CLEARAS Water Recovery

Autumn Fisher

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COMPANY BACKGROUND

- Founded in 2008 and headquartered in Missoula, Montana with satellite offices in Oregon and Nevada.
- Recently listed in Water Environment Federation Nutrient Roadmap publication.
- Growth driven by our performance, people and relationships.
- Differentiated solution optimizing the relationship between natural processes and equipment to achieve best-in-class water quality and a competitive total cost of ownership.
- Experienced team: power generation, civil infrastructure / engineering, information systems, renewable energy and financial services.
- Integration of world class supply chain partners.

CLEARAS has worked methodically through biological and mechanical optimization in addition to market validation efforts adding long-term and sustainable growth opportunities.
Project results driving growth opportunities. Over 25,000,000 gallons treated through technology demonstration efforts.
TECHNOLOGY OVERVIEW (CLEARAS VIDEO)
System process and controls mimic traditional activated sludge plants.
SYSTEM BENEFITS

• Sustainable Approach to Nutrient Recovery

• Primary Benefits
  • Total Phosphorus (TP) recovery
  • Total Nitrogen (TN) recovery

• Ancillary Benefits
  • Total Suspended Solids (TSS) removal
  • Biochemical Oxygen Demand (BOD) removal
  • Carbon Dioxide Recycling Potential
  • Dissolved Oxygen Increases (30 – 40%)
    • Cost savings potential

• Non-Chemical
  • No additional sludge handling costs

• Modular and Scalable Platform
  • Easily expands to meet increased flow requirements
  • Allows the plant to retire the conversation on nutrients

Ultrafiltration as final ABNR phase allows for savings associated with existing disinfection methods; chemical savings (chlorine) or power savings (UV).
Data set includes 234 separate trials. Average incoming phosphorus = 1.91 mg/L
Average treated phosphorus = 0.02 mg/L
Data set includes 234 separate trials. Average incoming ammonia = 14.09 mg/L
Average treated ammonia = 0.49 mg/L
AUSTIN, MN PERFORMANCE

Average Influent TP: 5.89 mg/L

*Average Treated TP: 0.11 mg/L (0.035 mg/L without upset day)
### Total Nitrogen Results

- **Average Influent TN:** 125.2 mg/L
- **Average Treated TN:** 39.7 mg/L

#### Influent TN [mg/L] In-House
- Batch 1: 125.0
- Batch 2: 108.5
- Batch 3: 137.5
- Batch 4: 139.1
- Batch 5: 122.0
- Batch 6: 119.2

#### Permeate TN [mg/L] In-House
- Batch 1: 25.7
- Batch 2: 28.2
- Batch 3: 41.1
- Batch 4: 45
- Batch 5: 41.1
- Batch 6: 56.9

#### Graph Instructions

- **X-axis:** Batch Number
- **Y-axis:** Concentration [mg/L]
- **Data Points:** (125.0, 108.5, 137.5, 139.1, 122.0, 119.2) for Influent TN
- **Data Points:** (25.7, 28.2, 41.1, 45, 41.1, 56.9) for Permeate TN

#### Average Results

- **Average Influent TN:** 125.2 mg/L
- **Average Treated TN:** 39.7 mg/L
AUSTIN, MN PERFORMANCE

**Major Takeaways**

- **Total Phosphorus Reduction:** 99%
- **Ortho Phosphorus Reduction:** 98%
- **Total Dissolved Phos. Reduction:** 98%
- **Ammonia Reduction:** 87%
- **BOD Reduction:** 100%
- **Total Suspended Solids Reduction:** 100%
- **Chloride Reduction:** 89%
- **Mercury Reduction:** 100%

- **Specific Conductance Reduction:** 71%
- **Bicarbonates CaCO3 Reduction:** 68%
- **Bicarbonates HCO3 Reduction:** 67%
- **Un-ionized Ammonia Reduction:** 97%
- **Total Kjeldahl Nitrogen Reduction:** 88%
- **Total Dissolved Solids Reduction:** 69%
- **Sodium Reduction:** 77%
MANKATO, MN PILOT SUMMARY

• 3 Phases

• Phase 1
  • Secondary Effluent

• Phase 2
  • Primary Effluent

• Phase 3
  • Secondary Effluent
  • Filtrate from Belt Filter Press

• Performance Evaluation
  • Nutrient reduction (P and N)
  • Evaluate potential chloride and TDS reductions

Results

Total Phosphorus Reduction: 98%
Ortho Phosphorus Reduction: 100%
Total Nitrogen Reduction: 32%
TSS Reduction: 86%

TP:TN Removed 1 : 7
## MANKATO BIOMASS CHARACTERIZATION

### Average Biomass Characteristics

- **Nitrogen Average:** 8.10%
- **Protein Average:** 50.6%
- **Fat Average:** 3.79%
- **Ash Average:** 11.74%
- **Carbohydrate Average:** 26.88%
- **P2O5 Average:** 4.44%
- **Potash Average:** 1.63%

