Environmental Dynamics International

Presents

Cold Weather Nitrification/Denitrification in Lagoons

October 13, 2016

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Environmental Dynamics International

Agenda

- Overview & Background
- IDEAL Bioreactor
- Performance Data (Round 1)
- Nutrient Removal in Lagoons
  - Phosphorous & Nitrogen Pathways
  - Treatment Philosophies
- Performance Data (Round 2)
- Nutrient Rebound
- Configurations
- Q&A

Overview & Background

Overview & Background

- Leader in aerated lagoons for 40 years
  - Introduced retrievable panel technology for aerated lagoons in 1970s
  - Continued innovative aeration and treatment design

Complete Mix Lagoon

Partial Mix Lagoon

Overview & Background

- Applying design expertise to advanced biological processes for 35+ years
  - Activated sludge and extended aeration plants
  - Over 3,500 installations world-wide

Botina, Paraguay

Millbury, MA

Overview & Background

- 25 Years of Sequencing Batch Reactor Systems
  - Over 300 international installations

Greater Noida, India – 72 MGD

Zywiec, Poland – 27 MGD

Overview & Background

- Integrated Fixed-Film System (IFAS) Innovation and Lagoon Installation
  - 50+ domestic MBBR installations


Attached-Growth Lagoon Media

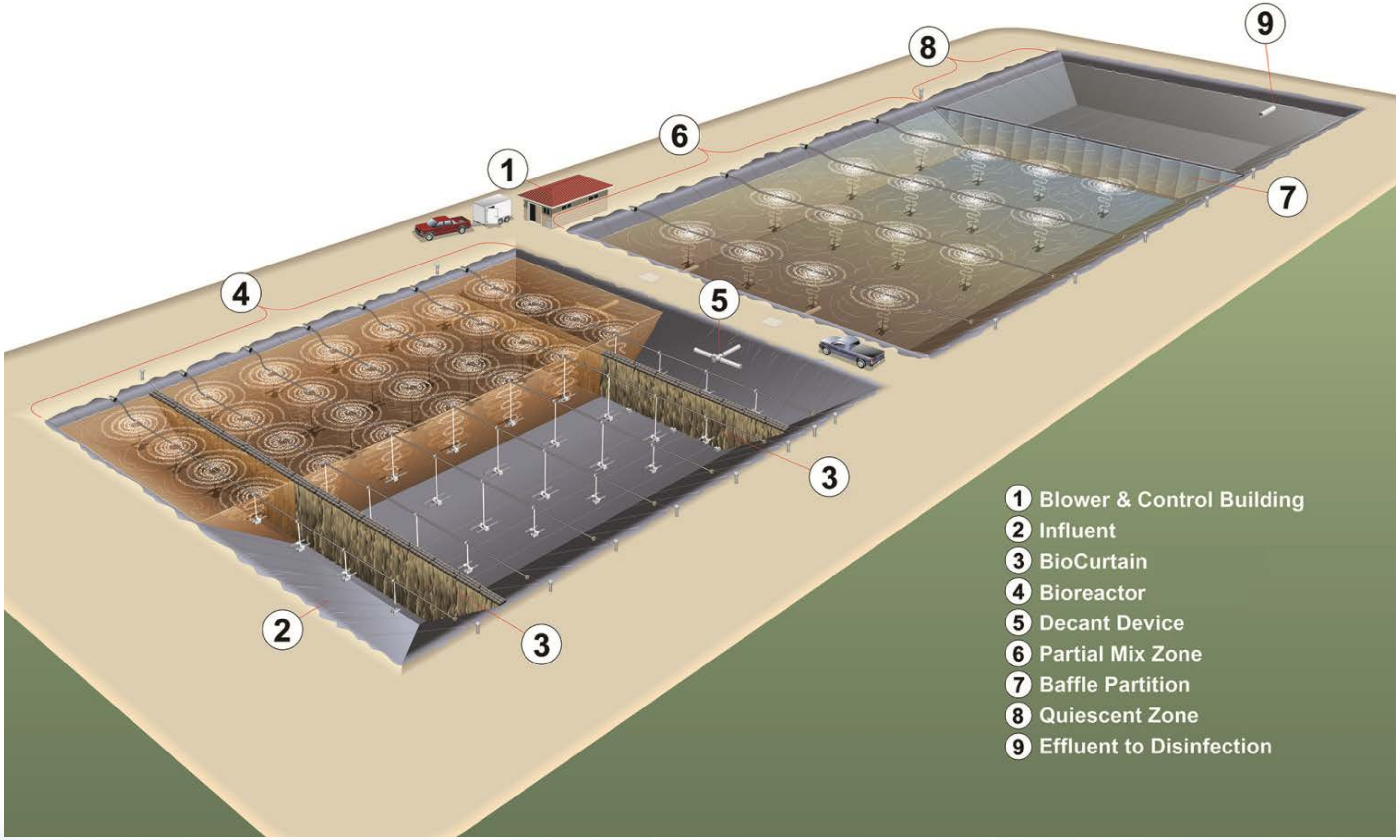

Media (Installed)

The IDEAL Bioreactor

The IDEAL Bioreactor

- Intermittently Decanted Extended Aeration Lagoon (IDEAL)
  - An advanced upgrade for lagoon-based treatment processes
    - Especially nutrient (ammonia, nitrogen, phosphorous) removal
  - Incorporates proven technologies across 40 years of wastewater treatment experience

What is the IDEAL Bioreactor?



Intermittently Decanted Extended Aeration Lagoon (IDEAL)

