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Overhauling Dinosaurs: Upgrading 20th Century Digesters for Next Generation Performance

4H Center – THE Ohio State University, Columbus, Ohio

Brown AND Caldwell

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20th vs 21st Century Digestion

Brown AND Caldwell

Different Tiers of Digestion

Originally Built	Early 20th Century	Late 20th Century	21st Century
Rate of Digestion	Low	H gh	Advanc
SRT (days)	30 – 60	- 30	8 – 1

Different Tiers of Digestion

Originally Built	Early 20th Century	Late 20th Century	21st Century
Rate of Digestion	Low	High	Advanced
SRT (days)	30 – 60	15 – 30	8 – 15
Loading Rate (ppd/cf)	0.05 – 0.10	0.10 – 0.20	0.20 – 0.40
Mixing	Minimal or No	Intermittent	Continuous
Heating	Sometimes	Yes	Yes

Different Tiers of Digestion

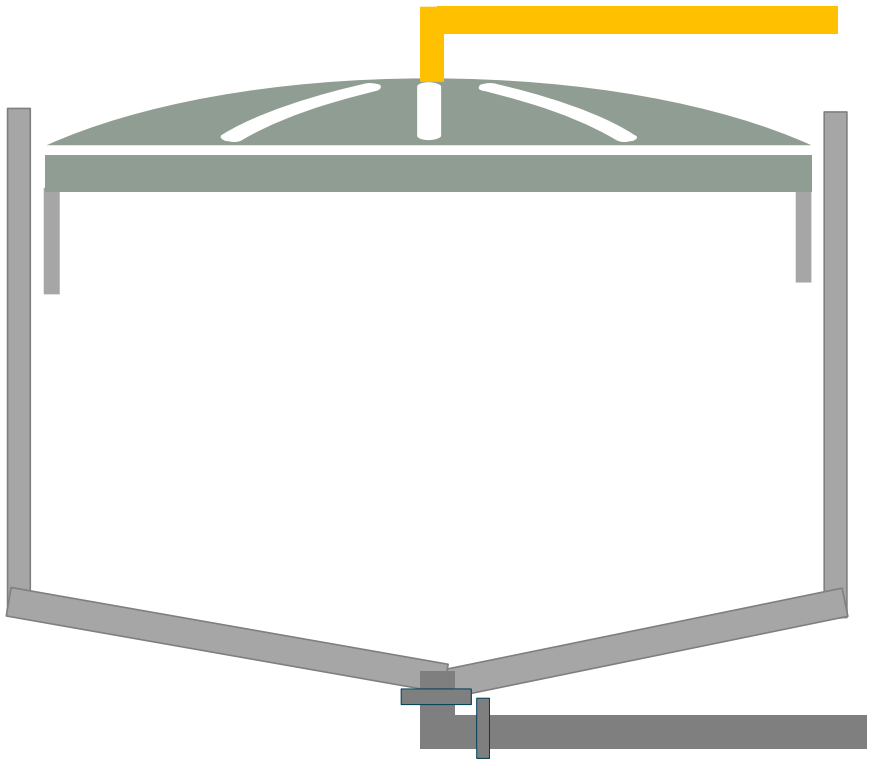
Originally Built	Early 20th Century	Late 20th Century	21st Century
Rate of Digestion	Low	High	Advanced
SRT (days)	30 – 60	15 – 30	8 – 15
Loading Rate (ppd/cf)	0.05 – 0.10	0.10 – 0.20	0.20 – 0.40
Mixing	Minimal or No	Intermittent	Continuous
Heating	Sometimes	Yes	Yes
Feeding	Intermittent	Uniform feed schedule	Continuous

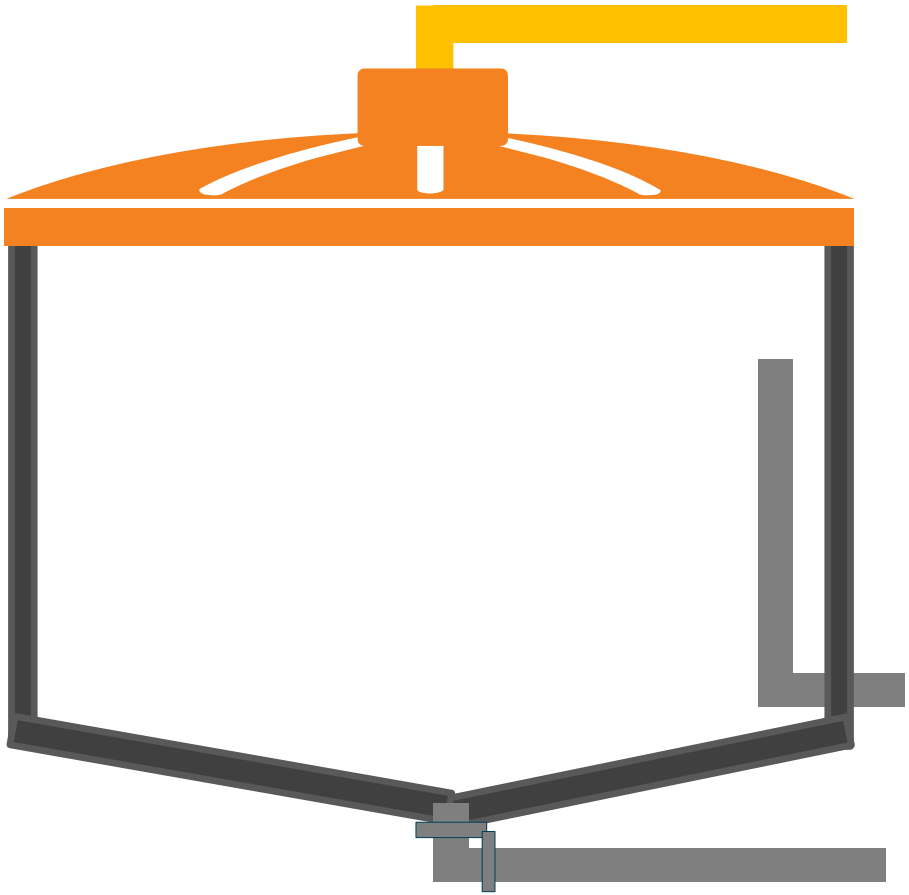
Different Tiers of Digestion

Originally Built	Early 20th Century	Late 20th Century	21st Century
Rate of Digestion	Low	High	Advanc
SRT (days)			
Reactor	Stratified	Low S ecific Gravity	High Specific Gravity
Fugitive Emissions	Significant	Less	Minimized

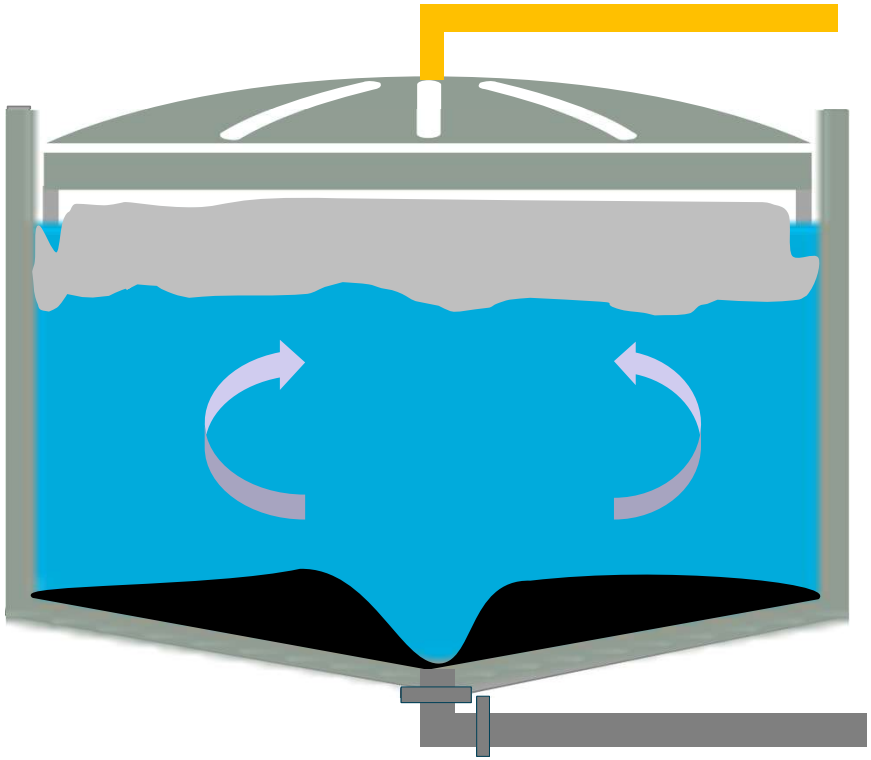
How to Upgrade Dinosaurs ***Cost Effectively***

