CLEARAS Robert’s WWTP & Other Project Updates

PRESENTOR: AUTUMN FISHER, Vice President - Project Delivery
PRESENTATION OUTLINE

- ABNR (EcoRecover) Process Overview
- Roberts
  - Compliance Background
  - Roberts Project & Construction Summary
  - Commissioning / Inoculation / Performance Testing Updates
- Other EcoRecover Project Highlights
- EcoRecover Sustainability Benefits
ECORECOVER OVERVIEW

**System process and controls mimic traditional activated sludge plants.**
• Location: Northwest WI

• Population: 1,800

• 0.465 MGD SBR facility
  o Average flow: 0.100 MGD

• Previous TP discharge limit: 1 mg/L

• Current TP discharge limit:
  o Monthly Average: 0.12 mg/L
  o Annual Average: 0.04 mg/L
- Alternatives evaluation
  - Source minimization
    - Primarily residential influent
    - Centrate evaluation – centrate received from regional biosolids facility
  - Facility optimization
  - Watershed alternatives
  - Piloting
    - Chemical alternative
      - Alum
      - Ferric
      - Cerium Chloride
    - Ultra-filtration
    - EcoRecover (ABNR)
WHY ECORECOVER? – SYSTEM BENEFITS

• Primary Benefits
  o Total Phosphorus recovery
  o Ammonia recovery

• Ancillary Benefits
  o Total Suspended Solids (TSS) removal
  o Biochemical Oxygen Demand (BOD) removal
  o Eliminate/reduce phosphorus removal chemical
  o Dissolved Oxygen increases
  o Pathogen reduction/elimination
  o Algae co-product value

• Sustainable, Modular and Scalable
ROBERTS, WI - ECORECOVER OVERVIEW

Design
- Flow: 0.150 MGD
- Influent TP: 4.0 mg/L (5 lbs/day)
- Effluent TP: 0.04 mg/L
- Carbon Recycled: 875 lbs/day

Algae biomass production
- 200–300 lbs/day

Timeline
- Fully constructed in fall 2020
- Performance test in fall 2021

Status: Integration of existing SBR in process

Applying lessons learned to current projects
VILLAGE OF ROBERTS, WI – CONSTRUCTION

- Groundbreaking: October 2019
- Early onset of Winter: November 2019
- Winter Conditions
  - Urgency to proceed with construction because of Roberts’ compliance timeline
  - With winter construction, comes problems....
- COVID
- Lack of responsiveness from sub-contractors
- Project is substantially complete
Concrete pouring conditions inside the heated hoop houses
VILLAGE OF ROBERTS, WI – CONSTRUCTION HIGHLIGHTS
• Mix Tank
  o 53,000 gallons – bolted steel
  o 26,500 gallons – used for phase 1
VILLAGE OF ROBERTS, WI – CONSTRUCTION HIGHLIGHTS

- Air mixing
- Feed and discharge piping
PBR Feed Pumps

Effluent / Backwash Pumps
Algae Harvest

- Harvest Pumps
- Centrifuge Skid

- Not Pictured:
  - Algae Scales
  - Cooler for Storage
  - Algae dryer
Pig Assembly Air Distribution Manifolds
Photobioreactors
Inoculation Steps

- Inoculate 4 of 10 PBRs with algae seed from South Davis UT stock culture fence
- Slowly increase feed from upstream SBRs as algae grows
- Bring additional PBRs and system volume online as algae grows
- Continuous harvest to maintain a 4 – 5 day SRT
Day 1
12 mg/L TSS

Day 5
118 mg/L TSS

Day 8
400 mg/L TSS
**VILLAGE OF ROBERTS, WI – CURRENT STATUS**

**Current Conditions:**
- System is fully constructed and operational
- Optimization of existing SBR plant and EcoRecover continues
- Planning for dryer installation – Spring 2022

**Next Steps:**
- Slowly increase loading rate to increase algae density and treat 100% of SBR effluent
- Initiate 2-week performance testing after system reaches operating algae TSS (~800-1000 mg/L)
- Biomass agreements for plastics / foams and inks executed – **waiting for dryer installation**
VILLAGE OF ROBERTS, WI – LESSONS LEARNED

**PBR Thrust Blocking**
- Applies light pressure on u-bends/elbows and reduces lateral thrust and coupling slippage.

**Pig System Design**
- Transitioned from knife gate valves to ball valves and redesigned flow control to optimize pig launch efficiency.

**Partial Flow Control**
- Ability to gradually increase total flow and loadings through EcoRecover – originally “all flow or no flow.”

**LED Light Design**
- Switched from watts/gallon to photosynthetic photon flux density (PPFD)* as key design metric, resulting in 60 PPFD base design and transition to overhead “white” broad spectrum lighting.

**Carbon Dioxide Addition**
- Transitioned from injection quill CO₂ feed at each PBR to a gas sparger block manifold delivery system.

**Existing Infrastructure**
- Equalization (if necessary), mix tank, and membrane tanks present infrastructure reuse possibilities.

