THE Water Research FOUNDATION

WRF 4973 Nutrient Optimization

Starting Shortly

Applied Fundamentals for Nitrogen and Phosphorus Removal Optimization

Presenters: JB Neethling, David Stensel, James Barnard and Bryce Figdore

March 17, 2021

12:00 – 2:00 PM EST

Search: WRF 4973 webinar

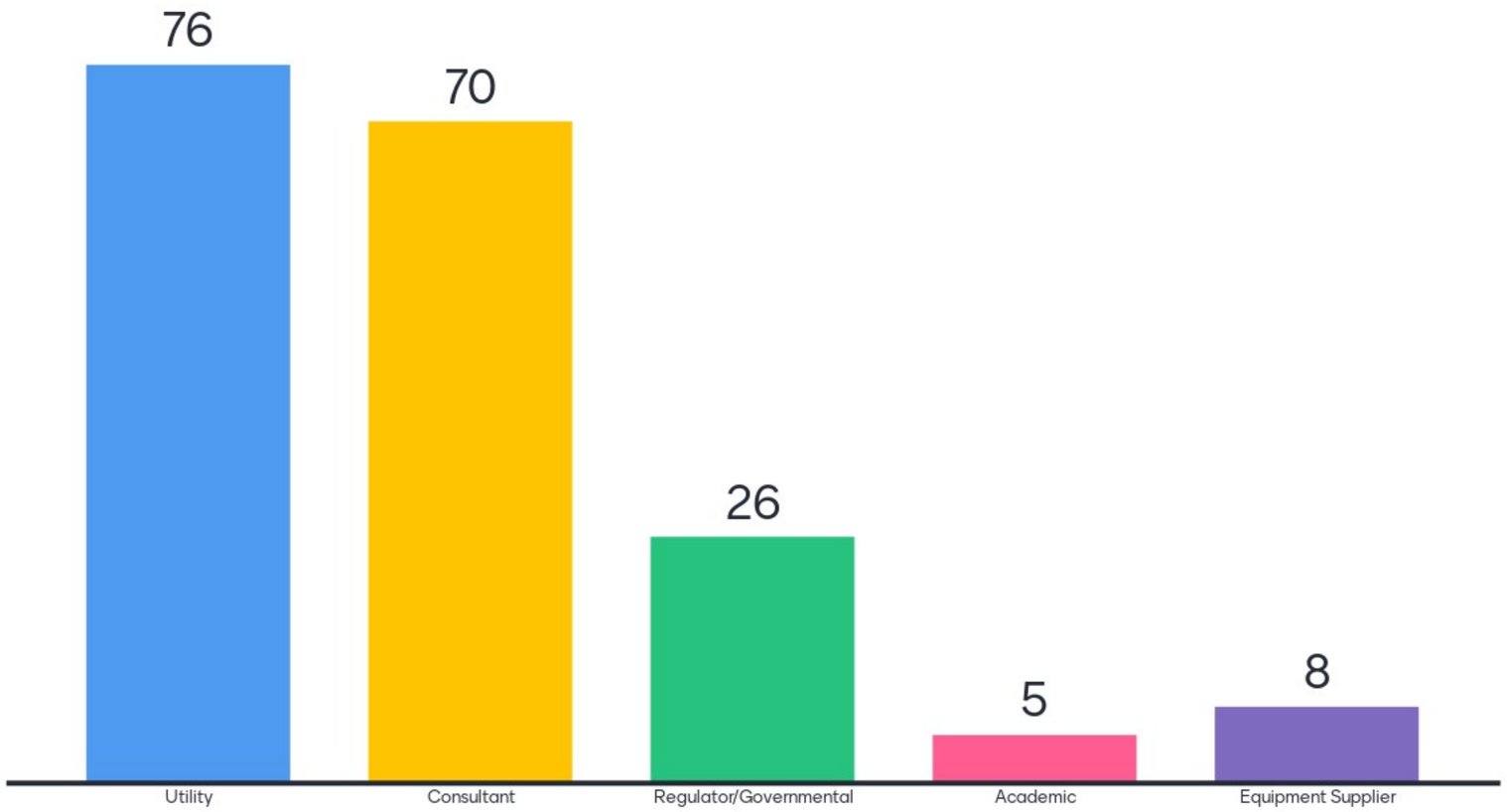
Applied Fundamentals for Nitrogen and Phosphorus Removal Optimization

