Environmental Dynamics International

Presents

Lagoon Solutions: Treatment Performance and Nutrient Removal

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Agenda

- Compliance and Capacity
- Lagoon Aeration
- Lagoon Processes
  - Traditional
  - Review of Advanced Technologies
- Final Thoughts
- Q&A

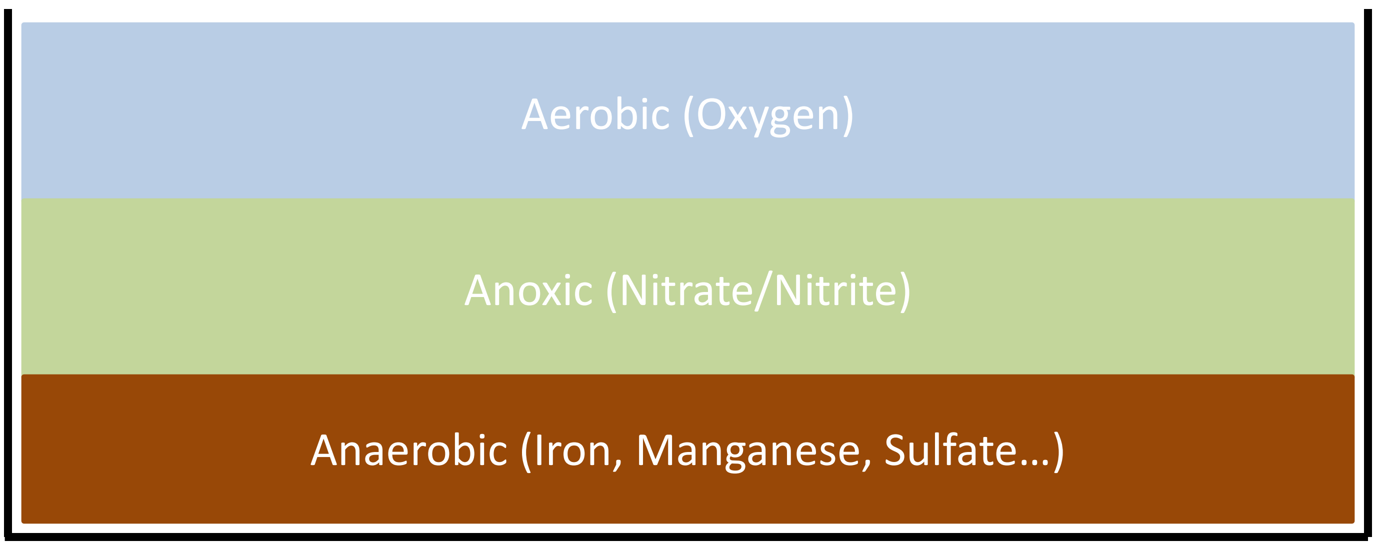
Compliance and Capacity

Compliance and Capacity

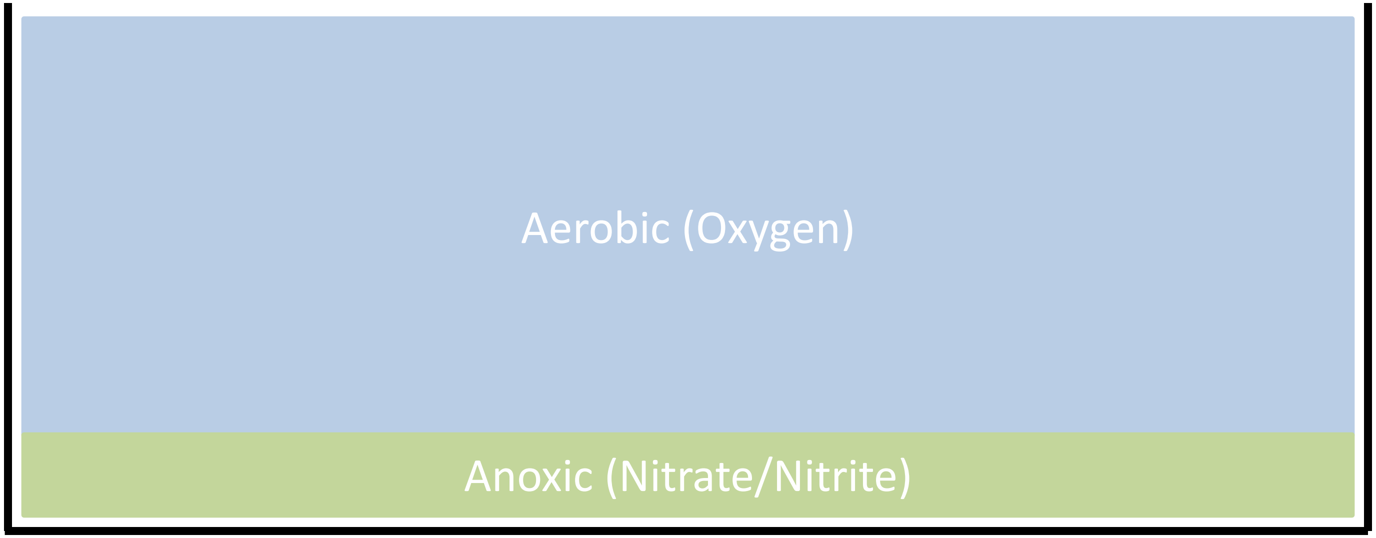
- VAST
  - Volume
  - Aeration
  - Short-circuiting
  - Temperature

