January 11, 2018

VIA E-MAIL

Mr. Michael Scott
Director
Division of Waste Management
North Carolina Department of
Environmental Quality

Re: The Chemours Company FC, LLC ("Chemours") Plan to Install Granular Activated Carbon Treatment on Residential Drinking Water Wells

Dear Mr. Scott,

As requested, please find enclosed Chemours' plan for installing and maintaining granular activated carbon ("GAC") treatment units on residential drinking water wells in proximity of Chemours' Fayetteville, North Carolina facility ("Fayetteville Works"). Eligible wells to be included in this program are those wells in primary residential drinking water service from which either Chemours or the North Carolina Department of Environmental Quality ("DEQ") has analyzed samples and detected C3 dimer acid (CASRN 13252-13-6) at or above the North Carolina Department of Health and Human Services' provisional health goal of 0.14 µg/L (140 ppt) (for convenience, hereinafter referred to as "Affected Wells").

As you are aware, Chemours has been conducting a continuing residential wells sampling program, in consultation and cooperation with DEQ, to identify any exceedances of the provisional health goal, and has been providing free bottled water to residents, both while their sampling results are pending and thereafter if their results are at or above the provisional health goal. The purpose of the enclosed plan is to move expeditiously to relieve homeowners of the inconveniences associated with using bottled water by installing proven technology that will remove C3 dimer acid, thus enabling them to resume using their well water without any concern for the presence of C3 dimer acid exceeding the health goal.

As set forth in the enclosed Implementation Plan, Chemours plans to make unconditional offers to each Affected Well owner to install, operate, and maintain GAC treatment units. A copy of the prospective correspondence to such owners is also enclosed. As indicated, Chemours will install, operate, and maintain these GAC treatment units at its own cost and expense, free of any costs, burden or liability to these residents. All systems will be field tested at each location to validate the effectiveness of the treatment to remove any unacceptable levels of C3 dimer. The program will extend to both Affected Wells identified to date and any residential drinking water wells determined in the future to contain water that equals or exceeds the provisional health goal. The Company is continuing to extend its sampling investigation in accordance with its ongoing consultations with DEQ; and our plan going forward also includes further sampling for those wells that to date have tested *below* the health goal, but above 100 ppt, for three additional sampling rounds on a quarterly basis, to verify that they do not constitute Affected Wells.

The enclosed Implementation Plan includes detailed results of the pilot testing program that Chemours performed to verify that GAC treatment is fully effective for the purpose required. These systems have proven effective in treating polyfluorinated compounds ("PFCs") at other facilities within the United States and in the in-situ pilot testing conducted near the Fayetteville Works in which the specific PFC of concern, C3 dimer, was removed. Chemours is confident that the systems are capable of removing C3 dimer acid to or below the level of detection, which is 2 orders of magnitude lower than the health goal, and will meet the health goal when put into routine operation and properly maintained. We believe strongly that no additional pilot tests are necessary before we can and should begin offering GAC treatment units to every Affected Well owner, so they can be freed of the constraints or inconveniences of bottled water, about which we have heard expressions of weariness from residents.

That said, Chemours also has been informed by DEQ that some members of the community might be skeptical of the efficacy of these units because the in-situ pilot testing was done on only 1 well, owned by a Chemours employee. We assure DEQ and our neighbors that the pilot test results are absolutely accurate, representative and reliable. Our program puts no one at risk (except, conceivably, Chemours): we will continue supplying bottled water as we have been, until *after* validation testing at that specific location, the results of which (certified laboratory analyses of both pre-treatment and post-treatment well water) will be shared immediately upon receipt with both the resident and DEQ. Chemours is so confident that these systems will perform excellently that it will undertake the expense of purchasing, installing and testing the systems with the explicit understanding and agreement that Chemours will -- at its sole cost and obligation -- remove the systems and return the Affected Well owner's property to its pre-installation condition, if any system fails to meet the objective of C3 dimer acid removal. Further, all units will be maintained and operated by Chemours on a timetable that insures that new carbon is installed before, under the circumstances of each owner's respective well water use, the system might begin to lose its effectiveness in eliminating exceedances of the health goal.

Chemours plans to commence contacting these affected residents January 22, 2018 and to begin shortly thereafter installing GAC treatment units pursuant to the enclosed Plan at each location whose owner accepts the unconditional offer. Accordingly, Chemours respectfully requests that DEQ review and provide its comments, if any, on the enclosed materials before that date, so that installation of these systems as an alternative to bottled water is not further delayed for any residents who want them. The Company will continue to provide bottled water to those owners of Affected Wells who decline the offer or wish more time to consider it.

One final matter we wish to address summarily here, in addition to addressing it in the enclosed Implementation Plan. Questions have been raised about the possibility that other PFCs might be present at low levels in off-site groundwater drawn from the Affected Wells. We have, as DEQ knows, conducted analyses for certain other PFCs (i.e., those for which reliable analytical methods have been established); and the results of those analyses have been furnished timely to DEQ. That sampling indicates that very few other PFCs that might arguably be associated with operations from the Chemours facility are found in off-site groundwater impacted by C3 dimer. As explained in detail in the Implementation Plan, the levels detected of those other compounds were in the same range (in one case) or lower than C3 dimer. Further, the post-treatment analyses of those samples confirm that the GAC units are capable of removing those PFCs as well (down to or below the level of detection under established, validated analytical methods). Chemours therefore believes that the GAC units will remedy any other such PFC contamination attributable to plant operations, even in the absence of any health goal or other standard against which to judge whether the trace levels found are of potential concern. Nonetheless, our Implementation Plan includes a cooperative sampling verification program subject to NCDEQ review to confirm GAC units' effectiveness in removing these other measurable PFCs, to further validate this beneficial finding.

Please contact me at your earliest convenience with any questions, comments or concerns with this next step in Chemours' program to address off-site groundwater concerns or the enclosed materials supporting it.

Thank you.

Sincerely,

Kevin P. Garon
Project Director
Chemours Corporate Remediation Group

Enclosures

cc: Bill Lane, North Carolina Department of Environmental Quality
Linda Culpepper, North Carolina Department of Environmental Quality
Francisco Benzoni, North Carolina Department of Justice
Amy H. Cannon, Cumberland County
Greg Martin, Bladen County

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January 11, 2018 ***via email: Kevin.Garon@Chemours.com***

Mr. Kevin P. Garon
Principal Project Director
Chemours Corporate Remediation Group

Subject: Carbon Implementation Plan – Chemours Fayetteville

Dear Mr. Garon,

Parsons is collaborating with Chemours to establish a Carbon Implementation Plan to treat polyfluorinated compounds (PFCs) in residential well water. The Carbon Implementation Plan is presented herein. Attachments to this plan include (1) reporting of supporting laboratory carbon studies performed by Parsons; (2) a residential private well questionnaire developed by Chemours; (3) an Operations and Maintenance (O&M) agreement form by Chemours; and (4) example letters to homeowners from Chemours.

This Plan contains two parts. Part I discusses the effectiveness of Granular Activated Carbon (GAC) treatment of PFCs, including results of laboratory and pilot testing of the treatment of impacted residential drinking water supplies nearby Chemours' Fayetteville, North Carolina facility ("Fayetteville Works"). Part II provides Chemours' plan to provide GAC treatment units for residential drinking water supplies nearby the Fayetteville Works where Chemours or the North Carolina Department of Environmental Quality ("DEQ") have detected C3 dimer acid (CASRN 13252-13-6) at or above the North Carolina Department of Health and Human Services' provisional health goal of 0.14 µg/L (140 ppt).

PART I: EFFECTIVENESS OF GAC FOR C3 DIMER ACID TREATMENT

As discussed further below, GAC treatment has proven effective in treating PFCs both at other sites in the United States and in laboratory and pilot tests of residential drinking water supplies near the Fayetteville Works.

Potential Utility of GAC

GAC treatment has been utilized throughout the United States — and is a proven technology — to treat PFCs. Illustrative examples include, but are by no means limited to:

- The New Jersey Drinking Water Quality Institute (DWQI) recommends GAC or an equally efficient technology for removing PFCs including perfluorooctanoic acid (PFOA), perfluorooctanoic sulfide (PFOS), and perfluornonanoic acid (PFNA), detected above DWQI-recommended Maximum Contaminant Levels (MCLs) ("Recommendations for Perfluorinated Compound Treatment Options for Drinking Water," New Jersey Drinking Water Quality Institute, Treatment Subcommittee, June 2015; available at http://www.nj.gov/dep/watersupply/pdf/pfna-pfc-treatment.pdf).
- The American Water Works Association (AWWA) indicates removal efficiencies using granular or powdered activated carbon of ≥ 90% for PFOA, PFOS, and PFNA for a variety of applications, including households. ("Perfluorinated Compounds: Treatment and Removal"; available at: https://www.awwa.org/Portals/0/files/resources/water%20knowledge/rc%20healtheffects/AWWAPFCFactSheetTreatmentandRemoval.pdf)

- GAC effectiveness was demonstrated in studies evaluating removal of PFCs from municipal drinking water in Hoosick Falls, New York and has been successfully applied for removal of PFCs from residential (e.g., South New Jersey) drinking water supplies and industrial wastewater / groundwater (e.g., Parlin, New Jersey; Parkersburg, West Virginia).

Evaluation of GAC for C3 Dimer Acid Treatment

In light of GAC treatment's effectiveness for treating a range of PFCs elsewhere in the United States, Chemours undertook laboratory and pilot tests of GAC treatment for C3 dimer acid and other PFCs to evaluate the technology's effectiveness in treating residential drinking water supplies near the Fayetteville Works and to determine the rates at which the GAC media is used up. As discussed below and in greater detail in the attached Technical Memorandum (Attachment 1), these tests confirm that GAC treatment is effective in treating C3 dimer acid and other PFCs in these water supplies to remove these compounds down to or below their respective levels of detection, well below the provisional health goal for C3 dimer acid and any reasonably foreseeable remediation or health goals, should any be established for one or more of these other PFCs in the future.

Chemours installed a North American Aqua Environmental, Inc. WHS-400 GAC adsorption system consisting of dual carbon contactors at a residence near the Fayetteville Works where untreated well water testing indicated C3 dimer acid to be present at concentrations averaging approximately 800 ppt. These levels were consistently among the highest levels regularly detected in the off-site groundwater investigation that Chemours has undertaken in the vicinity of Fayetteville Works, and within a factor of two of the single highest concentration measured. The purpose of the installation was to provide an opportunity to verify and troubleshoot application of GAC for removing C3 dimer acid in residential water systems which represented an elevated influent C3 dimer acid concentration. The GAC used in this system was Calgon Filtrasorb® 600 GAC (F600 GAC).

To provide a basis of evaluation, Parsons analyzed the effectiveness of F600 GAC for removing C3 dimer acid from residential well water through performance of bench-scale laboratory carbon adsorption studies, including (1) isotherm testing, and (2) column testing. Technical details are provided in Attachment 1 of this report. Testing summaries are presented in this section.

Isotherm Testing. The objective of isotherm testing was to determine the general adsorptive capacity of F600 GAC for removing C3 dimer acid from residential well water. Testing was performed by spiking C3 dimer acid into a batch of well water and then adding the spiked well water to a series of bottles each containing different amounts of pulverized and sieved (#325) F600 GAC. After mixing for at least 24 hours, the treated water from each bottle was filtered and analyzed for the concentration of C3 dimer acid remaining in solution (C_e). These results were used as follows:

- The "x/m" ratio (mass of C3 dimer acid adsorbed divided by mass of carbon) was calculated for each bottle.
- The x/m values were plotted against the corresponding C_e values to generate a Freundlich adsorption isotherm of the form $x/m = K_f C_e^{1/n}$, where K_f and 1/n are the Freundlich isotherm parameters.
- The results for K_f and 1/n were used to estimate the adsorption capacity of F600 GAC to treat C3 dimer acid to or below the provisional State health goal per NCDHHS of 0.14 µg/L (140 ppt).
- The adsorption capacity was used to calculate the rate of GAC utilization *under equilibrium conditions* based on the reported C3 dimer acid influent concentration of 0.8 µg/L (800 ppt).

Two tests were performed, each at different spiked C3 dimer acid concentrations. The results of this testing and calculations are summarized in Table 1.