Strategies to Optimize WRRFs for Nutrient Removal

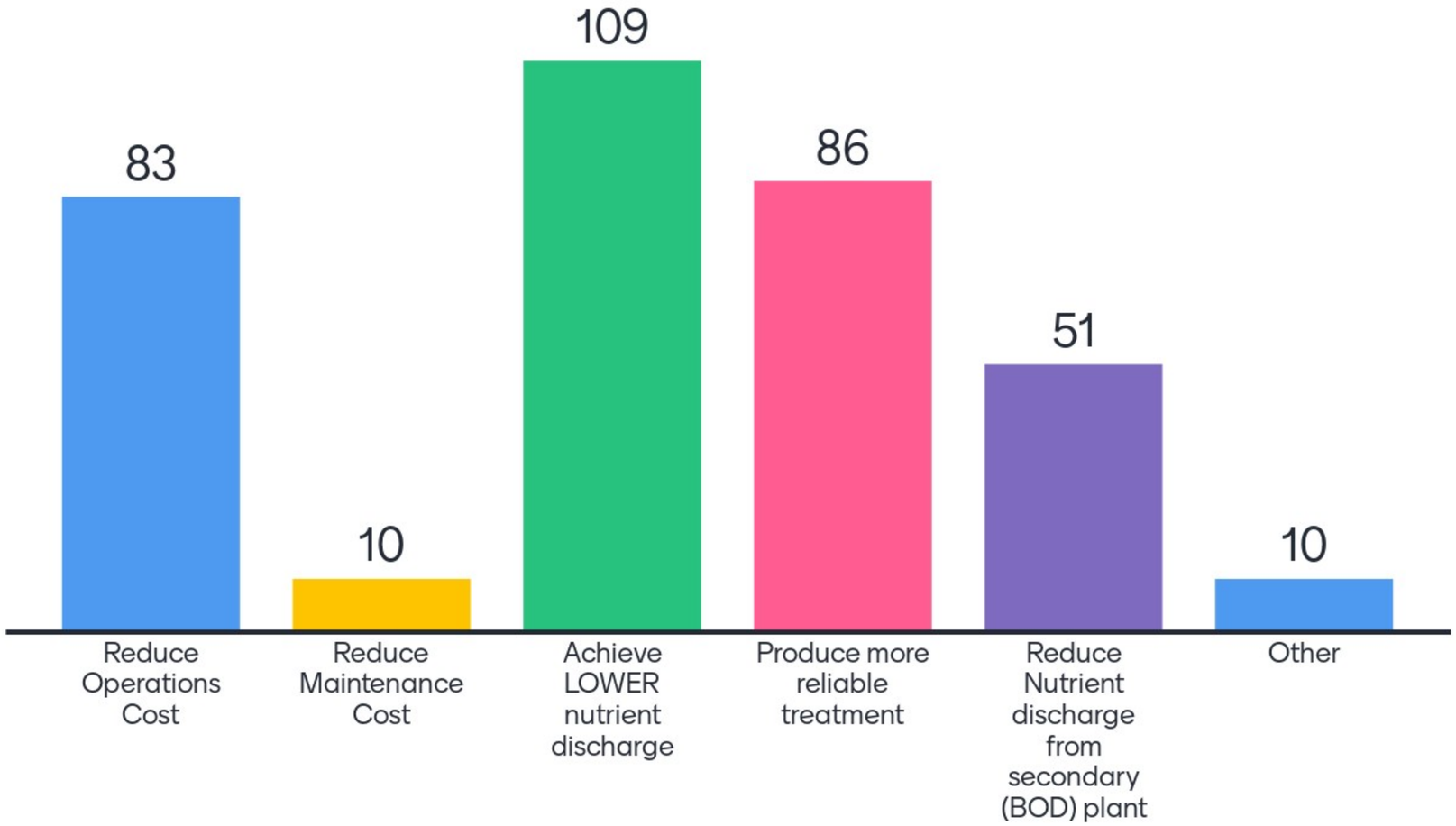
17 March 2021

INTRODUCTION - OVERVIEW

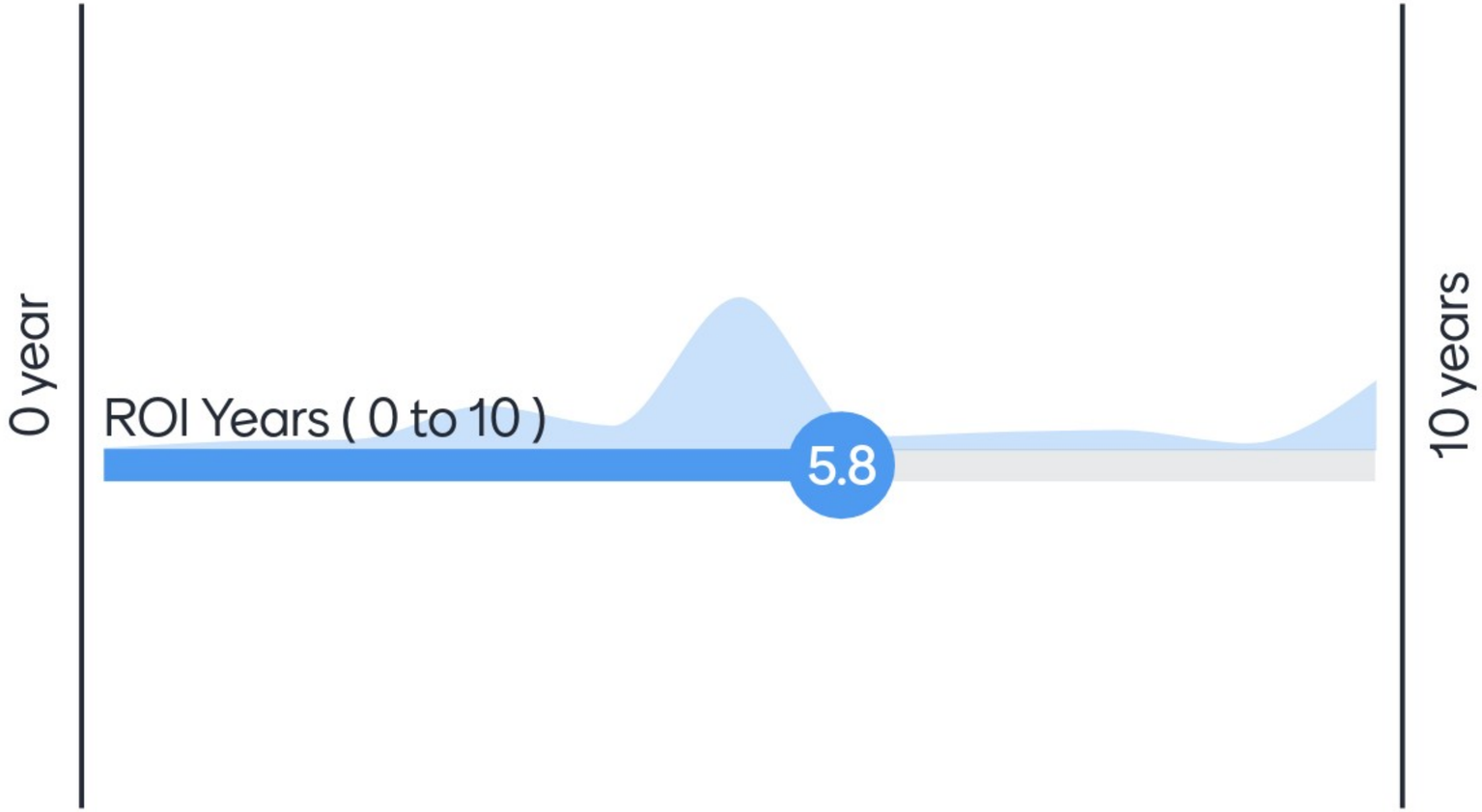
What is your job/position?



What are your TWO MAIN optimization goals/interest?



What Return on Investment period is acceptable for reduced operating cost?



What situations have you encountered where process performance was diminished by "non-ideal" conditions?

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Excess water	Reduced Capacity	CSO plant
Wide variations in loading	Large storm events	Winter
Both high and low flow events.	Under loaded plant	Recycle impacts causing inhibition

What situations have you encountered where process performance was diminished by "non-ideal" conditions?

Low pH.

industrial inputs

plant load changes

Construction activities negating impact of optimization work

side stream slug loads

plant upset

Climate. Temperature.

Large storms and snowmelts

not sure of what is being asked

What situations have you encountered where process performance was diminished by “non-ideal” conditions?

Filament problem combined with rain event

No side stream treatment

wide diurnal patterns

slug industrial loads, slug septage receiving station loads, snowmelt

Mainly temperature

Excessive peak flowIntermittent industrial discharges of high strength

mixed liquor high temperatures 35 deg C +

RAS/WAS control or lack there of

It seems that old aeration/mixing systems can create less than ideal reactors and/or systems can be constrained by aerator turndown limits.

What situations have you encountered where process performance was diminished by "non-ideal" conditions?

filimentous

plant flow far below design flow

reduced capacity/changes due to active construction projects

A raining incidence