Lagoon Aeration

Lagoon Aeration – Why Aeration?



Lagoon Aeration – Why Aeration?



Lagoon Aeration – What to Use?

- Surface vs. Diffused Aeration
  - Surface
    - Easy, less expensive to install
  - Diffused
    - Higher energy efficiency
      - Generally 40-50% the power for equivalent oxygen

Lagoon Aeration – What to Use?

- Fine Bubble vs. Coarse Bubble
  - Fine Bubble
    - SOTE 1.5-2.2%/ft
    - Maintenance requirement (membrane changes)
      - Backflow prevention
    - Head loss across membrane
      - May increase <u>or</u> decrease with age and use
    - Greater volumetric pumpage for mixing (than coarse bubble)

Lagoon Aeration – What to Use?

- Fine Bubble vs. Coarse Bubble
  - Coarse Bubble
    - SOTE 1%/ft
    - No maintenance expected
    - Nominal head loss
    - Less volumetric pumpage for mixing (than fine bubble) but able to lift heavy particles with focused suction (i.e., airlift pump)

Lagoon Aeration – What to Use?

- Fine Bubble and Coarse Bubble
  - Challenges of combining the two:
    - Engineered orifice satisfies design at one airflow rate
      - High or lower air flow results in disproportionate air flow to coarse
    - Less efficient overall
      - Combining 2%/ft with 1%/ft must result in higher air flow than 2%/ft throughout
    - No mixing advantage for the addition of sparsely-placed airlift pumps

Lagoon Processes

Lagoon Processes - Traditional

- Four Primary Types:
  - Anaerobic
    - Covered (welded), no oxygen, mostly industrial
  - Facultative
    - Atmospheric oxygen, also as QZ for settling
  - Partial Mix
    - Aeration, minimal suspension of solids
  - Complete Mix
    - Aeration, homogenous conditions

Lagoon Processes - Traditional

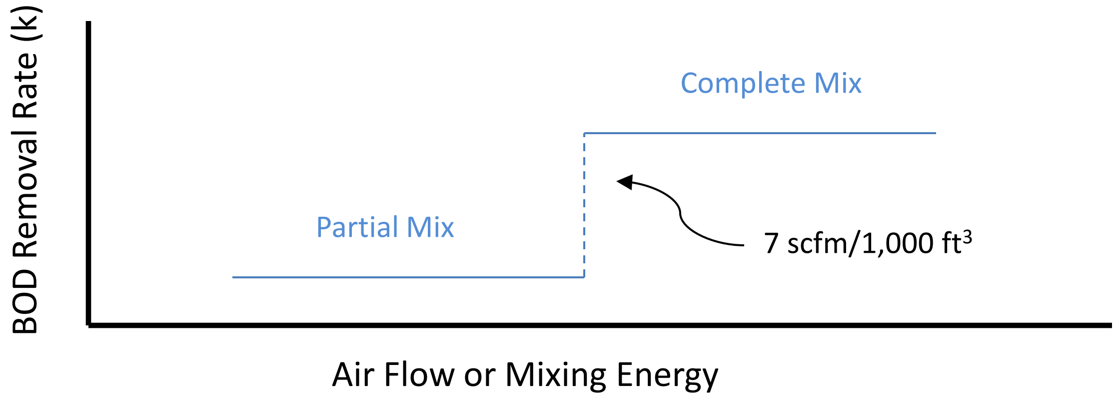
- Partial Mix Design
  - For BOD: $\frac{C_e}{C_0} = \frac{1}{\left[1+\left(\frac{kt}{n}\right)\right]n}$
    - t = hrt (days)
    - n = # of ponds
    - k = 0.276 /day @ 20° C
      - $Kt = 0.276 \ * \ 1.036^{T-20}$

