PROGRESS UPDATE NO. 2

Emerging Contaminants Treatment Strategy Pilot Study

B&V PROJECT NO. 196369

PREPARED FOR

Cape Fear Public Utility Authority

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BLACK & VEATCH

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1.0 Purpose

This document presents the status of ongoing bench- and pilot-scale testing to evaluate the performance of several proposed treatment technologies in their removal of perfluoroalkyl substances (PFASs), including perfluoro-2-propoxypropanoic acid (commonly known as GenX).

2.0 Introduction

PFASs have been detected in the Cape Fear River, which is the source of raw water for the Sweeney Water Treatment Plan (WTP). The Sweeney WTP provides drinking water to Cape Fear Public Utility Authority (CFPUA) customers in the city of Wilmington and New Hanover County in North Carolina.

In response to the detection of GenX and other PFASs in the Cape Fear River and because of concern over potential health effects, CFPUA is proactively investigating the feasibility and effectiveness of PFAS removal technologies. CFPUA is one of the first utilities in the United States to pursue treatment to target removal of these compounds. Initial evaluations performed by Black & Veatch were provided in Technical Memoranda 1 and 2. As a result of those evaluations, bench- and pilot-scale testing of granular activated carbon (GAC) filter media and ion exchange (IX) resins was initiated. The details of the bench- and pilot- scale testing are presented herein.

3.0 Testing and Analysis

Granular activated carbon filter media and ion exchange resin were selected for bench- and pilot-scale testing. Reverse osmosis/nanofiltration was excluded because of much higher life-cycle cost and potential challenges related to disposal of the concentrate, but the technology will be considered if testing of GAC and IX fail to meet testing goals. The following sections provide information on the testing.

3.1 TESTING GOALS

The primary goal of the testing is to establish the adsorption characteristics for PFASs and other contaminants of emerging concern (CECs) on GAC media and IX resin. These characteristics will be used to refine the previous study-related evaluations and identify the most advantageous short- and longer-term treatment strategies for removal of PFASs and CECs at the Sweeney WTP. The data will help define a design basis for full-scale implementation of the selected technology. Ancillary benefits are also being identified as part of the study, such as reductions in total organic carbon (TOC), disinfection byproduct (DBP) formation, and inorganic compounds.

3.2 MEANS AND METHODS

Means and methods for the bench- and pilot-scale testing were included in a previous progress report dated Nov. 3, 2017. Refer to the previous report for details.

CFPUA expanded the list of analyzed components to include additional per- and polyfluorinated components beginning with the November 7, 2017 samples. As a result, some additional components are presented herein that were not included in the previous report.

3.3 GAC INTERIM RESULTS TO DATE

Interim results of the ongoing pilot testing are presented in Table 3-1. All data is reported based on equivalent bed volumes of water treated.

Each GAC test column continues to exhibit gradual breakthrough of TOC and PFASs, led by shorter chain per- and polyfluorinated compounds. Each GAC media is exhibiting chromatographic peaking, which is the preferential adsorption of one molecule over another. As a result, shorter carbon chain molecules are being released by the GAC into the effluent contributing to greater than 100 percent breakthrough values. Results also continue to show that shorter carbon chains (PFBA, PFBS, GenX, etc.) are not as strongly adsorbed on the GAC media as the longer carbon chain molecules (PFDA, PFOS).

