McBaine Water Treatment Plant Improvement Project

Pilot Testing and Alternatives Analysis

October 2021
Presentation Agenda

• Project Overview
• Pilot Purpose and Findings
• Recommended Alternative
• Opportunities for Engagement
Project Overview
McBaine Water Treatment Plant

- Built in **1970**
- Serves **50,300 customers**
- Covers an **89 square-mile service area**
How we deliver clean, safe water

1. Wellfield Supply
2. Aeration
3. Water Softening
4. Filtration & Disinfection
5. Distribution
Purpose
Project Purpose

- Replace aging infrastructure for enhanced reliability
- Improve current treatment performance
- Restore water treatment capacity
- Prepare for potential future treatment enhancements
Disinfection Byproduct Formation

TOC and UV\textsubscript{254} are measures of DBP precursors and serve as treatment targets to reduce DBP formation in the system.
Disinfection By-Product Precursors & Surrogates

Avg pH: 8.5±0.1
Temperature controlled: 25°C

Correlation for all Treatment Processes
\[ y = 75.855x - 13.434 \]
\[ R^2 = 0.8646 \]
Granular Activated Carbon Adsorption
Ozone – Biologically Active Filtration
Pilot Study and Alternatives Analysis
Treatment Processes

- Ozone – Biologically Active Filtration (BAF)
  - Integrate in existing filters or as post-filtration process
- Filter GAC Adsorbers
  - Replace anthracite cap in existing filters with GAC
- GAC Contactors
  - Add GAC Contactors following filtration
  - Add new High Service Pump Station (HSPS) & convert upcoming HSPS to Intermediate Pump Station
Alternatives Analysis Purpose

Evaluate process enhancements to meet long term water quality goals

Bench-Scale Study

Pilot-Scale Study
Bench-Scale Study

- Ozone Dose Optimization
- GAC Media Selection
- DBP Formation Potential Over Time
- Aeration for Distribution System DBP Removal
Ozone Dose Optimization

![Graph showing ozone residual vs. minutes for different ppm concentrations (0.5 ppm, 1.0 ppm, 2.0 ppm, 3.0 ppm, 4.0 ppm). Each concentration has a distinct line and data points indicating the ozone residual over time.](image)
Bromate Formation from Ozonation

![Graph showing Bromate Formation vs Ozone Dose]

- **Bromate Formation (µg/L)**
- **Ozone Dose (mg/L as O₃)**

MCL (Maximum Contaminant Level)
GAC Media Selection for Pilot-Scale Study

Total Trihalomethanes

Haloacetic Acids

Calgon F400 selected as pilot-scale GAC Media.
Air Stripping Testing to Evaluate Potential Effectiveness at Full-Scale

Prior to Aeration

TTHMs formation after aeration makes this alternative ineffective.

After Aeration

After 7-days of SDS
Pilot-Scale Study

1. Ozone/Biofiltration
2. GAC Filter Adsorber
3. GAC Contactor
Haloacetic Acid Formation Potential of All Pilot Effluents
TTHM Formation Potential of Ozone/Biofiltration Effluent

Baseline
O3:TOC 1

Ozone Challenge
Testing
O3:TOC 1.5

Nutrient Enhancement
BAF2
Ammonia 0.2 mg/L
Ortho-P 0.05 mg/L
O3:TOC 1

MCL

Days

Ozone Influent  Ozone Effluent  BAF 1  BAF 2
TTHM Formation Potential of GAC Filter Adsorber Effluent

Increased EBCT
Filter Adsorber 1
EBCT changed from 5 to 20 min

MCL
TOC Removal of GAC Filter Adsorber

Steady state operation of Filter Adsorber 1 indicates biological activity.

