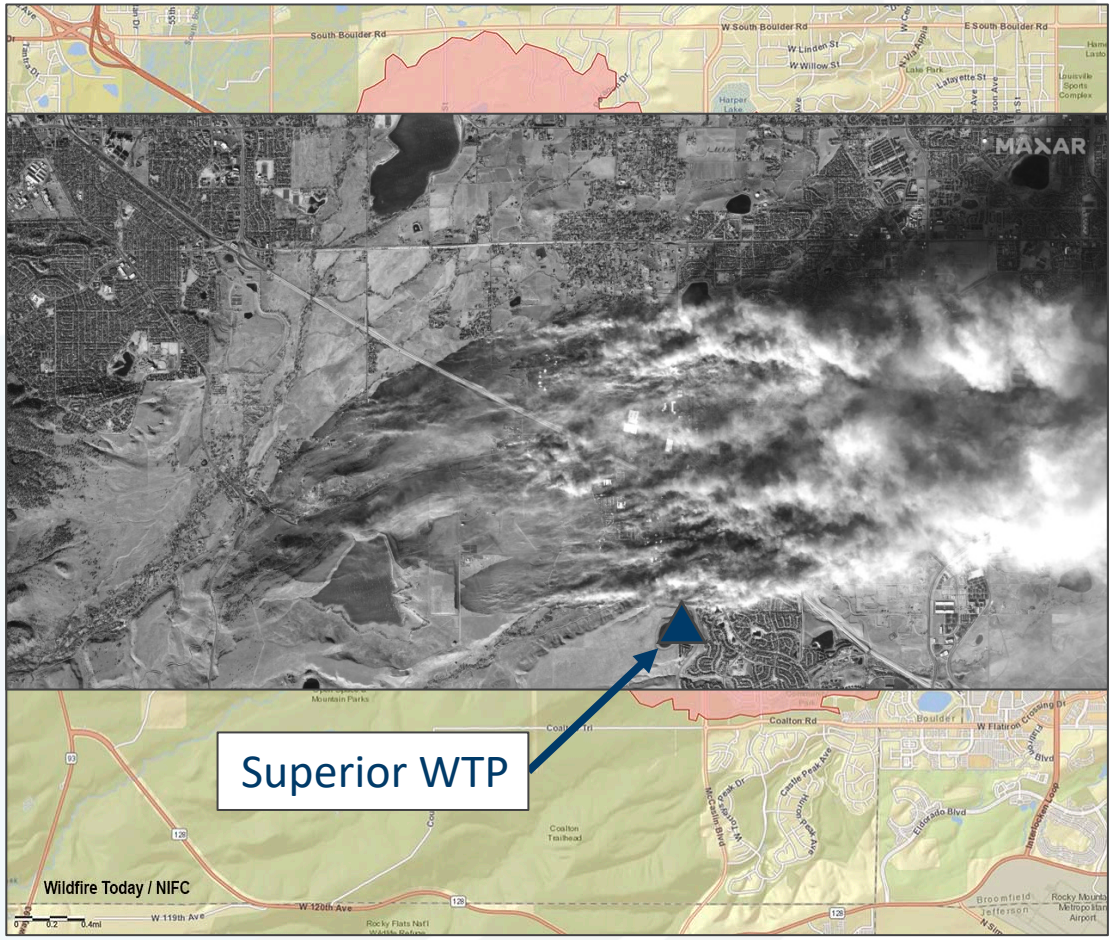
Corona WUI Fire Workshop: Town of Superior Earthy/Smoky Odor Concern and Response

February 13, 2023

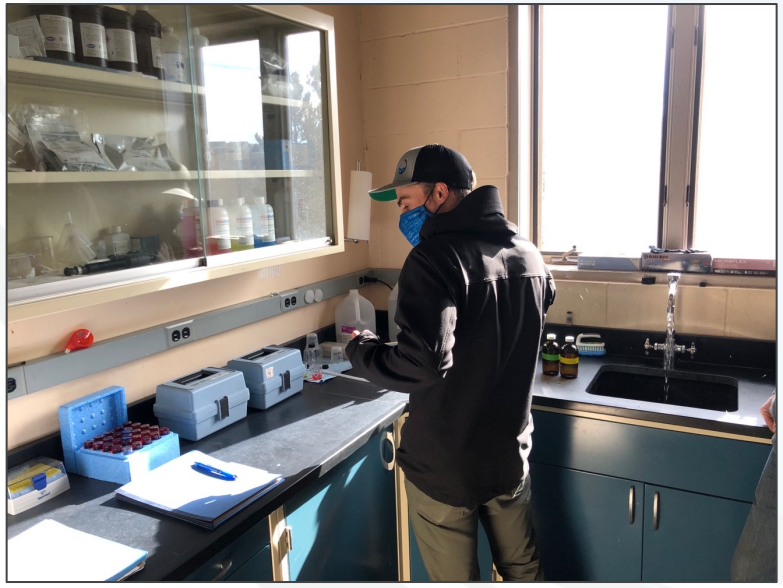
Marshall Fire – A Wildland Urban Interface (WUI) Fire

- Town of Superior (Superior), Boulder County, Colorado
- December 30, 2021
- Most destructive fire in Colorado history
- 6,084 structures burned; 1,084 structures destroyed; 370 residences in Superior
- Fire breached water treatment plant (WTP) property

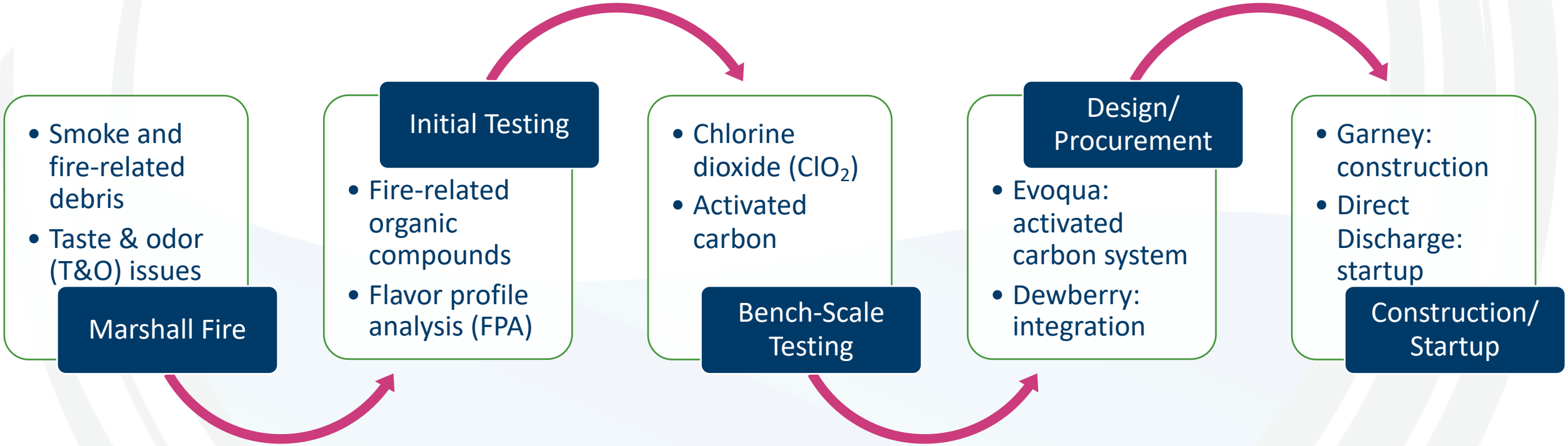


Marshall Fire – A Wildland Urban Interface (WUI) Fire

Initial Sampling – January 2022



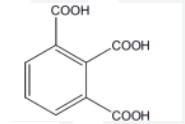
Emergency Response Timeline

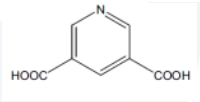


Initial Testing – January 2022

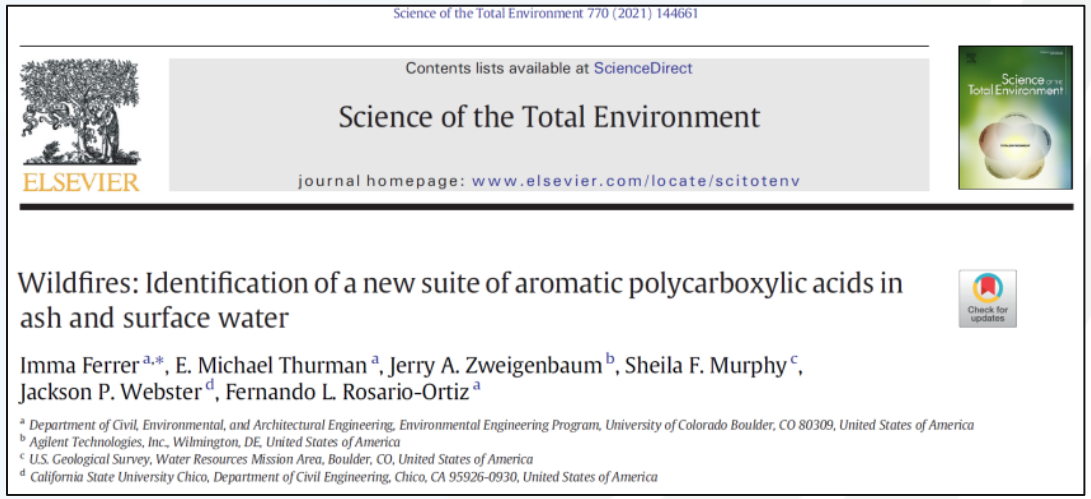
- Hundreds of smoky T&O complaints throughout Superior
- WTP (3 samples):
  - Raw
  - Filtered without free chlorine
  - Filtered with free chlorine
- Residences (4 samples):
  - Pitkin Ave
  - Lasalle St
  - Eldorado Dr
  - Calmante Pl

