# Summary of Graduate Student Research with Madison Water Utility

2002-2018

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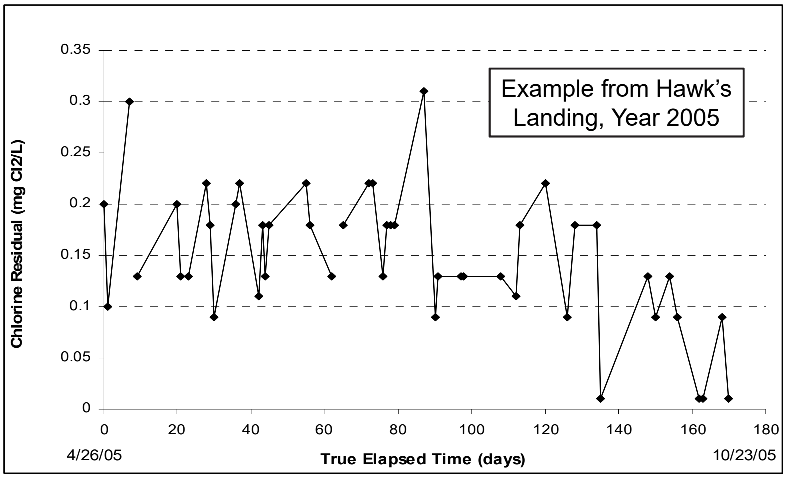
2002-2006

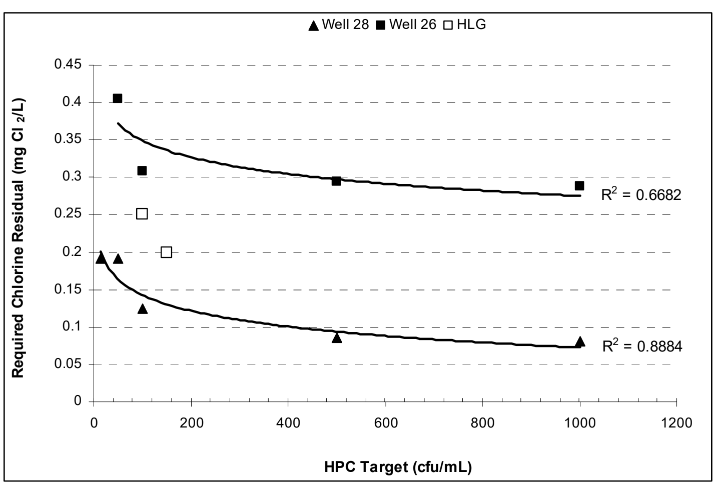
## CHLORINE RESIDUAL STUDIES

# Chlorine Concentrations Before and During Research






# Chlorine Needed to Achieve Microbial Control




Unit Well 3 Area

| Chlorine Range (mg/L) | < 0.10 | ≥ 0.10 |
|---|---|---|
| Mean HPC (cfu/mL) | 797 | 231 |
| % samples HPC > 100 cfu/mL | 37 | 21 |
| % samples HPC > 500 cfu/mL | 16 | 6 |
| % samples HPC > 1000 cfu/mL | 9 | 5 |

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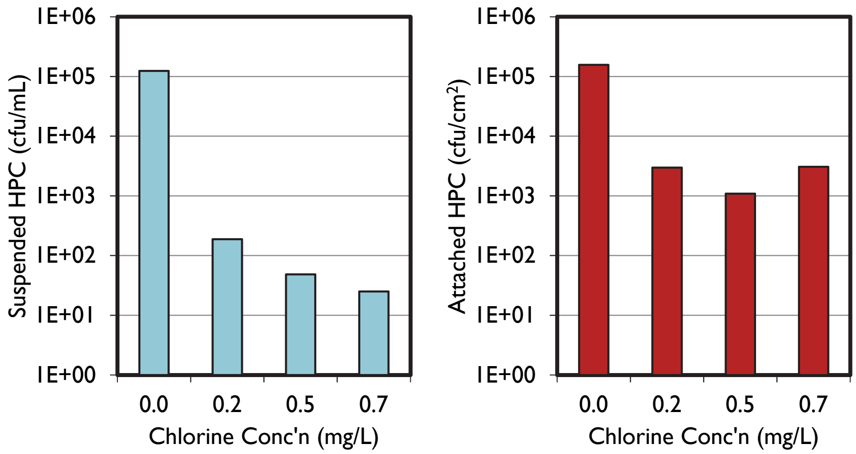
## Pilot-Scale Experiments for Microbial Control