Lagoon Processes - Traditional

- Complete Mix Design
  - For BOD: $\frac{C_e}{C_0} = \frac{1}{\left[1+\left(\frac{kt}{n}\right)\right]n}$
    - t = hrt (days)
    - n = # of ponds
    - k = 2.5 @ 20° C *(Note: PM = 0.276)*
      - $Kt = 2.5 * 1.036^{T-20}$

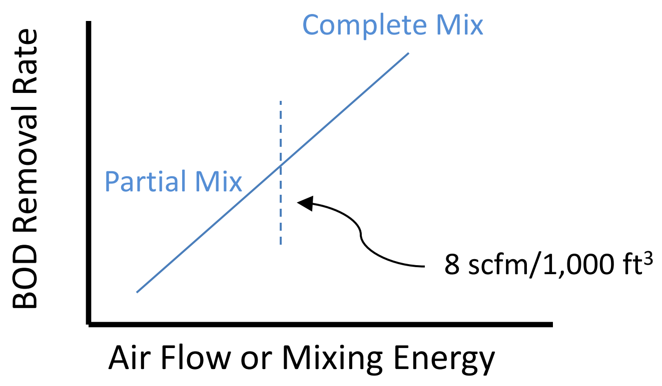
Lagoon Processes - Traditional

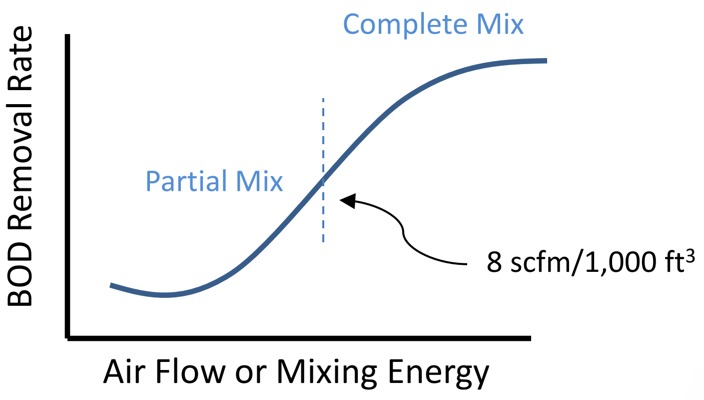
- Complete vs. Partial Mix Design
  - What does “completely mixed” mean?
    - Is this really a step function?



Lagoon Processes - Traditional

- Complete vs. Partial Mix Design
  - What does "completely mixed" mean?
    - Is it linear?
    - Or sinusoidal?





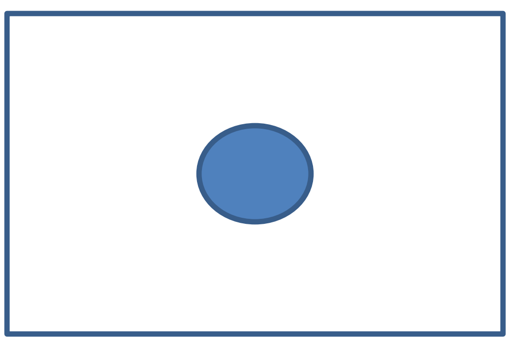
Lagoon Processes - Traditional

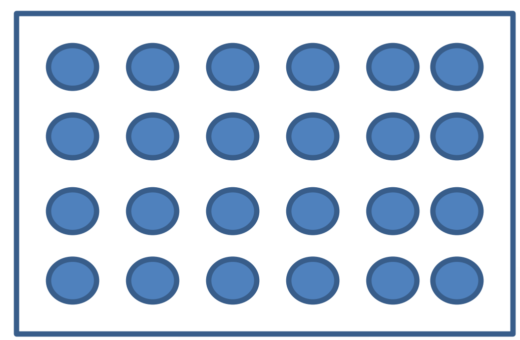
- Complete vs. Partial Mix Design
  - What does "completely mixed" mean?
    - Is it linear?
    - Or sinusoidal?

