CITY OF WALLA WALLA

HDR

Challenge Testing Slow Sand Filtration with Raw Wastewater and Concentrated Cryptosporidium

Pierre Kwan, PE

01 Introduction

City of Walla Walla Mill Creek WTP

- First constructed in 1920s
  - Sedimentation only
- Last major expansion in 1998
  - LT1ESWTR compliance
  - Added ozonation system after sed basins
- 24 MGD capacity
- Mill Creek surface water
- Groundwater from four wells

LT2ESWTR Compliance

- *Cryptosporidium* removal credit
  - Ozonation credit is temperature dependent
  - Mill Creek water can be very cold (snowmelt fed)
  - <1.0-log credit during winter

- Treatment evaluation
  - Reviewed many processes
  - Selected slow sand filtration
    - Low cost
    - No new chemicals
    - No backwash
    - Simplicity

Pilot Testing

- Filter sand parameters
  - Uniformity coefficients
  - Effective sizes
  - Metal leaching
  - Loading rates
- Roughing filters
- Floating covers
- Pre-ozonation

Concerns

- Cold water
- Low levels of raw water coliform
  - Difficult to show 2-log removal
- Loading rates
  - Lower rates = bigger filters = higher construction costs

LT2 Compliance and Pilot Testing

- Slow sand pilot
  - 2010 – 2014
  - Four winters
  - WSDOH guidelines
- Spiking tests in winters of 2013 and 2014

Cryptosporidium & Coliform Testing

- Winter testing
- Spiked influent
- Inactivated, intact *Crypto* oocysts
  - Nominal 500 oocysts/L
- Primary wastewater effluent
  - Nominal 500 cfu/100 mL coliform

Cryptosporidium & Coliform Testing

- Weekly *Cryptosporidium* sampling and analysis
  - 50 L samples instead of 10 L samples
  - Bio-Vir in California
  - 7-10 calendar day turnaround

- Daily coliform sampling and analysis
  - Did not want to be done at City's labs
  - Walla Walla Regional Testing Services
  - 24-hour turnaround

