PFAS & Arsenic Treatment in Mid to Large NH Water Systems

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Outline of Presentation

- PFAS Treatment
  - Brief overview of PFAS & Regulations
  - PFAS Treatment Options
  - MVD Experience
  - Dover Experience
- As Treatment
  - Brief overview of As & Regulations
  - As Treatment Options
  - Epping Experience

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What are Perfluoroalkyl Substances or PFAS?

- **Per- and polyfluoroalkyl substances (PFAS) are used to make everyday products resistant to stain, heat, oil, grease, and water.**
- **These include:**
  - PFOA (perfluorooctanoic acid)

  - PFOS (perfluorooctane sulfonic acid)

- **Carbon-fluorine bond is one of the strongest in chemistry: very stable compound!**

evoqua WATER TECHNOLOGIES

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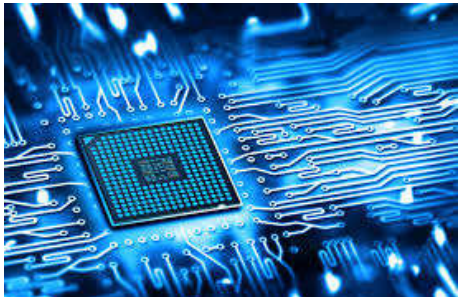
Where Are PFAS Used?



What Types of Sites Can Be Sources of PFAS?

- *Fire training facilities
- Fire stations
- *Refineries
- *DoD sites/Military bases
- *Commercial and private airports
- *Landfills (leaching from consumer products)
- *Biosolids land application
- Rail yards
- *PFAS **c**hemical facilities
- *Plating facilities
- *Textile/carpet manufacturers

***Sites with high probability of risk-based criteria exceedance**

PFAS Naming Conventions

PFAS Standards (ppt)

PFAS Compound	2009 Health Advisory	May 2017 Health Advisory	NHDES Interim 2017?	NHDES January 2019	NHDES June 2019	NHDES 2020
PFOA	400	70	100	38	12	12
PFOS	200	70	No Std ?	70	15	15
PFOA + PFOS	No Std	70	No Std?	N/A	N/A	N/A
PFHxS	No Std	No Std	No Std	85	18	18
PFNA	No Std	No Std	No Std	23	11	11

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UE PFAS Timeline Summary

- Feb 26, 2016 – PFOA in MVD water
- In 4-1/2 years we've gone from…
  - PFAS?? – What the heck is that?

to

  - Some of lowest MCL's in US
  - One PFAS WTP online
  - One PFAS WTP under construction
  - Two PFAS WTP's in design

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PFAS TREATMENT

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Preliminary Treatment Evaluation - 2016

- Processes evaluated
  - Ion exchange
  - Membrane Filtration (Reverse osmosis)
  - Adsorption with granular activated carbon (GAC)
  - Advanced oxidation

REMOVAL RATE		
Treatment Technology	PFOA	PFOS
Activated Carbon Adsorption	>90%	>90%
Membrane Filtration	>90%	>90%
Anion Exchange	10-90%	>90%
Advanced Oxidation	<10%	<10-50%

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Preliminary Treatment Evaluation - 2016

- GAC by far the most common treatment
- Better at long chain C8's like PFOA and PFOS
- Less effective with shorter chain PFAS
- Media life of 1 – 2 years, impacted by
  - pH
  - Empty Bed Contact Time (EBCT) – 10 min common
  - NOM in water
  - Inorganics in water
  - Presence or absence of chlorine

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Preliminary Treatment Evaluation - 2016

- Emerging technologies
  - Synthetic resins
    - Higher adsorptive capacity than GAC (smaller footprint)
    - Shorter EBCT
    - Higher media cost
    - Better at short chain removal
    - No drinking water facilities-still in development

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PFAS Treatment Options - 2020

- Most common
  - Adsorption with GAC
  - Ion Exchange with Resin
- Less common
  - Membrane filtration – RO
- Innovative or in development
  - Fluoro-sorb® adsorbant
  - Zeolite adsorbant
  - Photocatalytic oxidation
  - Photochemical oxidation or reduction
  - Persulfate radical treatment
  - Sonochemical pyrolysis

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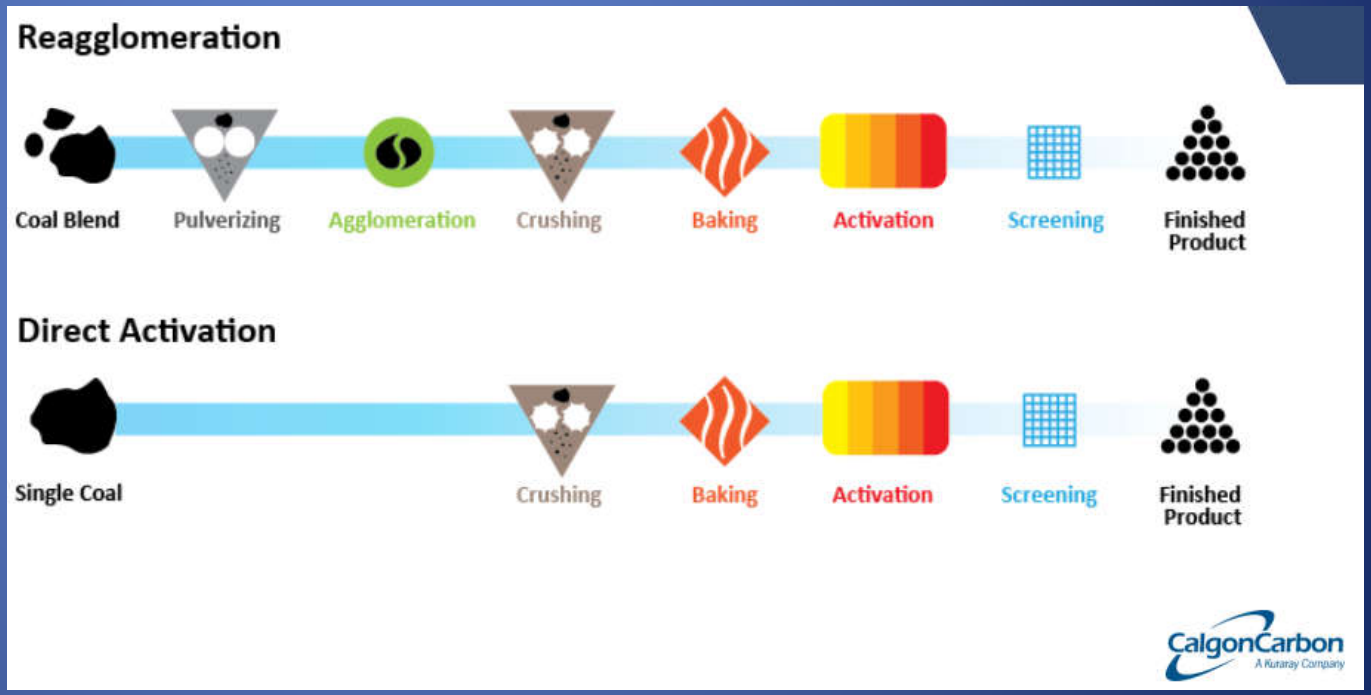
GAC Treatment

- What is Activated Carbon?
  - Carbonaceous material
    - Coal
    - Coconut
    - Wood



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GAC Treatment

- Highly porous
  - Macropores = Highway
  - Mesopores = Parking lot
- Large Surface Area to Volume ratio
- High adsorptive capacity

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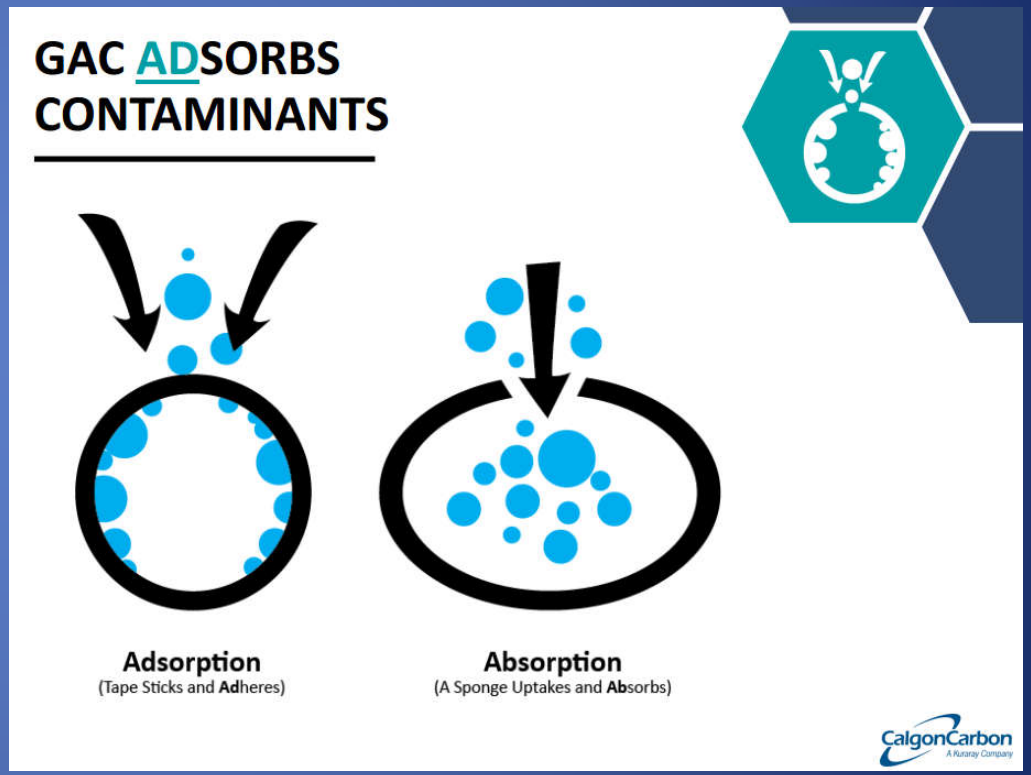
GAC Treatment

- Uses adsorption
- Electrochemical forces cause contaminants to "stick" to carbon
- Main design parameter is EBCT



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EBCT

- Empty Bed Contact Time
  - Time that water and/or particles are in contact with media
- Nominal
  - Volume of empty media bed/flow = Time
- Different GAC's have different densities
  - If given lbs of media, need density to get volume

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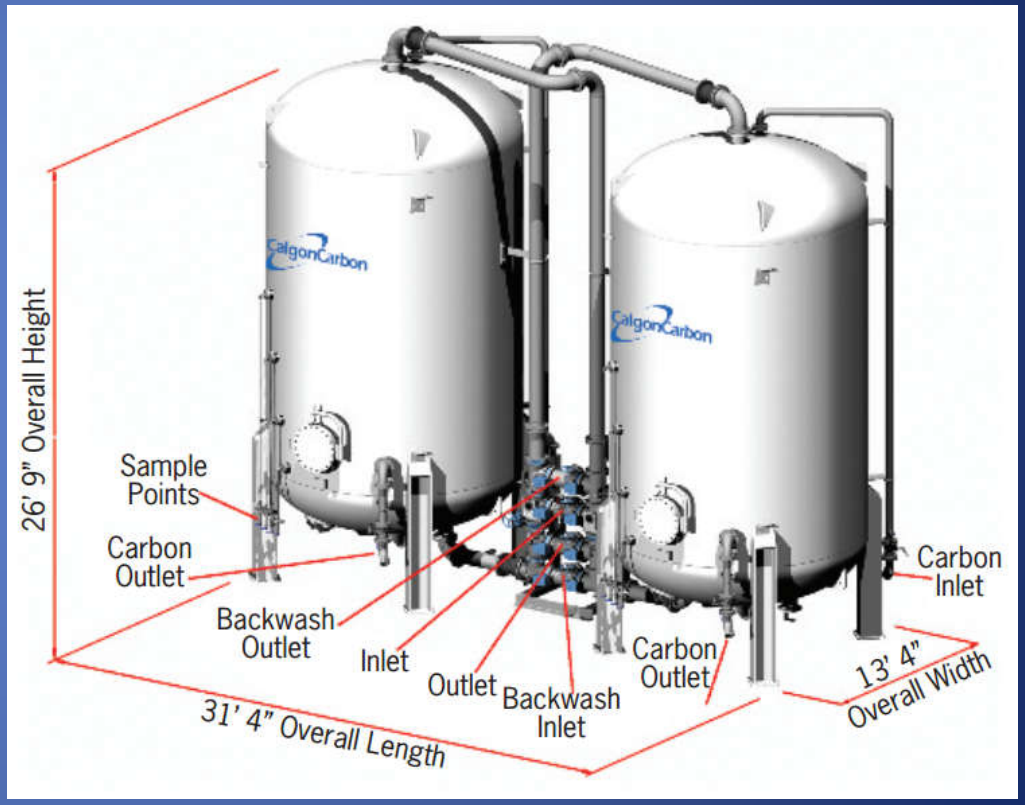
GAC Treatment

- Large pressure vessels
  - 12 ft diam pictured
    - 27 ft (+/-) tall
    - 40,000 lbs GAC
  - Lead/Lag or really… Adsorber/Polisher
  - Pipe rack
  - 24 hour wetting
  - 36 hour rinse
  - Initial backwash



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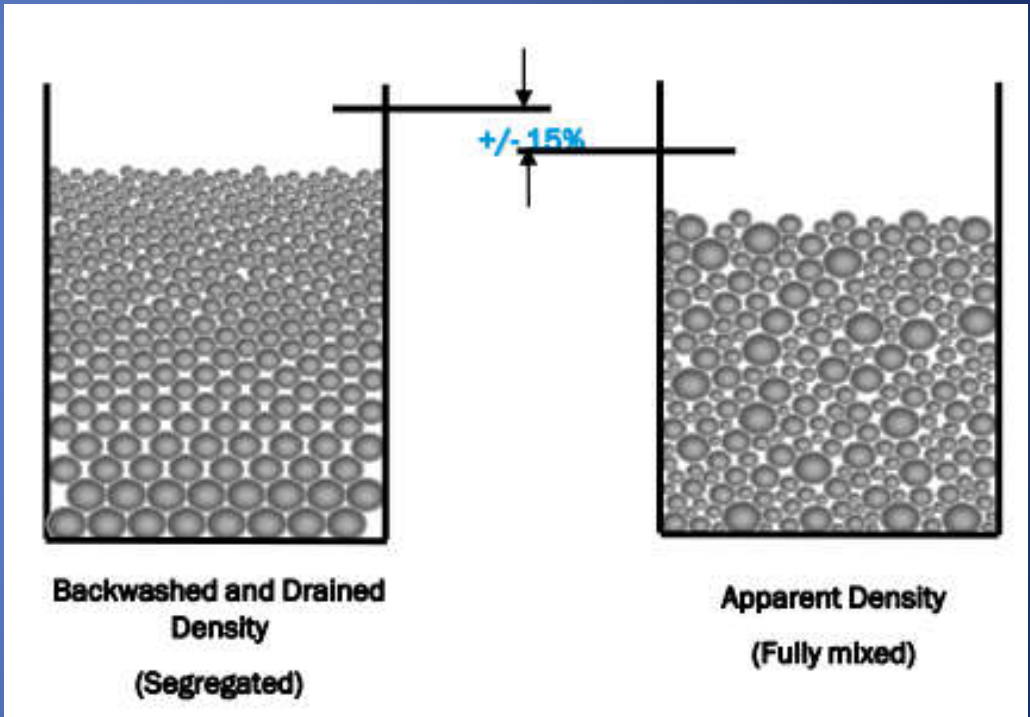
GAC Treatment

- Backwashing
  - Only at startup to remove fines and stratify bed
  - Discouraged during normal operation - could cause early breakthrough



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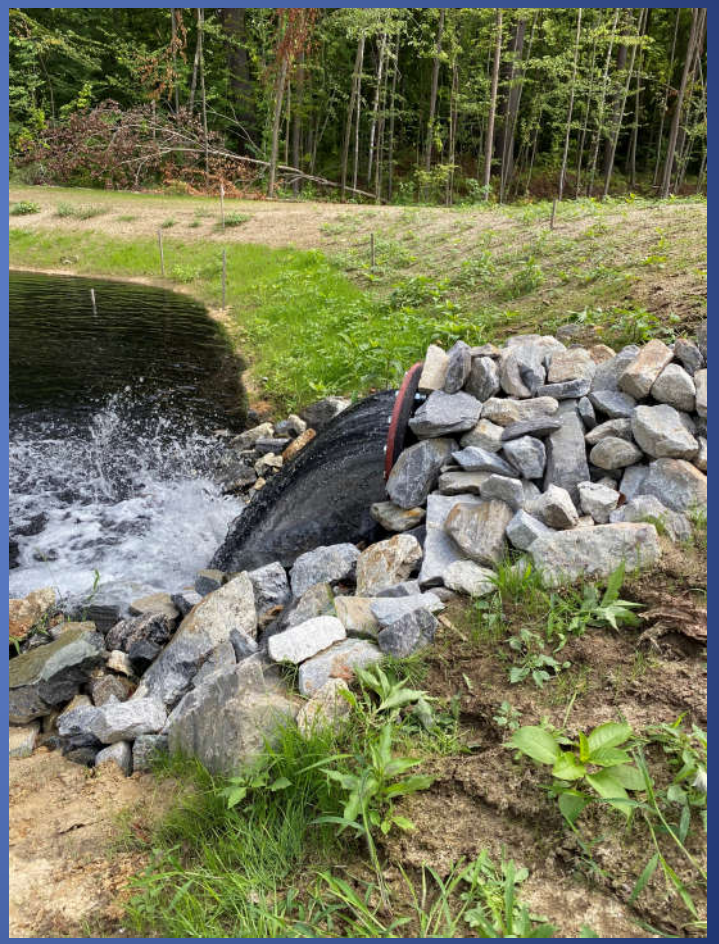
GAC Treatment

- Backwash disposal
  - Sewer?
  - Infiltration basin?