There is no accepted lagoon model known as "Vigorously Mixed"

Lagoon Processes - Traditional

- Complete vs. Partial Mix Design
  - What does “completely mixed” mean?
    - Energy input is only one dimension
    - What about distribution of energy?





Review of Advanced Technologies

Review of Advanced Technologies

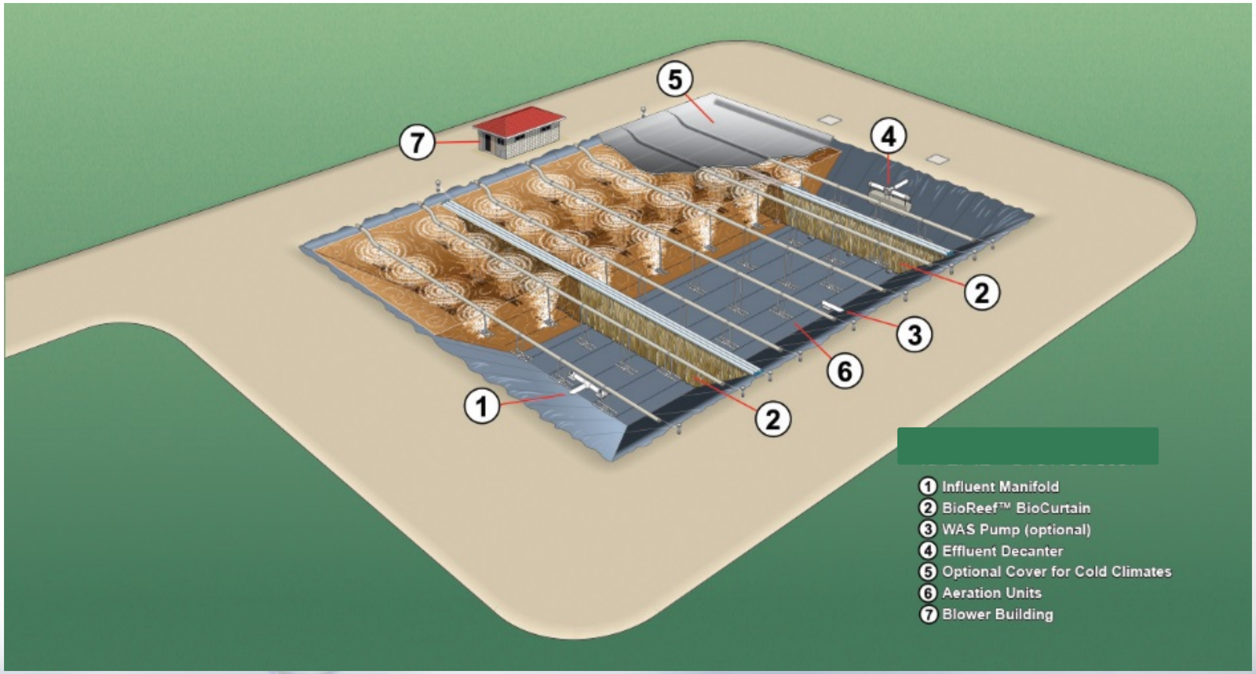
- Front-of-the-Plant
  - Advantages
    - Decreased footprint
    - Total nitrogen removal
    - Reduced energy
      - Shared blowers for BOD/ammonia
      - Denitrification reduces energy cost (use nitrate vs. oxygen)

Review of Advanced Technologies

- Front-of-the-Plant
  - Disadvantages
    - Sludge management
      - Wasting rates/timing
      - Sludge removal from digester
    - Increased mechanical components
      - Valves, pumps, clarification equipment, etc.
    - Potentially more complicated construction project
      - Maintaining lagoon operation, dirt work, etc.

