Emerging Water & Wastewater Treatment Technologies

Lagoon Optimization

Deer Creek State Park Lodge & Convention Center
Mount Sterling, Ohio

August 3, 2016

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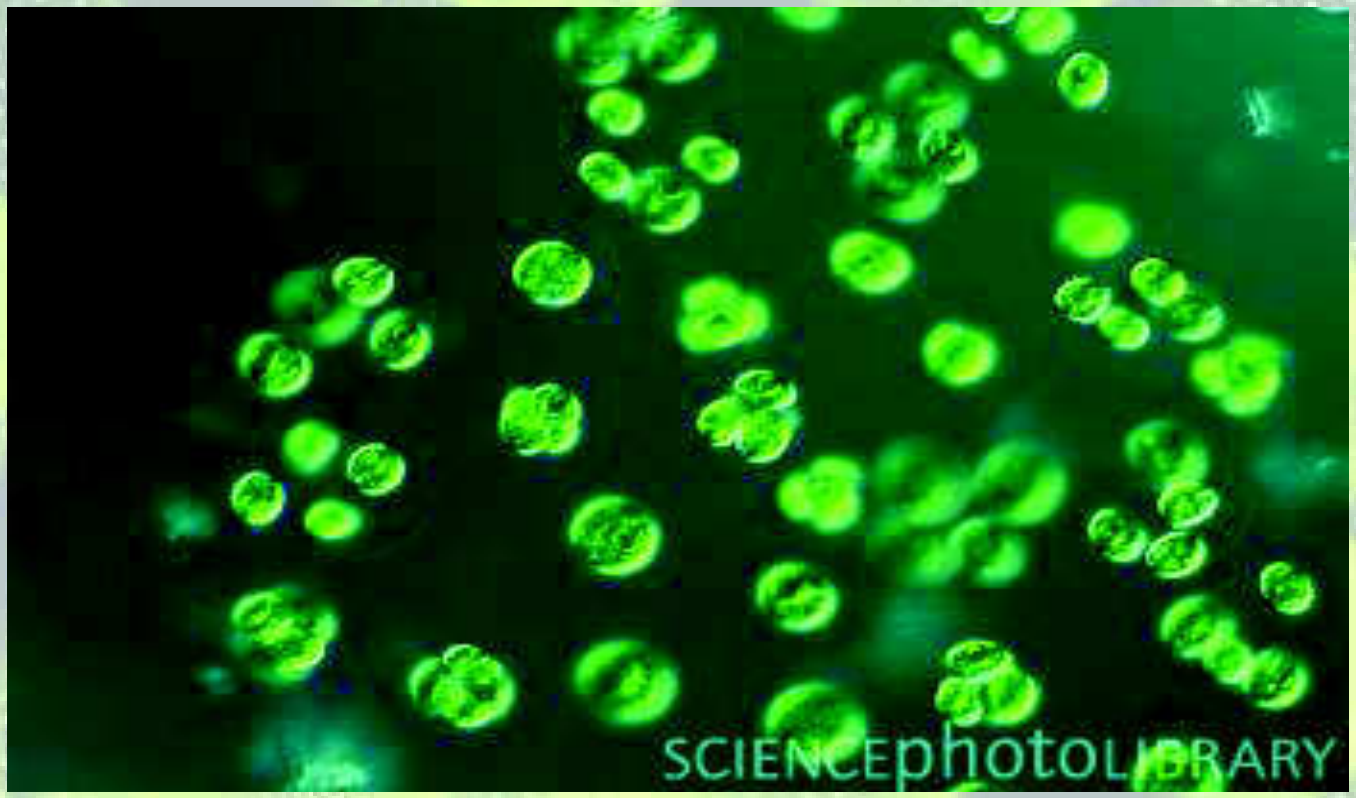

Microalgae
(Lagoon Optimization)