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GAC Treatment

- After initial backwash
- FTW with monitoring
  - pH, As
- Raw water fed in series
- Sample taps in vessels and pipe rack
- Breakthrough
  - Switch lead and lag vessels
  - Replace GAC in lead vessel

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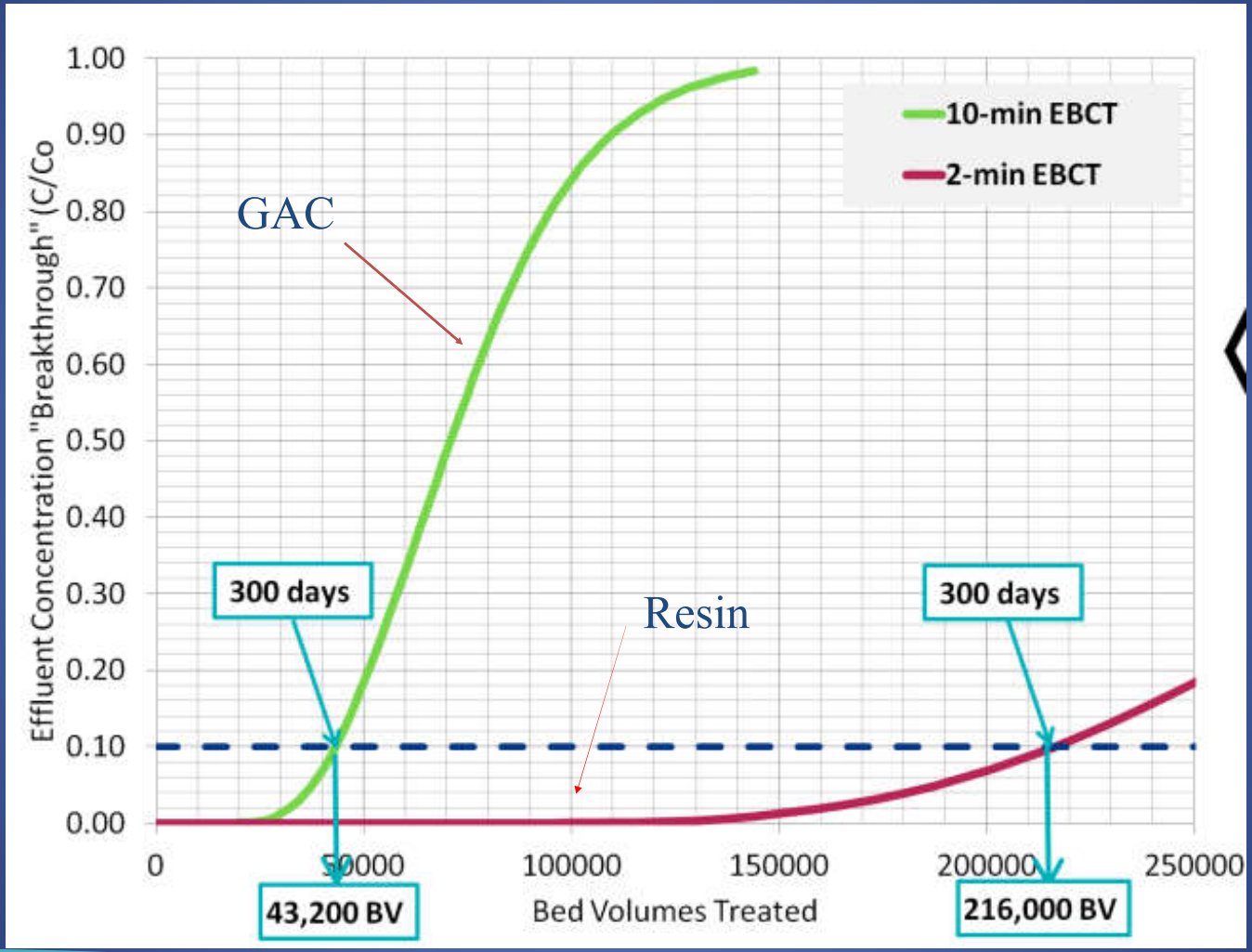
Breakthrough Curve



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GAC Changeout

- Done by GAC vendor
  - Slurry out old & pump in "new"
- "New" GAC
  - Can be virgin carbon…or
  - Reactivate spent GAC, supplement with virgin
- Legacy issues

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GAC Bed Life

- Dependent on…
  - PFAS concentration
  - EBCT
  - Competition for adsorption sites
    - NOM
    - Fe/Mn/SO_4
    - Chlorine
- How do you determine?
  - Pilot testing
    - Meaningful only if you get to breakthrough
    - Could take > 1 year
  - Rapid Scale Small Column Tests
    - Scale down large contactor to small column

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Rapid Scale Small Column Tests (RSSCT's)

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RSSCT's

- Small columns…< 1"
- Grind GAC to corresponding size
- Use water proposed for treatment
- Allows thousands of BV's in much faster time
- Can compare different GAC's under same water quality and conditions
- Develop breakthrough curves
- Equate BV's to actual time for full scale

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RSSCT Considerations

- Two methods
  - Constant diffusivity
    - Relatively good at predicting breakthrough
    - Shorter and more convenient
  - Proportional diffusivity
    - More predictive but takes more time and water
  - Good to know which way your lab is doing it
- Snapshot based on quality of water used for test
- Some concerns about RSSCT results differing from reality
  - At the moment – best we have

Possible GAC Issues

- Increased pH
  - Release of hydroxide ions and/or alkaline metal salts
  - Resolved by FTW or chemical addition
- Leaching of trace elements from GAC into water
  - Arsenic has been main concern
  - Resolved by GAC selection and/or FTW
- Rollover
  - Mass transfer zone breaks through bed into effluent
  - More with poorly adsorbed compounds, i.e. short chains
  - Can cause temporary effluent concentration > influent\
  - Resolved by FTW

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Ion Exchange (IX) - Resin

- 2016 – No drinking water PFAS applications…BUT
- Research & development in full swing
- 2020 – At least 4 companies marketing PFAS specific resin
  - Pease – Haven Well (on line or close)
  - Ayer, MA (in design or construction)

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Resin IX Treatment

- What is resin?
  - Tiny synthetic polymer (hydro-carbon based) beads
  - Anionic (positively charged) to attract neg PFAS ions

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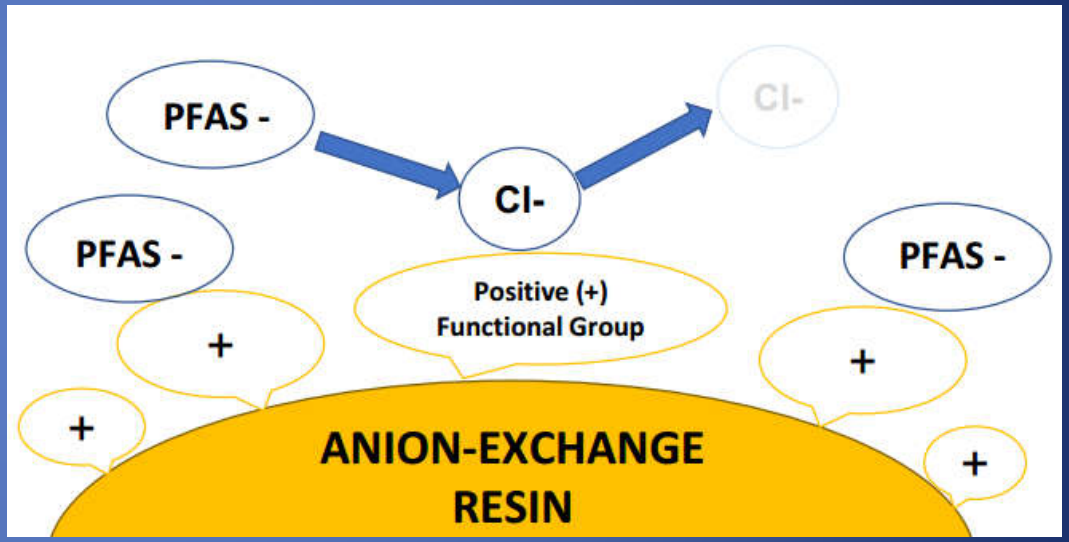
Resin (IX) Treatment

- How does resin work?
  - Beads have (+) charged functional groups on surface
  - (-) charged PFAS ions are attracted to (+) functional group
  - Chloride ion released or "exchanged"



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Resin IX Treatment

- Pressure vessels like GAC
- Initial BW to classify media
- Rinse
  - pH drop?
  - FTW
- Lead/Lag
  - Feed water in series
  - Sample taps in vessels and pipe rack
- Breakthrough
  - Switch lead and lag vessels
  - Replace resin in lead vessel
- Spent resin disposal

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Resin Bed Life

- Similar to GAC - dependent on…
  - PFAS concentration
  - EBCT
  - Competition for exchange sites
    - NOM
    - Chloride
    - Fe/Mn/SO_4
    - Chlorine
- TSS
- How do you determine?
  - Preliminarily – from vendor models based on water quality, experience
  - Pilot testing
  - No validated RSSCT for resin – can't grind the beads

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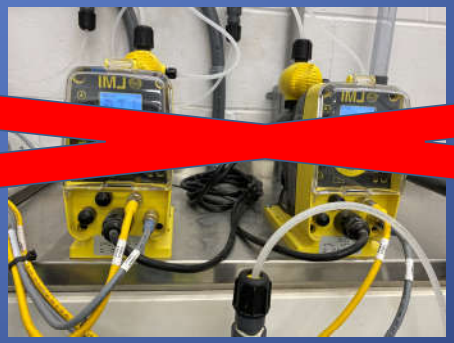
Resin Requirements

- TSS protection
  - Particulates can clog resin
  - Backwashing after initial not recommended
  - 5 micron cartridge filter
- Chlorides
  - Lower the better
  - Not effective at > 100 mg/L
- Oxidants
  - Will damage beads
  - Cannot use ahead of resin



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GAC vs Resin

Parameter	GAC	Resin
EBCT	10 min	1.5-2.5 min
Media Volume	Larger (10-15') vessels	Smaller (5-10') vessels
Media Cost	Lower cost per lb	Higher cost per lb
Media Life	Shorter than resin	Longer than GAC
PFAS Removal	Effective for PFOA, PFOS, less for short chain PFAS	Better short chain removal as well as PFOA & PFOS
Feed Water Quality Req'mts	Can tolerate low residual chlorine (<0.1 mg/L)	Must dechlorinate, chloride<100 mg/L, Fe/Mn<0/1 mg/L
Pretreatment	No prefiltration required	5 micron filter required
Startup Considerations	Temp pH spike & elevated As possible	Temp pH & alkalinity drop possible
Media Disposal	Reactivate and reuse or incinerate spent media, vendor can handle	Single use. Disposal by vendor or 3rd party

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Reverse Osmosis (RO)

- Semi-permeable membrane
- High pressure feed water
- PFAS rejected > 90%
- Treated water passes membrane
- Reject stream
  - Concentrated solids
  - Contaminants incl PFAS

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RO Design Considerations

- Removes wide range of PFAS including short chains
- Will remove other contaminants
  - Na, Chloride, 1,4-Dioxane for example
- Finished water conditioning
  - pH adjustment
  - Remineralization
- Disposal of concentrated reject stream is challenging
  - Concentrated PFAS may require GAC treatment
- Membrane fouling is potential issue
  - If Fe/Mn present, may need pretreatment
- Small footprint, but high capital and O&M cost
- Large RO PFAS WTP's in AL & NC – no experience in NE

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Newer RO Option

- Multiple stage closed circuit RO
- Claim 98% water recovery vs. normal of 75%
- Evaluated for use in MVD but rejected due to pretreatment needs and cost reasons

MVD's PFAS Treatment Experience

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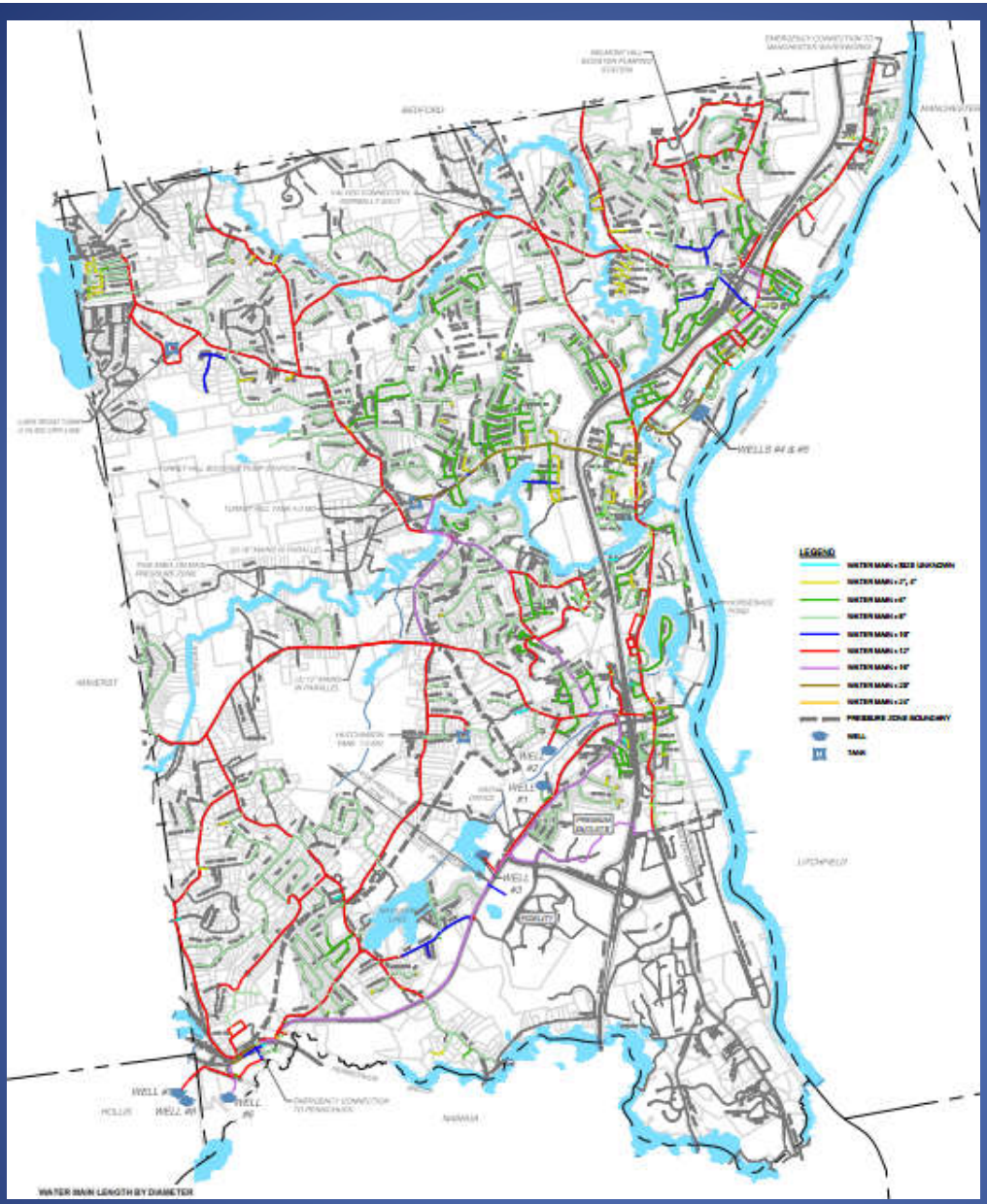