Poor mixing, non-reactive P, interplay within our biological processes (we are an HPO plant)

plant overload and maintenance

Unreliable blowers

diluted influent periods, due to rain events.

Wet weather eventsAeration issues

What situations have you encountered where process performance was diminished by “non-ideal” conditions?

unequalized centrate return

increase MLSS

None

Nitrogen Removal

David Stensel

What strategies have you used/know of to improve nitrification efficiency in winter operation. Temperature is 12C and pH is 6.6

Glycol	Adjust SRT	Bioaugmentation
Add alkalinity!	Not an issue in Hawaii	increase SRT
Step feed to increase SRT	None	Increased MLSS

What strategies have you used/know of to improve nitrification efficiency in winter operation. Temperature is 12C and pH is 6.6

- MBBR technology
- Add alkalnity
- Increased SRT
- Increase mcrt
- Longer srt and slow hrt down
- SRT control
- Increase alkalinity
- Increase alkalinity
- IFAS

What strategies have you used/know of to improve nitrification efficiency in winter operation. Temperature is 12C and pH is 6.6

Reduce wasting (increase SRT)

Increase MLSS

Adjust srt

increase SRT

Increase MLSS

Increase alkalinity

Alkalinity addition

alkalinity

Increase SRT and add alkalinity

What strategies have you used/know of to improve nitrification efficiency in winter operation. Temperature is 12C and pH is 6.6

Increase sludge mass

Longer SRTs

We are not that cold, but increase MLSS and SRTs

increase MLSS

improve O2 and SRT

Increase SRT

Incorporate media

Not an issue in Atlanta

Ehancing alkalinity

What strategies have you used/know of to improve nitrification efficiency in winter operation. Temperature is 12C and pH is 6.6

granular sludge

Increase SRT

Increase recycle

Increase SRT

increase mlss

SRT/alkalinity/MLSS

Changes to feed location in step feed operation

Unknown

More alkalinity.

