Cape Fear River Water Questions and "Answers"
Water Sources, Testing, Quality, and Health Issues

(Roger Shew: Dept. of Earth and Ocean Sciences/Environmental Sciences)

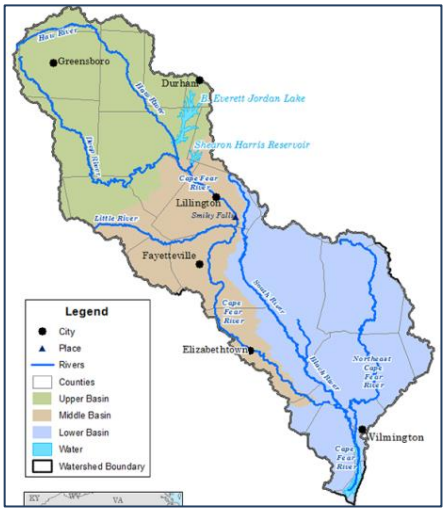
Please Note: The questions came from those posed at multiple forums and the answers are summations from multiple sources. They are provided in somewhat of a layman's format though with some of the science details added, including references, for further information. The information concerns Brunswick and New Hanover counties for the most part, though obviously others, including Pender County, utilize Cape Fear River water. The Star News, CFPUA, Brunswick Water Utility, NC Department of Environmental Quality, Department of Health and Human Services and others have provided valuable water quality information for our area. The information contained here is only a summation of a few of the common questions that are asked and should be viewed as a work in progress; further research and/or investigations and explanations are needed and some studies have begun. The information included is for ***educational use only and not intended to support or advocate for any point of view****. It is an attempt to place multiple pieces of information into one location with some of the more important references that have been mentioned in the press in one location as well. It should not be used as a reference itself – please go to the actual reference sites listed for complete information. Because of the format, there are likely grammatical errors, etc. I do apologize for errors; however, the goal is to provide a running summary and update of the issue for the community. Roger Shew, August 7, 2017*

1. **What is the Cape Fear River Watershed?**

Answer:

The Cape Fear Watershed is the largest watershed contained entirely within the state and the only river that directly drains to the Atlantic Ocean. The Lower Cape Fear watershed is comprised of the Cape Fear, Northeast Cape Fear, and Black rivers.

(from https://en.wikipedia.org/wiki/Cape_Fear_River)



(from http://www.regions.noaa.gov/secar/index.php/cape-fear/)

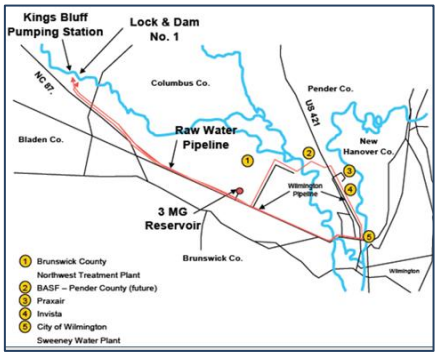
2. **Where is the Cape Fear River water source for Brunswick, New Hanover, and Pender counties?**

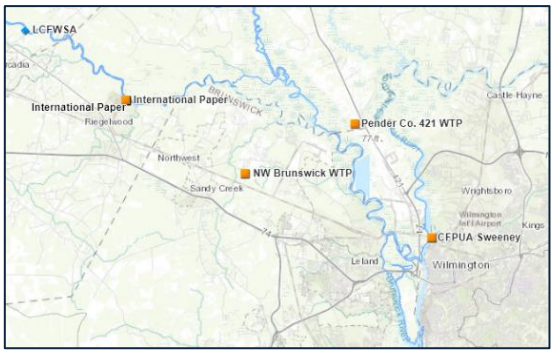
Answer:

Water intakes (King's Bluff) are located upstream of Lock and Dam #1 in southern Bladen County. The water is piped (20+ miles) to water treatment plants including:

a. Northwest Water Treatment Plant (NWWTP) in northern Brunswick County
b. Sweeney Water Treatment Plant in New Hanover County
c. Hwy 421 Water Treatment Plant in Pender County

(from http://www.lcfwasa.org/facilities-and-customers)

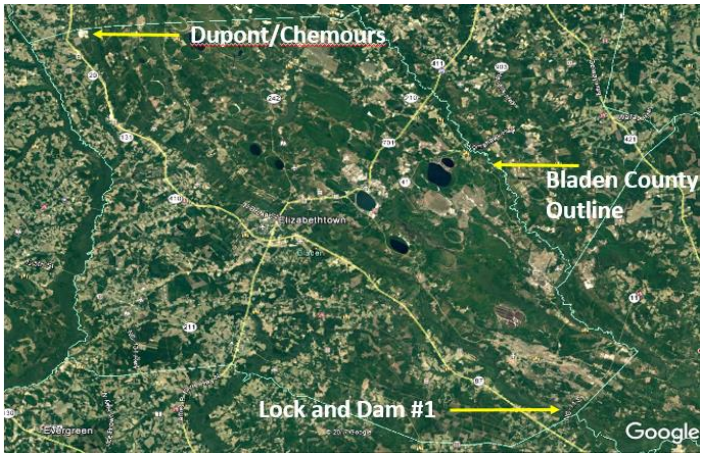


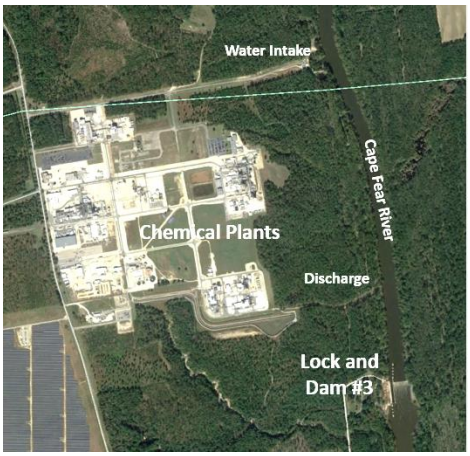


3. Where are the Dupont/Chemours Plants

Answer:

Northern Bladen County on west bank of river just above William O'Huske/Lock and Dam #3. The plant is located approximately 55 river miles (~90 km) upstream of the King's Bluff water intake atLock and Dam #1. Reference Maps are Google maps from 10/2016.





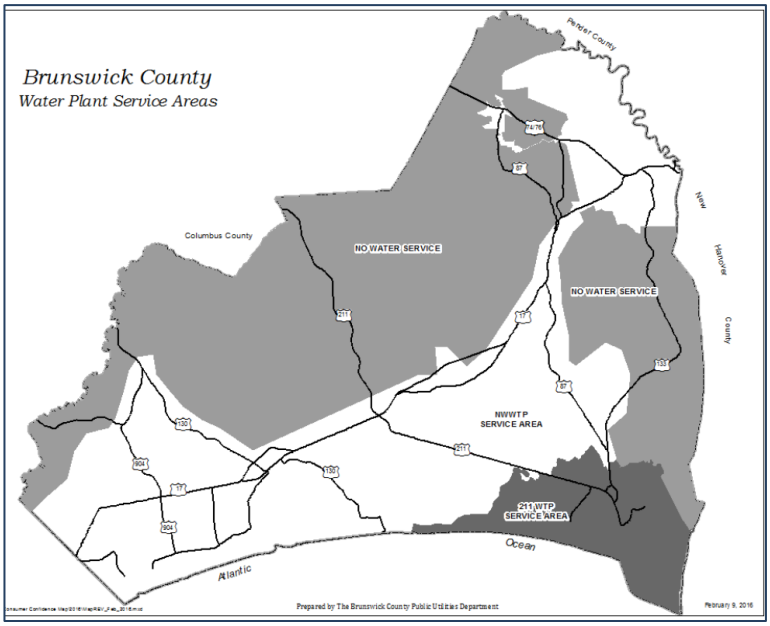
4. Who uses the Cape Fear River as a source of water in Brunswick, New Hanover, and Pender counties?