How to Cost-Effectively…Restore Tank Integrity

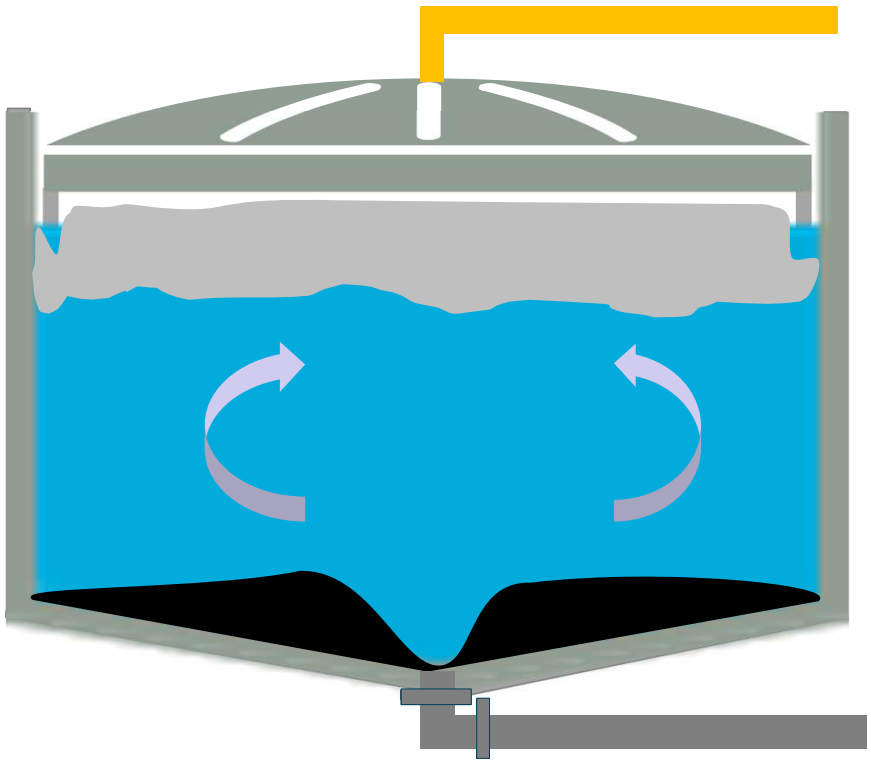


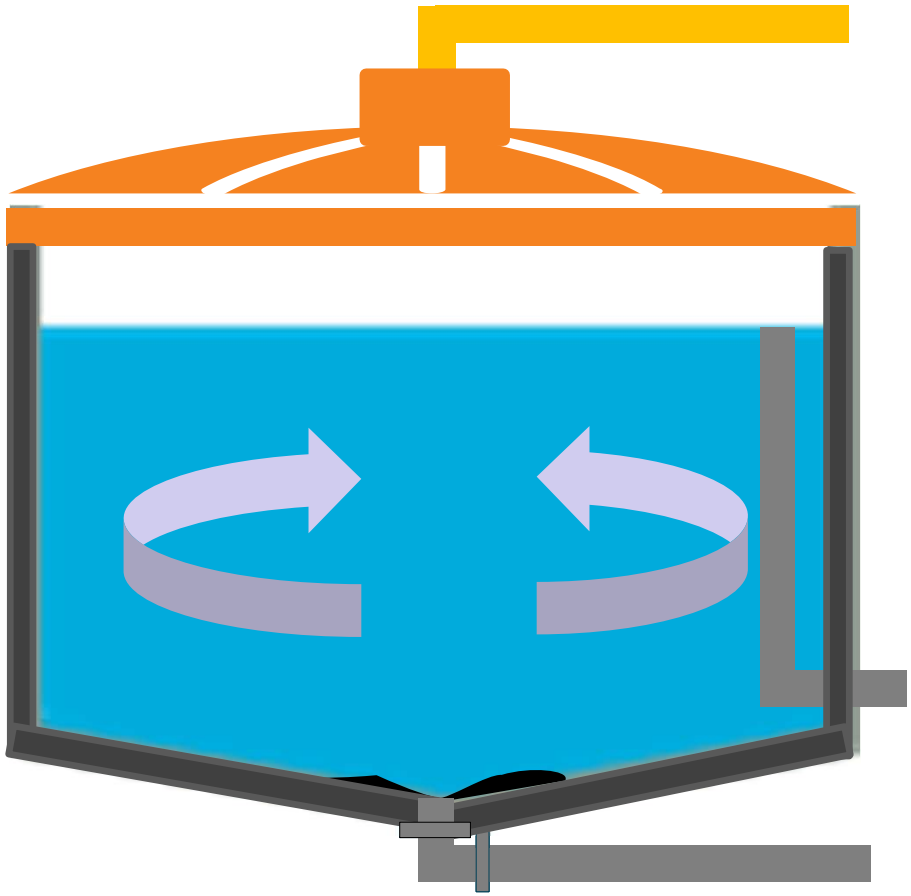


How to Cost-Effectively…Upgrade Support Systems



How to Cost-Effectively…Upgrade Support Systems





Restore Tank Integrity

Brown AND Caldwell

Floating Covers

May require repair or replacement due to condition

Large source of fugitive methane and odorous emissions

Hard to manage foam and are less compatible with advanced digestion

Common Cover Replacement Options

"Fix" the Floating Cover

Common Cover Replacement Options