Table 1. Isotherm Test Results Summary for C3 Dimer Acid Adsorption on Filtrasorb® F600

Test	C3 Dimer Acid Spike (mg/L)	Freundlich Model Results		F600 Adsorption Capacity at Provisional State Health Goal of 0.14 µg/L	F600 Utilization At Equilibrium
		K_f	1/n		
A	0.25	9.9	0.34	0.50 mg / g GAC	1.1 lb./100,000 Gal
B	2.0	11.6	0.42	0.29 mg / g GAC	1.9 lb./100,000 Gal

Bench-Scale Column Testing. A bench-scale column test was also performed to capture breakthrough of the C3 dimer acid "wave front" under typical flow conditions to estimate actual GAC utilization as water passes through a column bed. Two 1-in diameter Pyrex columns were set up in series, including a "short" lead column (35 g F600 GAC) and "long" lag column (115 g F600 GAC). The GAC was de-aerated by soaking in distilled water, placing the GAC in the column apparatus (held in place by glass wool), ensuring the GAC properly "seated" in the columns, and recirculating distilled water overnight to eliminate air bubbles. A batch of well water was spiked with C3 dimer acid to a final concentration of 123 µg/L and introduced through the columns at a hydraulic loading rate of 2.07 gpm/ft^2. C3 dimer acid samples were collected in column effluent periodically over a 54-hour period. The results and extrapolation to estimated field GAC utilization are summarized in Table 2.

Table 2. Bench-Scale Column Test Results Summary for C3 Dimer Acid Adsorption on Filtrasorb® F600 and Extrapolation to Estimated Field Performance

Bench Column Test Results		Estimated Field Performance (Volumetric Extrapolation)				
Column Study Influent C3 Dimer Acid (µg/L)	EBCVs to Breakthrough(1)	GAC (lb.)	WHS-400 EBCV (ft^3)(2)	Field Influent C3 Dimer Acid (µg/L)	Volume to Breakthrough, Scaled to Field Influent Conc. (gal)	Estimated GAC Utilization (lb. per 100,000 gal)
123	493	200	5.2	0.8	2,900,000	6.8

(1) At health advisory limit of 0.14 µg/L (140 ppt); EBCV of lead + lag column carbon beds.
(2) Individual column; based on 200 lb. F600 GAC and apparent density (tamped) of 0.62 g/cc (38.7 lb./ft^3).

Based on extrapolation of laboratory results to field installation, estimated GAC utilization at a nominal 1 gpm continuous flow under ideal treatment conditions (hydraulic loading rate ≤ 5 gpm/ft^2; no short-circuiting) would be approximately 36 lb. per year. Based on this utilization rate, a carbon unit containing 200 lb. of F600 GAC would be expected under proper treatment conditions and no short-circuiting to provide over 5 years of service before breakthrough at the provisional health goal of 0.14 µg/L (140 ppt) while treating water from this location at an influent C3 dimer acid concentration of 0.8 µg/L (800 ppt).

Field Pilot Study. The residential North American Aqua WHS-400 system installed in the affected area consisted of two (2) WHS-400 contactors configured in series, each containing 200 lb. of Calgon Carbon Filtrasorb® 600 GAC, and was installed after a pre-existing iron filter. Cumulative flow and periodic sampling for C3 dimer acid in the influent, lead column effluent, and lag column effluent was performed periodically after installation.

Monitoring under actual water use demand was performed for a period of 5 weeks following installation, followed by a 5-week period during which a continuous flow of approximately 1 gpm was imposed (for the purposes of accelerating assessment of possible breakthrough).

An average influent C3 dimer acid concentration of approximately 0.8 μg/L (800 ppt) was measured in the untreated water collected from the well during the course of the study. Breakthrough from the lead column at the provisional State health goal of 0.14 μg/L (140 ppt) occurred at approximately 45,000 gallons of flow, resulting in a GAC utilization rate of 440 lb. per 100,000 gal. The field test demonstrated that an installed GAC system was capable of removing C3 dimer acid to well below the provisional State health goal and that verification sampling and regular monitoring would be required to ensure the system is replenished with fresh carbon before the C3 dimer acid has a chance to breakthrough at or above this goal.

In addition to C3 dimer acid, additional PFCs were tracked during field testing. The list of PFCs and summary of analyses are presented in Section 6.3 of the carbon column testing Technical Memorandum (Attachment 1). A majority of the compounds were below detection in influent samples; of the compounds that were measured at detectable levels by an independent certified analytical laboratory (EPA Method 537 – list of 15 PFCs), the levels were considerably below that of C3 dimer acid. Internally-measured Table 3 compounds including perfluoroalkyl ether carboxylic acids (PFECAs) and perfluoroalkyl ether sulfonic acid (PFESA) byproducts indicated a comparable influent concentration and breakthrough of perfluoro(3,5-dioxahexanoic) acid (PFO2HxA). Overall, C3 dimer acid may reliably be utilized as a primarily indicator compound for PFCs along with verification sampling of EPA Method 537 and Table 3 compound lists at a select number of residential GAC installations.

PART II PROPOSED GAC UNIT INSTALLATION.

Based on the comparison of field testing results to the conclusions from bench-scale isotherm and column testing, Chemours will provide residential GAC unit water treatment and/or monitoring to protect drinking water as follows:

- Chemours will offer a residential GAC treatment system to any resident where a the C3 dimer acid concentration in a drinking water well on their property exceeded 0.14 μg/L (140 ppt) based on analysis conducted by Chemours or DEQ, including analyses conducted as part of Chemours' ongoing residential well sampling program undertaken in consultation with DEQ.
- For residences whose C3 dimer acid analytical result showed between 0.10 and 0.139 μg/L (100 and 139 ppt) in a drinking water well, Chemours will sample quarterly for one-year (4 rounds); and if any such subsequent result exceeds 0.14 μg/L (140 ppt), GAC will be offered to those residents as well.
- Chemours will call and/or visit each resident where an offer will be made and fill out a design questionnaire (Attachment 2), walk the property and get owner input on where to install the system, present pictures of the sheds and offer direction on where the shed could be placed by the resident/owner.
- Chemours will present the resident/owner with an O&M agreement (Attachment 3) and retain signatures of approval; Chemours will explain the operation and benefits of the treatment system, but will not seek to persuade any resident/owner that they should accept the offer of GAC treatment if they are disinclined to do so, and will make clear that Chemours will continue to provide them bottled water, free of charge, if they prefer.

- Chemours will schedule a time convenient to the owner/resident to install the system. Installation will be performed only by licensed plumbers.

Chemours will begin offering such residences GAC treatment units starting on January 22, 2018. Example letters to be sent to homeowners/residences are provided in Attachment 4.

SAMPLING AND MAINTENANCE PLAN

GAC Treatment System Description and Installation

The GAC systems considered for application to residences across the affected area are the North American Aqua Environmental, Inc. WHS-400 systems. Each system will consist of two (2) contactors in series. In the event of limited space (for example, crawl spaces with height limitations), smaller WHS-200 units may be considered.

The GAC units operate under the normal water supply pressure. Flow enters through the top of each unit and down through the carbon bed in each column. The flow is distributed axially across the column at the top. Water proceeds down through the GAC bed to a collector at the bottom of the column, from which the water proceeds through a transfer line up through and out of the column.

Specifications for the North American Aqua Environmental, Inc. WHS-200 and WHS-400 units are provided as an attachment to the Carbon Implementation Plan. Select specifications are listed in Table 3.

Table 3. WHS-200 and WHS-400 Specifications

Product	WHS-200	WHS-400
Recommended Flow Rate (gpm)	3 – 6	4 – 7
Operating Pressure (psi)	0 – 125	0 – 125
Vessel Material	Fiberglass Reinforced Polyester	Fiberglass Reinforced Polyester
Valving (Brass) (in.)	¾	¾
Piping (Copper) (in.)	¾	¾
Min. Floor Space (in.)	30 x 20	35 x 24
Diameter (in.)	10	13
Overall Height (in.)	35	54
Shipping Weight (lbs.)	258	606
Operational Weight (lbs.)	450	1,091

Installation, Startup, and Operation

The following are the primary installation and startup considerations.

- At the time of initial installation, an iron removal system will be installed ahead of the GAC system. The purpose of the iron removal system is to improve GAC system performance by preventing GAC fouling and to prevent buildup of backpressure which could result in short-circuiting in the GAC units.
- All iron removal and GAC system installation work will be performed by a licensed plumber.

- All systems will be installed and plumbed per manufacturer requirements.
- Start up and charge each new GAC unit per manufacturer recommended procedures, including de-aeration and backwashing.
- After backwashing, the units will be filled slowly during which time the GAC units will be tapped or lightly agitated to make sure the GAC properly seats within the GAC vessels.
- After soaking, backwashing, and seating the GAC, normal flow through the units can proceed.
- Select a Maintenance Concentration of 0.070 µg/L (70 ppt), equal to one-half the provisional State health goal which, if detected in the effluent from the lead column, triggers GAC changeout. Monitor for C3 dimer acid in column effluent to verify successful installation (troubleshooting) and performance monitoring (to determine when carbon needs to be changed out).
- Ensure systems are installed in a manner which prevent backflow or seepage out of the carbon columns.
- Perform and provide to the owner and to DEQ validation analyses of pre- and post-treatment concentrations of C3 dimer acid to confirm, before placing the unit into actual use and resumption of well water use for drinking purposes that the system is performing the treatment as expected and required to insure compliance with the provisional health goal.
- Bottled water will continue to be provided until any unexpected underperformance by the GAC system is corrected or a replacement unit is installed and tested to demonstrate the expected treatment performance.

A field standard operating procedure (SOP) detailing specific steps will be developed subsequent to submission of this Carbon Implementation Plan and prior to commencement of field work, to provide specific installation, startup, and operational technical and logistical assistance for each residential GAC system.

Sampling Schedule

Sampling will be performed for C3 dimer acid, as the governing indicator of PFCs, periodically from the following sampling points at the schedule described below:

- Between iron removal system and lead GAC contactor ("Pre" samples)
- Between the lead and lag GAC contactors ("Mid" samples)
- After the lag GAC contactor ("Post" samples).

Sampling for EPA Method 537 and Table 3 compounds will be performed at four (4) select residences (e.g., North, South, East, and West of the Fayetteville Works) along the same sampling schedule as C3 dimer acid. Chemours proposes to select the specific residences in concert with NCDEQ.

GAC changeout criteria based on sampling results and changeout procedures are described in the next section of this plan.

Sampling will be conducted according to the following schedule for WHS-400 systems:

- Sampling will be performed at the Pre, Mid, and Post sample points two weeks following initial installation, to ensure the system has been properly installed and is successfully treating C3 dimer acid.

- Sampling will be performed at the Mid sampling point every two weeks for an additional two sampling events following initial installation for continued troubleshooting;
- Sampling for GAC system performance and breakthrough monitoring will be performed quarterly at the Mid sampling point assuming verification sampling performed during the troubleshooting period confirms successful installation and startup of the GAC system.
- This sampling schedule will be repeated each time GAC changeout is performed.

A similar sampling plan (schedule and sample points) will be implemented for WHS-200 system installations, except that sampling for GAC system performance and breakthrough monitoring will be performed every 1.5 months following the initial troubleshooting period.

In the event that breakthrough of C3 dimer acid at or above the respective state provisional health goal is detected from the lead column during a given year, more frequent sampling will be instituted at the specific residence where this occurs. If other PFCs from the EPA Method 537 or Table 3 lists are detected above any state provisional health goals for those compounds at the select residences during quarterly sampling, then more frequent sampling and / or sampling at additional residences will be considered.

Samples for C3 dimer acid and EPA Method 537 will be analyzed by Chemours' contract independent certified analytical laboratory. Table 3 analyses will be performed internally. Sample results will be submitted to Chemours' quality assurance / quality control contractor, who will perform the necessary oversight to ensure data quality objectives are met consistent with Chemours' sampling program.

Monitoring for iron removal system performance will rely primarily on residential user reporting of indications of iron buildup including reduced water pressure at fixtures and detection of orange color in water. Based on patterns of iron buildup going forward, a regular iron removal system replacement schedule tailored to each household will be developed to ensure iron buildup does not occur going forward.

Sample Results Reporting

Results of sampling will be reported as follows:

- Results from each sampling event will be provided to homeowners as results are available. Sampling results from initial performance testing of each system will also be provided contemporaneously to DEQ.
- A report will be prepared and submitted to DEQ each quarter summarizing all sampling results by residence. The results will be presented in a spreadsheet containing the residential address, date of GAC system installation, sampling dates, sampling results, and any follow-on activities (e.g., GAC unit replacement). The quarterly report will also include the results of supplemental sampling of wells which have exhibited C3 dimer concentrations between 100 and 139 ppt.

GAC Changeout Criteria

GAC replacement will be the earlier of the following events:

1. When C3 dimer acid is detected at or above 0.070 µg/L (70 ppt; or one-half the health advisory limit) in samples collected between the lead and lag GAC columns; or
2. One-year after installation or previous GAC changeout.