- Fire-related organic compound testing:
  - Liquid chromatography/ quadrupole time of flight-mass spectrometry (LC/QTOF-MS) at CU by Drs. Imma Ferrer and Michael Thurman
  - 12 compounds:
    - Benzene polycarboxylic acids (BPCA)
    - Pyridine carboxylic acid (PCA)
    - Other related carboxylic acids





  - Detection limits (DL): 50 to 500 ng/L



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journal homepage: www.elsevier.com/locate/scitotenv

ELSEVIER

Wildfires: Identification of a new suite of aromatic polycarboxylic acids in ash and surface water

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Draft Cameron Peak Wildfire Water Quality Monitoring Recovery Plan

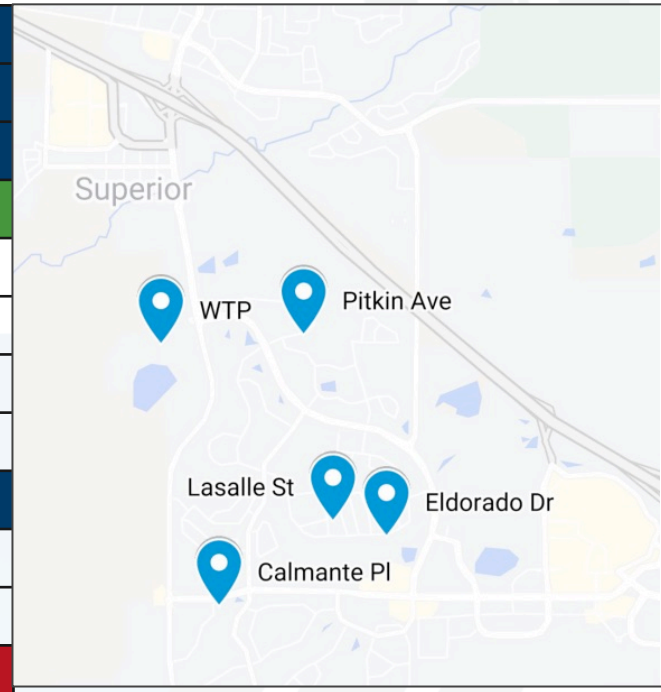
City of Fort Collins Utilities – April 7, 2021

Initial Testing – January 2022 – LC/QTOF-MS

Fire-Related Organic Compound	DL (ng/L)	WTP Concentration (ng/L)			Residence Concentration (ng/L)			
		Raw	Filtered-No Cl_2	Filtered-Cl_2	Pitkin Ave	Lasalle St	Eldorado Dr	Calmante Pl
3,5-PCA	50							
1,2,4-BPCA	200							
1,2,3-BPCA	100			**100**	**100**	**110**	**120**	**110**
1,3,5-BPCA	100							
1,2-BPCA	500							
1,4-BPCA	500			**1,500**	**850**			
1,3-BPCA	500							
3-methyphthalic acid	200							
1,4-naphthalene dicarboxylic acid	100							
2,6-naphthalene dicarboxylic acid	100							
4,4'-biphenyl dicarboxylic acid	100							
2,2'-biphenyl dicarboxylic acid	50							

Initial Testing – January 2022 – FPA

Smoky Odor Rating	WTP			Residence			
	Raw	Filtered-No Cl_2	Filtered-Cl_2	Pitkin Ave	Lasalle St	Eldorado Dr	Calmante Pl
Water Temperature: 20°C							
None							
Very weak							
Weak							
Weak/moderate							
Moderate							
Water Temperature: 45°C							
None							
Very weak							
Weak							
Weak/moderate							
Moderate							

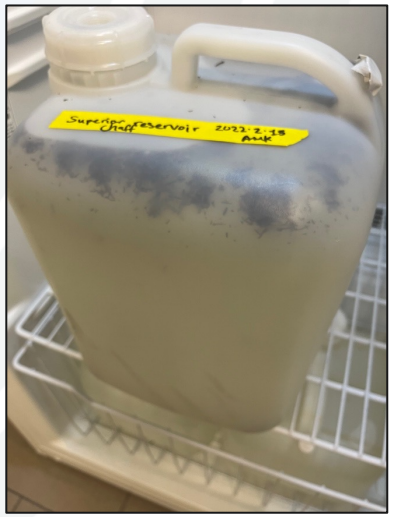


Project Goals

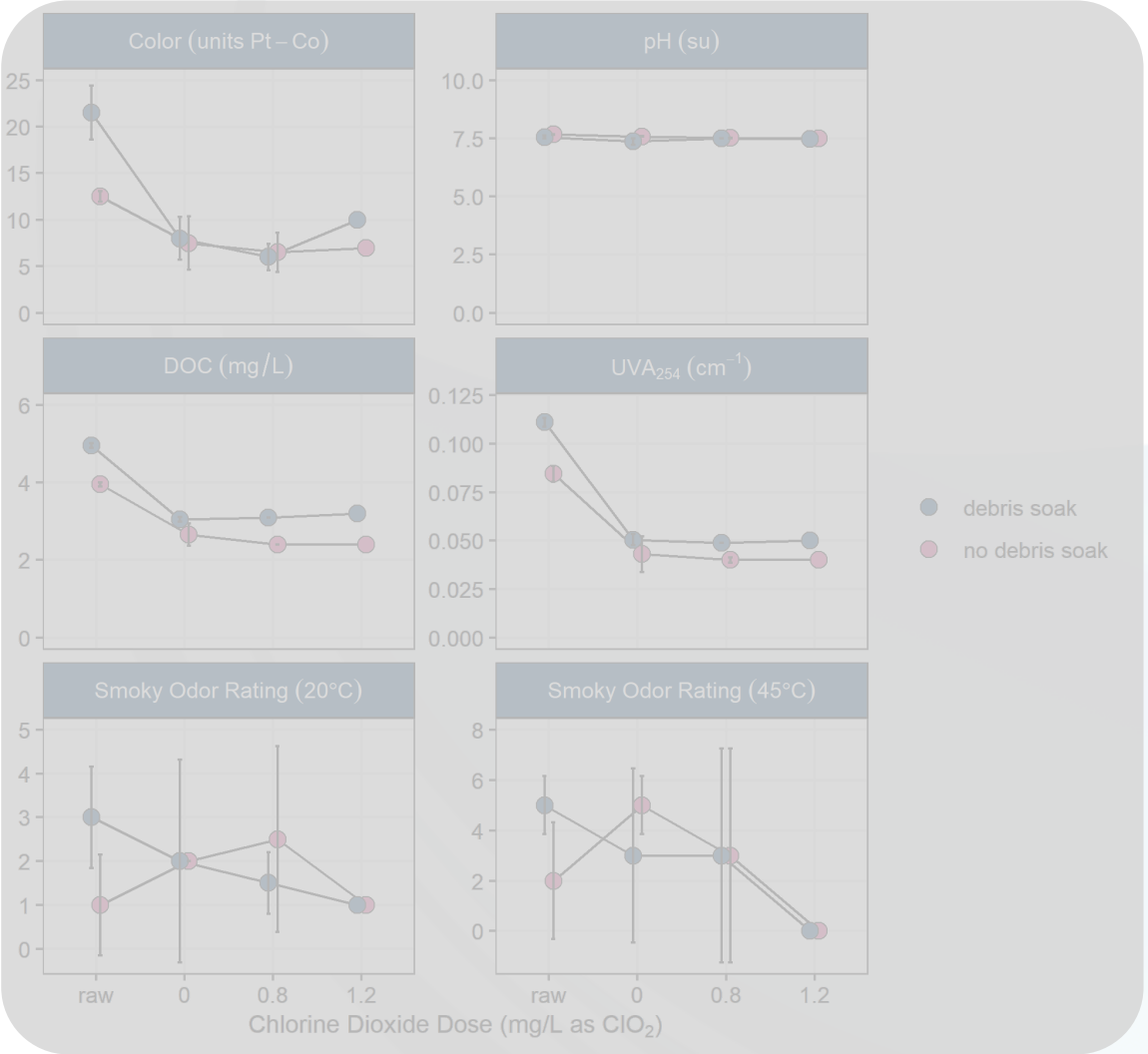
- Evaluate several (typical) treatment technologies for the removal of earthy/smoky T&O at Superior's WTP:
  - Chlorine dioxide (ClO_2) oxidation
  - Activated carbon adsorption:
    - Powdered activated carbon (PAC)
    - Granular activated carbon (GAC)
- Evaluate based on odor testing rather than fire-related organic compound analysis (LC/QTOF-MS)
  - FPA
  - Corona odor testing
- Coordinate findings with Superior, Direct Discharge, Dewberry, and Evoqua, to implement a solution