MVD DISTRIBUTION SYSTEM

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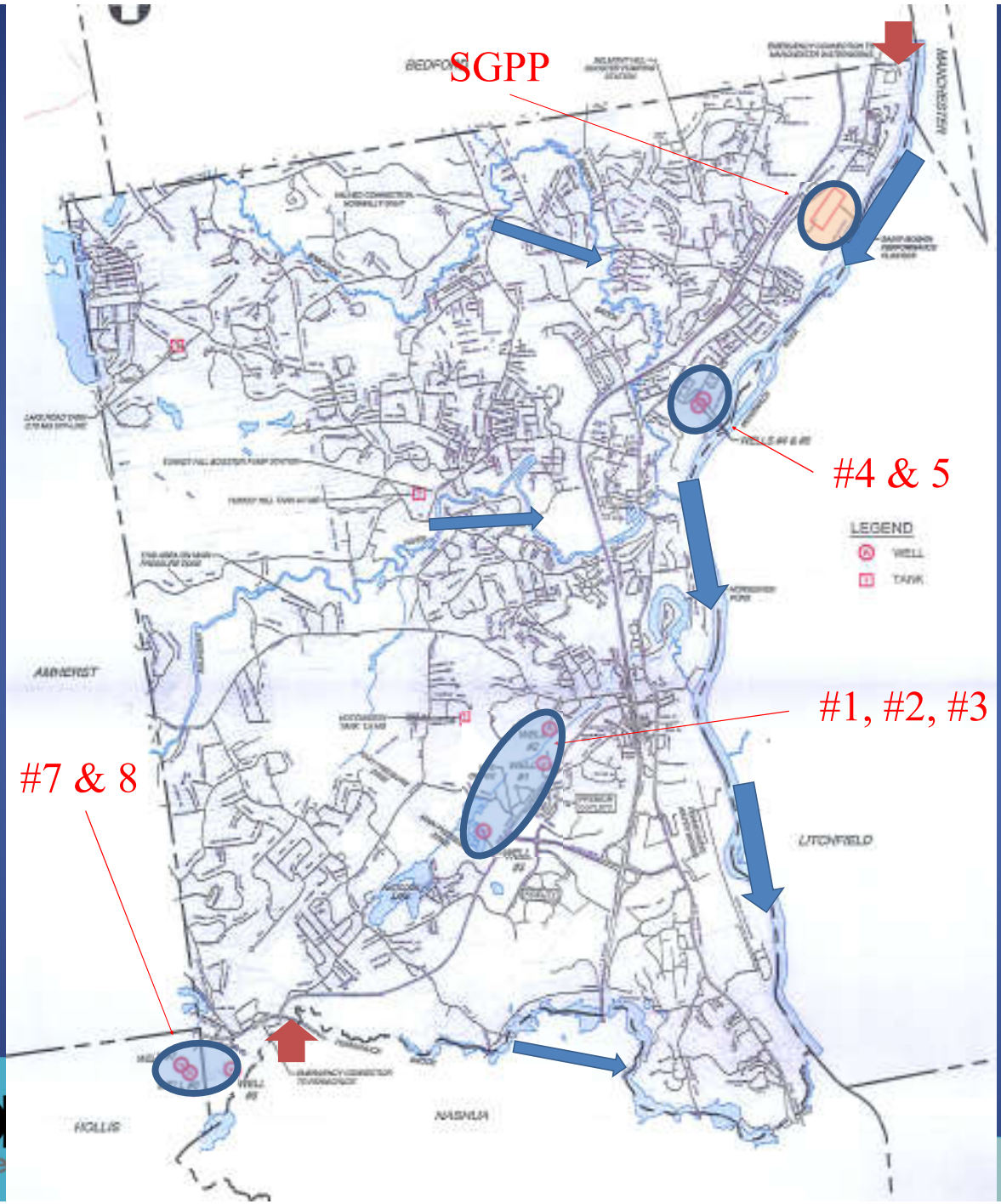
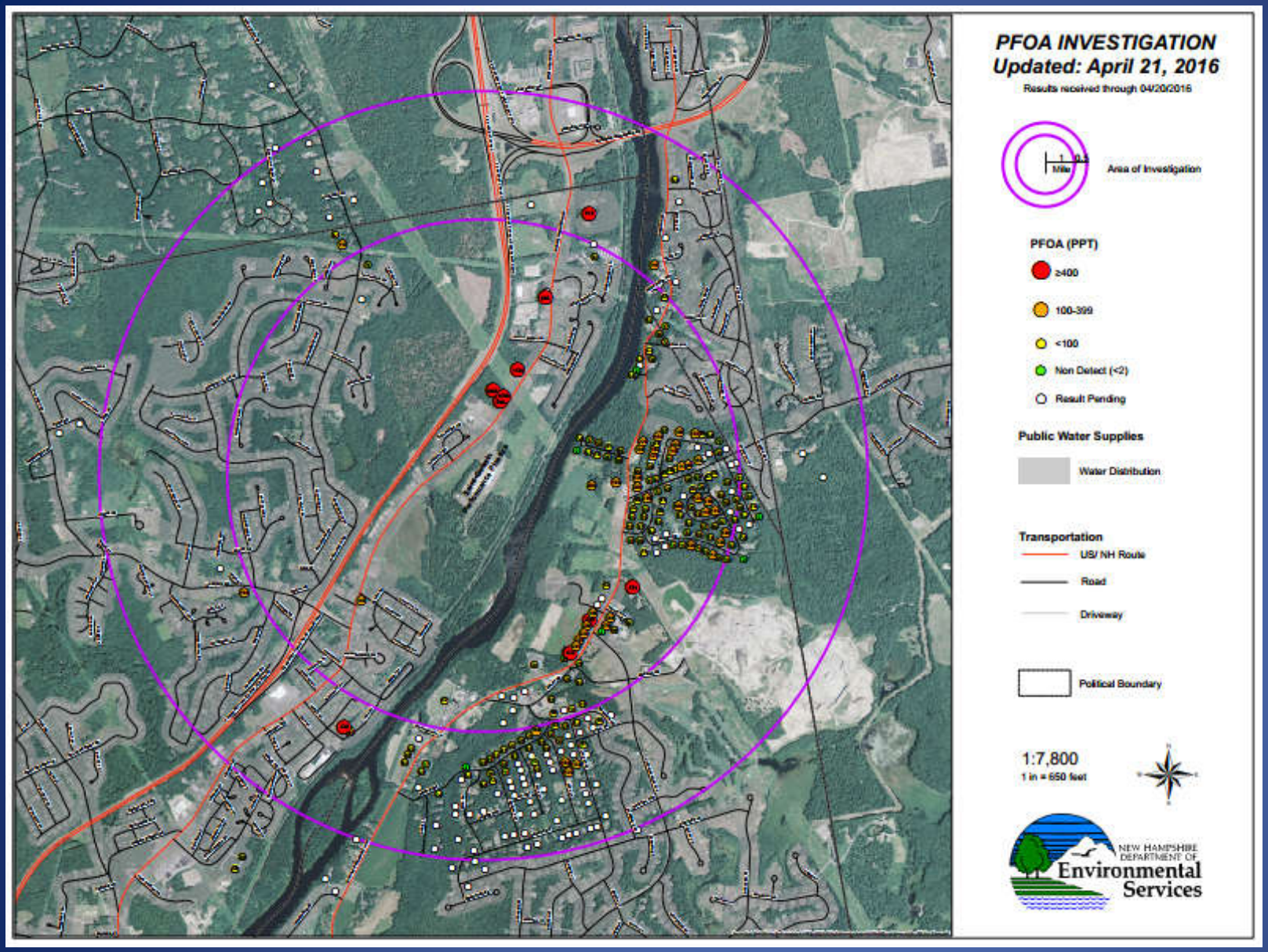


MVD SUPPLY SOURCES



Aerial Dispersion Pattern

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MVD Wells

WELL	CAPACITY	ISSUES	STATUS
MVD-1	0 gpm	Screen failure	Decommissioned 2005
MVD-2	1,100 gpm	Largest, best quality well PFOA > 12 ppt	On line, permitted for 1,500 gpm PFAS WTP in design
MVD-3	800 gpm	Elevated Fe & Mn PFOA > 12 ppt	On line, use limited due to elevated Fe/Mn, Na, & Chloride
MVD-4	410 gpm	PFOA $\geq$ 70 ppt	PFAS WTP online 2020
MVD-5	620 gpm	PFOA $\geq$ 70 ppt	PFAS WTP online 2020
MVD-6	1,500 gpm	VOC contamination	Off line since 1988
MVD-7	500 gpm	Elevated Fe & Mn PFOA > 12 ppt	On line, Fe/Mn WTP PFAS WTP under construction
MVD-8	750 gpm	Elevated Fe & Mn PFOA > 12 ppt	On line, Fe/Mn WTP PFAS WTP under construction

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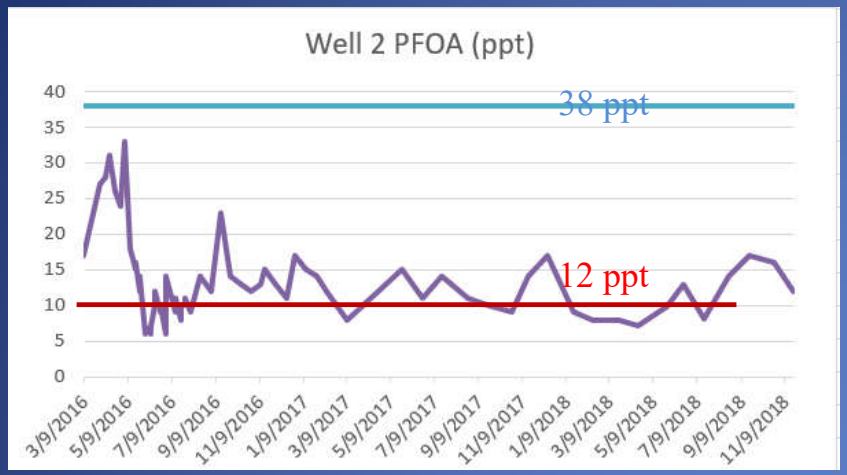
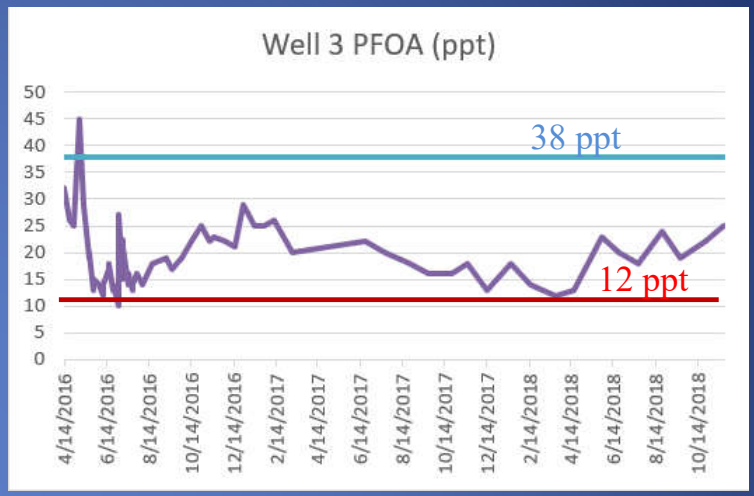
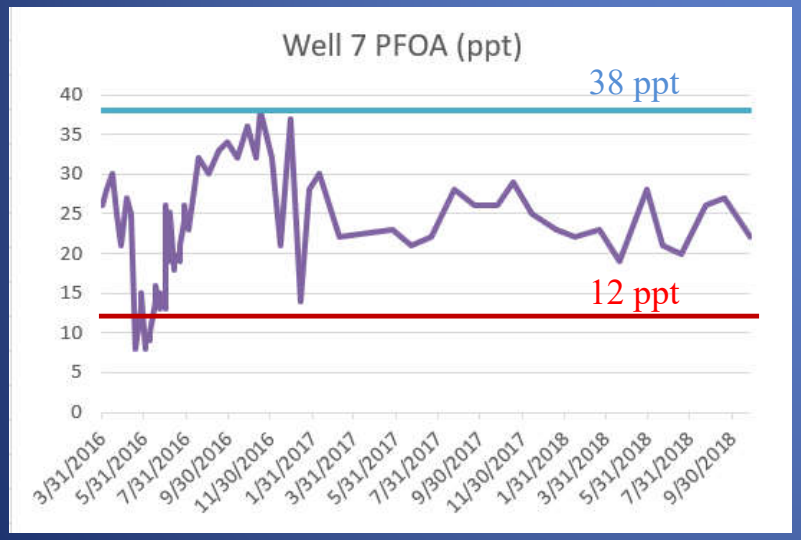
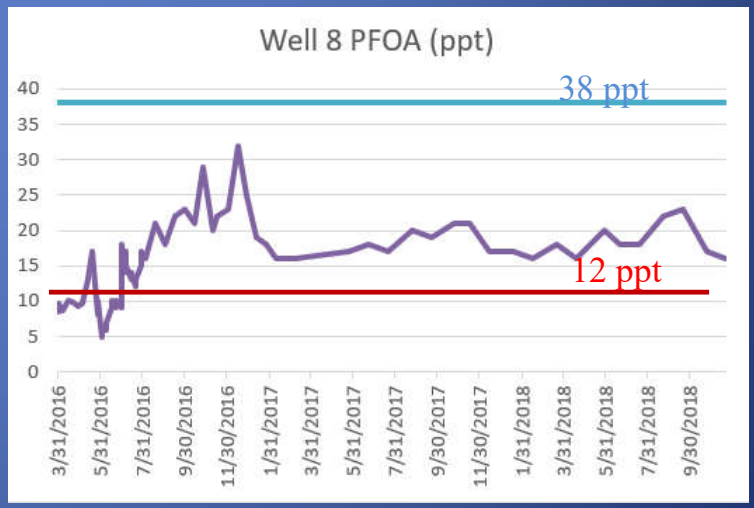
PFOA Concentration History









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MVD Wells 4 & 5

- Feb 2016 – PFOA detected
- May 2016 – DES adopts 70 ppt AGQS for PFOA
- June 2016 – DES notifies MVD to take 4 & 5 offline until treatment in place
- Settlement agreement (2 yr process) with SGPP to partially fund WTP design and construction
- Final design started May, 2018

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Process Selection

- Options were GAC & Resin
  - GAC used in Hoosick Falls, NY – SGPP Funded
  - Resin still in development – no actual DW applications in 2018
  - Settlement agreement dictated use of GAC

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GAC Selection

- GAC Vendors
  - Calgon
  - Evoqua
  - Cabot
- GAC varieties
  - Bituminous coal based
  - Lignite coat based
  - Coconut shell based
- Each vendor claims their GAC is the best

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GAC Selection

- Collect and send water quality to vendors
  - PFAS of course
  - Parameters that impact/compete with GAC for adsorption sites
  - TOC
    - Not normally tested for
    - Good to approx. NOM
- Goal is to get prelim recommendation on GAC

Table 1
Average Raw Water Quality of Existing Wells (March 2010 - through July 2014)

Parameter	Units	MCL/SMCL*	Well #2	Well #3	Well #4	Well #5	Well #7	Well #8
pH	Units	6.5-8.5*	6.01	5.85	5.87	5.92	6.00	5.89
Turbidity	NTU	1	<.5	<.5	<.5	<.5	<.5	<.5
Copper**	mg/L	1.3	<.01	<0.1	<.01	<.01	<.01	<.01
Iron	mg/L	0.3	<.05	**0.63**	<.01	<.05	**0.90**	**0.63**
Manganese	mg/L	0.05	<.01	**0.35**	<.01	<.01	**0.30**	**0.10**
Sodium	mg/L	100-250	30.0	**118.0**	55.2	96.3	56.4	53.2
Lead**	mg/L	0.015	<.01	<.01	<.01	<.01	<.01	<.01
Chloride	mg/L	250	62	234	106	201	119	128
Nitrate	mg/L	10	<1	<1	3.4	1.7	<1	<1
Hardness	mg/L		38	76	53	74	52	71

Table 2
PFOA Concentrations in Parts per Trillion (PPT)

Sample Date	Well #2	Well #3	Well #4	Well #5	Well #7	Well #8
4/14/14	15		42*	42*		
4/22/14		BDL				
7/14/14					26*	26*
10/7/14	BDL	BDL	BDL*	BDL*		
6/15/15					0.020*	20*
3/9/16 (1)	17		90	54		
3/9/16 (2)				52		
3/31/16 (1)	27		90	56	26	8.5
3/31/16 (2)						9.7
4/7/16	28		94	52	28	8.6

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GAC Selection

- Arsenic issue
  - Hoosick Falls, NY
    - No As in raw
    - Over 10 ppb in finished
    - FTW for 10 BV's (160,000 gal)
  - Portsmouth Demonstration
    - Same GAC
    - No As issue
- pH issue
  - Portsmouth Demonstration
    - Initial pH went up to 9
    - FTW for up to 30 days
  - Hoosick Falls, NY
    - Same GAC
    - No pH issue

POINT – EVEN WITH SIMILAR WATER QUALITY
CAN'T ASSUME GAC WILL REACT THE SAME

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Arsenic in GAC

- Byproduct of activation process
- Associated in part with ash content
- Acid Rinsing reduces As
- UE "soak tests"
  - Simulate 24 hr wetting
    - Sample for As
  - Simulate 36 hr rinse
    - Sample for As
- GAC 4 had best results

GAC Arsenic Leaching Tests, ppb
Merrimack Village District
2018-2020

Wells 4&5

Hours	GAC 1	GAC 2	GAC 3	GAC 4
0	0	0	0	0
24	58.3	438	0.689	1.74
36	40.3	134	0.689	4.07

Wells 7&8

Hours	GAC 1A	GAC 2A	GAC 5	GAC 4
0	0	0	0	0
24	6.14	17.1	34.8	1.42
36	8.38	4.81	23	2.43

Wells 2&3

Hours	GAC 1A	GAC 2A	GAC 3	GAC 4
0	0	0	0	0
24	8.65	11.9	0.689	2.65
36	13.5	5.83	0.689	2.72
24	9.06	6.34	0.689	1.88

