# Energy Reduction Analysis at New Prague Wastewater Treatment Facility

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MnTAP

UNIVERSITY OF MINNESOTA

# Minnesota Technical Assistance Program

- Created in 1984
- University of Minnesota
- Staffed by Scientists and Engineers
- Process Specific Assistance
- Confidential and Non-regulatory

# MnTAP Mission

**Strengthening Minnesota businesses by improving efficiency, while saving money through energy, water and waste reduction.**

- **Businesses remain competitive**
- **Improve employee and public health**
- **Protect the environment**

# MnTAP Services

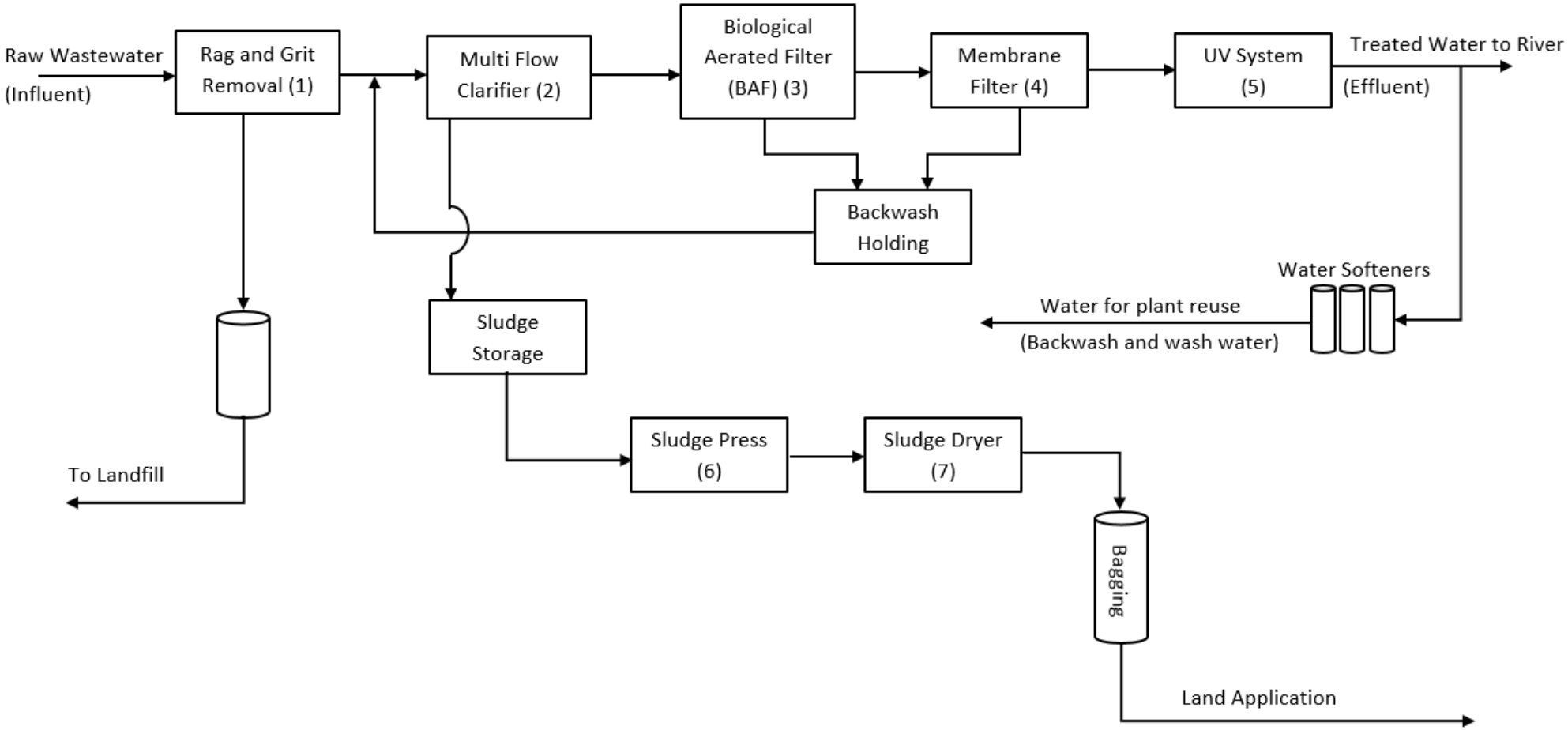
- Technical Assistance
  - Site assessment visits
  - Phone and e-mail requests
  - Intern program
  - Demonstrations/Research
- Minnesota Materials Exchange
- Communications and Outreach

# Company Overview

- Remove contaminants from wastewater
- 7,700 residents
- Regulated by Minnesota Pollution Control Agency
- Class A wastewater facility
- Upgraded in 2010
- Many energy savings ideas implemented, knew of more opportunities but unsure how to proceed


NEW PRAGUE
A Tradition of Progress

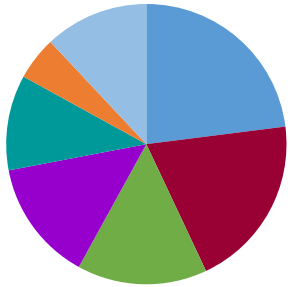
# City of New Prague Wastewater Plant Flow Diagram

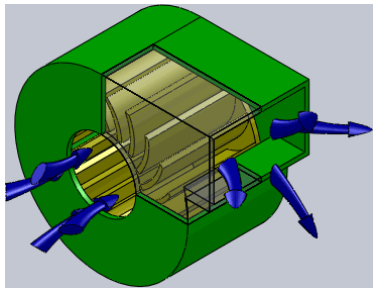


# Incentives to Change

- **Operating budget covered by water and sewage fees**
  - Have exceeded budget
  - Excess covered in city taxes
- **Next MPCA permit may include more requirements**
  - Require additional equipment
  - Minimize energy increase with optimizing
- **SMMPA and MnTAP reached out to us to partner in energy savings**
- **St. Peter, MN had a successful project in 2016**

