Brown AND Caldwell

Hybrid Biofilter for Biosolids Odor Control

NEWEA Conference

January 24, 2022

Overview

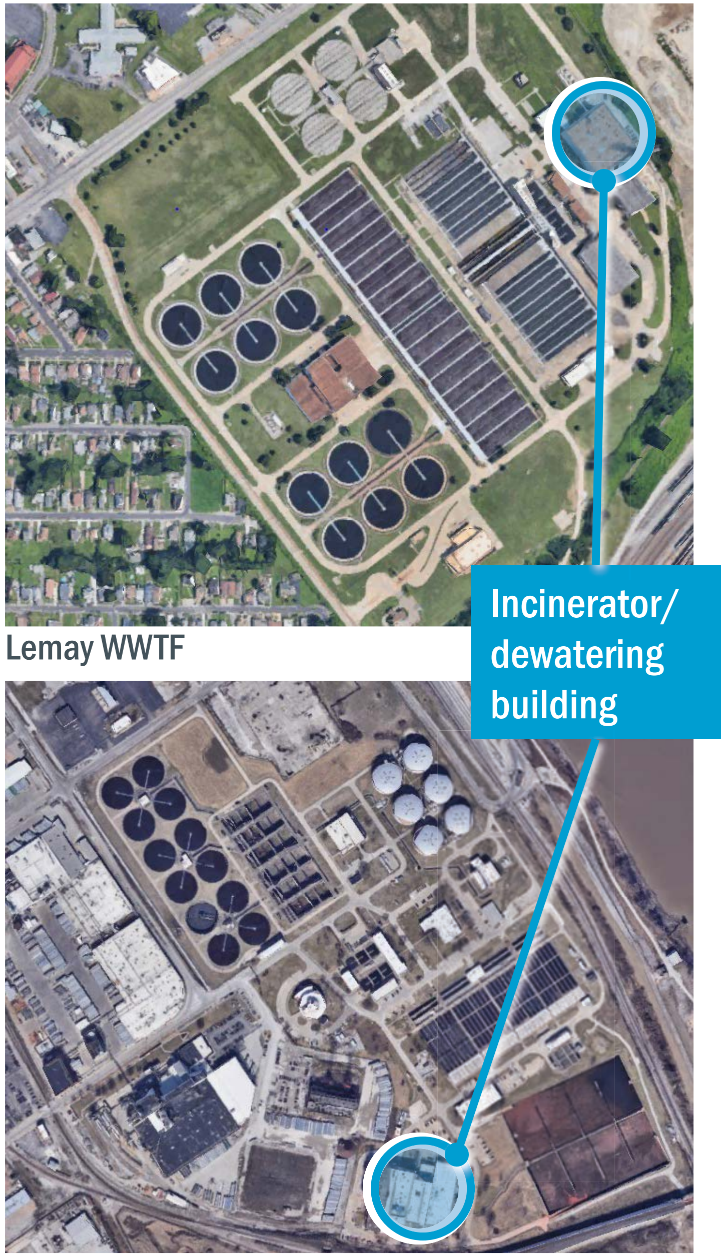
1. Project introduction
2. Odor sampling completed
   - Locations
   - Sampling methods
   - Sample types
3. Results and technology selection

Project Introduction

- New solids dewatering facilities for Lemay and Bissell Point WWTFs in St. Louis, MO as part of project for new incinerators
- New dewatering buildings include:
  - Sludge blend wells for primary and secondary sludge
  - Centrifuges
  - Cake collection bins (from centrifuges)
  - Cake receiving bins (trucked in from offsite)
- Sampling completed Sep 9-25, 2020 to provide data for basis of design for new odor control facilities

Sampling Locations

- Existing dewatering buildings include:
  - Blended sludge wells
  - Belt filter press
  - Cake receiving bin
  - Scum concentrator