---

* PPFD (photosynthetically-active photon flux density) measures photosynthetically-active radiation (PAR) delivered to a specific area and is expressed as micromoles-per-meter squared-per second (μmol/m²/s).
Algae Information Management System (AIMS)

- AIMS: Designed to manage and maximize the relationship between mechanical processes and algae-biological performance. Simple integration into existing plant SCADA.

- Intuitive HMI to allow operators in-the-field to easily control the ABNR process.
Algae Total Suspended Solids
Phosphorus Recovery Performance
• 2 additional facilities in Wisconsin implementing EcoRecover to meet phosphorus compliance - Mondovi, WI and Waupun, WI
  ▪ Mondovi: $18 - $20M total project funded by USDA
  ▪ Waupun: $35M total project funded by USDA

• South Davis, UT – North Plant
  o ABNR originally designed for the South Plant in 2018
    ▪ Inhibitor from upstream industrial dischargers forced a change to the North Plant
  o North Plant Conceptual Design Approval from UT DEQ
MONDOVI, WI - ECORECOVER OVERVIEW

Greenfield WWTP with upstream SBRs & EcoRecover phased implementation

Low interest loan and grant funding – USDA RD

Design
- Flow: 0.300 MGD
- Influent TP: 2 mg/L (5 lbs/day)
- Effluent TP: 0.05 mg/L
- Carbon Recycled: 875 lbs/day

Algae biomass production
- 200–300 lbs/day

Timeline
- Groundbreaking Fall 2021
- Completion Q4 2022
Groundbreaking
September 2021
Multiple pilot evaluations to confirm design basis

**Design**
- Flow: 2.14 MGD
- Influent TP: 3.36 mg/L (60 lbs/day)
- Effluent TP: 0.05 mg/L
- Carbon Recycled: 11,000 lbs/day

**Algae biomass production**
- 2,000–3,000 lbs/day

**Timeline**
- Construction underway
- Completion Q1 2023

Low interest loan and grant funding – USDA RD
Groundbreaking
May 2021
WAUPUN, WI – CONSTRUCTION PROGRESS
• Location: North Central UT

• Population: 90,000 (split between 2 WWTPs)

• 12 MGD facility
  o 9 MGD ABNR upgrade
  o Current TP discharge limit: 1 mg/L
  o Future TP limit: 0.1 mg/L
  o Future NH3-N limit: 4.5 mg/L

• ABNR Benefits
  o Extends the life of their existing trickling filter plant
  o Provides a P and N recovery system
  o Modular and scalable to meet future, potential loading from food waste to energy project
SOUTH DAVIS, UT- ECORECOVER OVERVIEW

Design validation stock culture fence in operation since 2018

Design
- Flow: 9 MGD
- Influent TP: 2 mg/L (150 lbs/day)
- Effluent TP: 0.05 mg/L
- Carbon Recycled: 26,000 lbs/day

Algae biomass production
- 10,000–11,000 lbs/day

Timeline
- Design underway
- Construction Begins Q2 2023
- Completion Q4 2024
ECORECOVER BENEFITS: CO-PRODUCT OPPORTUNITY

• EcoRecover produces algal biomass which can be sourced into a diverse range of markets.

• Opportunity to recover costs associated with system CapEx - results in long-term lower cost of ownership.

• Residual income stream back to the facility throughout the useful life of the project.
ALGAE BIOMASS MARKET OPPORTUNITY

The sale of co-products creates long-term, residual value streams for Customers.

BIO MASS SERVICES

LIMITED PROCESSING: Early co-product efforts are focused on delivering whole-cell, dried algae to end markets (Bioplastics, Food & Feed) for immediate value capture. Within this framework, Clearas provides biomass services to EcoRecover customers for a fee.

ADVANCED PROCESSING: Long-term, co-product efforts may focus on capturing increased value through bio-refining more advanced products. Within this framework, Clearas will purchase biomass from EcoRecover customers, refine, and deliver a portfolio of products to end markets.

TO WHOM: BENEFIT:

CUSTOMER: Receives long-term recurring income stream.

CLEARAS: Multi year direct purchase agreement with customer/owner

ALGAE BUYER: Reliable, long-term supply of quality biomass for transition away from carbon-based inputs
BIOMASS PRODUCTS & CUSTOMERS

BLOOM: An Algix Company brand, launched the world’s first algae-blended EVA to the footwear industry as a sustainable ingredient in flexible foams for high rebound applications such as shoes, sporting products, and accessories.

Living Ink, Technologies: A biomaterial's product company developing environmentally safe and sustainable ink products grown from algae.

Living Ink makes pigments from algae instead of petroleum.

@wndr_alpine printed shirts in Algae Ink. “Snow is sacred. Science is real”
ENVIRONMENTAL & ECONOMIC SOLUTION

Problem: Meeting Restricting Nutrient Discharge Regulations

- Wastewater Phosphorus
- Nitrogen
- Carbon Dioxide
- Energy

Environmental Benefits

- Clean Water
- Clean Air
- Algae Biomaterial

Financial Benefits

- Reuse quality water
- Carbon credits
- Recurring algae biomass sales
- Nutrient trading credits
- Upstream optimization
THANK YOU!

Autumn Fisher
CLEARAS VP of Project Delivery
afisher@clearaswater.com
920-539-2993