What strategies have you used/know of to improve nitrification efficiency in winter operation. Temperature is 12C and pH is 6.6

Srt adjustnent

Media

Increased Srt

fortunate to have warmer temperatures

Increase alkalinity first, then increase SRT

increase biomass in aeration process.

Add alkalinity

Increase mlss

increase aerobic MCRT

What strategies have you used/know of to improve nitrification efficiency in winter operation. Temperature is 12C and pH is 6.6

Raise MLSS, add alkalinity

increase alkalinity

Increase operating pH, operate with higher MLSS, Higher SRT

Increase IR

add alkalinity

Add alkalinity

Design at the outset.

Add Alkalinity

IFAS

What strategies have you used/know of to improve nitrification efficiency in winter operation. Temperature is 12C and pH is 6.6

Increase SRT and monitor PH.

Mag OH

Change MLVSS/adjust SRTAdd chemical

Adjust SRT

load balance

+ SRT

increase SRT

MABR

Look at your solids inventory

What strategies have you used/know of to improve nitrification efficiency in winter operation. Temperature is 12C and pH is 6.6

Increase MLSS

Add alkainity

Alkalinity addition to increase pH, increase SRT

Densification

Increase mlss

Increased SRT

Increase SRT

Catchment management

Add alkalinity

What strategies have you used/know of to improve nitrification efficiency in winter operation. Temperature is 12C and pH is 6.6

Inc SRT

Step feed

None

increase SRT, reduce wasting for a short period

Reduce anoxic volume

Haven't nitrified in winter. Will have requirements in the future.

??

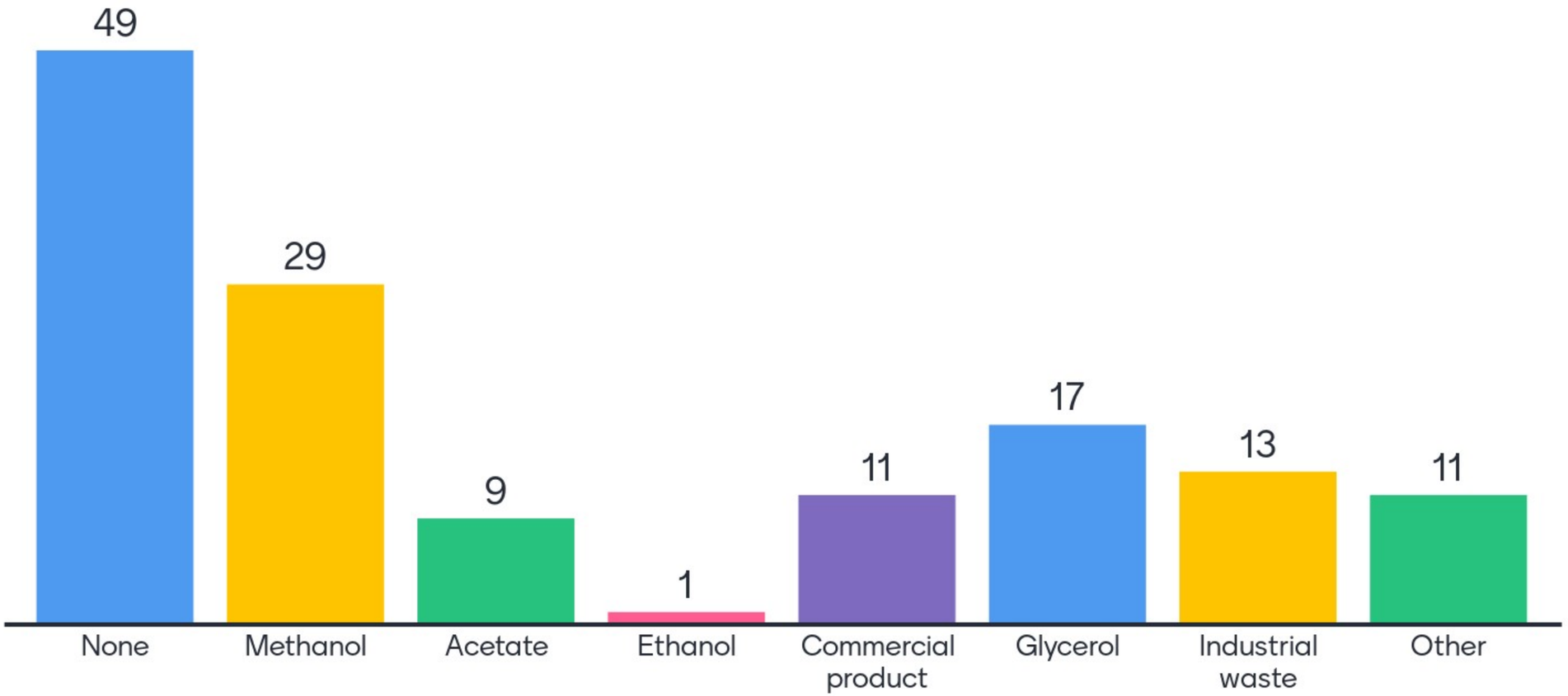
Methanol

None

What strategies have you used/know of to improve nitrification efficiency in winter operation. Temperature is 12C and pH is 6.6

Increased MCRT MLSS Concentration

Which supplemental substrate do you use at your facility to enhance denitrification. Select ALL that applies.



