UV-AOP as an Additional Cyanotoxin and Microbial Barrier

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Outline

Celina Background
The Water Source: Grand Lake
Existing Water Treatment Process
Drivers for Selecting UV-AOP
Implementation
Background: Celina, OH

~10,500 People
Water source: Grand Lake
Local economy: Agriculture, light industry, tourism
Cyanotoxins have caused significant economic harm
Water Source: Grand Lake

Originally constructed as a canal feeder
Currently water supply/recreational
Near-ideal cyanobacteria incubator

- Nutrients
- Sunlight/Mixing
- Tenacious strain of *Planktothrix*
Tell Me More About Cyanotoxins!

Cyanotoxins are released into environment by both living and dead cyanobacteria
Extremely stable and decompose slowly
Toxic; can cause illness or death in people, animals
Common types: Microcystins, cylindrospermpopsin, anatoxin-a, Saxitoxin. Other poorly-characterized ones also exist.
Grand Lake Microcystin Levels, 2010-2018

Source: Ohio Environmental Protection Agency
Why Are They Even Using This Source?

Water source must be on same side of continental divide as WWTP discharge.

South of divide: insufficient groundwater quantity and quality.

North of divide: moderate to poor quality, required WW outfall relocation.
Advanced Treatment Drivers

- UV-AOP
- Cyanotoxin Barrier
- Pathogen Protection
- Process Complimentarity
- Future Water Supply Options
- Micro-constituent Protection
UV Advanced Oxidation Process (UV-AOP)

Typical UV Light Dose (mJ/cm^2)

- UV-AOP
- UV

Oxidizing Potential (eV)

- Hydroxyl Radical
- Ozone
- Hydrogen Peroxide
- Permanganate
- Free Chlorine
- Chlorine Dioxide
Key Challenges – Space and Time!

Space allotted in previous design and hydraulic profile
Accelerated installation timeframe
City to self-install equipment
UV AOP Design Alternatives

• Option 1
  • 0.5-log 1,4-Dioxane Destruction and 0.5-log NDMA Destruction (>2 log MC-LR)
  • Design Flow = 3.0 MGD
    • 24” Reactors

• Option 2
  • 4-log Virus Inactivation
  • 0.5-log Destruction of MIB / 1.0-log Destruction of MC-LR
  • Design Flow = 2.0 MGD
    • 12” Reactors
Design Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>2 trains of 2 reactors in series each (4 reactors) in operation</td>
<td></td>
</tr>
<tr>
<td>Maximum Total Flow Rate Per Train (MGD)</td>
<td>1.5</td>
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<tr>
<td>Design Total Flow Rate Per Train (MGD)</td>
<td>1.0</td>
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<tr>
<td>Maximum Allowable Headloss per Train (inches w.c.)</td>
<td>3</td>
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<tr>
<td>Virus Inactivation</td>
<td>4-log</td>
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<tr>
<td>Degradation of MIB / Degradation of MC-LR</td>
<td>0.5-log / 1.0-log</td>
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<tr>
<td>Maximum Hydrogen Peroxide Dose (mg/L)</td>
<td>12.0</td>
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</table>

<table>
<thead>
<tr>
<th>Water Quality Parameter</th>
<th>Value</th>
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<tr>
<td>Influent Water Temperature (°C)</td>
<td>2 - 28</td>
</tr>
<tr>
<td>UV Transmittance (UVT) at 254 nm (%), Range</td>
<td>97.0 – 99.3</td>
</tr>
<tr>
<td>Total Hardness (mg/L as CaCO₃)</td>
<td>94.3 – 190.3</td>
</tr>
<tr>
<td>pH (standard units) Range (Avg)</td>
<td>8.91 – 10.0 (9.35)</td>
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<tr>
<td>Total Organic Carbon (mg/L)</td>
<td>1.30 – 4.35 (2.06)</td>
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<tr>
<td>Alkalinity (mg/L as CaCO₃)</td>
<td>50.1 – 88.1</td>
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Bid and Accelerated Schedule

Engaged vendors early during system design
Vendors sized systems based on design criteria
Bids evaluated based on life cycle cost
City acted as the prime contractor
OEPA permitting – focused on equipment approval

<table>
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<tr>
<th>Schedule Item</th>
<th>Days from Award</th>
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<tr>
<td>Notice of Award</td>
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<tr>
<td>UV-AOP Equipment Delivery</td>
<td>70</td>
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<tr>
<td>Other equipment, panels, programming</td>
<td>84</td>
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</tbody>
</table>

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Installation
Moral of the Story

1. UV-AOP complements the existing treatment process
2. Allows greater flexibility for future water supply changes
3. Procurement approach and self-install saved time and cost
4. UV is a good option for smaller systems too!