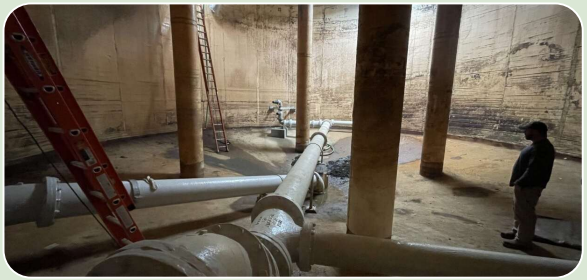
"Fix" the Floating Cover

Replace with Fixed Steel

Common Cover Replacement Options

"Fix" the Floating Cover

Replace with Fixed Steel



Replace with Fixed Concrete

Concrete Corrosion

#5 @ 12"
DRILL AND EPOXY GROUT INTO
EXISTING CONCRETE WALL
PROVIDE 10" MIN EMBEDMENT
SEE 03600

EL 276.40

EL 275.40

BOND WITH EPOXY
SEE 03600

PVC LINER ON ALL NEW
CONCRETE SURFACES
ABOVE BASE SLAB
SEE 09881

1'-4" WALL

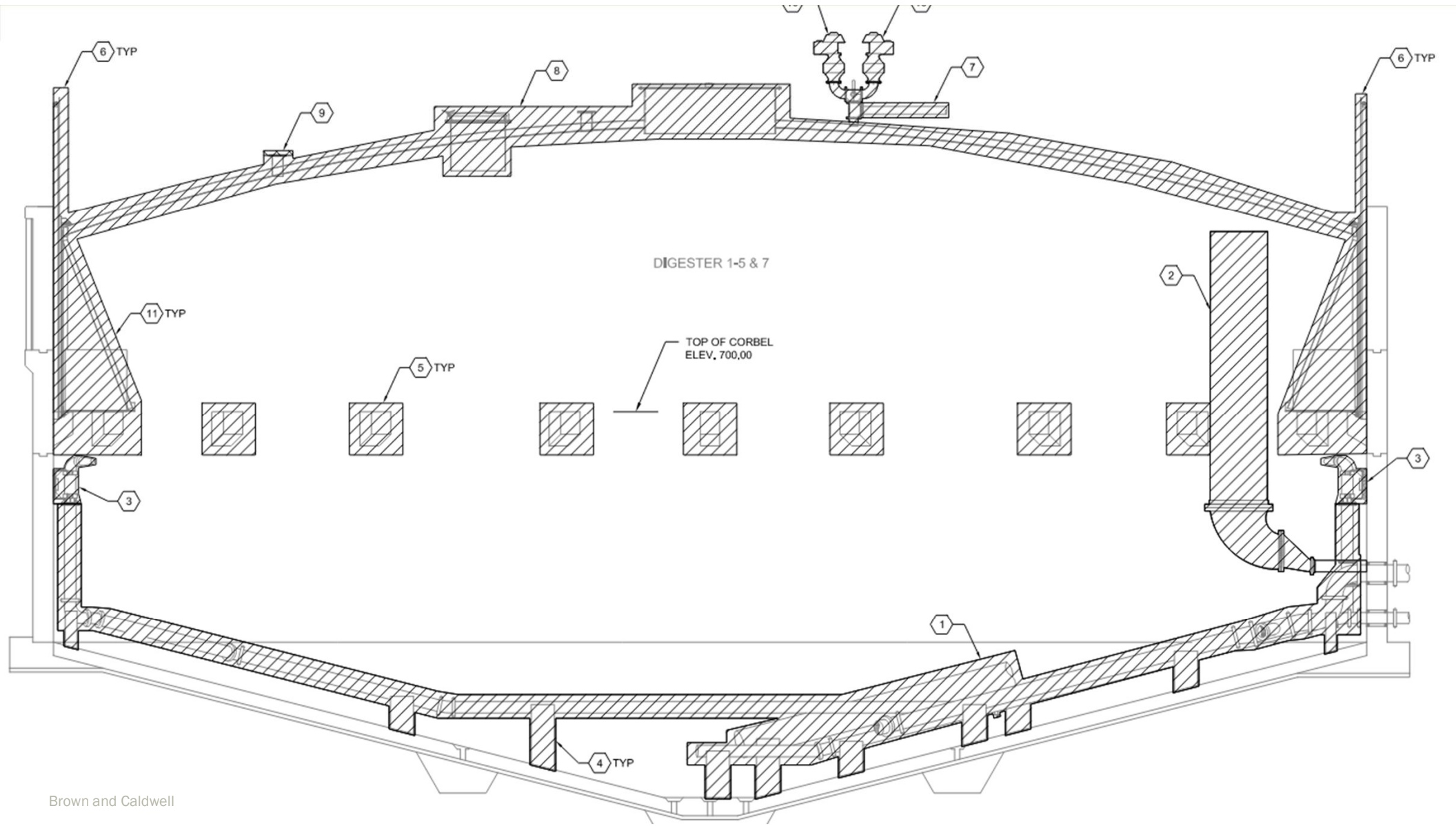
EL 265.40

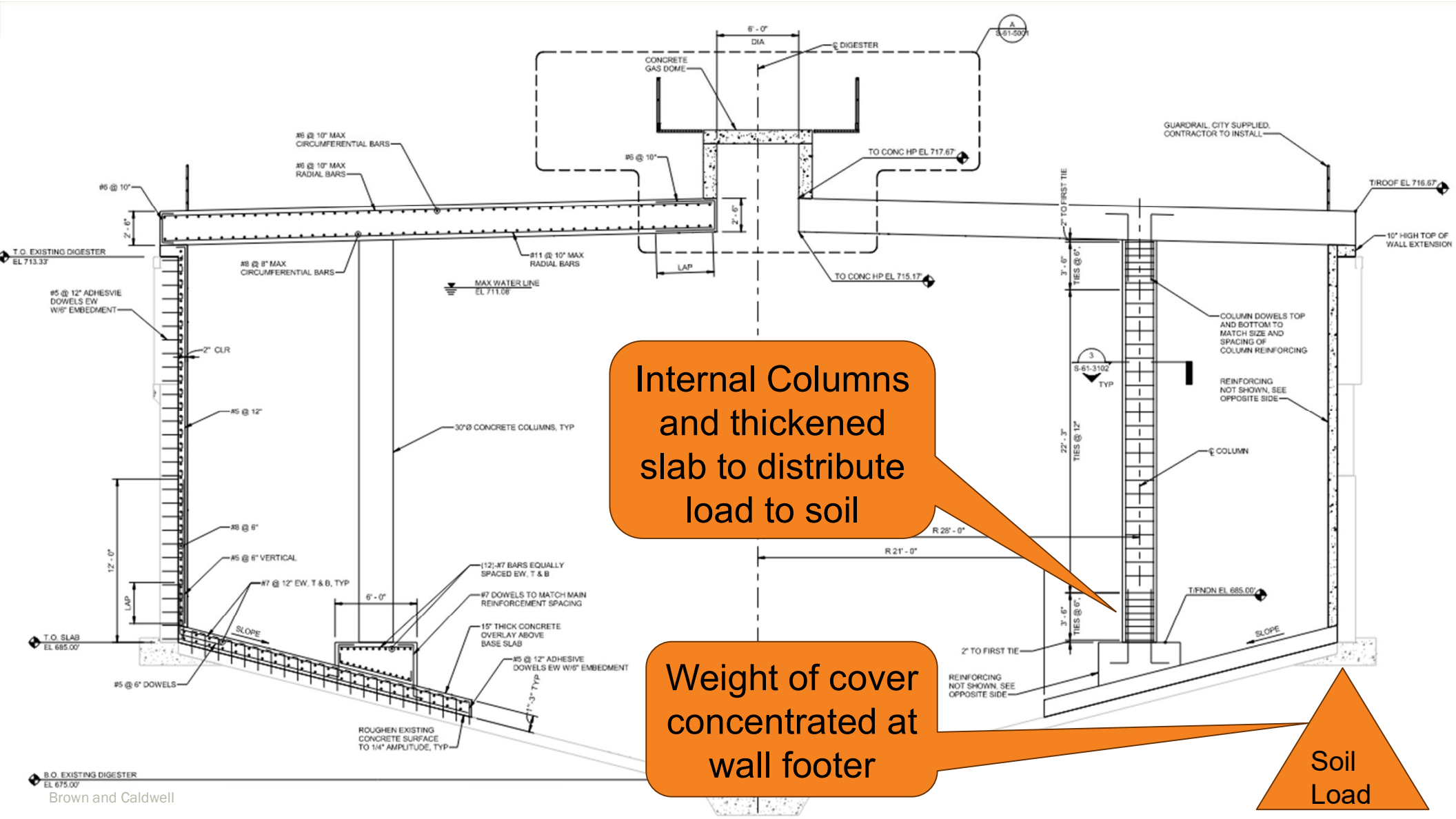
10" WALL

#6 @ 12"

SECTION 2 / 810-S-01

SCALE: 3/8"=1'-0"