Well 2

Hours	GAC 1B	GAC 4	GAC 3
0	0	0	0
24	1.11	ND	ND
36	0.836	ND	ND

Detection limit = 0.689

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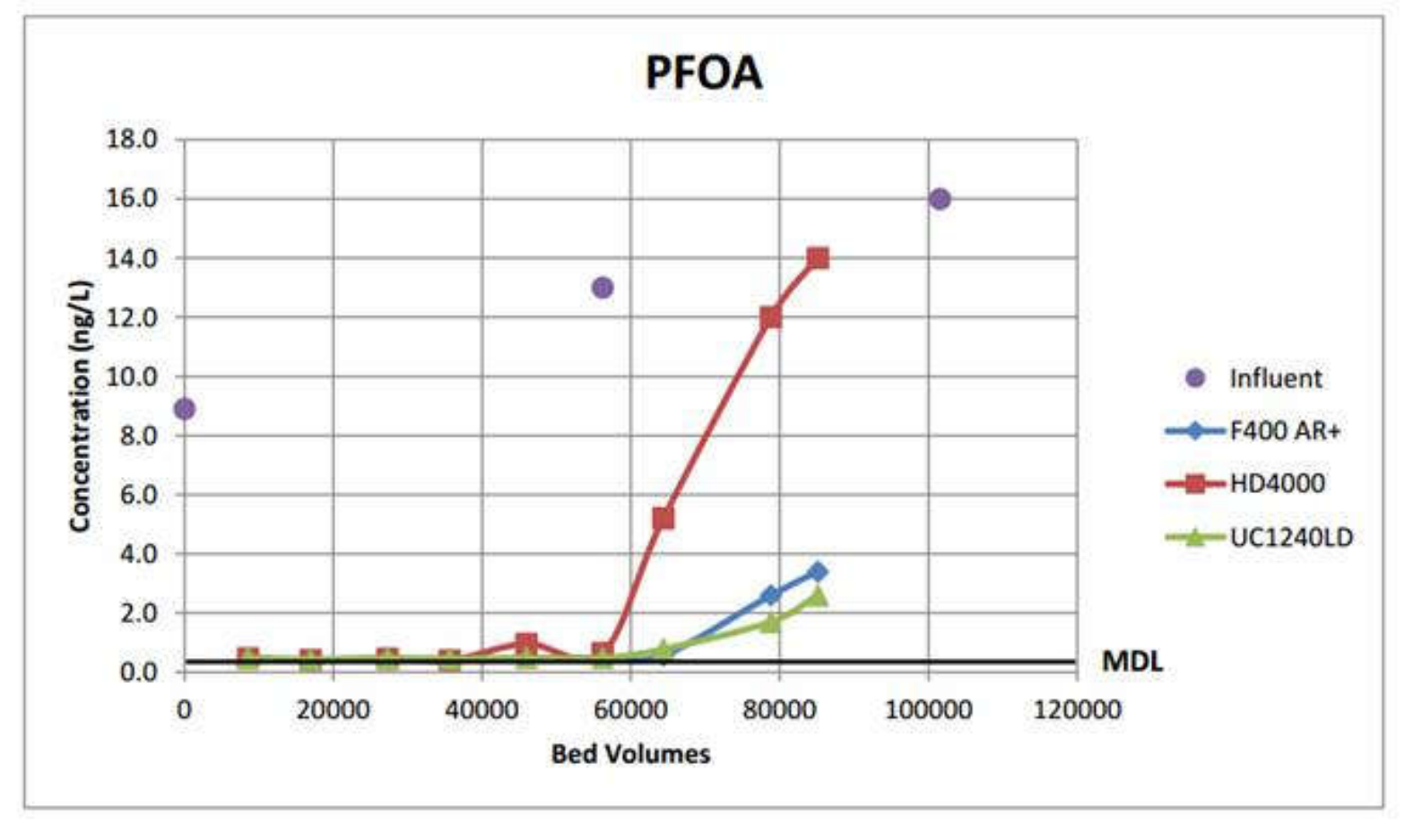
RSSCT Results – PFOA (C8)



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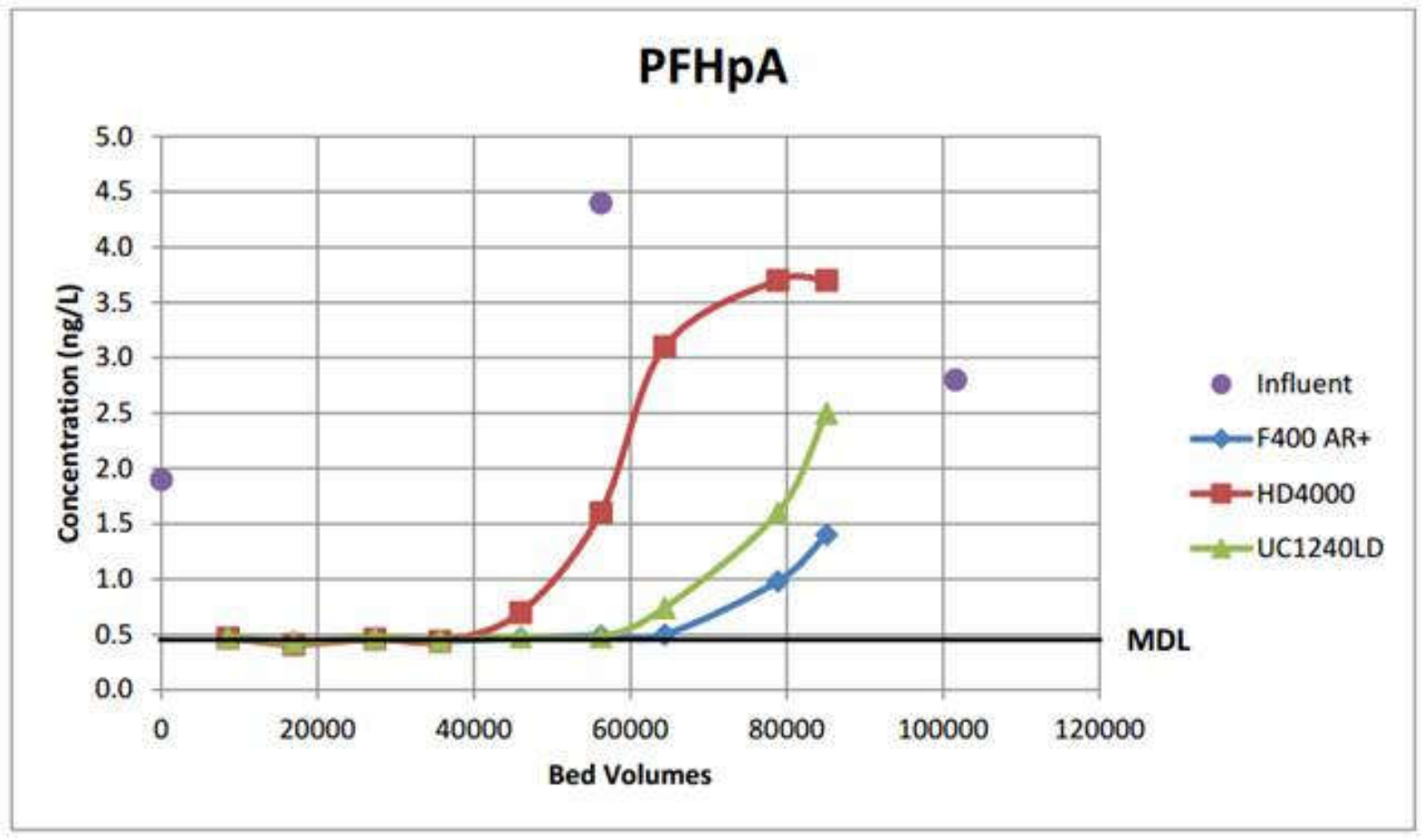
RSSCT Results – PFHpA (C7)



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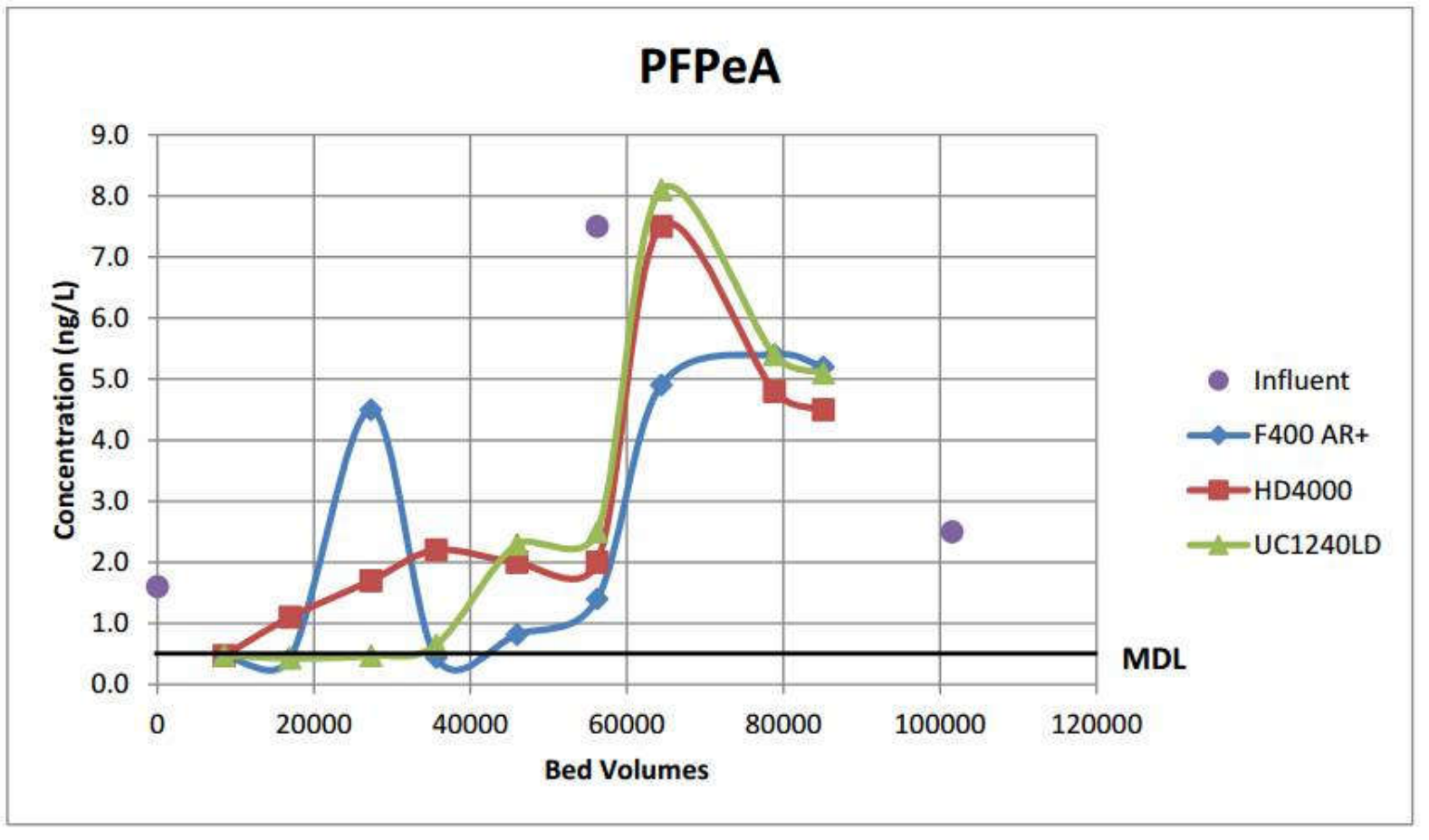
RSSCT Results – PFPeA (C5)



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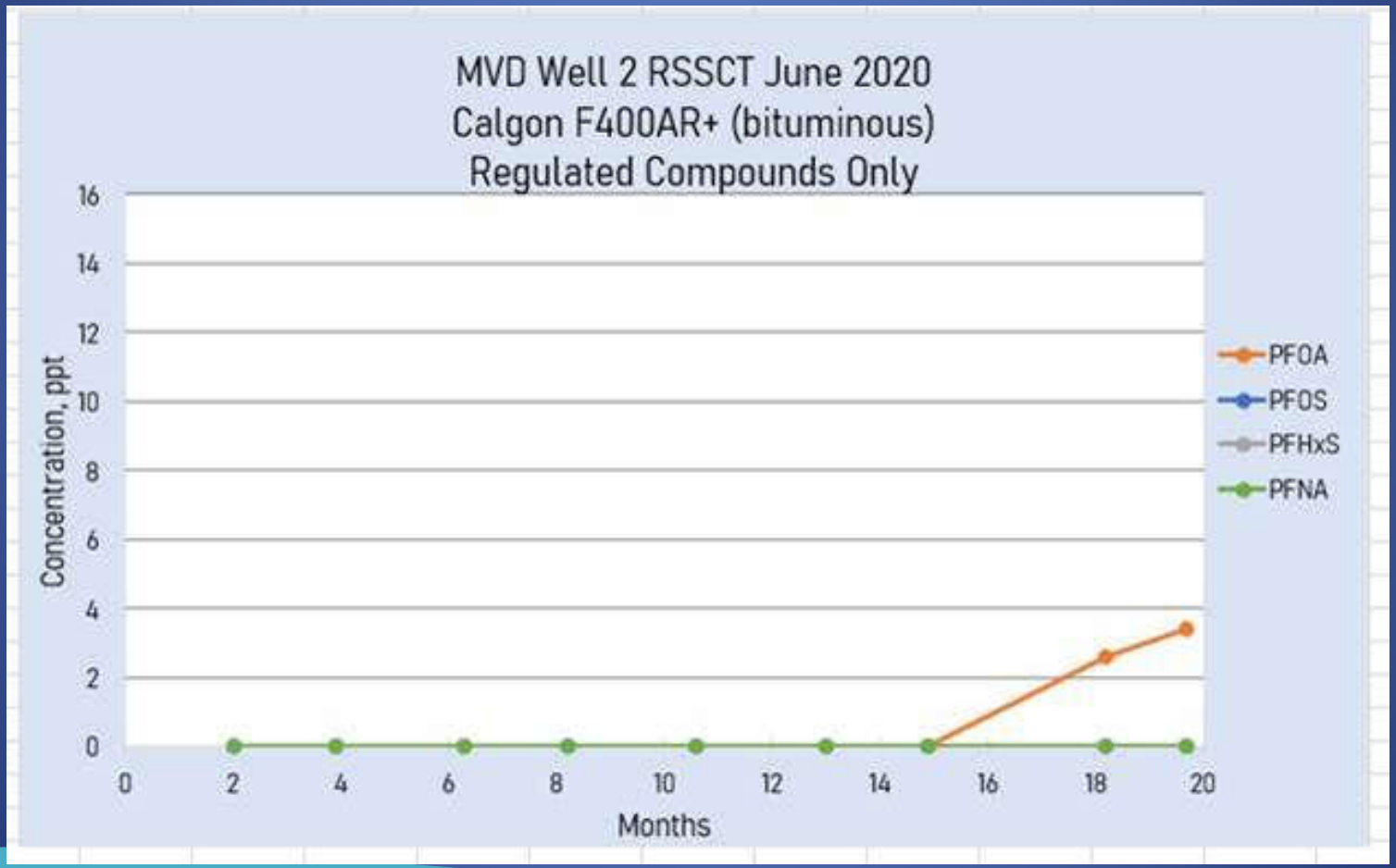
RSSCT Results – Regulated PFAS



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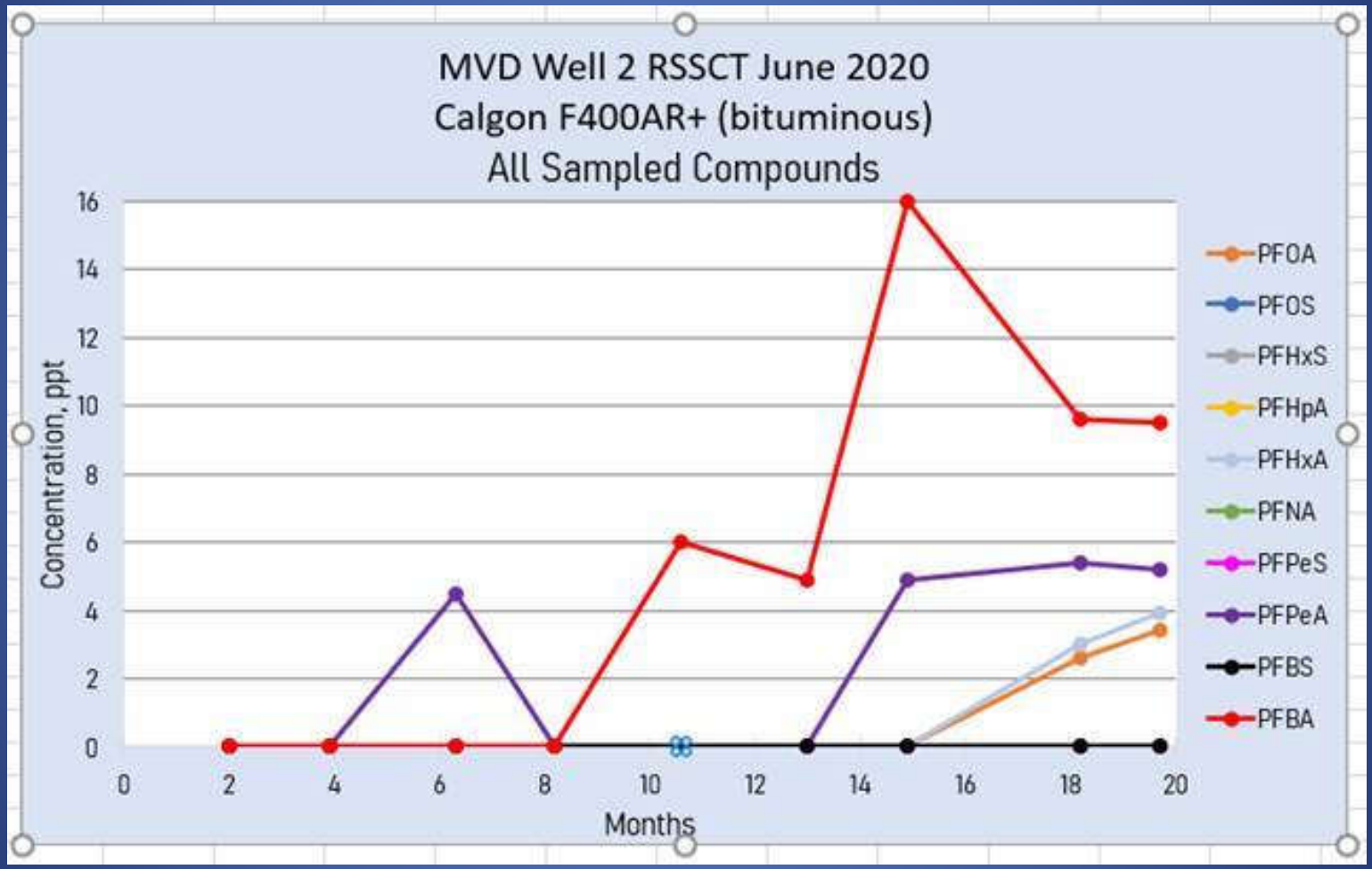
RSSCT Results – All Sampled PFAS