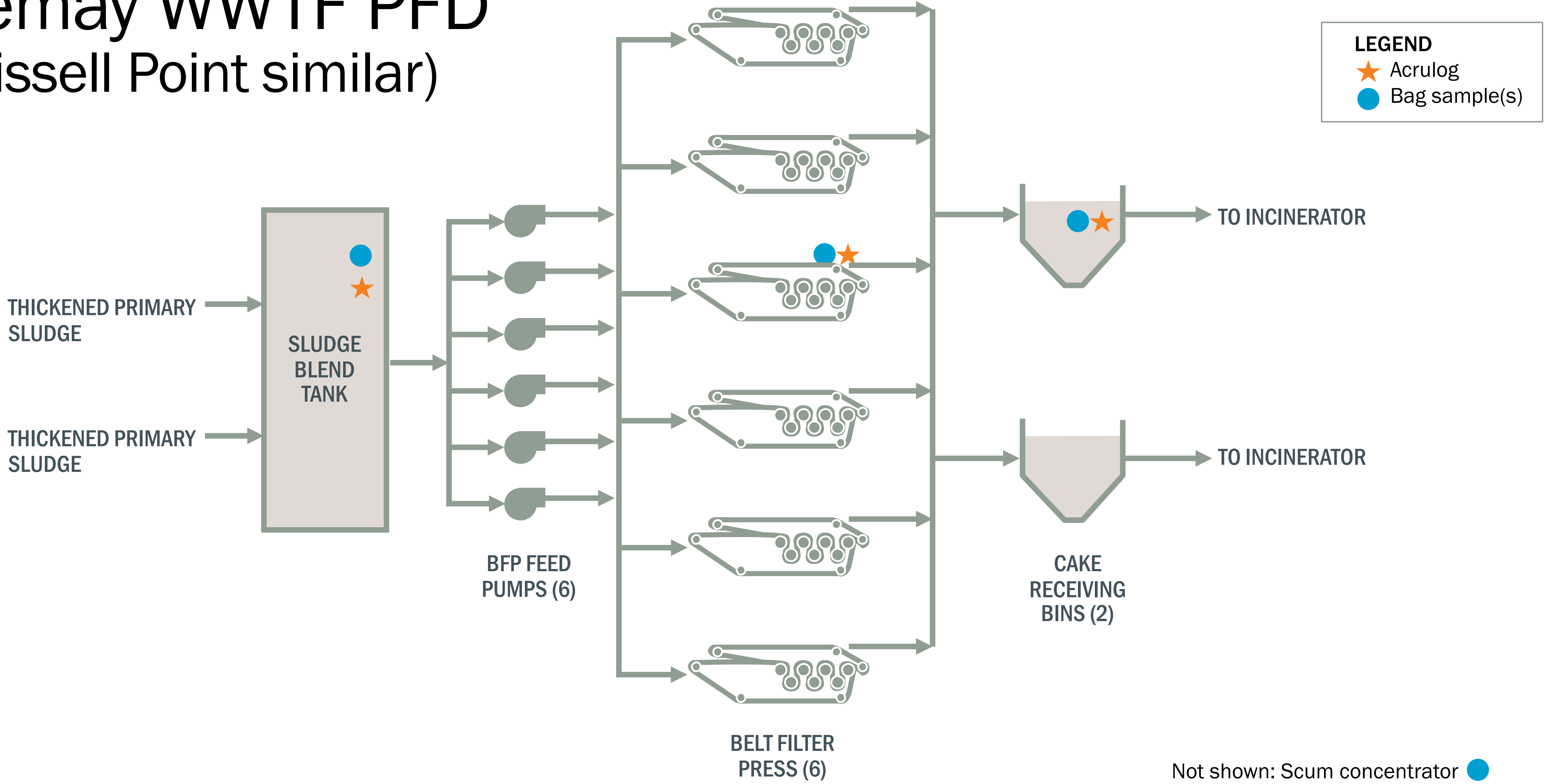


Bissell Point WWTF

Sampling Methods

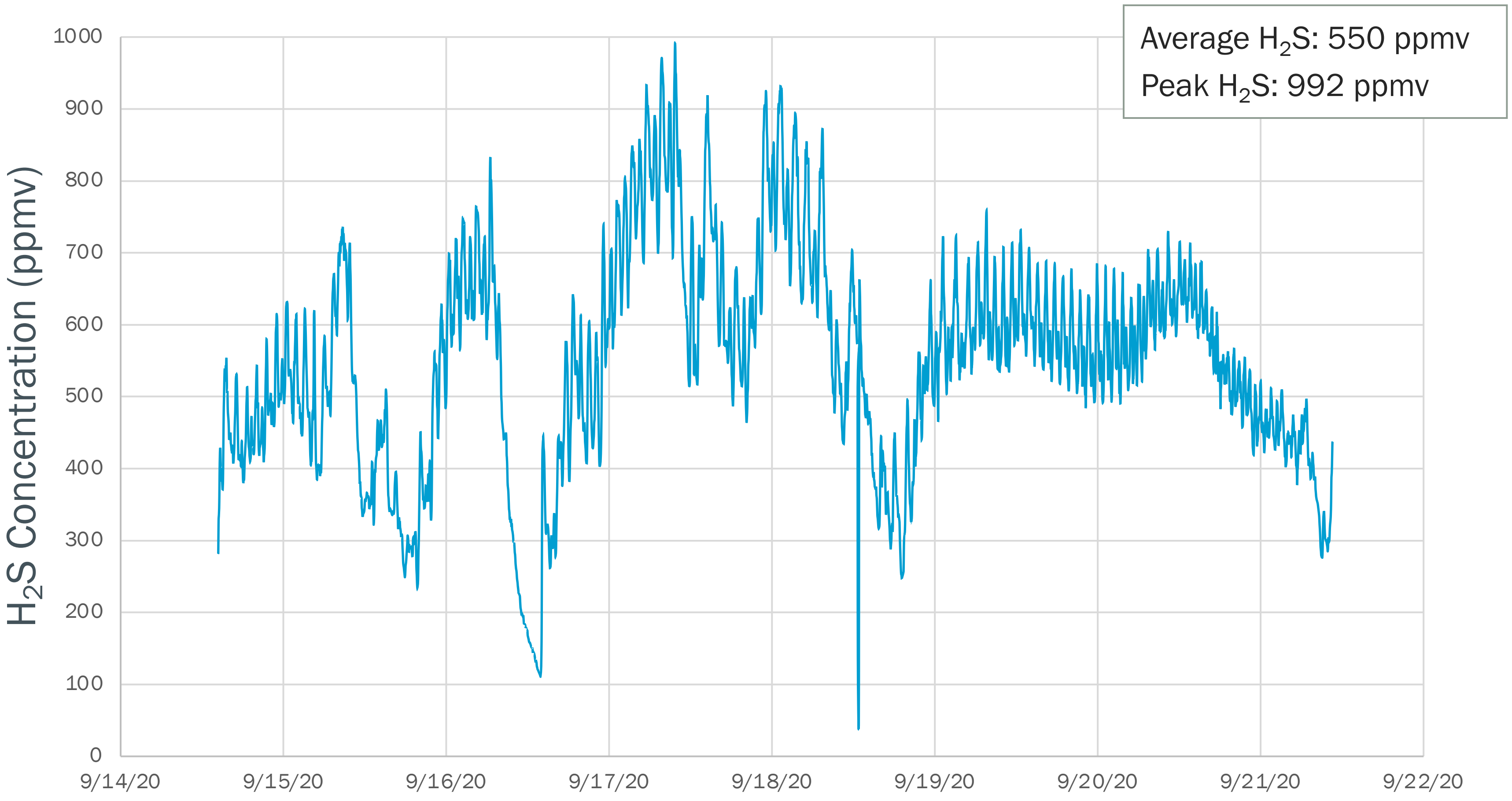
- Grab samples:
  - Bag samples for lab analysis (1)
  - Jerome Meter (2)
- Continuous sampling:
  - Acrulog monitors (3)

Lemay WWTF PFD
(Bissell Point similar)