Answer:

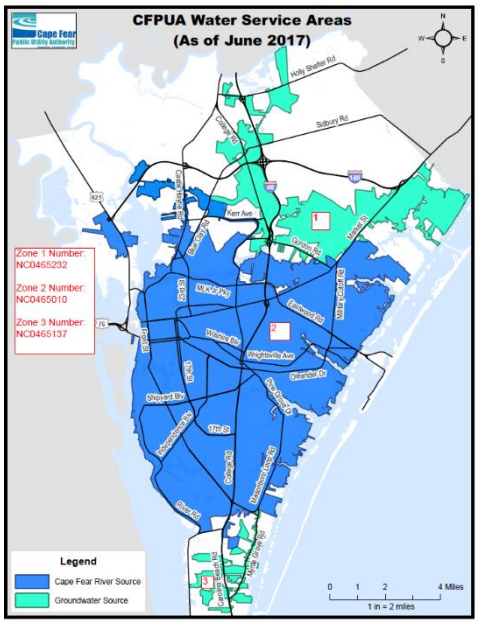
Brunswick County treats water from the Cape Fear River (supplied by Lower Cape Fear Water and Sewage Authority (LCFWSA)) at the NWWTP (located in Northwest) and distributes it in the areas from northern Brunswick southward through central Brunswick County. Part of this water is considered an Interbasin Transfer as the water will not be returned to the Cape Fear River. Areas in southeast Brunswick use groundwater from the water treatment facility on Hwy 211; see map below for water plant service. H_2GO currently purchases water processed in the NWWTP for their customers, though they are pursuing a groundwater source.

New Hanover County treats Cape Fear River water at the Sweeney Water Treatment Plant (a 35 million gallon per day (mgd) capacity plant). Most of that water is used in the City of Wilmington. There are also groundwater sources with the 6 mgd nano-filtration plant near Ogden (uses Castle Hayne and Peedee aquifers) as a primary source for northern New Hanover but other areas use groundwater sources too, such as Wrightsville Beach and Monterey Heights. The CFPUA use map is shown below; the map includes reference zones in the CFPUA service area to determine your water source.

As mentioned, Pender County also uses Cape Fear River water – currently 2 mgd; the plant is the HWY 421 WTP. The county received approval for a much larger interbasin transfer allocation this year. Pender WTP has only been open 4.5 years.



(from http://www.brunswickcountync.gov/wp-content/uploads/2015/02/CCR-2016.pdf)



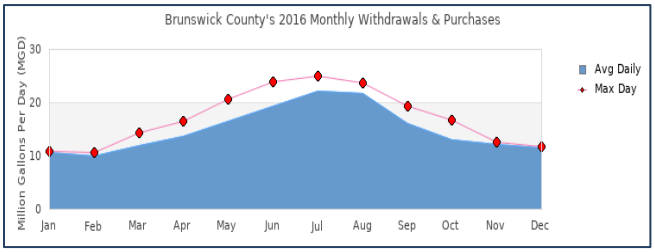
(from http://www.cfpua.org/507/CFPUA-Water-Service-Area-2017)

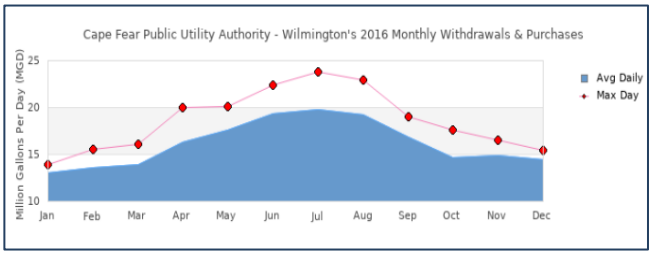
5. **How much water is used daily in Brunswick and New Hanover and what are the sources?**

Answer:

The Brunswick County water capacity is 30 mgd: 24 mgd from the NWWTP (Cape Fear River source) and 6 mgd from the Hwy 211 WTP (groundwater from the Castle Hayne aquifer). The largest system demand in 2016 was 24.65 mgd in July but the average was 14.8 mgd.

New Hanover County/CFPUA water capacity is 41 mgd: 35 mgd from the Sweeney Water Treatment Plant (Cape Fear River source) and 6mgd from the Nano-filtration in Ogden (groundwater sources from the Castle Hayne and Peedee aquifers). Average 2016 water demand was 16.1 mgd; the average daily withdrawal from the Cape Fear River was 15.4 mgd.





Data from NC Division of Water Resources: http://www.ncwater.org/Water_Supply_Planning/Local_Water_Supply_Plan

6. **Where can I find water quality reports for our counties? What are the contacts for further information?**

Answer:

a. Brunswick County

Brunswick County Public Utility: Phone: 910-253-2655; Website: http://www.brunswickcountync.gov/utilities/
Brunswick County Water Quality Report: http://www.brunswickcountync.gov/wp-content/uploads/2015/02/CCR-2016.pdf
H_2GO Report (Leland area): http://www.h2goonline.com/

Brunswick County Contacts for Water Treatment (also shown on water quality reports)
NWWTP: Glenn Walker, Water Plant Superintendent, 910-371-3490 or glenn.walker@brunswickcountync.gov
Hwy 211: Jeremy Sexton, Plant Superintendent, 910-454-0512 or jeremy.sexton@brunswickcountync.gov

b. New Hanover County

Cape Fear Public Utility Authority: Phone: 910-332-6550; Website: http://www.cfpua.org/
New Hanover/CFPUA Water Quality Report: http://www.cfpua.org/Archive.aspx?AMID=54

CFPUA contact: Water Treatment Division (910) 332-6769; 235 Government Center Dr. Wilmington

c. Pender County

Pender County Utility: Phone: 910-259-1570; Website: http://www.pendercountync.gov/utl/

Note – Emergent contaminants including GenX are NOT part of the reports as these are not required to be tested for by law and until recently have not been tested for in the water.

7. **How is surface water treated currently?**

Answer: There are differences between water treatment plants; please refer to the actual plants for specific questions. The answer below is a summary of the Sweeney Water Treatment Plant to process Cape Fear River water. These techniques DO NOT remove GenX or other Perfluorinated substances that are currently under investigation. Comments on this will be discussed below. <u>This data is summarized from the CFPUA website</u>.

1) **Ozonation**. Water is treated with its first ozone to remove flavors and change the color
2) **Sludge Removal.** Water goes to multiple basins where flocculation and coagulation take particles out via settling
3) **Ozone Treatment.** Oxidation and disinfection of the water
4) **Turbidity Removal**. Biological filters remove material that makes the water cloudy
5) **UV Treatment**. High intensity ultraviolet light used to sterilize pathogenic organisms
6) **Chemicals Added**: Chlorine – disinfects water; Sodium hydroxide – to change/keep acidity levels; Orthophosphate – corrosion inhibitor to protect pipes; Fluoride – dental health
7) **Storage and Aeration.** Reservoirs can store 16 million gallons. Provide further aeration to remove byproducts.
8) **Chlorine Addition.** Insurance of removing pathogenic organisms and to keep water safe

Note: The NC Department of Environmental Quality (NCDEQ), Public Water Supply (PWS) Section, Source Water Assessment Program (SWAP) conducts assessments for all drinking water sources across North Carolina. The purpose of the assessments are to determine the susceptibility of each drinking water source (well or surface water intake) to Potential Contamination Sources (PCSs). See: http://deq.nc.gov/node/82906 and for SWAP Reports: https://deq.nc.gov/about/divisions/water-resources/drinking-water/drinking-water-protection-program/source-water-assessment-program

8. **Who uses groundwater and what are the groundwater sources?**

Answer: This answer concerns only water utilities and not individual/personal groundwater source wells. There are numerous individuals that use their own water source wells from shallow aquifers, particularly in Brunswick and Pender.