At the time of GAC changeout:

- The lead unit will be removed. The existing Lag unit will be moved to the Lead position;
- The empty Lag position unit will be replaced with a fresh F600 carbon unit. Replacing the Lag unit with fresh carbon provides the most protective water treatment for the residence.

Plan Modification

In the event that the provisional C3 dimer acid health goal of 140 ppt is revised or superseded, this plan may be revised accordingly and as appropriate.

• • •

Parsons appreciates the opportunity to assist Chemours with addressing this very important project. If you have any questions or concerns with this Carbon Implementation Plan, please do not hesitate to contact me.

Sincerely,

Ted Schoenberg, PhD, PE

cc Steve Shoemaker; Chemours
Les Cordone, PE; Parsons
Tracy Ovbey; Parsons
Matthew McGowan; Parsons

ATTACHMENT 1

CARBON COLUMN STUDY TECH MEMO

PARSONS

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TECHNICAL MEMORANDUM

January 11, 2018

To: Kevin P. Garon; Chemours

From: Matt McGowan; Parsons

Subject: Chemours Fayetteville – C3 Dimer Acid Bench Carbon Column Study Results

TECHNICAL SUMMARY

Laboratory testing demonstrated the following utilization rates of Calgon Filtrasorb® F600 granular activated carbon (GAC) for removing C3 Dimer Acid from in-situ well water, based on an influent concentration of 0.8 µg/L (800 ppt) and in reference to the provisional health goal announced in 2017 by the North Carolina Department of Health and Human Services ("DHHS") of 0.14 µg/L (140 ppt):

- Utilization rate at equilibrium (isotherm testing): 1.1 – 1.9 lb. / 100,000 gallons.
- Breakthrough point (column testing): 6.8 lb. / 100,000 gallons.

Field testing of F600 GAC in a North American Aqua Environmental, Inc. WHS-400 system demonstrated removal of C3 dimer acid to non-detect levels; however, the carbon utilization rate based on breakthrough at 0.14 µg/L from the lead column was approximately 440 lb. per 100,000 gallons treated. Potential factors resulting in higher GAC utilization in the field trial compared to that predicted from the laboratory column study include the following:

- Flow conditions: Field testing over the 1st half of the field trial proceeded under actual household demand conditions. Testing over the 2nd half of the field trial proceeded at a continuous flow rate of 1 gpm; the resulting hydraulic loading rate of 1.1 gpm/ft^2 was at the very low end of the acceptable range for industrial-type systems, and was not representative of residential service (intermittent high-demand) for which GAC systems such as the WHS-400 are designed.
- GAC preparation. GAC must undergo thorough wetting / de-aeration, followed by backwashing to remove fine carbon particulates. The GAC must then be properly "seated" in the GAC housings.
- Iron fouling. Significant iron was observed in the influent well water to the GAC units. Iron has the potential to foul GAC and to increase backpressure which can result in short-circuiting.

Factors to optimize performance and reduce breakthroughs include (1) standardized installation, startup, and operating procedures; (2) C3 dimer acid monitoring protocol for initial troubleshooting and on-going performance verification, maintenance, and GAC replenishment; and (3) installation and monitoring of effective iron removal systems suitable for household application.

EXECUTIVE SUMMARY

Parsons performed bench-scale carbon column testing of (2,2,3,3-tetrafluoro-2-(heptafluoropropoxy)propionic acid (C3 dimer acid) in November 2017 to estimate GAC utilization under actual flow conditions. Bench-scale column testing results were compared to results of field testing performed by others of a North American Aqua Environmental, Inc. WHS-400 GAC treatment system installed at a residence in the affected area.

Isotherm Testing

Isotherm testing conducted by Parsons prior to laboratory column studies confirmed Calgon Filtrasorb® F600 GAC was effective for treating C3 dimer acid in well water from the area of interest. Isotherm testing was reported in the Technical Memorandum "Chemours Fayetteville – C3 Dimer Acid Carbon Isotherm Study Results" (Appendix A). Application of the Freundlich isotherm model resulted in an estimated adsorption capacity of 0.29 – 0.50 mg C3 dimer acid per g GAC *at equilibrium* to achieve a target treated concentration of 0.14 µg/L (140 ppt). Based on an influent concentration of 0.8 µg/L (800 ppt) based on field testing, estimated GAC utilization at equilibrium of 1.1 – 1.9 lb. / 100,000 gallons water treated was calculated.

Bench Column Testing Procedures

Column testing was performed at Parsons' Syracuse, NY treatability laboratory using well water collected from the same residence and at the same point of collection as water used in the isotherm study. The purpose of column testing was to demonstrate removal of C3 dimer acid and estimate GAC utilization rates based on breakthrough as water flowed through a bed of GAC. Calgon F600 GAC was used in the column study, as had been used in the isotherm study. 1-in diameter Pyrex tubing was used to house the carbon beds. Two columns were operated in series including a short (35 g GAC) lead column and long (115 g GAC) lag column. Distilled water was used to de-aerate the GAC and eliminate bubbles within the column beds to prevent short-circuiting.

A 40-gallon batch of well water was spiked to an added C3 dimer acid concentration of 123 µg/L. The use of a higher test influent concentration (approximately two orders of magnitude higher than the average well water influent concentration of0.8 µg/L measured during field testing) was consistent with standard GAC column testing methodology to compress the duration of the test while providing data scalable to full-scale installations. Influent was pumped from the spiked batch through the beds using a peristaltic pump at a flow rate of 42.8 mL/min, providing a hydraulic loading rate of 2.07 gpm/ft^2. Effluent from both the lead and lag columns was collected at discrete time intervals over a 54-hour period and analyzed for C3 dimer acid by TestAmerica, Arvada, CO.

Bench Column Testing Results

Breakthrough was defined for this study at the provisional State health goal of 0.14 µg/L. Breakthrough of C3 dimer acid occurred at approximately 46 hours from the lag column, or after 493 lead + lag Empty Bed Contact Volumes (EBCVs) had passed. Scaled to an influent concentration of

0.80 µg/L, and based on an EBCV of 5.2 ft^3 for the GAC in a single WHS-400 contactor, the estimated GAC utilization was 6.8 lb. per 100,000 gallons water treated.

Field Results Comparison

Based on the bench column study results and assuming proper installation, startup and operation, each WHS-400 unit filled with 200 lbs. of F600 GAC would be expected to provide an extended period of C3 dimer acid adsorption capacity at the influent concentrations reported to Parsons at typical residential water use estimates. Parsons recommends the installation of two (2) units in series would be a minimum design standard, and regular monitoring to detect for C3 dimer acid breakthrough. Parsons also recommends carbon replacement should be performed when breakthrough is detected at a pre-selected action level (e.g., one-half the provisional health goal) from the lead column.

Field testing of an installed WHS-400 system containing F600 GAC was performed over a 10-week period from September to November 2017. Over this stretch, regular flow monitoring and analysis of C3 dimer acid and other polyfluorinated compounds (PFCs) were performed. The 10-week evaluation included 5 weeks of actual water demand followed by 5 weeks during which a continuous, increased flow rate of 1 gpm was imposed to accelerate the test time table while maintaining a hydraulic loading rate reflective (on the low end) typical of GAC adsorption systems.

The field test demonstrated the ability of the installed system to remove C3 dimer acid to below detection. Breakthrough at the provisional health goal (0.14 µg/L) from the lead column occurred after approximately 45,000 gallons had been treated, or an effective utilization rate of approximately 440 lb. GAC per 100,000 gallons treated. An examination into the potential design and operability factors contributing to the departure between expected versus actual GAC utilization in the installed system highlighted the importance of the following:

- Flow conditions.
    - Field testing over the 1st half of the field trial proceeded under actual household demand conditions. Testing over the 2nd half of the field trial proceeded at a continuous flow rate of 1 gpm; the resulting hydraulic loading rate of 1.1 gpm/ft^2 was at the very low end of the acceptable range for industrial-type systems, and was not representative of residential service (intermittent high-demand) for which GAC systems such as the WHS-400 are designed. During demand, the hydraulic loading rate would be closer to typically recommended.
    - Low hydraulic loading rates can result in short-circuiting.
- Proper GAC preparation during installation and GAC replenishment to prevent short-circuiting, including:
    - Sufficient soaking time to de-aerate the GAC;
    - Backwashing to remove fine carbon particulates from the bed;

  - Prevention of seepage out of carbon beds which can result in preferential flow channels.
- Systematic monitoring of C3 dimer acid following installation and startup including:
  - Short-term troubleshooting monitoring (e.g., biweekly); and
  - Long-term performance monitoring (e.g., quarterly) once stable consistent performance has been established.
- Removal of iron ahead of the GAC units, to:
  - Prevent possible coating of GAC granules which can reduce the amount of carbon available for adsorption; and
  - Prevent backpressure buildup in the GAC units which can potentially result in short-circuiting.

Field testing also confirmed that C3 dimer acid may justifiably serve as the governing indicator compounds driving GAC treatment, monitoring, and maintenance requirements. Additionally, sampling for full EPA Method 537 + PFECA/PFESA scans is recommended in a select number of residences during each sampling event (See Section 6.3).

Recommendations

Based on the findings of the carbon column testing and comparison to field results, the following strategy for installation and startup, monitoring, and carbon replacement is recommended to maximize protection of residents from exposure to PFCs in their domestic water supply, consistent with feasibility of implementation that affords the desired drinking water protection:

- Place a minimum of two (2) WHS-400 contactors in series at each installation.
- Ensure units are installed by properly licensed tradespeople, in a manner which prevents backflow / seepage from the columns when water is not in demand.
- Ensure the GAC is properly de-aerated upon installation by soaking for at least two hours, and backwashing the carbon to remove fine carbon particulates.
- Select a Maintenance Concentration of one-half the health advisory standard which, if detected in the effluent from the lead column, triggers:
  - Replacement of lead column with a fresh column;
  - Movement of the lag unit to the lead position; and:
  - Placement of the fresh column to the lag position.
- Ensure systems are installed in a manner which prevent backflow or seepage out of the carbon columns.

- Monitor for C3 dimer acid as follows following initial installation and startup:
  - Effluent from both the lead and lag carbon units after two weeks;
  - Continued sampling every two weeks of effluent from the lead column for a suitable period (e.g., 2 months);
  - A reduced frequency of performance monitoring (e.g., quarterly) may be warranted pending development of a body of data indicating when breakthrough from the lead column occurs and allowing for continuous improvement in installation and operational procedures.
- Monitor for C3 dimer acid as follows following carbon replenishment (after breakthrough occurs):
  - Effluent from both the lead and lag carbon after two weeks for troubleshooting;
  - Effluent from the lead column after two more weeks for troubleshooting;
  - Resumption of performance monitoring schedule (e.g., quarterly) as warranted from results from post-carbon replenishment troubleshooting sampling.
- Monitor for EPA Method 537 and PFECA/PFESA compound lists at a select number of residential GAC installations alongside C3 dimer acid during each sampling event (troubleshooting and performance / breakthrough monitoring).
- Install and monitor a reliable iron removal system upstream of GAC adsorption to prevent GAC fouling and reduce backpressure which may increase the potential for short-circuiting within the GAC columns.
  - Simple field iron test kits (e.g., HACH) can facilitate field monitoring for iron concentrations. Alternatively, the presence of reduced flow at household fixtures may signal iron buildup in the GAC units.

COLUMN STUDY

1.0 INTRODUCTION

Parsons performed isotherm testing in October 2017 to determine the general adsorptive capacity of Calgon Filtrasorb F600 GAC for C3 dimer acid compound in native groundwater. Milestone concentrations reported to Parsons included an influent concentration of 0.8 µg/L, a provisional State health advisory concentration of 0.14 µg/L, and a method detection limit for C3 dimer acid analysis of 0.010 µg/L. A nominal 1 gpm continuous flow rate was used for GAC utilization calculations.

The isotherm study examined the C3 dimer acid specifically. Other characteristics of the well water which may have affected GAC adsorption performance of C3 dimer acid (i.e., chemical properties; other PFCs potentially present) were implicitly captured since well water from a residence near Chemours' Fayetteville, North Carolina facility ("Fayetteville Works") was sourced for the study. The results of the study were reported in the technical memorandum "Chemours Fayetteville – C3 Dimer Acid Carbon Isotherm Study Results" (Appendix 1). A summary of the results is presented in Table 1-1.

