BUILDING A WORLD OF DIFFERENCE

CFPUA Workshop:
Update on Removal of GenX & Other PFAS
Agenda

- Data Summary
- Treatment Goals
- Replacement Frequency
  - Deep Bed GAC
  - Ion Exchange
- Media Changeout
- Existing Media Replacement
- Action Items
Data Review
Pilot Plant Setup – Phase II

**Key:**
- GAC
- IX

**Columns:***
- **COLUMN 10**: Calgon Filtrasorb 400
- **COLUMN 11**: Calgon Filtrasorb 400
- **COLUMN 12**: Norit Hydrodarco 4000
- **COLUMN 13**: Norit GAC 400
- **COLUMN 5**: Evoqua Dowex PSR-2
- **COLUMN 6**: Calgon CalRes 2304
- **COLUMN 7**: Purolite PFA694E
- **COLUMN 8**: Purolite PFA694E
- **COLUMN 9**: Calgon CalRes 2301

**Flow:**
- FROM INTERMEDIATE OZONE
- EXISTING FILTERS
- TO UV DISINFECTION
- TO PLANT DRAIN
# Pilot Updates

## Start Dates:

<table>
<thead>
<tr>
<th>Column</th>
<th>Media</th>
<th>Start Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Col 10</td>
<td>F400</td>
<td></td>
</tr>
<tr>
<td>Col 11</td>
<td>F400</td>
<td></td>
</tr>
<tr>
<td>Col 12</td>
<td>Hydrodarco 4000</td>
<td>Jan. 16, 2018</td>
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<tr>
<td>Col 13</td>
<td>GAC 400</td>
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<tr>
<td>Col 5</td>
<td>Dowex PSR-2 Plus</td>
<td>Sep. 5, 2017</td>
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<tr>
<td>Col 6</td>
<td>CalRes 2304</td>
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<tr>
<td>Col 7</td>
<td>Purofine PFA694E</td>
<td>Jan. 17, 2018</td>
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<tr>
<td>Col 8</td>
<td>Purofine PFA694E</td>
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</tr>
<tr>
<td>Col 9</td>
<td>CalRes 2301</td>
<td>Jan. 9, 2018</td>
</tr>
</tbody>
</table>

## Recent Sampling:

- **PFAS**
  - Jan. 30, Feb. 13
- **EDCs/PPCPs**
  - Jan. 30
- **THMs (DBP Formation Potential)**
  - Feb. 13

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*No PFAS data has been received on new columns.*
TFC Prior UV

Concentration ng/L

Day

Total PFAS* (33)
Total PFAS (20)
Total PFAS (9)
PFPrOPrA/GenX

414
285
174

0 20 40 60 80 100 120 140 160 180 200
Column 3 - Post Filter F400

- TOC
- Total PFAS* (33)
- Total PFAS (20)
- Total PFAS (9)
- PFPrOPrA/GenX
- PFHxA (C6)
- PFHpA (C6)
- PFOA (C7)
- PFNA (C7)
- PFBS (C9)
- PFOS (C9)

Percent Breakthrough (C_i/C_0)

Bed Volumes Treated
Column 4 - Post Filter AC 12X30 CX

- Total PFAS* (33)
- Total PFAS (20)
- Total PFAS (9)
- PFPr/OPrA/GenX
- PFHxA (C6)
- PFHpA (C7)
- PFOA (C8)
- PFNA (C9)
- PFBS (C4)
- PFHxS (C6)
- PFOS (C8)

Effluent Concentration (ng/L) vs Bed Volumes Treated (vol.)

Bed Volumes Treated

0 2,000 4,000 6,000 8,000 10,000 12,000 14,000 16,000 18,000 20,000

Effluent Concentration (ng/L)

0 100 200 300 400 500 600 700

6,700
Column 5 - Post Filter IX Column 1

Percent Breakthrough \((C_i/C_o)\)

Bed Volumes Treated

- TOC
- Total PFAS* (33)
- Total PFAS (20)
- Total PFAS (9)
- PFPrOPrA/GenX
- PFHxA (C6)
- PFHpA (C7)
- PFOS (C8)
- PFNA (C9)
- PFBS (C4)
- PFHxS (C6)
- PFOS (C8)
Treatment Goals
Treatment Goals