What strategies have you used/seen to reduce N in a four stage Anox/Aer/Anox/Aer process?

Swing zones

Reduce return DO

N/A

reduce aerated volume

DO control

increase DO

DO control

Add carbon to post anoxic

Reduce DO in summer

What strategies have you used/seen to reduce N in a four stage Anox/Aer/Anox/Aer process?

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Recycle	Controlling DO carry-over	N/A
ABAC	Swing zones	Increase DO
NA	Not applicable	DO control

What strategies have you used/seen to reduce N in a four stage Anox/Aer/Anox/Aer process?

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- Swing zones
- DO control
- Low DOs
- NA
- DO co trol
- Do controlswing zones
- Add carbon to second anoxic
- Increase recycle
- Low DO in last Aer pass

64

What strategies have you used/seen to reduce N in a four stage Anox/Aer/Anox/Aer process?

DO control

Increase doIncrease mlss recycle

DO control

Swing zones

automate methanol dosing

low DO

Increase DO

Control DO through zones

Tapered DO using diffused air

What strategies have you used/seen to reduce N in a four stage Anox/Aer/Anox/Aer process?

Plug excess diffusers

Recycle rates

Boost DO

Not aware of any.

inetnsification by MABR

carbon supplement

DO control

Degassing

NA

What strategies have you used/seen to reduce N in a four stage Anox/Aer/Anox/Aer process?

Carbon addition in second anoxic

DO control

adjust recycle rate

intermittent aeration, swing zones

DO control

Opening between the aerobic and second anoxic zone

Step feed

low DO

NARCY pump rates

What strategies have you used/seen to reduce N in a four stage Anox/Aer/Anox/Aer process?

Add methanolIncrease DOIncrease recycle

Swing stages or carbon addition

Carbon feed from craft beer waste

Step feed and internal recircling ratio control

Improve RAS and Carbon mixing, increase Anoxic HRT

Carbon addition

N/A

control sludge age and aeration

RAS Fermentation

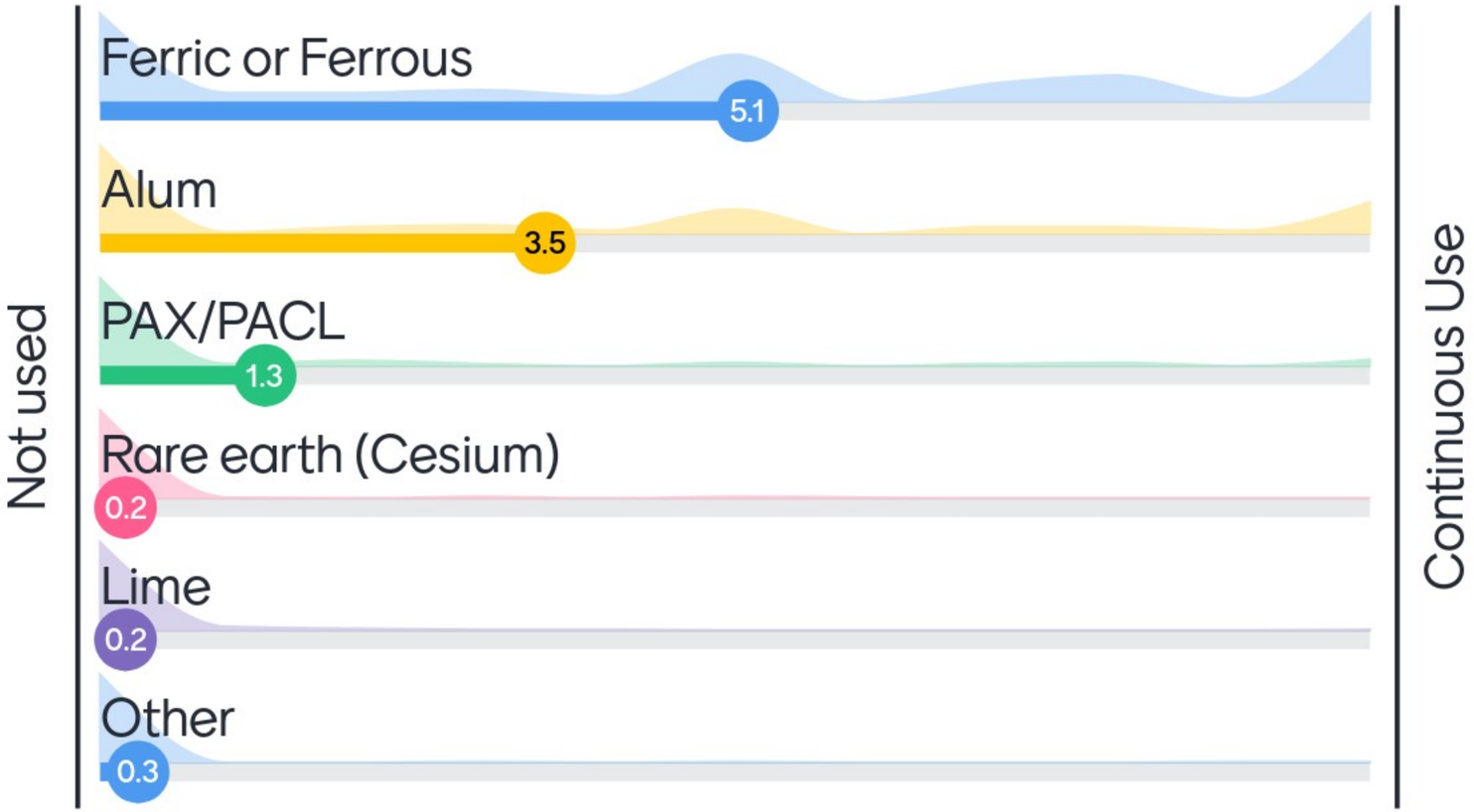
What strategies have you used/seen to reduce N in a four stage Anox/Aer/Anox/Aer process?