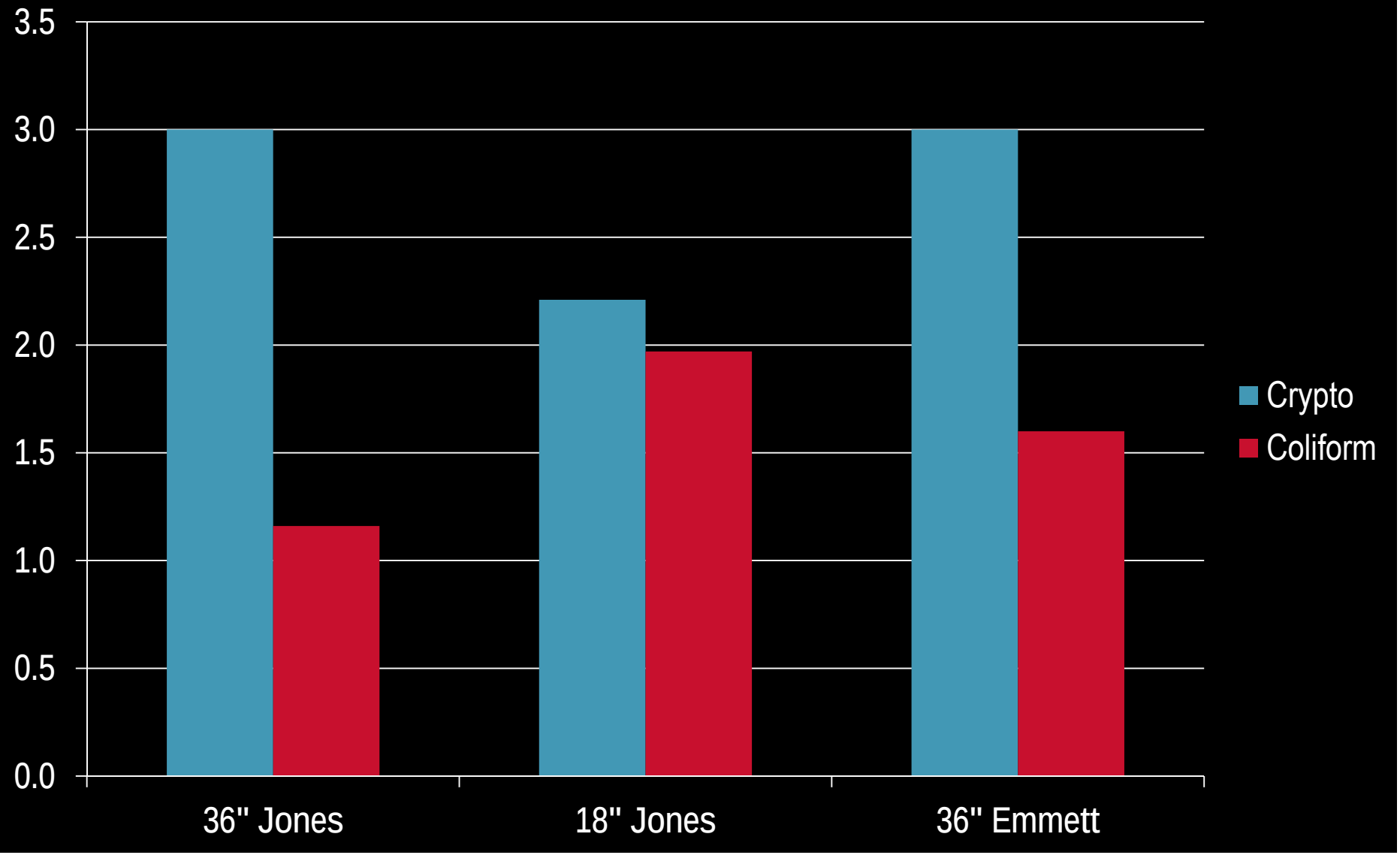
02 2013 Winter Results

Winter 2013 Spiking Test

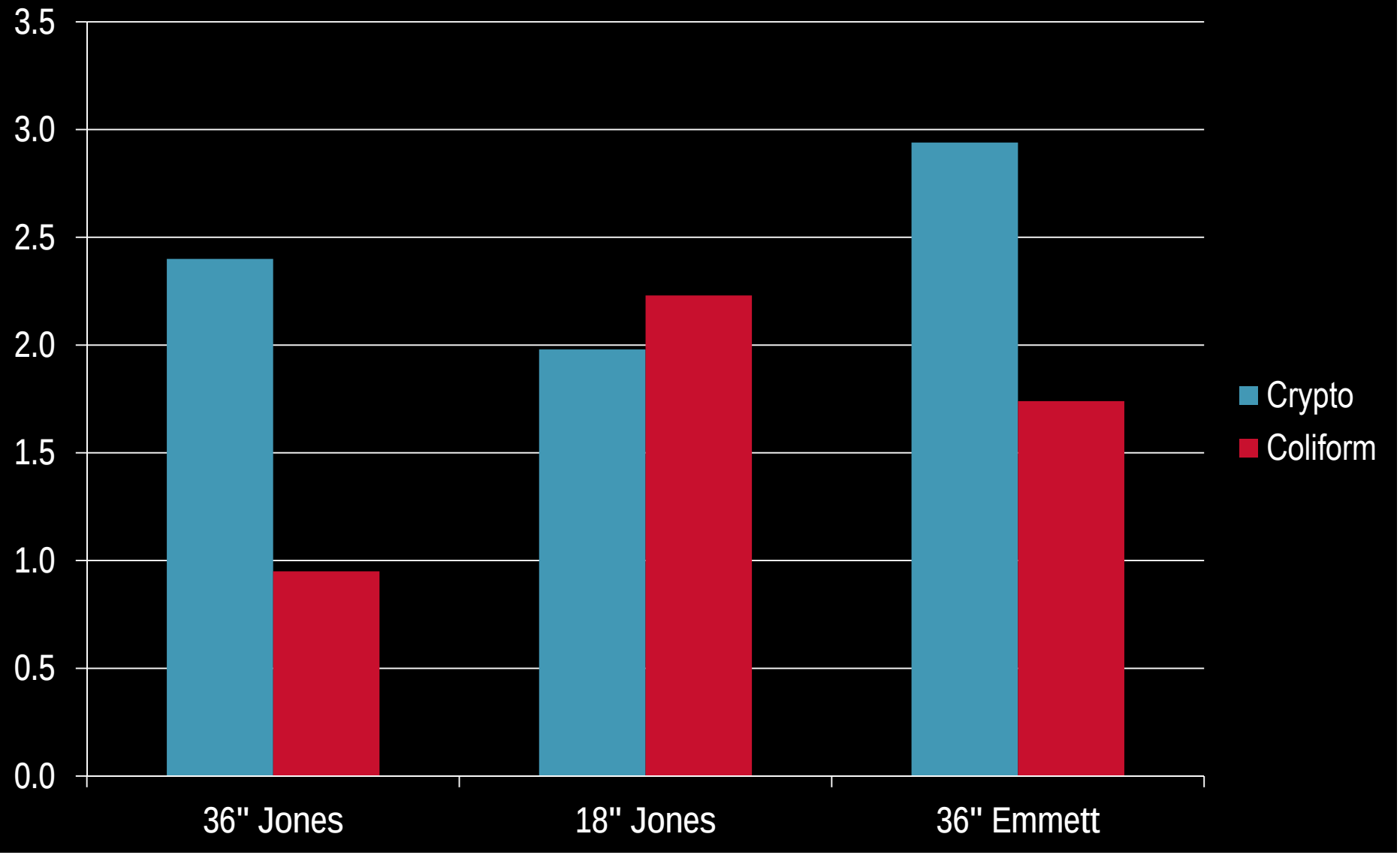
Filter	Sand	Effective Size (mm)	Uniformity Coefficient	Nominal Filter Depth (inches)	Roughing Filter?
2	Jones (Umatilla)	0.27	2.59	36	Yes
3	Jones (Umatilla)	0.27	2.59	18	No
4	Emmett (Boise)	0.17	2.25	36	No