Table 1-1. Isotherm Test Results Summary for C3 Dimer Acid Adsorption on Filtrasorb® F600

Test	C3 Dimer Acid Spike (mg/L)	Freundlich Model Results		F600 Adsorption Capacity at Target Treated C_e	F600 Utilization At Equilibrium(1)
		K_f	1/n		
A	0.25	9.9	0.34	0.50 mg / g GAC	5.8 lb. /year
B	2.0	11.6	0.42	0.29 mg / g GAC	9.9 lb. /year

(1) Based on 1 gpm continuous flow; equivalent to 1.1 lb. /100,000 gal (Test A) and 1.9 lb. /100,000 gal (Test B).

The calculated GAC utilization at equilibrium from the isotherm study would represent ideal contact conditions between water and the F600 GAC. However, by definition, these column study results do not necessarily demonstrate actual levels of adsorption or determination of breakthrough of the C3 dimer acid "wave front" under actual flow conditions.

2.0 COLUMN STUDY OBJECTIVES

The objectives of the bench-scale column study were to:

- Confirm removal of C3 dimer acid (2,2,3,3-tetrafluoro-2-(heptafluoropropoxy)propionic acid) from native groundwater during flow through a bed of Calgon Filtrasorb® F600 GAC.
- Determine when breakthrough of C3 dimer acid in a bed of F600 GAC would be expected, to assist with GAC contactor sizing and GAC monitoring / replacement frequency.

3.0 RAW WATER SAMPLING

Test water for the C3 dimer acid isotherm study was collected at the same point of collection as the residential well water used in the isotherm study. 40-gallons of test water was collected in collapsible plastic carboys and shipped overnight to Parsons' Treatability Laboratory in Syracuse, NY.

4.0 TEST PROCEDURES

4.1 General GAC Column Study Methodology

Groundwater spiked with an appropriate concentration of target compound is pumped through two GAC test beds installed in series. Each test bed is contained within a circular Plexiglass column, held in place with glass wool. An appropriate hydraulic loading rate is applied. Samples for the target compound are collected at discrete time intervals at the outlet of each column to observe progression of the target compound "wave front" and as such capture breakthrough. The influent concentration, flow rate, and timing of breakthrough are scaled to support design including contactor sizing and configuration, and anticipated GAC utilization rates thereby informing an appropriate schedule for monitoring and GAC replacement to prevent breakthrough.

4.2 Specific Test Procedures

Two (2) individual columns fabricated from 1-in ID Plexiglass were arranged in series, including a short-bed column containing 35 g of F600 GAC and a long-bed column containing 115 g F600 GAC. The GAC for each column was pre-rinsed with distilled water to remove fugitive carbon particulates and saturate the carbon pores, then added wet to the column tubes. The carbon was held in place with glass wool and rubber stoppers penetrated with tubing connections. Interconnecting tubing was composed of flexible plastic tubing. A peristaltic pump was used to pump column influent from a reservoir through the columns. Flow proceeded from the bottom to the top of each column. A tee in the line between the lead and lag columns allowed lead column effluent samples to be collected. Lag column effluent samples were collected from tubing leading from the exit stopper of the lag column. Figure 4-1 shows the column study in operation.

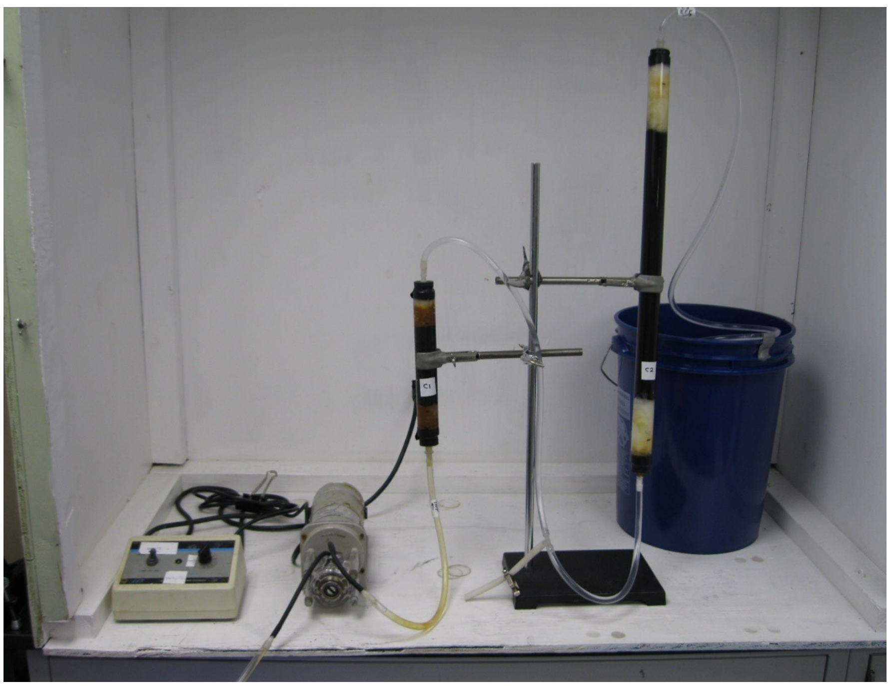

Figure 4-1. Bench-Scale GAC Carbon Study Setup

To prepare the columns, distilled water was pumped once-through to allow the beds to expand to dislodge any remaining carbon particulates and to allow the carbon beds to seat properly. The columns were then packed with glass wool on top, after which the stoppers with connecting tubing were installed. Distilled water was then recirculated through the columns overnight to keep the activated carbon wetted and eliminate residual air bubbles to prevent short-circuiting.

A test batch of approximately 40 gallons of post-screened residential groundwater was spiked with GX 903 (a product received from Fayetteville Works containing a known concentration of C3 dimer acid). Spiking of the 40-gal batch was facilitated by preparing a 1 mg/mL intermediate C3 dimer acid spiking solution. The flow rate was set to 42.8 mL/min, imposing a hydraulic loading rate to the columns of 2.07 gpm/ft^2. Lead and lag effluent samples were collected for C3 dimer acid at several time intervals after the start of the experiment. Column influent was also sampled across the duration of the study. The sampling scheduled from this test is summarized above. Samples for C3 dimer acid analysis were submitted to TestAmerica, Arvada, CO through the Syracuse NY TestAmerica service center.

4.3 Data Evaluation

Bench-scale column test results were used to estimate GAC utilization in installed systems based on the breakthrough results obtained during testing, scaled accordingly to actual installed conditions including an influent C3 dimer acid concentration of 0.8 µg/L, the provisional State health goal of 0.14 µg/L defining breakthrough, and a nominal 1 gpm continuous flow rate.

5.0 RESULTS

Table 5-1 summarizes the raw data obtained from the effluent from each column.

Table 5-1. Column Study Measured C3 dimer acid Analytical Results

Timepoint	Elapsed Time (Hr)	Effluent Concentration (µg/L)	
		Lead	Lag
1	1.0	4.8	< 0.010
2	2.0	9.1	< 0.010
3	4.2	19	< 0.010
4	6.2	32	< 0.010
5	8.0	51	< 0.010
6	13.7	62	< 0.010
7	16.2	75	0.027
8	21.7	75	< 0.010
9	25.5	76	< 0.010
10	30.2	93	< 0.010
11	36.2	96	0.47
12	46.0	92	0.12
13	53.8	98	0.47

An influent concentration of 123 ± 10 µg/L was measured across the duration of the study. Breakthrough from the lead (short) column occurred in less than one hour and is considered an artifact of testing based on the elevated influent test concentration; breakthrough from the lag column at the provisional State health goal of 0.14 µg/L occurred at 46.4 hours. Breakthrough from the lag column is shown in Figure 5-1.

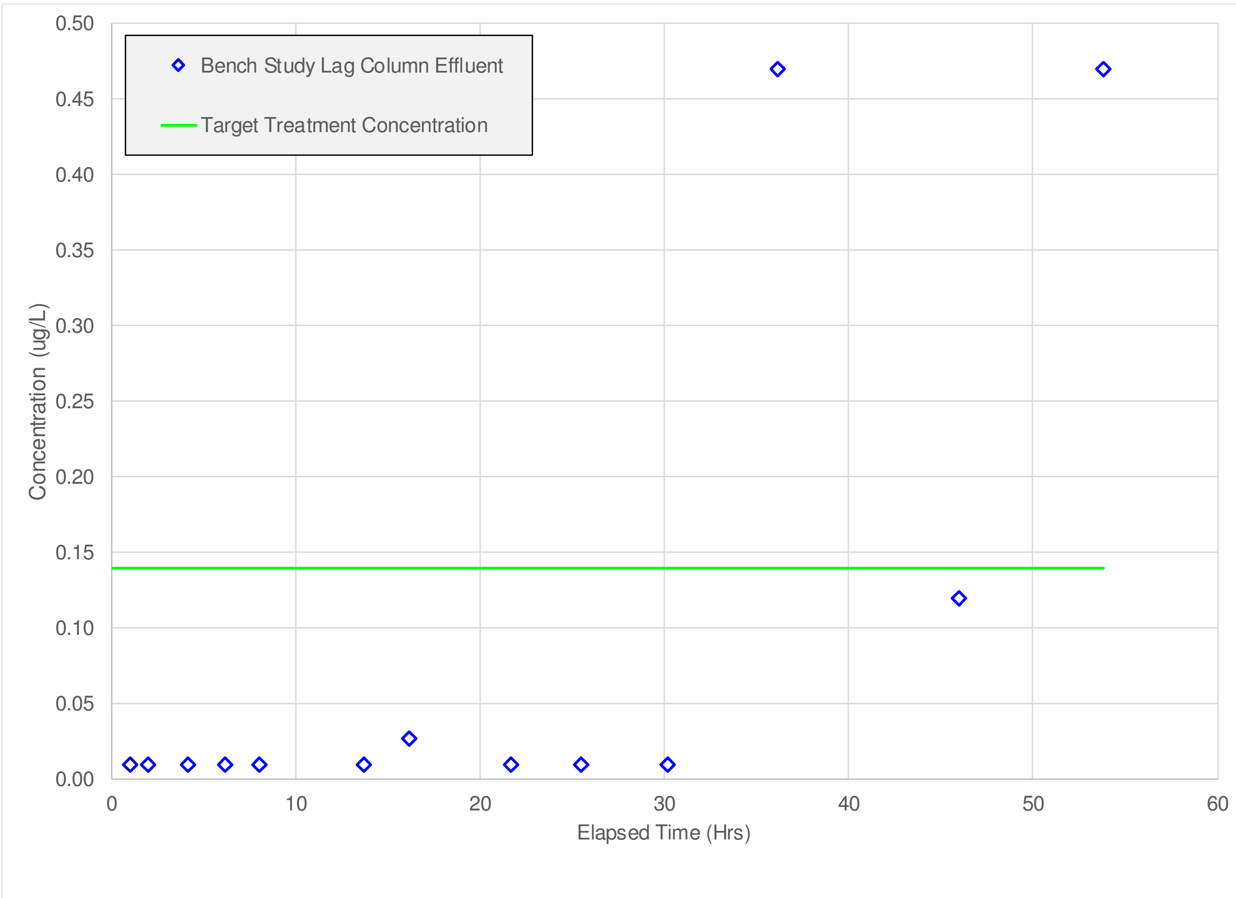

Figure 5-1. Breakthrough Curve in Bench Column Study Lag Column

<u>Carbon Utilization Estimation Based on EBCVs</u>

A conservative estimate for installed carbon utilization was prepared by analyzing the bench column study lead + lag columns collectively as a single column. Based on the collective (lead + lag) empty bed contact volume, approximately 493 EBCVs of flow had passed at the breakthrough time point. The following was used to prepare the carbon utilization estimate:

- Bench-scale EBCV Lead + Lag: 0.0085 ft^3
- F600 Apparent Density (Tamped): 0.62 g/cc = 38.7 lb. /ft^3

- Installed GAC Vessel: North American Aqua WHS-400
    - GAC Mass (one vessel): 200 lb. (per manufacturer technical specification)
    - EBCV (Actual Contact): 5.17 ft^3 (based tamped density per Calgon technical specification and mass of GAC in one vessel)
- Influent Concentrations:
    - Column study: 123 µg/L
    - Field: 0.8 µg/L.

Based on these values, the following estimate was prepared:

- Total Flow: (493 EBCV)(5.17 ft^3/EBCV)(7.48 gal/ft^3)(123/0.8) = 2.9×10^6 gal
- Carbon Utilization = [(200 lb.)/(2.9×10^6 gal)](100,000 gal) = 6.8 lb. per 100,000 gal

At a nominal 1 gpm continuous flow rate:

- Time to Breakthrough = (2.9×10^6 gal)/(1 gpm)(1440 min/d) = 2305 d = 5.6 years
- Carbon Utilization = 200 lb. /5.6 Years = 36 lb. /yr.