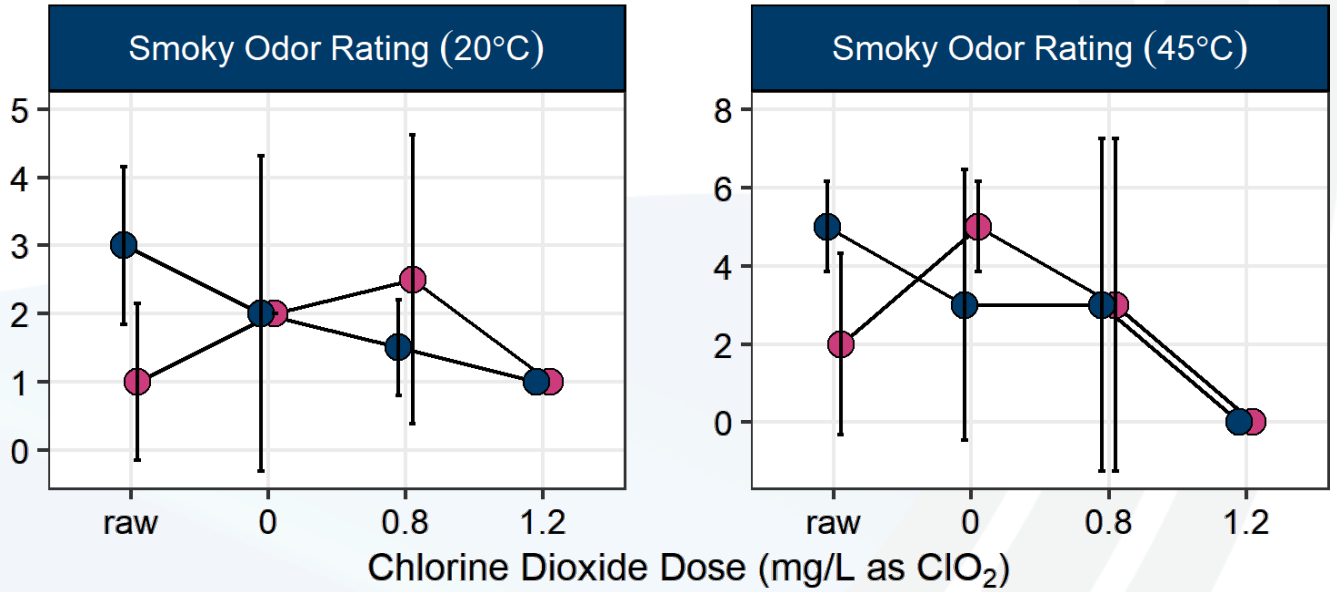
Bench-Scale Testing

- Jar tests:
  - Odor: smoky
  - Coagulant – USALCO CC 2225
  - Chlorine dioxide (ClO_2) – CDG Solution 3000
  - PAC – Calgon WPH 1000, Norit PAC 20B
- GAC rapid small-scale column tests (RSSCT):
  - Odor: earthy/smoky
  - Bituminous coal:
    - Evoqua UltraCarb 1240 LD (UC)
    - Calgon F400 (F400)
  - Coconut shell:
    - Evoqua AquaCarb 1240C (AC)
    - Calgon OLC 12x40 (OLC)