• Primary - PFAS Removal
  • Potential Metrics:
    • >95% Removal – RO Only
    • Removal of PFAS20 to <70 ng/L.
    • Treatment Barrier Approach – Set media replacement frequency (no metric)
  • Other primary requirements
    • Changeout frequency >180 days
    • Maintains PFOA, PFOS, and GenX below health advisories

• Secondary
  • Flexibility for alternative future use
  • Reduce potential for THM formation
  • Removal of EDCs/PPCPs and other CECs
  • Reduce potential for adverse corrosion effects
  • Headache for operations
  • Familiarity with technology
**PFAS20 vs All Measured PFCs**

**Perfluoroalkyl carboxylic acids**
1. PFBA
2. PFPeA
3. PFHxA
4. PFHpA
5. PFOA
6. PFNA
7. PFDA
8. PFUnA
9. PFDoA
10. PFTrDA
11. PFTeDA

**Perfluoroalkyl sulfonic acids**
12. PFBS
13. PFPeS
14. PFHxS
15. PFHpS
16. PFOS
17. PFNS
18. PFDS

**Others**
- NEtFOSAA
- NMeFOSAA
- PFOSA
- 4:2 FTS
- 6:2 FTS
- 8:2 FTS
- PFPrOPrA/GenX
- ADONA
- F-53B Major
- F-53B Minor
- PFMOBA
- PFMOPrA
- PFMOAA
- PFO2HxA
- PFO3OA
- PFO4DA
- Pfion Biproduct 1
- Pfion Biproduct 2

**KEY**
- Bold = Detected
- Red = No standard (Estimated)
Updated Site Layouts
Deep Bed GAC Contactors Design Summary

<table>
<thead>
<tr>
<th>Contactors</th>
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<tbody>
<tr>
<td>Quantity</td>
<td>10</td>
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<tr>
<td>Design Flow Rate, gpm</td>
<td>4,085</td>
</tr>
<tr>
<td>Type</td>
<td>Concrete Basin</td>
</tr>
<tr>
<td>Length (ea), ft</td>
<td>22</td>
</tr>
<tr>
<td>Width (ea), ft</td>
<td>37.6</td>
</tr>
<tr>
<td>Area (ea), sf</td>
<td>827</td>
</tr>
<tr>
<td>Media, per contactor</td>
<td></td>
</tr>
<tr>
<td>Bed Depth, ft</td>
<td>10</td>
</tr>
<tr>
<td>Max Loading Rate, gpm/ft²</td>
<td>4.3</td>
</tr>
<tr>
<td>EBCT, min</td>
<td>20</td>
</tr>
<tr>
<td>Bed Volume, cf</td>
<td>8,272</td>
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Ion Exchange Design Summary

<table>
<thead>
<tr>
<th>Vessels</th>
<th>18 duty/2 standby</th>
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<tbody>
<tr>
<td>Quantity</td>
<td>1,910 gpm</td>
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<tr>
<td>Design Flow Rate, gpm</td>
<td>1,910</td>
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<tr>
<td>Flow Direction</td>
<td>Downflow</td>
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<tr>
<td>Diameter, ft</td>
<td>12</td>
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<tr>
<td>Total Height, ft</td>
<td>15</td>
</tr>
<tr>
<td>Resin, per vessel</td>
<td>Styrene-DVB, Gel; Non-regenerable</td>
</tr>
<tr>
<td>Bed Depth, ft</td>
<td>7</td>
</tr>
<tr>
<td>Max Loading Rate, gpm/s.f.</td>
<td>17</td>
</tr>
<tr>
<td>Max Pressure Drop, psid</td>
<td>15</td>
</tr>
<tr>
<td>Bed Volume, cf</td>
<td>792</td>
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Media Replacement Frequency
Two Approaches

1. Vary replacement frequency to achieve < 70 ng/L PFAS20
   - Flow increase = shorter bed life
   - Higher concentrations = shorter bed life
   - Media replacement costs increase over time

2. Replacement at set interval (Treatment Barrier Approach)
   - Flow increase = less removal
   - Higher concentrations = less removal
   - Media replacement costs are constant
## Sweeney WTP Flow Rates