Na

Phosphorus Removal - Chemical

JB Neethling

Which of these chemicals have you used for P removal?



Please note all chemical dose locations you've used/seen for P removal

NA

Primary clarification

Not used.

Tertiary

Primary and Secondary

Ferric chloride

N/A

Secondary clarifier

Primary

Please note all chemical dose locations you've used/seen for P removal

Primary, Secondary, and Tertiary

Prior to clarifiers

Pre-Dewatering

Secondary Clarifier Splitter Box

Primary

Primary Clarification

anaerobic digester

Secondary clarification

Tertiary

Please note all chemical dose locations you've used/seen for P removal

Primary. secondary and tertiary	Primary	secondary
secondary	primary	Tertiary
Primary	primary effluent	PST, ASP, Pre-FST, Pre-TSR

Please note all chemical dose locations you've used/seen for P removal

Before primary or secondary clarifiers

tertiary - pre-filter

Primary

Secondary, tertiary

Primary

primary eff

Secondary clarification

Primary, end of aeration

Final Clarification

Please note all chemical dose locations you've used/seen for P removal

NA

before primary clarifier

Tertiary

Primary, secondary

NA

Primary, secondary and tertiary

Upstream of Primary Clarification

Primary

Primary clarifier and second clarifier

100

Please note all chemical dose locations you've used/seen for P removal

PrimarySecondaryTertiaryPre-DigestionPre-Dewatering

End of oxic zone

Primary clarifiers

Sludge dewatering treatment

Primary clarifiersSecondary clarifiers

Primary

Primary, Secondary, Tertiary

pre PST, Pre HST, Pre TSR

Secondary

100

Please note all chemical dose locations you've used/seen for P removal

N/A

Mainly primaryA little in the aeration tank

Primaries, after aeration, prior to tertiary filter or ballasted floc

Primary and Final Clarifiers

Secondary

Primary and secondary clarifiers

Primary

Prior Clarification

primary, dual purpose as part of odor control H2S control

100

Please note all chemical dose locations you've used/seen for P removal

Pretreat, end of aeration tanks

Primary

Primary influentSecondary effluent

tail end of aeration tanks

digesters, secondary clarifiers, upstream of filtration

Centrate

Between the biological process and clarifiers

primary

Primary, MLSS channel, dewatering

100

Please note all chemical dose locations you've used/seen for P removal

clarifier or before filtration.

after aeration basin before secondary clarifier

after aeration

PrimarySide streamAeration effluent

primary; before filters

Dewatering centrate return

Secondary Clarifier Splitter Box

Head works, aeration tank, RAS return, before filters

None at WW plant. Spent Ferric at Water treatment plant binds P into solids

Please note all chemical dose locations you've used/seen for P removal

Filtration

Near end of aeration

Before Primary Settling TanksBefore tertiary filters

Primary and secondary

Primary/secondary clarifiers

Secondary Clarifier.

after aearation

In tertiary application in clarifiers. We also dose it to the teriary sludge lie that is recycled back to the head of the plant.

Ahead of tertiary filters.

Please note all chemical dose locations you've used/seen for P removal

secondary clarifier

primary clarifiers

before primary and after aeration tank (dual point)

Primary Dewatering and MLSS channel

After primary: mixed liquor upstream of sec clarifiers; upstream of tertiary filters

before rotating biological contactors

to aeration, post secondary clarifer prior to disc filtration.

INfluent (ahead of Primaries, In first stage of Aeration, last stage of Aeration,

N/A

Please note all chemical dose locations you've used/seen for P removal

none

Biological Phosphorus Removal

James Barnard

What strategies have you seen or used to achieve EBPR without spending "much" capital to modify a conventional MLE process?

NA

N/A

Pulled out the internal recycle pumps

Turn off air in part of pass one

More filtration

turn off mixers or aeration

partition anoxic reactor

Better process control with online instruments

RAS fermentation

What strategies have you seen or used to achieve EBPR without spending "much" capital to modify a conventional MLE process?