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Municipal

Greenhouse

Primary
Lagoon Cell

Electrocoagulation

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The Challenges We Face

Fact

- 30% of the wastewater treatment systems in the United States employ some sort of lagoon system

Challenges:

- Power consumption and maintenance costs are increasing
- Most rural and small communities cannot afford the costs associated with mechanical alternatives
- Discharge regulations will become more stringent for all NPDES permit holders

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Wastewater Treatment Challenges

BOD

TSS

Odor

pH

I & I

Toxicity

Mat Algae (cyanobacteria/ cyanotoxins)

Pond dimensions

Ice cover

Pond hydraulics

Temperature

Pond Configuration

Short Circuiting

Duckweed

Low Oxygen

Forced mechanical upgrades

Illegal Dumping

Land Application More Restrictive

Sludge Buildup

Phosphorus

Ammonia

TKN

Fecal Coliform

Bacteria

Viruses

Pharmaceuticals

Fluoride

Arsenic

Selenium

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Bad Algae vs. Good Algae

Bad Algae---“Mat algae” (cyanobacteria or blue-green algae) disrupt treatment process and pollute discharge waterways and can produce cyanotoxins.

Good Algae---Single-cell (microalgae) produce pure oxygen for the bacteria which, in turn, will out-compete the “mat algae” for nutrients.

Microalgae Facts

- **Single-cell - Do not form mats**
- **Doubles population every 24 hours**
- **Mobile (swims)**
- **<u>Creates a pure oxygen environment for bacteria</u>**
- **Symbiotic relationship between microalgae and bacteria**
- **Good bacteria population will out-compete the mat algae and duckweed for nutrients, resulting in weed control and odor control.**

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Biological Aeration
vs.
Mechanical Aeration

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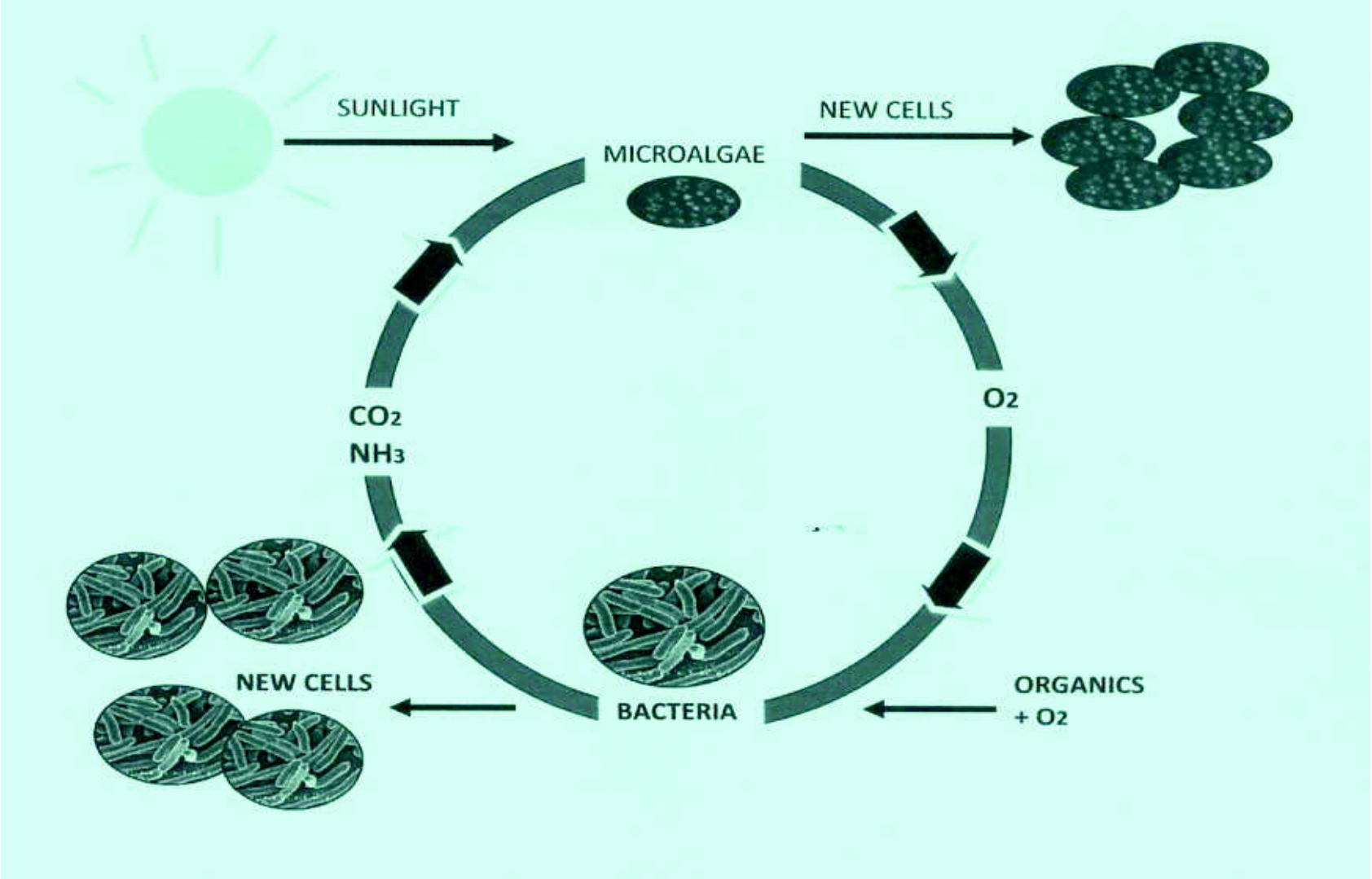
Symbiotic Relationship Between Microalgae and Bacteria