- March 19 – May 7, 2013
- Loading Rate 0.05 gpm/SF, later increased to 0.10 gpm/sf

Pathogen Log Removal – 0.05 gpm/sf



Pathogen Log Removal – 0.10 gpm/sf



2013 Summary

- Coliform removal ≠ *Cryptosporidium* removal
- Coliform is surrogate because of analysis cost and speed
- LT2ESWTR 2.0-log *Cryptosporidium* removal is met at <2.0-log coliform removal
- Under-reporting performance

DOH Response

- Mild winter
- Water temperature wasn't really cold
- 10.1 deg C average

Temperature (deg C)	Rate
≥5.0	0.10 gpm/sf, max
<5.0	0.05 gpm/sf, max
Any	0.02 gpm/sf, min.

I Didn’t Like The Answer

- 0.05 gpm/sf = very big filters
- Still plenty of land but higher construction costs

- Re-Test
- Wait until next January
- Hope that Mother Nature and Old Man Winter cooperates

03 2014 Winter Results

2014 Spiking Test

Filter	Sand	Effective Size (mm)	Uniformity Coefficient	Nominal Filter Depth (inches)	Roughing Filter?
1	Jones	0.17	2.01	44	Yes
2	Jones	0.17	2.01	32	Yes

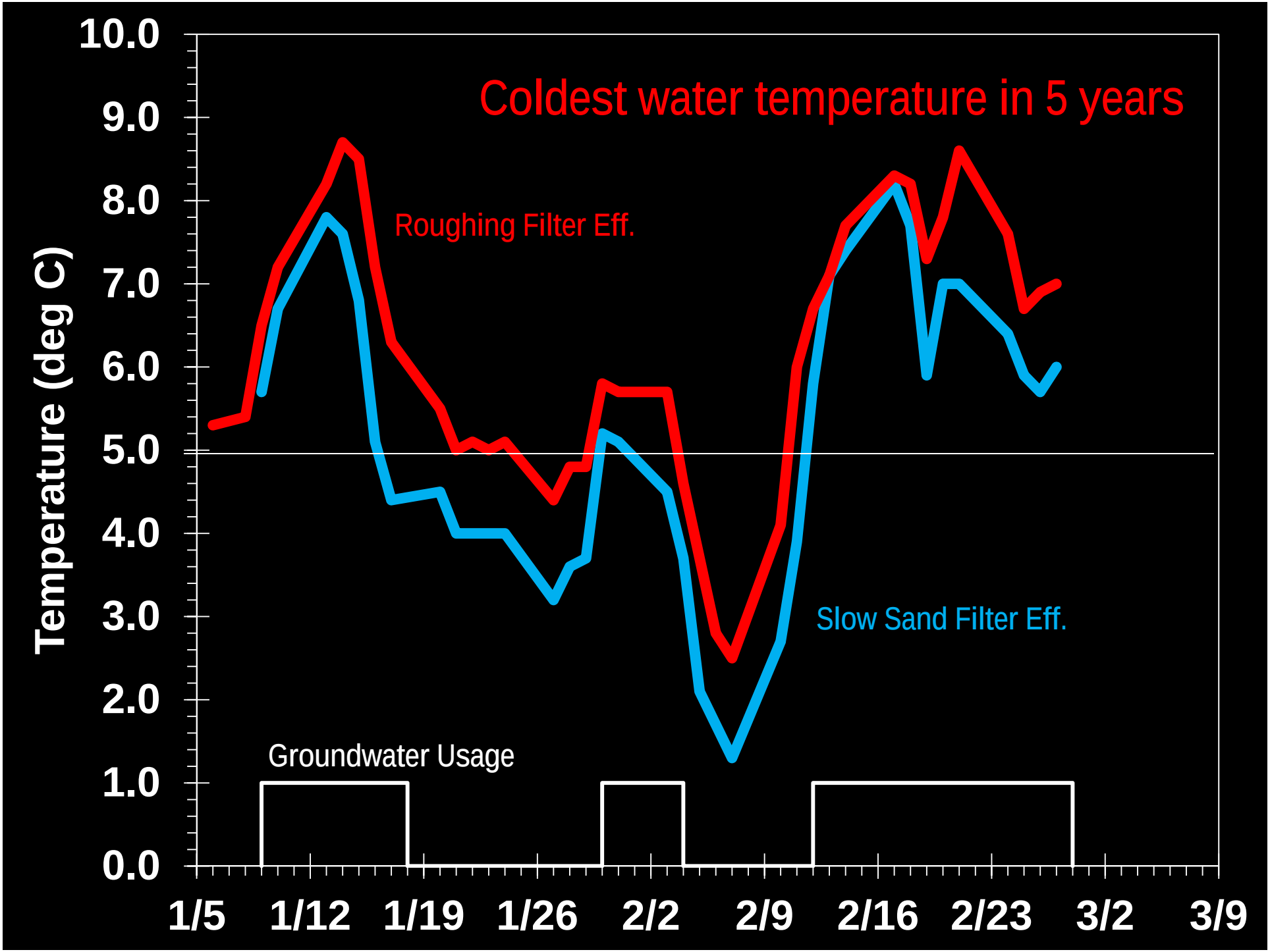
- January 13 – February 27
- Loading Rate at 0.07 gpm/sf, later to 0.1 gpm/sf