There are abundant shallow water/surficial aquifer use in our area. But there are significant Area Users of the deeper Castle Hayne and Peedee aquifers for groundwater in both Brunswick and New Hanover counties.

a. Brunswick County: The Hwy 211 Water Plant uses Castle Hayne Aquifer groundwater. It is used in the southeastern portion of the county in areas like Southport, St. James, and Oak Island.
H2GO has proposed to use groundwater from the Lower Peedee Aquifer as a water source for northern Brunswick Co. This is currently under discussion/review.

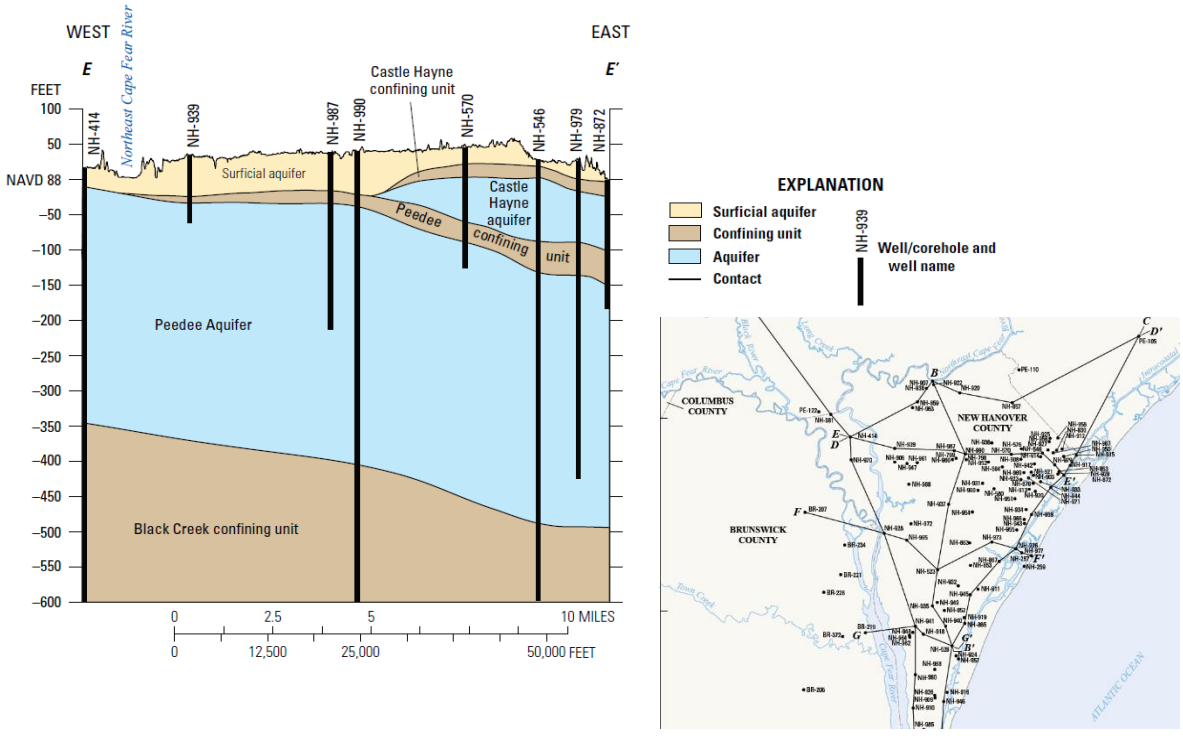
b. New Hanover County: There are several groundwater sources including the Nano-filtration source near Ogden, which is the largest. Water sources are from the Castle Hayne and Peedee (largest source) aquifers and this is used in northern New Hanover County. Other Utilities using groundwater are: Wrightsville Beach uses Peedee waters, Carolina Beach uses Castle Hayne and Peedee water, Kure Beach uses the Castle Hayne aquifer, and the area just south of the Wilmington City Limits is the Monterey Heights area, which also uses groundwater from the Castle Hayne and Surficial aquifers. A map of some of these areas is shown here: http://cfpua.maps.arcgis.com/apps/webappviewer/index.html?id=a5524a6e9e25400182553872212b73c9.

9. **How is groundwater treated? Does it have the same risk of contamination as the surface water?**

Answer:

Groundwater, like surface water, is treated differently at different water treatment facilities. Groundwater has less issues with turbidity and organic substances than surface water. The CFPUA Ogden source uses nano-filtration, which are micro-porous membranes to remove particulate matter and reduce levels of dissolved substances. The Hwy 211 facility in Brunswick County uses filters and polymers to remove the particulate matter.

Groundwater will have a minimal likelihood of contamination of GenX and other emergent contaminants that are discharged directly into the Cape Fear River. This is particularly true of confined aquifers (those separated from surface recharge by a confining layer or low permeability layer like clay), which are the primary source of public utility groundwater. Groundwater, of course, may be contaminated through illegal dumping or pumping of contaminants onto the land. In our area, this would be more likely in surficial aquifers; there are numerous contaminants like underground tank leakage. Everyone should be aware of potential contaminants to surface and groundwater. The groundwater is analyzed for contaminants in a similar manner to surface water. The water quality reports discussed above report on the groundwater analyses, too. Though unlikely to be contaminated, test are and should be conducted to ensure that this is the case.



Geologic Cross section of aquifers in NHC (from https://pubs.usgs.gov/sir/2014/5169/)