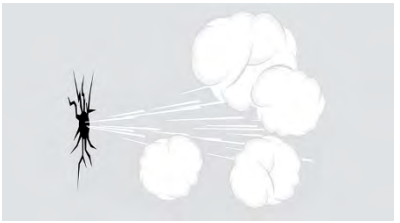
# Project Overview





1. **Characterize energy consumption plant-wide**
   - Identify energy-intensive equipment
   - Observe yearly consumption trends
2. **Quantify scrubber/HVAC reductions**
   - Determine suitable # air changes per hour (ACH)
   - Predict savings for reduced exhaust fan speeds

3. **Assess Biological Aerated Filter (BAF) blower reduction**
   - Dissolved oxygen aeration model



4. **Ultrasonic leak study**
   - Find compressed air leaks
5. **Lighting audit**
   - Determine suitable LED replacements and resulting savings

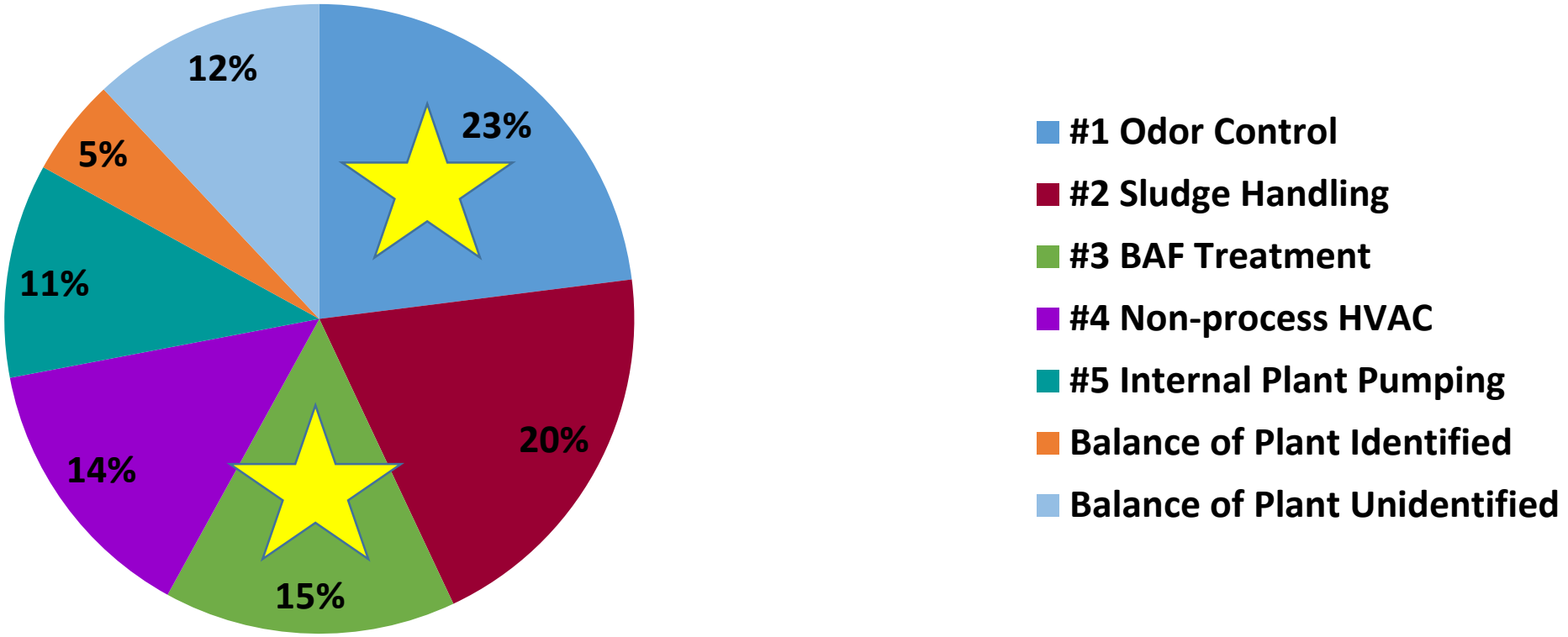
# EPA Energy Assessment Tool

- **Track energy usage for small wastewater facilities**
  - Excel spreadsheet
- **Method:**
  - Collect utility bills from 2014-2017
  - Collect motor specification data
- **Focus on electricity reduction**

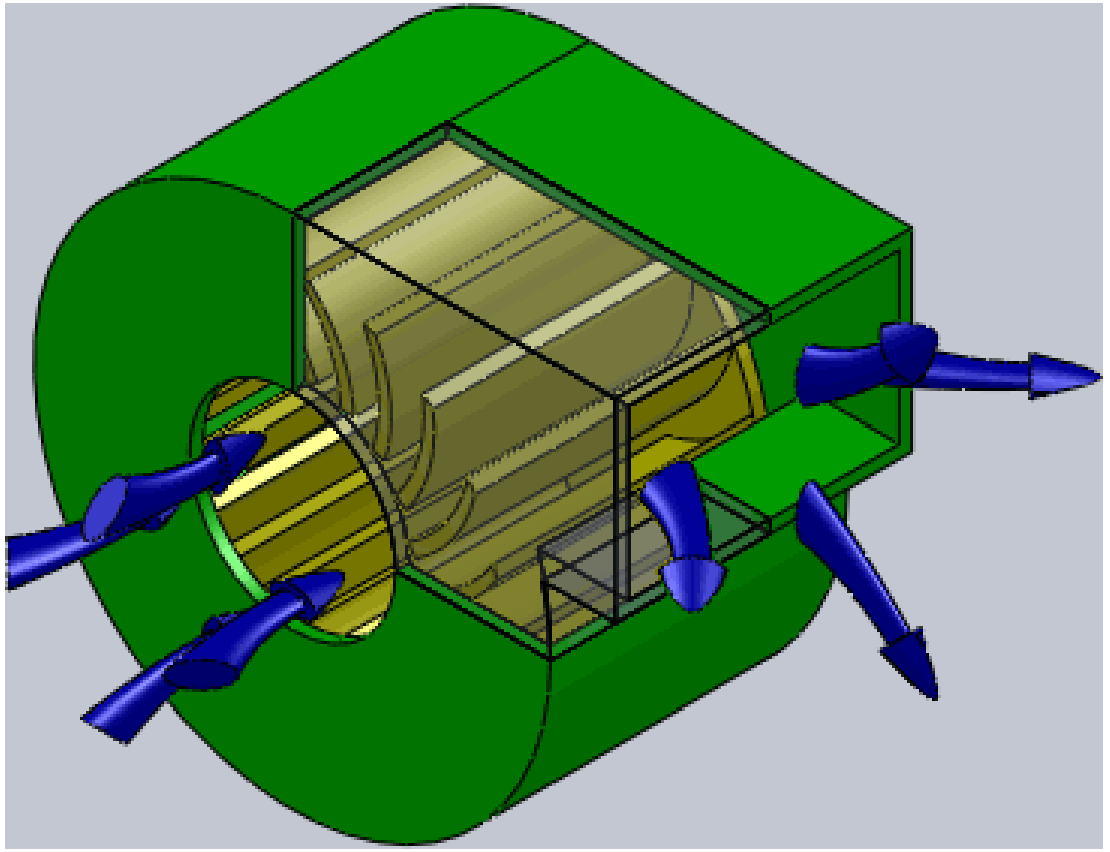
| Utility | Site Utility Use | Site Utility Costs | % of Costs |
|---|---|---|---|
| Electricity | 2,183,200 kWh | $166,663 | 76% |
| Natural Gas | 79,167 CCF | $48,180 | 22% |
| Water & Sewer | 870,000 GAL | $4,100 | 2% |