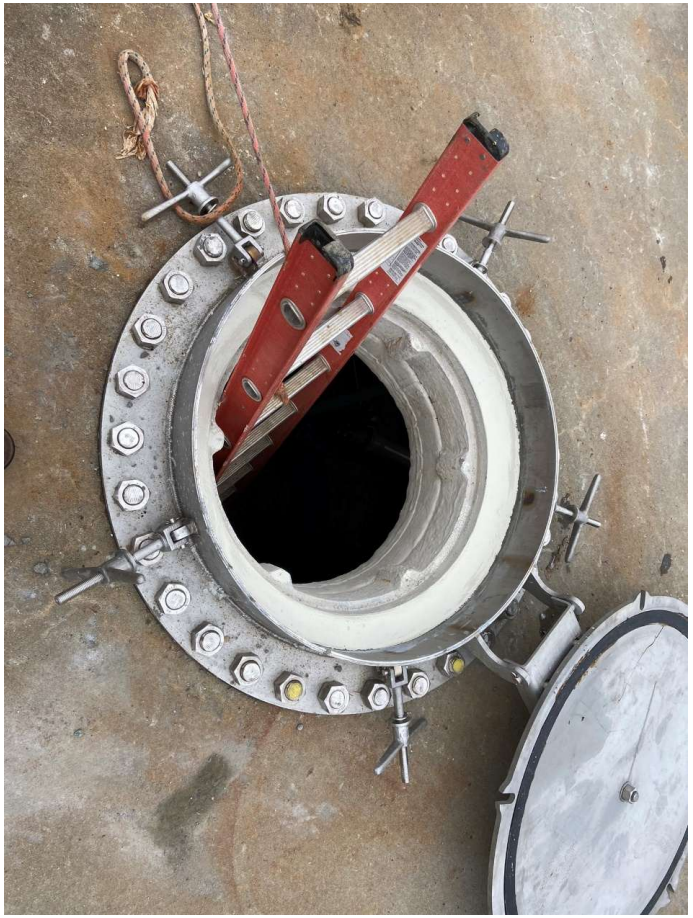

6 TYP
8
9
7
6 TYP
DIGESTER 1-5 & 7
2
11 TYP
TOP OF CORBEL
ELEV. 700,00
5 TYP
3
3
1
4 TYP



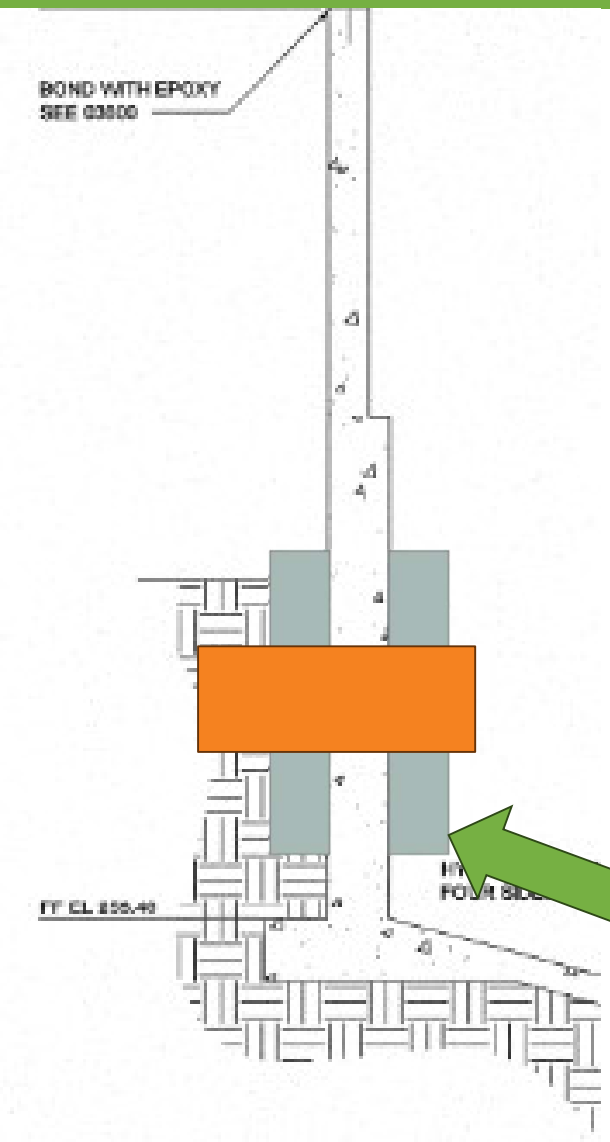
Gas Dome Corrosion Improvements

Corroded Access Manholes

New 316 SS Access Hatches



Large New Wall Penetrations



Displaces Rebar Supporting the Wall

More challenging to modify older walls

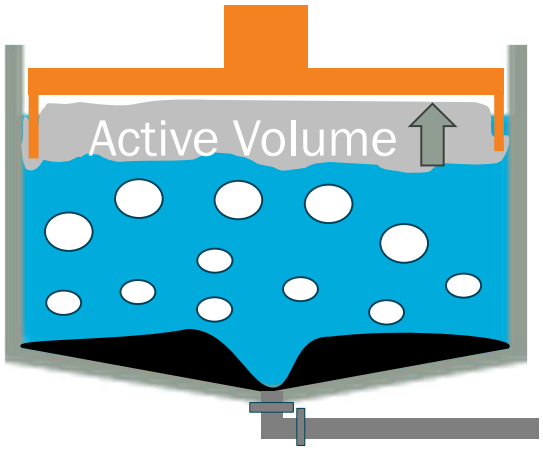
Requires bulkheads to support opening

Example

Upgrade Support Systems

Brown AND Caldwell

Enhanced Digestion

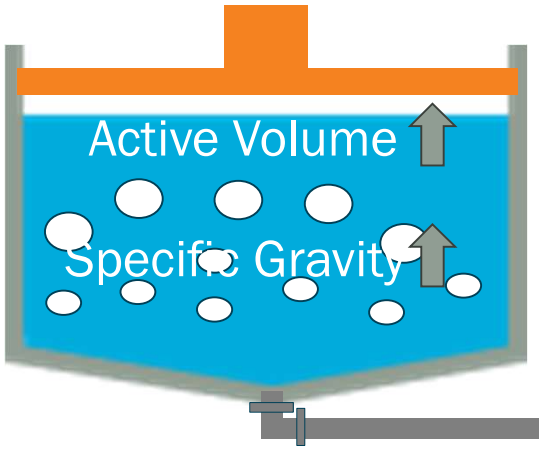


1. Removes scum & grit layers
2. Discourages stratification

Surface and cone withdrawal

Increased SRT enhances digestion

Enhanced Digestion



Move to continuous Mixing

More frequent feeding

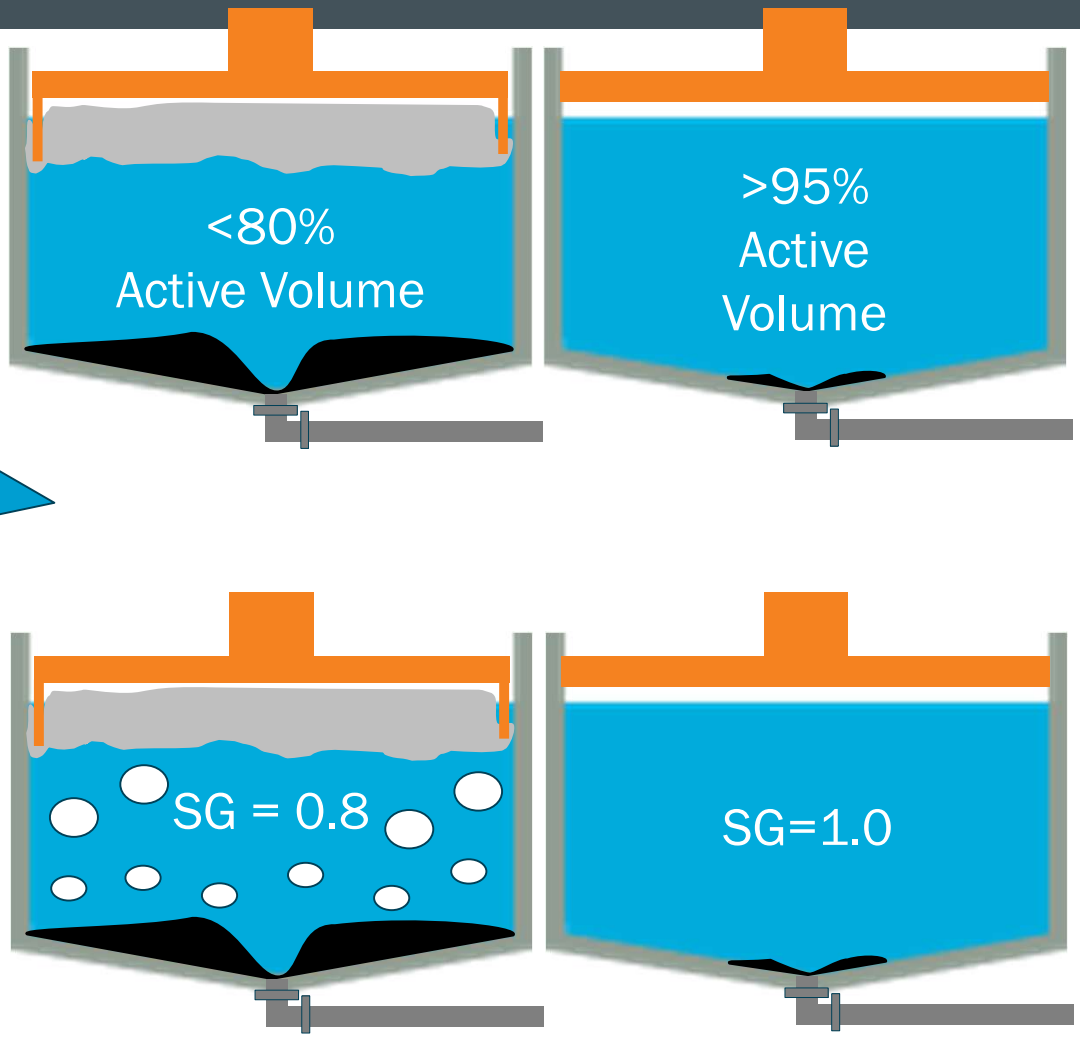
Surface and cone withdrawal

Increased SRT enhances digestion

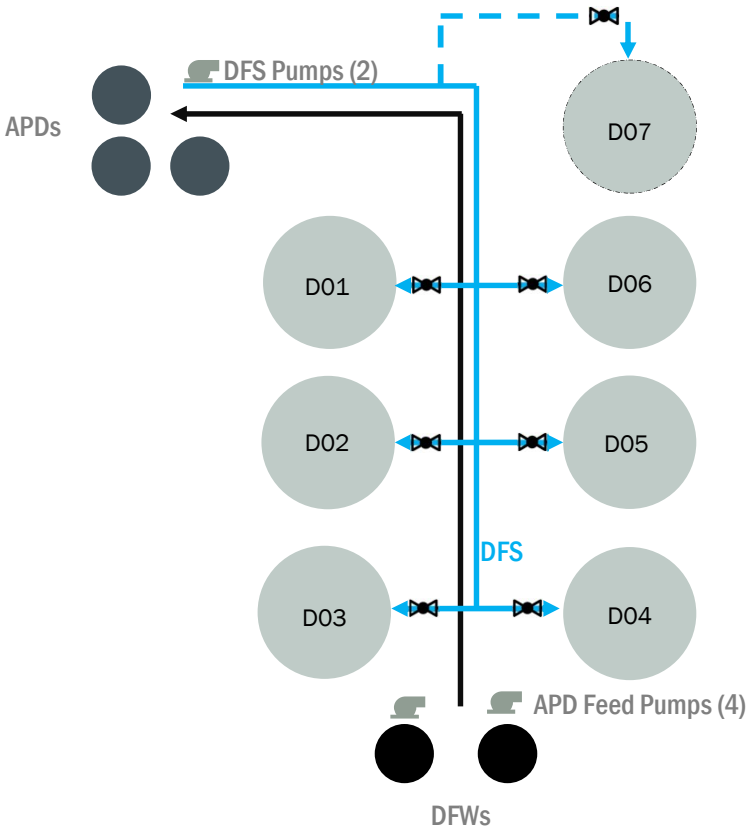
Reduces Entrained Biogas leaving digester with sludge

Enhancing Digestion

- More biogas produced
- More biogas extracted
- Less biogas emissions in downstream dewatering
- Less solids to dewater