Review of Advanced Technologies

- Front-of-the-Plant Treatment Examples
  - Lagoon-Based Batch Reactors
    - w/ or w/o attached growth



Review of Advanced Technologies

- Front-of-the-Plant Treatment Examples
  - Lagoon-Based Batch Reactors
    - w/ or w/o attached growth
  - Activated Sludge Lagoons

Review of Advanced Technologies

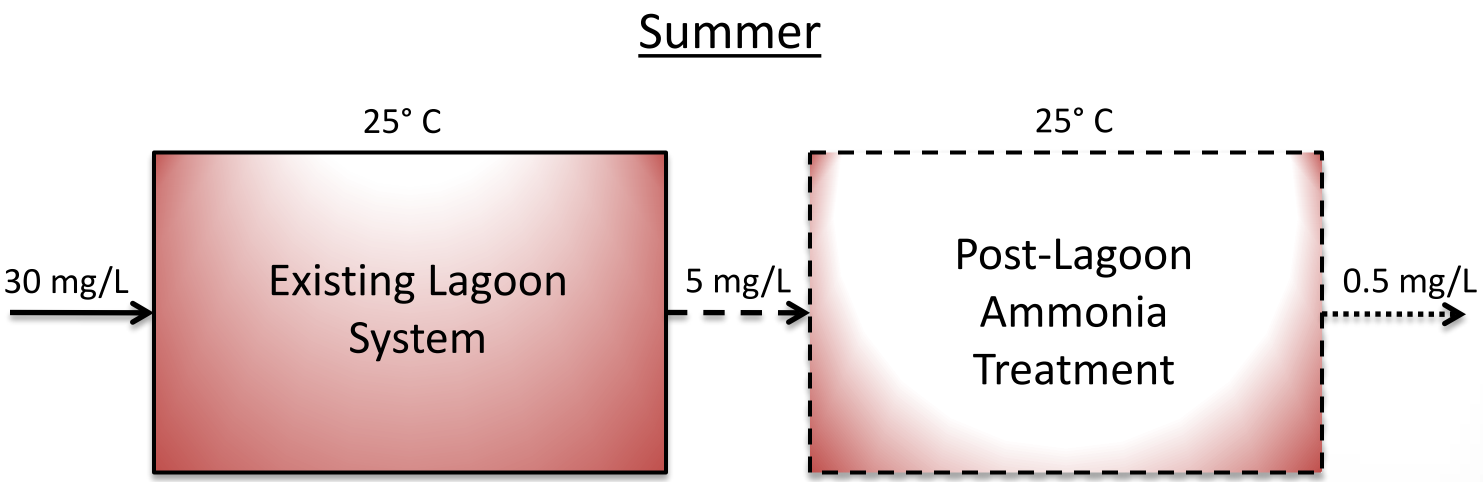
- Back-of-the-Plant
  - Advantages
    - Potentially less invasive construction
      - “Drop in” options may require little site modification
    - Easy to operate/maintain
    - Demonstrated extreme cold performance

Review of Advanced Technologies

- Back-of-the-Plant
  - Disadvantages
    - Must address variable loading and temperature
      - The one/two punch of fall/winter nitrification