**$718/MGAL Treated**

# Top Electrical Energy Use Systems



# Quantify scrubber/HVAC reductions



# Odor Scrubbers

| Room | Air changes per hour |
|---|---|
| BAF | 7.2 |
| Pretreatment | 4.8 |
| Biosolids | 4.0 |

# Option 1.1: 7.2 to 4.9 ACH → Implemented

| ACH | Annual Energy Consumption | Annual Operating Cost |
|---|---|---|
| 7.2 | 156,490 kWh<br>536 therms | $11,900<br>$332 |
| 4.9 | 50,3034 kWh<br>383 therms | $3,825<br>$240 |
| Savings | 106,000 kWh<br>150 therms | $8,100 |

# Option 1.2: Switch fans and reduce to 4.9 ACH

Swap biosolids and BAF scrubber fan

- Reduce fan flow rate from 7,600 to 5,283 ACFM

| ACH | Annual Energy Consumption | Annual Operating Cost |
|---|---|---|
| 4.9 | 102,618 kWh | $7,800 |
| Savings | 21,035 kWh | $1,600 |

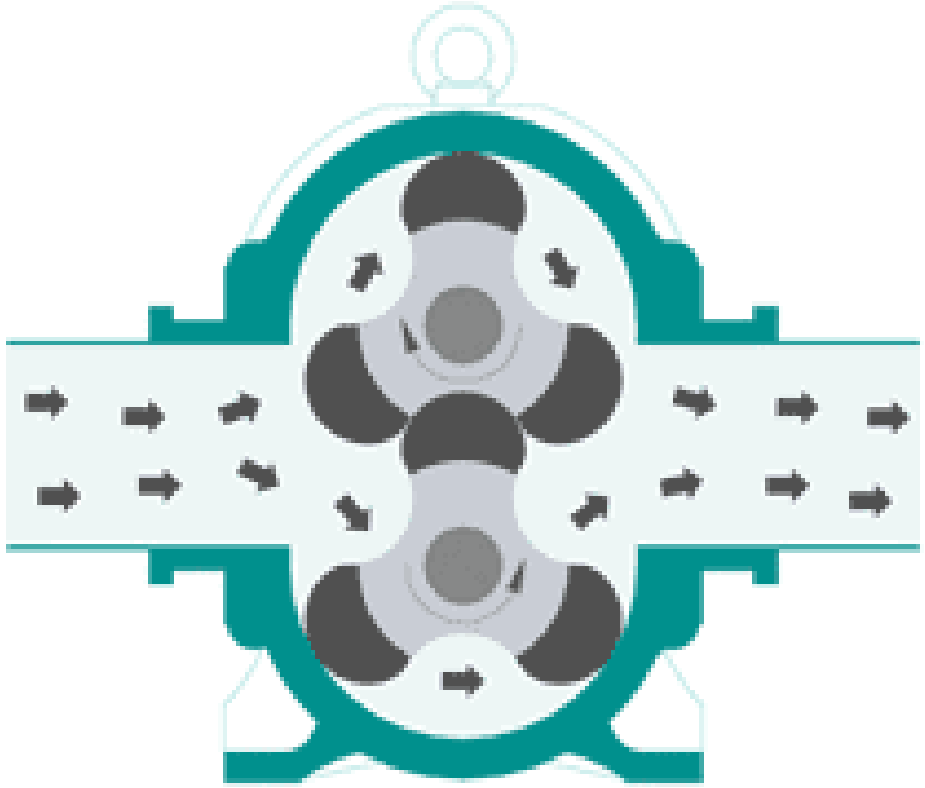
# Option 1.2: Further investigation/not recommended

- **BAF and biosolids odor scrubbers are different models**
  - Undetermined volumetric capacities
- **Undetermined labor costs**
  - Likely a week
- **Requires further investigation by Evoqua engineers**

