Low Cost, High Volume Algal Production Leveraging Nutrient Recovery from Municipal Wastewater

Chad Miller, VP Technology and Operations
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South Davis Sewer District Vision

Two plants servicing ~ 90k rate payers

Active member of consortium along Wasatch front that has successfully lobbied for liberal discharge limits

Fiscally conservative, but forward-thinking leadership
“We want South Davis to be the first agency in the world to send its rate payers a dividend check instead of a bill at the end of every month.”
Clearas Company History and Execution

C
P
N
PBR
Biofuel

$$$
Clearas Company History and Execution

2009

PBR

Biofuel

Recycle to Consumer

ABNR™

Nutrient Discharge

Wastewater Treatment

C P N

Recycle to Consumer

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Wastewater Treatment

2009

PBR

Biofuel

C P N

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Wastewater Treatment
Inland Empire Paper Company (left) and Fond du Lac, WI Wastewater Treatment (right)
Clearas Company History and Execution

• Dozens of successful municipal demonstrations

• Non-chemical solution to nutrient recovery problem

• Phosphorus consistently brought down to non-detect levels

• Multi-constituent mitigation

• Significant DO increase

• Capital recovery options
## Case History – Site Overview

### North Plant (7 MGD)*:

<table>
<thead>
<tr>
<th></th>
<th>Influent</th>
<th>$2^0$ Effluent</th>
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</thead>
<tbody>
<tr>
<td>TP</td>
<td>4.0</td>
<td>2.2</td>
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<tr>
<td>Ortho-P</td>
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<td>1.9</td>
</tr>
<tr>
<td>TKN</td>
<td>35.6</td>
<td>11.4</td>
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<tr>
<td>NO$_3$</td>
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<tr>
<td>NH$_3$</td>
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### South Plant (4 MGD)*:

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<td>5.3</td>
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*2014 - 2016 annual averages, ppm
Case History – Wasatch Resource Recovery
Case History – *Nutrient Dilemma*

- Biogas upgrading process yields clean carbon dioxide (nominally 30-50%) and methane that is pipeline ready

- Digestate (liquid fraction) is rich in both ammonia and ortho-phosphate

- Traditional options for managing the latter nutrient load include struvite formation or a return stream to the headworks

- Plant expansion and struvite reactors require additional investment in capital equipment and O&M
ABNR™

1. MIX

2. RECOVER

3. SEPARATE

4. HARVEST

Return Algae

Sunlight

Permeate

CO₂ from
Scrubbers

Digestate

Secondary Effluent

Equalization Tank
Clearas / Aqua Engineering Solution

SDSD South Plant Site Plan
Secondary effluent, digestate and CO₂ are delivered to the mix well where they are blended with return activated algae (RAA).
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• The algae, carbon and wastewater (mixed liquor) are then routed to the PBRs for the requisite retention time.
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The mix is then moved to a bank of separators for isolation of solids and clean permeate.
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The algae, carbon and wastewater (mixed liquor) are then routed to the PBRs for the requisite retention time.

The mix is then moved to a bank of separators for isolation of solids and clean permeate.

Waste is sent to harvest, RAA to the mix well and permeate to a local customer, equalization tank or discharge.
South Plant (4 MGD):

- 44,180 ft\(^2\) footprint (~1 acre)
- Significant reuse of existing infrastructure
- Routing of digestate from WWR to equalization tank (elevates TP to 3 ppm and NH\(_3\) to 20 ppm) reduces demand on primary and secondary processes
- Nominal TP reduction from 3.0 to 0.035 ppm
- Dry weight of biomass recovered ranges from 5,939 to 9,898 lbs (theoretical yield from 60 to 100% efficiency)
Biomass Recovery

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Normalized Conc., %</th>
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<tbody>
<tr>
<td>Proteins</td>
<td>51.5</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>29.3</td>
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<tr>
<td>Lipids</td>
<td>12.0</td>
</tr>
<tr>
<td>Ash</td>
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</table>

• C6 : C5 sugars > 9 : 1

• Bioaccumulation of metals shown to be negligible

• No coagulant or polymer utilized during harvest; results in low ash concentrations
Developing the Supply Chain