Outline

• Goals
• Technology Options
• Pilot Testing Conditions
• Progress and Status
• Q&A
Goals

- Produce recycled water for use in
  - Cooling tower makeup water
  - Boiler makeup water
  - Irrigation
- Recycled water quality to be suitable for
  - Direct use – non-detectable ammonia N
  - Use as RO feed
- Waste streams to be
  - In compliance with discharge requirements
  - Minimized to reduce disposal costs
Nitrification Technologies

- Suspended growth
- Attached growth
Attached Growth

- Clay or polystyrene media
- Rope, chip, disks, sponges, etc. media
Suspended Growth

- Conventional activated sludge systems
- Sequencing batch reactors
- Membrane bioreactors
Membrane Bioreactors (MBRs)

- Uses low-pressure membrane filtration system (e.g., microfiltration or ultrafiltration) and eliminates the need for clarifiers and filtration for solid-liquid separation
- Higher MLSS in smaller footprint
- To clean the exterior of the membranes, backpulsing and air scour is used
- Tertiary application is relatively new (Hamilton, Canada, CH2M HILL)
Membrane Bioreactors (MBRs)

**Advantages**
- Superior effluent quality
- Handle WQ variability
- Eliminates separate solids/liquid separation and tertiary filtration
- Pretreatment for NF/RO

**Disadvantages**
- Additional cleaning chemicals such as citric acid over other conventional technologies
- Proper maintenance of membranes required
- T-MBR new concept
T-MBR Pilot Testing Goals

- Provide proof of concept for use of a membrane bioreactor for nitrification on a tertiary treated wastewater.
- Verify the biological system capability to produce less than 1 mg/L ammonia nitrogen.
- Define and optimize the process design criteria.
- Take the system to failure and/or test the ability for recovery from failure.
## T-MBR Feed Water Quality

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Average Feed Values</th>
<th>Product Water Requirements</th>
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<tbody>
<tr>
<td>pH, SU</td>
<td>6.8</td>
<td>6.5-7.5</td>
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<tr>
<td>Temperature, °C</td>
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<td></td>
</tr>
<tr>
<td>BOD, mg/L</td>
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<td></td>
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<tr>
<td>TOC, mg/L</td>
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<td>TSS, mg/L</td>
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<tr>
<td>Turbidity, NTU</td>
<td>1.3</td>
<td>&lt;0.2</td>
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<td>Ammonia-N, mg/L</td>
<td>53</td>
<td>&lt;1</td>
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<tr>
<td>Nitrate-N, mg/L</td>
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<tr>
<td>Alkalinity, mg/L CaCO₃</td>
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<td>Ortho Phosphate-P, mg/L</td>
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<tr>
<td>TDS, mg/L</td>
<td>1,560</td>
<td>Monitored</td>
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</table>

Product water is to be also suitable for use as RO feed.
Ammonia Oxidation Basics

- **Nitrification** (*Nitrosomonas* and *Nitrobacter*):
  \[
  \text{NH}_4^+ + 2 \text{O}_2 \rightarrow \text{NO}_3^- + 2\text{H}^+ + \text{H}_2\text{O} \\
  1.02\text{NH}_4^+ + 1.89 \text{O}_2 + 2.02 \text{HCO}_3^- \rightarrow 0.021 \text{C}_5\text{H}_7\text{O}_2\text{N} + 1.06 \text{H}_2\text{O} + 1.92 \text{H}_2\text{CO}_3 + 1.00 \text{NO}_3^- 
  \]

- **Breakpoint chlorination**:
  \[
  2\text{NH}_4^+ + 3 \text{Cl}_2 \rightarrow \text{N}_2 (\text{g}) + 8\text{H}^+ + 6\text{Cl}^- 
  \]
Pilot Unit Components
What does the MBR Mixed Liquor Look Like?
Next Steps

- Continue monitoring under steady state conditions
- Conduct challenge tests
- Develop design criteria for the 12-mgd full scale system
Questions

Comments

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