

**Fluorochemical Removal by Home Filtration Devices
October 1, 2017**

North Carolina State University
Department of Civil, Construction, and Environmental Engineering
Dr. Detlef Knappe, Professor
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Sampling Information:

Location: Leland, NC 28451
Date: 8/4/17
Time: 8:20am
Sample Collector: John Merrill (NCSU)
Sample Analyst: Zachary Hopkins (NCSU)

Contact Name(s): Withheld
Phone: Withheld
Email: Withheld

Water Provider: H2GO
Primary Source: Northwest WTP (Cape Fear River)

*Treatment System: Culligan Aqua-Clear RO30
*Installation: 7/6/17
*Replacement: N/A
*System Flushing: (1) 8/3/17 – 10:30pm
(2) 8/4/17 – 5:15am

*As reported by location contact

Case Narrative:

On August 4, 2017 two water samples were taken from an undisclosed residence in Leland, NC, including (1) a sample treated by a Culligan Aqua-Clear RO30 reverse osmosis (RO) water treatment system and (2) a sample of untreated tap water. The samples were analyzed for fluorochemicals by liquid chromatography tandem mass spectrometry (LC-MS/MS). Fluorochemicals detected by LC-MS/MS are listed in Table 1. The limit of quantification (LOQ) for this method was 10 ppt (parts-per-trillion); therefore, any concentration below this limit cannot be determined.

As shown in Table 2 and in Figure 1, GenX was measured in the tap water sample at a concentration of 40 ppt; the GenX concentration was below the LOQ (<10 ppt) in the RO-treated water sample. Therefore, the GenX removal efficiency of the tested RO system was >75%. The sum concentration of all fluorochemicals, for which analytical standards are available, was 116 ppt in the tap water sample, and each fluorochemical, for which analytical standards are available, was below the LOQ (<10 ppt) in the RO-treated water sample. As shown in Table 2 and in Figure 2, the summed peak area counts for all targeted fluorochemicals in the tap water sample was 24,758, with the dominant fluorochemicals in the sample being perfluoro-2-methoxyacetic acid (PFMOAA) and Nafion byproduct 2. The summed peak area counts for all targeted fluorochemicals in the RO-treated water sample was 1,215. Therefore, the overall fluorochemical removal efficiency of the tested RO system was 95%. Generally, a larger chromatographic peak area count is associated with a higher concentration.

Table 1. Fluorochemicals detected by LC-MS/MS analysis

Compound	Molecular Weight	Formula	CAS #
Perfluorocarboxylic acids (PFCAs)			
Perfluorobutanoic acid (C4)	214.0	C ₄ HF ₇ O ₂	375-22-4
Perfluoropentanoic acid (C5)	264.0	C ₅ HF ₉ O ₂	2706-90-3
Perfluorohexanoic acid (C6)	314.1	C ₆ HF ₁₁ O ₂	307-24-4
Perfluoroheptanoic acid (C7)	364.1	C ₇ HF ₁₃ O ₂	375-85-9
Perfluorooctanoic acid (C8)	414.1	C ₈ HF ₁₅ O ₂	335-67-1
Perfluorononanoic acid (C9)	464.1	C ₉ HF ₁₇ O ₂	375-95-1
Perfluorodecanoic acid (C10)	514.1	C ₁₀ HF ₁₉ O ₂	335-76-2
Perfluorosulfonic acids (PFSA)			
Perfluorobutane sulfonic acid (PFBS)	300.1	C ₄ HF ₉ SO ₃	375-73-5
Perfluorohexane sulfonic acid (PFHxS)	400.1	C ₆ HF ₁₃ SO ₃	355-46-4
Perfluorooctane sulfonic acid (PFOS)	500.1	C ₈ HF ₁₇ SO ₃	1763-23-1
Perfluoroalkyl ether carboxylic acids with one ether group (mono-ether PFECAs)			
*Perfluoro-2-methoxyacetic acid (PFMOAA)	180.0	C ₃ HF ₅ O ₃	674-13-5
Perfluoro-3-methoxypropanoic acid (PFMOPrA)	230.0	C ₄ HF ₇ O ₃	377-73-1
Perfluoro-4-methoxybutanoic acid (PFMOBA)	280.0	C ₅ HF ₉ O ₃	863090-89-5
Perfluoro-2-propoxypropanoic acid (GenX)	330.1	C ₆ HF ₁₁ O ₃	13252-13-6
Perfluoroalkyl ether carboxylic acids with multiple ether groups (multi-ether PFECAs)			
*Perfluoro(3,5-dioxahexanoic) acid (PFO2HxA)	246.0	C ₄ HF ₇ O ₄	39492-88-1
*Perfluoro(3,5,7-trioxaoctanoic) acid (PFO3OA)	312.0	C ₅ HF ₉ O ₅	39492-89-2
*Perfluoro(3,5,7,9-tetraoxadecanoic) acid (PFO4DA)	378.1	C ₆ HF ₁₁ O ₆	39492-90-5
Perfluoroalkyl ether sulfonic acids (PFESAs)			
*Nafion byproduct 2 (Nafion BP2)	463.9	C ₇ H ₂ F ₁₄ O ₅ S	n/a