Review of Advanced Technologies

- Back-of-the-Plant
  - Addressing variable loading and temperature



Review of Advanced Technologies

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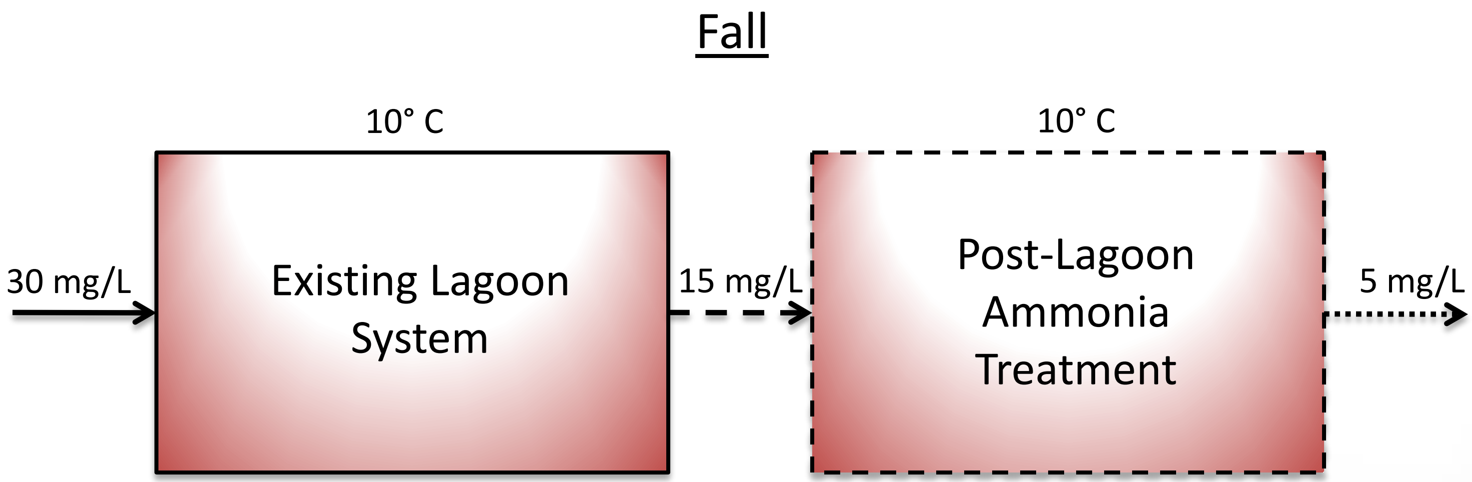
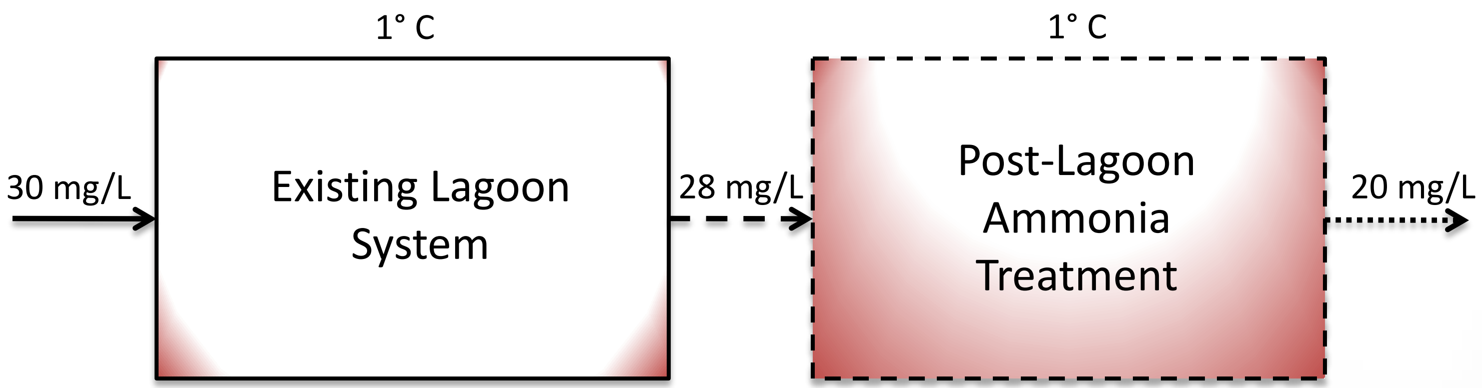


