed Pumps
Membrane Filters
Inclined Plate Settlers
Strainers
Disinfection Tank
Flocculation
Settled Sludge
Backwash
Drinking Water (Effluent)
DAF
Rapid Mix
Chlorine
Gravity Sludge Thickener
Vortex Grit Removal
Key:
Water Flow
Sludge/Backwash Flow
Sludge Sent to Drying Beds
Raw Water Head Tower
Raw Water (Influent)

Data Analysis

Initial Turbidity: 1.29 NTU



Initial Turbidity: 1.41 NTU

95% CI bars do not overlap!

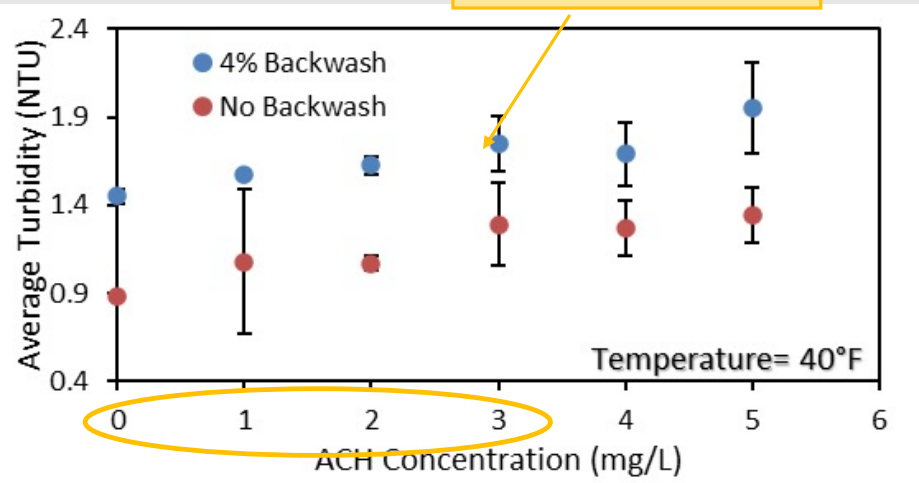


Figure 2: Displays the average turbidity from jar tests done at room temperature (left) and in the cold room (right) with low initial raw water turbidity (<2 NTU).