*No available authentic analytical standard

Table 2. Concentrations and chromatographic peak area counts of fluorochemicals

	GenX	Fluorochemicals with analytical standards	All fluorochemicals
Tap Water	40 ppt	116 ppt	24,758 peak area counts
RO Treated Water	<10 ppt	<10 ppt	1,215 peak area counts

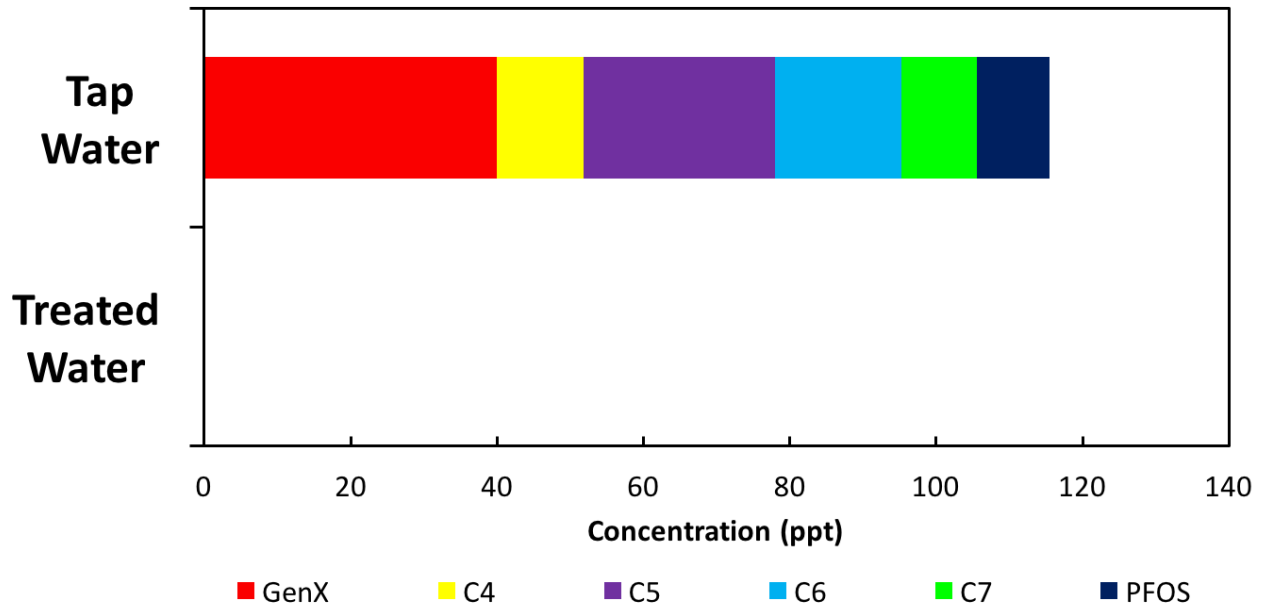


Figure 1. Concentrations of fluorochemicals with analytical standards. Only fluorochemicals with concentrations above the LOQ (>10 ppt) are presented. (Device: Culligan Aqua-Clear RO30)