Biosolids scrubber fan

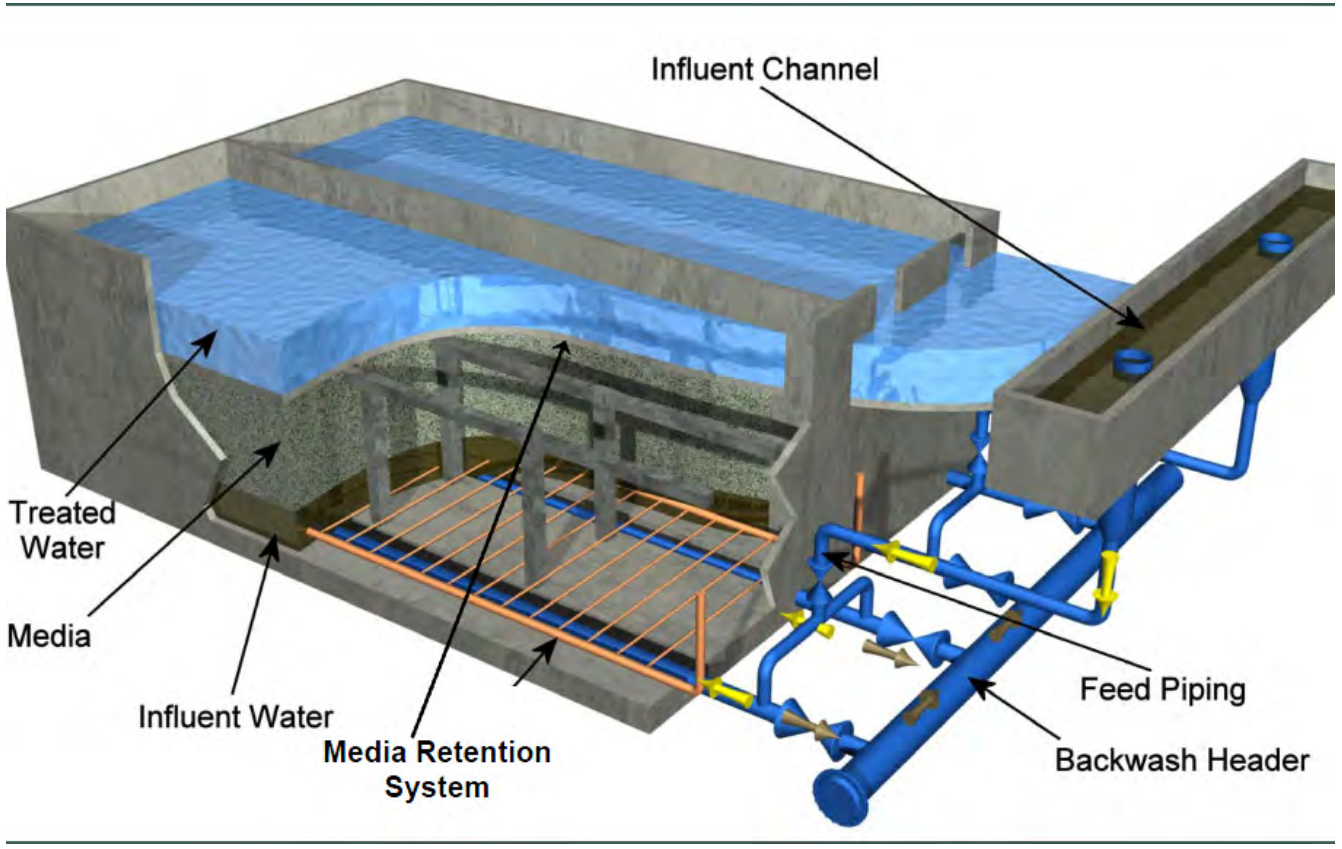
BAF scrubber fan

# Assess BAF Blower Reduction



# Biological Aerated Filter (BAF)

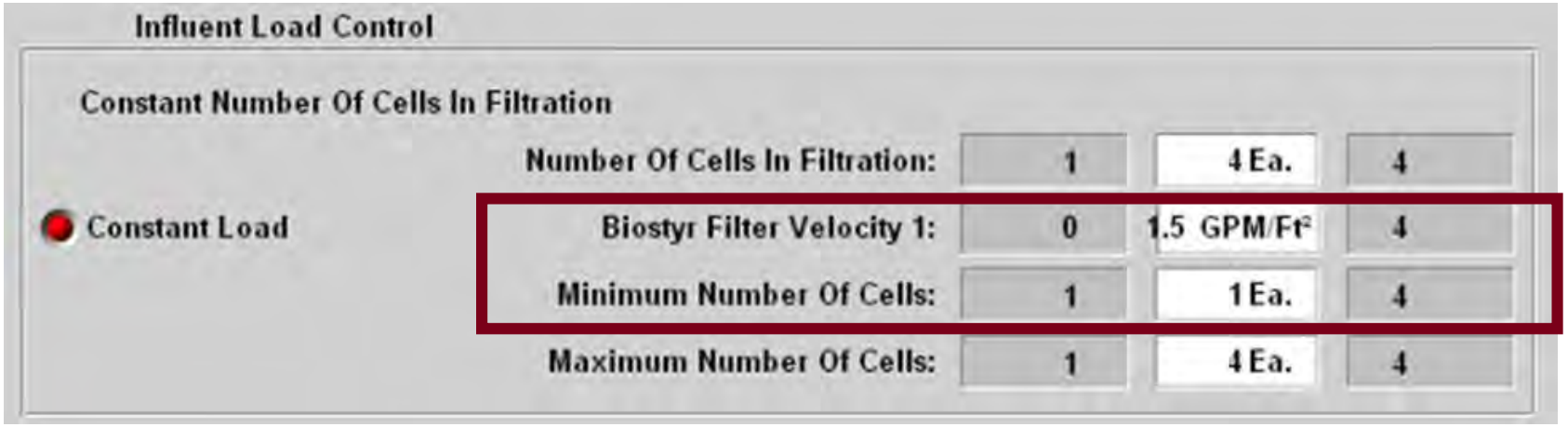
- **Secondary treatment**
  - Removes total suspended solids (TSS), ammonia, and carbonaceous biological oxygen demand
- **Microbes require oxygen**
  - 0.5-2 mg/L dissolved oxygen (DO)




BAF schematic by Veolia/Kruger

# Option 2.1: Adjust controls settings

- **Reduces blower operating hours**
- **Optimal set point at 1.5 gallons per minute per sqft**