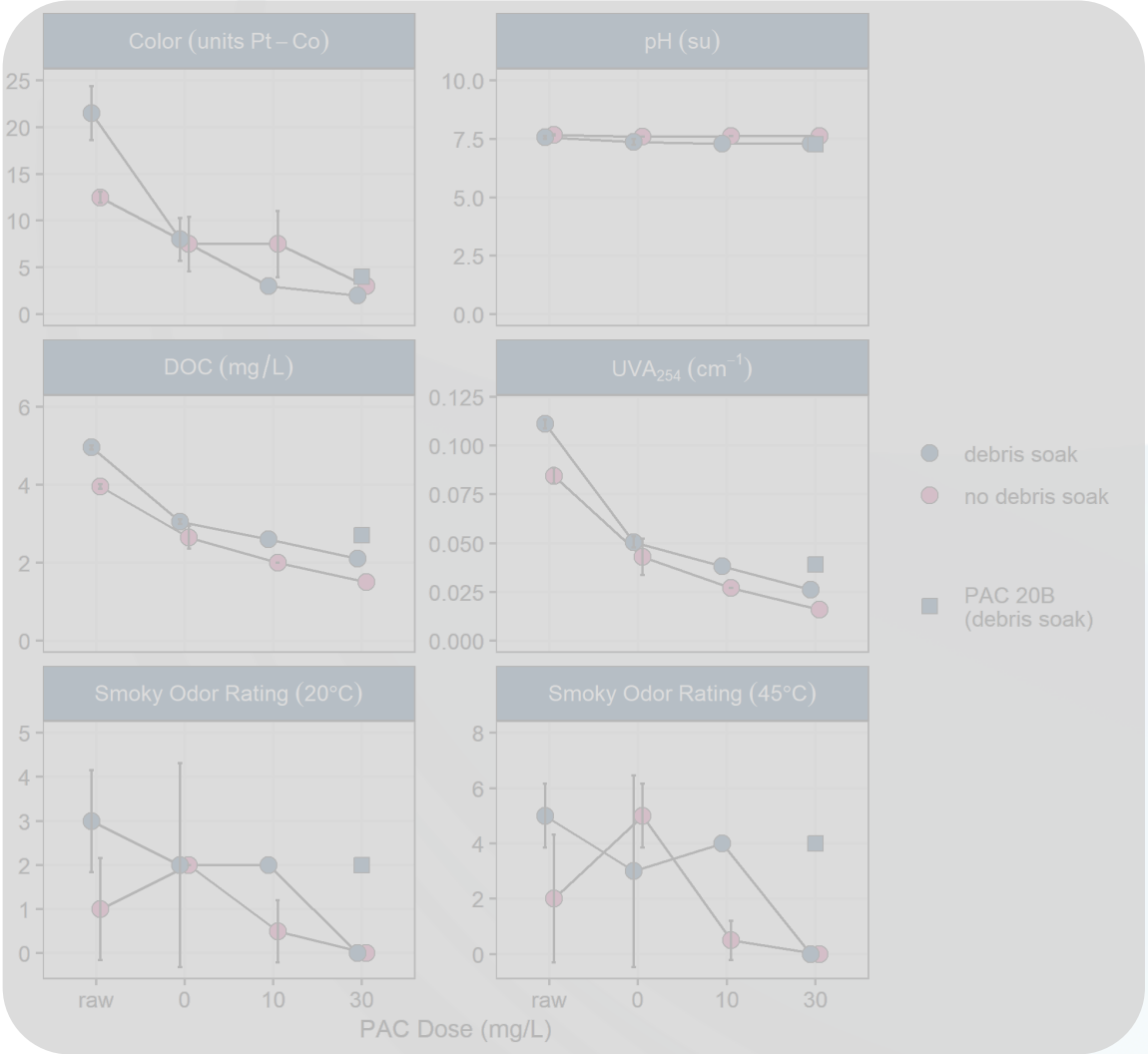


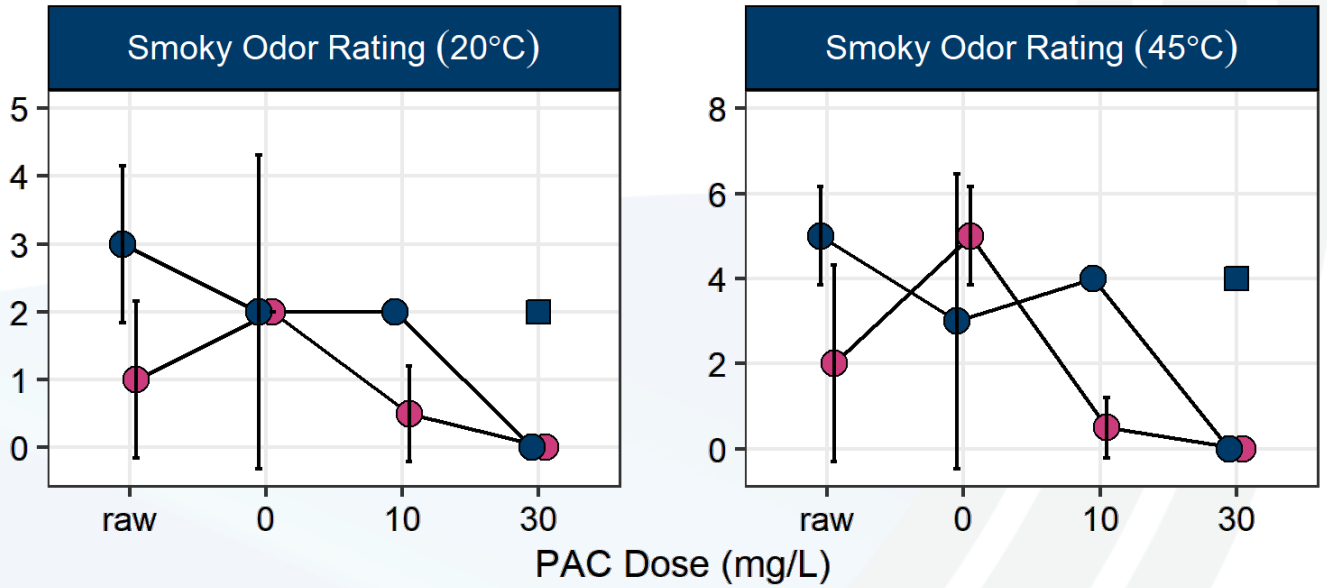
Bench-Scale Testing – Jar Test – Chlorine Dioxide





Bench-Scale Testing – Jar Test – PAC





Bench-Scale Testing – Jar Tests - Conclusions

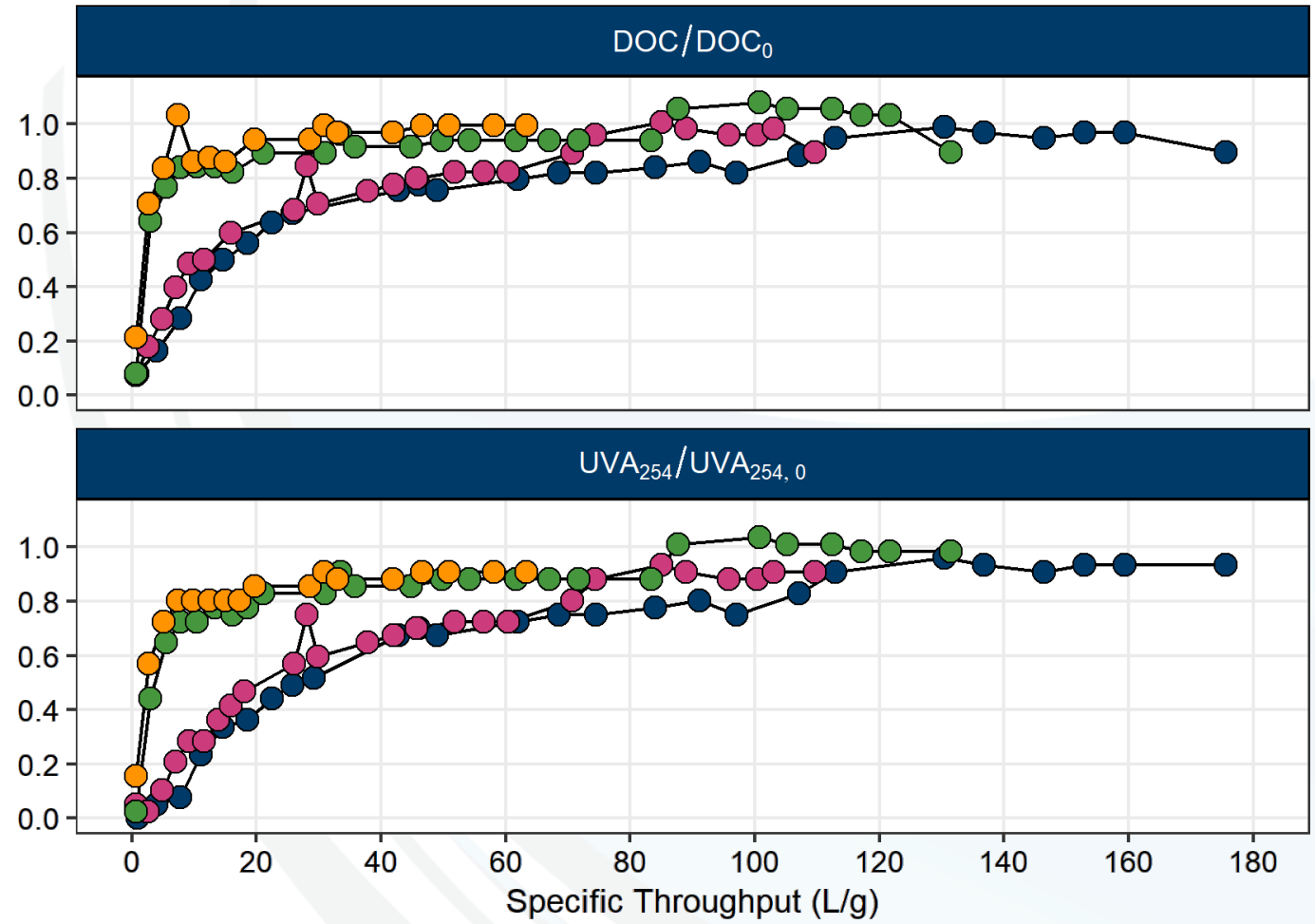
- Fire-related debris increased DOM content
- Chloride dioxide was only effective at eliminating smoky odor at 1.2 mg/L as ClO_2 and 45°C, but imparted a significant chlorinous odor
- Only PAC (Calgon WPH 1000) at 30 mg/L eliminated smoky odors under all conditions
- PAC results indicated GAC would be effective
- PAC would be difficult to implement given the legacy system at the WTP

→ **test GAC!**

Corona Odor Testing

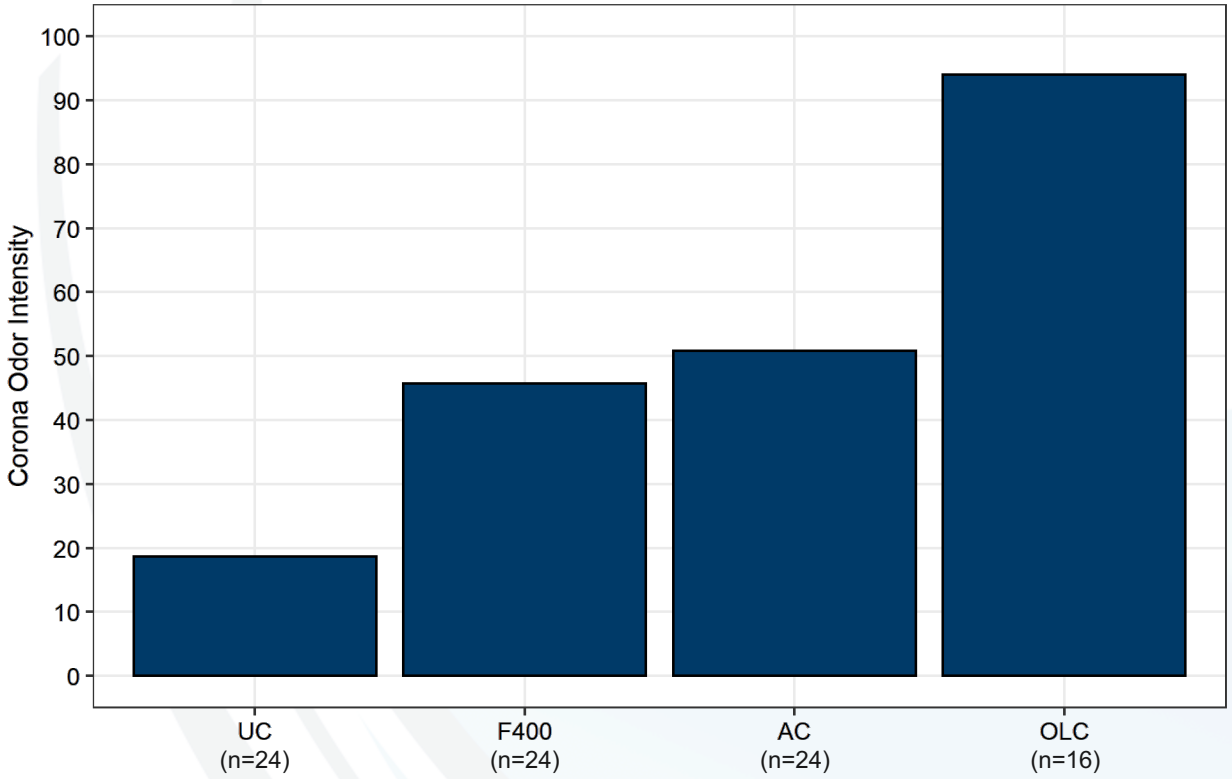
- 200 mL water sample:
  - RSSCT influent
  - RSSCT effluents
  - Reverse osmosis (RO) blank
- 500 mL Erlenmeyer flask with parafilmed top
- Heat to 45°C in a water bath
- Odor testing panel:
  - 3 to 6 people
  - 1 (unknown) water sample at a time
  - After every panel member has smelled each water sample:
    - 👍 (presence of earthy/smoky odor – 1)
    - 👎 (absence of earthy/smoky odor – 0)

