Making the Best of What You’ve Got

Optimizing Military Water Treatment Plant Processes for Cryptosporidium Removal & Regulatory Compliance

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Making the Best of What You’ve Got. Optimizing Military Water Treatment Plant Processes for Cryptosporidium Removal & Regulatory Compliance

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Presented at the NDIA Environment, Energy Security & Sustainability (E2S2) Symposium & Exhibition held 14-17 June 2010 in Denver, CO.
PURPOSE: Explain how optimizing an Army water system can meet multiple regulatory and treatment objectives.

1. Background
2. Case study
3. Conclusions
4. Recommendations
Regulatory Background

• Long Term 2 Enhanced Surface Water Treatment Rule
  – LT2ESWTR
  – Affects relatively small number of military water systems
    • Army ~ 20 water systems*
  – But, affects large population
    • Army ~ 0.3 million persons served
  – Purpose: Reduce acute health risks associated with microbial pathogens
    • Specifically Cryptosporidium

* Includes privatized water systems
Water System Background

River

Cl₂

Alum
Na₂Al₂O₄
Powdered Carbon

Rapid Mix

Polymer

Flocculation

Sedimentation

Filtration

Lime

Disinfection

Distribution
Case Study-Challenges

• Additional treatment required for LT2ESWTR
  – Provide additional 1-log *Cryptosporidium* treatment

• Cold water treatment challenges
  – Resulting scrutiny from state regulatory agency

![Average Percent Turbidity Removal Through Sedimentation](chart.png)

*Average Percent Turbidity Removal Through Sedimentation Jan 06 - Jan 10*
Case Study-Goals

- Identify options to meet both challenges
  - Single
    - Advanced filtration ($$$-$$$$)
    - Advanced disinfection ($$-$$$$)
    - Optimized filtration performance ($-$)
  - Multiple
    - Presedimentation + 1 more ($$$-$$$$)
    - Watershed protection + 1 more ($-$)
- Ensure simultaneous compliance
  - Lead and Copper Rule
  - Stage 2 Disinfectants and Disinfection Byproducts Rule
Optimized Filtration – CFE Criteria

Turbidity (NTU)

< or = 0.15 NTU in 95th %-ile of monthly measurements

CFE 95th Percentile

CFE Criteria
Optimized Filtration – IFE Criteria

Monthly samples > 0.3 NTU in two consecutive measurements

<table>
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<th>Jan 08</th>
<th>Jul 08</th>
<th>Jan 09</th>
<th>Jul 09</th>
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<td>Dec 08</td>
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Optimized Performance - Flocculation

Basin 1 Mixing Intensity (Gxt) = 9.8x10⁴
Basin 2 Mixing Intensity (Gxt) = 18x10⁴
Optimized Performance - Coagulation

• Evaluate alternative coagulants
  – Polyaluminum Chloride (PACl)
  – Ferric Sulfate (FeSO$_4$)
  – Ferric Chloride (FeCl$_3$)

• Benefits
  – Cold water effective
  – Regional experience
  – Reduced chemical usage
Alternative Coagulant Performance

Cold Water Turbidity Removal Performance (1-13 °C)

Average Percent Turbidity Removal (%)

- Current Treatment: 0.19 mM Al, 75%
- PACI: 0.083 mM Al, 95%
- FeSO4: 0.12 mM Fe, 77%
- FeCl3: 0.13 mM Fe, 73%

Average Settled Water Turbidity (NTU)

- Current Treatment: 0.19 mM Al, 0.25 NTU
- PACI: 0.083 mM Al, 1.42 NTU
- FeSO4: 0.12 mM Fe, 0.93 NTU
- FeCl3: 0.13 mM Fe, 1.1 NTU
Alternative Coagulant Performance

Seasonal Turbidity Removal Performance

Average Settled Water Turbidity (NTU)

Average Percent Turbidity Removal (%)

Current Treatment
0.19 mM Al
0.19 mM Al
0.083 mM Al
0.12 mM Fe
0.13 mM Fe

57% 97% 88% 93%
1.88 0.43 0.30
Alternative Coagulant Performance

Low and High pH Range Turbidity Removal Performance

![Bar graph showing turbidity removal performance at different pH ranges for various coagulants.]

- **Current**
- **PACl**
- **FeSO4**
- **FeCl3**

Raw pH range: 6.8 – 9.1
Simultaneous Compliance

• Stage 2 Disinfectants & Disinfection Byproducts Rule
  – PACI could increase disinfection byproduct formation
    • Removes less organic matter
  – May require acid addition
    • Carbon dioxide

• Lead and Copper Rule
  – May increase corrosion
    • Orthophosphate addition
## Costs - Annual Chemical Usage

<table>
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<tr>
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<th>Current Treatment</th>
<th>PACI</th>
<th>FeCl₃</th>
<th>FeSO₄</th>
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<tr>
<td>Coagulant ($/yr)</td>
<td>$70,000</td>
<td>$50,000</td>
<td>$40,000</td>
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<td>Post-Lime feed ($/yr)</td>
<td>$13,000</td>
<td>$6,000</td>
<td>$12,000</td>
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<tr>
<td>CO₂ addition ($/yr)</td>
<td>-</td>
<td>$9,000</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>PO₄ addition ($/yr)</td>
<td>-</td>
<td>$6,000</td>
<td>$6,000</td>
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<td><strong>TOTAL</strong></td>
<td><strong>$83,000</strong></td>
<td><strong>$71,000</strong></td>
<td><strong>$58,000</strong></td>
<td><strong>$85,000</strong></td>
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<td>Sludge production (Tons/yr)</td>
<td>26</td>
<td>17</td>
<td>34</td>
<td>42</td>
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Conclusions

• LT2ESWTR compliance and cold water treatment?
  – Optimizing flocculation not enough
  – Switching to PACI will work
    • CO₂ addition necessary at pH > 9.0
  – Iron coagulants not much better in cold water

• Simultaneous compliance
  – PACI: CO₂ addition to improve organics removal
  – Alternative coagulants: orthophosphate addition for corrosion control
Recommendations

- Conduct full-scale trial of PACl
- Improve overall treatment
  - Flocculation
    - Install variable frequency drives
    - Increase size of baffle wall openings
  - Adjust filter operations
  - Install online raw water monitoring equipment
Questions?