New Prague SCADA set point screen shot

# Option 2.1: Adjust SCADA settings→ Implemented

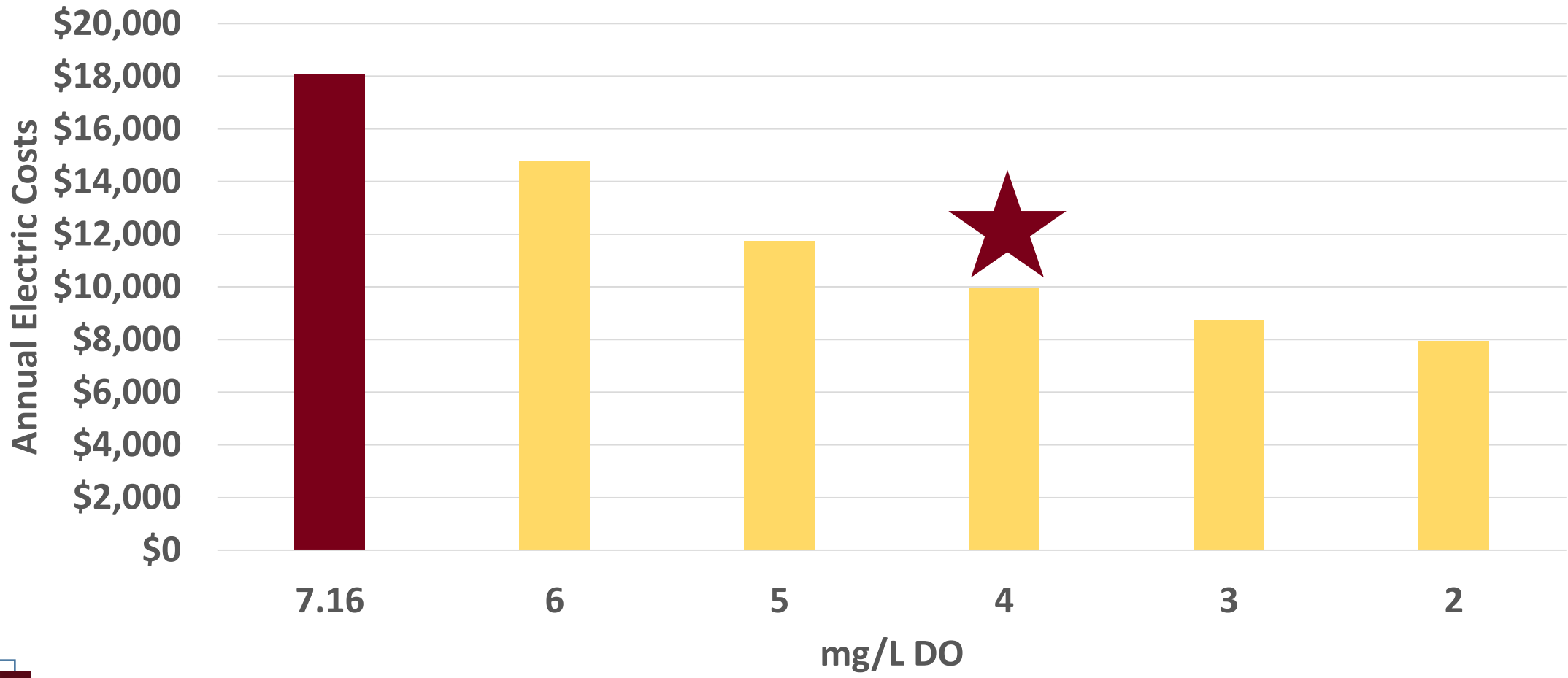
| Condition | Annual Energy Consumption | Annual Operating Cost |
|---|---|---|
| 2016 Baseline (min. 2 cells, TCV=1.0 gpm/sqft) | 385,300 kWh | $29,283 |
| 2017 Baseline (min 1 cell, TCV=1.5 gpm/sqft) | 237,693 kWh | $18,065 |
| Savings | 148,000 kWh | $11,200 |

# Option 2.2: Install VFDs to BAF Blowers → Recommended

- **Reduces power consumption during operation**
- **Eliminate inrush**
  - Reduces electric costs
  - Increase blower lifespan


Allen Bradley PowerFlex 753, the proposed VFD for installation

# Option 2.2: Install VFDs to BAF Blowers



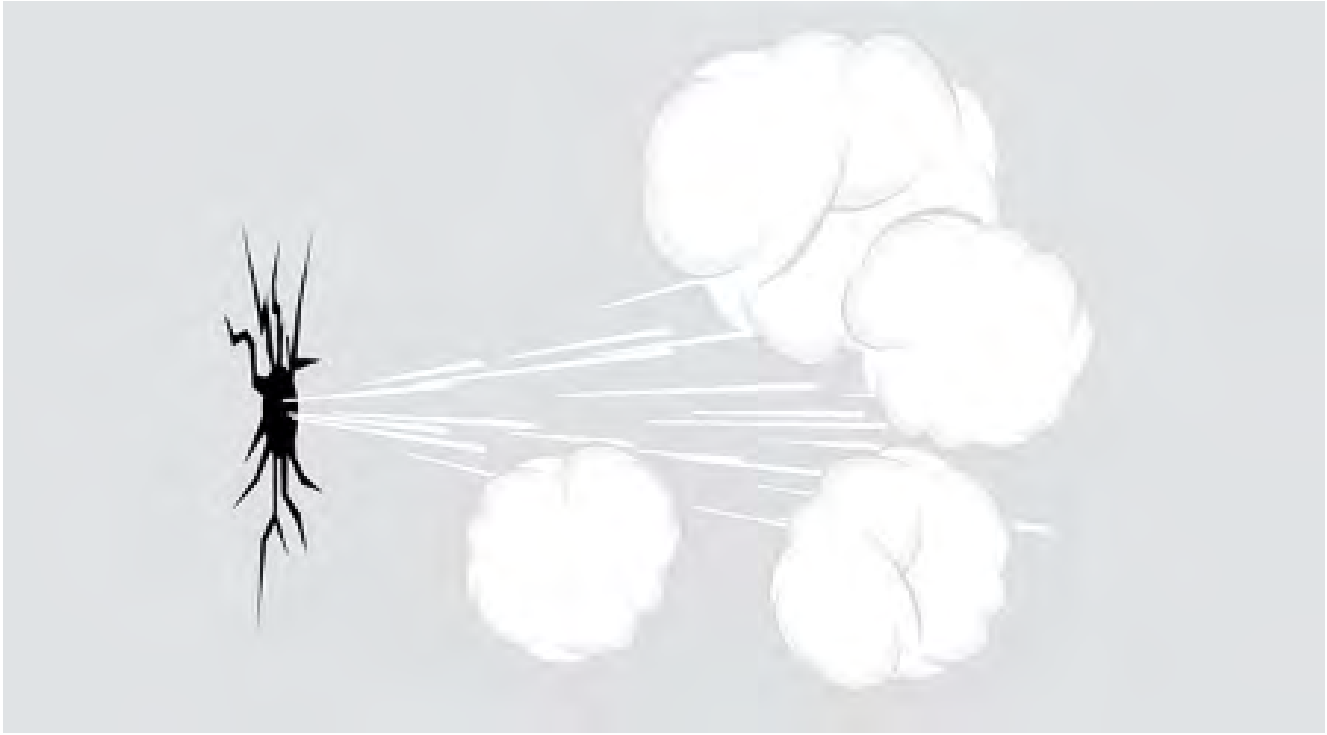
# Option 2.2: Install VFDs to BAF Blowers