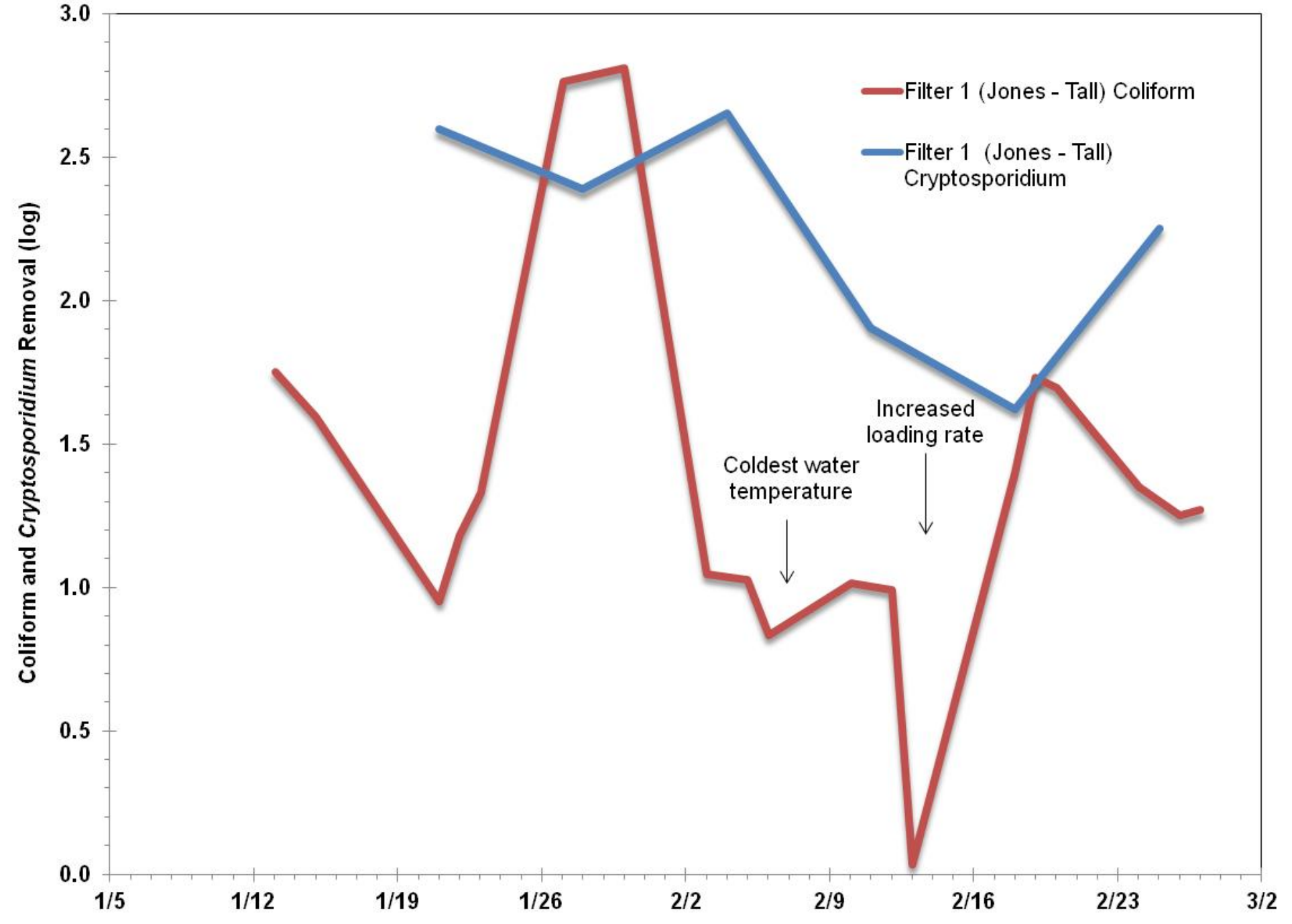
Differences

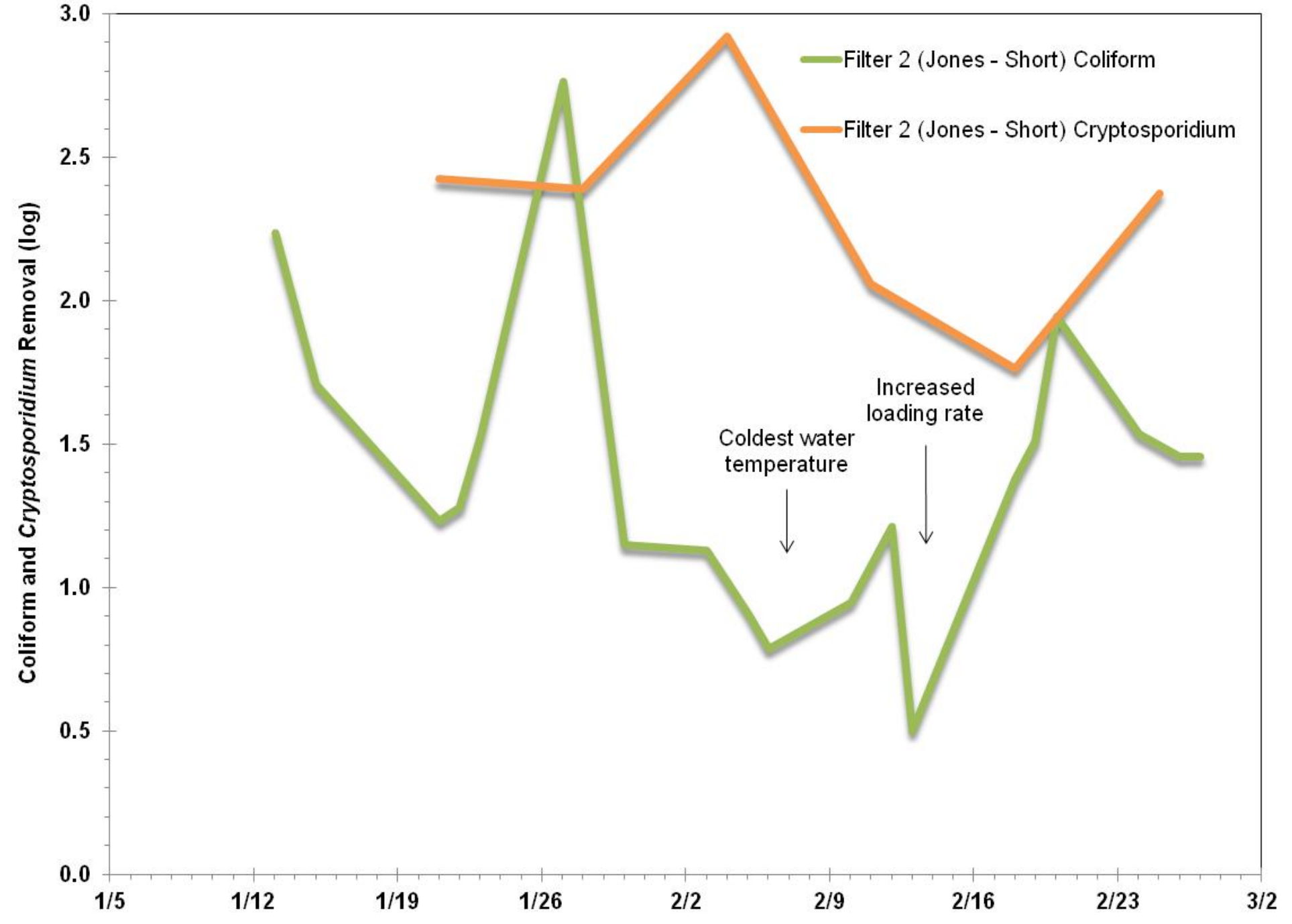
- Jones identified large area of very fine sands at quarry