Data Analysis

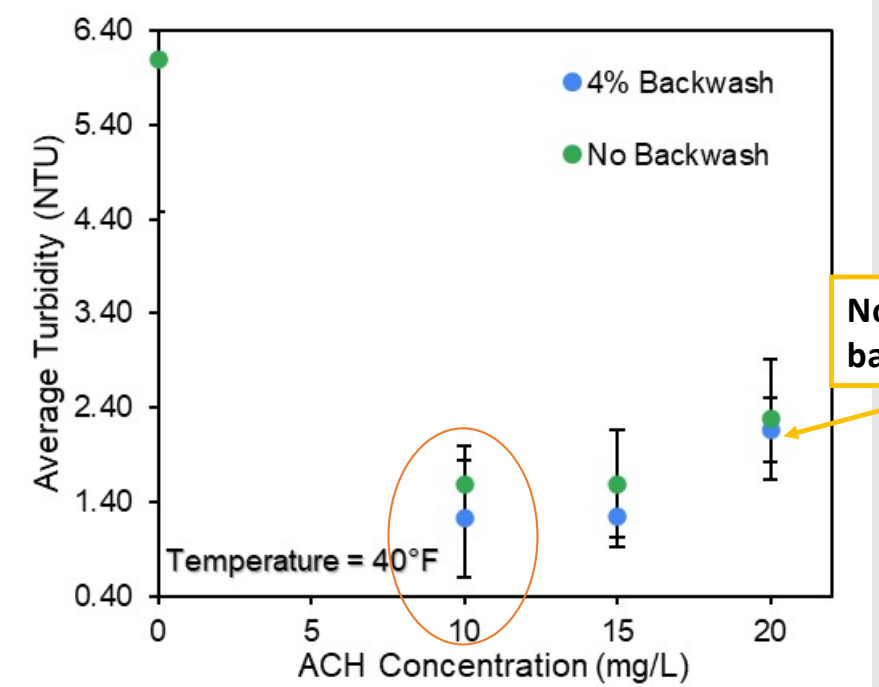
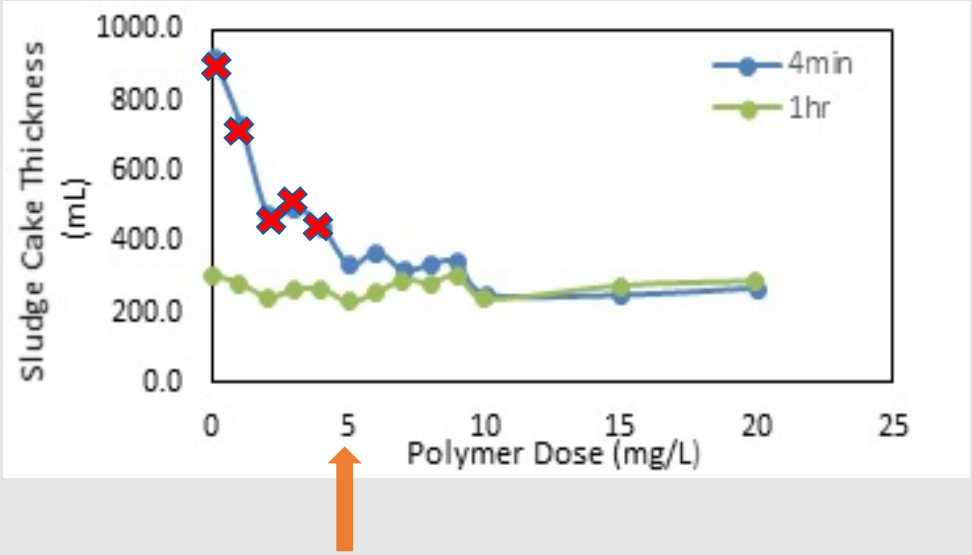


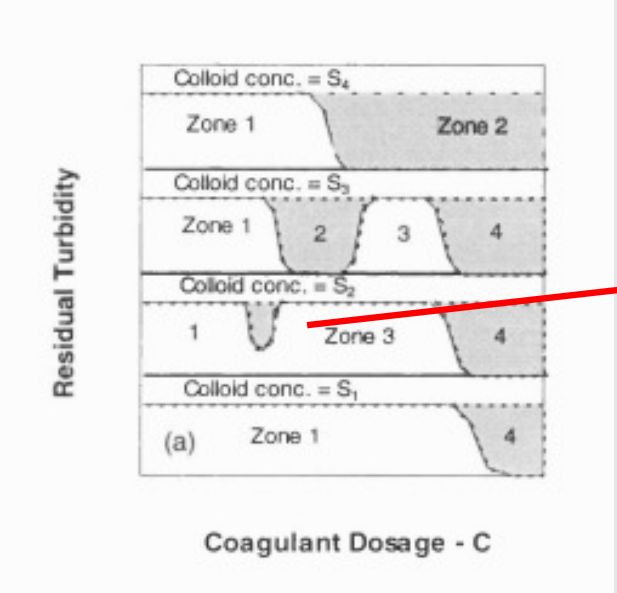
Figure 3: Displays the average turbidity of treated water samples from jar tests completed on 11/2/2021. Initial raw water turbidity was high due to logging operations in Sourdough Canyon.