IDEAL® Solution

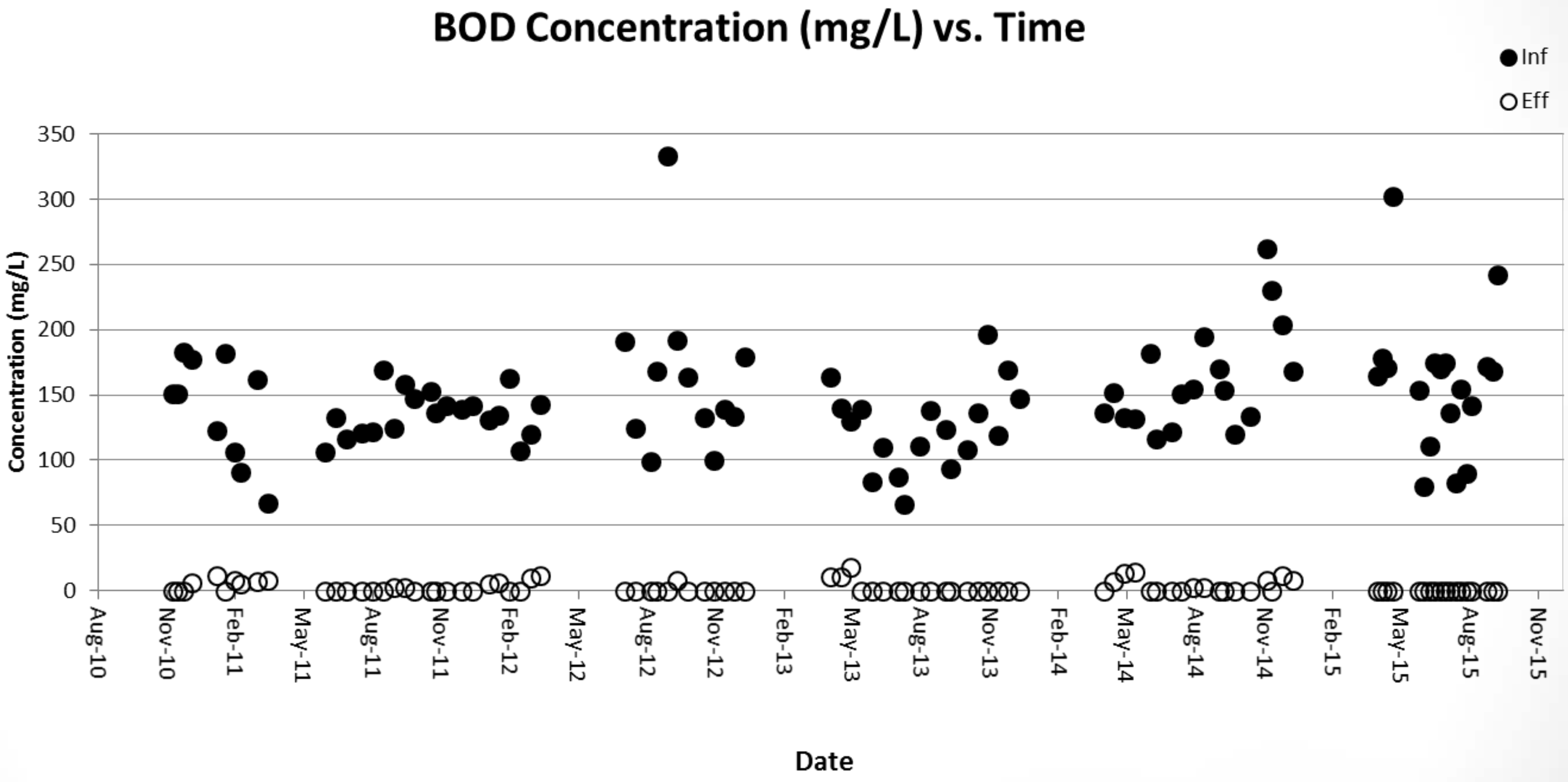
Phases

*operating sequence adjustable

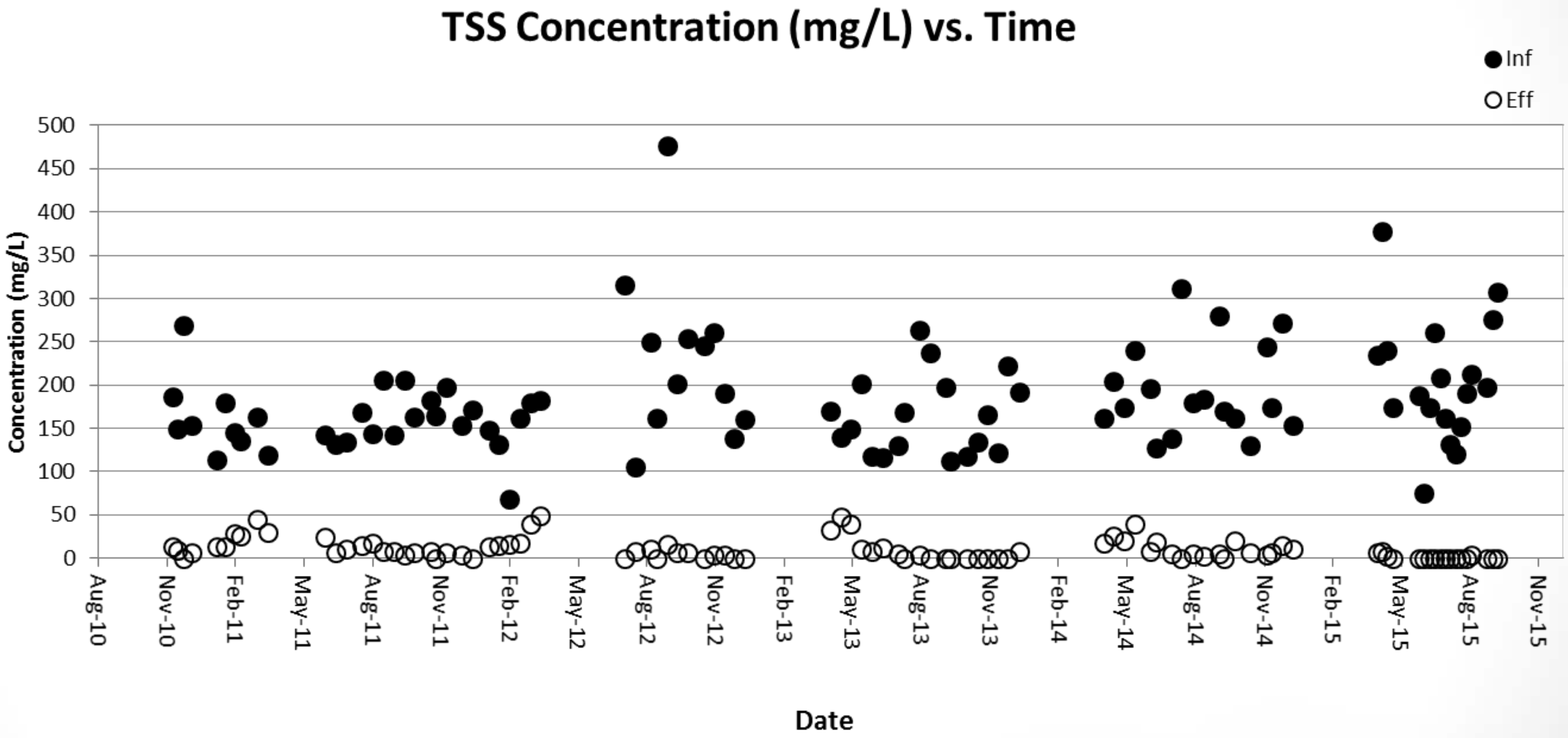
Performance Data (Round 1)

Performance Data – Grantsville, UT

Performance Data – Grantsville, UT



Performance Data – Grantsville, UT

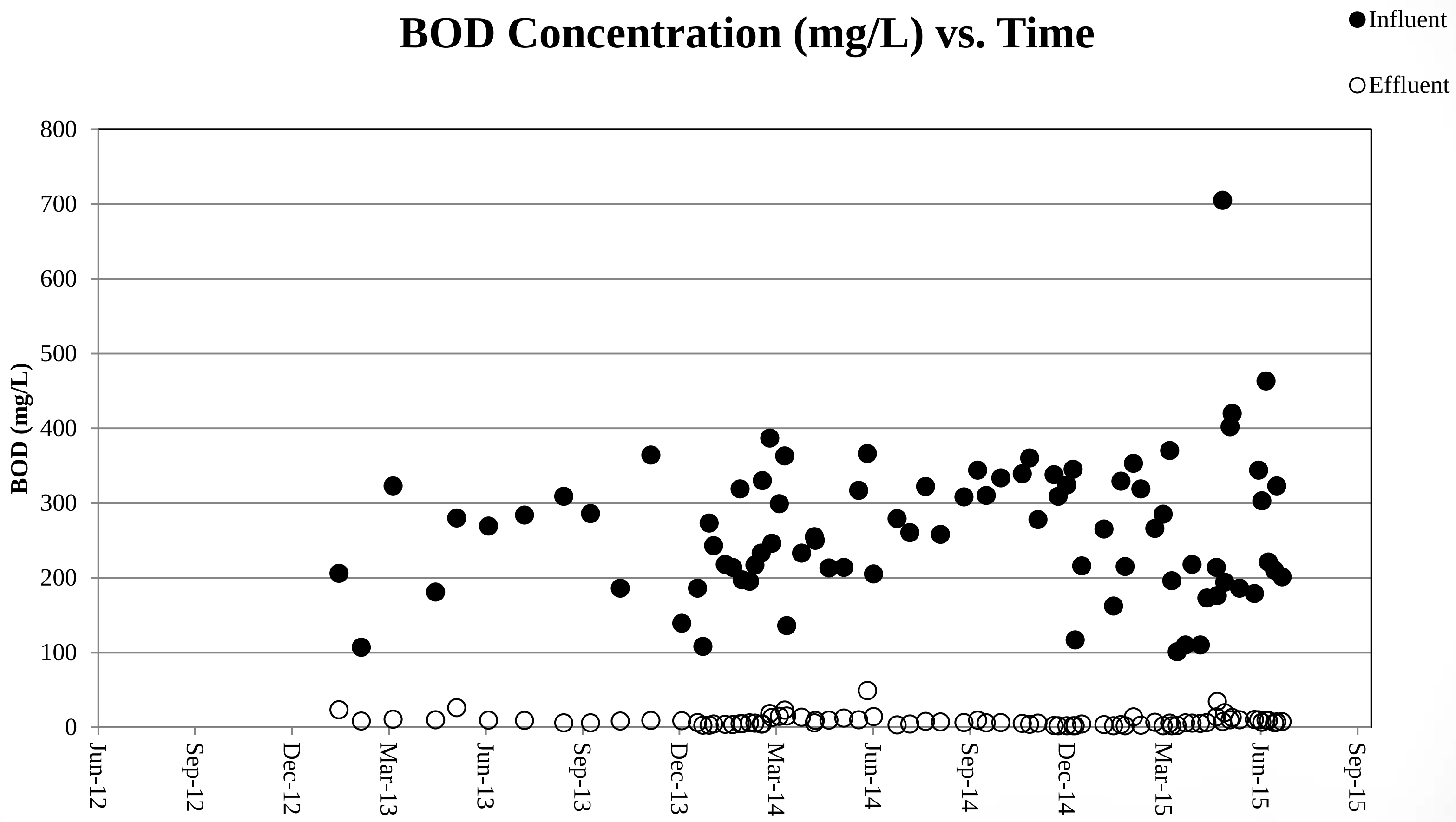


Performance Data – Grantsville, UT

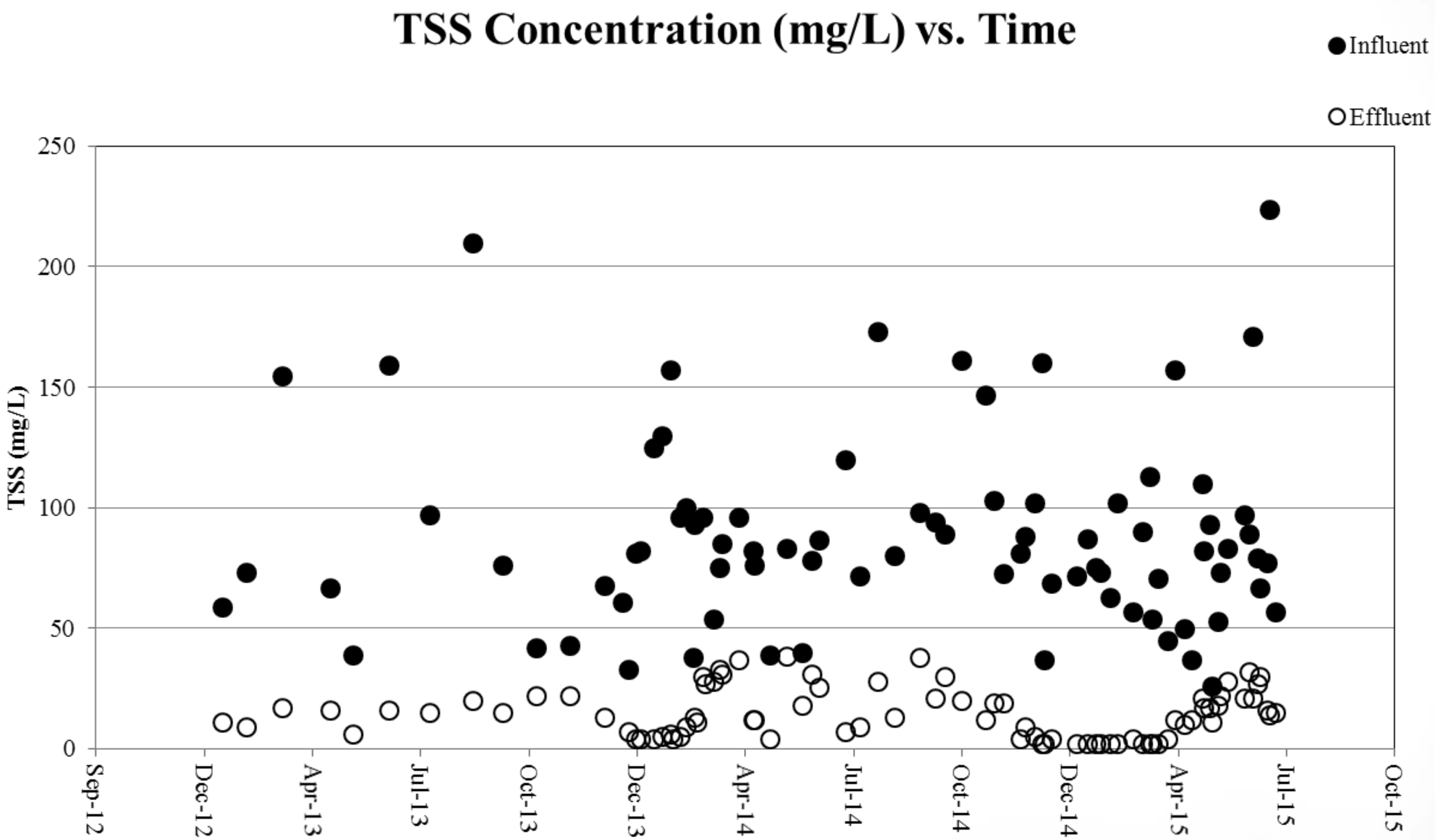
Process Data Summary (48+ Month Concentrations)			
Constituent	Influent	Effluent	Unit
BOD	147 ± 40	2.1 ± 4.1	mg/L
TSS	180 ± 60	11 ± 12	mg/L
	Minimum	Average	Maximum
Flow Rate (MGD)	.004	0.7	1.99