6.0 FIELD TESTING EVALUATION

6.1 Comparison of Field Testing to Laboratory Column Study Results

Results from bench-scale testing under controlled laboratory conditions were compared to the results obtain from a field trial conducted at the residence from which water for laboratory testing was collected. The installed system at the residence includes an iron pre-filter (home owner installed) followed by a North American Aqua WHS-400 two-column system, each containing 200 lb. of Calgon Filtrasorb® F600 GAC per product specifications.

Field testing included regular measurements for cumulative flow and for C3 dimer acid concentrations measured in the influent (Pre), Lead unit effluent (Mid), and Lag unit effluent (Post). The cumulative flow and period of analysis included a five-week period of normal water use by the residence followed by a deliberately-applied continuous flow of approximately 1 gpm for five weeks. A plot containing flow monitoring measurements and C3 dimer acid analytical results at all sampling locations is presented in Figure 6-1.

Figure 6-1 shows that measurable C3 dimer acid concentrations (i.e., above the method detection limit of 0.010 µg/L) started occurring in the lead column effluent after approximately 10,000 – 15,000 gallons had flowed through. Following this initial breakthrough, a number of elevated measurements were reported during the 2nd and 3rd weeks of November before settling back to what appears to be the natural breakthrough trend at 11/27/17 (0.077 µg/L) and 11/29/17 (0.44 µg/L). Based on this trend, breakthrough at the lead column (not the lag column) at the provisional State health goal (0.14 µg/L) occurred after approximately 45,000 gallons had been treated. Based on this breakthrough result, GAC utilization was approximately 440 lb. per 100,000 gallons treated, compared to 7.7 lb. per 100,000 gallons predicted from the laboratory column study results.

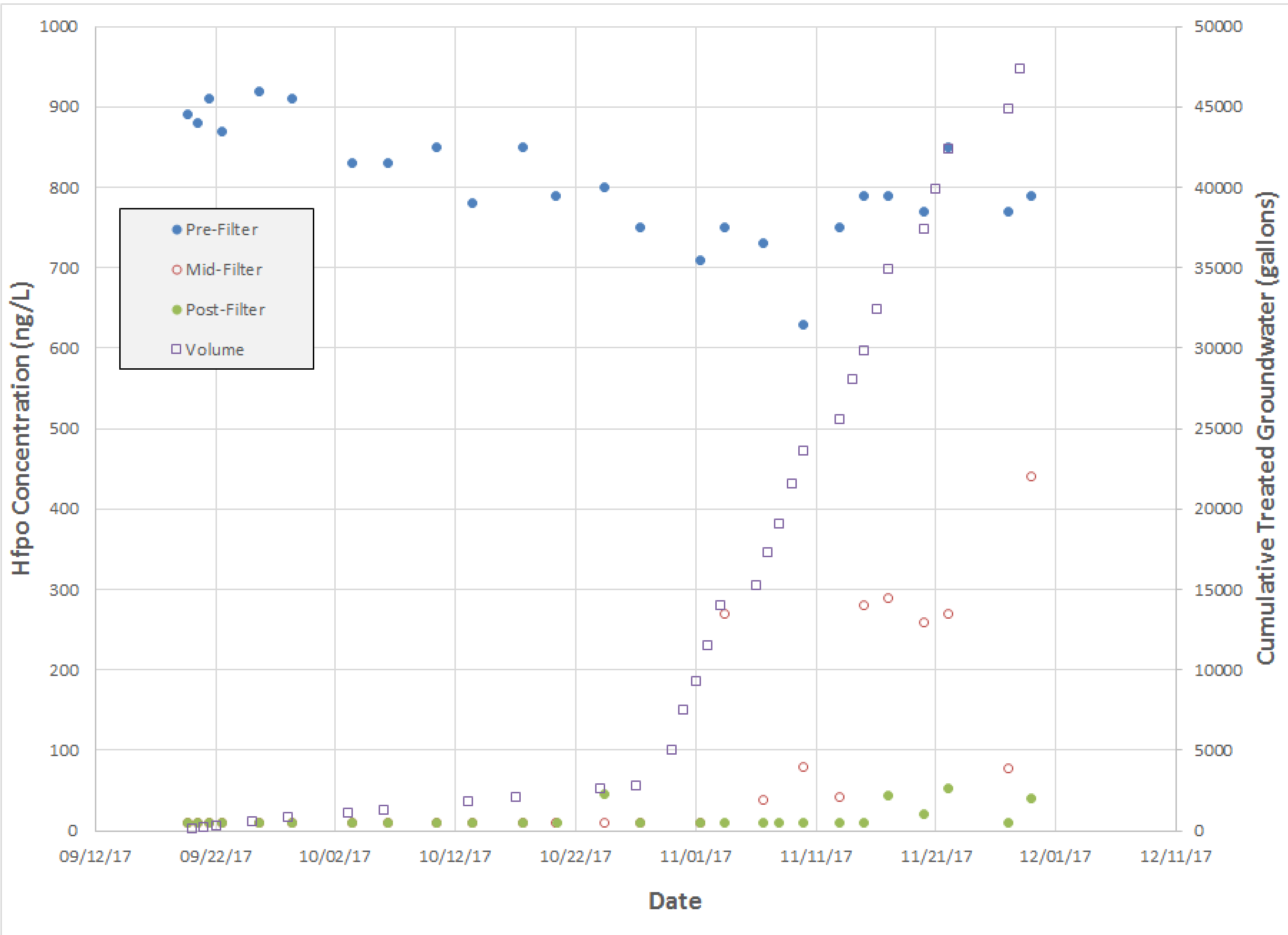

Figure 6-1. Field Trial Results

Lag column effluent (Post) samples were all < 0.010 µg/L until the period of elevated measurements on the same sampling days as occurred in the lead column (Mid) samples, after which values settled back to below detection on 11/27/17. However, a result of 0.040 µg/L was reported for 11/29/17. The reported concentration on 11/29/17 from the Post sample was less than one third the health advisory concentration; however, the appearance of C3 dimer acid in the Post sample after 45,000 gallons is consistent with higher GAC utilization than predicted from the laboratory column study.

The laboratory study represents highly-controlled conditions regarding setup and operation, and regular observation (e.g., for short-circuiting) is greatly enhanced by the use of clear Pyrex tubing. However, the laboratory study also used water from the same residence such that any effects due to characteristics of the well water would have been captured in the laboratory study and as such would not explain the discrepancy.

6.2 Potential Factors Contributing to Departure Between Field and Laboratory Results

Parsons examined design and operability factors which may have resulted in the observed field performance relative to estimates predicted from column testing.

Design. The WHS-400 units are specified by the North American Aqua Environmental, Inc. as follows:

- Diameter: 13-in → Cross-sectional area = 0.92 ft^2
- GAC Mass: 200 lb.
- Bed Depth: 50 in
- Recommended flow rate: 4 – 7 gpm

The units are designed to accommodate intermittent high-flow demand typical of residential water use. The GAC units operate under the normal water supply pressure. Flow enters through the top of each unit and down through the carbon bed in each column. The flow is distributed axially across the column at the top as it flows into the columns. Water proceeds down through the GAC bed and through a basket-like feature at the bottom of the column, from which the water is transferred through a transfer line up through and out of the column. As such, the column represents plug-type flow through the column under pressure when a demand is placed.

Flow during the first 5-week period of field testing was under actual demand conditions. However, a continuous flow of 1 gpm was sustained during the 2nd 5-week period. Based on the cross-sectional area of the carbon units, the hydraulic loading rate during this period was 1.1 gpm/ft^2. This is on the very low end of hydraulic flow rates (1 – 5 gpm/ft^2) typically applied in industrial systems and which the laboratory column study simulated. The relatively low hydraulic loading rate and maintenance of continuous flow through a system designed primarily for intermittent, high demand (during which times the hydraulic loading rate would be more favorable) may have factored into higher utilization due to short-circuiting.

Operability.

Other potential mitigating factors which should be considered going forward in the placement and operation of installed GAC contactors for this application may include the following:

- Ensure GAC is properly wetted / de-aerated, and ensure the GAC properly "seats" within the carbon units. This is vital to prevent short-circuiting.

- Backwash the columns to removal fine carbon particulates. Backwashing may also help seat the GAC properly before normal flow is applied.
- Install a reliable iron removal system upstream of the GAC units, and regularly monitor the iron concentration in the effluent from the iron removal system. Iron carryover into the GAC units has the potential to reduce GAC performance (due to coating) and increase backpressure, which could potentially result in short-circuiting through the GAC units. In the event iron measurements are not feasible, iron buildup may be ascertained through a reduction in flow at household fixtures. Based on the frequency at which reduced flow is detected, a regular iron system maintenance / replacement schedule applicable to each household could potentially be developed.

A Standard Operating Procedure (SOP) outlining specific steps during installation and carbon changeout may alleviate any operational shortcomings. Frequent up-front sampling is recommended which can help troubleshoot and refine operational procedures, which may improve carbon utilization and extend periods between changeouts.

6.3 Other Polyfluorinated Compounds (PFCs)

6.3.1 EPA Method 537 List of 15 Compounds

EPA Method 537 scans were performed by an independent certified analytical laboratory for samples collected from the Pre, Mid, and Post sample points on 11/6/17 and 11/22/17. These dates correspond to approximately 6.5 and 9 weeks, respectively, after the field trial commenced, or approximately 1.5 and 4 weeks after the initiation of a continuous 1 gpm flow stream through the system. Duplicate sampling and analysis were performed at the Post sampling point on 11/22/17. The analyzed compounds and corresponding detection limits are listed in Table 6-1.

Table 6-1. EPA Method 537 Compound List and Detection Limits

Compound	Abbreviation	Method Reporting Limit (µg/L)
N-ethyl perfluorooctane sulfonamidoacetic acid	NEtFOSAA	0.020
N-methyl perfluorooctane sulfonamidoacetic acid	NMeFOSAA	0.020
Perfluorobutanesulfonic acid	PFBS	0.0020
Perfluorodecanoic acid	PFDA	0.0020
Perfluorododecanoic acid	PFDoA	0.0020
Perfluoroheptanoic acid	PFHpA	0.0020
Perfluorohexanesulfonic acid	PFHxS	0.0020
Perfluorohexanoic acid	PFHxA	0.0020

Perfluorononanoic acid	PFNA	0.0020
Perfluorooctanesulfonic acid	PFOS	0.0020
Perfluorooctanoic acid	PFOA	0.0020
Perfluoropentanoic acid	PFPeA	0.0020
Perfluorotetradecanoic acid	PFTeA	0.0020
Perfluorotridecanoic acid	PFTriA	0.0020
Perfluoroundecanoic acid	PFUnA	0.0020

The following provides a summary of results from the sampling and analysis for the EPA Method 537 list of compounds.

- The following compounds were reported above their respective Method Reporting Limit in Pre (influent) samples:
  - PFHpA: 0.0028 – 0.0029 µg/L (2.8 – 2.9 ppt)
  - PFHxA: 0.0040 – 0.0041 µg/L (4.0 – 4.1 ppt)
  - PFPeA: 0.013 µg/L (13 ppt)
  - PFOA: 0.011 – 0.015 µg/L (11 – 15 ppt)
- During the 11/6/17 sampling, all 15 compounds in Table 6-1 were reported below their respective Method Reporting Limit at the Mid and Post sample points.
- During the 11/22/17 sampling, the only compound with values reported above its Method Reporting Limit in Mid and Post samples was PFPeA, as follows:
  - Mid sampling point: 0.010 µg/L (10 ppt)
  - Post sampling point: 0.0034 µg/L (3.4 ppt), respectively.
  - Post sampling point (duplicate): 0.0035 µg/L (3.5 ppt).
- Although PFOS was not detected in the Mid or Post samples on 11/22/17, the duplicate scan indicated a reported value of 0.024 µg/L (24 ppt). This appears to be inconsistent with the absence of PFOS in the Pre (influent) samples collected both 11/6/17 and 11/22/17.
- No other compounds from Table 5-1 were detected in any of the samples collected during these two sampling events.

6.3.2 Table 3 Compounds

Analyses for Table 3 compounds including perfluoroether alkyl carbonic acids (PFECAs) and perfluoroether alkyl sulfonic acids (PFESAs) were performed internally to Chemours for samples collected from the Pre, Mid, and Post sample points on 10/12/17, 11/6/17 and 11/22/17. The analyzed compounds and corresponding detection limits are listed in Table 6-2.