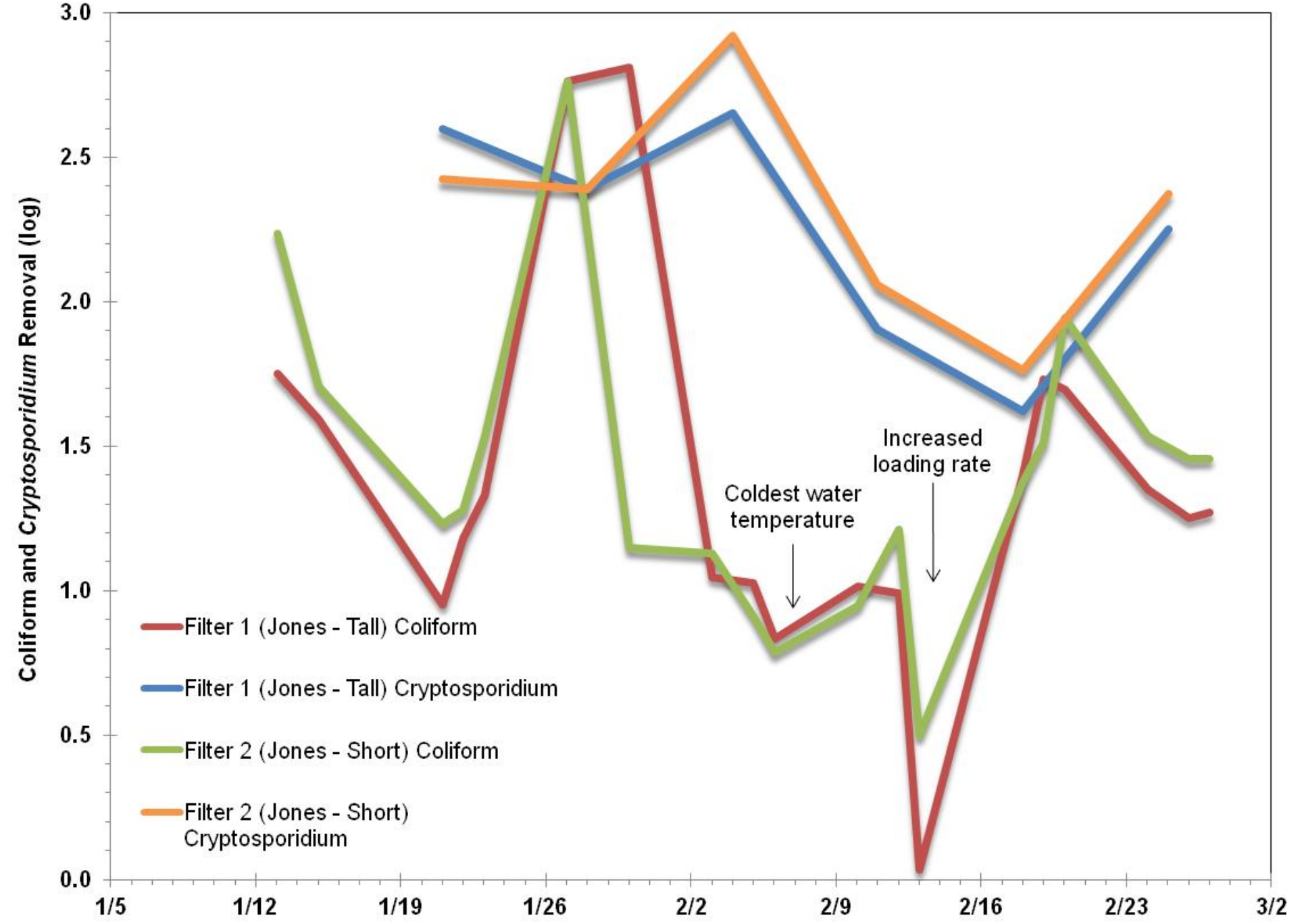
- Sand washed by Jones using their industrial equipment
  - Exact same procedure for full-scale procurement
  - Previous sands washed by City