Performance Data – Miner, MO

Performance Data – Miner, MO



Performance Data – Miner, MO



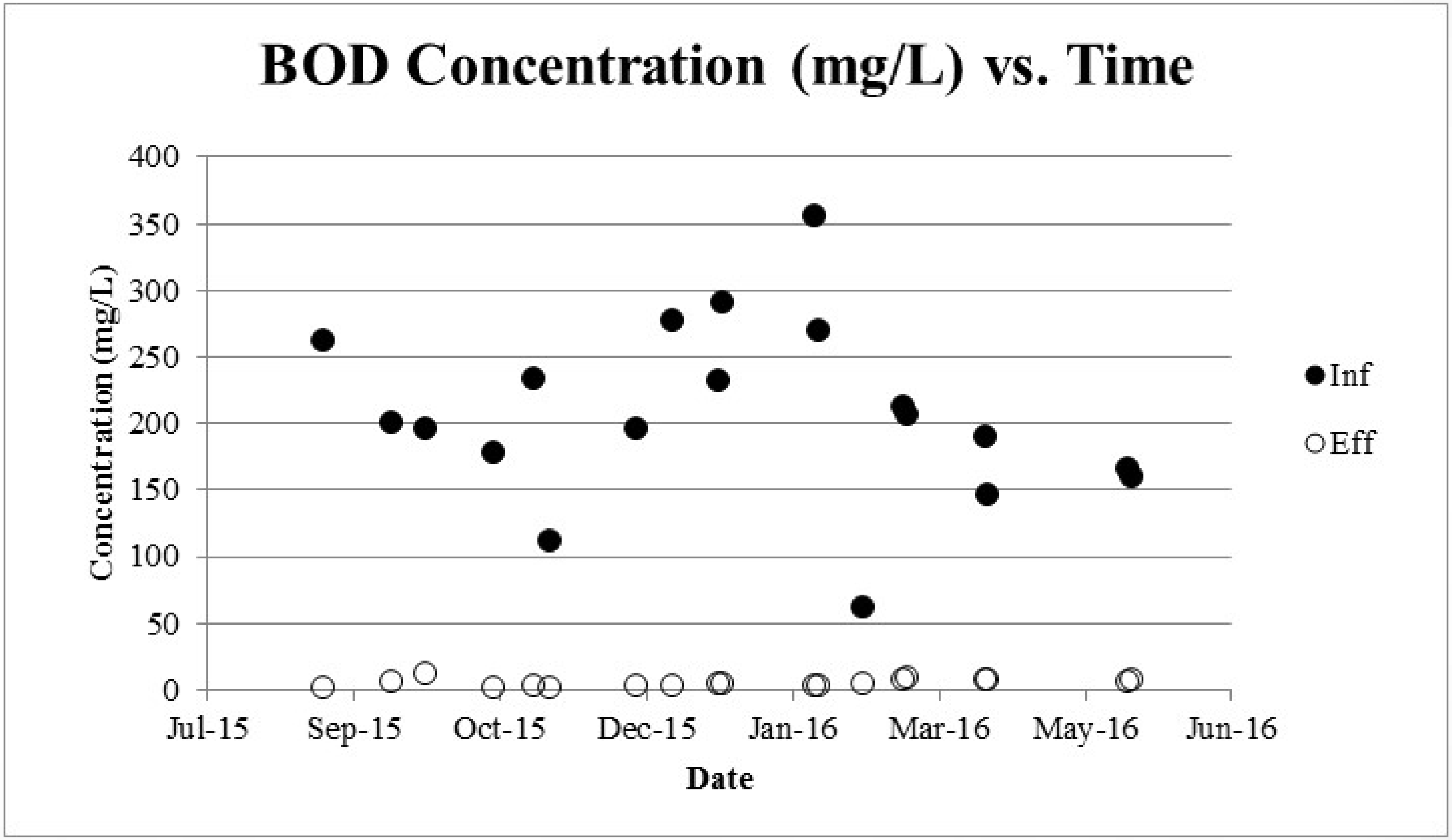
Performance Data – Miner, MO

Process Data Summary (24 Month Concentrations)			
Constituent	Influent	Effluent	Unit
BOD	260 +/- 90	8.6 +/- 7.3	mg/L
TSS	90 +/- 40	14 +/- 10	mg/L

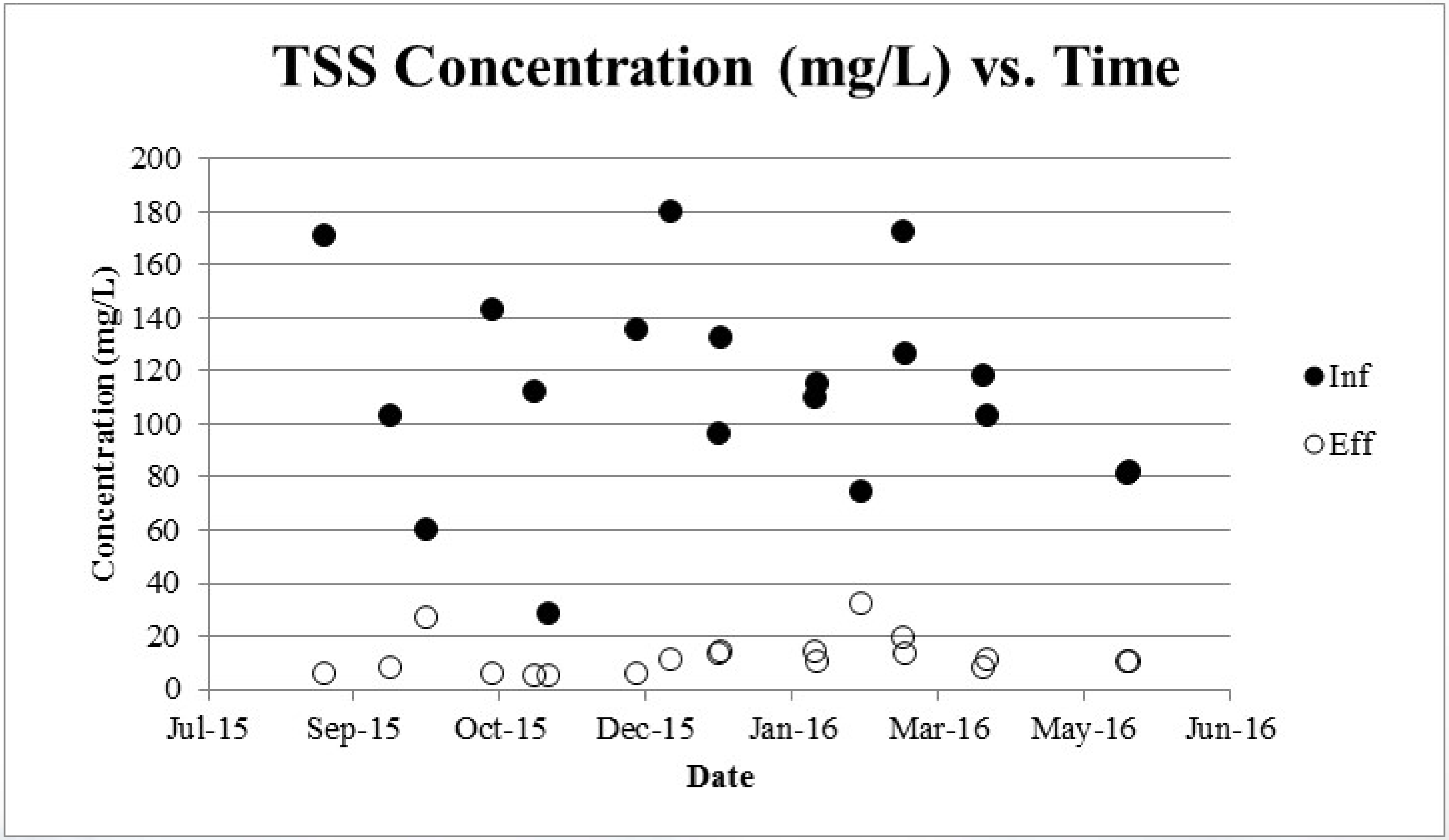
Performance Data – New Madrid, MO

(Photo Not Available)

Performance Data – New Madrid, MO



Performance Data – New Madrid, MO



Performance Data – New Madrid, MO

Process Data Summary			
Constituent	Influent	Effluent	Unit
BOD	210 +/- 70	5 +/- 2.7	mg/L
TSS	110 +/- 40	12 +/- 7	mg/L

Nutrient Removal in Lagoons

Nutrient Removal in Lagoons

- Phosphorous
- Nitrogen
  - Ammonia/Ammonium
  - Nitrate/Nitrite
  - Cellular/Biomass/Sludge

EPA Ammonia Criteria

Nutrient Removal in Lagoons

Nutrient Removal in Lagoons

Missouri Department of Natural Resources

Changes to the Water Quality Standard for Ammonia

Water Protection Program fact sheet 10/2013
Division of Environmental Quality, Leanne Tippett Mosby, Director

Ammonia toxicity varies by temperature and by pH of the water. Assuming a stable pH value, but taking into account winter and summer temperatures, Missouri includes two seasons of ammonia effluent limitations. Typical ammonia effluent limitations for a facility discharging to a stream with no dilution allowances, under the current water quality standard, are:

- Summer – 3.6 mg/L daily maximum, 1.4 mg/L monthly average.
- Winter – 7.5 mg/L daily maximum, 2.9 mg/L monthly average.

Under the new EPA criteria, where mussels are present or expected to be present, typical effluent limitations for a facility discharging to a stream with no dilution allowance would be:

- Summer – 1.7 mg/L daily maximum, 0.6 mg/L monthly average.
- Winter – 5.6 mg/L daily maximum, 2.1 mg/L monthly average.