<table>
<thead>
<tr>
<th>Year</th>
<th>AADF</th>
<th>Peak DF</th>
<th>Year</th>
<th>AADF</th>
<th>Peak DF</th>
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<tbody>
<tr>
<td>2018</td>
<td>14.0</td>
<td>21.0</td>
<td>2029</td>
<td>20.7</td>
<td>31.0</td>
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<tr>
<td>2019</td>
<td>14.5</td>
<td>21.8</td>
<td>2030</td>
<td>21.4</td>
<td>32.1</td>
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<tr>
<td>2020</td>
<td>15.0</td>
<td>22.5</td>
<td>2031</td>
<td>22.2</td>
<td>33.3</td>
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<tr>
<td>2021</td>
<td>15.6</td>
<td>23.4</td>
<td>2032</td>
<td>23.0</td>
<td>34.5</td>
</tr>
<tr>
<td>2022</td>
<td>16.1</td>
<td>24.2</td>
<td>2033</td>
<td>23.8</td>
<td>35.7</td>
</tr>
<tr>
<td>2023</td>
<td>16.7</td>
<td>25.1</td>
<td>2034</td>
<td>24.7</td>
<td>37.0</td>
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<td>2024</td>
<td>17.3</td>
<td>26.0</td>
<td>2035</td>
<td>25.5</td>
<td>38.3</td>
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<td>2025</td>
<td>17.9</td>
<td>26.9</td>
<td>2036</td>
<td>26.5</td>
<td>39.7</td>
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<tr>
<td>2026</td>
<td>18.6</td>
<td>27.9</td>
<td>2037</td>
<td>27.4</td>
<td>41.1</td>
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<tr>
<td>2027</td>
<td>19.2</td>
<td>28.9</td>
<td>2038</td>
<td>28.4</td>
<td>42.6</td>
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<tr>
<td>2028</td>
<td>19.9</td>
<td>29.9</td>
<td>2039</td>
<td>29.3</td>
<td>44.0</td>
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</table>

3.6% increase year over year; peaking factor of 1.5
Seasonal Flow Variation

- **Peak summer months**
  - May through September (5 months/161 days)
  - Peak season factor = 1.16

- **Offpeak months**
  - October through April (7 months/204 days)
  - Offpeak season factor = 0.92

- Total treated volume is equivalent in two seasons
- Goal is to replace on May 1 and October 1
Replacement to achieve < 70 ng/L PFAS20

<table>
<thead>
<tr>
<th>Duration/Vessel (Days)</th>
<th>Filtrasorb 400 14,200 BVs</th>
<th>AC1230CX 13,400 BVs</th>
<th>DOWEX PSR-2 148,000 BVs</th>
<th>CalRes 2304 162,000 BVs</th>
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</thead>
<tbody>
<tr>
<td>Year</td>
<td>AADF</td>
<td>Peak SF</td>
<td>AADF</td>
<td>Peak SF</td>
</tr>
<tr>
<td>2018</td>
<td>14.0</td>
<td>16.2</td>
<td>628</td>
<td>541</td>
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<td>2025</td>
<td>17.9</td>
<td>20.8</td>
<td>491</td>
<td>423</td>
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<td>2032</td>
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<td>382</td>
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<td>2039</td>
<td>29.3</td>
<td>34.0</td>
<td>300</td>
<td>259</td>
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<table>
<thead>
<tr>
<th>Frequency ¼ Replacement (Days)</th>
<th>Filtrasorb 400 14,200 BVs</th>
<th>AC1230CX 13,400 BVs</th>
<th>DOWEX PSR-2 148,000 BVs</th>
<th>CalRes 2304 162,000 BVs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>AADF</td>
<td>Peak SF</td>
<td>AADF</td>
<td>Peak SF</td>
</tr>
<tr>
<td>2018</td>
<td>14.0</td>
<td>16.2</td>
<td>157</td>
<td>135</td>
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<tr>
<td>2025</td>
<td>17.9</td>
<td>20.8</td>
<td>123</td>
<td>106</td>
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<td>2032</td>
<td>23.0</td>
<td>26.7</td>
<td>96</td>
<td>82</td>
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<td>2039</td>
<td>29.3</td>
<td>34.0</td>
<td>75</td>
<td>65</td>
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</table>
### Replacement every 720 days (staggered at 180 days)