Switch of mixers

NA

Basin/zone conversion

Septic sludge storage tank returning liquors

reduce aerated zone

Incorporate activated primary clarification

None

RAS fermentation

MLSS fermentation

What strategies have you seen or used to achieve EBPR without spending "much" capital to modify a conventional MLE process?

NA

Using existing tank and convert it to a Fermenter

NA

using excess tankage for primary sludge fermentation but it didn't really work

Reduce ASP DO, reduce RAS rates, Turn off mixers

Re-use existing tankage for fermentation

NA

Swing zones

activated primaries

What strategies have you seen or used to achieve EBPR without spending "much" capital to modify a conventional MLE process?

adding a pre-anoxic before anaerobic.

Step feed, recycle

Are-allocate mass

NA

Feed sludge from PST to An zone

multiple zones

try to ferment in primaries - high blanket

Ferment sludge in existing tanks, such as thickener.

Occurred in corners of tanks with surface mixers

What strategies have you seen or used to achieve EBPR without spending "much" capital to modify a conventional MLE process?

Maximum detention in primary clarifiers before Anaerobic process.

Tank re-purpose

Add methanol

On-off aeration

n/a

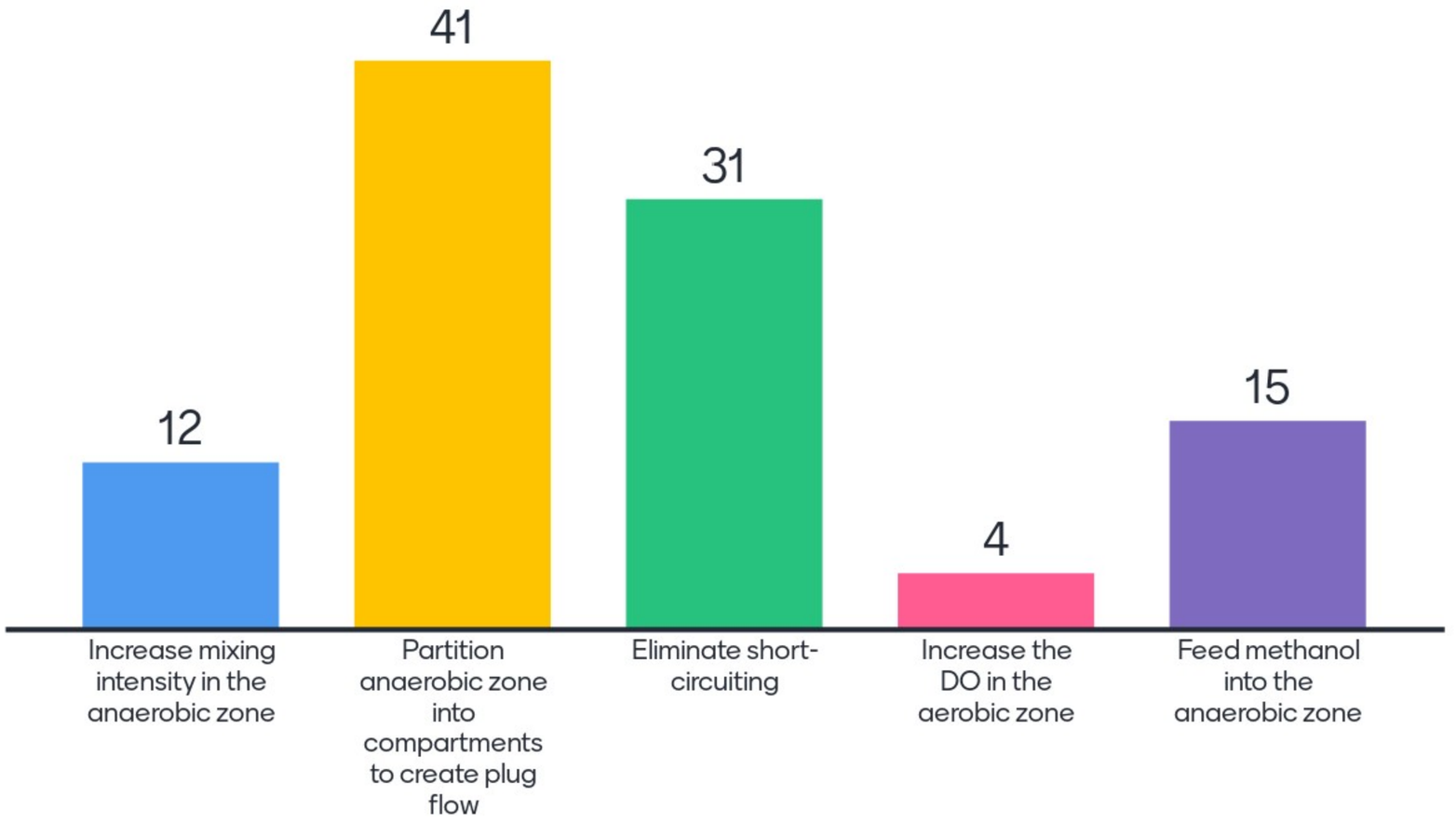
look into processes

Changed the Anoxic stage to fermentation basin and used SND in ditches

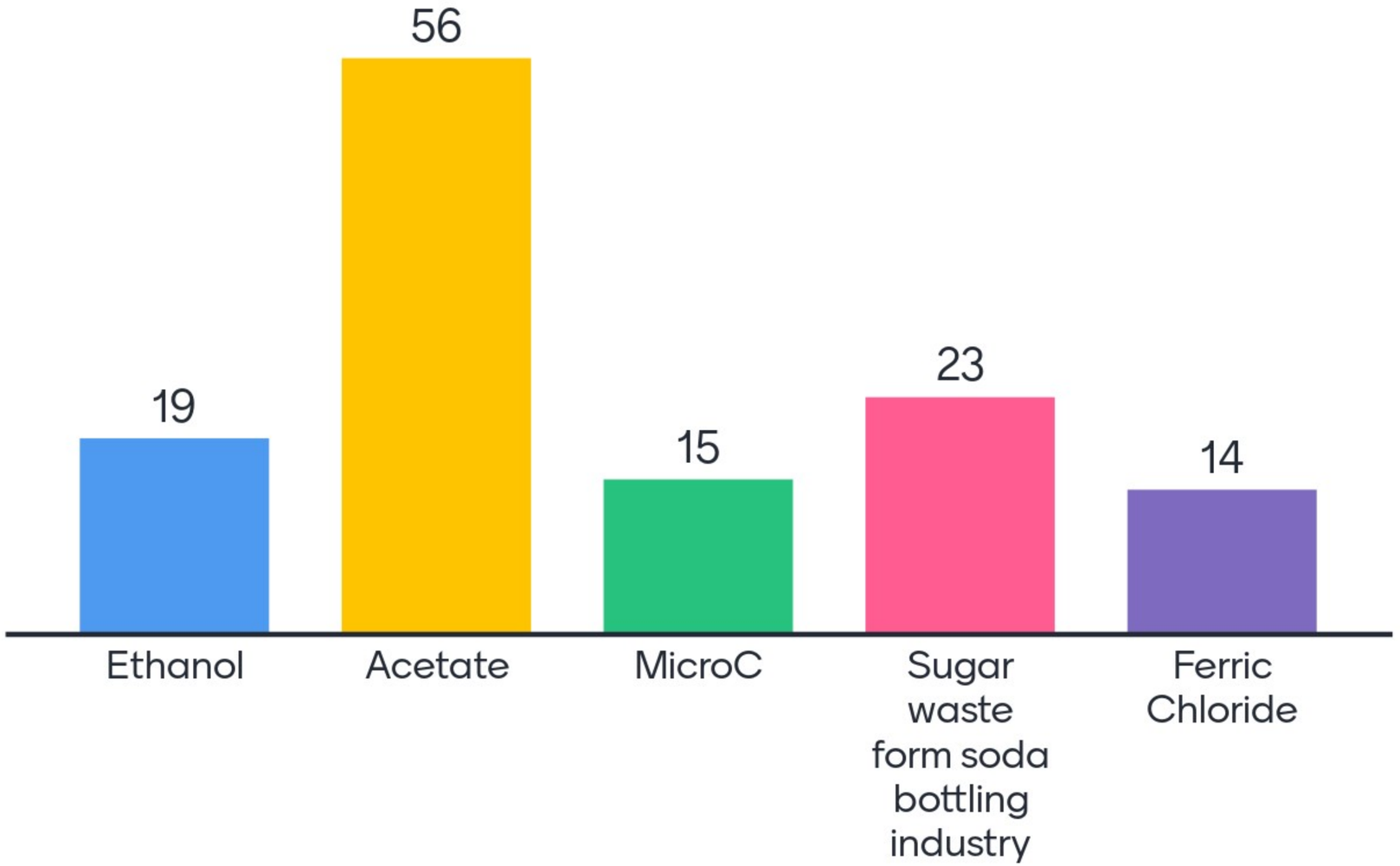
Longer Sludge age MCRT 12 to 20 days.Less Anaerobic Mixing

N/a

Which of the following strategies could IMPROVE RELIABLE performance in a conventional EBPR plant?



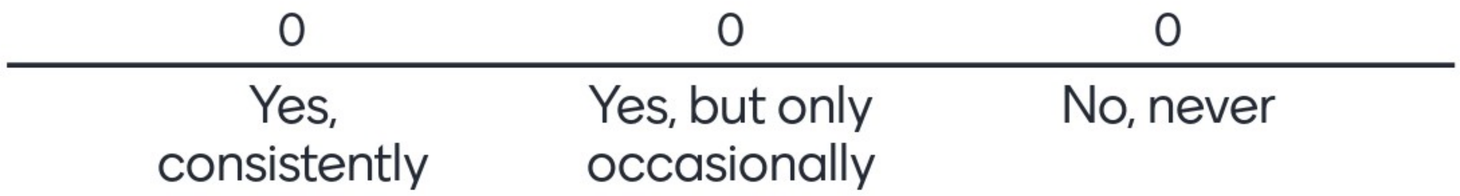
What chemical additions can improve EBPR?



Granulation/Densification

Bryce Figdore

Has your WRRF observed potential granulation or densification of activated sludge?



What design/operating features may be helping granulation / densification? Please include facility name and location if you're willing.