Columbus Southerly Existing Digestion

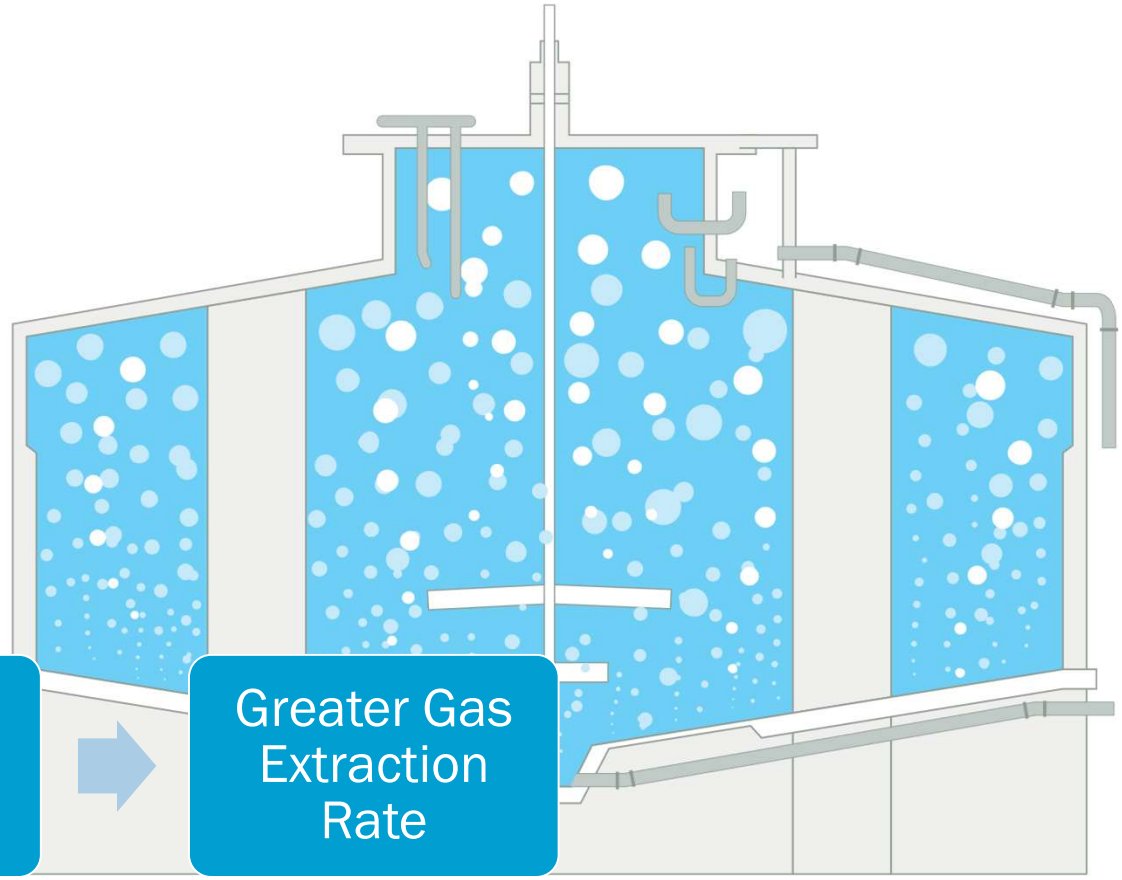


Common Issues to Address

- Intermittent Mixing

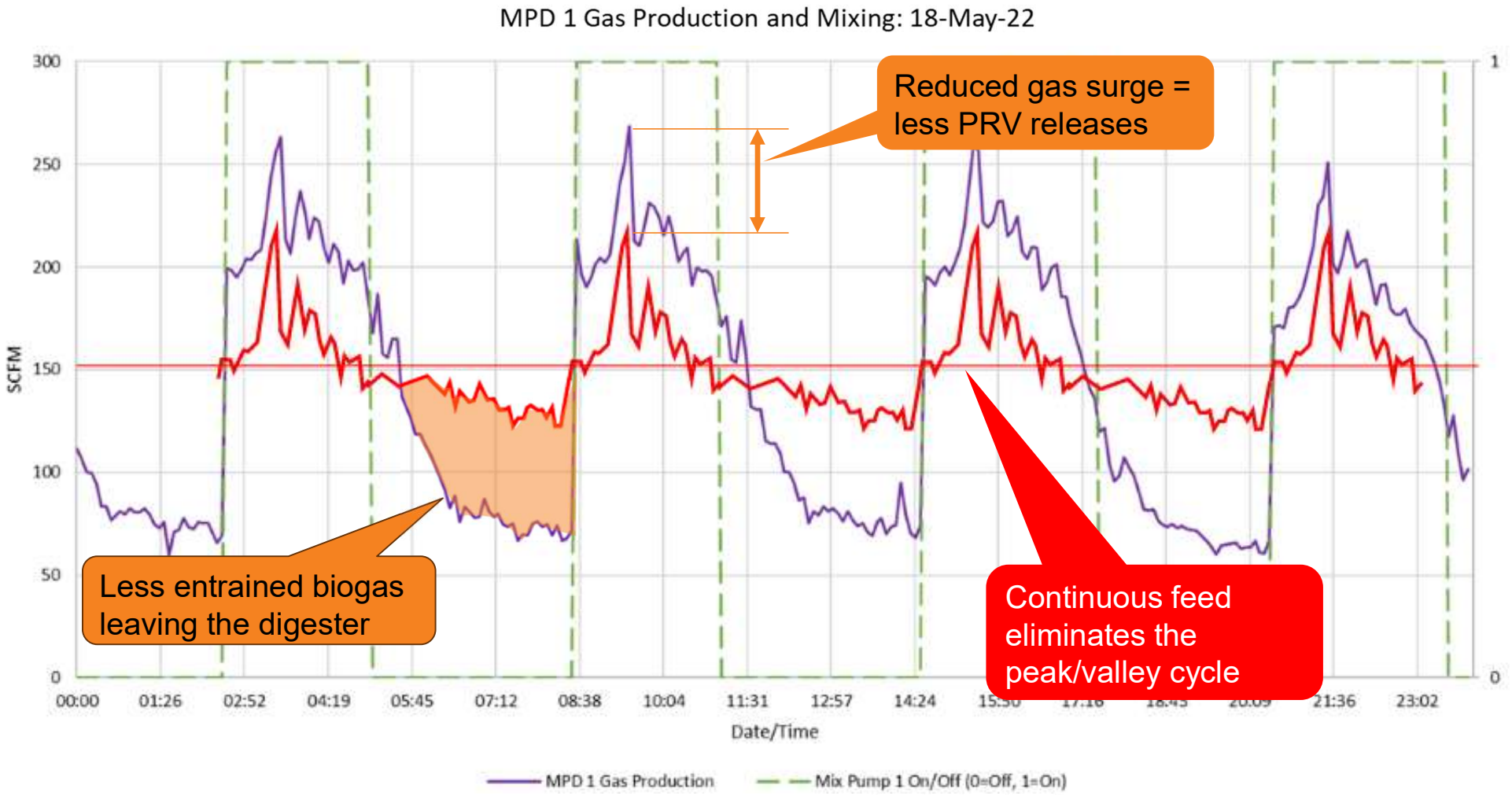
Why Continuous Mixing…?
Gas Extraction

- Entrained Gas rises faster in lower viscous fluids
- Sludge is shear thinning



More Mixing → Lower Viscosity → Greater Gas Extraction Rate

Why Continuous Mix?



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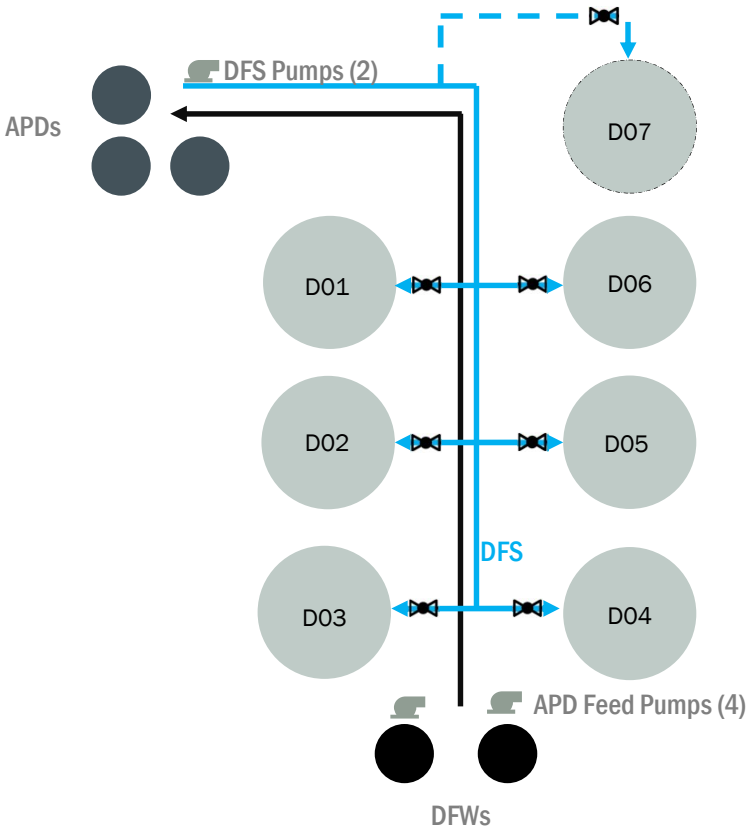
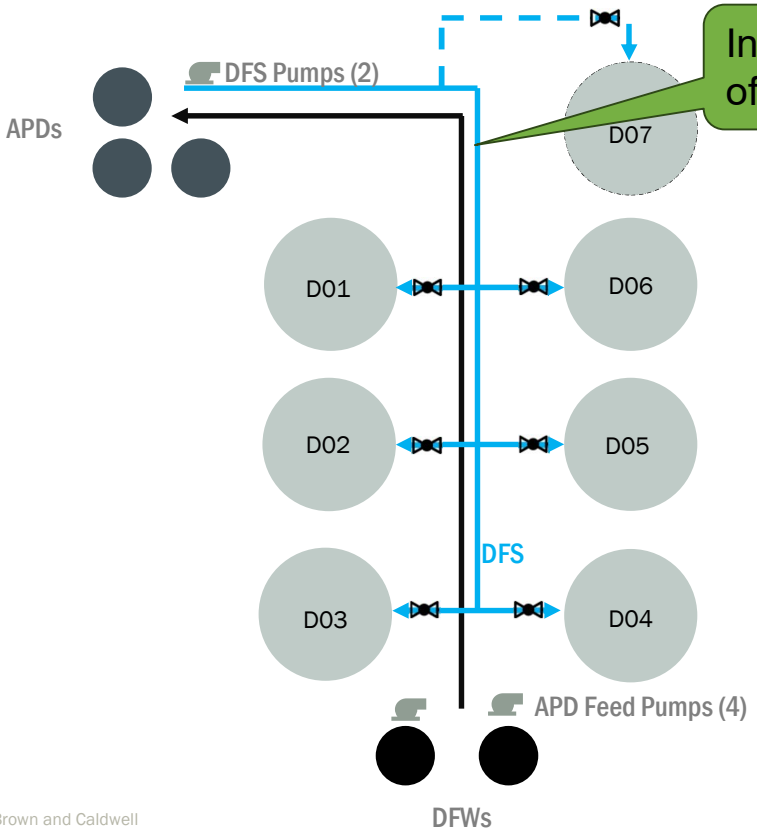