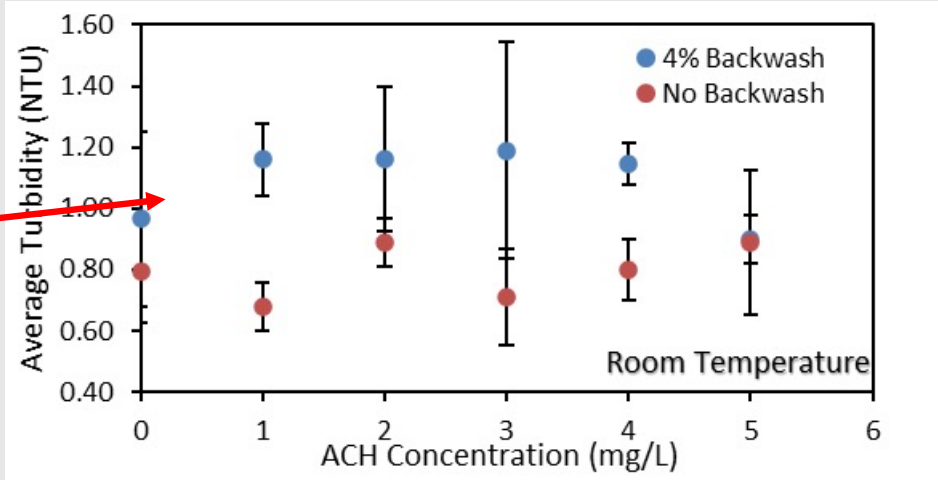
Data Analysis



Polymer Dose (mg/L)	Pass/Fail	Average Cake thickness after 4min (mL)	Average cake thickness after 1 hour
0	Fail	923.3	303.8
1	Fail	730	280
2	Fail	477.5	243
3	Fail	500	265
4	Fail	440	265
5	Pass	336.3	229.4
6	Pass	372.5	257.5
7	Pass	320	290
8	Pass	337.5	282.5
9	Pass	345	305
10	Pass	252.5	238.3
15	Pass	250	275
20	Pass	270	287.5

Flocculation Mechanism



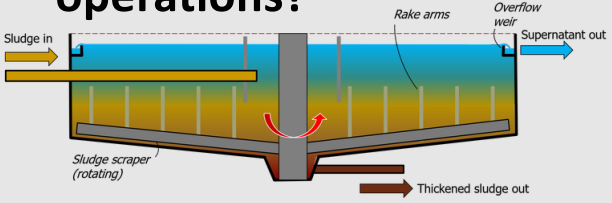


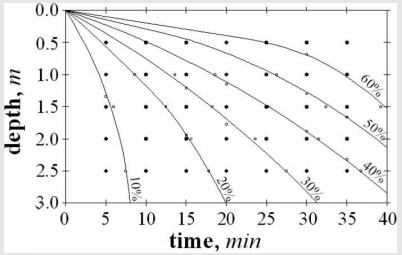
Zone 1- Insufficient coagulant added and destabilization does not occur
Zone 2- Sufficient coagulant added, charge neutralization of colloids and turbidity removal
Zone 3- Too much coagulant added, re-stabilization of colloids
Zone 4- High amount of coagulant added, turbidity removal by sweep flocculation

Research retrieved from Duan, 1997.

Recommendations- Low Initial Turbidity

- **Optimal dose range:** 0-3 mg/L
  - Increase sample size and additional testing to hone in on value
- Is charge reversal causing the increasing turbidity with increasing ACH dose trend?
  - Jar tests with ACH doses 0, 0.5, 1, 3, 5, 10, 15 mg/L. Do we notice zones described in Duan's research
  - Measure electrokinetic properties after rapid mix
- **Other tests:** vary pH, change backwash %
- Use backwash recycle to conserve water resources, but understand that significant difference may exist in treated water turbidity for backwash addition vs. no backwash… **How does this impact other plant unit operations?**





Recommendations – High Initial Turbidity

- **Chemical Dose:** 10mg/L ACH
- Recommend using backwash addition. No evidence of significant effect of backwash addition on treated water turbidity (vs non-backwash samples)
- No testing performed on low coagulant dose (<10 mg/L).
- Effects of changing pH

Zeta Potential as an alternative to jar testing?

- Why?
  - Wide range of conditions
  - Charge reversal, may be overdosing
- How?
  - Apply voltage, particles move toward opposite electrode
  - Velocity proportional to particle charge
- Who?
  - Aurora, CO; Everett, WA
  - 10% less sludge
  - 20% cost savings
  - Prevents overdosing
  - Coagulation dosage automation (less time doing jar tests)