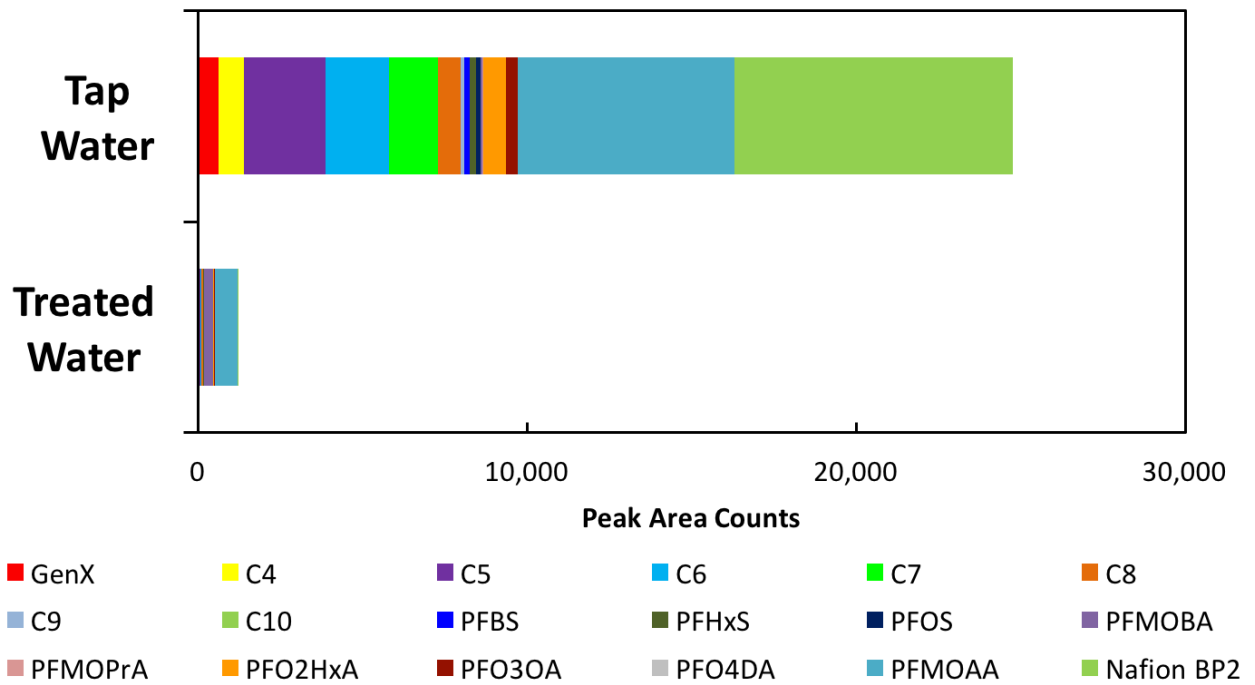


Figure 2. Chromatographic peak area counts for all detected fluorochemicals. (Device: Culligan Aqua-Clear RO30)

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Sampling Information:

Location: 1110 Anchors Bend Way, Wilmington, NC 28411
Date: 8/11/17
Time: 11:05am
Sample Collector: John Merrill (NCSU)
Sample Analyst: Zachary Hopkins (NCSU)

Contact Name: Robert French
Phone: (251) 401-1970
Email: robert.s.french@chemours.com

Water Provider: Cape Fear Public Utility Authority
Primary Source: Sweeney WTP (Cape Fear River)