Review of Advanced Technologies

- Back-of-the-Plant
  - Addressing variable loading and temperature

Winter



Review of Advanced Technologies

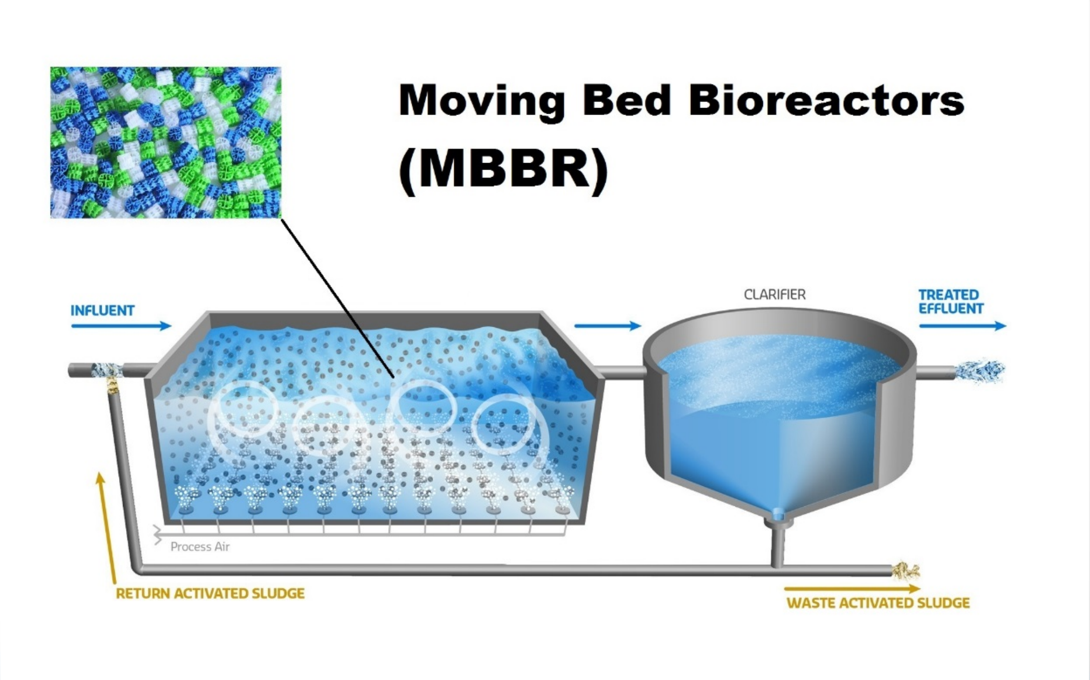
- Back-of-the-Plant
  - Disadvantages
    - Must address variable loading and temperature
      - Solutions:
        - » Thermal Covers (normalize temperature)
        - » Re-Heat Water (Since at least 2006)
        - » Bioaugmentation
        - » Step-Feed/Short-Circuit

Review of Advanced Technologies

- Back-of-the-Plant
  - Disadvantages
    - Must address variable loading and temperature
    - Filtration may be necessary
    - Full sludge removal may be necessary
    - Total nitrogen removal difficult/complicated
    - Potential long term viability issues