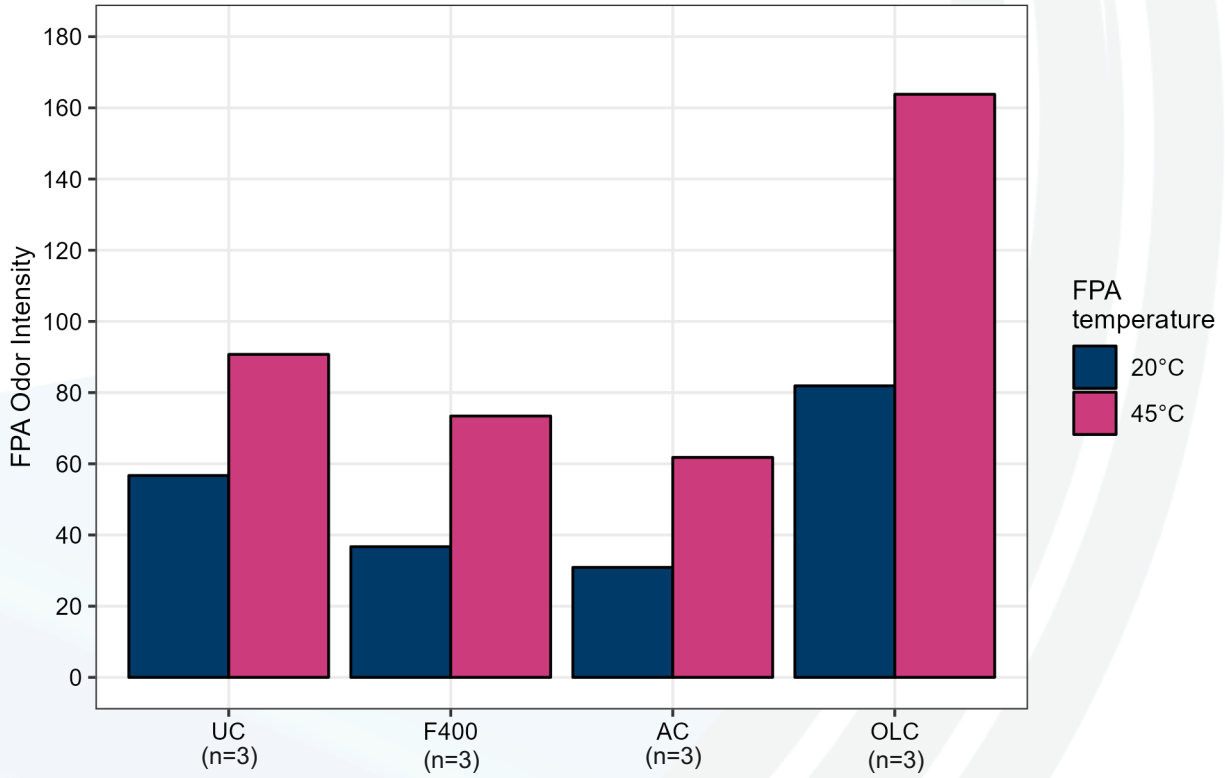
Bench-Scale Testing – GAC



GAC
- UC
- F400
- AC
- OLC

Bench-Scale Testing – GAC

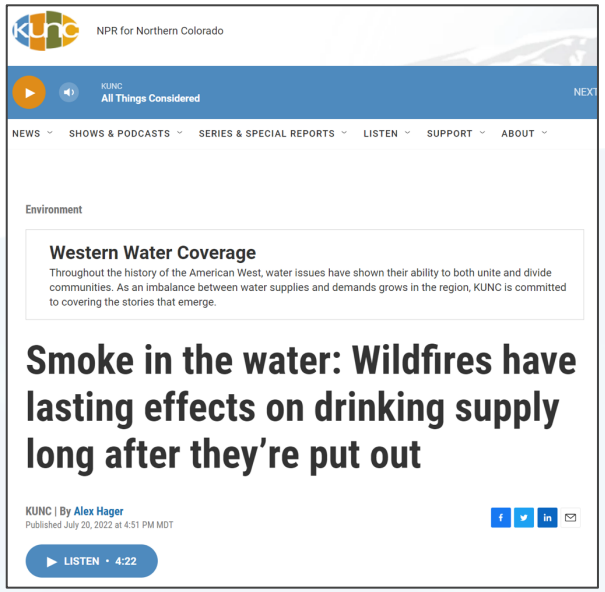




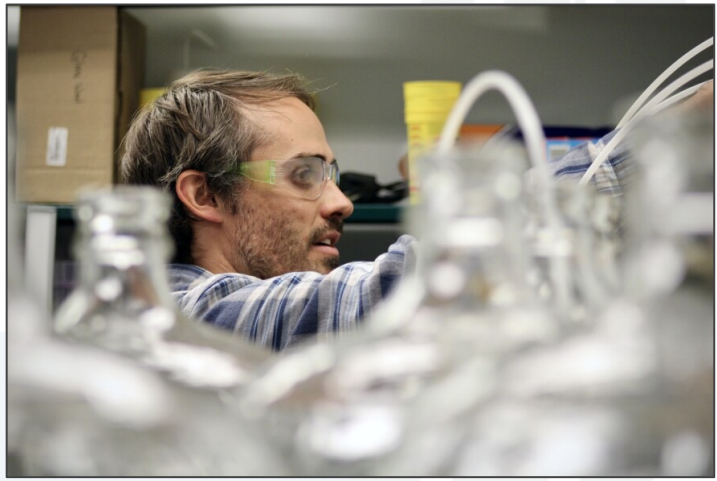
Bench-Scale Testing – GAC – Conclusions

- Fire-related debris increased DOM content
- UC and F400 were more effective at removing DOM than AC and OLC
- Based on Corona odor testing, UC was the most effective at removing smoky odors
- Based on more limited FPA odor testing, AC was the most effective at removing smoky odor

→ **UltraCarb 1240LD it is (was)!**



https://www.kunc.org/environment/2022-07-20/smoke-in-the-water-wildfires-have-lasting-effects-on-drinking-supply-long-after-theyre-put-out



Outcomes

- Evoqua Water Technologies LLC HP1020CIX 4-Tier GAC system:
  - 10 ft diameter, 20 ft overall height
  - UltraCarb 1240LD:
    - Mass: ~16,000 lb/vessel
    - Volume: ~700 ft^3/vessel
  - Design flow rate: 750 gpm/vessel
  - 3 vessel pairs, 6 total vessels
- Hydraulics:
  - Piping switched from series to parallel
  - Placed between existing WTP granular media filters and clearwell

Outcomes

- Design/operational issues:
  - Hydraulics → kept hydraulic loading rate low to limit headloss
  - Siting → used existing parking lot
  - Supply chain → make do with what's available!
  - Winterization → building in process
- American Public Works Association (APWA) Colorado Chapter project of the year (2022)
- Rental to permanent installation

Full-Scale Odor Sampling and Testing

- Purpose: detect earthy/smoky (and other) odor before Superior customers and trigger first GAC replacement
- Waters:
  - Raw
  - Combined GAC influent (filter effluent)
  - Mid-bed sample point prior to freezing issues:
  - Combined GAC effluent (no Cl_2)
  - RO blank
- DOC and UVA_{254} measurements:
  - Combined GAC influent
  - Vessel 4 mid-bed sample point prior to freezing issues
  - Combined GAC effluent
  - If possible, tie breakthrough to earthy/smoky (and other) odor detection for future GAC replacements:
    - As of January 27: TOC at 70% breakthrough from combined GAC effluent
    - As of February 2: UVA_{254} at 44% breakthrough from combined GAC effluent
    - Combined GAC effluent still odor-free

Acknowledgements

- Town of Superior:
  - Alex Ariniello – Public Works Director
  - Jim Widner – Utilities Superintendent
- Direct Discharge:
  - Dave Lewis
  - Sean Smith
  - Vinnie Montez
- Dewberry:
  - Pat Radabaugh
  - Mike Syverson
  - Sarah Vander Meulen
- Evoqua:
  - Mark Delaurentis

Thank you! Questions?