*Treatment System: Culligan Aqua-Clear (w/ Total Defense Filter)
*Installation: 6/13/17
*Replacement: N/A
*System Flushing: (1) 8/11/17 – 5:00am
(2) 8/11/17 – 8:50am

*As reported by location contact

Case Narrative:

On August 11, 2017 two water samples were taken from 1110 Anchors Bend Way, Wilmington, NC 28411, including (1) a sample treated by a Culligan Aqua-Clear (w/ Total Defense Filter) water treatment system and (2) a sample of untreated tap water. The samples were analyzed for fluorochemicals by liquid chromatography tandem mass spectrometry (LC-MS/MS). Fluorochemicals detected by LC-MS/MS are listed in Table 1. The limit of quantification (LOQ) for this method was 10 ppt (parts-per-trillion); therefore, any concentration below this limit cannot be determined.

As shown in Table 2 and in Figure 1, GenX was measured in the tap water sample at a concentration of 71 ppt; the GenX concentration was below the LOQ (<10 ppt) in the RO-treated water sample. Therefore, the GenX removal efficiency of the tested RO system was >85%. The sum concentration of all fluorochemicals, for which analytical standards are available, was 195 ppt in the tap water sample, and each fluorochemical, for which analytical standards are available, was below the LOQ (<10 ppt) in the RO-treated water sample. As shown in Table 2 and in Figure 2, the summed peak area counts for all targeted fluorochemicals in the tap water sample was 53,925, with the dominant fluorochemicals in the sample being perfluoro-2-methoxyacetic acid (PFMOAA) and Nafion byproduct 2. The summed peak area counts for all targeted fluorochemicals in the RO-treated water sample was 1,711. Therefore, the overall fluorochemical removal efficiency of the tested RO system was 97%. Generally, a larger chromatographic peak area count is associated with a higher concentration.

Table 1. Fluorochemicals detected by LC-MS/MS analysis

Compound	Molecular Weight	Formula	CAS #
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Perfluorobutanoic acid (C4)	214.0	C ₄ HF ₇ O ₂	375-22-4
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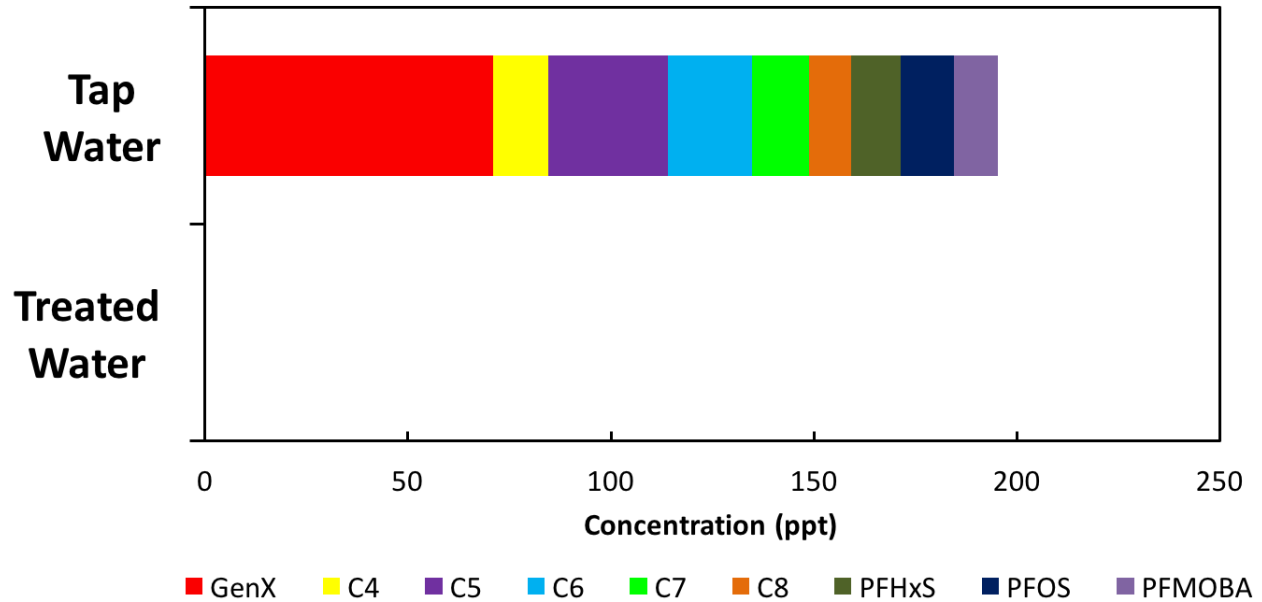