Not shown: Scum concentrator

Sampling Results



Bissell Point WWTF blended sludge well Acrulog H_2S monitoring plot

Sampling Results

CAS #	Compound	Result µg/m³	MRL µg/m³	Result ppbV	MRL ppbV
7783-06-4	Hydrogen Sulfide	**120,000**	14	**84,000**	10
463-58-1	Carbonyl Sulfide	**200**	25	**80**	10
74-93-1	Methyl Mercaptan	**3,300**	20	**1,700**	10
75-08-1	Ethyl Mercaptan	ND	25	ND	10
75-18-3	Dimethyl Sulfide	**550**	25	**220**	10
75-15-0	Carbon Disulfide	ND	16	ND	5.0
75-33-2	Isopropyl Mercaptan	ND	31	ND	10
75-66-1	tert-Butyl Mercaptan	ND	37	ND	10
107-03-9	n-Propyl Mercaptan	ND	31	ND	10
624-89-5	Ethyl Methyl Sulfide	ND	31	ND	10
110-02-1	Thiophene	ND	34	ND	10
513-44-0	Isobutyl Mercaptan	ND	37	ND	10
352-93-2	Diethyl Sulfide	ND	37	ND	10
109-79-5	n-Butyl Mercaptan	ND	37	ND	10
624-92-0	Dimethyl Disulfide	ND	19	ND	5.0
616-44-4	3-Methylthiophene	ND	40	ND	10
110-01-0	Tetrahydrothiophene	ND	36	ND	10
638-02-8	2,5-Dimethylthiophene	ND	46	ND	10
872-55-9	2-Ethylthiophene	ND	46	ND	10
110-81-6	Diethyl Disulfide	ND	25	ND	5.0

Bissell Point WWTF blended sludge well lab results

#	Field No.	Sample Description	DT	RT
1	1	Cake Bin - Bissell	3,900	2,100
2	2	BFP - Bissell	11,000	5,500
3	3	Scum - Bissell	1,200	650
4	4	Sludge Well - Bissell	14,000	8,500

Sampling Results

WWTF and Sampling Location		H_2S Concentration (ppmv)		Odor Units (D/T)
		Average	Peak	
Lemay WWTF	Blended sludge well	336	539	470,000
	Belt filter press	25	84	> 600,000
	Cake receiving bin	78	272	39,000
Bissell Point WWTF	Blended sludge well	550	992	140,000
	Belt filter press	41	256	110,000
	Cake receiving bin	4.5	25	39,000
	Scum concentrator	-	-	12,000

Calculated Odor Loadings

Bissell Point WWTF

Odor Control Strategy	Design Airflow Rate (cfm)	Odor Loading Parameter			
		Average H_2S (ppmv)	Peak H_2S (ppmv)	Average Odor (D/T)	Peak Odor (D/T)
Diluted air stream: including cake receiving and truck loading bays	22,000	8	20	5,000	10,000
Concentrated air stream: not including cake receiving and truck loading bays	6,000	25	70	19,000	38,000

Lemay WWTF

Odor Control Strategy	Design Airflow Rate (cfm)	Odor Loading Parameter			
		Average H_2S (ppmv)	Peak H_2S (ppmv)	Average Odor (D/T)	Peak Odor (D/T)
Diluted air stream: including cake receiving and truck loading bays	21,000	15	25	40,000	80,000
Concentrated air stream: not including cake receiving and truck loading bays	5,000	70	100	160,000	320,000

Odor Control Alternatives

Vapor Phase Odor Control Technologies

- Wet chemical scrubbing
- Biofilters
- Biotrickling filters (BTF)
- Dry media adsorption
- Ionization

Odor Control Alternatives

Wet Chemical Scrubbing

- Good for H_2S or ammonia removal (depending on chemical used)
- Moderate organic sulfide removal
- Smaller footprint – 1-2 second contact time
- Requires chemical storage
- High O&M requirements
  - Spray nozzles
  - Recirc pumps
  - Metering pumps
  - Instrumentation
  - Hazardous chemical handling

Odor Control Alternatives

Biofilters

- Engineered or organic media
- Good for removal of variety of odor compounds
- Large footprint – 30-60 second contact time
- Requires acclimation time
- Moderate O&M requirements
  - Humidification nozzles
  - Irrigation nozzles
  - Short-circuiting (smoke testing helps)