Table 6-2. PFECA and PFESA Compound List and Detection Limits

Compound	Abbreviation	Limit of Quantitation (µg/L)
Perfluoro-2-methoxyacetic acid	PFMOAA	0.21
Perfluoroether alkyl carbonic acid – A	PFECA-A	0.20
Perfluoroether alkyl carbonic acid – G	PFECA-G	0.20
Perfluoroether alkyl carbonic acid – F	PFECA-F	0.20
Perfluoro(3,5-dioxahexanoic) acid	PFO2HxA	0.20
Perfluoro(3,5,7-trioxaoctanoic) acid	PFO3OA	0.20
Perfluoro(3,5,7,9-tetraoxadecanoic) acid	PFO4OA	0.20
C7HF13O7	C7HF13O7	0.20
PFESA Byproduct 1	PFESA_Byproduct 1	0.20
PFESA Byproduct 2	PFESA Byproduct 2	0.20

The following provides a summary of results from the sampling and analysis for the Table 3 compounds.

- PFO2HxA was measured in influent (Pre) samples above its Limit of Quantitation during all three sampling events, at a range of 0.86 – 0.94 µg/L (860 – 940 ppt).
  - Concentrations of PFO2HxA in Mid samples collected on 10/12/17 and 11/6/17 were below the LOQ; the Mid sample collected on 11/22/17 exhibited a concentration of 0.54 µg/L (540 ppt) suggesting breakthrough at the Lead column.
  - Concentration of PFO2HxA in Post samples were below the LOQ for all sampling events, demonstrating this compound did not break through the Lag column at or above the LOQ.
- PFECA-F was tentatively measured above its Limit of Quantitation in influent (Pre) samples collected 10/12/17 and 11/6/17 at 0.36 µg/L (360 ppt), and Mid Sample collected 11/6/17 with a reported concentration of 0.66 µg/L (660 ppt) almost twice the influent sample concentration.
  - Co-elution of an interfering or structurally-similar isomer may have limited ability to quantify this compound.
  - The reported concentration in Post samples was below the Limit of Quantitation from all sampling events. Subsequent sampling on 11/22/17 resulted in reported concentrations below the Limit of Quantitation for the Pre and Mid samples as well.

- PFMOAA was reported in the Mid sample on 11/6/17; however, PFMOAA was below the Limit of Quantitation in influent (Pre) samples during all three sampling events.

In summary, the concentration of C3 dimer acid was comparable to PFO2HxA, which broke through along a similar timeline from the Lead column as C3 dimer acid. Otherwise, C3 dimer acid was the predominant compound relative to all other EPA Method 537 and PFECA/PFESA compounds analyzed. Based on these observed results, the following conclusions have been developed:

- C3 dimer acid may satisfactorily serve as a governing indicator compound driving GAC treatment, monitoring, and maintenance requirements. Additionally, sampling for full EPA Method 537 + PFECA/PFESA scans is recommended in a select number of residences during each sampling event.
- In the event PFO2HxA or other PFECA/PFESA compounds demonstrate breakthrough prior to C3 dimer acid, then utilization of C3 dimer acid as the governing indicator may need to be reassessed.

7.0 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions were developed based on the results of the column study:

- C3 dimer acid in the groundwater matrix is adsorbed effectively onto Calgon Filtrasorb® F600 GAC under flow conditions at typical hydraulic loading rates for carbon contactors.
- Estimated F600 GAC utilization assuming an influent C3 dimer acid concentration of 0.8 µg/L and a provisional health goal of 0.14 µg/L is approximately 6.8 lb. per 100,000 gallons treated.
- A significantly accelerated time to breakthrough was observed during field testing compared to laboratory testing, with carbon utilization of approximately 440 lb. per 100,000 gallons treated observed.
- Field analysis of other PFCs demonstrate removal of all other compounds by GAC and justifies utilization of C3 dimer acid as a governing indicator compound driving GAC treatment, monitoring, and maintenance requirements along with EPA Method 537 and PFECA/PFESA compounds analyzed in a select number of residences during each sampling event.

Parsons has developed the following conclusions and recommendations based on these conclusions plus associated observations from the lab and field.

- Place a minimum of two (2) WHS-400 contactors in series at each installation.
- Ensure units are installed by properly licensed tradespeople, in a manner which prevents backflow / seepage from the columns when water is not in demand.

- Ensure the GAC is properly de-aerated upon installation by soaking for at least two hours, and backwashing the carbon to remove fine carbon particulates.
- Select a Maintenance Concentration of one-half the health advisory standard which, if detected in the effluent from the lead column, triggers:
  - Replacement of lead column with a fresh column;
  - Movement of the lag unit to the lead position; and:
  - Placement of the fresh column to the lag position.
- Ensure systems are installed in a manner which prevent backflow or seepage out of the carbon columns.
- Monitor for C3 dimer acid as follows following initial installation and startup:
  - Effluent from both the lead and lag carbon units after two weeks;
  - Continued sampling every two weeks of effluent from the lead column for a suitable period (e.g., 2 months); and
  - A reduced frequency of performance monitoring (e.g., quarterly) may be warranted pending development of a body of data indicating when breakthrough from the lead column occurs and allowing for continuous improvement in installation and operational procedures.
- Monitor for C3 dimer acid as follows following carbon replenishment (after breakthrough occurs):
  - Effluent from both the lead and lag carbon after two weeks for troubleshooting;
  - Effluent from the lead column after two more weeks for troubleshooting; and
  - Resumption of performance monitoring schedule (e.g., quarterly) as warranted from results from post-carbon replenishment troubleshooting sampling.
- Monitor for EPA Method 537 and PFECA/PFESA compound lists at a select number of residential GAC installations alongside C3 dimer acid during each sampling event (troubleshooting and performance / breakthrough monitoring).
- Install and monitor a reliable iron removal system upstream of GAC adsorption to prevent GAC fouling and reduce backpressure which may increase the potential for short-circuiting within the GAC columns.
  - Simple field iron test kits (e.g., HACH) can facilitate field monitoring for iron concentrations. Alternatively, the presence of reduced flow at household fixtures may signal iron buildup in the GAC units.

The recommended strategy is intended to maximize protection of residents from exposure to C3 dimer acid in their domestic water supply while presenting a feasible course of action to this end. Documentation of the recommended strategy in a procedural document might be prudent.

• • •

Parsons is pleased to assist Chemours on this very important project. To discuss any aspects of this memorandum, please contact Mr. Ted Schoenberg.

cc: Steve Shoemaker; Chemours
Les Cordone, PE; Parsons
Tracy Ovbey; Parsons
Matthew McGowan; Parsons

APPENDIX A

CARBON ISOTHERM STUDY TECH MEMO

PARSONS

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TECHNICAL MEMORANDUM

January 11, 2018

To: Kevin P. Garon; Chemours

From: Matt McGowan; Parsons

Subject: Chemours Fayetteville – C3 Dimer Acid Carbon Isotherm Study Results

EXECUTIVE SUMMARY

Parsons performed isotherm testing in October 2017 to ascertain the general adsorptive capacity of Calgon Filtrasorb® F600 GAC for C3 dimer acid compound in native groundwater matrix. Isotherm testing was performed at Parsons' Syracuse, NY treatability laboratory.

Procedures

Two isotherm studies were set up, at the target spiked C3 dimer acid concentrations indicated:

- Test A: 0.25 mg/L
- Test B: 2.0 mg/L.

Each study included seven (7) 1-quart wide-mouth amber glass test bottles containing pulverized, sieved (#325), and dried Filtrasorb® F600 carbon ranging from 0.05 – 40 g, plus an undosed control. Spiking was performed by preparing a 1 mg/mL spiking solution using GX 903 (product containing C3 dimer acid, provided by Chemours Fayetteville Works), then adding the appropriate volume of spiking solution to an 8-liter batch of site groundwater for each test. Spiked groundwater was added to each isotherm test bottle, allowing some room for mixing. Test bottles were weighed both empty and filled to allow determination of actual experimental GAC doses. Bottles were agitated, placed on a rotary shaker table, and mixed for 24-hours.

After mixing, the test bottles were allowed to settle. The settled decant was filtered using a glass syringe through 1 µm pore size syringe filters into analytical sample containers (2 x 250 HDPE per test bottle). Test samples were submitted to TestAmerica, Arvada, CO for C3 dimer acid analysis.

Results

The Freundlich adsorption isotherm model $x/m = K_f C_e^{1/n}$, where x/m = adsorption capacity at a given equilibrium concentration (C_e), was used to describe the data obtained in each test. Specific adsorption performance (x/m) was calculated for each test bottle and plotted versus the corresponding equilibrium concentration measured by TestAmerica, providing for determination of the Freundlich parameters K_f and 1/n. The adsorption capacity of F600 for C3 dimer acid was then calculated for a target treated concentration (C_e) equal to the state provisional health goal of 0.14 ug/L, using the calculated Freundlich parameters. The results are presented in Table E-1. The calculated capacity between tests showed generally good agreement (within a factor of 2).

Table E-1. Isotherm Test Results for C3 Dimer Acid Adsorption on Filtrasorb® F600

Test	K_f	1/n	F600 Adsorption Capacity at Target Treated C_e (1)
A	9.9	0.34	0.50 mg / g GAC
B	11.6	0.42	0.29 mg / g GAC

(1) 0.14 µg/L

Based on these results, the resulting amount of GAC which would be required assuming an influent C3 dimer acid concentration of 0.8 µg/L would be approximately 1.1 – 1.9 lb per 100,000 gallons treated. For comparison, rough estimated usage for benzene would be at the high end of this range and toluene at the low end based on select studies performed by Parsons for other applications (in which considerable competitive sorption was present).

The reported adsorption capacities do not capture the wave front through the GAC, so the actual GAC required may be significantly higher. This can be optimized through proper column design (e.g., two columns in series to increase GAC utilization) and periodic monitoring from after both the lead and lag beds to ensure carbon is replaced before breakthrough from the lag bed can occur.

1.0 STUDY OBJECTIVE

The objective for this study was to determine the general adsorptive capacity of Calgon Filtrasorb F600 GAC for C3 dimer acid compound in native groundwater matrix. The influent concentration based on residential field testing was approximately 0.8 µg/L. A target treated concentration of 0.14 µg/L was selected based on the state provisional health goal per North Carolina Department of Health and Human Services (NCDHHS). The analytical limit for C3 dimer acid was 0.010 µg/L.

2.0 RAW WATER SAMPLING

Test water for the C3 dimer acid isotherm study was collected downstream from an existing pre-filtration system at a residence in the area of interest. 5-gallons of test water was collected in individual one-gallon plastic bottles and shipped overnight to Parsons' Treatability Laboratory in Syracuse, NY.

3.0 TEST PROCEDURES

3.1 General GAC Adsorption Isotherm Methodology

Standard GAC adsorption protocol was used. The isotherm study was conducted by adding different amounts of pulverized and sieved GAC to a series of identical test samples containing groundwater spiked to an appropriate concentration with target compound. The concentration of target compound remaining in solution (equilibrium concentration, C_e) at each GAC dose following a period of mixing (e.g., 24-hours) was measured. The amount of target compound adsorbed (x) was calculated at each dose (m); x/m was then calculated at each dose and plotted versus the corresponding C_e values to generate the Freundlich adsorption isotherm. Performance of the study using residential well water accounted for matrix background effects that may have affected adsorption performance (versus performance in pure water).

3.2 Specific Test Procedures

Two individual tests were performed. For each test, an 8-liter batch of site groundwater was spiked using GX 903 (product containing C3 dimer acid compound, provided by Chemours Fayetteville Works) to the following target spiked concentrations:

- Test A: 0.25 mg/L (250 µg/L)
- Test B: 2.0 mg/L (2,000 µg/L)

These target concentrations were on the order of 250 and 2,000-fold higher than the influent concentration reported to Parsons, to provide sufficient “relief” for measuring adsorption performance.

A spiking solution (1 mg/mL) was prepared to facilitate spiking of batch groundwater. The 1 mg/mL spiking solution was prepared by diluting GX 903 at 1.539 mL per liter based on measured GX 903 product density of 1,625 mg/mL and 40% of GX 903 product as C3 dimer acid as reported to Parsons. Spiking of the test batches was then performed by adding the 1 mg/mL spiking solution at the rate of 2 mL and 16 mL per 8L test batch for Tests A and B, respectively.

The spiked groundwater water was added to a series of eight (8) clean 1-quart wide-mouth amber glass bottles each containing a different mass of pulverized, sieved (325 mesh), and dried (105°C) Filtrasorb 600 GAC, including a control bottle containing no GAC to account for losses no attributable to GAC adsorption. The target GAC doses ranged from 0.05 – 40 g/L. The bottles were weighed (1) empty and (2) after adding GAC and test water to determine exact test volumes and thereby calculate actual experimental GAC test doses. The bottles were capped and vigorously shaken for one minute, then placed on a table-top rotary mixer for at 24 hours.