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Well 4 & 5 WTP

- Spec'd GAC 4
- CMU building, wood truss roof
  - Vinyl siding, asphalt shingles
- 2 – 12' diameter, 26' tall GAC contactors
- Provisions for resin addition
- Chem feed, control room, generator
- Eliminate pump stations, new pumps, pitless adaptors

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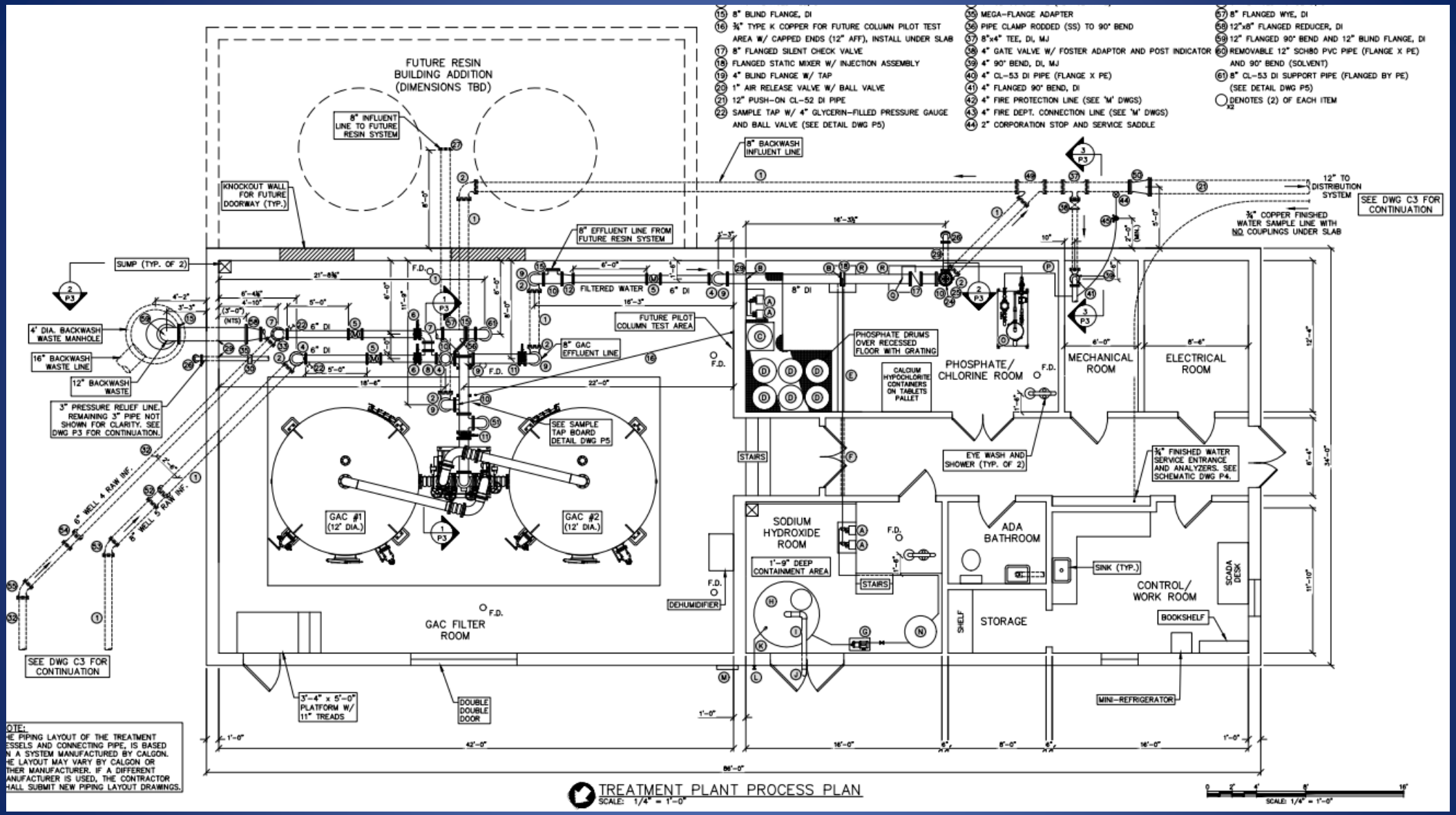

TREATMENT PLANT PROCESS PLAN
SCALE: 1/4" = 1'-0"

SCALE: 1/4" = 1'-0"

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GAC Design Considerations

- Treatment goals
  - Meet MCL's for regulated compounds?
  - Non Detect of any PFAS compound?
- GAC system
  - Manufacturers layouts, tank heights & piping different
  - Design for biggest footprint & tallest tank?
- Building
  - Need to design 30 ft walls
  - Access for GAC loading/unloading

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GAC Design Considerations

- Discharge requirements for BW & FTW
  - Sewer to WWTP? Town of Merrimack said no to MVD
- Site Design
  - Big trucks need to maneuver through site, load & unload
  - Infiltration basins if sewer not an option
- Flexibility and expandability
  - Design GAC vessels to accept future alternative media?
  - Design WTP to add resin or additional absorbers?

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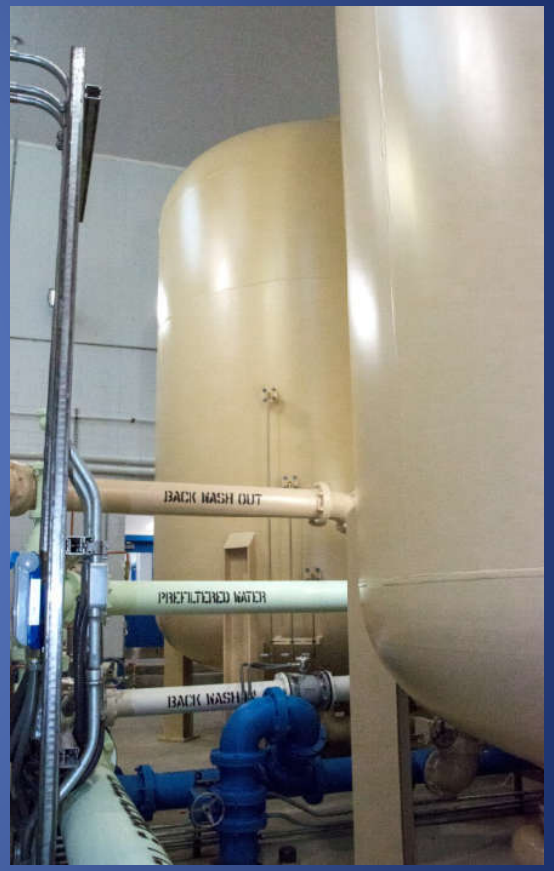
Well 4 & 5 WTP



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Well 4 & 5 WTP

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Well 7 & 8 WTP

- Existing 1.8 MGD Fe/Mn WTP with Greensand Plus
- Resin?
  - Chlorine in GSP effluent
  - Chlorides > 100 mg/L
- GAC selected
  - Limited expansion area
  - 2-15 ft diam GAC vessels

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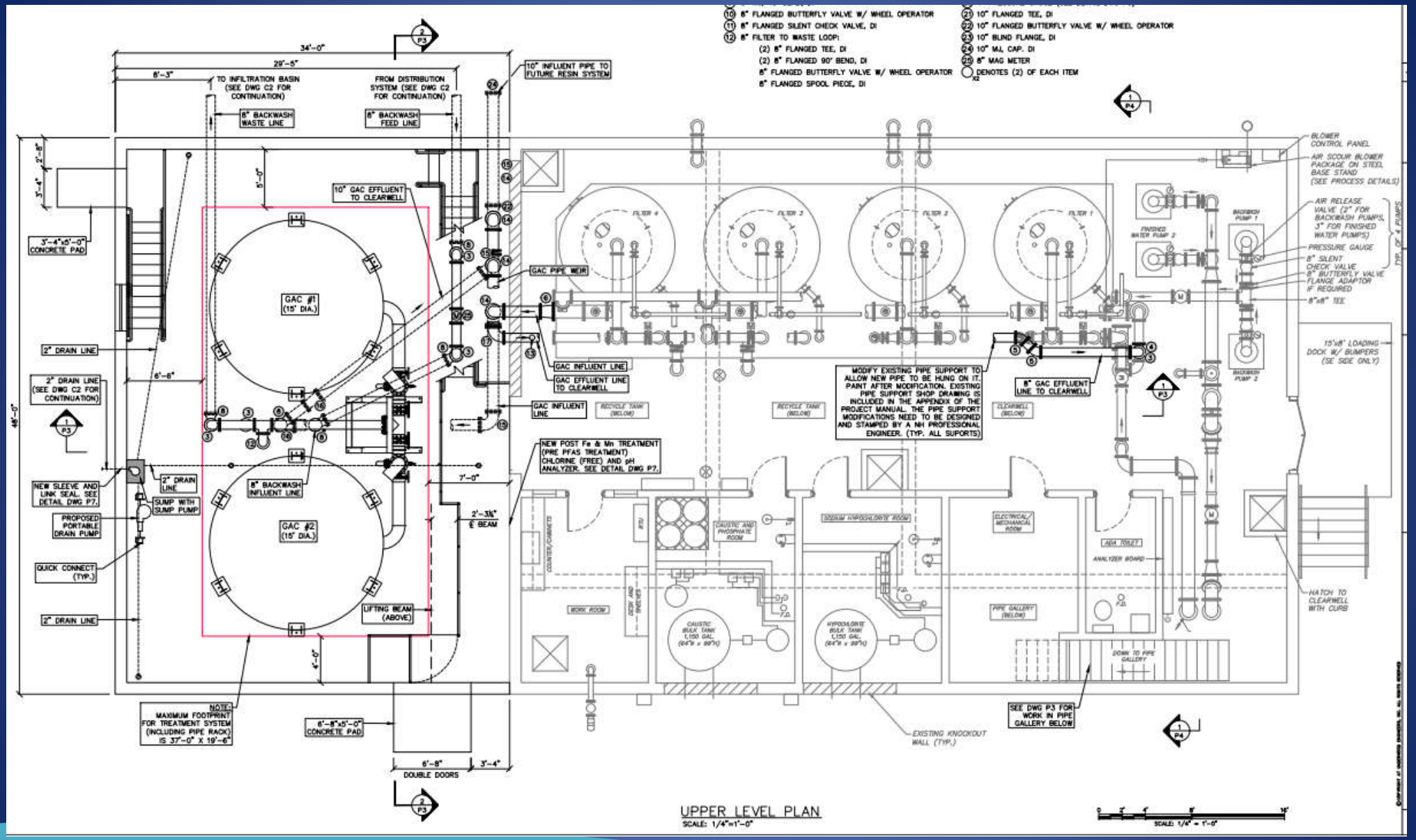

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Well 7 & 8 WTP

- Existing tanks 12 ft tall
- Adding 27 ft tall tanks
  - Addition floor at basement level of existing WTP
  - Keeps roof line constant
- Add additional infiltration basin for GAC backwash

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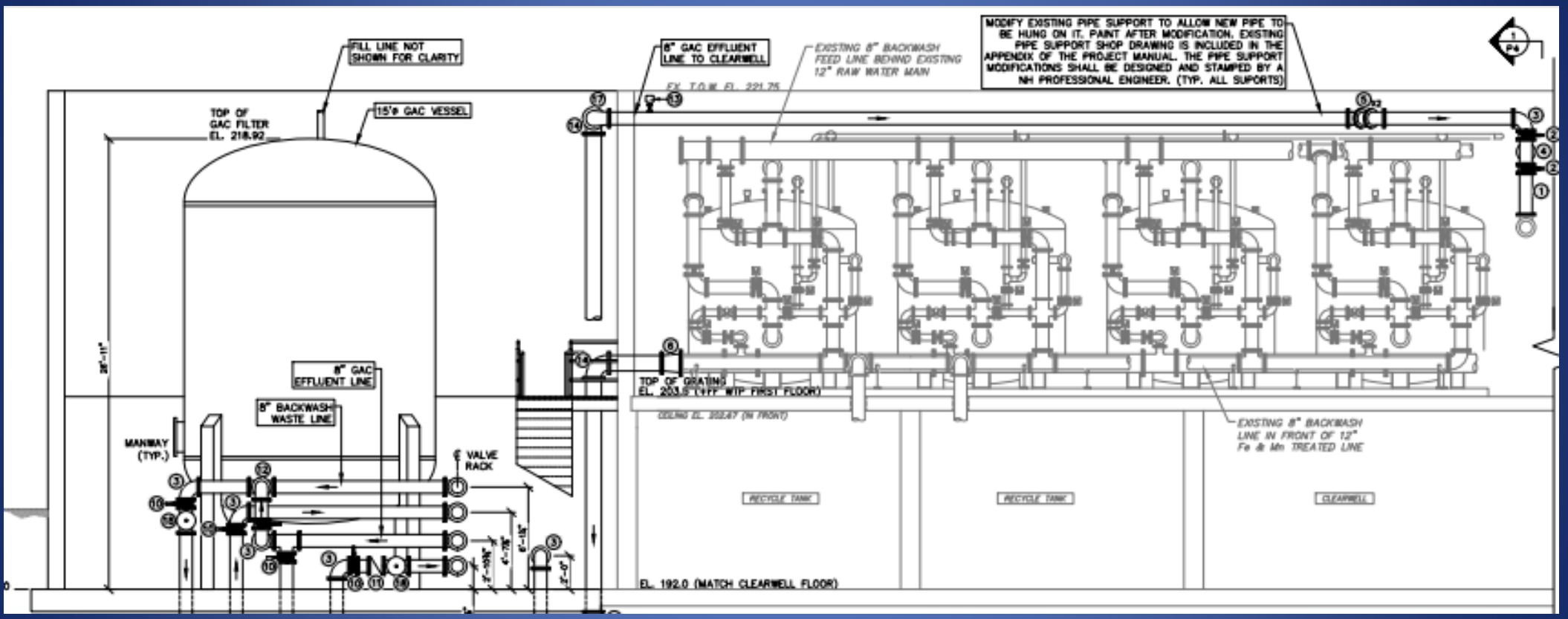

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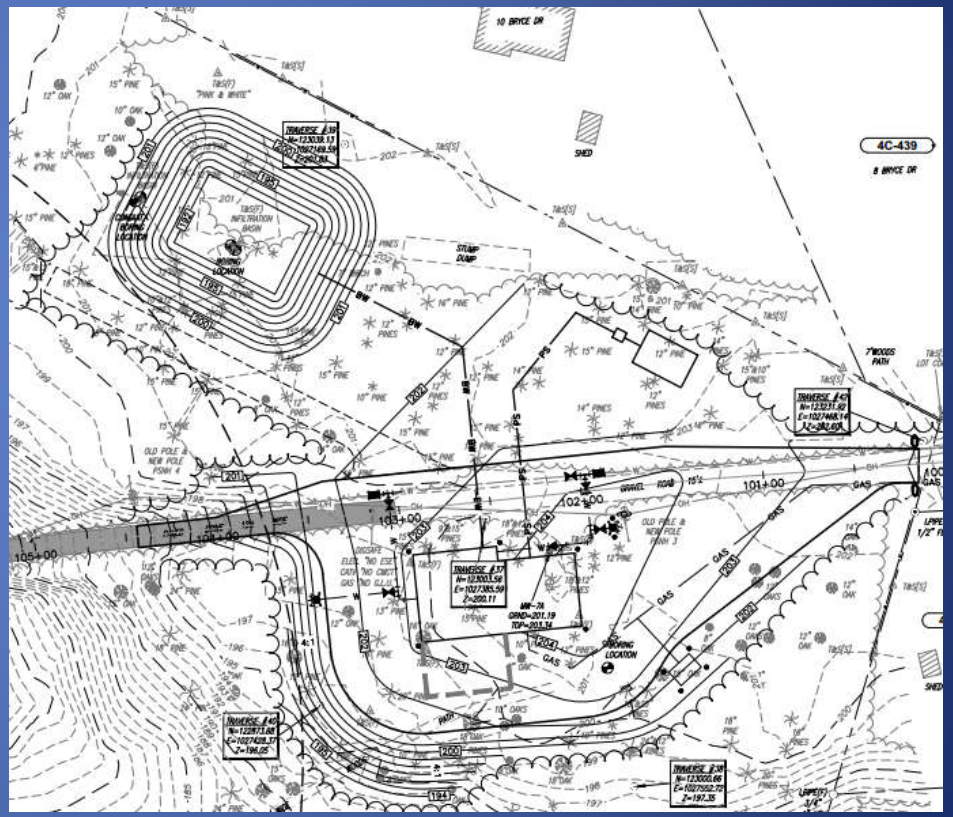
Well 2 WTP