- Thicker sand filters
  - 44” instead 36”


Coldest water temperature in 5 years
Roughing Filter Eff.
Slow Sand Filter Eff.
Groundwater Usage
Temperature (deg C)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1/5
1/12
1/19
1/26
2/2
2/9
2/16
2/23
3/2
3/9


3.0
2.5
2.0
1.5
1.0
0.5
0.0
Coliform and Cryptosporidium Removal (log)
1/5
1/12
1/19
1/26
2/2
2/9
2/16
2/23
3/2
Filter 1 (Jones - Tall) Coliform
Filter 1 (Jones - Tall) Cryptosporidium
Coldest water temperature
Increased loading rate


Filter 2 (Jones - Short) Coliform
Filter 2 (Jones - Short) Cryptosporidium
Coldest water temperature
Increased loading rate
Coliform and Cryptosporidium Removal (log)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/5
1/12
1/19
1/26
2/2
2/9
2/16
2/23
3/2


3.0
2.5
2.0
1.5
1.0
0.5
0.0
Coliform and Cryptosporidium Removal (log)
1/5
1/12
1/19
1/26
2/2
2/9
2/16
2/23
3/2
Coldest water temperature
Increased loading rate
Filter 1 (Jones - Tall) Coliform
Filter 1 (Jones - Tall) Cryptosporidium
Filter 2 (Jones - Short) Coliform
Filter 2 (Jones - Short) Cryptosporidium

2014 Testing Summary

- Coliform removal ≠ *Cryptosporidium* removal
- No real difference between tall column and short column
- Cold water temperatures
- Problematic testing
  - Ice formation
  - No headloss measurements