## Influence of Unidirectional Flushing on Microbial Quality in Area Served by Unit Well 10

| | Sample Period | | |
|---|---|---|---|
| | Pre-Flush | 7-day Post-Flush | 30-day Post-Flush |
| Mean HPC (cfu/mL) | 207 | 136 | 177 |
| % samples HPC > 100 cfu/mL | 28% | 20% | 20% |
| % samples HPC > 500 cfu/mL | 12% | 3% | 3% |
| % samples HPC > 1000 cfu/mL | 5% | 2% | 0% |

Unidirectional flushing produced similar results for chlorine residuals

Department of Civil and Environmental Engineering
University of Wisconsin-Madison

## 2007-2012

# UNIDIRECTIONAL FLUSHING STUDIES



# Suspension of Iron & Manganese Solids

Solids captured from flushing run when hydrant was first opened (mostly iron with some manganese)

Solids captured from backwash of pyrolusite filter (mostly iron but with more manganese than photos on left)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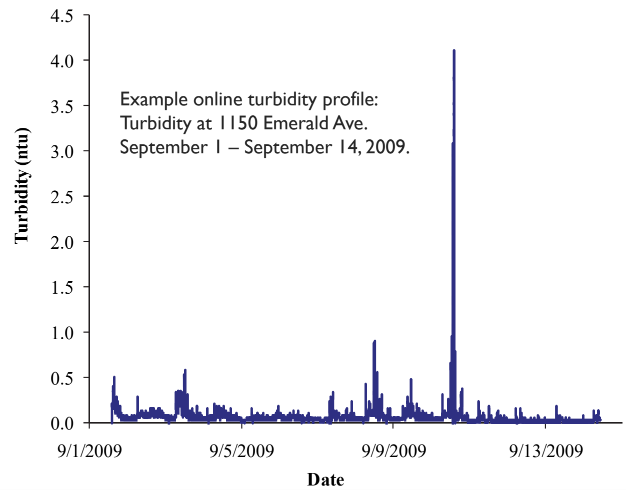
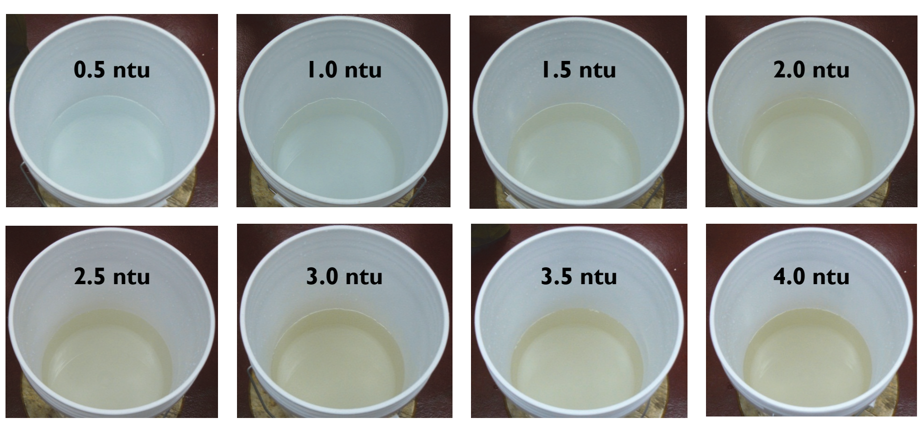
# Online Turbidity Monitoring

- Helped define magnitude of observed turbidity events
- Coupled with customer complaint data:
  - Turbidity spikes higher than 2.5 ntu coincided with significant increase in probability of complaints
- Coupled with operations data:
  - 60% of flushing runs produced spike higher than 2.5 ntu along the main being flushed
  - 40% of main breaks coincided with spike higher than 2.5 ntu at a location within a mile of the break