After mixing, the bottles were removed from the shaker and allowed to settle for at least one hour. Treated water from each test bottle (including control) was collected using a glass syringe fitted with 1 µm pore size syringe filters to remove residual pulverized GAC from suspension, and transferred into unpreserved HDPE sample bottles (2 x 250 mL for each test bottle). The filtered samples were submitted through the Syracuse, NY TestAmerica service center for analysis at the Arvada, Colorado TestAmerica facility. Samples from Test A were also collected and analyzed for chemical oxygen demand (COD) by Parsons using a HACH test kit to assess the degree of potential interference (competitive adsorption) attributable to background organic content.

3.3 Data Evaluation

The Freundlich model was used to interpret isotherm data upon receipt of equilibrium concentration data from TestAmerica. The Freundlich model relates the equilibrium concentration of the adsorbate (target compound) to the mass of adsorbate that is adsorbed to the carbon as follows:

$$\frac{x}{m} = K_f C_e^{1/n} \qquad \text{Equation 1}$$

where: x/m = mass of adsorbate per mass of adsorbent

C_e = equilibrium concentration of adsorbate in solution after adsorption

K_f = empirical constant

n = empirical constant.

The parameters K_f and $1/n$ were calculated through logarithmic linearization of Equation 1 and linear, least-squares graphical analysis, as follows:

$$Log\left(\frac{x}{m}\right) = LogK_f + \frac{1}{n} LogC_e \qquad \text{Equation 2}$$

Equation 2 is in the form of a linear equation y = mx +b, with y = $log(x/m)$, x = $LogC_e$, m (slope) = $1/n$, and b (y-*intercept*) = $logK_f$.

For each applied absorbent dose, the x/m ratio was calculated as follows:

$$\frac{x}{m} = \frac{V(C_0 - C_e)}{M} \qquad \text{Equation 3}$$

where: C_0 = Initial concentration of adsorbate in solution before adsorption

V = Isotherm test sample volume

M = Mass of carbon applied to sorption experiment container.

In these calculations, C_0 = equilibrium concentration in control sample, to account for any losses not attributable to adsorption to the GAC.

An equivalent means for calculating x and m was as follows:

- $x = C_0 - C_e$ (mg/L)
- m = Actual GAC dose (g/L)

The x/m ratios were then simply calculated as the ratio of these values at each applied GAC dose. The $log(x/m)$ values were then plotted versus the corresponding $log(C_e)$ values and fitting a line using a least-squares linearization to obtain the Freundlich parameters K_f and 1/n.

4.0 RESULTS

4.1 Freundlich Model Results and Adsorption Capacity

Table 5-1 summarizes the raw data and associated data interpretation calculations developed during the isotherm study. Plots containing the isotherms for Test A and Test B are presented in Figures 5-1 and 5-2, respectively.

Table 5-1. C3 Dimer Acid GAC Isotherm Test Data and Calculations

Bottle	Actual Test Volume (L)	GAC Dose (g/L)		C_e		x	x/m
		Target	Actual	(µg/L)	(mg/L)	mg/L	mg/g
Test A							
A-1	0.95	0	Control	400	0.400	--	--
A-8	0.95	0.05	0.056	150	0.150	0.250	4.476
A-2	0.95	0.15	0.160	2.6	0.0026	0.3974	2.482
A-3	0.95	0.50	0.526	1.5	0.0015	0.3985	0.758
A-4	0.97	1.5	1.546	0.026	0.000026	0.399974	0.259
A-5	0.95	5.0	5.274	< 0.10	--	Not Used	
A-6	0.94	15	15.973	1.6	0.0016		
A-7	0.92	40	43.526	1.0	0.0010		
Test B							
B-1	0.95	0	Control	1100	1.100	--	--
B-8	0.95	0.05	0.056	820	0.820	0.280	5.105
B-2	0.95	0.15	0.160	95	0.095	1.005	6.310
B-3	0.95	0.50	0.526	2.1	0.0021	1.0979	2.078
B-4	0.97	1.5	1.546	0.41	0.00041	1.09959	0.698
B-5	0.95	5.0	5.274	0.092	0.000092	1.099908	0.209
B-6	0.94	15	15.973	0.026	0.000026	1.099974	0.070
B-7	0.92	40	43.526	< 0.010	--	--	--

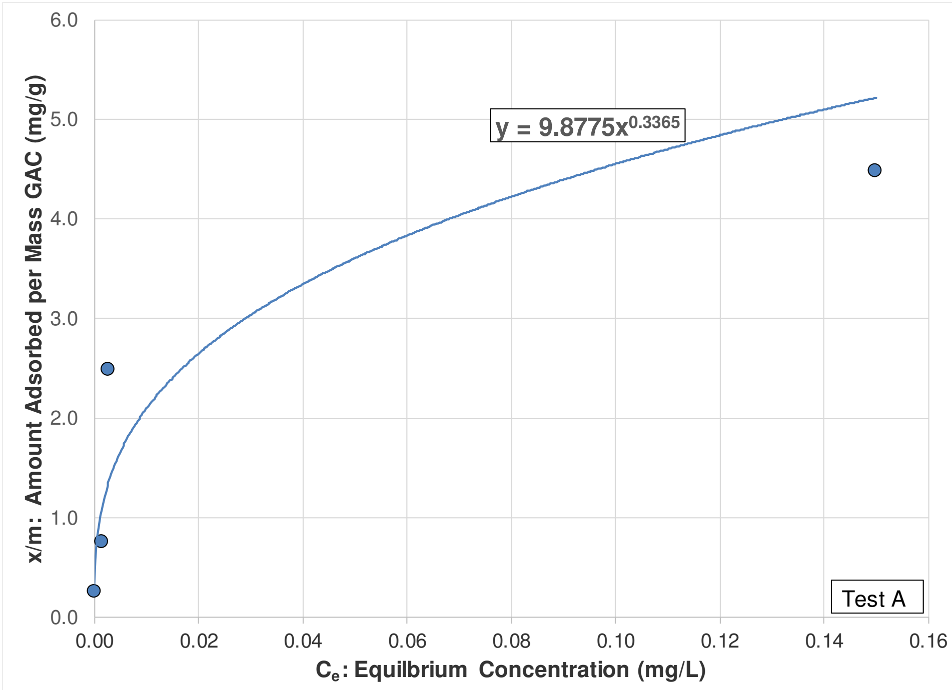

Figure 5-1. C3 Dimer Acid Adsorption Isotherm – Test A

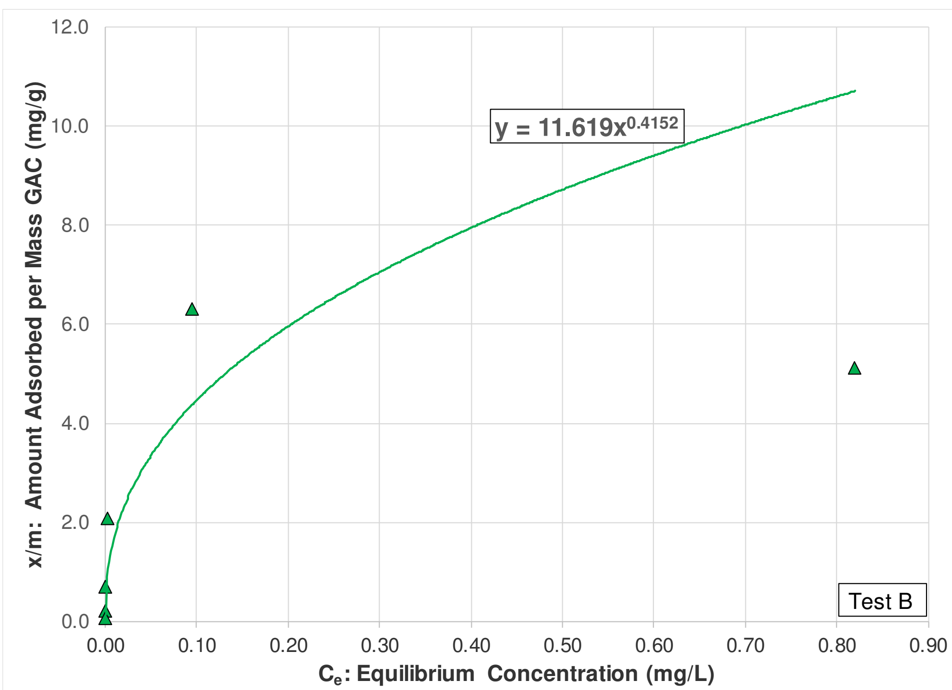

Figure 5-2. C3 Dimer Acid Adsorption Isotherm – Test B

The isotherm plots show x/m (amount compound adsorbed per mass of GAC) on the Y-axis, and equilibrium concentration C_e (akin to effluent concentration) on the X-axis. The plots overall indicate that x/m increases with C_e. Overall, the data obtained showed good agreement with Freundlich isotherm modeling, providing high confidence in the test results as being indicative of the adsorptive nature of C3 dimer acid on Filtrasorb F600 GAC.

The adsorption capacity of F600 for C3 dimer acid was then calculated for a target treated concentration (C_e) of 0.14 ug/L based on the calculated Freundlich parameters from the isotherm study. The results including the calculated Freundlich parameters and associated adsorption capacities are presented in Table 5-2.

Table 5-2. Isotherm Test Results for C3 Dimer Acid Adsorption on Filtrasorb® F600

Test	K_f	1/n	F600 Adsorption Capacity at Target Treated C_e[(1)]
A	9.9	0.34	0.50 mg / g GAC
B	11.6	0.42	0.29 mg / g GAC

(1) 0.14 µg/L

The calculated adsorption capacities between tests showed generally good agreement.

4.2 GAC Utilization at Equilibrium

Estimated GAC utilization was calculated assuming the following inputs:

- Influent C3 dimer Acid concentration (C_0): 0.8 µg/L
- Treated C3 dimer acid concentration (C_e): 0.14 µg/L.

The estimated utilization (lb /100,000 gallons) was calculated as follows:

- The total mass of C3 dimer acid adsorbed per year (mg) = V * (C_0 – C_e), where V = total volume (liters) = 100,000 gallons (to obtain lb per 100,000 gal treated).
- Carbon utilization was calculated by dividing the total mass of C3 dimer acid adsorbed (mg) by the adsorption capacity (mg/g) at the target treated concentration, and converting g GAC to lb GAC.

Based on the adsorption capacities reported in Table 5-2 and estimated influent concentration, the estimated F600 GAC utilization would be approximately 1.1 – 1.9 lb/100,000 gal. For comparison, rough estimated usage for benzene would be at the high end of this range and toluene at the low end based on select studies performed by Parsons for other applications (in which considerable competitive sorption was present).

The reported adsorption capacities and associated utilization estimates do not capture the wavefront of C3 dimer acid through the GAC, where the actual GAC required may be significantly higher. This can be optimized through proper column design (e.g., two columns in series to increase

GAC utilization) and periodic monitoring from after both the lead and lag beds to ensure carbon is replaced before breakthrough from the lag bed can occur.

6.0 PATH-FORWARD RECOMMENDATION

Based on discussion with Chemours, a column study is recommended which would (1) confirm removal of C3 dimer acid during flow through a bed of Filtrasorb® F600 GAC; (2) assess the kinetics of C3 dimer acid adsorption to the F600 GAC; and (3) determine when breakthrough in an F600 GAC bed would be expected to occur based on a given flow rate and influent C3 dimer acid concentration. The column study would be conducted as follows:

- Prepare two F600 GAC column beds in series including a short (e.g., 10 cm) and long (e.g., 40 cm) bed, each inside a 1-inch diameter plexiglass tube. The GAC would be held in place with glass wool plugs and rubber stoppers with holes to accommodate fittings attached to tubing.
- The GAC would be prepared by rinsing and wetting the carbon, preparing the beds, running distilled water through the columns while allowing the beds to expand (to expel carbon particulates), recirculating distilled water through the beds to ensure the carbon is completely soaked and bubbles removed (to prevent short-circuiting).
- A batch of groundwater spiked with C3 dimer acid would prepared and then pumped through the columns at a suitable loading rate (e.g., 2 gpm/ft^2, or approximately 41 mL per min (across the 1-inch diameter tubing). The duration of the study would be approximately 48 hours.
- Samples would be collected in the effluent from each column after several time intervals (e.g., 1, 2, 4, 8, 12, 16, 24, 32, 40, 48) for the duration of the study, and analyzed for C3 dimer acid. Samples from test batch would also be collected for C3 dimer acid analysis.