DOH Response

- Cold winter…
- Didn't sample at the absolute coldest water temperatures

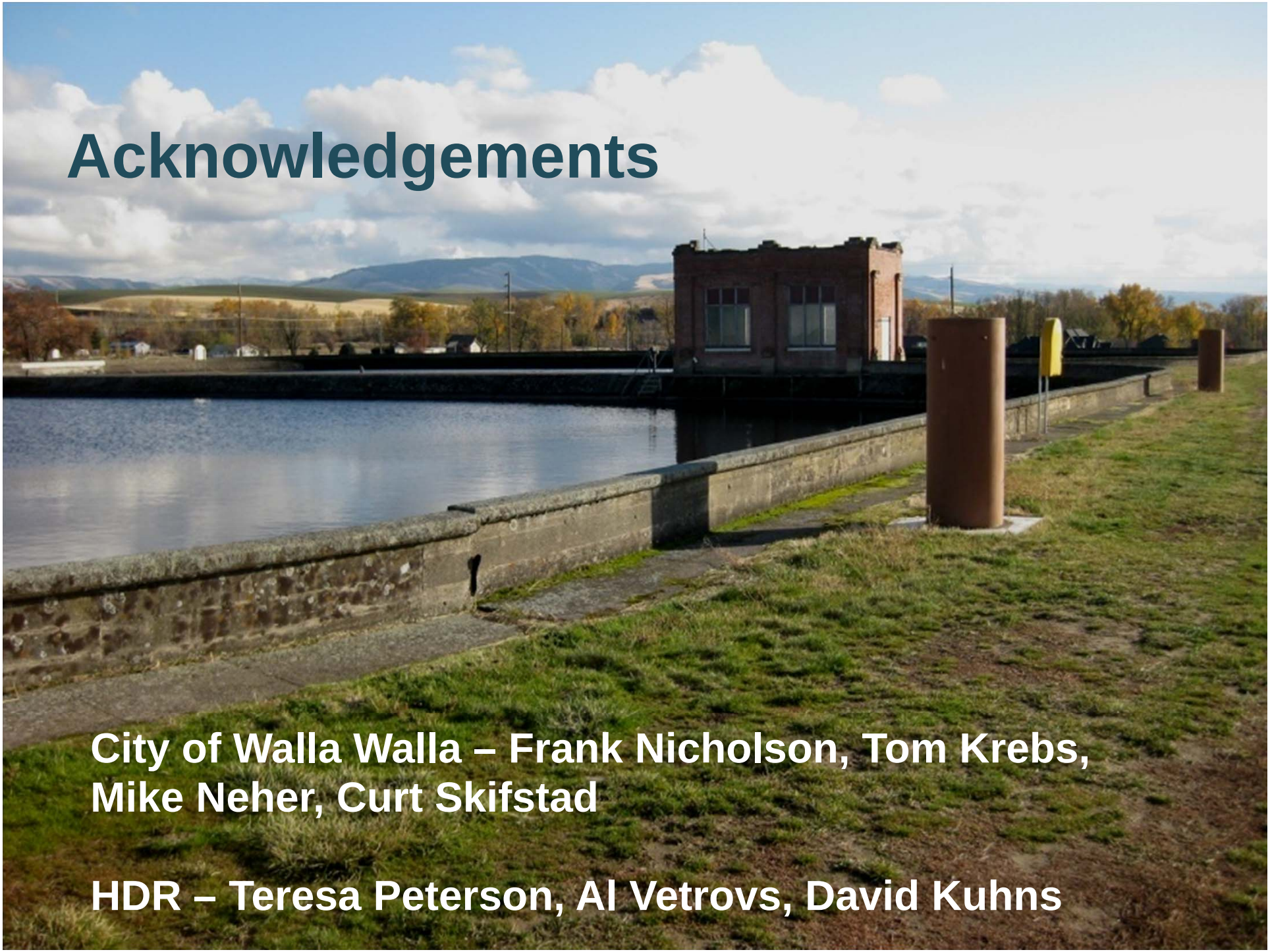
Temperature (deg C)	Rate
≥5.0	0.10 gpm/sf, max
3.0 – 5.0	*0.07 gpm/sf, max*
<3.0	0.05 gpm/sf, max
Any	0.02 gpm/sf, min.

04 Spiking Test Conclusions

Conclusions

- Relying on coliform surrogate under-reports performance
  - >2.0-log coliform removal probably means >2.0-log *Cryptosporidium* removal → LT2 compliance
  - <2.0-log coliform removal can still mean >2.0-log *Cryptosporidium* removal → still achieves LT2 compliance
- Strong water temperature dependency
  - Biologically active filters

Acknowledgements



City of Walla Walla – Frank Nicholson, Tom Krebs, Mike Neher, Curt Skifstad

HDR – Teresa Peterson, Al Vetrovs, David Kuhns

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