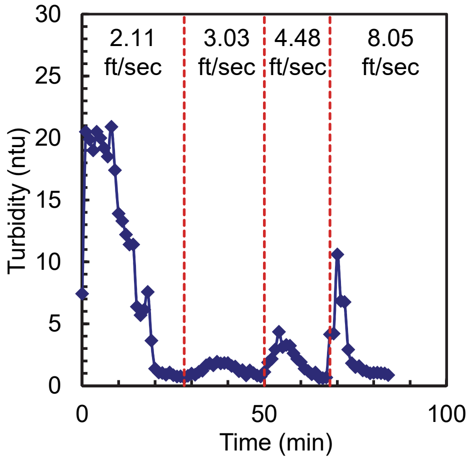

# Iron Appearance in 5 Gallon Buckets

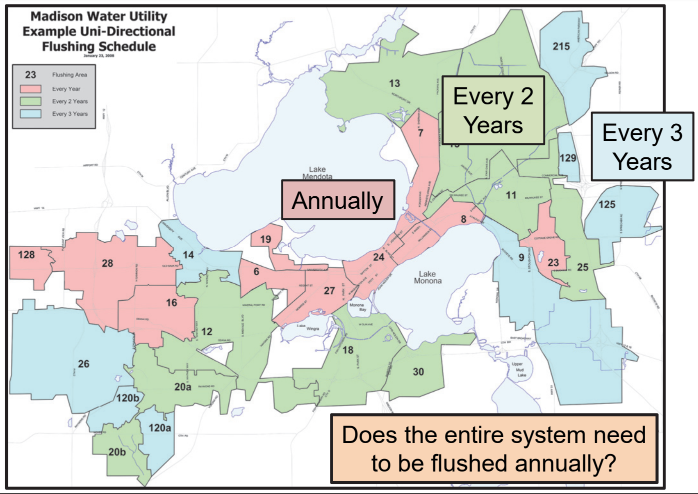



Depth of water in each bucket is 4 inches

# Flushing Operations

## (Can we save water and time?)



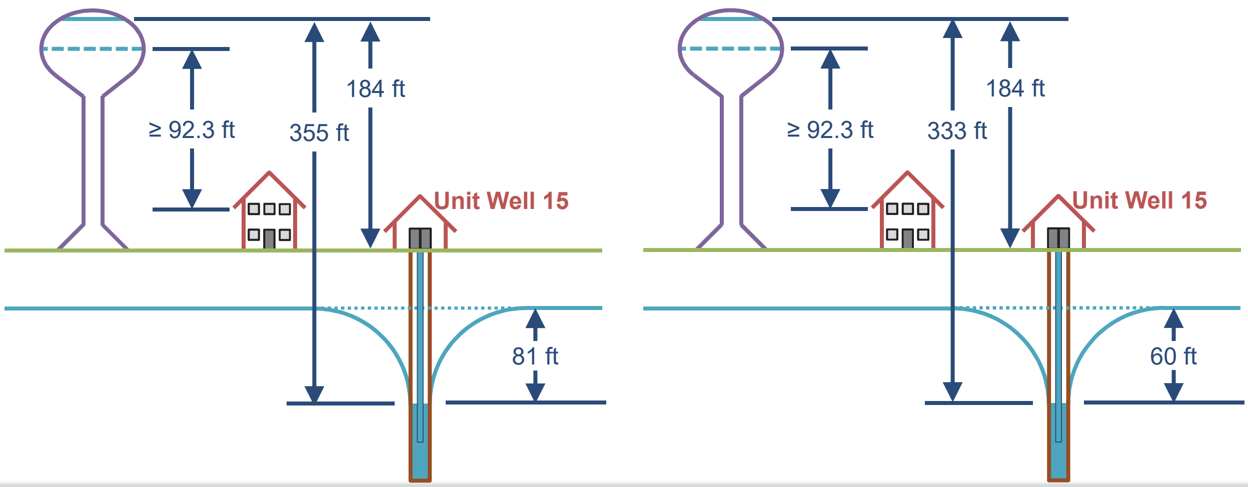

How much water can be pumped into system before flushing needed?
Unit Well 8: 380 MG
Unit Well 9: 291,000 MG