Odor Control Alternatives

Bio-Trickling Filters (BTFs)

- Variety of media types
- Recirculation or once-through configuration
- Typically tower orientation – contact time 10-20 seconds
- Geared for H_2S removal only
- Requires acclimation time
- Moderate O&M requirements
  - Recirc pumps
  - Spray nozzles
  - Mist and grease eliminator

Odor Control Alternatives

Dry Media (Activated Carbon)

- Variety of media types
- Good for removal of variety of odor compounds
- Relatively small footprint– contact time 3-4 seconds
- Low O&M requirements
- Possible complications
  - Moisture occupies pore spaces
  - High odor concentrations result in frequent media replacement

Odor Control Alternatives

Ionization

- Creates free radicals, ionized air, cold plasma
- Can treat supply or exhaust air
- Very small footprint
- Inappropriate for high odor air streams
- Limited track-record
- Emits ozone
- Free radicals attack rubber-based materials

Odor Control Alternatives

Alternatives Considered

- Only multi-stage systems due to high H_2S and odor levels
  - Biotrickling filter (BTF) followed by carbon
  - Biofilter followed by carbon
  - 3-stage chemical scrubber (acid, caustic, hypochlorite solution)
- Primary odorous compounds of concern are H_2S, organic sulfides

Odor Control Alternatives

Alternatives Considered

- Alternatives eliminated due to expected high fenceline emissions:
  - BTF + carbon
  - Chemical Scrubber
- Which leaves....

Biofilter + carbon!

Odor Control Alternatives

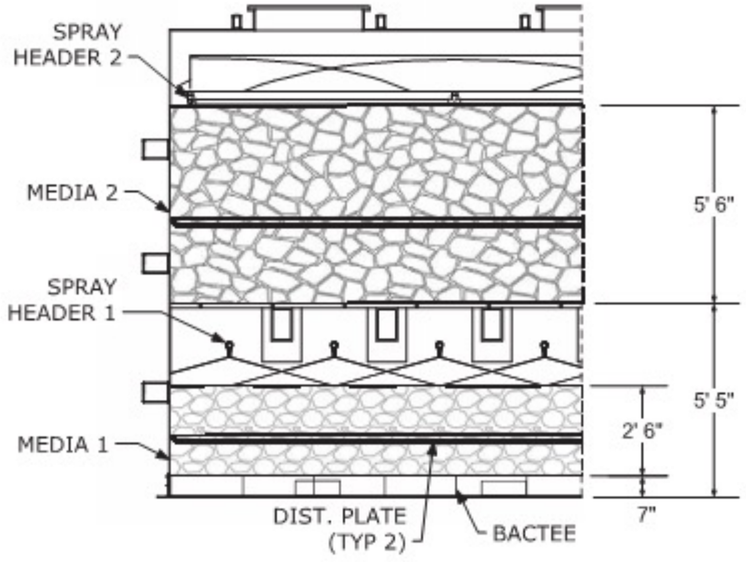
Vendor responses on design loads:

- "Due to relatively high H_2S we may be better off using a roughing stage short-EBRT BTF upstream of the biofilter. The high levels of H_2S can serve to acidify the media in a biofilter and limit its performance in deal with total odor not associated with H_2S."
- "The H_2S loadings seem quite high and we wouldn't recommend biofilters for these applications. We would need to knock down the H_2S with a BTF before the second stage."
- "70 ppm average is too high for an engineered media biofilter – really need a first stage trickling filter to rough that down."