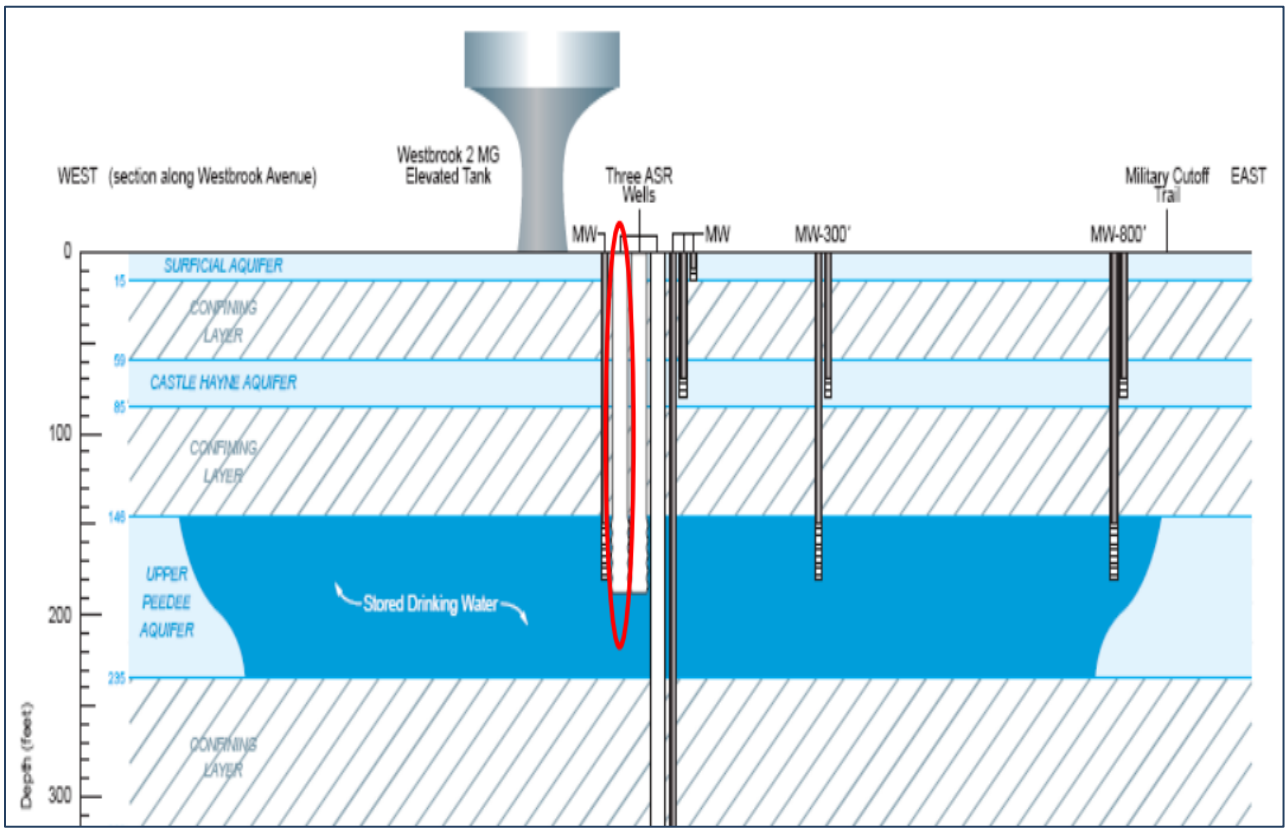
10. Aquifer Storage and Recovery (ASR) has been mentioned as a supplemental source of water in New Hanover County. What is ASR and is it at risk of being contaminated or of contaminating our groundwater?

Answer:

The goal of an aquifer storage and recovery facility is to pump excess treated water into an underground aquifer that may be recovered (pumped back out) at a later time to supplement the water supply. The idea is to use this water when demand would be highest, such as in the summer. In the case of the CFPUA ASR facility, the goal was to have 1+ mgd available to be added to CFPUA's total capacity when needed.

CFPUA's system, located near Military Cutoff, stored water in the confined Peedee Aquifer. The ASR is not supplying water to the utility at the present time. It has, however, been tested and cycled with treated Cape Fear River water from the Sweeney Plant. The injected water does not extend far from the injection well and there is a buffer zone between the injected water and the native water of the aquifer. Any injected water at this location would have little chance of reaching the Ogden nano-filtration facility as stated by CFPUA.

IMPORTANT: Since Cape Fear River water was injected as stored water it is likely, that there would be GenX in the water. The diagram illustrates the NHC aquifer storage and recovery plan for NHC at the Westbrook (Military Cutoff) location.



(from https://www.nccoast.org/wp-content/uploads/2015/09/6-Water-Summit-ASR-Alternative-CFPUA.pdf)

Test Results: Testing of the waters beginning on 6/22/17 did show that the stored water had high levels of GenX. CFPUA has has made the statement that they will remove this water from the aquifer. Pumping and cycling must be done to remove it. One thing is sure, cleaning groundwater is more difficult than surface water. Testing will be done to confirm that the levels of GenX are lowered. Some of the test results are shown below. As discussed in Questions 14 and 15, 140 ppt is the health assessment level from the NC Department of Health and Human Services.

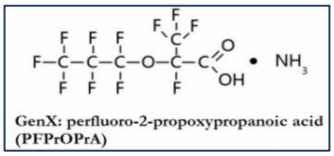
Test Data on the ASR Water (ppt = parts per trillion):

06/22/2017 results: Test America = 820 ppt	EPA = 588 ppt	CFPUA announced on 8/7/2017 that they
06/29/2017 results: Test America = 400 ppt	EPA = 336 ppt	will pump out ~48 million gallons from the
07/06/2017 results: Test America = 190 ppt	EPA = 148 ppt	Peedee aquifer to remove all water that
07/13/2017 results: Test America = 120 ppt	EPA = N/A	was pumped into the ASR from the CFR.

All tests since this time were below the 140 ppt value.

11. What is GenX and the other Perfluorinated substances that have been discussed as emergent contaminants?

Answer:


GenX: perfluoro-2-propoxypropanoic acid (PFPrOPrA)

Perfluorinated chemicals (Perfluoroalkyl and Polyfluoroalkyl substances or PFAS) include those with carbon chains attached to fluorine atoms. C8 or PFOA (perfluorooctanoic acid) has 8 carbons while GenX with a formula of $CF_3CF_2CF_2OCF(CF_3)COOH.NH_3$ ($C_6H_4F_{11}NO_3$) has 6 carbons, so it has a shorter chain. The fluorine-carbon bond is very strong, and as stated by EPA and DuPont, these compounds are very stable, which is why they are important to industry. This is also why they are likely to be long-lived in the environment. The uses for these chemicals include Teflon, packaging, water-resistant products, fire-fighting foams, and more. Because of the known carcinogenic properties of C8, DuPont and others agreed to stop production of it by 2015. It is notable that the EPA issued a civil penalty against Dupont for failing to submit risk information on PFOA and there was the Ohio Valley class action lawsuit over contaminated water that ultimately led to a $670 million settlement. The replacement for these chemicals was to be GenX; DuPont started producing it in 2009. However, as was revealed on June 15, 2017, DuPont/Chemours had been discharging GenX as a by-product of vinyl ether production since 1980.

An excellent timeline for the history of C8 and GenX was produced by the Star News. Please see **the Star-News Special Section called "Toxic Water Crisis" that was published on June 28, 2017.**

There are many sources of information on these and other contaminants. Here is one definition and a website:
Definition: Emergent contaminant, according to EPA, is: *"a chemical or material characterized by a perceived, potential, or real threat to human health or the environment or by a lack of published health standards. A contaminant also may be "emerging" because of the discovery of a new source or a new pathway to humans."*

Website: The 1996 Safe Drinking Water Act requires that EPA, once every 5 years, issue a new list of up to 30 unregulated contaminants to be monitored by public water systems. The 2012 list, called the third unregulated contaminant monitoring rule (https://www.epa.gov/dwucmr/third-unregulated-contaminant-monitoring-rule) listed six perfluorinated compounds including perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA). For information, it also listed 1,4-Dioxane, another contaminant of concern found in the Cape Fear. For info on this see: http://www.capefearriverwatch.org/wp-content/uploads/2017/07/CFR_Knappe_052417.pdf .

12. What is known about the levels of contamination in the river?

Answer:

Although we now know that some level of GenX has been in the river since 1980 (reference the Chemours briefing in NHC on June 15, 2017), the measurement of GenX in the river has really only been done since 2013. Of course the paper published in 2016 by Sun et al. (*Legacy and Emerging Perfluoroalkyl Substances Are Important Drinking Water Contaminants in the Cape Fear River Watershed of North Carolina, Environmental Science and Technology Letters*) was what primarily led to the current investigations of our water in the Cape Fear River..

The amount of GenX, listed as perfluoro-2-propoxypropanoic acid or PFPrOPrA in the report, was found to be 631 ng/L or 631 parts per trillion (ppt)***** in the raw water at the Water Treatment Plant. Six other perfluoroalkyl ether carboxylic acids were found in the waters, too. Some of these were found to occur at levels ~100 times that of GenX. Water testing has been initiated to test multiple sites along the Cape Fear River (see Question #17 for these sites/data). Chemours stated they would stop the release of GenX into the river and did so around June 20th. However, subsequent testing that Chemours did found some additional sources of GenX discharge from the plant grounds. Chemours notified DEQ and this discharge was stopped on July 12, 2017.