Nutrient Removal in Lagoons

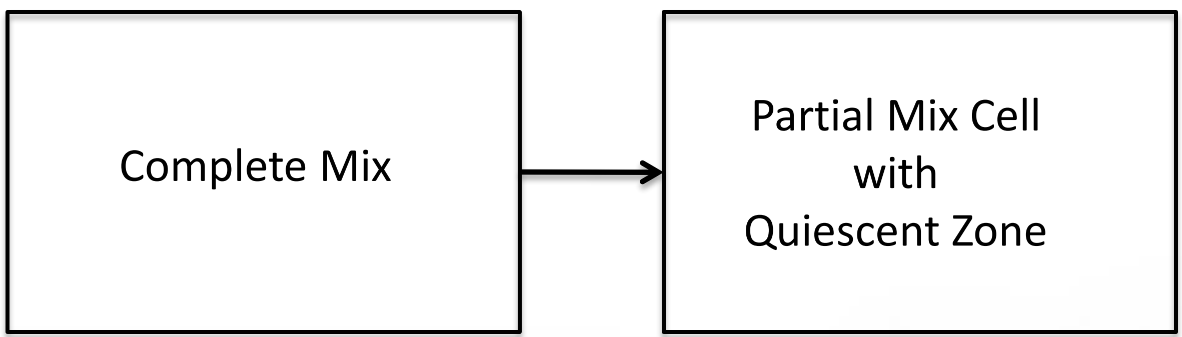
Wastewater Treatment Technologies

Key:
A – Preferred when feasible
B – Has demonstrated capability in meeting ammonia when designed appropriately
C – Shows potential for meeting ammonia limitations.
D – Unlikely to meet ammonia limitations, or data inconclusive

Wastewater Technology	Ammonia Effluent Limit (mg/L)			
	< 0.7	0.7 - 1.4	1.5 - 2.5	2.5 - 5.0
Land Application	A	A	A	A
Wetland	D	D	D	D
Facultative Lagoon	D	D	D	C
Aerated, Partial Mix Lagoon	D	D	D	C
Lagoons with Approved Retrofits	C	C	C	B
Recirculating Sand Filter	C	C	C	B
Trickling Filter	D	D	C	B
Oxidation Ditch	B	B	B	B
Extended Aeration Package Plant	D	C	B	B
Sequencing Batch Reactor	B	B	B	B
Biological Nutrient Removal	B	B	B	B
Enhanced Biological Nutrient Removal	B	B	B	B
Membrane Bioreactors	B	B	B	B
Breakpoint Chlorination	D	D	C	C
Moving Bed Biofilm Reactor	B	B	B	B
Integrated Fix Film Activated Sludge	B	B	B	B
Side Stream Nutrient Removal	B	B	B	B

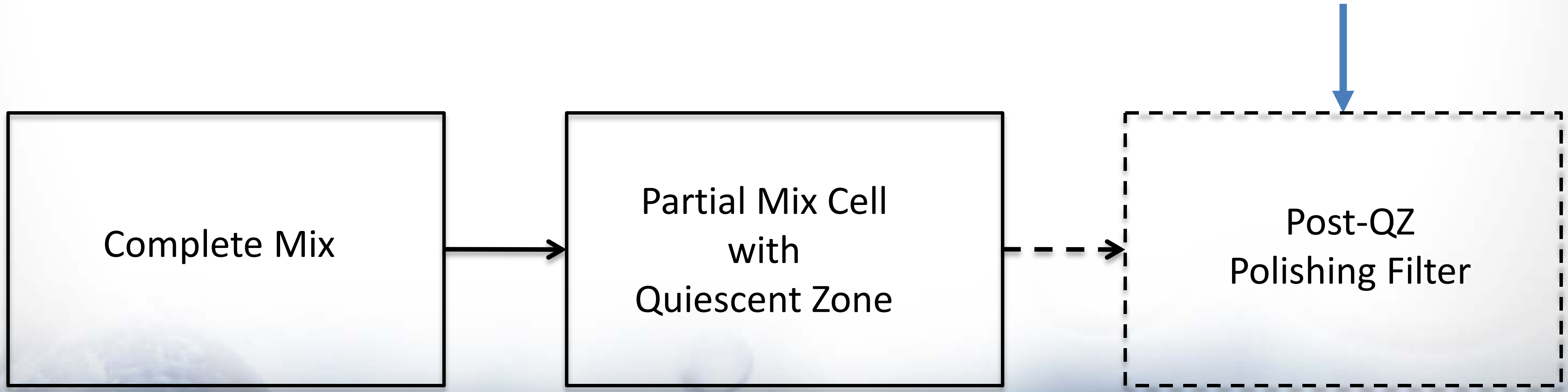
Nutrient Removal in Lagoons

- Solution to Challenges:
  - Increase Biomass
    - Back-of-the-Plant
    - Middle-of-the-Plant
    - Front-of-the-Plant



Nutrient Removal in Lagoons

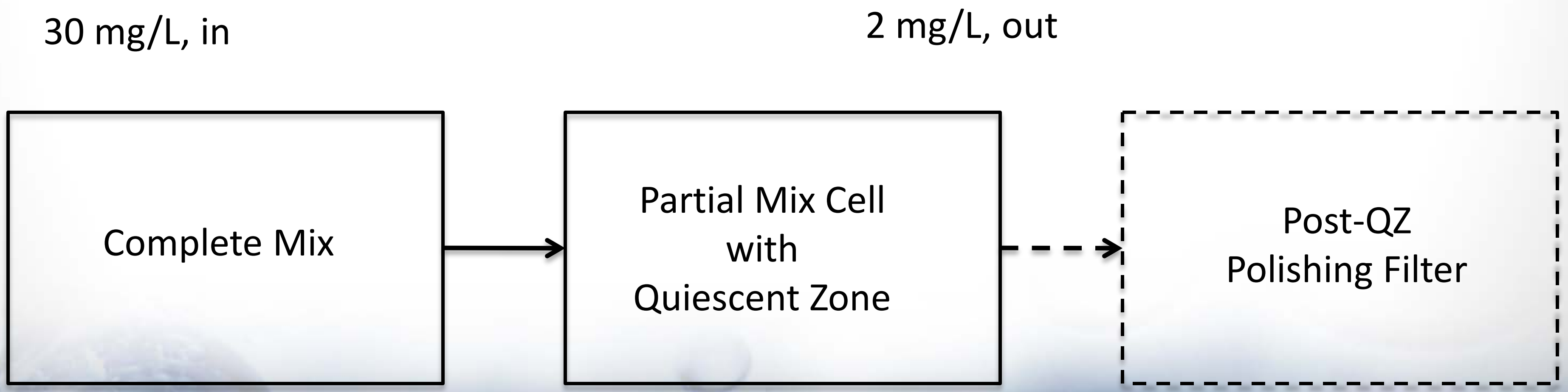
- Select a Selector
  - Back of the Plant
    - Attached growth “filters”
    - Must address variable loading (temperature induced)



Nutrient Removal in Lagoons

- Select a Selector
  - Back of the Plant
    - Attached growth "filters"
    - Must address variable loading (temperature induced)

Summer



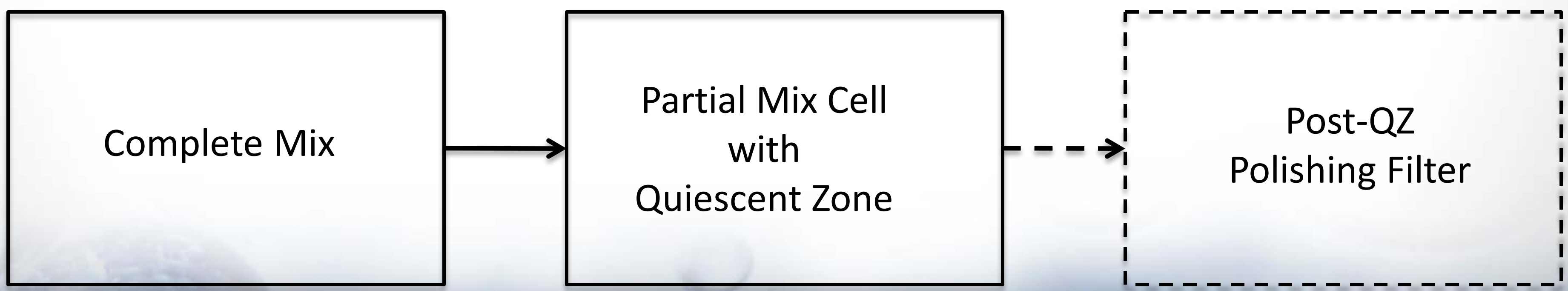
Nutrient Removal in Lagoons

- Select a Selector
  - Back of the Plant
    - Attached growth “filters”
    - Must address variable loading (temperature induced)