Figure 1. Concentrations of fluorochemicals with analytical standards. Only fluorochemicals with concentrations above the LOQ (>10 ppt) are presented. (Device: Culligan Aqua-Clear w/ Total Defense Filter)

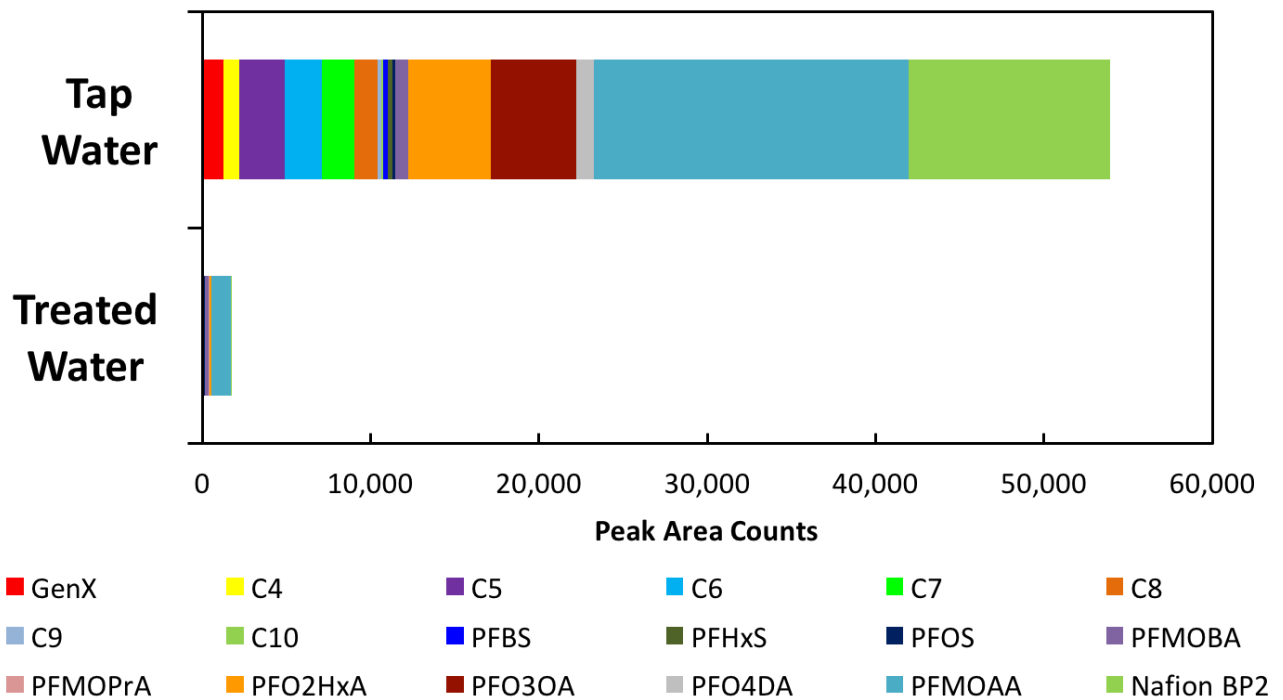


Figure 2. Chromatographic peak area counts for all detected fluorochemicals. (Device: Culligan Aqua-Clear w/ Total Defense Filter)