There was a spike in GenX on July 16, 2017 that may have originated from that last discharge. Based on river flow conditions at that time (approximately 2000 cubic feet per second), it would take approximately 4.5 days for the river water to travel from the Chemours Plant to Lock and Dam #1 intake.

*Nanograms/Liter (ng/l) is equal to parts per trillion (ppt) so 631 ng/l = 631 ppt; ppt will be used in the remainder of this summary. One ppt is one gallon in one trillion gallons. The average flow or discharge down the Cape Fear River each day at Lock and Dam #1 is ~3.3 billion gallons of water.

Testing is continuing. CFPUA is testing every day for GenX; values are posted on their website at http://www.cfpua.org/ . The NC Department of Environmental Quality (DEQ) post their results at https://deq.nc.gov/news/hot-topics/genx-investigation . Brunswick County test results may be found at http://www.brunswickcountync.gov/genx/ .
See question #13 and #14 for the sites and test results.

13. What areas are being sampled for contamination and what are the current test results?

Answer:

The Department of Environmental Quality has posted the sites that are being tested. CFPUA and others are also doing their own sampling and discussions are underway for longer term monitoring. The initial testing sites posted by DEQ are very important to get a more comprehensive look at current levels. The map and list of the sites are shown below. Testing of these perfluorinated compounds requires special labs.

(modified from https://deq.nc.gov/news/hot-topics/genx-investigation/genx-sampling-sites)

14. What are the tested levels of GenX at these locations?

Answer:

Test Results have been coming in from the initial June and early July testing. It will continue for the foreseeable future. Two water labs are being used for the analyses: U.S. Environmental Protection Agency lab in Research Triangle Park and Test America, a lab in Colorado under contract to Chemours. One early comment is that the levels of GenX and other PFAS have been coming down from the initial measurements and they are lower than measured in the Sun et al., 2016 paper. Chemours has agreed to stop all discharges; hopefully this will lead to no or very low levels.

Shown below are some of the early testing results; only a selection of the test data are shown. See the complete table of test results at the end of the document for all results. Results of the testing from the various sites may be found at:

CFPUA (http://www.cfpua.org/289/Public-Information (CFPUA is conducting daily tests – some info below)
DEQ (https://deq.nc.gov/news/hot-topics/genx-investigation)
Brunswick County (http://www.brunswickcountync.gov/genx/)

CFPUA Data

Date	GenX (ppt) untreated
6/26	149
6/30	69
7/5	94
710	102
7/14	114
7/16	336
7/18	128
7/20	85
7/22	53
7/25	97
7/27	55

Select Test Locations

Location	6/22/17 (ppt)		6/29/17 (ppt)		7/6/17 (ppt)		7/12/17 (ppt)	
	Test America	EPA	Test America	EPA	Test America	EPA	Test America	EPA
Chemours Outfall	**39000**	**21760**	**19000**	**15250**	**30000** (7/3)	**21530**	**3300**	**2430**
Water Intake L&D#1 (LCFWSA)	**830**	**639**	**67**	**72**	**150**	**119**	**130**	**67**
NWWTP (finished)	**910**	**695**	**51**	**52**	**150**	**125**	**110**	**69**
Sweeny WTP (finished)	**1100**	**726**	**110**	**100**	**97**	**87**	**110**	**95**
Pender County WTP (finished)	**340**	**269**	**160**	**112**	**81**	**68**	**100**	**100**
ASR (Stored Water)	**820**	**588**	**400**	**336**	**190**	**148**	**120**	**120**
Wrightsville Beach (GW)	**26**	**27**	**24**	**28**	**28**	**24**	**29**	**<10**

The latest data from Chemours on 7/24/17 *shows a GenX value of 150 ppt; all other sites below 140 ppt on 7/20/17. For a complete list of tests as of 7/24/2017 posted by DEQ see chart at end of report.*

15. What are the possible health concerns for the perfluorinated compounds (PFAS) and GenX?

Answer:
EPA states that laboratory studies indicate the effects of PFOA and PFOS to include kidney and testicular cancer, impaired fetal development, and various effects on the liver, thyroid, and immune system. The health advisory for these compounds for drinking water was to not exceed 70 ppt. There is little information on GenX impacts on health. There are no human studies but there are limited animal studies that indicate that it may have similar effects such as liver and red blood cell non-cancer effects and pancreas, liver, and testicular cancer effects. See further information below in #16 for health advisory information.

16. Do we know what amount is considered a hazardous/dangerous level of contamination for GenX?

Answer:
The short answer is NO as there are no definitive studies on GenX. However, the Department of Health and Human Services (DHHS) has now suggested a level of 140 ppt based on limited studies. A discussion follows in this answer and in Question #17 on the calculation of this health assessment level. It should be noted that this is a flaw in rules and regulations; chemicals are sometimes allowed to be used before knowledge is known about their potential impacts. It is important to remember that these compounds are believed to be long-lived in our environment and therefore it is important to know the impacts on wildlife (particularly top predators) and humans. There is some information, however.

First, let's consider two other perfluorinated compounds that have been studied much more than GenX; these are PFOS and PFOA. EPA (https://www.epa.gov/ground-water-and-drinking-water/drinking-water-health-advisories-pfoa-and-pfos) has established a health advisory level of 70 ppt for PFOS and PFOA. Additionally, the 2012 3rd Unregulated Contaminant Monitoring Rule, discussed above, listed minimum reporting levels for these compounds at 40 and 20 ppt, respectively. It is important to note that these do not represent definitive cut-offs between safe or unsafe levels; they are to **"provide guidance for a margin of protection."** The health impacts of these compounds, and likely other perfluorinated compounds, have been described by EPA in the following way –
"EPA's health advisories are based on the best available peer-reviewed studies of the effects of PFOA and PFOS on laboratory animals (rats and mice) and were also informed by epidemiological studies of human populations that have been exposed to perfluoroalkyl substances (PFASs). These studies indicate that ***exposure to PFOA and PFOS over certain levels may result in adverse health effects, including developmental effects to fetuses during pregnancy or to breastfed infants (e.g., low birth weight, accelerated puberty, skeletal variations), cancer (e.g., testicular, kidney), liver effects (e.g., tissue damage), immune effects (e.g., antibody production and immunity), thyroid effects and other effects (e.g., cholesterol changes)."***

What about GenX? As mentioned, the Sun et al. (2016) paper listed GenX at 631 ppt at our water treatment plant. The DHHS, in a prepared statement of 6/12/17, stated that "there are no U.S. regulatory guideline levels for GenX." (http://news.nhcgov.com/wp-content/uploads/2017/06/GenX-Health-Effects-Summary-DHHS-6_12_17-PDF.pdf). However, they went on to say that in a 2-year European toxicity and cancer study on rats that a "Derived No Effect Level" was obtained. Using these values and U.S. risk assessment calculations, the DHHS stated that these no effect levels correspond to a concentration in drinking water of 70,909 ppt (>100 times the 631 ppt). This led DHHS to state that "GenX levels detected in 2013-2014 would be expected to pose a Low risk to human health." It should be noted that others (http://healthycanadians.gc.ca/health-system-systeme-sante/consultations/perfluorooctane-sulfonate/alt/perfluorooctane-sulfonate-eng.pdf) have proposed high acceptance levels for another PFAS, PFOS.