| Condition | Annual Energy Consumption | Annual Operating Cost |
|---|---|---|
| 2017 Baseline (min 1 cell, TCV=1.5 gpm/sqft) | 237,693 kWh | $18,100 |
| 4.0 mg/L target DO | 130,560 kWh | $9,922 |
| Savings | 107,000 kWh | $8,142 |

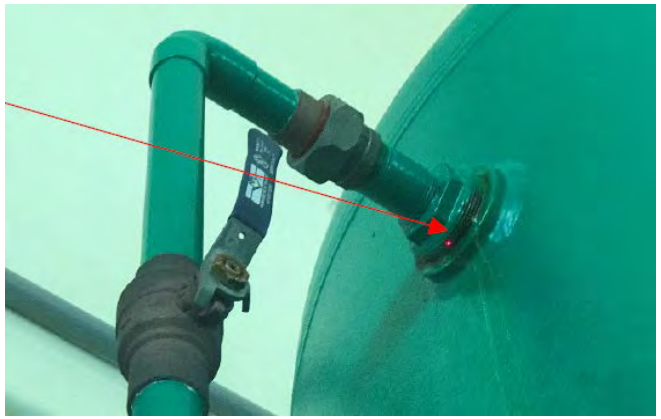
# New Prague Effluent Requirements

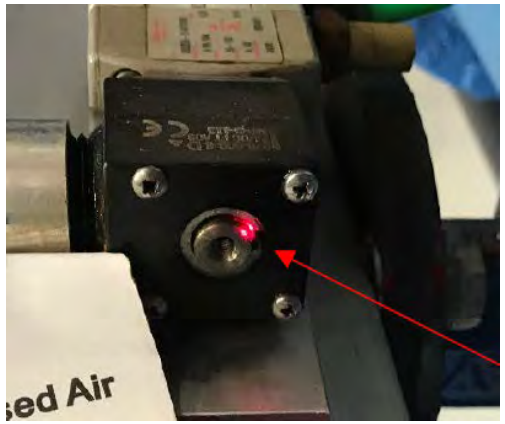
| Parameter | Limit (mg/L) | Limit Type | Effective Period |
|---|---|---|---|
| Dissolved Oxygen (DO) | 7 | Calendar Month Minimum | Jan-Dec |
| Carbonaceous Biological Oxygen Demand (CBOD), 05 Day | 5 | Calendar Month Average | Jan-Dec |
| Nitrogen, Ammonia, Total | 7.7 | Calendar Month Average | Dec-Mar |
| Nitrogen, Ammonia, Total | 1.3 | Calendar Month Average | Apr-May |
| Nitrogen, Ammonia, Total | 1.0 | Calendar Month Average | Jun-Sep |
| Nitrogen, Ammonia, Total | 1.9 | Calendar Month Average | Oct-Nov |
| Total Suspended Solids (TSS) | 30 | Calendar Month Average | Jan-Dec |