Common Issues to Address

- Intermittent Mixing
- Intermittent Feeding

Columbus Southerly Digester Feed Options

Existing Sequential Feed



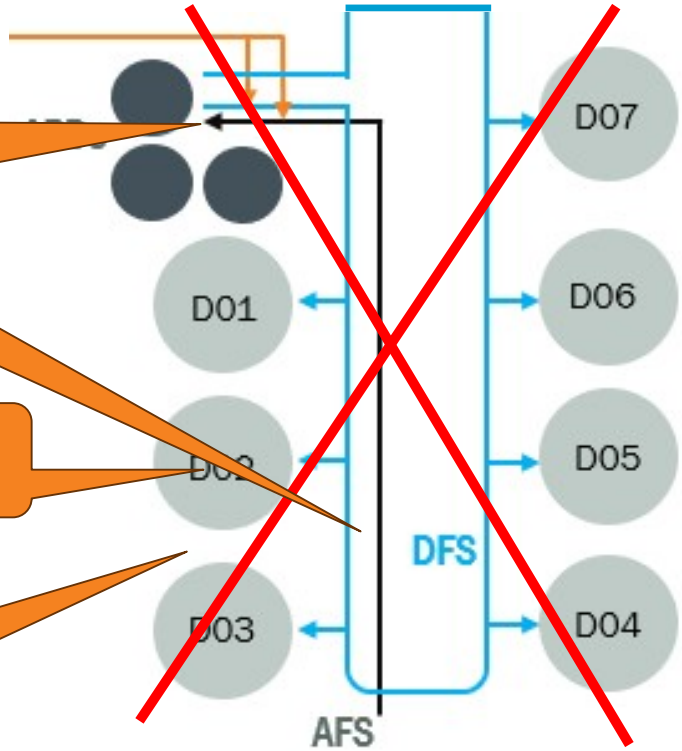
Loop for Continuous Feed

Increase cycle frequency of feed system

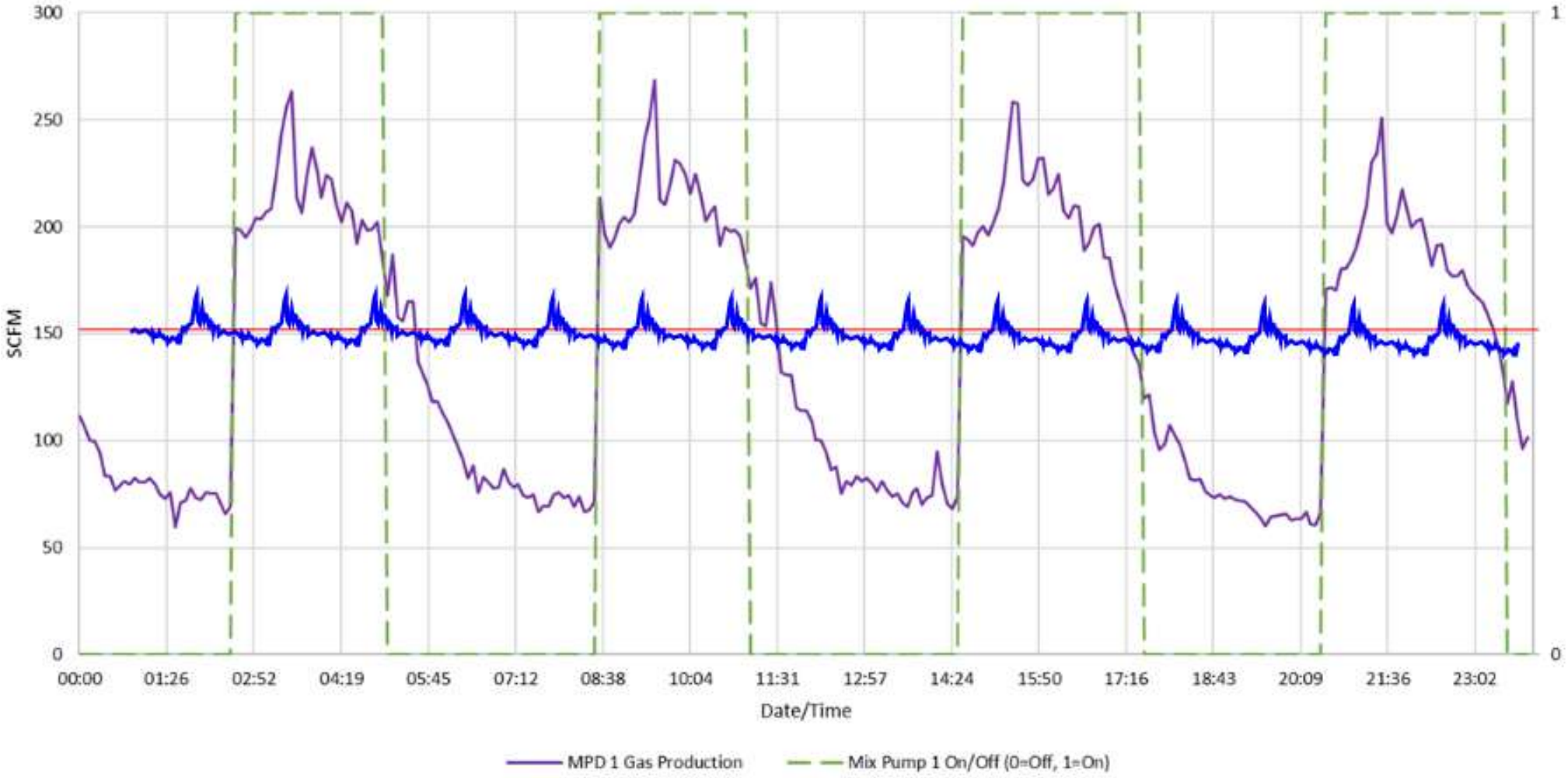
No room in APD area or tunnel gallery for loop system