The objective would be to capture breakthrough of C3 dimer acid to estimate breakthrough in an installed system by scaling to the actual flow rate, influent concentration, and mass of GAC. The shorter column increases chances of capturing breakthrough through at least one bed, in the event breakthrough is not captured in the effluent from C2.

ATTACHMENT 2

RESIDENTIAL PRIVATE WELL QUESTIONNAIRE

Private Well Questionnaire

Owner Name ______________________________________Phone No._____________________________

Owner Mailing
Address____

Communication with Renter approved by Owner ____

Renter Name ______________________________________Phone No._____________________________

Well Address ____

What are the pipe sizes and materials for the interior plumbing? ___________________________________

What is the type and horsepower of the well pump? ____

How deep is the well? ____

What is the well's depth to the water table? ____

What is the approximate location of the well? ____

Where is the existing pressure tank located? ____

What is the existing water pressure in the house (if known from pressure tank setting)?

Does the house have a basement? ____

Is the basement fully or partially finished? ____

Is the home a single- or two-story structure? ____

Does the resident live in this house all year round? ____

If they are seasonal residents, is the home heated throughout the winter? ____________________________

Are there any increased seasonal demands on water use? ____

Is there a public/community water distribution system in the vicinity of the home? If so, what is the name of the public water supplier?

Is there a water softener or other treatment system installed? ______________________________________

If yes, where is it located and is it easily accessible? ____

Is your utility room/basement easily accessible (e.g., interior/exterior door access, stairs)?

Are there additional water pipes branching off of the pipe between the well and the house?

Does this well provide water for other residences?____

Is the well water used for purposes such as watering gardens and/or livestock, in addition to household purposes? Please list these uses.

ATTACHMENT 3

O&M AGREEMENT

Granular Activated Carbon Treatment System Installation, Operation, and Maintenance Agreement

I (we), ____, the owner(s) (hereafter referred to as Owner(s)) of the parcel of real estate and improvements located at ____ (hereafter referred to as the Property), consent to have The Chemours Company (hereafter referred to as Chemours), its affiliates, and its designated contractor(s) enter on to the Property to install a Granular Activated Carbon Treatment System (hereafter referred to as GAC Treatment System) and connect it to the water supply line running from the Property's well to the primary living space on the Property. The North Carolina Department of Health and Human Services ("NCDHHS") has issued a provisional health goal for the chemical compound HFPO-DA (which is sometimes referred to as "Gen X" or "C3 dimer") of 0.14 ug/L. Although Chemours does not agree with NCDHHS' provisional health goal, Chemours is offering, at this time, installation of granular activated carbon treatment, if the measured concentration of HFPO-DA in the drinking water at the Property is greater than 0.14 ug/L. Owner(s)' consent is contingent upon the conditions provided below. Fulfillment by Chemours of its obligations specified in this Agreement is also contingent upon the conditions below.

Condition 1. Chemours will provide at its cost all construction, labor and materials necessary to install the GAC Treatment System and connect it to the water supply line running from the Property's source water to the primary living space on the Property.

Condition 2. Chemours will provide at its cost all labor and materials necessary to restore any damage to improvements on the Property that result from Chemours' work installing the GAC Treatment System and connecting it to the water supply line. Restoration shall consist of returning all improvements on the Property damaged by Chemours to as near as possible the condition existing on the date that installation and connection activities begin. The Owner(s) agree that in the case of grass that is damaged as part of the construction work, reseeding of the damaged area is acceptable.

Condition 3. Chemours will pay for all operation and maintenance of the GAC Treatment System, including timely replacement of the carbon filtering medium, based on quarterly sampling and analysis results. All operation, maintenance and filter replacement will be performed by Chemours' designated contractor(s).

Chemours will provide for operation and maintenance of the GAC Treatment System until (a) Chemours demonstrates to the satisfaction of the North Carolina Department of Environmental Quality ("DEQ") that the water system's source water prior to treatment contains less than 0.14 ug/L of HFPO-DA in drinking water for four consecutive quarters; or (b) Chemours provides an alternative means for providing to the Property drinking water that contains less than 0.14 ug/L of HFPO-DA. In the event that DEQ or DHHS should determine that the current health goal of 0.14 ug/L should be modified, Chemours will demonstrate that the GAC Treatment System meets that revised goal or will provide an alternative means for providing drinking water that meets the revised goal.

When Chemours' obligation to operate and maintain the GAC Treatment System ends, Chemours will monitor annually the source water at the Property for a period of five (5) years. Chemours will pay all expenses to remove the GAC Treatment System entirely and return the Property to its condition before the equipment's installation.

Condition 4. Chemours will be responsible for personal injury or property damage caused by negligence in the performance of the work described in Conditions 1, 2, and 3 or by malfunction of the GAC Treatment System. Chemours will not be responsible for any damage caused by any other persons, including but not limited to the negligence of the Owner(s) or their invitees or licensees.

Condition 5. Chemours and its contractor(s) may have access to the Property during normal business hours (Monday through Friday between 8:00 a.m. and 5:00 p.m.) to perform the installation, connection, sampling and any necessary restoration. When Chemours and its contractor(s) must enter the primary living space, it will seek with the Owner(s) a mutually agreeable time to do so.

Condition 6. Owner(s) grant Chemours the authority to obtain at its cost all necessary federal, state, and county permits for completion of the work described above on behalf of Owner(s) as required.

Condition 7. Chemours' designated contractor(s) will be licensed, bonded and insured.

This Agreement is understood and intended by Chemours and the Owner(s) to be without any admission of liability or fact, and nothing in this Agreement shall be considered as an admission by Chemours or the Owner(s) in any proceeding.

This Agreement reflects the complete agreement between Chemours and the Owner(s) with respect to the subject matter covered herein and supersedes any and all prior agreements on the same subject matter. This Agreement may not be altered, amended, changed, terminated or modified in any respect except in writing agreed to by both Chemours and the Owner(s). Owner(s)' consent is provided on this date, ________________________________ by:

____________________________ and ___________________________________
Owner(s)' Signature

_____________________________ and ___________________________________
Owners(s)' Printed Name(s)

Agree by Chemours:

Kevin P. Garon, Principal Remediation Project Manager, representing The Chemours Company
Printed Name, Title

Chemours Signature

Date

ATTACHMENT 4

EXAMPLE LETTERS TO HOMEOWNERS

Example: Treatment System Offer Letter from Chemours to Homeowner

January __, 2018

Chemours Fayetteville Works: Residential Drinking Water Well Sampling Program

Dear Resident,

On _____, 2017, we contacted you with results from the well water sample we collected from your property on ____, 2017. That sample was taken as part of a program to determine whether trace levels of the chemical compound HFPO-DA (sometimes referred to as "Gen X" or "C3 dimer") are present in local drinking water wells, including yours. As we reported to you and the State (NCDEQ and NCDHHS) at that time, preliminary results indicated the level of GenX found in your well was above the provisional state health goal of 140 parts per trillion (ppt) announced last year by DHHS. It's our understanding that NCDEQ confirmed that finding with you in subsequent correspondence, following their independent review of the data.

Chemours has recently completed testing of drinking water treatment technology with the goal of offering affected residents a reliable whole house treatment solution in place of the bottled water currently being provided. The selected technology, which uses granular activated carbon (GAC) as the treatment medium, is specifically designed for removing a wide range of contaminants from drinking water in residential well applications. It has been employed successfully to treat contaminated groundwater at many locations throughout the United States. Independent laboratory testing and a pilot study sponsored by Chemours has demonstrated the capability of this technology to reliably and consistently remove GenX to levels below the provisional health goal when installed and maintained in continuous operation in accordance with Chemours' implementation plan. The test results and an associated report on the pilot study that have been shared with NCDEQ and the Water Districts of Cumberland and Bladen Counties show that as a general matter, the level of GenX removal achieved provides an ample margin of safety below the provisional health goal consistent with the specified maintenance plan for the technology to be installed. (Chemours will share these same materials with any residents who wish to see them).
Chemours' submission to NCDEQ also includes the details of Chemours' plan to offer these treatment systems to affected residents *free of charge*, including installation and operating costs. Along with the treatment system, Chemours is also offering to collect verification samples on a regular routine basis for independent laboratory analysis to confirm GenX removal and determine the required timing of GAC cartridge replacement needed to meet acceptable performance. These results will be reported to residents as received, and Chemours will bear the cost of GAC cartridge replacement.

Chemours will continue bottled water service to residents who take advantage of this offer, until the initial verification test results for each installed system show it is performing satisfactorily. Based on testing to date, we have every confidence that each system will perform as expected; we will be conducting home-by home testing of every unit and share results with NCDEQ, to give homeowners and their families confidence in this program.

We believe this solution is the best option we can offer affected residents to remedy drinking water impacts and address the inconvenience of the current bottled water program. We sincerely hope that all residents who are offered this solution, including you, will accept.. The offer is unconditional and requires no commitments, costs, or obligations other than coordinating with our installation and sampling teams to conduct their work. .. If you are interested in exploring this option further, please call (*number TBD*) at your earliest convenience to schedule an in-home visit where we will provide further details and collect information on your well and installation preferences. We will respond to requests on a first come basis, and, will work diligently to promptly respond to all requests.

In the interim, we confirm that Chemours will continue to provide you bottled drinking water free of charge pending verification of system performance once installed. Bottled water remains available at the Chemours facility for your pick-up between 9 am and 8 pm; Chemours will also arrange to deliver water to your home if you wish. Should you wish to speak with someone at Chemours regarding future deliveries, please call (*number TBD*) and leave your name, address, and phone number. Until such time as we can implement whole-house treatment at your residence, please continue to refer to the Fact Sheet prepared by DHHS, which contains information about GenX and their guidelines for safe use of your water for non-drinking purposes. If you choose to decline this offer of treatment, please sign below and return this letter in the enclosed self-addressed stamped envelope.

Chemours remains committed to being a responsible member of this community and a good neighbor. As always, we are working with the agencies to remedy this matter transparently and as quickly as possible, and we sincerely apologize for the inconvenience caused to you and your family. Please call (*number TBD*) with any questions.

Very truly yours,

Ellis McGaughy
Plant Manager
Chemours Fayetteville Works

I decline the offer of treatment from Chemours.

Owner’s signature and date of decline.

Example: Continued Monitoring Offer Letter from Chemours to Homeowner

January __, 2018

Chemours Fayetteville Works: Residential Drinking Water Well Sampling Program

Dear Resident,

We very much appreciate your cooperation in allowing us to collect a water sample from the well on your property on ___, 2017. That sample was taken as part of a program to determine whether trace levels of the chemical compound HFPO-DA (sometimes referred to as "Gen X" or "C3 dimer") are present in local drinking water wells, including yours. As we reported to the State (NCDEQ and NCDHHS) at that time, preliminary results indicated the level of GenX found in your well was below the provisional health goal of 140 parts per trillion (ppt) announced last year by DHHS. It is our expectation that NCDEQ has confirmed that finding with you in subsequent correspondence, following their independent review of the data.

At this time, Chemours is offering to monitor free of charge for GenX in drinking water wells that showed initial results between 100 ppt and the provisional health goal of 140 ppt. Sampling would be conducted on a quarterly basis (i.e., once every three months) for up to three additional quarterly events in order to demonstrate that these wells remain below the provisional health goal. If the concentration of GenX is detected above 140 ppt in any of those monitoring events, Chemours will immediately upon receiving such results offer to provide bottled water free of charge as well as to offer installation of a whole-house treatment system using technology proven to remove GenX from drinking water, as an alternative to bottled water once installed and tested to verify satisfactory treatment performance. Treatment system installation and operating costs will be borne by Chemours and will be offered free of any costs or charges to residents whose wells are found to exceed the provisional health goal.

Because the initial result reported for your well exceeds the 100 ppt threshold for this program, Chemours is offering to include your well in this additional monitoring program. If you choose to accept this offer, please contact us at (*number TBD*) at your earliest convenience and provide your name, address and a phone number where we may reach you. We will contact you with further information and to schedule a visit to explain this program and arrange for sampling at times that are convenient to you. While Chemours representatives will conduct the sampling, the analyses will be performed by an independent laboratory certified by the State. Your sampling results will be promptly reported to you and NCDEQ. If you choose to decline this offer, please sign below and return this letter in the enclosed self-addressed stamped envelope.

Chemours remains committed to being a responsible member of this community and a good neighbor. As always, we are working with the agencies to address this matter transparently and as quickly as possible, and we sincerely apologize for any concern caused to you and your family. Please call (*number TBD*) with any questions.

Very truly yours,

Ellis McGaughy
Plant Manager
Chemours Fayetteville Works

I decline the offer of further monitoring of my drinking water well by Chemours.

Owner’s Signature and Date of Decline