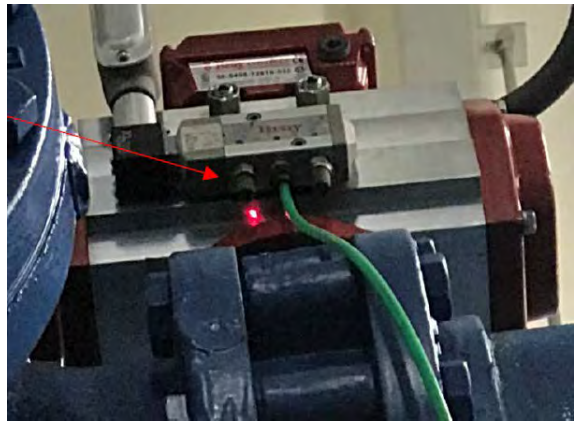
# Ultrasonic Leak Study



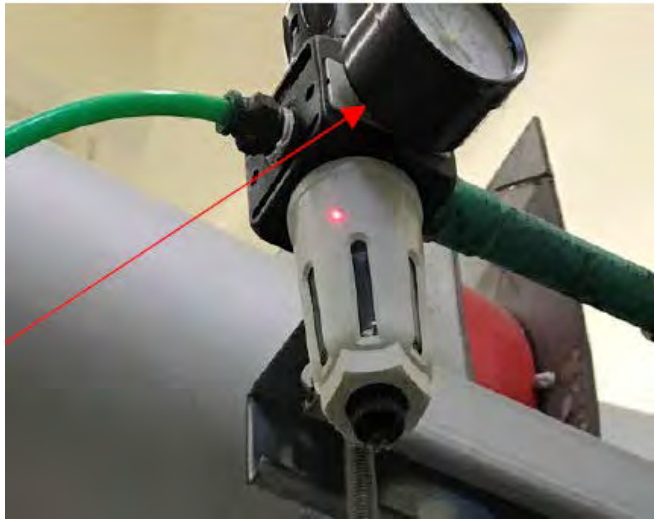
# 8 Leaks Found

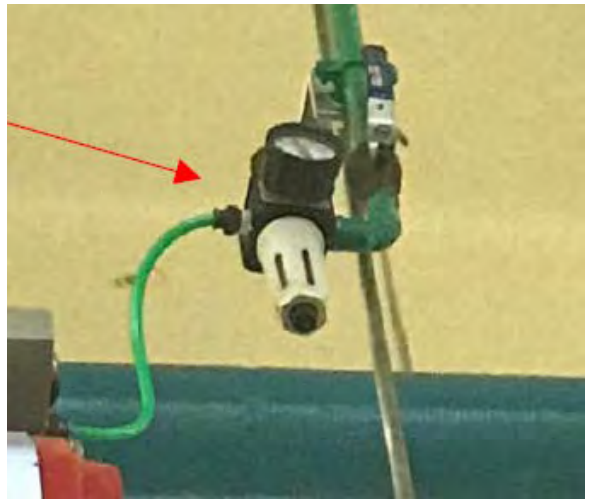












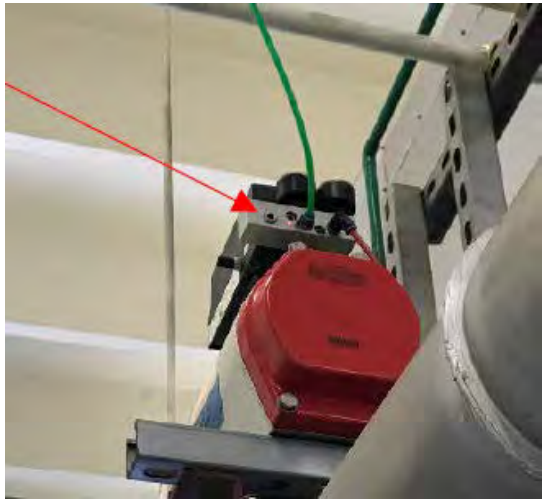
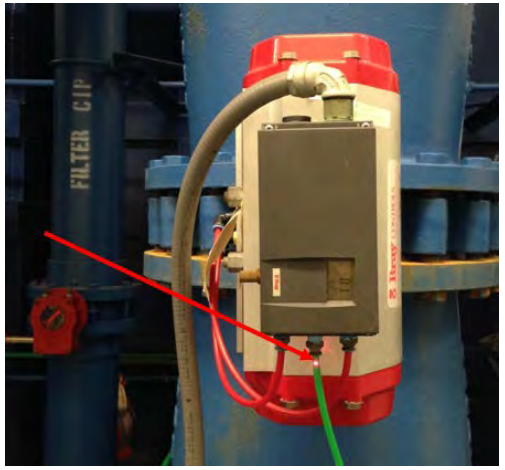
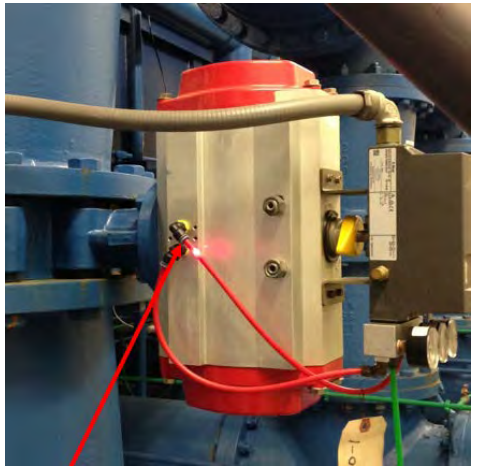
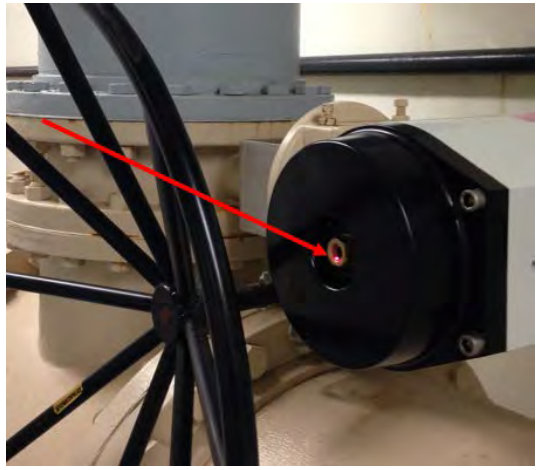