Capital Cost for additional pumps/piping

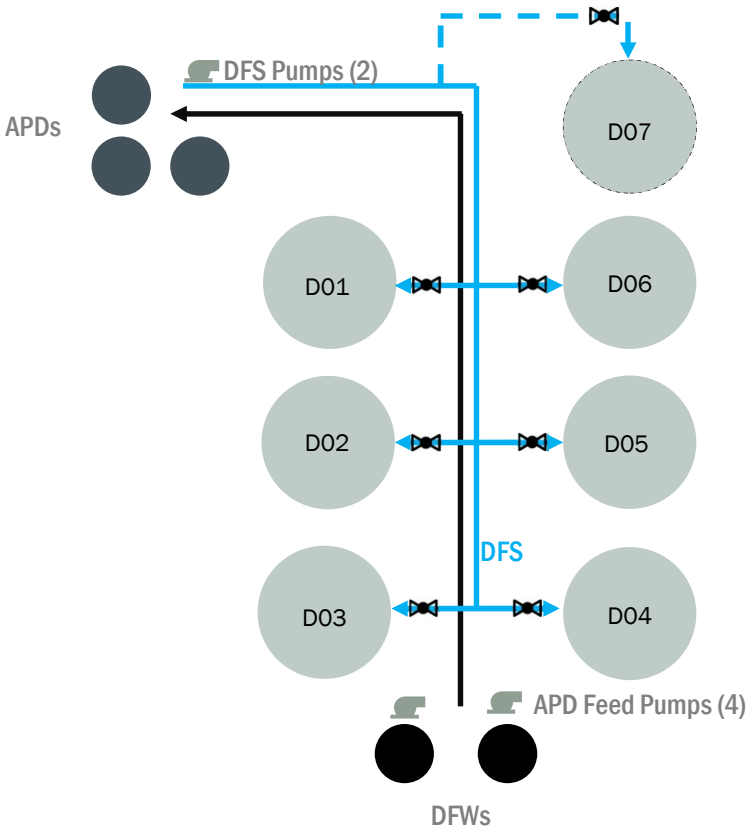
Maintaining Plant Operations



Cost-Effective Approach to “Semi” Continuous Feed



Columbus Southerly Existing Digestion

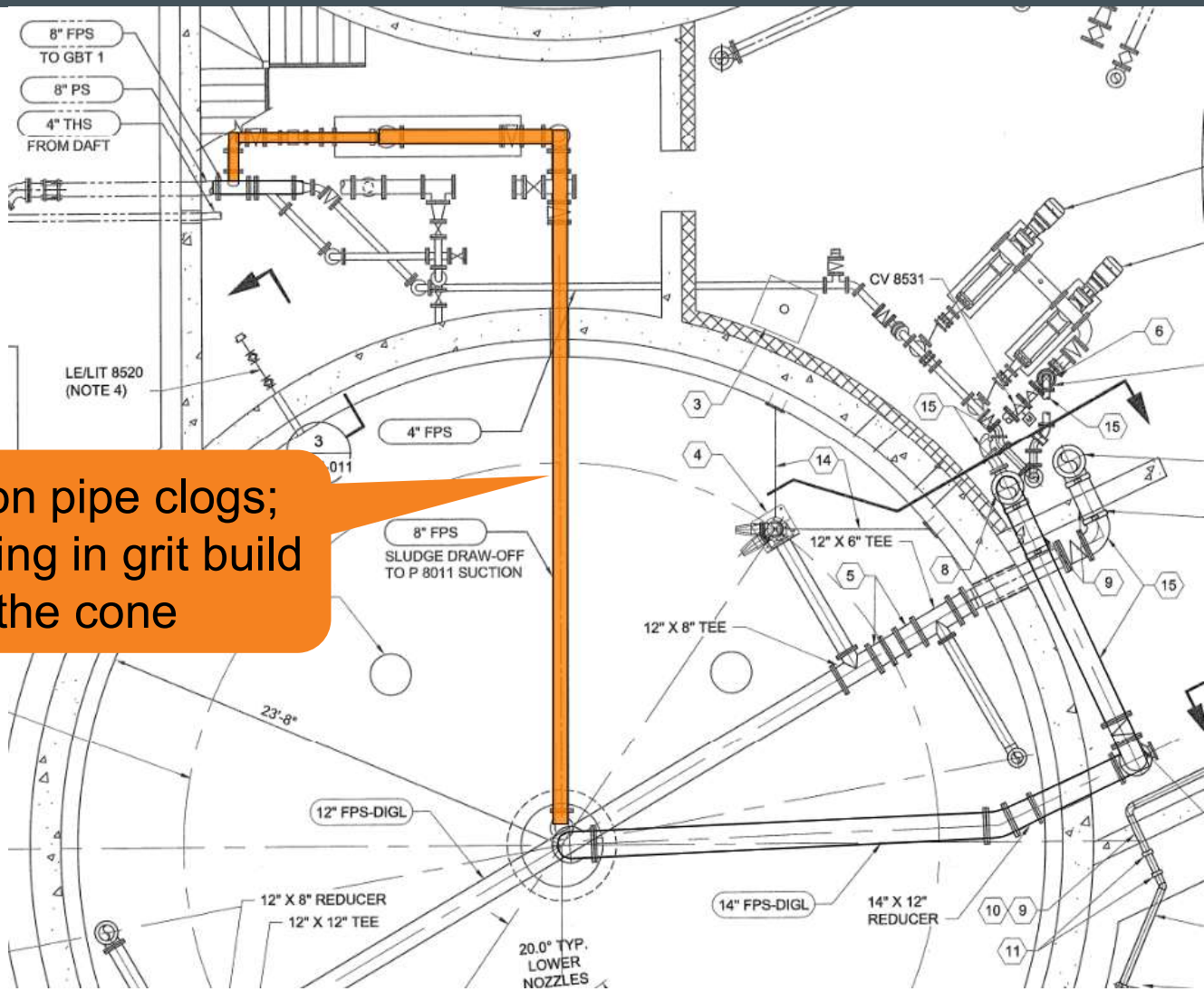


Common Issues to Address

- Intermittent Mixing
- Intermittent Feeding
- No Cone Withdrawal

Cone Withdrawal Improvements

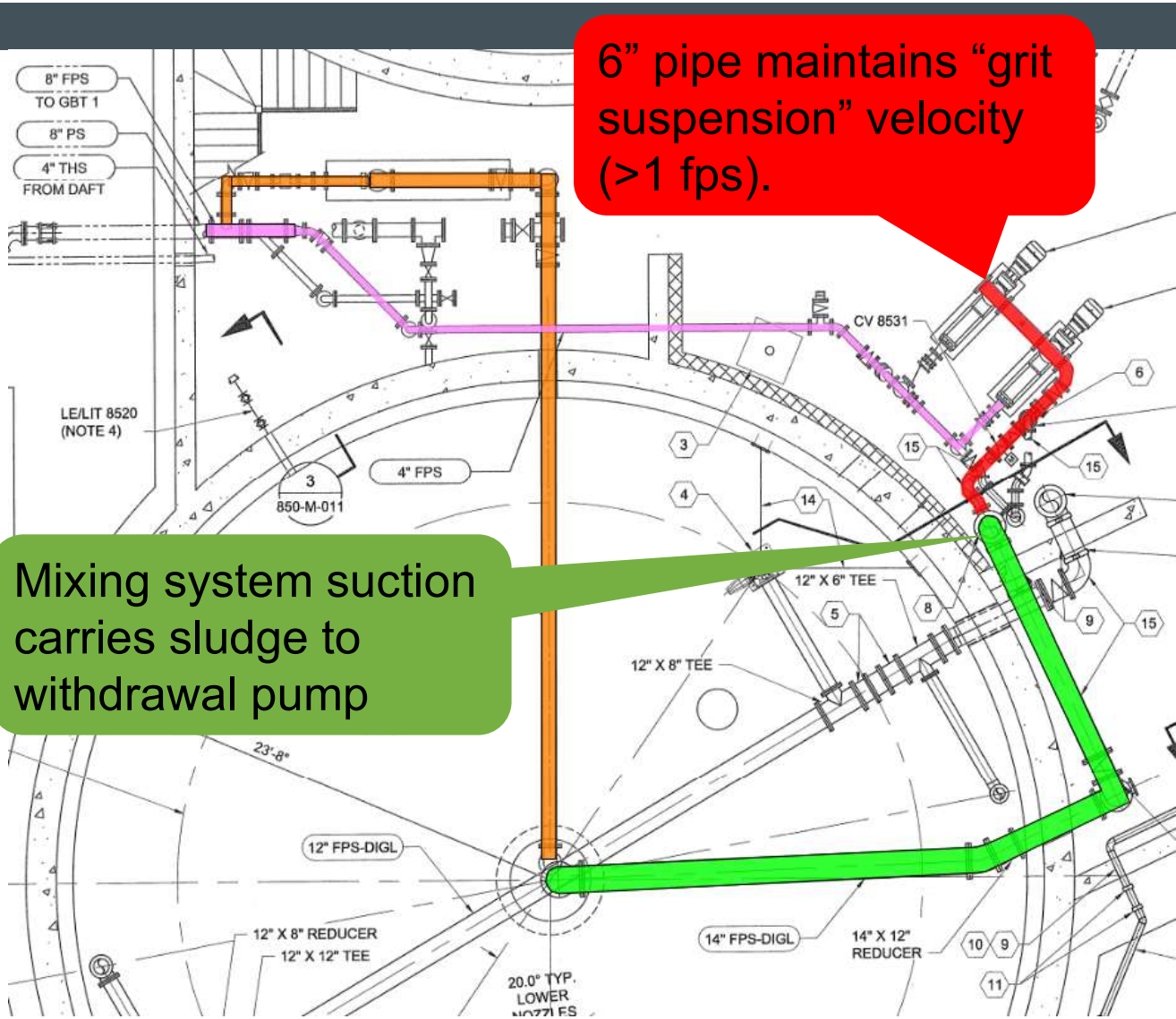
	Old	New
Color Code	Orange	
Suction Diameter (in)	8	
Suction Flow (gpm)	100	
Suction Velocity (fps)	~0.6	
Continuous Withdrawal?	No	
Grit Settling Velocity (fps)	<1	
Grit Scour Velocity (fps)	5	