Contrary to the above, **multiple sources suggest lower exposure levels should be applied**, particularly until detailed studies are conducted. Dr. Knappe, one of original investigators, stated "It's irresponsible to…..tell people that the water is safe at those levels." More importantly there are two studies that have been published overseas dealing with these same issues. A Dutch Report was published in 2016 by the National Institute for Public Health and the Environment titled "Evaluation of Substances used in the GenX Technology by Chemours, Dordrecht" that suggested the effects of GenX are similar to PFOA (http://www.rivm.nl/dsresource?objectid=4dbc9941-4a77-44b7-9ff0-0cce0d7aac72&type=pdf&disposition=inline). There is also a several part study from Sweden in 2015 published In: Science of the Total Environment (http://www.diva-portal.org/smash/record.jsf?pid=diva2%3A1085404&dswid=-9989#sthash.V65aA60W.dpbs) by Gomis et al. One of these, ***Comparing the potency in vivo of PFAS alternatives and their predecessors***, stated that "some PFAS alternatives may have a higher toxic potency than their predecessors". The other paper titled ***A modeling assessment of the physicochemical properties and environmental fate of emerging and novel per- and polyfluoroalkyl substances*** states that "Even though the fluorinated

alternatives contain some structural differences, their physicochemical properties are not significantly different from those of their predecessors. Furthermore, most of the alternatives are estimated to be similarly persistent and mobile in the environment as the long-chain PFASs." A **discussion of the revision of this higher value (>70,000 ppt) to the current health assessment level of 140 ppt is given in Question #17.**

Three items of note:

a. CDC says most people in US have PFAS in the body; they measured the concentration of PFAS in blood of a sample population (older than 12) and found PFOA at 2.1 ppb (that is 2100 ppt); PFOS at 6.3 ppb, and PFHxS at 1.3 ppb. It would be interesting to determine the concentration of these in Wilmington residents and in fish for comparison.

b. It should be obvious from the above that more studies are needed. Following the testing of the waters to obtain the levels of the contaminants in the river, there must be work done by DHHS, DEQ, and EPA to determine "safe levels" of these contaminants. **And now, DHHS has issued a much lower risk assessment level – SEE #17.**

c. The Governor, NCDEQ, and DHHS have stated that they will be asking for additional impact studies and studies on human impacts to determine the properties and effects of GenX and other perfluorinated compounds.

17. The Department of Health and Human Services (DHHS) has now lowered (7/14/2017) their health risk assessment for GenX. What is that value and why did they lower it?

Answer:
As mentioned above, there is no federal standard for levels of GenX. DHHS can therefore issue what they call a health assessment that includes a health screening goal. DHHS states that a "health goal is a non-regulatory, non-enforceable level of contamination below which no adverse health effects would be expected over a lifetime of exposure." However, the health assessment value is not a hard and fast rule or boundary line of safe or dangerous.

DHHS is now reporting a value of a health risk level of 140 ppt for the "most vulnerable population – i.e. bottle-fed infants, the population that drinks the largest volume of water per body weight." This means there could be an increased risk of adverse health effects over a lifetime of consuming water with contaminant levels >140 ppt. The DHHS says that this value may continue to change with further studies/evaluation but that this level, which is a conservative estimate, should be "protective of other, less vulnerable groups including pregnant women, nursing mothers, children, and adults."

What changed to lead to this much lower recommendation? According to DHHS the following led to the change.
1. The preliminary assessment assumed drinking water was the only source of exposure; the update assumes only 20% of the exposure is from water. EPA uses a default factor of 20% when other exposure information is lacking*
2. Differences in the use of sub-chronic (shorter term exposure effects) versus chronic (long-term exposure levels) animal studies. Also other studies supported a lower level for different PFAS types.
3. After consultation with EPA, a different set of animal studies was identified to use as a starting point of study.

* There are other possible exposure sources like air, soil, and food; as these aren't known a more conservative value is used to try to account for the unknown.

Here is a summary of the variables and calculation that DHHS used to arrive at the 140 ppt level.

Important factors in the calculation are body weight, water intake, and percent coming from water versus other sources. Of high importance is the establishment of a reference dose which is a "daily exposure level without appreciable risk". These values are used to determine a Drinking Water Equivalent Level (DWEL), which is a provisional health goal. Adults have a higher DWEL because of the amount of water intake relative to body weight.

The formula is: **DWEL = RfD x BW ÷ Intake x RSC x Unit Conversion**
Where the variables for the DWEL = Drinking Water Equivalent Level are:
RfD = Reference Dose (daily oral exposure likely not to have an appreciable risk of deleterious effects during a lifetime); 0.0001 mg/day
BW = Body weight in kilograms (1 kg = 2.2 lbs); value used for infant 7.8 kg (17 lbs)
Intake = amount of water ingested from contaminant source daily (liters/day; one liter = 33.8 ounces); value used for infant 1.1 liters/day
RSC = Relative Source Contribution (amount coming from water; other sources are possible like air, soil); DHHS established 0.2 (20%)

Calculation from DHHS: DWEL = 0.0001 mg/day x 7.8 kg ÷ 1.1 L/day x 0.2 x 10^6 ng/mg = 141.8 ng/l or ppt (DHHS used 140 ppt).
(As stated, an 80 kg (175 lbs) drinking 2.1 liters per day would have a DWEL of over 700 ppt (5 x the infant level)

The press release of 7/14/2017 contains abundant information as well as the calculation of the new health risk assessment. Please refer to this document for further information. It is important to note that this, too, may be revised with new information but this value is much more in line with other PFAS warnings.
(https://ncdenr.s3.amazonaws.com/s3fs-public/GenX/NC%20DHHS%20Risk%20Assessment%20FAQ%20Final%20Clean%20071417%20PM.pdf)

18. Are there any correlations of health effects (cancer) in the area counties that utilize Cape Fear River water?

Answer:
DHHS released a cancer study summary of selected cancer rates for Bladen, Brunswick, New Hanover, and Pender Counties and their comparison to NC statewide rates. The rates do not ascribe causality, just rates of occurrence. Therefore, these cannot be linked to GenX or other contaminants. They are just statistics to show any abnormalities in rates of cancer incidence in the four counties relative to reported rates statewide. The comparison time frame is from 1996 to 2015. The listed types of cancer for comparison were liver, pancreas, testicular, kidney, and uterine. (https://www.ncdhhs.gov/news/press-releases/nc-dhhs-releases-summary-selected-cancer-rates-counties-cape-fear-region)

In summary, the "county-specific cancer rates examined here were not significantly higher than state rates, with the exception of testicular and liver cancers in New Hanover County during specific periods." The testicular cancer rate was higher during the entire 20 year period and the liver rate was higher during the 2006-2010 period. Only a comprehensive study can provide information on whether specific exposure/chemicals may be a link to the different cancer types.

NOTE: One of the issues with this comparison is using whole county cancer rates. It is important that we only look at those individuals that would be using predominantly river water for drinking. In this regard, the best comparison area to study would be restricted to Wilmington and northern Brunswick County where river water has been used for years. Many of the other locations in these counties use alternative water sources such as groundwater. Therefore, these would have little or no relationship to any river water contaminants.

Separating out individuals and areas to determine true rates is very difficult. These types of studies that need to sort out correlations and tracking individuals requires time and detailed studies.

19. Removal, and/or reduction to "safe" levels, of GenX and other perfluorinated compounds are of utmost importance. What methods have been found, if any, to remove them from the Cape Fear River water?

Answer:
This, and the determination of health advisory levels for the contaminants, are the most difficult but also the most important questions to answer. Just as in trying to determine a recommended "safe" level of contaminants in the water, the fact is there needs to be more testing and studies on what are the most effective methods of removing perfluorinated compounds from water. This is because conventional water treatment techniques (coagulation, aeration, oxidation, ozonation, chlorination, and granular filtration are mostly ineffective in removing PFASs from drinking water (https://www.ncbi.nlm.nih.gov/pubmed/24275109). CFPUA is working with the engineering firm Black and Veatch to determine what they can do to remove GenX and other compounds from the water. There are ways to remove the compounds but at varying efficiencies and costs.