Winter

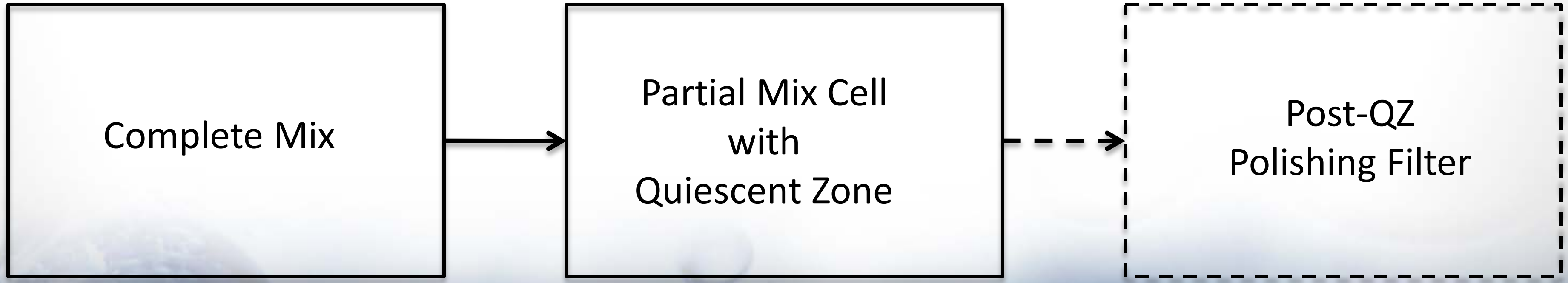
30 mg/L, in

25 mg/L, out



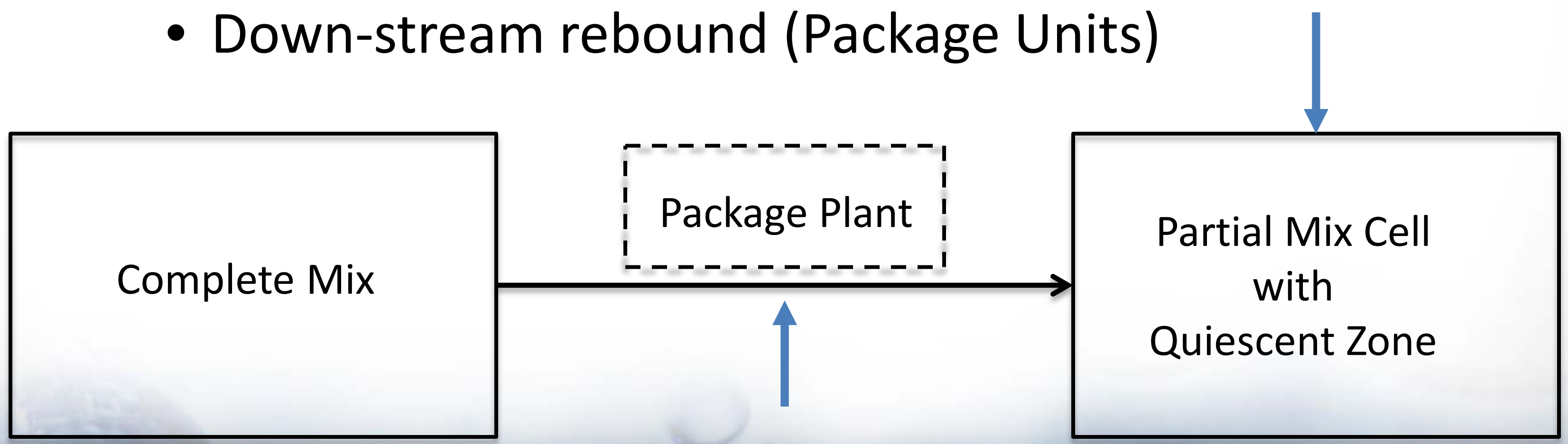
Nutrient Removal in Lagoons

- Select a Selector
  - Back of the Plant
    - Attached growth “filters”
    - Must address variable loading (temperature induced)
    - Possible BOD & TSS management needs



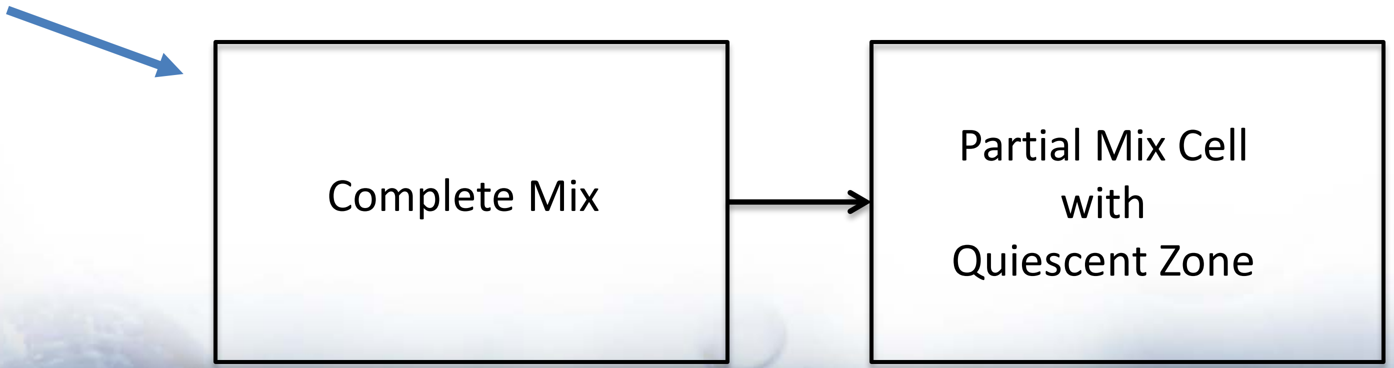
Nutrient Removal in Lagoons

- Select a Selector
  - Back-of-the-Plant
  - Middle-of-the-Plant
    - Must address variable loading (temperature induced)
    - Short-circuiting potential (PM Units)
    - Down-stream rebound (Package Units)



Nutrient Removal in Lagoons

- Select a Selector
  - Back-of-the-Plant
  - Middle-of-the-Plant
  - Front-of-the-Plant
    - Down-stream rebound potential
    - Denitrification



Performance Data (Round 2)

Miner, MO Ammonia Data

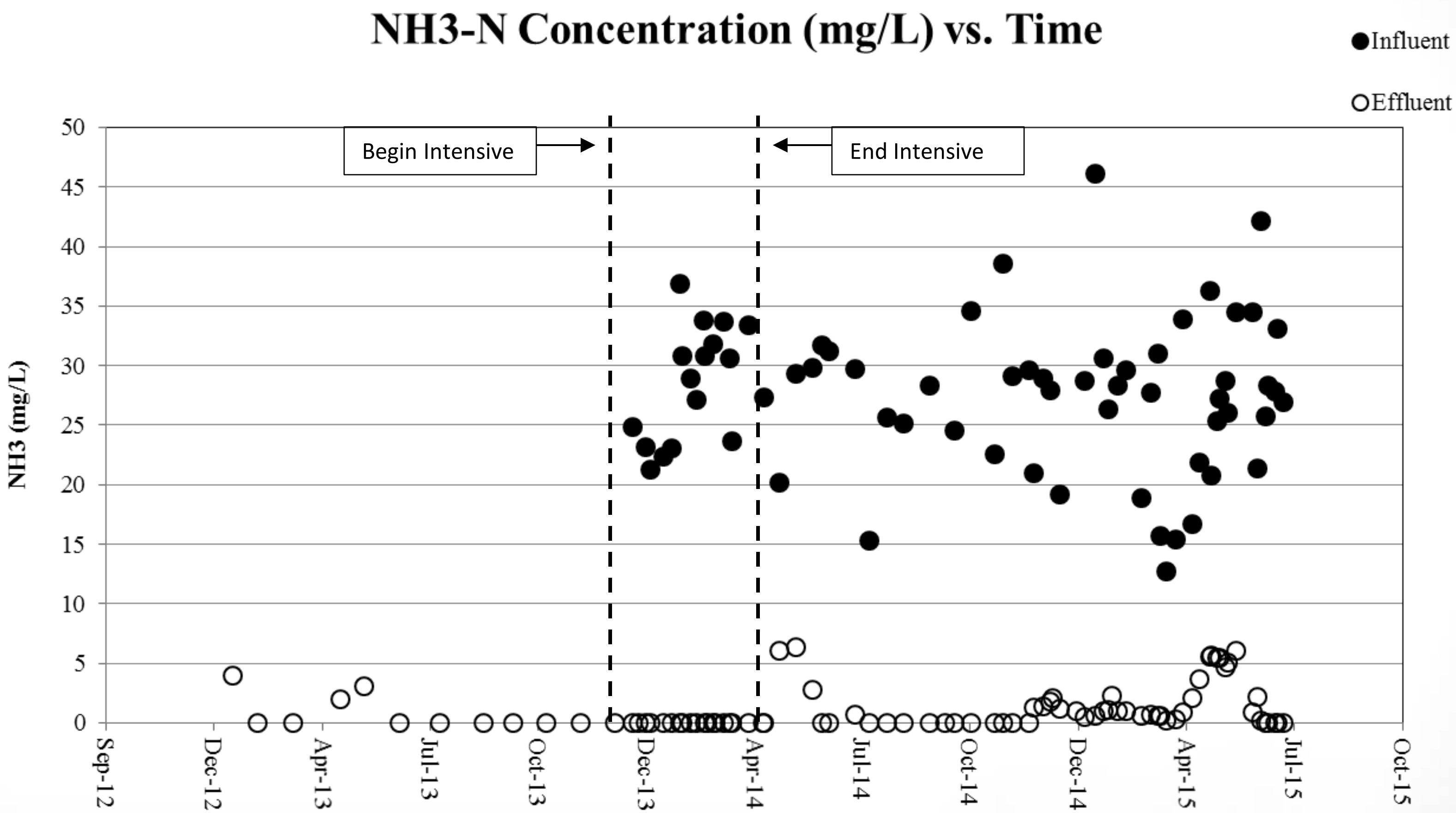
Miner, MO Ammonia Data

Process Data Summary (24 Month Concentrations)			
Constituent	Influent	Effluent	Unit
Ammonia-N	28 +/- 6	0.66 +/- 1.3	mg/L
(April-September)	27 +/- 6	1.9 +/- 2.4	mg/L
(October-March)	28 +/- 7	0.5 +/- 0.8	mg/L