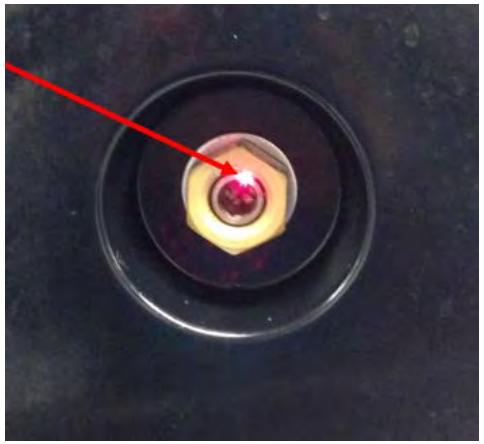
Photo credit: Marcus Hendrickson

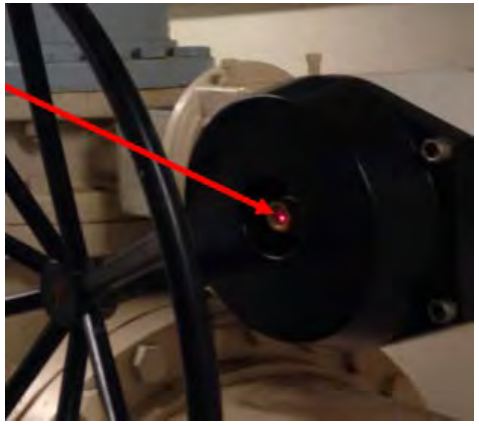
# 6 Additional Leaks Found

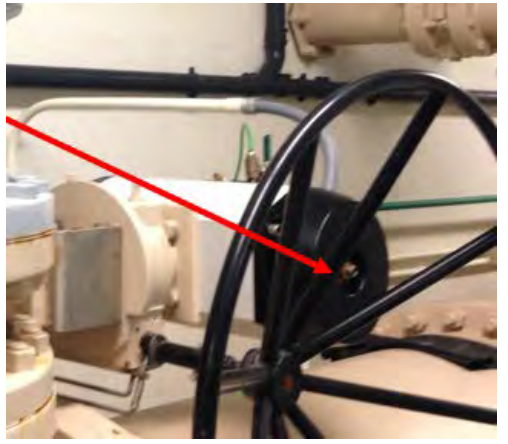










# Option 3.1: Seal compressor leaks

| Condition | Annual Energy Consumption | Annual loss |
|---|---|---|
| 8 leaks | 13,820+ kWh | $1,050+ |

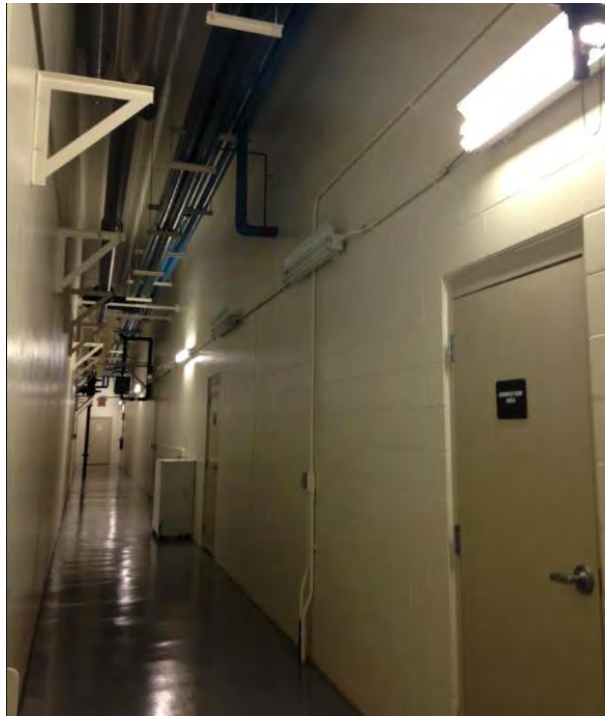
- **Status: In progress**
  - 9 leaks fixed
  - $827+ saved annually
- **Implementation Cost**
  - $220


# Lighting Audit

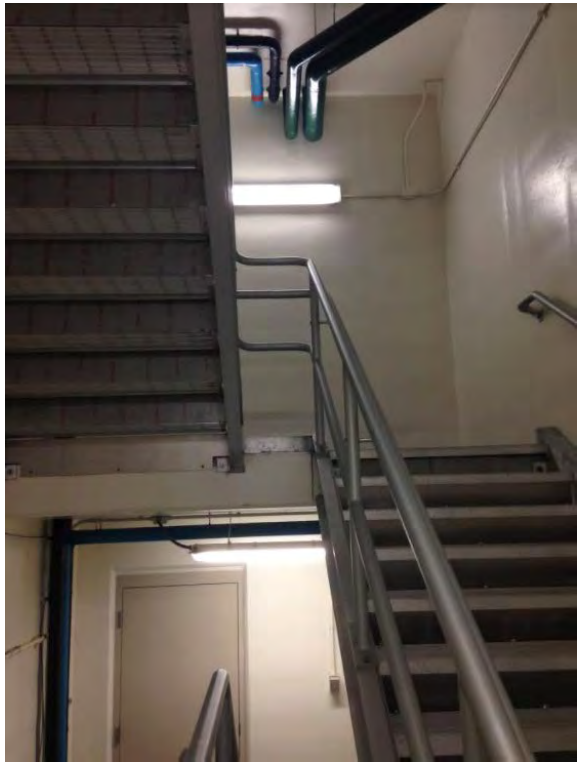
# LED Technology Constantly Improving

- **New Prague WWTF lighting**
  - 112 lights are on 24/7
- **LED refits**
  - Longer lifespan (50,000 hours)
  - Lower power consumption (18 watt)
  - Compatible with ballasts

LED exterior fixture in progress of installation



Main hall lighting



Stairwell lighting

# Option 4.1: Upgrade lights to LED

| Condition | Annual Energy Consumption | Annual Operating Cost |
|---|---|---|
| Fluorescent/MH/HPS | 70,268 kWh | $5,340 |
| LED | 41,654 kWh | $3,165 |
| Savings | 28,613 kWh | $2,175 |

# Potential Savings Summary

| Recommendations | Annual Reduction | Implementation Cost | Annual Savings | Payback Period | Status |
|---|---|---|---|---|---|
| Reduce ACH to 4.9 | 106,000 kWh<br>150 therms | $0 | $8,100 | - | Implemented |
| SCADA change and reduce DO to 4.0 mg/L using VFD | 254,740 kWh | TBD | $19,300 | 4-5 years | Recommended |
| Seal leaks | 13,820 kWh | $220 | $1,050+ | 2.6 months | In Progress |
| Upgrade to LED | 28,600 kWh | TBD | $2,100 | 2-3 years | Recommended |
| **Totals** | **403,000 kWh<br>150 therms** | **TBD** | **$30,550** | **TBD** | - |

# Future recommendations

- **Reduce scrubber and make-up air unit to 4.0**
  - Reduces 125,000 kWh and $9,500
- **Study VFD installation on main lift station pump effects**
  - Eliminate inrush throughout facility
  - More efficient chemical feed
  - Prolong motor life
- **Sludge aeration blower**
  - Possible upgrades and installations
  - Contacted Aeration Industries International

# Special thanks to the following

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# Thank you for listening!

**Questions?**

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