- GAC selected for process
  - High chlorides NG for resin
  - Consistent with other 2 WTP's
- 1,500 gpm capacity
  - 2 trains with 2 - 12 foot diameter vessels (4 total)
- Infiltration basin for GAC BW & FTW
- Currently working toward 90% design documents



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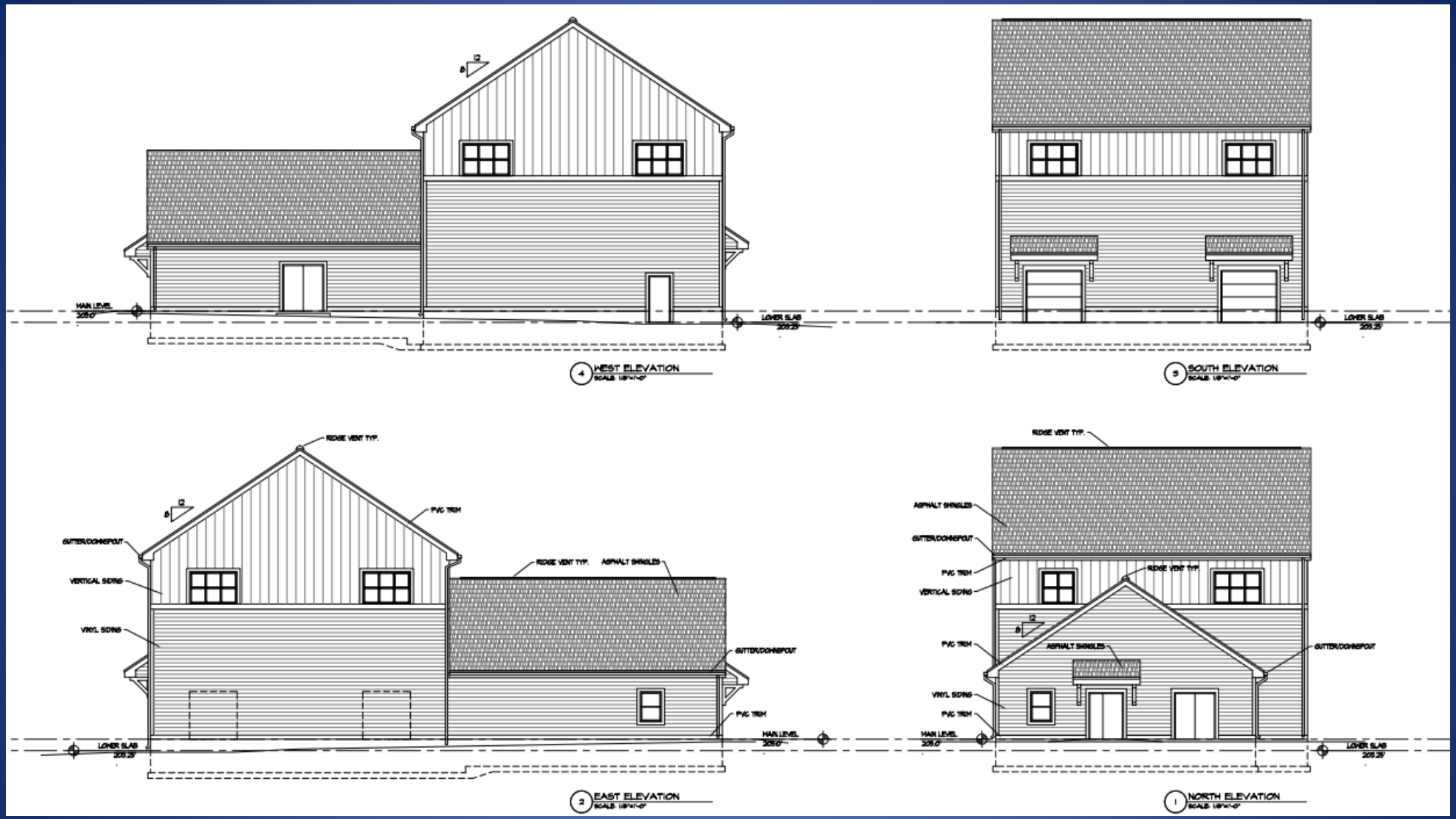

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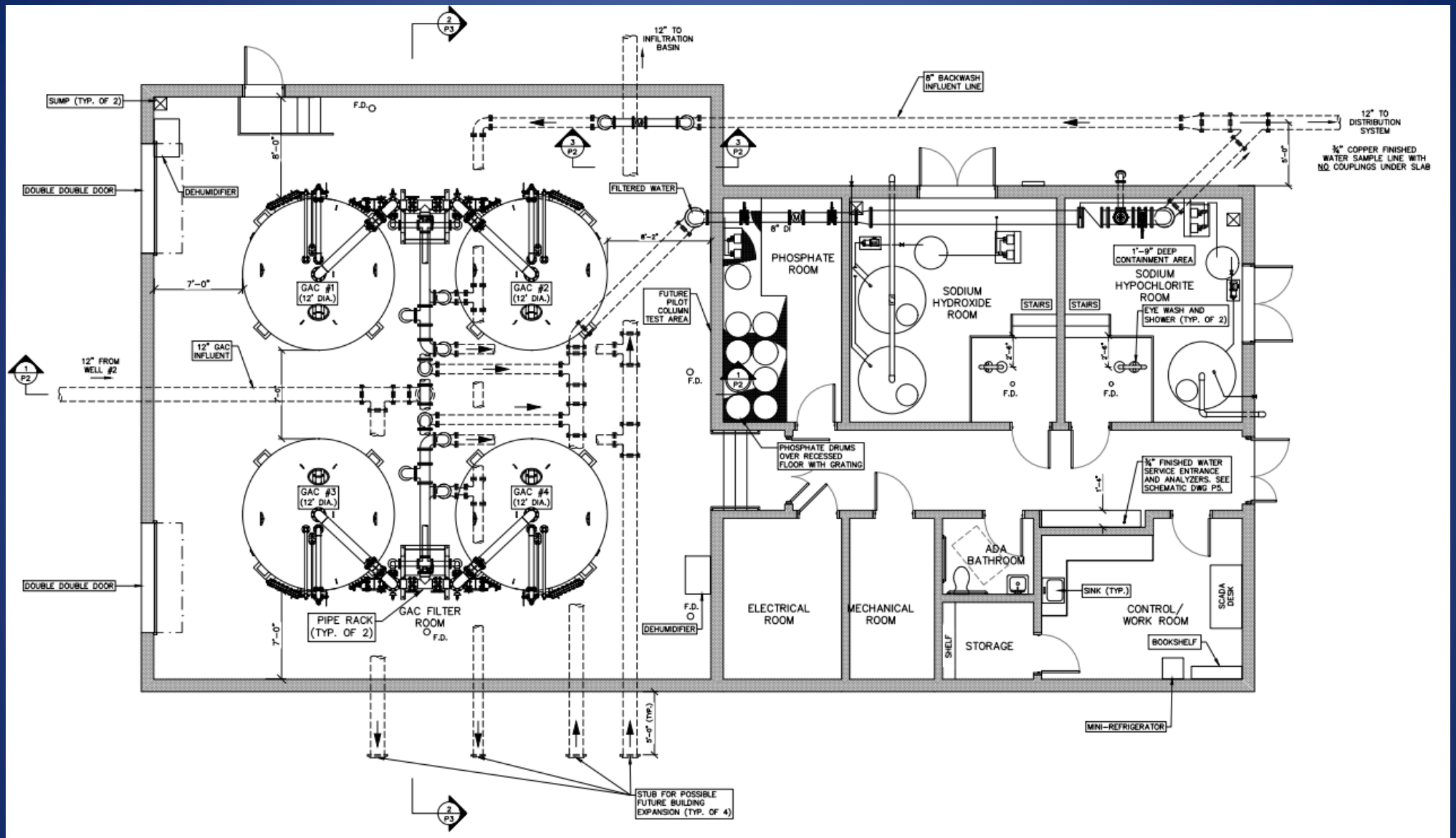

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Dover's PFAS Experience

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Pudding Hill Aquifer

- Dover Wells at Pudding Hill
  - Griffin Well
    - Fe/Mn WTP
    - Aeration for VOC's
  - Ireland Well
  - Well DPH-1
    - Newer to replace Griffin

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PFAS Detection

- 2017-2018 Monitoring

Well	PFOA + PFOS	Status
Griffin Well	301 ppt	Off line 2015
Ireland Well	0 – 279 ppt	Off line 2018
DPH-1	4 – 5 ppt (PFOA)	Limited use

- Other contaminants
  - Fe/Mn
  - MtBE
  - 1,4-Dioxane

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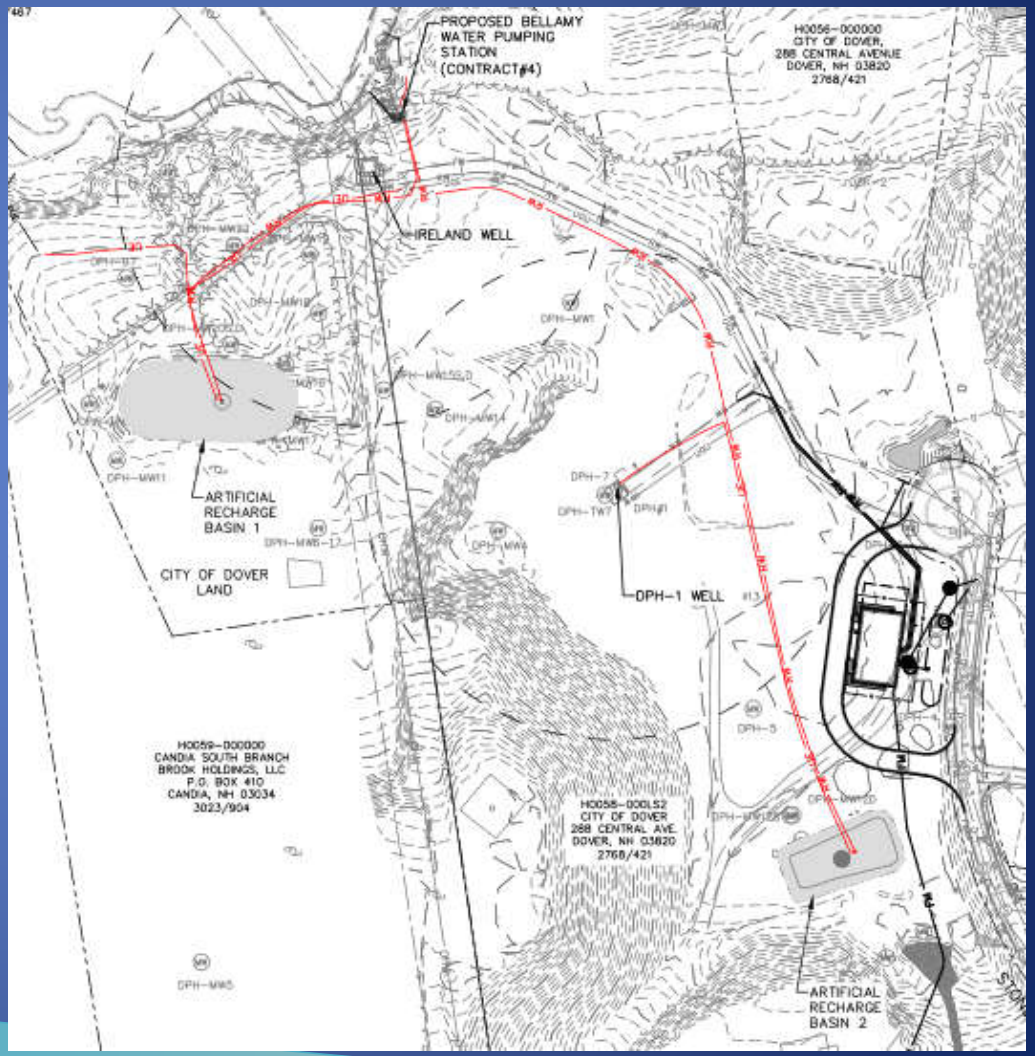
Artificial Recharge

- Gravel washing
  - AR “by mistake”
- Bellamy River Pump Station
- Two new basins planned
  - Aquifer recharge
  - GW mound to divert contamination believed to be coming from site to west



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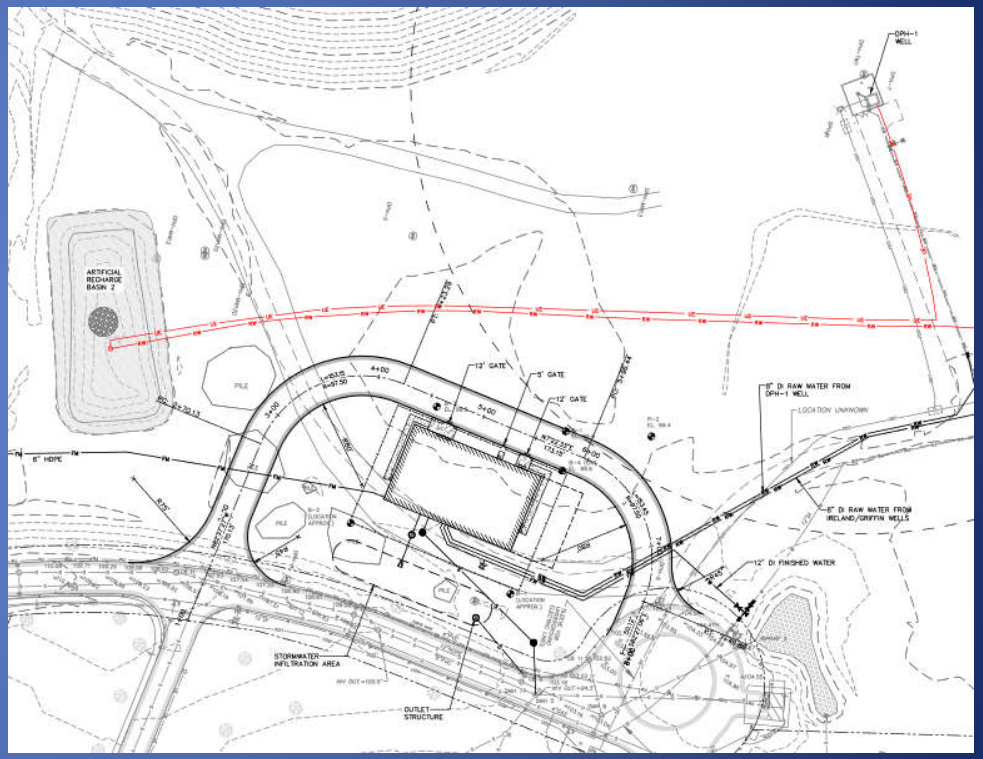
Pudding Hill WTP

- Treatment steps
  - Greensand Plus for Fe/Mn
  - Advanced Oxidation Process (AOP) for 1,4-Dioxane
    - Hydrogen Peroxide & UV
  - PFAS treatment
    - GAC and/or Resin ?