Miner, MO Ammonia Data

Miner, MO Ammonia Data

Miner, MO Ammonia Data

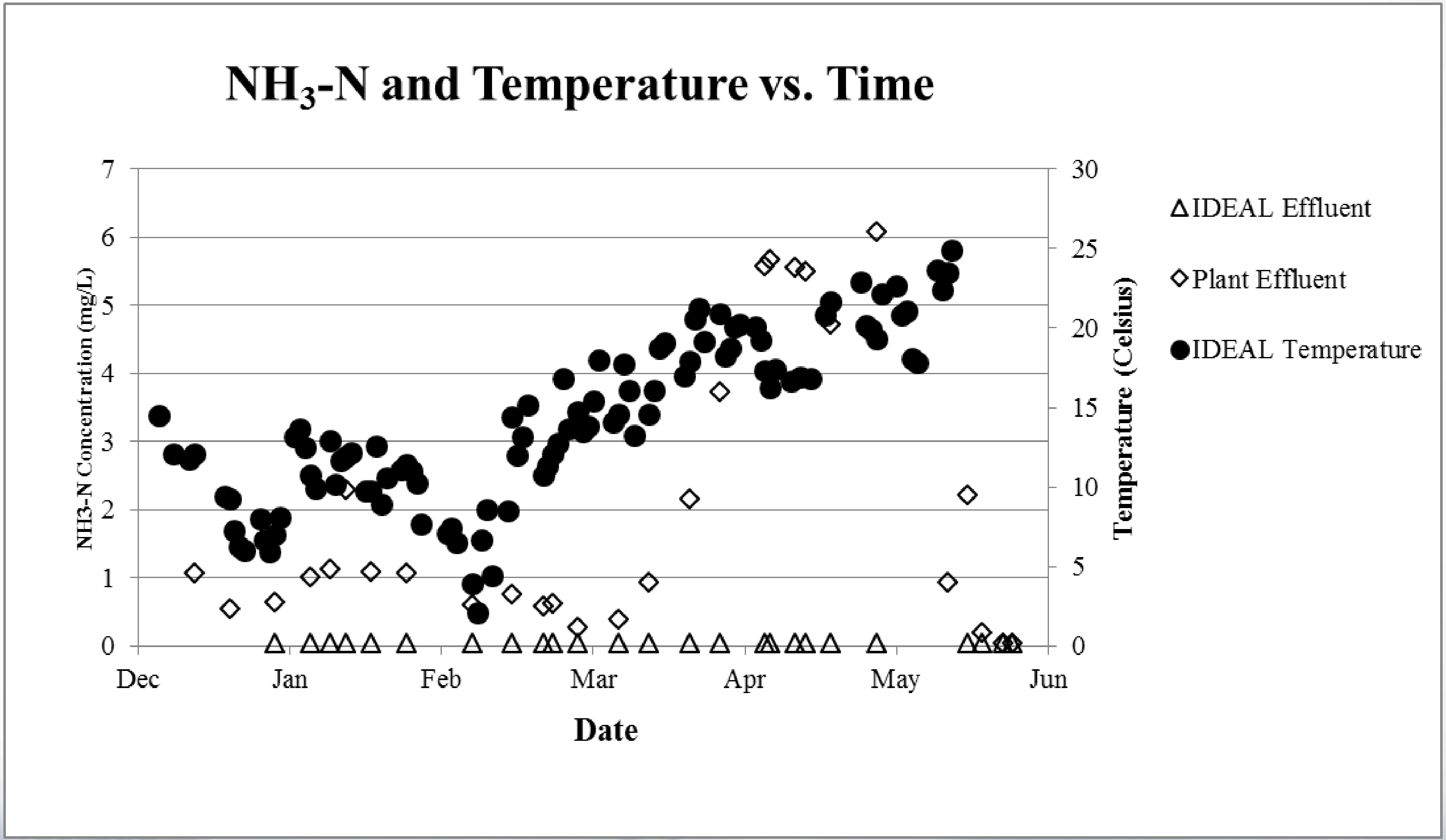


Miner, MO Ammonia Rebound Data

(IDEAL Bioreactor vs. PM/QZ Effluent)

Miner, MO Ammonia Rebound Data

(IDEAL Bioreactor vs. PM/QZ Effluent)



Miner, MO Ammonia Rebound Data

(IDEAL Bioreactor vs. PM/QZ Effluent)

Process Data Summary (30 Month Concentrations)			
Constituent	Influent	Effluent	Unit
Ammonia-N	28 +/- 6	0.24 +/- 0.39	mg/L
(April-September)	27 +/- 6	0.15 +/- 0.26	mg/L
(October-March)	28 +/- 7	0.28 +/- 0.43	mg/L

IDEAL Miner, MO Case Study

Ideal Process Data Summary (2013-2014 Winter) a/ Warm Up		
Constituent	Influent (mg/L)	Effluent (mg/L)
BOD	275 +/- 75	13 +/- 6
TSS	75 +/- 23	25 +/- 9.8
Ammonia-N	31 +/- 4	0.05 +/- 0
Nitrate-N	0.05 +/- 0.06	11 +/- 4
Nitrite-N	0.12 +/- 0.18	0.91 +/- 0.86
Total Nitrogen	42 +/- 10	15 +/- 4
IDEAL Bioreactor Characteristics		
Flow (MGD)	0.18 +/- 0.02	
Temperature (°C)	11 avg (16 max, 4.4 min)	
MLSS (mg/L)	1300 +/- 300	
F:M Ratio	0.045	

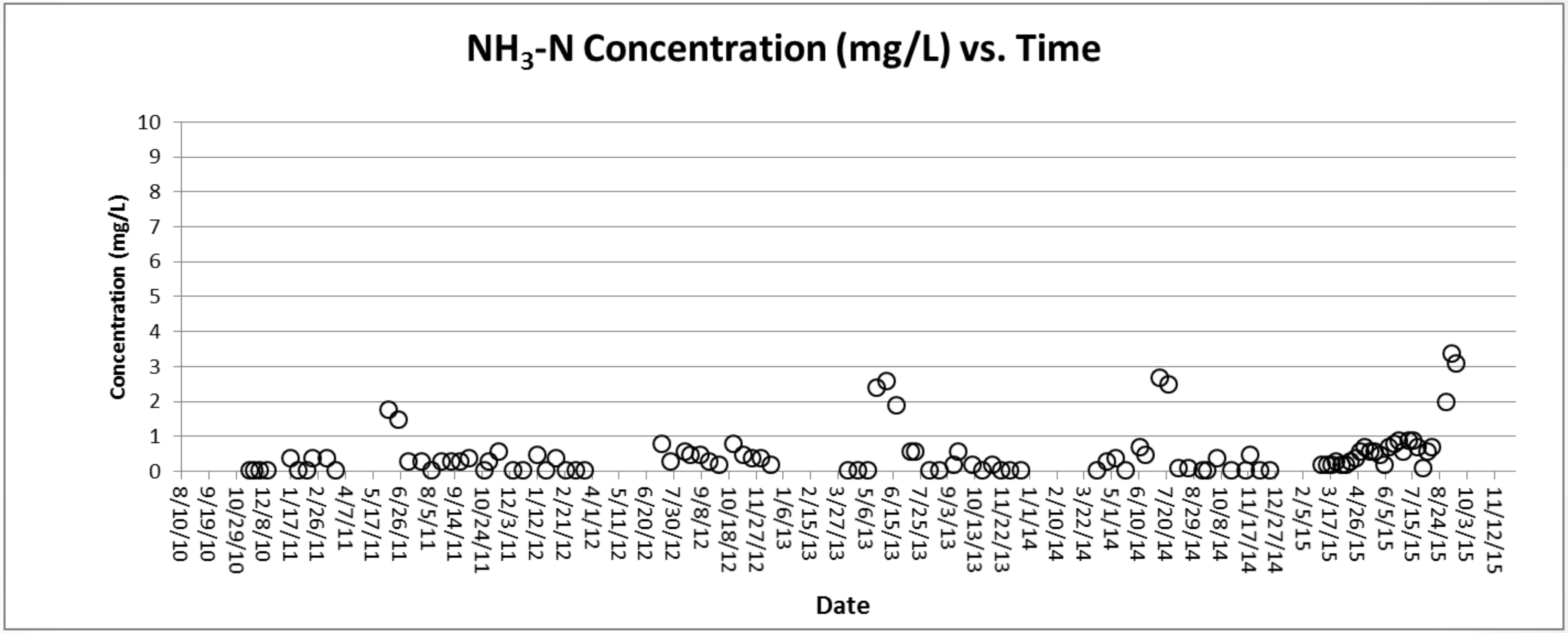
Note I: Error calculated using Student's T with a 98% confidence interval

Note II: Effluent Ammonia-N consistently below method detection limit of 0.05 mg/L

Grantsville, UT Ammonia Rebound Data

(IDEAL Bioreactor vs. PM/QZ Effluent)

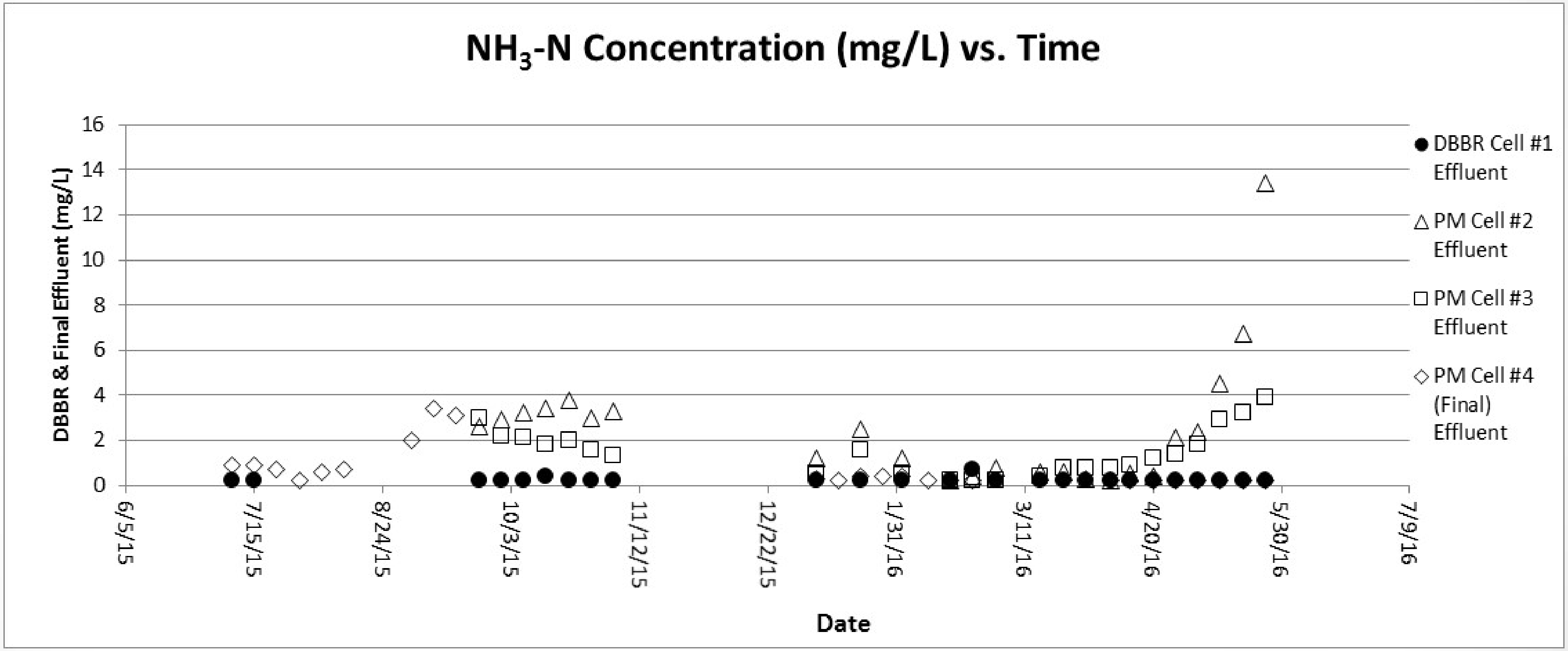
IDEAL Performance Data – Grantsville, UT