Table 3-1 Sampling Results as of November 7, 2017

	Column Influent	GAC-1	GAC-2	GAC-3	GAC-4	IX-1	IX-2
Bed Volumes	---	13,500	13,700	14,000	14,100	62,500	62,500
Empty Bed Contact Time (min)	---	10	10	10	10	1.5	1.5
Perfluoroalkyl Carboxylic Acids (PFCAs)	**ng/L**	**Percent Breakthrough**					
PFBA	23-24.3	114	104	114	110	97	91
PFPeA	55.6-58.7	101	102	120	119	70	109
PFHxA	64.5-65.2	83	90	105	110	26	12
PFHpA	42.3-42.6	74	74	98	113	6	ND
PFOA	23.3-23.7	64	70	83	97	ND	ND
PFNA	5.21-6.52	43	49	51	62	ND	ND
PFDA	4.68-5.91	27	31	32	31	ND	ND
PFUdA	ND-0.871	ND	ND	ND	ND	ND	ND
PFDoA	ND	ND	ND	ND	ND	ND	ND
PFTrDA	ND	ND	ND	ND	ND	ND	ND
PFTeDA	ND	ND	ND	ND	ND	ND	ND
Perfluoroalkyl Sulfonates (PFSs)	**ng/L**	**Percent Breakthrough**					
PFBS	5.9-6.31	70	85	95	108	ND	ND
PFPeS	1.32-1.34	68	69	87	90	ND	ND
PFHxS	9.19-9.34	54	59	75	72	ND	ND
PFHpS	ND	ND	ND	ND	ND	ND	ND
PFOS	20.2-21.4	25	27	36	35	ND	ND
PFNS	ND	ND	ND	ND	ND	ND	ND
PFDS	ND	ND	ND	ND	ND	ND	ND
Perfluoroalkyl Sulfonamides (PFSAs)	**ng/L**	**Percent Breakthrough**					
PFOSA	ND	ND	ND	ND	ND	ND	ND

	Column Influent	GAC-1	GAC-2	GAC-3	GAC-4	IX-1	IX-2
Bed Volumes	---	13,500	13,700	14,000	14,100	62,500	62,500
Empty Bed Contact Time (min)	---	10	10	10	10	1.5	1.5
Perfluoroalkyl Ether Carboxylic Acids (PFECAs)	**ng/L**	**Percent Breakthrough**					
PFMOAA*	0.442-0.792	158	126	135	138	148	138
PFMOPrA*	ND	ND	ND	ND	ND	ND	ND
PFO2HxA*	23.8-88.4	106	97	109	120	153	191
PFMOBA*	1.74-2.13	111	110	107	114	75	38
PFO3OA*	12.1-71.7	129	98	123	132	28	30
PFPrOPrA/GenX	28.3-29	113	110	107	114	75	38
PFO4DA*	4.25-32.3	73	75	76	95	2	ND
Other Per- and Polyfluorinated Compounds	**ng/L**	**Percent Breakthrough**					
ADONA	ND	ND	ND	ND	ND	ND	ND
F-53B Major	ND	ND	ND	ND	ND	ND	ND
F-53B Minor	ND	ND	ND	ND	ND	ND	ND
Nafion Byproduct 1*	ND	ND	ND	ND	ND	ND	ND
Nafion Byproduct 2*	4.2-22.6	74	91	75	91	ND	ND
N-MeFOSAA	ND	ND	ND	ND	ND	ND	ND
N-EtFOSAA	ND	ND	ND	ND	ND	ND	ND

* Measurement is considered an estimate as the analytical lab does not have a standard for measurement of this compound.
ND – Not detected

3.4 IX INTERIM RESULTS TO DATE

Interim results of the ongoing pilot testing are presented in Table 3-1. Both ion exchange columns now show breakthrough of several shorter carbon chain molecules before 50,000 bed volumes. Both also appear to show chromatographic peaking for several perfluoroalkyl ether carboxylic acids.

4.0 Discussion

- The bench-scale and pilot testing is ongoing and scheduled to continue through the first quarter of 2018 until testing goals are achieved.
- PFASs are being observed in the pilot GAC media effluent.
  - All columns are exhibiting effluent PFAS concentrations near or above the influent concentration for shorter carbon chain PFASs.
  - Longer carbon chain PFAS molecules continue to be partially removed.
- PFASs are being observed in the pilot IX resin effluent.

  - Both columns are exhibiting effluent PFAS concentrations near or above the influent concentration for a few of the shortest carbon chain PFASs.
  - Longer carbon chain PFAS molecules have yet to show any breakthrough.
- Testing will evolve as data is received to refine short- and long-term treatment strategies.
- Additional pilot columns are being considered for testing of other GAC and IX adsorbents.

5.0 Conclusions/Recommendations

The following conclusions and recommendations can be developed based on the interim testing results.

- Pilot testing is ongoing and should continue in order to fully characterize the performance of GAC and IX technologies for PFAS removal.
- With breakthrough occurring in the current GAC and IX pilot columns, the next round of pilot testing with additional media and longer empty bed contact time is being developed by the team with execution planned in the next few months.
- Additional piloting will create a competitive bidding environment and provide additional design and operating cost information in regard to EBCT. This information will optimize the design to lower operating cost.