Oxygen Production:
How Do We Know How Much Microalgae

Table 1: Total Oxygen Production from Algae Photosynthesis

Parameter	Value for December (month with the least amount of sunlight)	Value for June (month with the most amount of sunlight)
Energy available for photosynthesis (Assume 5% of that from sunlight)	50 kJ/ft^2-day	75 kJ/ft^2-day
Algae cell production by photosynthesis (Assume 24 J produce 1 mg of algal cells)	2,083 mg algal cells/ft^2-day	3,125 mg algal cells/ft^2-day
Oxygen production by algae cells (1.56 mg of O_2 for every 1 mg of algal cells)	3,250 mg O_2/ft^2-day	4,875 mg O_2/ft^2-day
Oxygen production in terms of pounds per acre per day in a stagnant pond	310 lbs O_2/acre-day	470 lbs O_2/acre-day
Total oxygen production with mixing and continuous algae addition (200% that of a stagnant pond)	**620 lbs O_2/acre-day**	**940 lbs O_2/acre-day**

1 mg of microalga cells produces 1.56 mg of O2.

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Greenhouse & Microalgae Growth Tanks

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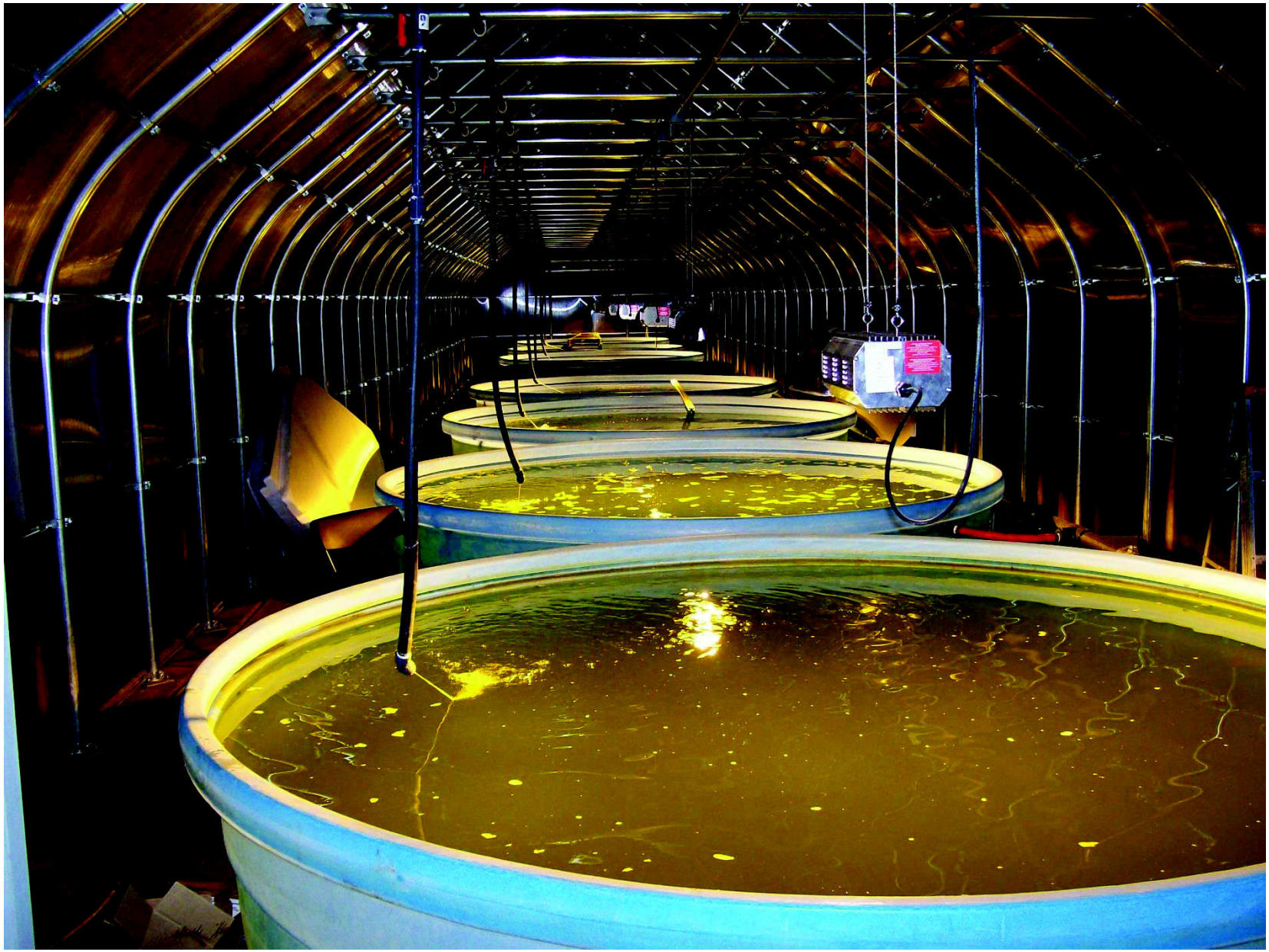
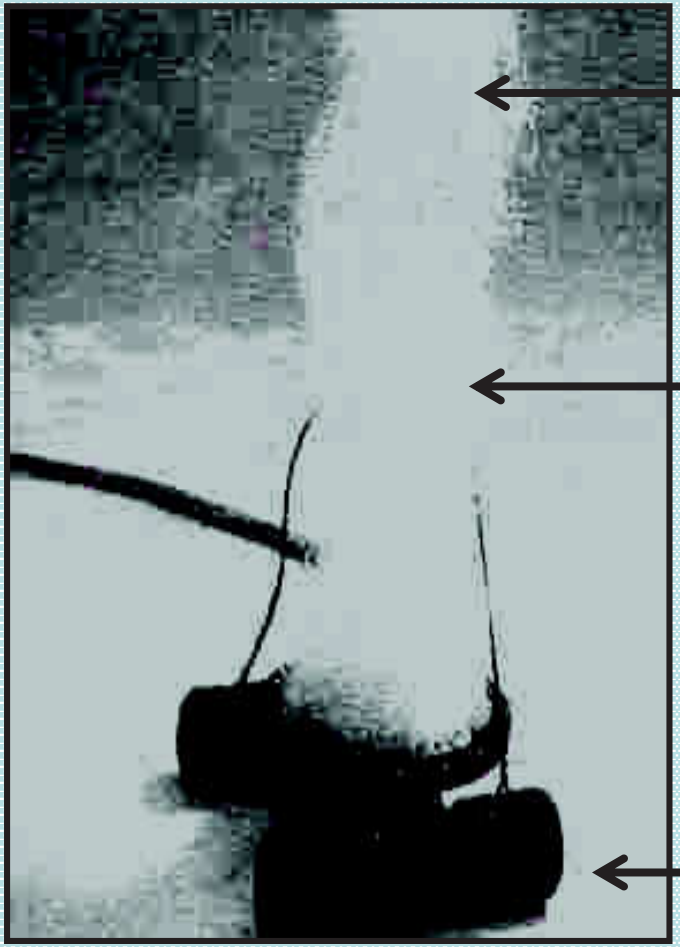
Greenhouse Lighting for Microalgae