Grantsville, UT Ammonia Rebound Data

(IDEAL Bioreactor vs. PM/QZ Effluent)

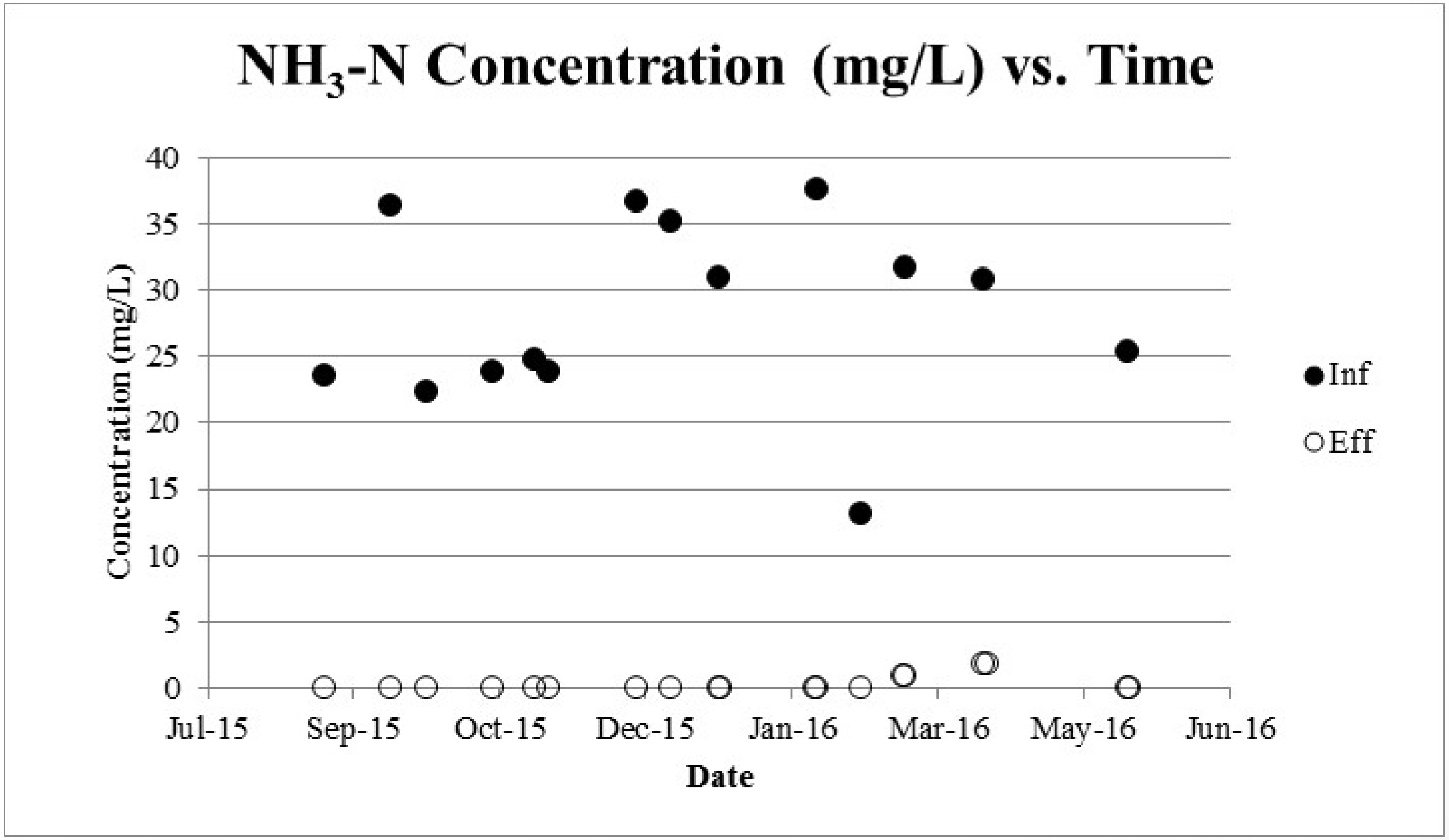
IDEAL Performance Data – Grantsville, UT



New Madrid, MO Ammonia Data

Note: Miner, MO shown as example; layout similar

New Madrid, MO Ammonia Data



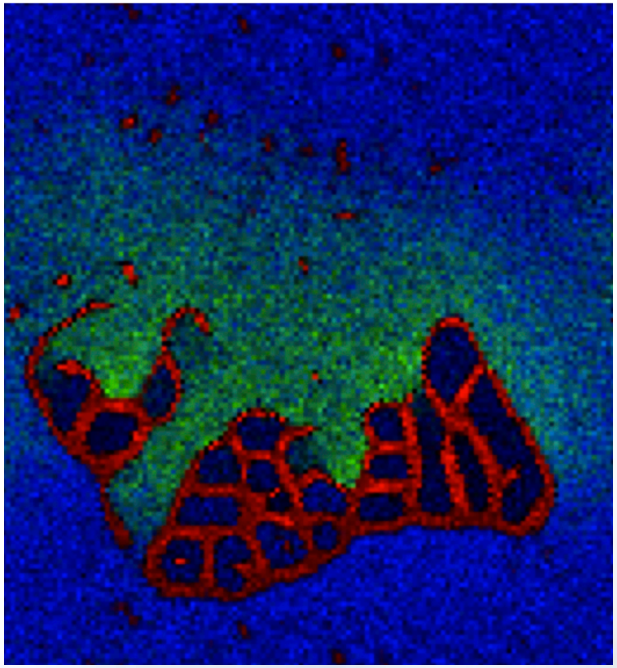
New Madrid, MO Ammonia Data

Process Data Summary (5 Month Concentrations)			
Constituent	Influent	Effluent	Unit
Ammonia-N	28 +/- 7	0.33 +/- 0.61	mg/L

Nutrient Rebound

Nutrient Rebound

- Rebound Defined
  - Pollutants (namely nutrients) generated during sludge digestion

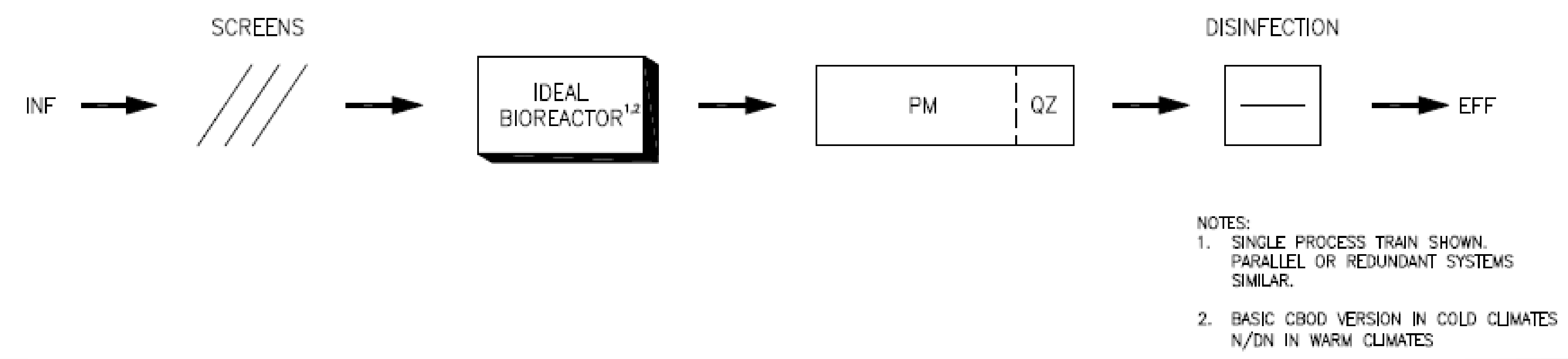


Nutrient Rebound

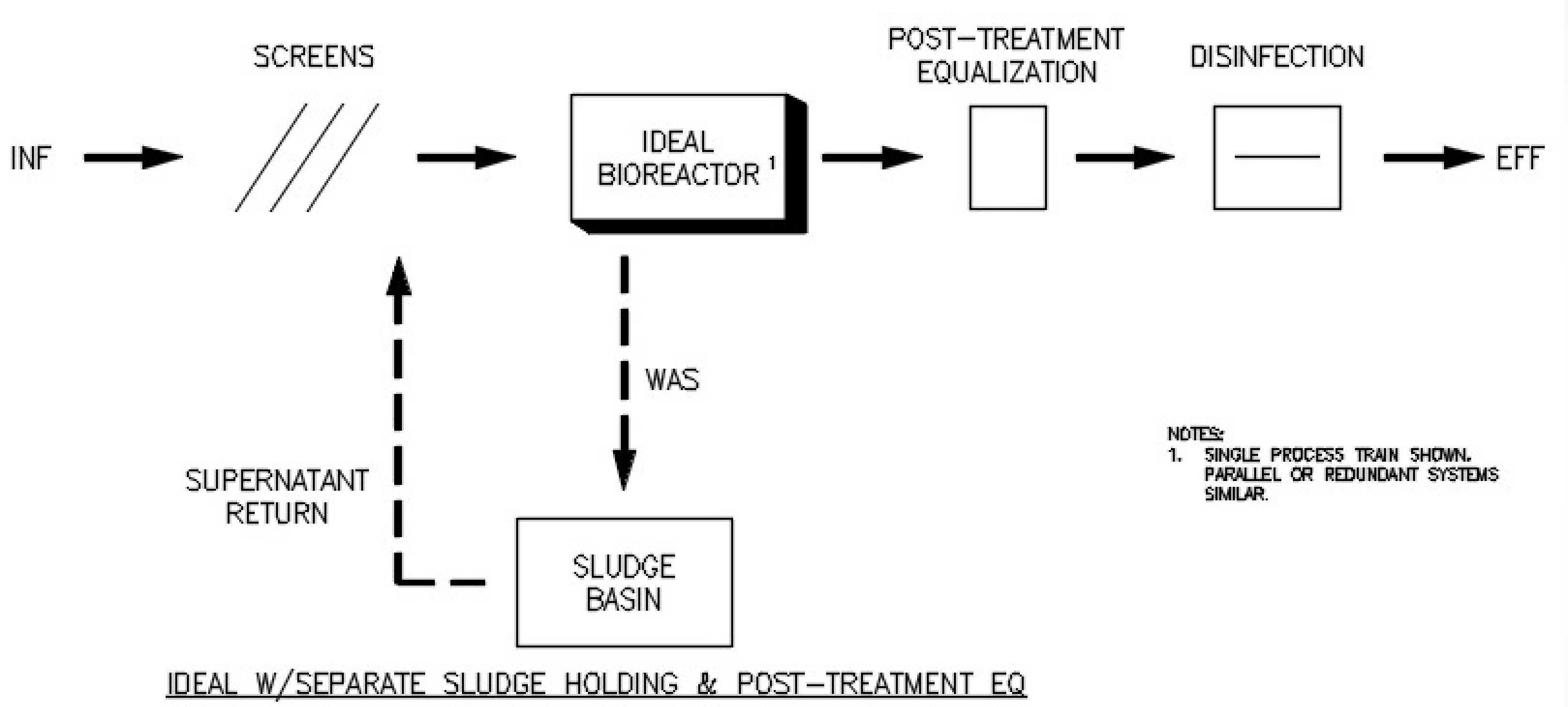
- Rebound in Lagoons
  - Occurs during the sludge digestion process
    - Always in the background
  - Unsteady State = Major Events
    - Decay is "temperature-dependent"