Increased EBCT
Filter Adsorber 1 EBCT changed from 5 to 20 min
TTHM Formation Potential of GAC Contactor Effluent

Calculated based on TTHM and UV$_{254}$ correlation
TOC of GAC Contactor Effluent

<table>
<thead>
<tr>
<th>TTHM (µg/L)</th>
<th>TOC (mg/L)</th>
<th>UV$_{254}$ (cm$^{-1}$)</th>
<th>GAC Bed Volumes</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>1.2</td>
<td>0.019</td>
<td>15,000</td>
</tr>
<tr>
<td>64</td>
<td>1.0</td>
<td>0.015</td>
<td>10,000</td>
</tr>
</tbody>
</table>
TOC Removal of GAC Contactor

Target Bed Volumes & Replacement Intervals can be increased with additional TOC removal following upcoming WTP Improvements.
TOC Removal of GAC Filter Adsorber

Steady state operation of Filter Adsorber 1 indicates biological activity.

Increased EBCT
Filter Adsorber 1
EBCT changed from 5 to 20 min.

Steady state operation of Filter Adsorber 1 indicates biological activity.
GAC Contactor Recommended Alternative for Free Chlorine Primary Disinfection

FUTURE POTENTIAL IMPROVEMENT - GAC CONTACTOR*

- Chlorine
- Fluoride
- GAC Contactors
- Wetwell
- High Service Pump Station

*GAC contactor downstream of existing WTP eliminates chloramination needs.
GAC Contactor Recommended Alternative for Free Chlorine Primary Disinfection
Opinion of Probable Cost for GAC Contactor

Total Class 5 Construction Cost Estimate | $46,700,000
---|---
Class 5 Range Low (-15%) | $39,700,000
Class 5 Range High (+25%) | $58,400,000

<table>
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<tr>
<th>Item</th>
<th>Cost ($)</th>
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<tbody>
<tr>
<td>Annual GAC Replacement Cost</td>
<td>$2,670,000 - $4,160,000</td>
</tr>
<tr>
<td>Annual Power Cost</td>
<td>$20,000</td>
</tr>
<tr>
<td>Total Annual Operating Cost</td>
<td>$2,690,000 - $4,180,000</td>
</tr>
<tr>
<td>20 year Present Worth</td>
<td>$98,700,000 - $127,300,000</td>
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Pilot Study and Alternatives Analysis
Conclusions

• GAC contactors recommended for free chlorine disinfection based on current treated water quality
• DBP water quality goals significantly impact life-cycle costs
• Current WTP improvements may improve removal of DBP precursors (TOC)
• Improved TOC removal may reduce GAC life-cycle costs
• Biologically active filtration may be a future option depending on full-scale TOC removal
Project Schedule (Current Improvements)

<table>
<thead>
<tr>
<th>2020</th>
<th>2021</th>
<th>2022</th>
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<tr>
<td>Field surveys &amp; investigations</td>
<td>Water system modeling, testing, data collection &amp; analysis</td>
<td>Permit review</td>
</tr>
<tr>
<td></td>
<td>Design</td>
<td>Bid project to contractors</td>
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<tr>
<td></td>
<td></td>
<td>Award construction contract</td>
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<tr>
<td></td>
<td></td>
<td>Start construction</td>
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Engagement Opportunities

como.gov/utilities/mcbaine-wtp-project/

@ColumbiaWaterLight

WLmail@CoMo.gov

573.874.CITY (2489)

Virtual meeting dates TBD
Thank You
Correlation between TTHM Formation Potential and Total Organic Carbon

Avg pH: 8.5±0.1
Temperature controlled: 25°C

Correlation for all Treatment Processes
\[ y = 75.855x - 13.434 \]
\[ R^2 = 0.8646 \]
Correlation between Total Organic Carbon and UV$_{254}$ Absorbance

Avg pH: 8.5±0.1
Avg Temp: 14.7±0.4 deg C

GAC Effluent Correlation

\[ y = 0.0207x - 0.0059 \]

\[ R^2 = 0.8935 \]
Correlation between TTHM Formation Potential and UV$_{254}$ Absorbance

Avg pH: 8.5±0.1
Temperature controlled: 25 deg C

GAC Effluent Correlation
$y = 4298.1x - 2.2723$
$R^2 = 0.9629$
DBP Speciation

Total Trihalomethanes

Haloacetic Acids
TTHM Formation Potential of Ozone/Biofiltration Effluent
Potential Water Quality Goals with Free Chlorine Primary Disinfection

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