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PFAS Treatment Process Selection

- Potential concerns with GAC
  - Design PFAS levels > MVD
  - Total contaminant load unknown
  - If high levels persist, may require frequent changeouts
  - Comparison of capital and O&M costs indicate GAC & resin may be cost competitive

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PFAS Treatment Process Selection

- Logistics
  - UV-Peroxide AOP required for 1,4-Dioxane
  - Resin requires quenching of upstream peroxide or chlorine
  - Literature says GAC or chlorine for quenching peroxide residual
  - Can't use chlorine to quench peroxide as that will damage resin also
  - Three possible options to add resin…**all require GAC**

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PFAS Treatment Process Selec

- Recommendation
  - Design now around GAC
  - Design provisions for future resin
    - Space for cartridge filters
    - Space for future resin vessels and/or…
    - Design GAC contactors so that resin could be used instead
    - Account for future head loss of resin (25 psi +/-)
    - Design provisions for piloting
    - Pilot alternative resins and GAC during initial years of plant operation

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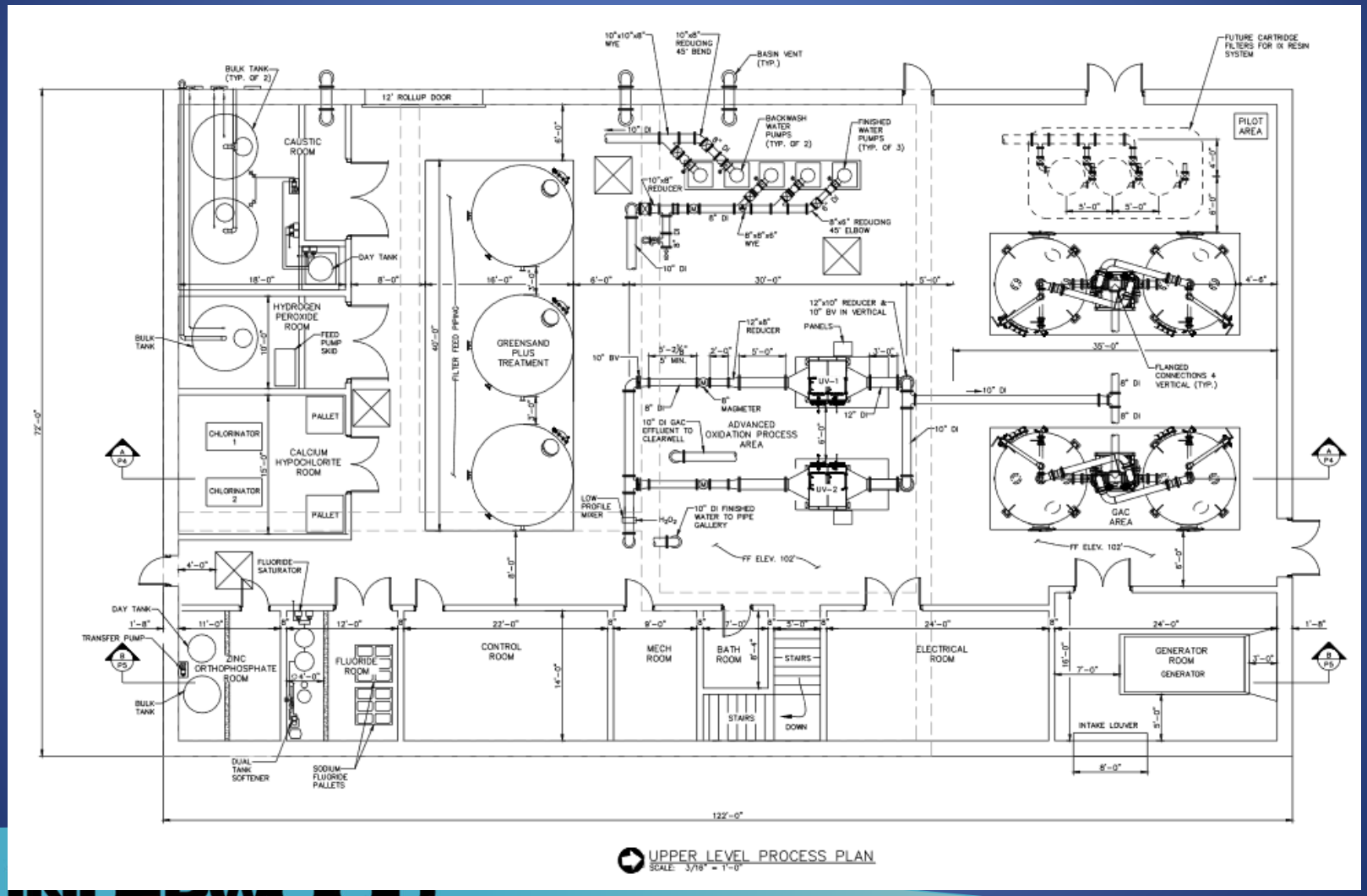
Pudding Hill WTP Floor Plan



UPPER LEVEL PROCESS PLAN
SCALE: 3/16" = 1'-0"

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Arsenic Treatment

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Arsenic (As)

What is it?

- Naturally occurring metalloid
- Colorless, tasteless & odorless in drinking water

Health Effects?

- Cancer
- Diabetes
- Neurological disorders
- Birth defects

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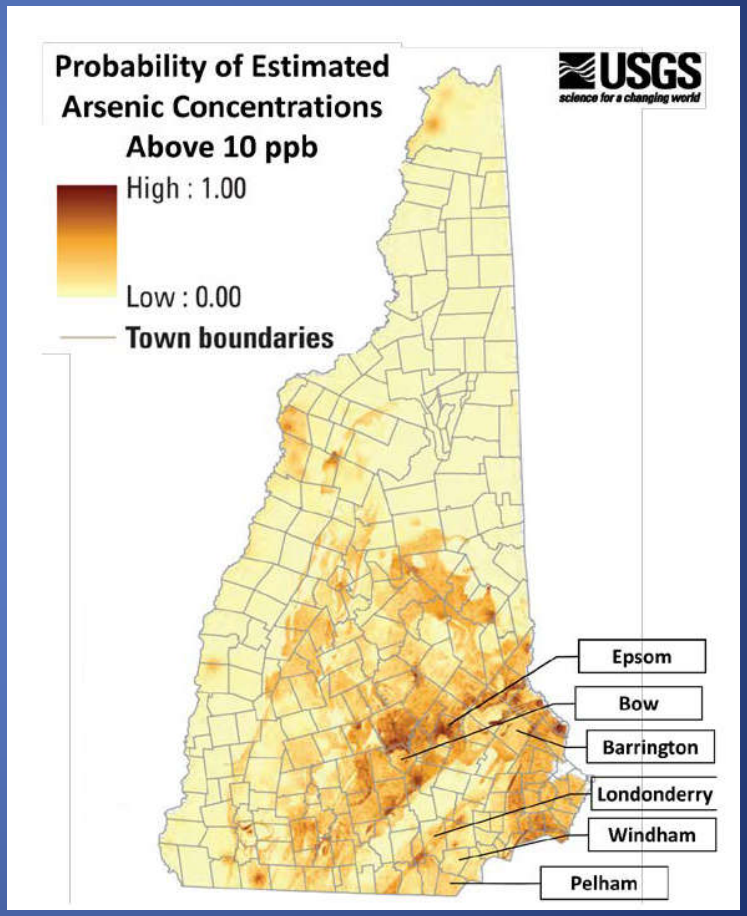
Arsenic Occurrence

- Different oxidation states
- Arsenite – As(III)
- Arsenate – As(V)
- As(III) harder to remove from water – need to oxidize to As(V) for most treatment options



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Regulations

"The U.S. Environmental Protection Agency (EPA) typically sets MCLs for drinking water contaminants at a level at which a lifetime of exposure would result in one excess cancer in one million people exposed…The 10 ppb MCL for arsenic is associated with a far greater risk – 3,000 in a million (roughly 1 in 300).."

- Current Maximum Contaminant Level (MCL)
  - **10 parts per billion (ppb)**
  - January 2006
  - Federal Regulation
- Future Maximum Contaminant Level (MCL)
  - **5 parts per billion (ppb)**
  - Expected July 2021
  - Compliance based on running annual average
  - State Regulation

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Arsenic Treatment Options

- Ion Exchange
- Adsorption onto iron based media
- Reverse Osmosis
- Co-precipitation with iron

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Arsenic Treatment Options

- Anionic Exchange Resin
  - Strong base anionic resin
  - Feed oxidant (NaOCl) to oxidize As(III) to As(V)
  - Process same as for PFAS
    - Cartridge prefilter required
    - As exchanged for chloride ions
  - Resin can be single use or regenerated with brine solution
  - Need to dispose of brine waste

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Arsenic Treatment Options

- Adsorption onto iron based media (granular ferric hydroxide or GFH)
  - Feed oxidant (NaOCl) to oxidize As(III) to As(V)
  - Cartridge prefiltration
  - As adsorbed onto iron hyroxide
  - Single use media is replaced when exhausted so no waste stream

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Arsenic Treatment Options

- Reverse Osmosis
  - Semi-permeable membrane
  - High pressure feed water
  - As rejected by membrane
  - Treated water passes membrane
  - Reject stream
    - Concentrated solids including As

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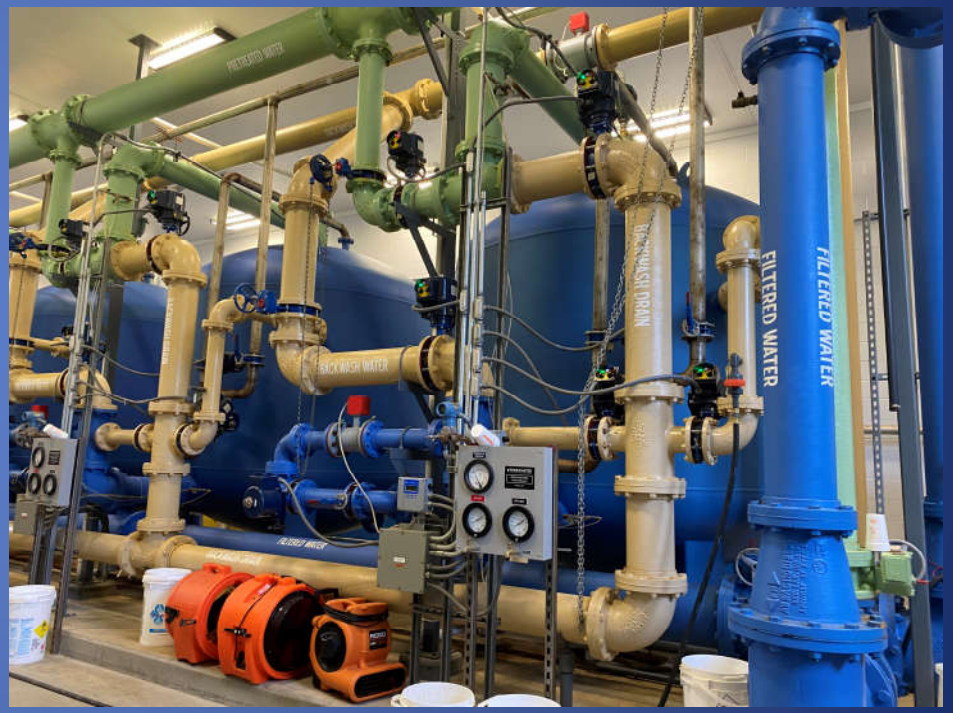
Arsenic Treatment Options

- Co-Precipitation with Iron
  - Feed oxidant (NaOCl) to oxidize As(III) to As(V)
  - Pressure filters with Fe & Mn removal media
    - Greensand Plus
    - LayneOx
  - As(V) adsorbed onto and entrapped in media with Fe
  - Key parameters
    - pH 5.5 – 8.5
    - Fe:As min ratio of 20:1
  - Backwash filters on H_L or T
    - Sewer
    - Infiltration Basins



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Epping's Arsenic Treatment Experience

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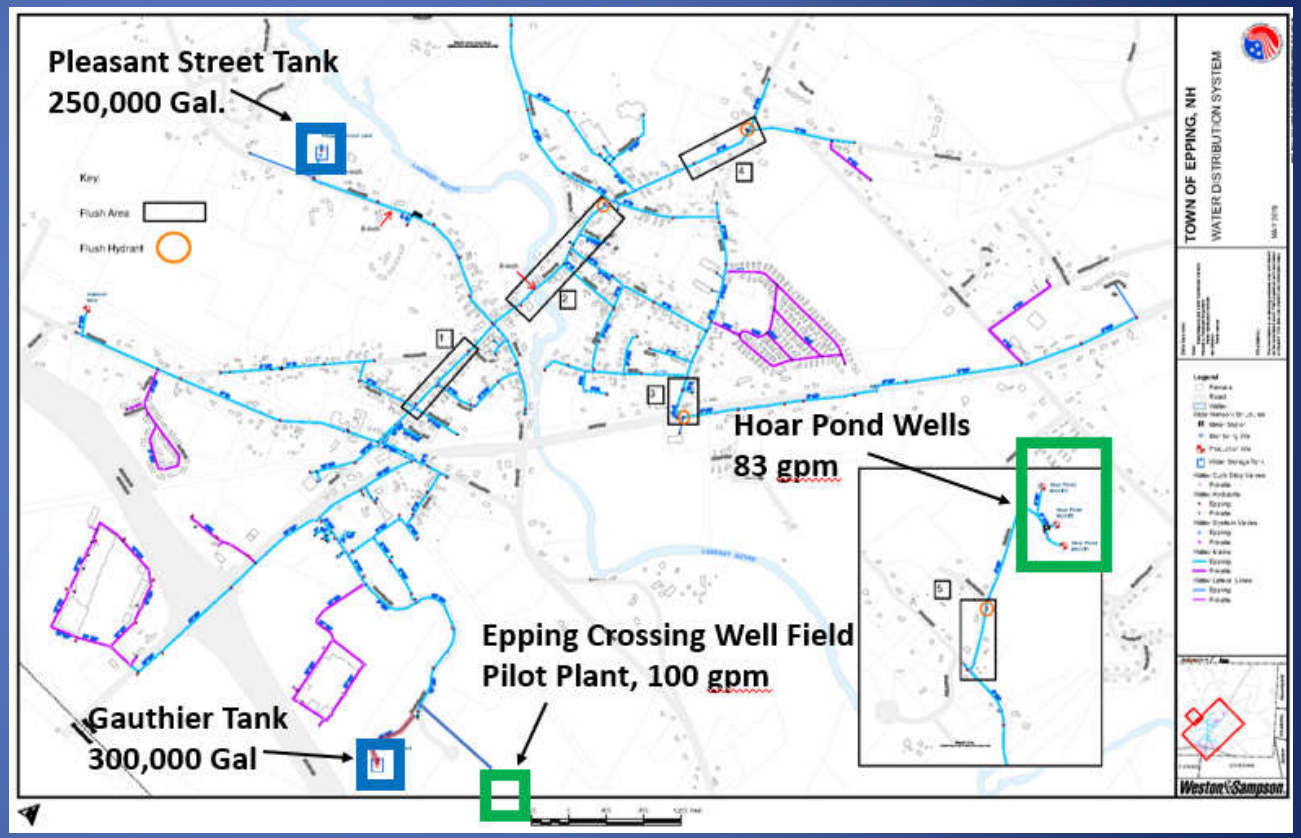
Epping Water Supply System

- Hoar Pond Wellfield
  - As = 9 ppb
  - Can't meet future reg
  - Do not plan to treat
- Epping Crossing Wellfield
  - As = 19 ppb
  - Treatment planned
  - Replace Hoar Pond



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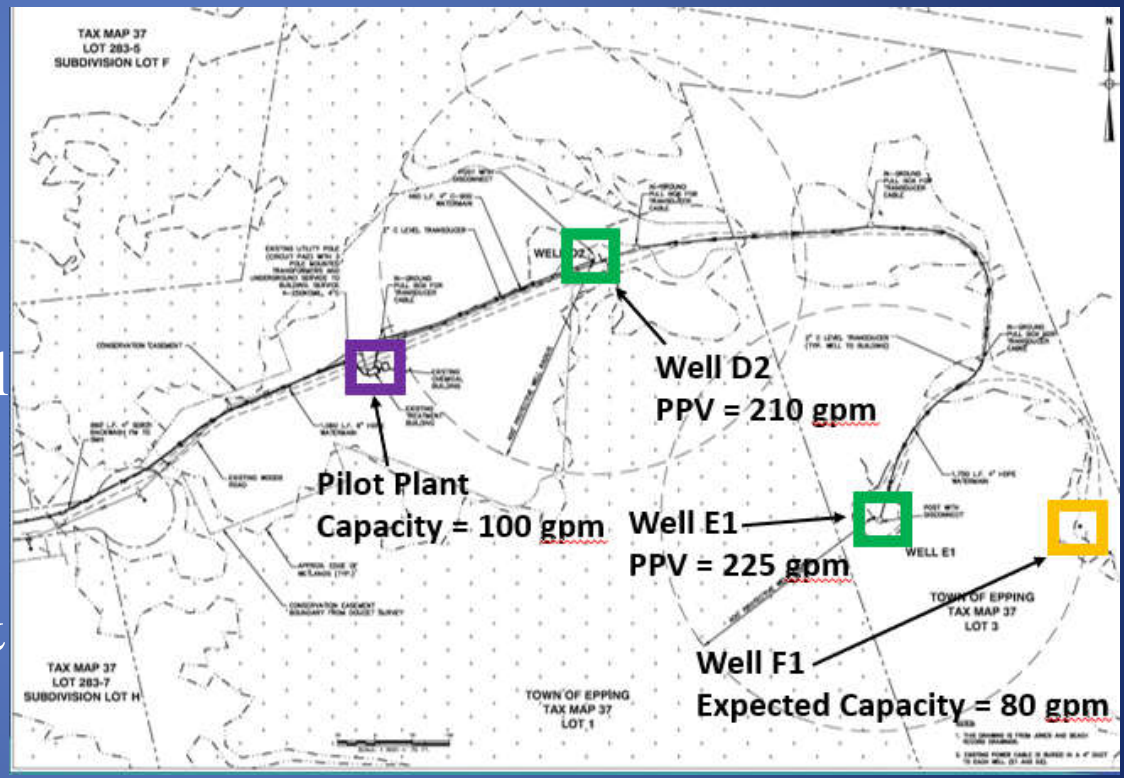
Epping Cross Well Field