Lagoon Configurations

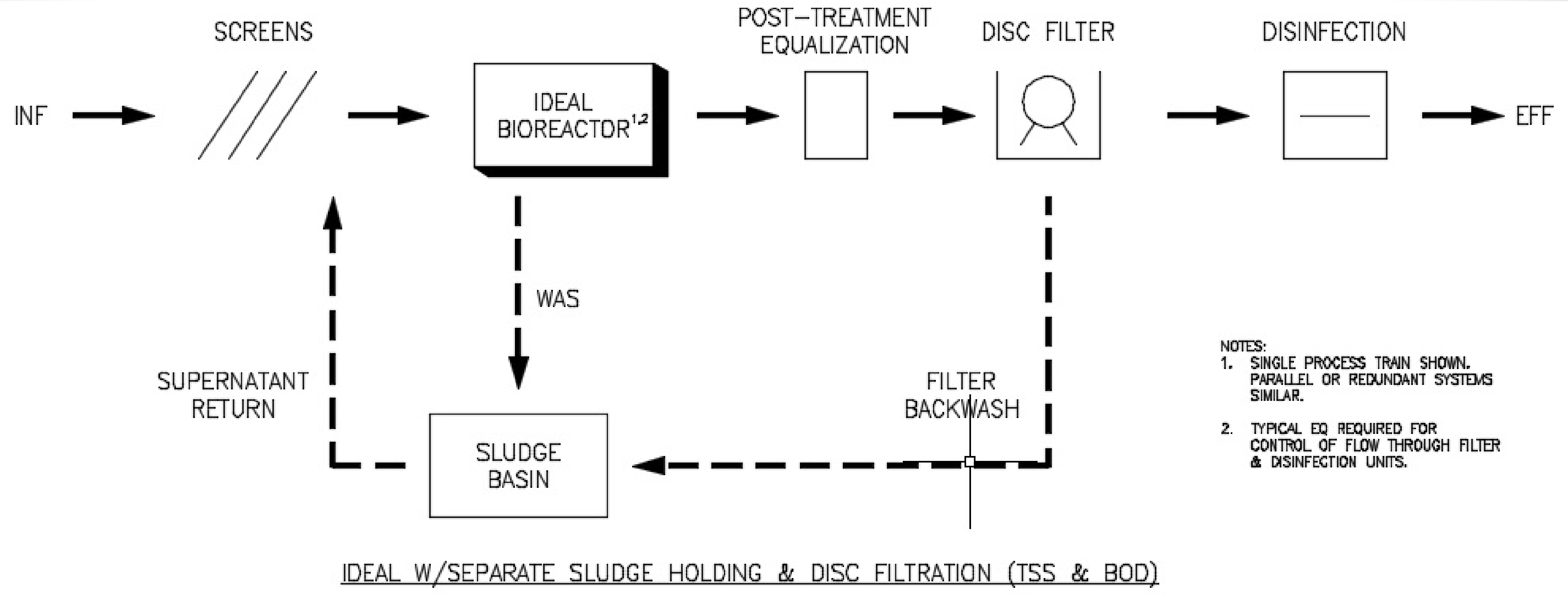
Lagoon Configurations



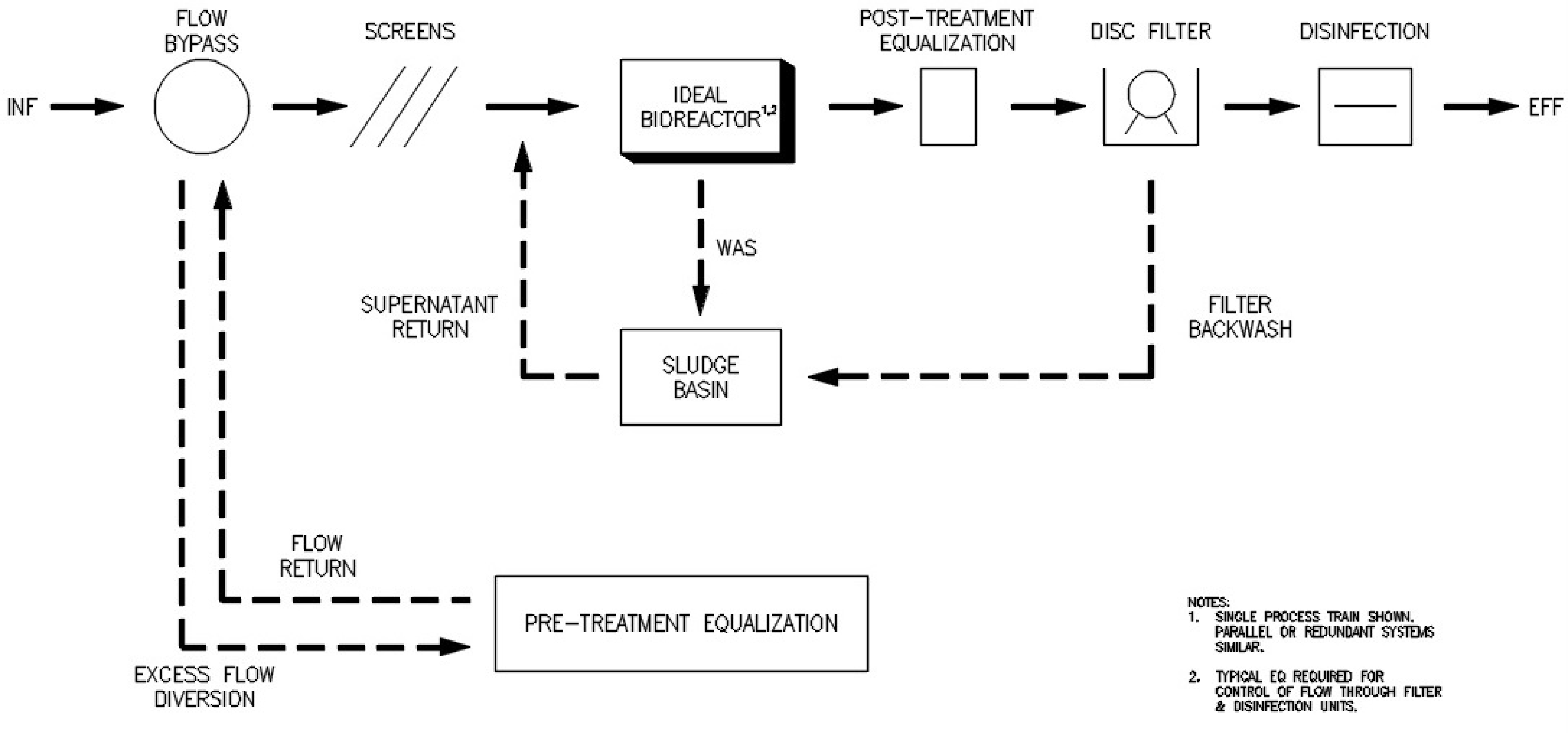
Lagoon Configurations



Lagoon Configurations



Lagoon Configurations



IDEAL W/EXCESS FLOW STORAGE, SLUDGE HOLDING, & DISC FILTER

Final Thought

Wastewater Treatment Technologies

Key:
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C – Shows potential for meeting ammonia limitations.
D – Unlikely to meet ammonia limitations, or data inconclusive

Wastewater Technology	Ammonia Effluent Limit (mg/L)			
	< 0.7	0.7 - 1.4	1.5 - 2.5	2.5 - 5.0
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Wetland	D	D	D	D
Facultative Lagoon	D	D	D	C
Aerated, Partial Mix Lagoon	D	D	D	C
Lagoons with Approved Retrofits	C	C	C	B
Recirculating Sand Filter	C	C	C	B
Trickling Filter	D	D	C	B
Oxidation Ditch	B	B	B	B
Extended Aeration Package Plant	D	C	B	B
Sequencing Batch Reactor	B	B	B	B
Biological Nutrient Removal	B	B	B	B
Enhanced Biological Nutrient Removal	B	B	B	B
Membrane Bioreactors	B	B	B	B
Breakpoint Chlorination	D	D	C	C
Moving Bed Biofilm Reactor	B	B	B	B
Integrated Fix Film Activated Sludge	B	B	B	B
Side Stream Nutrient Removal	B	B	B	B

Summary

- IDEAL Bioreactor is a cost effective solution.
- BOD and TSS <20 mg/l.
- Ammonia < 0.5 mg/l.
- Total Nitrogen Reduction 66%.
- Separate Solids Digestion.
- Reactor Temperature 2° C.

Final Thought

Q&A

Lagoon Configurations