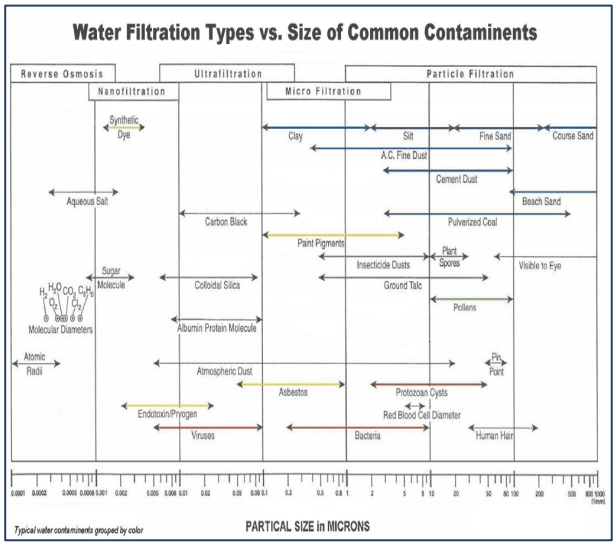
Of course, **the best thing to do is STOP the discharge of contaminants into the river.** This is obviously the safest and in the long run likely the most cost-effective method of removal. Chemours has agreed to stop discharge but sampling is continuing to ensure that is the case. Keep in mind there were 6, and maybe more, contaminants in the river that should be considered for removal as well (these are the 6 found in the Sun et al., 2016 paper).

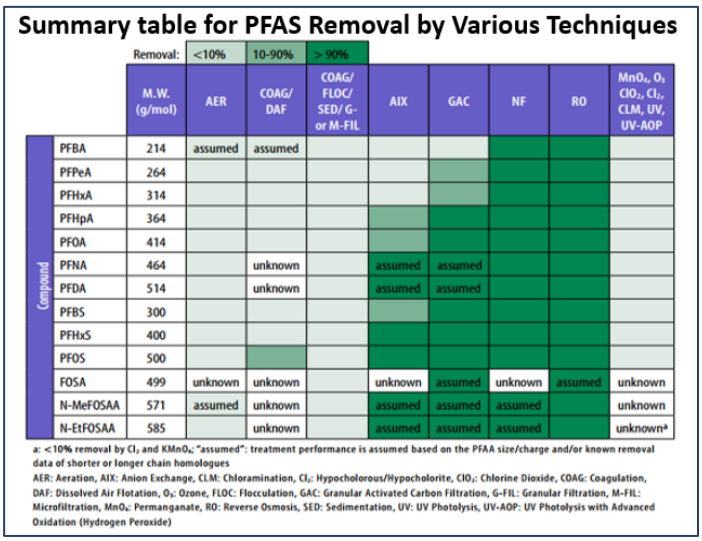
A few comments on removal are described below; note there are many more papers, this is just a summary. Many believe, and the table below shows, that the most effective removal is accomplished with Reverse Osmosis. However, Nano-Filtration, Granulated Activated Carbon, and Ion Exchange may be effective.

a. **Reverse osmosis (RO).** Simply put, reverse osmosis is a water purification process that takes place when pressure is applied to a solution (Cape Fear River water in this case) causing the water to pass through a semi-permeable membrane. The dissolved and suspended material in the water is trapped on the membrane and "pure" water passes through to the other side for use/drinking. Since RO removes dissolved materials from the water that "flavor" it, some components have to be added back in after treatment. The membrane is very effective at removing extremely small materials as shown in the figure below. **It is important to note that the substances that are removed from the water accumulate in the membrane. This material must be flushed from the membrane; therefore, disposal of this material must be considered**.

Several studies have suggested that RO is the most effective means of removal of perfluorinated compounds from water. One summary article (http://www.waterrf.org/resources/StateOfTheScienceReports/PFCs_StateOfTheScience.pdf)

is particularly instructive; the summary table below is from this source. Note that the RO column is shown to be >90% effective at removal of all of the compounds, including some of the shorter chain ones. This does not include GenX but it is believed that this would be removed, too. Detlef Knappe has presented results from home testing of RO units that show these home units effectively remove perfluorinated contaminants. It is important to realize that home units generate from 1 to 4+ gallons of waste water for every gallon of purified water. The waste water has to be disposed of and currently our wastewater plants can't remove the perfluorinated contaminants either.





(from Dickenson, E.R.V., and C. Higgins. 2016. Treatment Mitigation Strategies for Poly- and Perfluoroalkyl Substances. Denver, Colo.: Water Research Foundation

Table 2. Percent removal for most effective PFAS treatment technologies.

Site	#4	#4	#10	#10	#14	#14	#7	#20
Treatment	RO	RO	RO	RO	AIX	AIX	GAC	GAC
Sample date	12/6/2011	2/22/2012	1/9/2012	3/6/2012	5/30/2012	9/19/2012	8/21/2012	4/25/2007–4/22/2008
PFBA	>90%	>82%	N/A	>95%	−9%	0%	33%	−17%
PFPeA	>79%	>82%	>99%	>98%	0%	0%	74%	>22%
PFHxA	>97%	>98%	>99%	>99%	14%	−14%	91%	>68%
PFHpA	>81%	>86%	>98%	>95%	54%	38%	>89%	N/A
PFOA	>54%	>47%	>98%	>98%	76%	73%	>48%	>92%
PFNA	>87%	>87%	>98%	>95%	N/A	>67%	>37%	N/A
PFDA	>76%	>67%	>99%	>99%	N/A	N/A	N/A	N/A
PFUnA	N/A	N/A	>77%	>71%	N/A	N/A	N/A	N/A
PFDoA	N/A	N/A	>87%	>84%	N/A	N/A	N/A	N/A
PFBS	>93%	>98%	>96%	>94%	83%	80%	>96%	N/A
PFHxS	>95%	>94%	>96%	>90%	>97%	>98%	>96%	>41%
PFOS	>98%	>99%	>96%	>96%	>90%	>94%	>89%	>95%
PFDS	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
FOSA	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
N-MeFOSAA	>43%	>36%	>84%	>79%	N/A	N/A	N/A	N/A
N-EtFOSAA	N/A	N/A	>55%	>58%	N/A	N/A	N/A	N/A

N/A – not available.

http://www.sciencedirect.com/science/article/pii/S0043135413008932?via%3Dihub

Other studies that state RO is effective and often the best removal method include:

1. New Jersey Drinking Water Quality Institute (http://www.nj.gov/dep/watersupply/pdf/pfna-pfc-treatment.pdf) listed RO as removing 90% of PFAS. It also said nanofiltration was effective on these longer chain compounds.
2. Extensive look at multiple PFAS removal techniques, which is a followup to Appleman's Thesis Study. RO was found to be most effective, even for shorter chain PFAS. (Appleman, T., Higgins, C., Quinones, O., Vanderford, B., Kolstad, C., Zeigler-Holady, J., & Dickenson, E. (2014), Treatment of poly- and perfluoroalkyl substances in U.S. full-scale water treatment systems. Water Research, 51, 246-255).

b. **Nano-filtration** is also suggested to be effective. Nano-filtration removes solutes (chemicals dissolved in water) in the 0.001 micron (a micron is one millionth of a meter) while RO is effective to 0.0001 micron. Nano-filtration acts under a lower pressure than RO and is a somewhat cheaper process. This is the process CFPUA uses for groundwater at Ogden.