- Capacity of 435 gpm with wells D2 & E1
- Complies with DES groundwater supply regs
  - Meet ADF with largest well off
  - Meet MDF with all wells
  - BUT – need more supply & plan to permit Well F1



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Existing Pilot Plant

- Capacity – 100 gpm
- Filters
  - 3 – 3.5 ft diameter
- Media
  - Clack MTM
- Chemical Feed
  - 12.5% NaOCl
  - 40% Ferric Chloride
  - Provisions to raise/lower pH

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Epping Cross Wellfield Water Quality

Table 1.01: Historical Raw Water Data from Wells E1, D2 and Blended

Parameter	# of Samples	Well E1	Well D2	Blended E1 & D2
pH – field	33	9.17	8.57	8.71
pH – Lab	6	8.72	7.99	8.19
Temp (C)	32	11.5	11.8	
Arsenic, µg/L	6	16	21	19
Iron, mg/L	6	0.030	0.258	0.175
Manganese, mg/L	6	0.037	0.375	0.265
TDS, mg/L	6	230	318	
Alkalinity, mg/L	6	78	89	
Calcium, mg/L	6	7	34	
Sulfate, mg/L	6	18	22	

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Water Quality Summary

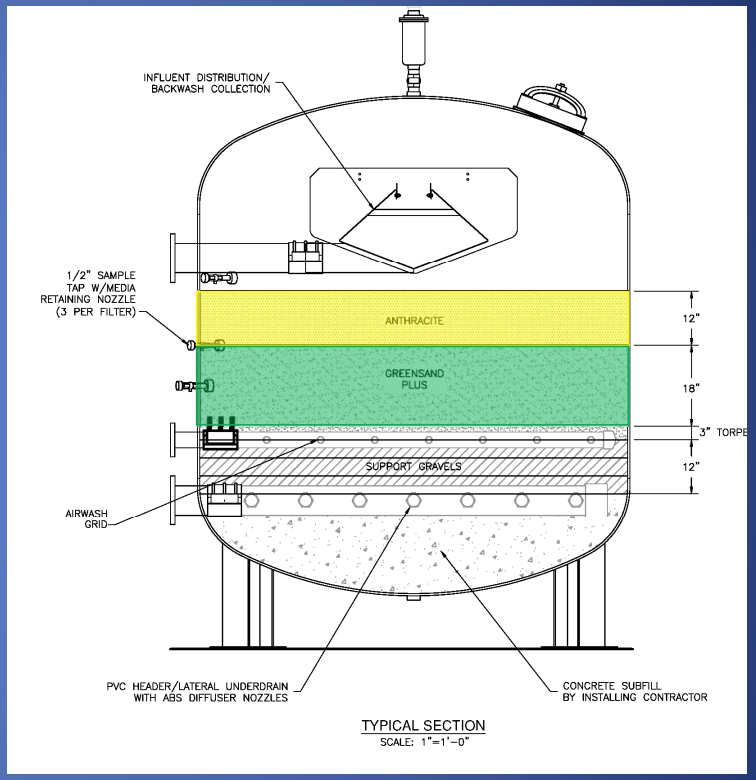
- pH - 8.19 to 8.7
  - At upper end or above optimal range for co-precipitation
- As – 19 ppb
  - Exceeds current (10 ppb) and future (5 ppb) MCL
- Fe – 0.175 mg/L
  - Less than SMCL of 0.3
  - Fe:As ratio = 175:19 or 9:1 < desired 20:1
- Mn – 0.265
  - Exceeds SMCL of 0.05 mg/L
  - Approaching 0.3 mg/L EPA HAL for infants
- Alkalinity – 78 to 89 mg/L
  - High pH and alkalinity provide corrosion control

Piloting

- Existing pilot – Clack MTM
  - Common residential media but not in larger WTP's
  - Lighter than Greensand media
  - Larger filter manufacturers wouldn't warrantee
    - Concerned with backwash – clumping and media loss
- Blueleaf pilot – Greensand Plus®
  - Evaluated increasing Fe and lowering pH
  - Adding Fe can reduce filter run time…balancing act

Manganese Greensand Process

- Filters
  - No = 3
  - Diameter = 8 ft
- Greensand Plus Media
  - Loading Rate = 2-12 gpm/sf
  - Anthracite Cap
    - Delays filter blinding
- Backwash
  - Combined water and air scour
  - Flow = 10-12 gpm/sf
  - Volume = 10,000 gal. – 16,000 gal.



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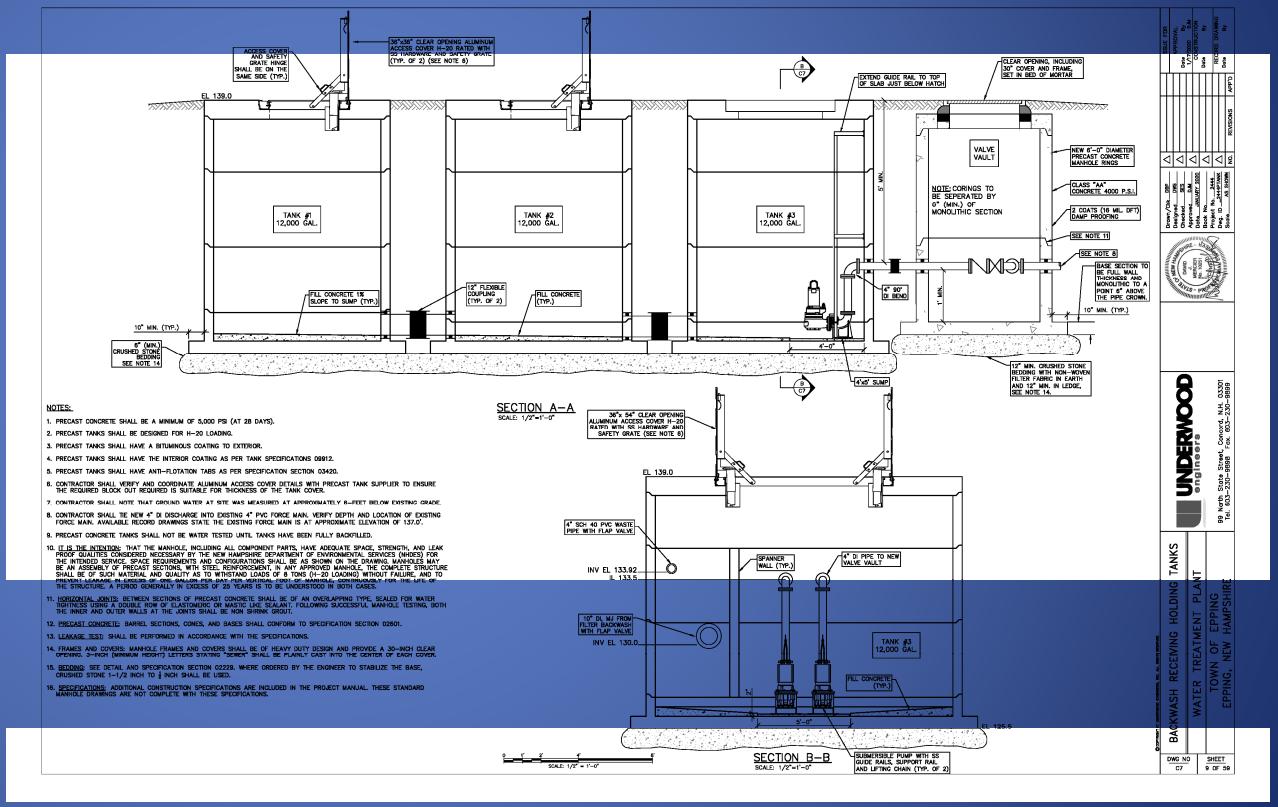
Backwash Equalization Tanks

- Backwash rate exceeds sewer capacity
- Added equalization tanks
- Included performance spec on BW volume



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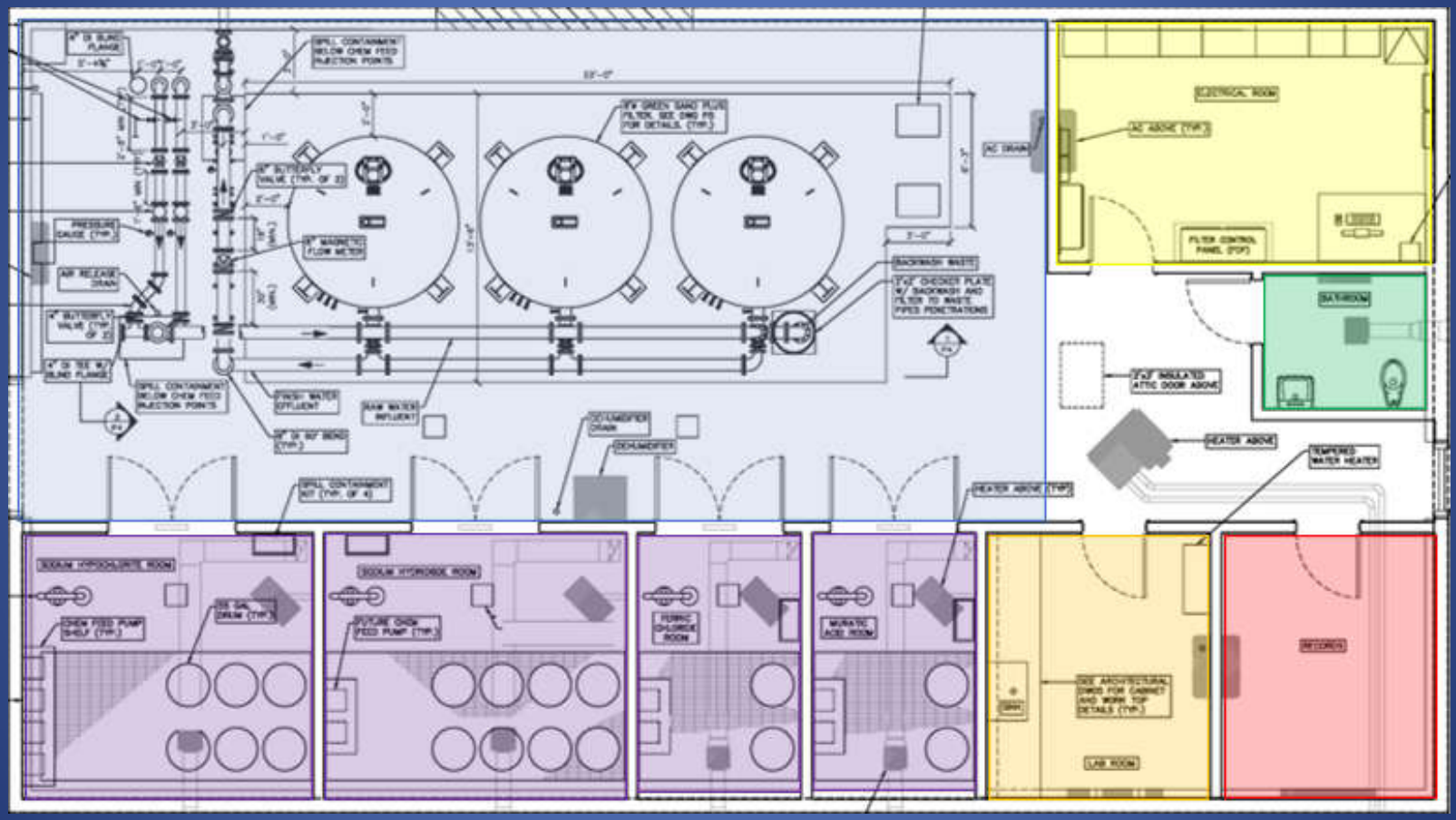
Epping Crossing WTP Floor Plan



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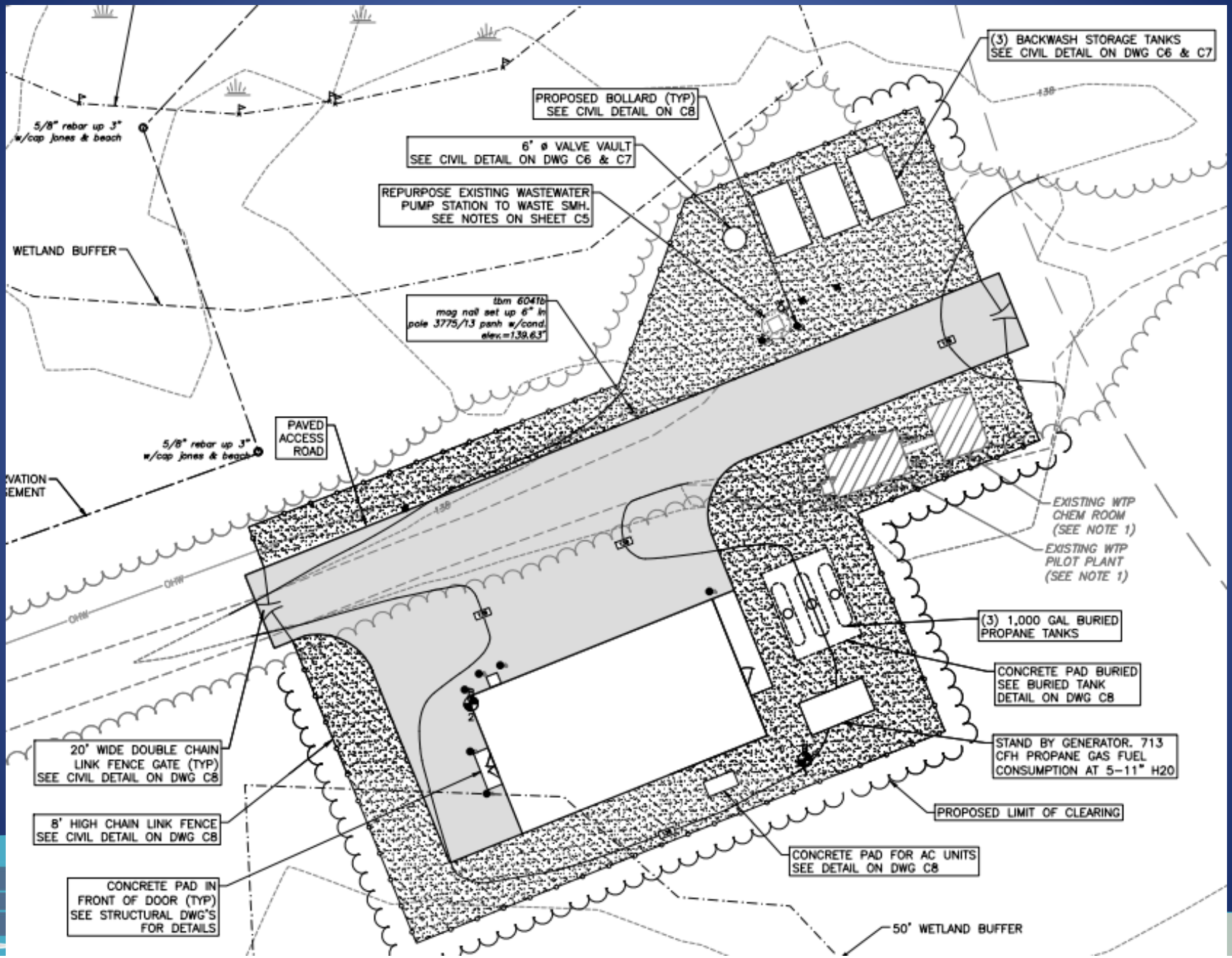
(3) BACKWASH STORAGE TANKS
SEE CIVIL DETAIL ON DWG C6 & C7
PROPOSED BOLLARD (TYP)
SEE CIVIL DETAIL ON C8
6" ø VALVE VAULT
SEE CIVIL DETAIL ON DWG C6 & C7
REPURPOSE EXISTING WASTEWATER
PUMP STATION TO WASTE SMH.
SEE NOTES ON SHEET C5
5/8" rebar up 3"
w/cap jones & beach
WETLAND BUFFER
tbm 6041b
mag nail set up 6" in
pole 3775/13 psnh w/cond.
elev.=139.63'
PAVED
ACCESS
ROAD
5/8" rebar up 3"
w/cap jones & beach
EXISTING WTP
CHEM ROOM
(SEE NOTE 1)
EXISTING WTP
PILOT PLANT
(SEE NOTE 1)
(3) 1,000 GAL BURIED
PROPANE TANKS
CONCRETE PAD BURIED
SEE BURIED TANK
DETAIL ON DWG C8
STAND BY GENERATOR. 713
CFH PROPANE GAS FUEL
CONSUMPTION AT 5-11" H20
20' WIDE DOUBLE CHAIN
LINK FENCE GATE (TYP)
SEE CIVIL DETAIL ON DWG C8
8' HIGH CHAIN LINK FENCE
SEE CIVIL DETAIL ON DWG C8
PROPOSED LIMIT OF CLEARING
CONCRETE PAD FOR AC UNITS
SEE DETAIL ON DWG C8
CONCRETE PAD IN
FRONT OF DOOR (TYP)
SEE STRUCTURAL DWG'S
FOR DETAILS
50' WETLAND BUFFER
OHW
OHW
138
138

Thanks For Your Attention
Questions?

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