### Table - Biomass Characteristics by Phase

<table>
<thead>
<tr>
<th>Phase 1 - Secondary</th>
<th>Phase 2 - Primary</th>
<th>Phase 3 - Secondary/Filter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Moisture</strong></td>
<td><strong>Moisture</strong></td>
<td><strong>Moisture</strong></td>
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<tr>
<td>6.61%</td>
<td>7.17%</td>
<td>7.17%</td>
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<tr>
<td><strong>Nitrogen</strong></td>
<td><strong>Nitrogen</strong></td>
<td><strong>Nitrogen</strong></td>
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<tr>
<td>7.89%</td>
<td>8.21%</td>
<td>8.19%</td>
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<tr>
<td><strong>Protein (crude)</strong></td>
<td><strong>Protein (crude)</strong></td>
<td><strong>Protein (crude)</strong></td>
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<tr>
<td>49.32%</td>
<td>51.28%</td>
<td>51.20%</td>
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<tr>
<td><strong>Fat (crude)</strong></td>
<td><strong>Fat (crude)</strong></td>
<td><strong>Fat (crude)</strong></td>
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<tr>
<td>3.72%</td>
<td>3.80%</td>
<td>3.85%</td>
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<tr>
<td><strong>Ash</strong></td>
<td><strong>Ash</strong></td>
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<tr>
<td>11.85%</td>
<td>11.91%</td>
<td>11.47%</td>
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<tr>
<td><strong>Carbohydrates</strong></td>
<td><strong>Carbohydrates</strong></td>
<td><strong>Carbohydrates</strong></td>
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<tr>
<td>28.50%</td>
<td>25.84%</td>
<td>26.31%</td>
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<tr>
<td><strong>P2O5</strong></td>
<td><strong>P2O5</strong></td>
<td><strong>P2O5</strong></td>
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<tr>
<td>4.24%</td>
<td>4.51%</td>
<td>4.56%</td>
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<tr>
<td><strong>Potash</strong></td>
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<tr>
<td>1.56%</td>
<td>1.66%</td>
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CO-PRODUCT OPPORTUNITY
<table>
<thead>
<tr>
<th>DETAILS</th>
<th>CLEARAS SERVICES</th>
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<tbody>
<tr>
<td>* Agreement Length: 3 – 5 Years</td>
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<tr>
<td>* Biomass Value: $1,000 - $2,000/Ton</td>
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<td></td>
<td>* Biomass Characterization</td>
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<td>* Marketing &amp; Communications</td>
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<td>* Sales</td>
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<td>* Contracting</td>
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<td>* QA / QC</td>
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<td>* Logistics Management</td>
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<tr>
<td>* ~ 70% to Partner</td>
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<td></td>
<td>* Dewatering</td>
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<td></td>
<td>* Drying</td>
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<td></td>
<td>* Packaging</td>
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<td></td>
<td>* Loading</td>
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<tr>
<td>* ~ 30% to CLEARAS</td>
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<td>* Aligns Incentives</td>
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<tr>
<td>* Recurring Revenue Stream</td>
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**CLEARAS BIORESOURCES**
- A subsidiary of CLEARAS, Inc.

**PARTNER / CUSTOMER RESPONSIBILITIES**

- Dewatering
- Drying
- Packaging
- Loading
Microalgae can contain anywhere from 20% - 70% protein content compared to 10% for corn and 40% for soybeans.
CLEARAS BioResources currently has offtake arrangements with companies focused on creating foam insoles for some of the largest shoe manufacturers in the U.S.
South Davis Sewer District

- $28M ABNR project announced May 2017 with a commission date of Spring 2019.

- Co-construction of food waste to energy along with ABNR creates an economic system to support the circular economy.

- Extends the life of existing / aging wastewater infrastructure.

- ABNR results in:
  - 4 MGD of the highest quality reuse water (3.0 mg/L TP to < 0.035 mg/L)
  - 17,500 lbs. of CO₂ recycled daily
  - 8,000 lbs. of algal biomass daily
  - 100% of biomass being sold for plastics and foams
  - Residual income stream to customer

From WASTE to VALUE!
Village of Roberts

- Design Flow: 0.150 MGD
- Design TP: 4.0 mg/L
- Future TP Limit: 0.04 mg/L
- Biomass Produced: 400 lbs/day
- Estimated CLEARAS Scope: $2.13 M
- Construction Initiation: Spring 2019
## Village of Cambria

- **Design Flow**: 0.120 MGD
- **Design TP**: 2.0 mg/L
- **Future TP Limit**: 0.075 mg/L
- **Biomass Produced**: 160 lbs/day
- **Estimated CLEARAS Scope**: $1.6 M
- **Construction Initiation**: Summer 2019
### City of Beaver Dam
- **Design Flow:** 4.0 MGD
- **Design TP:** 3.0 mg/L
- **Future TP Limit:** 0.075 mg/L
- **Biomass Produced:** 7900 lbs/day
- **Estimated CLEARAS Scope:** $20.8 M (includes a dryer for biomass)
- **Construction Initiation:** Fall 2019?

### City of Waupun
- **Design Flow:** 2.0 MGD
- **Design TP:** 2.0 mg/L
- **Future TP Limit:** 0.075 mg/L
- **Biomass Produced:** 4700 lbs/day
- **Estimated CLEARAS Scope:** $11.9 M
- **Construction Initiation:** 2019-2020?
CLEARAS AND THE CIRCULAR ECONOMY

Carbon Dioxide credits
RINs associated with Power Generation

RECEIVE

IN
$米

RECYCLE

IN
$米

CREATE

IN
$

RECOVER

IN
$

REUSE

Water: for industrial and agricultural purposes

Residual Income Streams
- Biomass: for multiple, large, and diverse markets
- Power via Biogas: ABNR tech can mitigate the increased nutrient load created by current biogas production
  - Food Waste to Enable
  - Anaerobic Digestion

Phosphorous: reducing Total P to near non-detect levels
Nitrogen: (reducing nitrates and ammonia)
Energy: no longer needed for upstream treatment
CLEARAS is at the center of a changing market landscape; delivering a next generation technology solution with a total cost of ownership advantage to customers.
QUESTIONS?

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Regional Director - Project Delivery

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Thank You!