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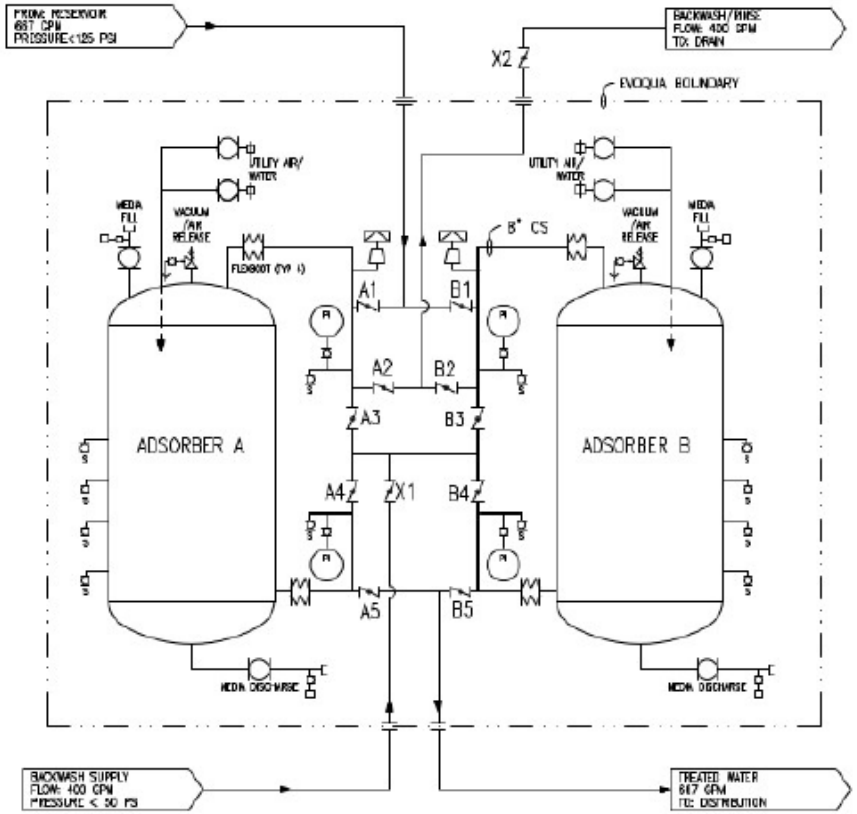
Dewberry®

Design-Build of GAC System

Evoqua GAC System

Design Parameters
(3) Skids, 2 tanks ea.
10’ diameter 9.5’ side shell height
Max flow: 750 gpm per tank
Min EBCT: 7 min



HP1020CIX SYSTEM 4 TIER FLOW DIAGRAM

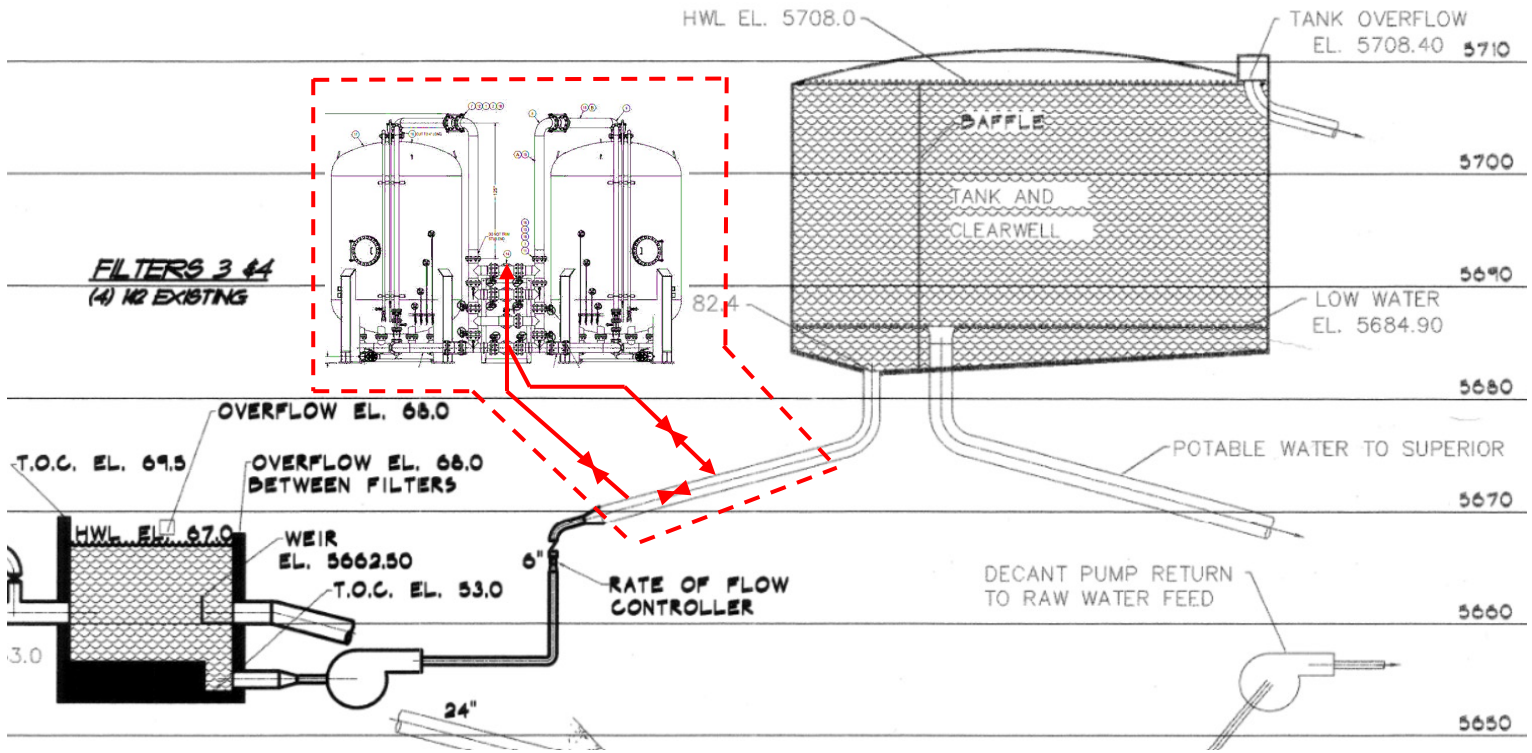
Evoqua Water Technologies

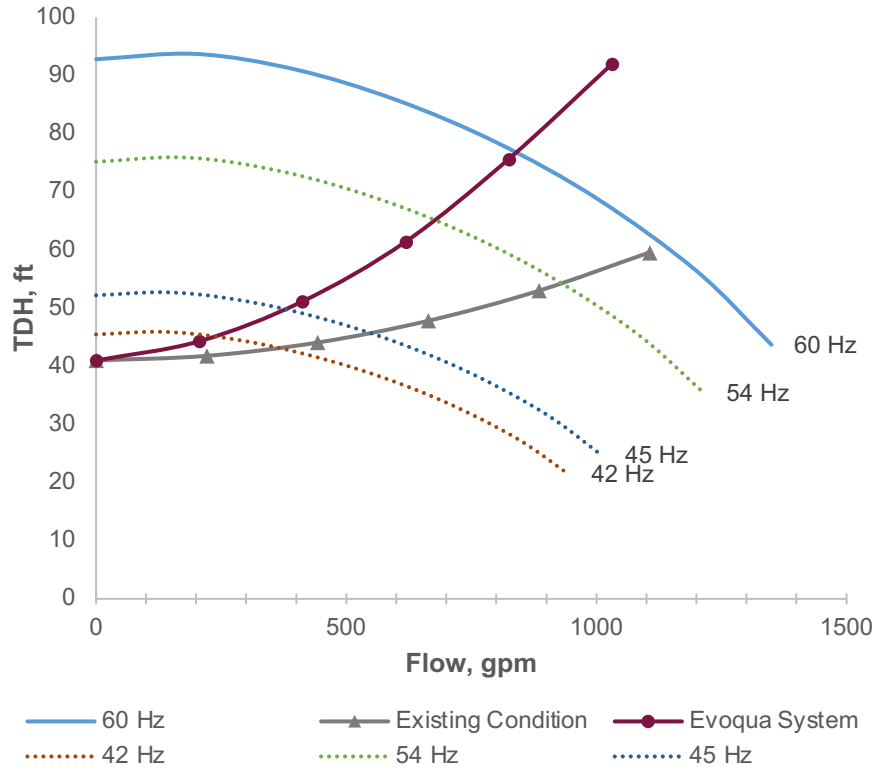
Evoqua Water Technologies

Design Challenges

- Schedule pressure
- Site limitations
- Conflicting utilities based on record drawings
- No survey or geotechnical information
- Hydraulic concerns
- Temporary versus permanent installation