Suction pipe clogs; resulting in grit build up in the cone

Cone Withdrawal Improvements

	Old	New
Color Code	Orange	Green
Suction Diameter (in)	8	14
Suction Flow (gpm)	100	2,400
Suction Velocity (fps)	~0.6	5.0
Continuous Withdrawal?	No	Yes
Grit Settling Velocity (fps)	<1	
Grit Scour Velocity (fps)	5	



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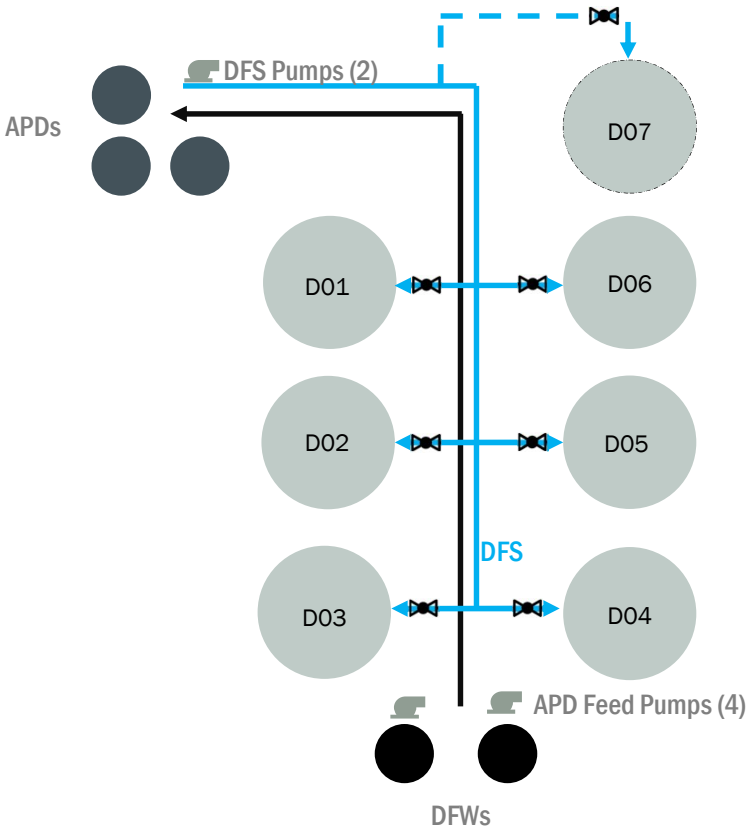


Common Issues to Address

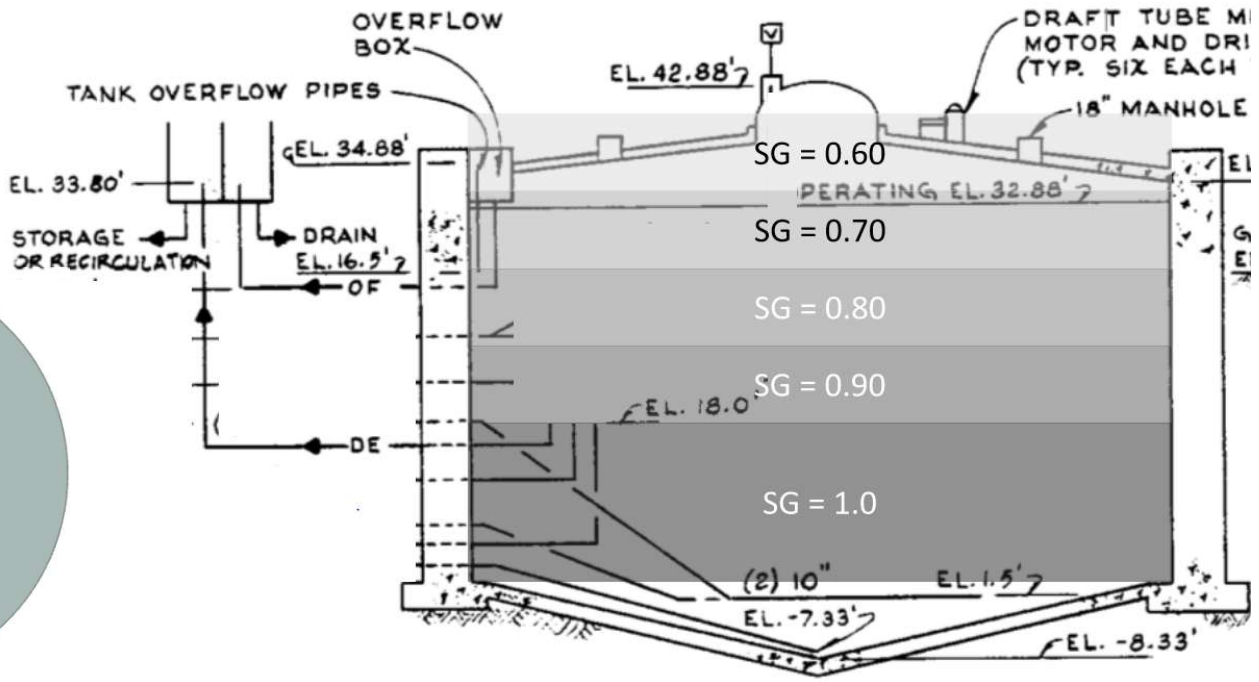
- Intermittent Mixing
- Intermittent Feeding
- No Cone Withdrawal
- No Surface Withdrawal

Add Surface Withdrawal

Addresses Foam Accumulation

Improves Biogas Separation

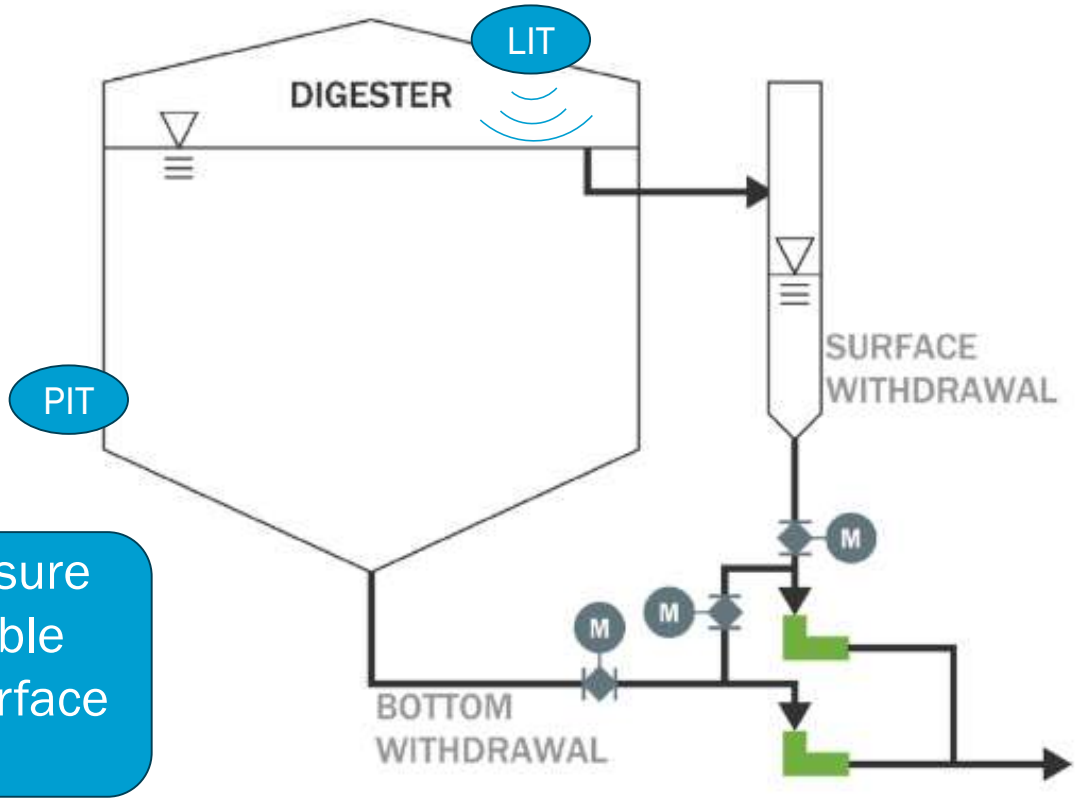
Increase Effective SRT



Withdrawal Best Practices

Utilize Cone AND Surface Withdrawal	
New Digesters	Retrofit Digesters
Continuously withdraw from both	Rotate between surface and cone

Use Difference between Radar and Pressure level sensors to track SG and/or Floatable levels…. This can inform split between surface and cone withdrawal times



Radar Level Transmitter for Floatable Detection

Closing – What's more Awesome than Digestion?

Squeezing 21st Century Performance out of a 20th Century Digester

How to Upgrade Dinosaurs ***Cost Effectively***

		20th Century	21st Century
		High	Advanc
Reactor	Stratified	Low S ecific Gravity	High Specific Gravity
Fugitive Emissions	Significant	Less	Minimized

Questions?