Greenhouse at Sunset

Laminar Mixing Creates Facultative Zones



Aerobic zone

Anoxic zone

Anaerobic zone

Diffuser Marker

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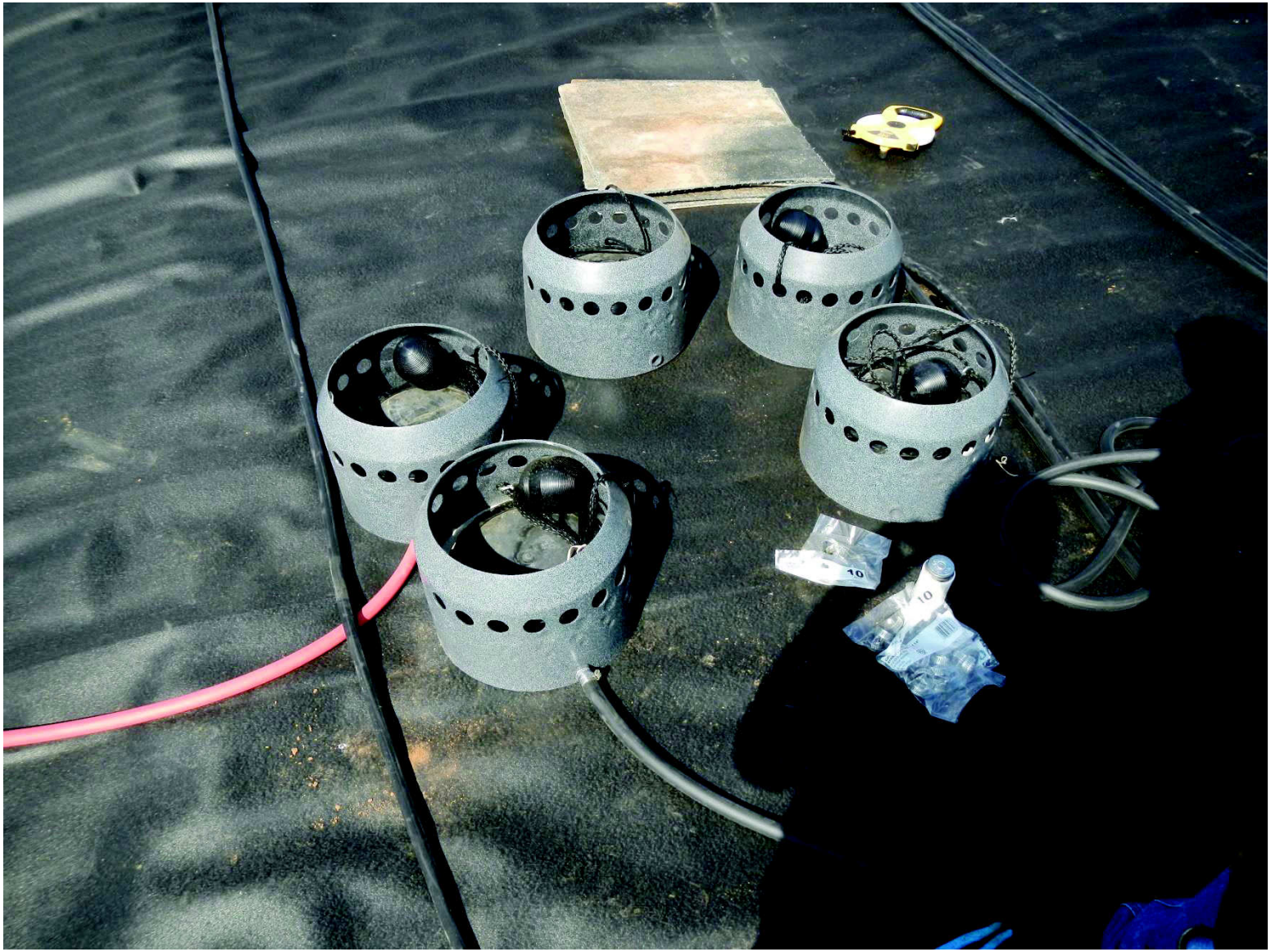