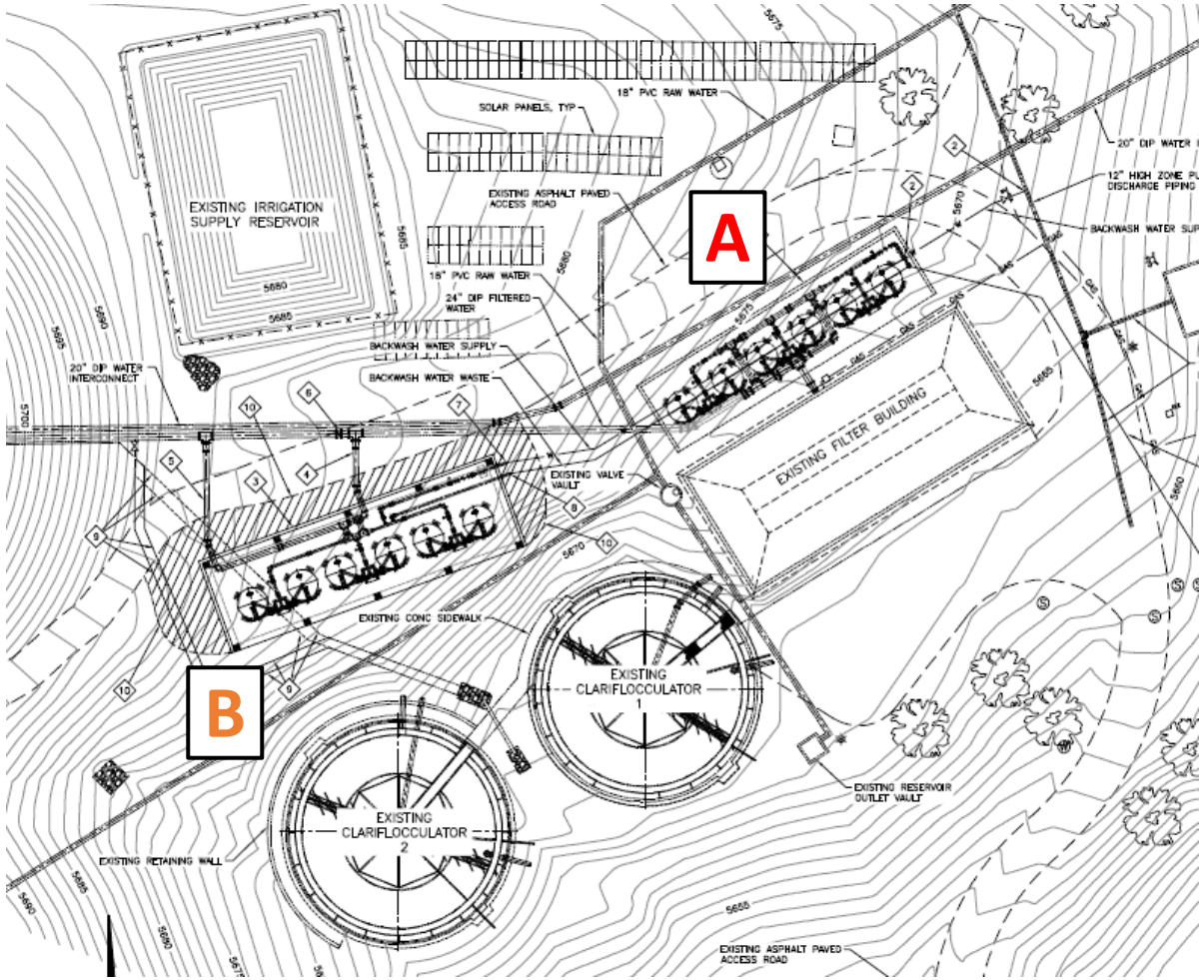
Hydraulics

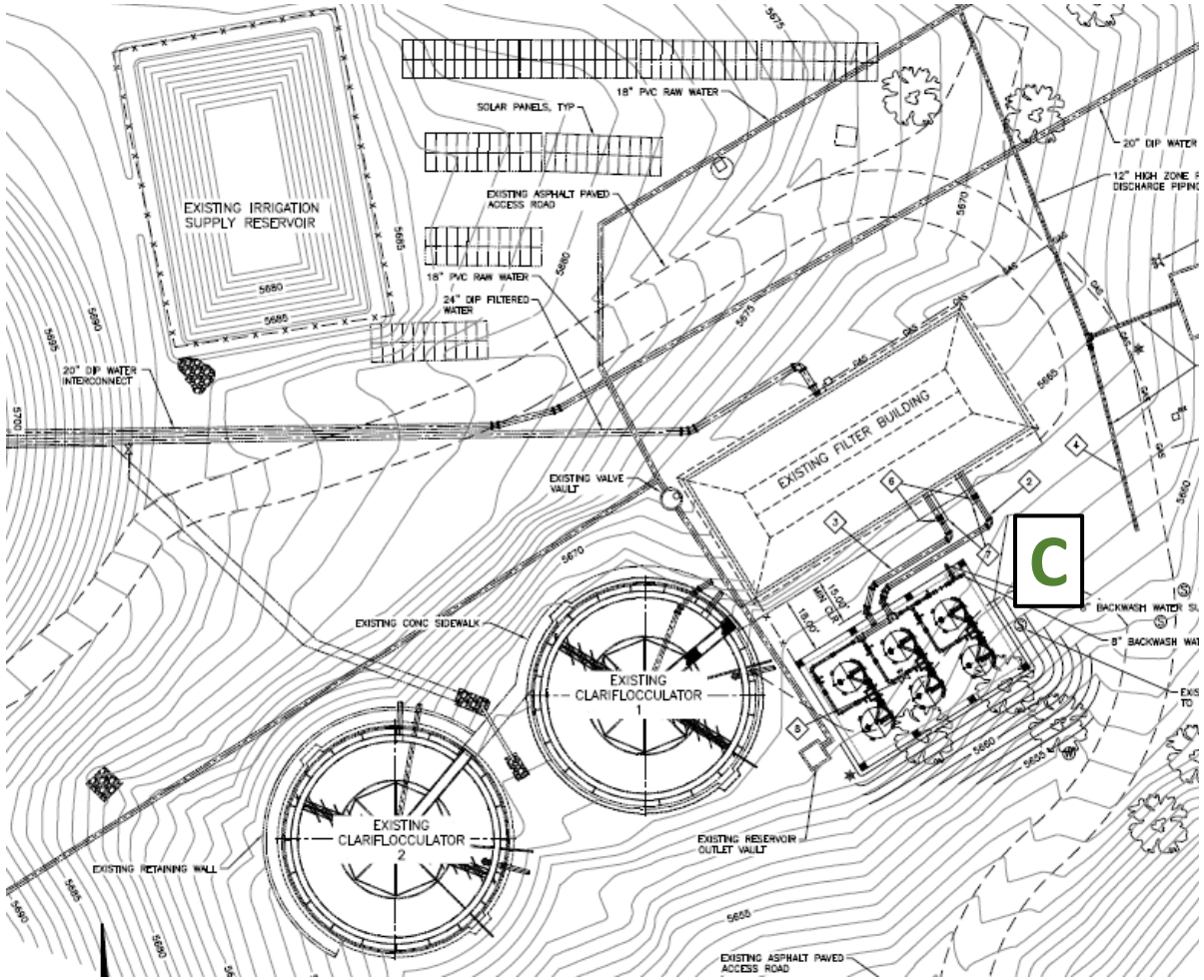

HWL EL. 5708.0
TANK OVERFLOW
EL. 5708.40
5710
BAFFLE
5700
TANK AND
CLEARWELL
5690
FILTERS 3 & 4
(4) M2 EXISTING
82.4
LOW WATER
EL. 5684.90
5680
OVERFLOW EL. 68.0
T.O.C. EL. 69.5
OVERFLOW EL. 68.0
BETWEEN FILTERS
POTABLE WATER TO SUPERIOR
5670
WEIR
EL. 5662.50
6"
T.O.C. EL. 53.0
RATE OF FLOW
CONTROLLER
DECANT PUMP RETURN
TO RAW WATER FEED
5660
24"
5650