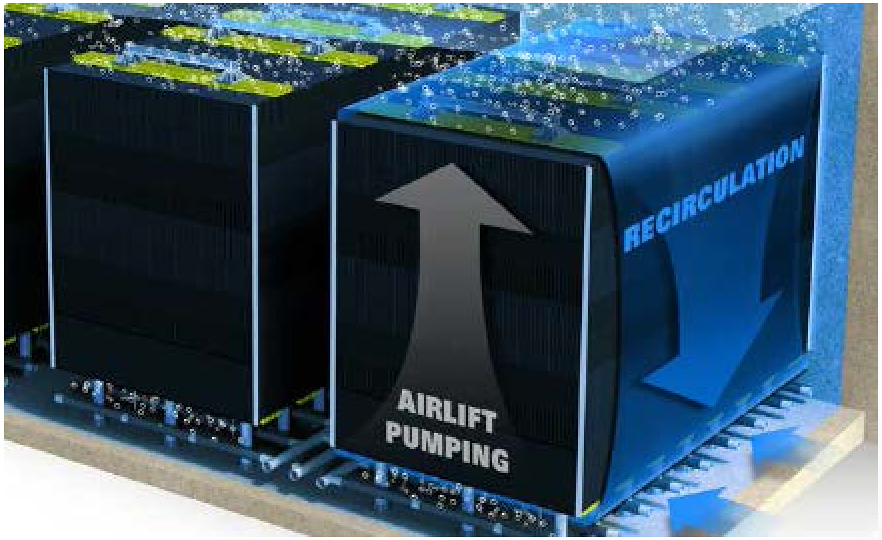
Review of Advanced Technologies

- Back-of-the-Plant Treatment (Examples)
  - IFAS (MBBR) w/ clarifier or filter



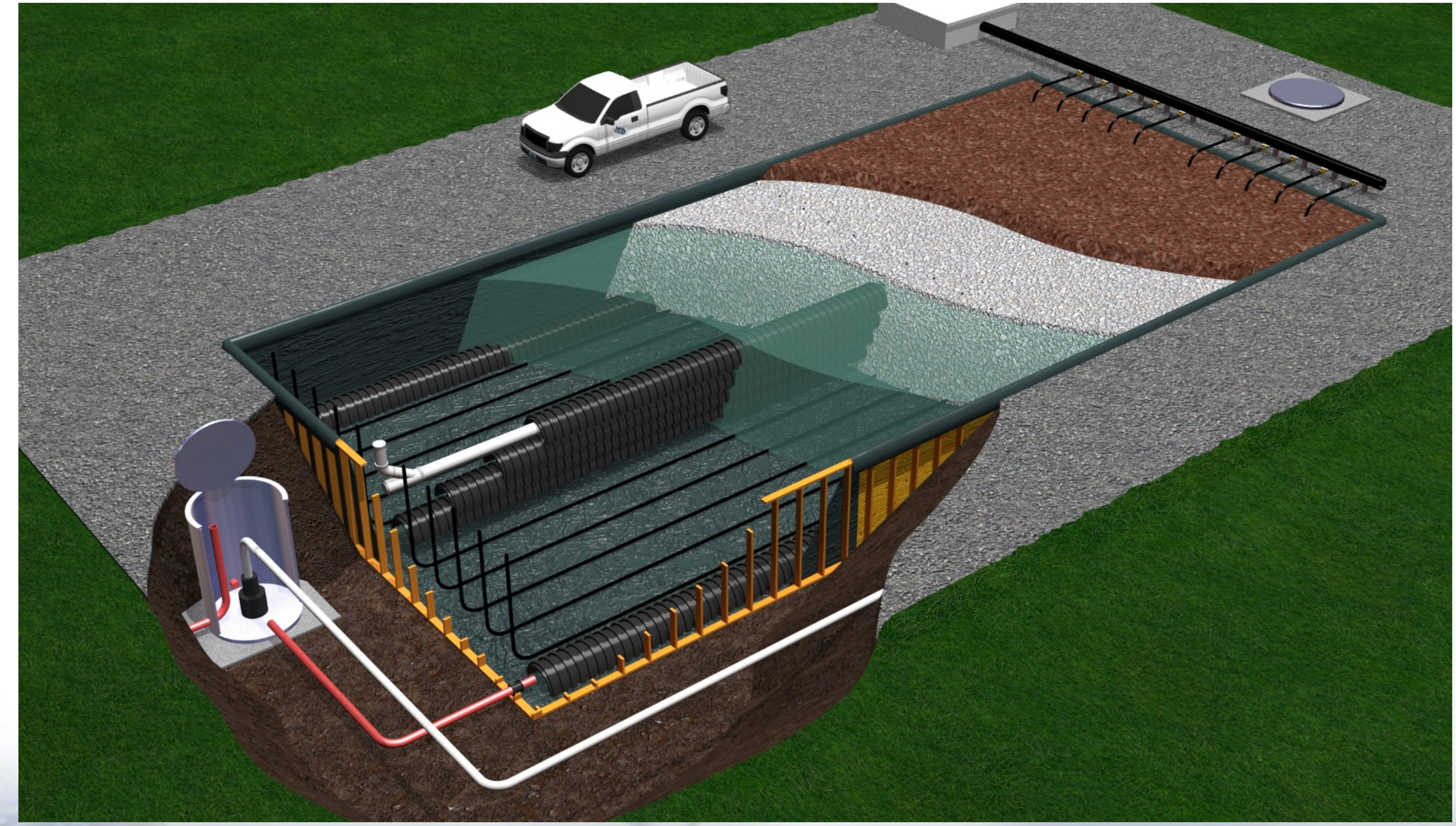
Review of Advanced Technologies

- Back-of-the-Plant Treatment (Examples)



Review of Advanced Technologies

- Back-of-the-Plant Treatment (Examples)



Final Thoughts

Final Thoughts

- Increasing Capacity (VAST)
  - Volume (sludge)
  - Aeration
  - Short-circuiting
  - Temperature
- No Silver Bullet
  - Front/Back-of-the-Plant dependent on client, operator, site limitations, and personal preference
  - All have advantages and disadvantages
- Design only as good as inputs
  - Influent studies needed!!!

Q&A

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