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Curtain Shore Anchors

Laminar Mixing

- can increase the **efficiency of sunlight exposure to the microalgae by up to 200%**
- distributes more pure oxygen into the lagoon
- creates an 18” to 24” ecosystem biomass of microalgae & bacteria, maximizing overall wastewater treatment.
- Provides the bacteria continual exposure to both the oxygen from the microalgae and to the BOD and TSS within the wastewater
- Keeps the microalgae and solids in suspension

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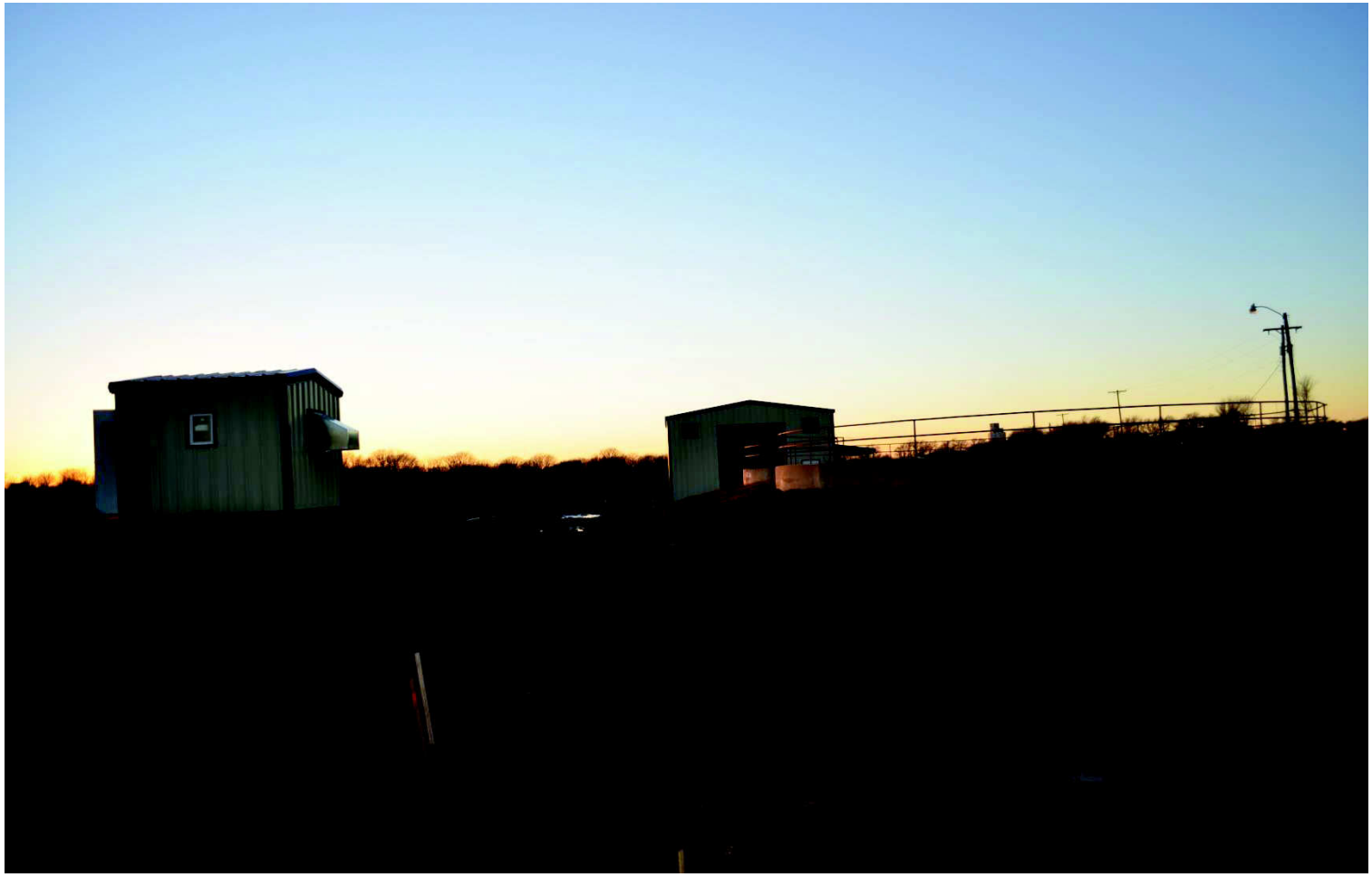
EC & Compressor Buildings



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EC Unit Connections

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Electrocoagulation Tertiary Treatment

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Solids Separation

Results: Bacterial Components

	Fecal Coliforms (CFU/ml)	Enterococci (CFU/ml)
Before EC Treatment	1,000,000	1,000,000
After EC Treatment	Below Detection	Below Detection

Data Source: Rosario and Adkinson
University of Southern Florida

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Results: Viral Components

	Phage, *E. coli* (Pfu/ml)	Phage, *B. subtilis* (Pfu/ml)	PMMoV (copies/ml)	HPyV (copies/ml)
Before EC Treatment	12,800	2,220	60,100	100,000
After EC Treatment	Below Detection	Below Detection	Below Detection	Below Detection

Data Source: Rosario and Adkinson
University of Southern Florida

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Journal of Environmental Management 88 (2008) Pgs. 437-447

"The cost for mechanical treatment is approximately 4-5.5 times higher than a lagoon system." (3.1.2 page 440)

"Aeration of lagoon systems (by mechanical means) may increase energy use considerably, by 3 times for a 0.1 MGD plant capacity, and 5 times for a 5 MGD plant capacity." (3.2.1 page 440)

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Review: What is the Powell Water Lagoon Logistics Solution?

- Is a patented and engineered process
- provides oxygen for wastewater treatment in traditional lagoon systems by cultivating beneficial microalgae
- replaces the traditional mechanical lagoon aeration components with this natural source of oxygen
- is a savings of 45% to 80% of the electrical costs for wastewater treatment
- allows lagoon systems to meet the ammonia limits *without* the conversion to a mechanical plant
- Provides additional nitrogen and phosphorus removal
- Reduces sludge accumulation

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THANK YOU!

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