2013-present

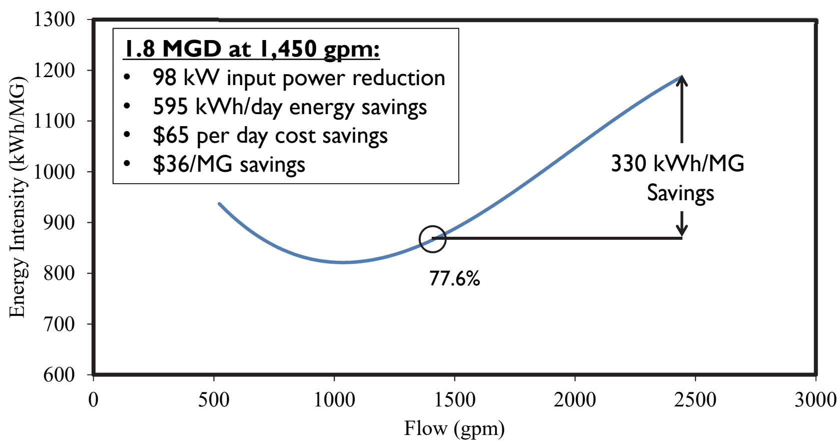
# STUDIES ON REDUCING ENERGY USE AND COST OF ENERGY

# VFD Example: Madison, Wisconsin – Well 15






# Estimated Savings from VFD Installation at Unit Well 30



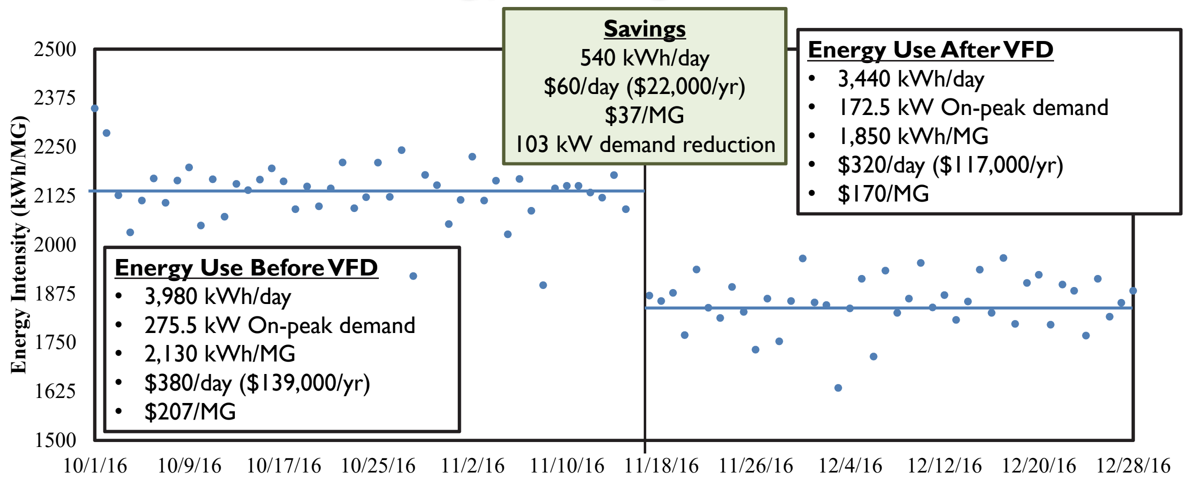

**Operation Before VFD**

- 1.88 MGD production
- Deep well pump
  - 2,410 gpm for 13 hrs/day
- Booster pump
  - 1,300 gpm for 24 hrs/day

**Operation After VFD**

- 1.87 MGD production
- Deep well pump
  - 1,450 gpm for 21.5 hrs/day
- Booster pump
  - 1,280 gpm for 24 hrs/day

# Observed Energy Savings at Unit Well 30






# Savings Over First 6 Months

VFD Operation: December 2016 – June 2017

**Savings compared to December 2015 – June 2016:**

- 277 kWh/MG energy intensity savings
- $25.40/MG savings
- 94,550 kWh saved
- $8,660 saved

**Savings compared to June 2016 – November 2016**

- 288 kWh/MG energy intensity savings
- $26.70/MG savings
- 97,940 kWh saved
- $9,090 saved

Note: this was done on the well with the highest expected savings and other wells will achieve lower savings

# Current Student and Goals

- Adam Luthin
  - Native of Belvidere, Illinois
  - BS Mechanical Engineering, University of Minnesota, 2014
  - Quality Engineer for Andersen Corp in New Jersey, 2014-2017
  - Successfully hiked the Appalachian Trail in 2017
  - Began MS Civil & Environmental Engineering in Fall 2017
- Goal: optimize pumping operations for minimum energy use (or minimum energy costs) on a system-wide basis