100
90
80
70
60
50
40
30
20
10
0
TDH, ft
0
500
1000
1500
Flow, gpm
60 Hz
54 Hz
45 Hz
42 Hz
60 Hz
Existing Condition
Evoqua System
42 Hz
54 Hz
45 Hz

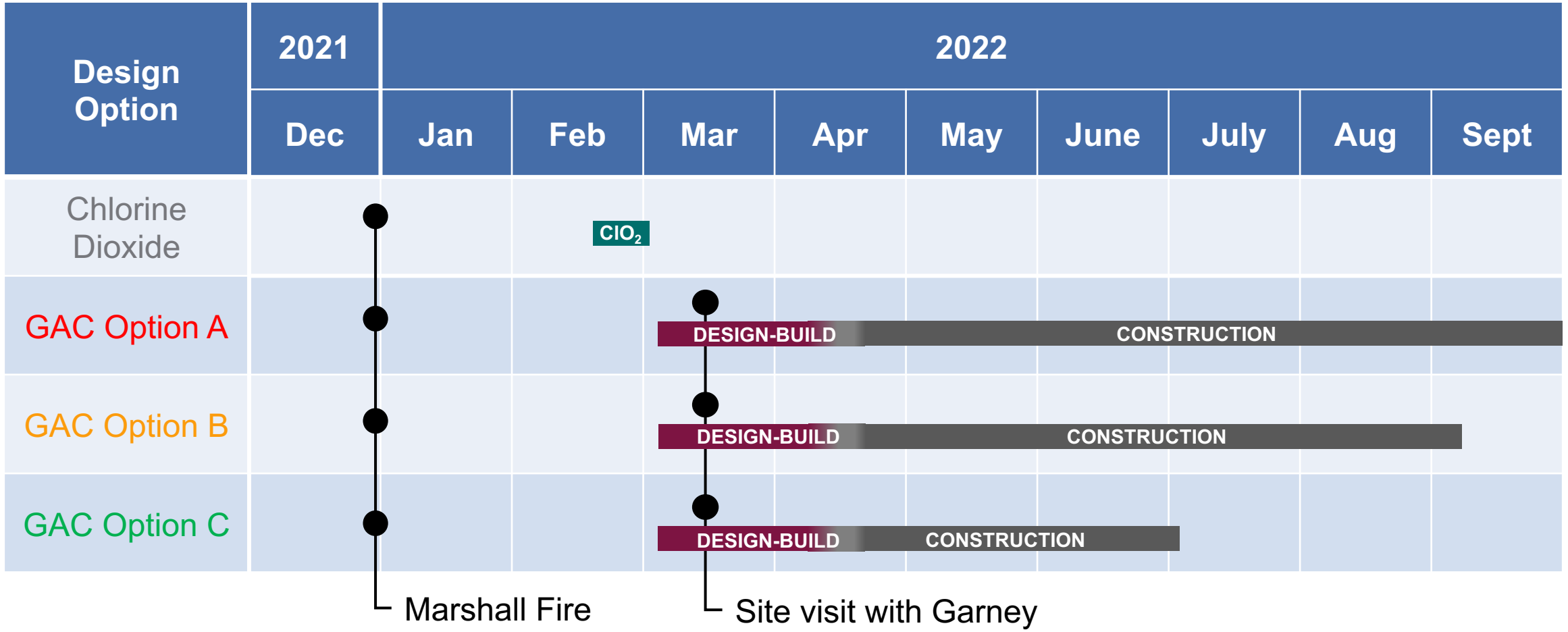
Constructability

Design-Build Iterations





Schedule


Design Option
2021
2022
Dec
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Chlorine Dioxide
ClO_2
GAC Option A
DESIGN-BUILD
CONSTRUCTION
GAC Option B
DESIGN-BUILD
CONSTRUCTION
GAC Option C
DESIGN-BUILD
CONSTRUCTION
Marshall Fire
Site visit with Garney

Design Features

Flow meters and modulating valves to each GAC skid

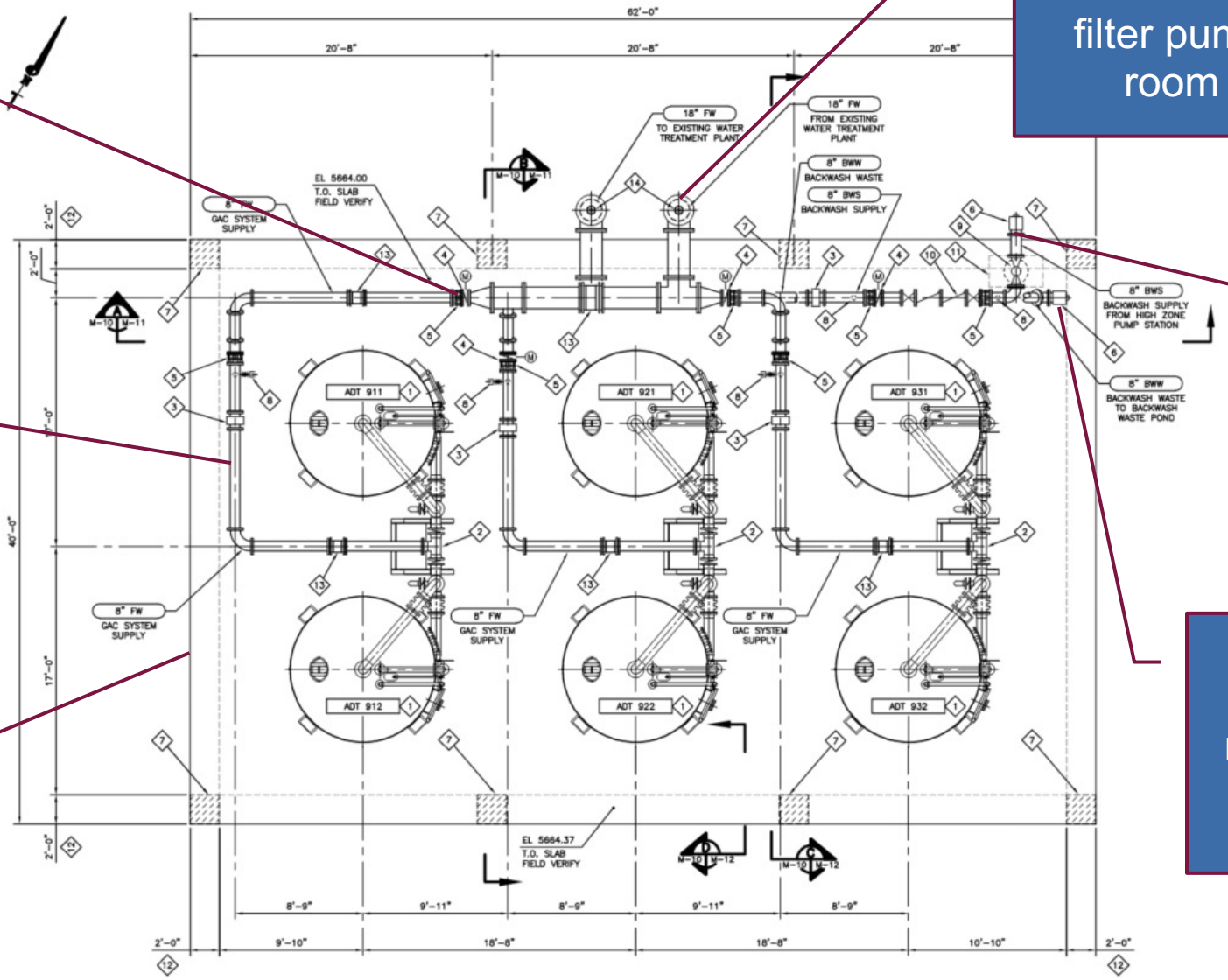
Drain lines on each pipe & slab drains

Provisions for future building

GAC bypass valves inside filter pump room

Backwash supply with flow meter and actuated valve control

Backwash waste to manhole tied to backwash pond



Supply Chain

- Quantities
  - Fittings: ± 167
    - Flow meters
    - Butterfly valves
    - Check valves
    - Air/vacuum release valves
    - Tees, bends, reducers
    - And more…
  - Pipe: ~800 LF
    - 18-inch
    - 8-inch

Thank you!