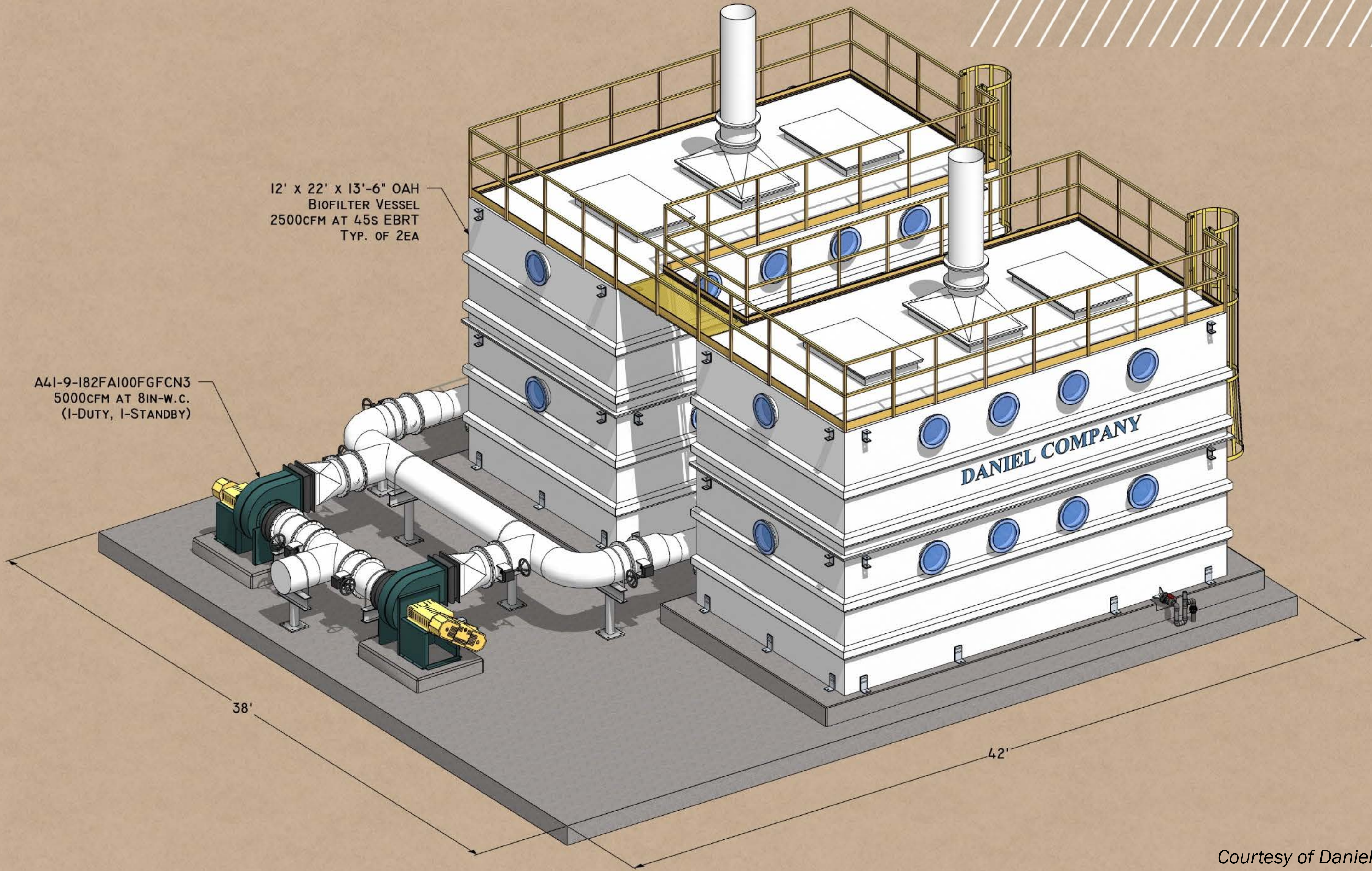
Odor Control Alternatives

Layered/Hybrid Biofilter

- Essentially a BTF + biofilter in one
- Two different media types in the two beds
  - Lower bed geared towards H_2S removal. Shorter EBRT (15 sec).
  - Upper bed geared towards RSCs and larger compounds. Longer EBRT (30 seconds).
- Each bed independently irrigated
  - Air from lower bed is very humid so don't need much irrigation in upper bed



Courtesy of Daniel Company



Courtesy of Daniel Company

Next Steps

- Design brought to 30% submittal
- Project has gone out to bid (RFP for design-builder)

Thank you!

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Questions?