<table>
<thead>
<tr>
<th>Bed Volumes Treated</th>
<th>Filtrasorb 400 720 days</th>
<th>AC1230CX 720 days</th>
<th>DOWEX PSR-2 720 days</th>
<th>CalRes 2304 720 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>AADF</td>
<td>Peak SF</td>
<td>AADF</td>
<td>AADF</td>
</tr>
<tr>
<td>2018</td>
<td>14.0</td>
<td>16.2</td>
<td>16,300</td>
<td>16,300</td>
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<tr>
<td>2025</td>
<td>17.9</td>
<td>20.8</td>
<td>20,900</td>
<td>20,900</td>
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<td>2032</td>
<td>23.0</td>
<td>26.7</td>
<td>26,800</td>
<td>26,800</td>
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<td>2039</td>
<td>29.3</td>
<td>34.0</td>
<td>34,100</td>
<td>34,100</td>
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</table>

<table>
<thead>
<tr>
<th>PFAS20 Concentration (ng/L)</th>
<th>Filtrasorb 400 14,200 BVs</th>
<th>AC1230CX 13,400 BVs</th>
<th>DOWEX PSR-2 148,000 BVs</th>
<th>CalRes 2304 162,000 BVs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>AADF</td>
<td>Peak SF</td>
<td>AADF</td>
<td>AADF</td>
</tr>
<tr>
<td>2018</td>
<td>14</td>
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<td>85</td>
<td>91</td>
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<td>2025</td>
<td>17.9</td>
<td>20.8</td>
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<td>125</td>
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<td>2032</td>
<td>23</td>
<td>26.7</td>
<td>153</td>
<td>167</td>
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<tr>
<td>2039</td>
<td>29.3</td>
<td>34.0</td>
<td>216</td>
<td>218</td>
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Media Replacement Logistics
Media Changeout

- Food grade dump trucks or multi-compartment tank (MCT) trailers
- Dump trucks commonly used for basins (GAC only)
- MCT trailers commonly used for vessels (GAC and IX)
- Limited to 40,000 lb load; 4 trucks in/out per day
- Vendor provides eduction equipment
- Need pressurized water for sluicing media (250 gpm @ 80 psi min.)
- Need means to collect sluice water draining from transferred media
- Plant operators needed for isolation of equipment and backwashing
Dump Truck – GAC – Unloading Fresh GAC
Dump Truck – GAC – Loading Spent GAC

Spent media being educted into the dump trailer. The two screen openings allow for the water to be drained out of the trailer prior to shipment.

Water from the screened openings can either be discharged directly to the ground or directed via hose to a customer preferred location.
Dump Truck – GAC – Loading Spent GAC
MCT Truck – IX
MCT Truck – IX

Bulk Tanker Installation

Bulk Tanker Removal
Super Sacks – Alternative

Super Sack Eduction Installation

Super Sack Eduction Removal
## GAC

<table>
<thead>
<tr>
<th></th>
<th>Contactors</th>
<th>GAC/Contactor</th>
<th>Trucks Per Contactor (40,000 lb)</th>
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<tbody>
<tr>
<td>Fresh</td>
<td>10</td>
<td>227,000 lb</td>
<td>6</td>
</tr>
<tr>
<td>Spent</td>
<td>10</td>
<td>391,000 lb</td>
<td>10</td>
</tr>
</tbody>
</table>

### Personnel
- Dump Truck Delivery/Removal = 3 to 4 service techs
- MDU/Super Sack = 5 to 6 service techs + 2 forklifts

### Timing
- Deep Bed Contactors – 3 to 4 days per contactor
- Existing Filters – 2 days per filter for GAC; 2 to 3 days extra for sand & gravel
<table>
<thead>
<tr>
<th></th>
<th>Vessels</th>
<th>Resin/Vessel</th>
<th>Super Sacks Per Vessel (42 cf)</th>
<th>Trucks Per Vessel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh</td>
<td>18</td>
<td>790 cf</td>
<td>19</td>
<td>1</td>
</tr>
<tr>
<td>Spent</td>
<td>18</td>
<td>910 cf</td>
<td>22</td>
<td>1</td>
</tr>
</tbody>
</table>

**Personnel**
- MCT Delivery/Removal = 2 service techs
- MDU/Super Sack = 5 to 6 service techs + 2 forklifts

**Timing**
- 1-2 Vessels per day
Existing Media Replacement
Existing Filter Media Replacement

- GAC/sand educted out of filters with water
- Sand/gravel vacuumed or shoveled (requires more effort)
- 1-2 days for GAC + 2-3 days for sand/gravel = 4-5 days per filter
- 4-5 service technicians
- 2-3 dump trucks for GAC
- 3-4 dump trucks for sand/gravel
- 6-7 dump trucks per filter
Existing Filter Media Replacement

GAC Media
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