c. **Granulated Activated Carbon (GAC)**. As shown above, GAC is also effective at removal of many compounds. The New Jersey reference above states that it is 90% effective. Close monitoring and selective materials may achieve a measure of removal. This was stated to be the case by Robert Bowcock (assistant to Erin Brockovich) at the Water Forum in NHC where he said that BIO-GAC/bituminous coal filters would be relatively cheap, easy, and fast. However, there are other articles that suggest this is less effective than RO, particularly for shorter chain PFAS, including:

1. Appleman et al. 2014 (see above reference)
2. Xiao et al., 2017, (http://pubs.acs.org/doi/pdf/10.1021/acs.est.7b00970)
3. Sun et al., 2016, (http://pubs.acs.org/doi/abs/10.1021/acs.estlett.6b00398)

These filters would certainly have to be monitored/maintained to ensure continuing removal.

d**. Ion exchange** (like a water softener process that removes ions from the water), as shown in the table above, is apparently effective at removing some of the PFAS molecules. It does not appear to be as effective as the three methods above. Testing would need to be done on this process to ensure short-chain molecules like GenX is removed.

CFPUA is working with the engineering firm Black and Veatch to determine best methodologies. It is also of course looking at the most cost-effective methods. RO is most expensive; some have estimated fitting the Sweeney Plant with RO would cost ~$100 million. GAC could be done by replacing or adding filters and filter ponds. GAC is the method that CFPUA is currently testing (August 1, 2017).
All of these processes will concentrate PFAS, which will have to be disposed of as well. This is one issue with home filtration units as the waste is flushed into the wastewater stream of your house that then has to be treated by our water treatment plants.

20**. How long will these compounds remain in the environment and in your body?**

Answer.
As stated, these compounds are very stable, which is why they are likely to be long-lived in the environment. The EPA, in a March 2014 Fact Sheet titled "Emerging Contaminants – Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA)", listed the half-life (time it takes for ½ of the product to decay) for PFOS as >41 years in water and 114 days in the atmosphere and for PFOA as >92 years in water and 90 days in the atmosphere. In this same fact sheet the ½ life in humans was listed as 2 to 9 years for PFOS and PFOA. Studies have suggested that the shorter chain GenX has shorter residence times. This was one of the reasons that GenX was considered to be safer, even before studies were done.

21. What do I do about my water?

Answer.
Unfortunately, there are no easy answers to this question. It really is, at this time, a personal decision on use of Cape Fear River water for drinking, cooking, bathing, washing, etc. as there are limited health guidelines for GenX and few, or in some cases, no guidelines for many of the other PFAS compounds. DHHS has issued the health assessment level of 140 ppt for GenX.

Many comments have been made that ingestion is most problematic. Bathing/washing, dish washing, clothes washing are of less concern according to authorities (toxicologists, DHHS, etc.). These same authorities do admit that there are limited studies. However, ingestion is certainly deemed to be most hazardous if there are elevated levels.
Hopefully there will be much more information as testing has been recommended by DHHS, DEQ, and the Governor; testing does take a long time to both plan and conduct.

We do at least have five pieces of information on GenX.
a. DHHS has suggested a level of 140 ppt as a conservative threshold for lifetime exposure.
b. GenX levels in the river have declined to below 140 ppt (end of July, 2017); testing continues to ensure this value.
c. There are methods to remove perfluorinated compounds from the water with reverse osmosis likely the most effective.
d. Standard water treatment does not remove these contaminants
e. Boiling water does not remove the contaminants

As mentioned, there are numerous suggestions for water use.
1. DHHS has said, relative to GenX, that the water is safe to drink (amounts are less than the 140 ppt assessment level.
2. Others say that they use treated water (like RO) for drinking and cooking but that they use river water for bathing/washing, etc. The comment is that even if GenX is lower, there are other compounds we don't know about.
3. Some opt to not use the river water at all until more is known about these contaminants.

Residents have asked if they should have RO or when is CFPUA or other WTPs going to put a filtering RO or other GAC system in place. A couple of comments:

1. RO is expensive, particularly for large water treatment plants. H_2GO in Leland has proposed a $30 million RO plant for their customers. CFPUA has made a statement at the NHC Forum that it would be around $100 million to put in RO treatment at Sweeney. It is important to know the level of contaminants to design a treatment system. According to CFPUA they are investigating alternatives (RO, GAC, Nano-filtration, Ion Exchange, etc.). The first treatment test they are undertaking is GAC.

2. There are home RO units that range in price from ~$200 to $500. If you do decide to install one, make sure and review product reliability and warranties and how they operate. You should realize that there will be from one to four gallons of waste water for every gallon of useable water in these RO units. The waste water is from the cleaning of the membranes. The material that is removed from the water has to go somewhere – and that becomes part of the wastewater. However, the water you use is the water from the river so there is no net increase in contaminants in the river water.
Before you install you should consider the costs, the levels of contamination, etc. and make an informed decision.

3. Some companies have stated that GAC can remove some of these chemicals. Make sure and ask that tests have been done to show that PFAS can actually be removed and how to replace the activated carbon to ensure it is working.

4. Boiling Water. This does nothing to remove PFAS.

What are other alternatives:
1. You can purchase RO water by the gallon from numerous stores
2. CFPUA is providing groundwater (remember it is not contaminated at the Ogden Plant) from the nano-filtration plant at Ogden free of charge. You may go there to obtain water.
3. CFPUA has also partnered with some churches to provide dropoff and collection of groundwater for the community beginning July 31, 2017. Individuals may bring containers to the church between the hours of 9 – 11 a.m. every Monday, Wednesday, and Friday. They will be filled by volunteers at the Ogden Plant and be brought back to the church for pickup between 1 – 3 p.m.
The churches include:
Warner Temple AME Zion Church, 620 Nixon St., (910) 763-6308
St. Phillip AME Church, 815 N. 8th St., (910) 762-3573
Ephesus SDA Church, 1002 Castle St., (910) 762-7755

22. Final Comments as we are all anxious about the water.

The Centers for Disease Control (CDC) have provided interim guidance to aid physicians and other clinicians with information for patient consultations on PFAS. This June 7, 2017 summary is titled "An Overview of Perfluoroalkyl and Polyfluoroalkyl Substances and Interim Guidance for Clinicians Responding to Patient Exposure Concerns" (https://www.atsdr.cdc.gov/pfc/docs/pfas_clinician_fact_sheet_508.pdf). **It is not about GenX but really more about the contaminants PFOS and PFOA as EPA has provided a health advisory level for these compounds;** but all of these are PFAS. One of their comments deals with water containing levels of PFOS and PFOA above the EPA health advisory levels of 70 ppt. They say, if you are concerned, you can reduce exposure by using alternative water sources for drinking, food preparation, cooking, brushing teeth or any other ingestion of water. This provides a potential suggestion for our waters if you are concerned and that is to use alternative water for ingestion until: the level of contaminants are known, the potential health impacts are known, and/or the chemicals have been eliminated from the discharge or treatment is available to remove the chemicals from the water. Remember, DHHS has now provided some guidance for health effects. And DEQ, CDC, EPA, and the Governor have all determined that more must be done to ensure our waters are safe.

CFPUA began (7/14/17) to offer free groundwater from their Ogden facility for those feeling they need to use an alternative source of water. Other church sites are now available for pickup of water from that plant. There are also stores/businesses that offer RO refill water at cheaper prices than new purchase of waters.

It would be great if there were a simple answer to this issue. There is NOT. However, keep asking questions of your water utility, keep up with the water testing to determine the level of contamination of the multiple contaminants in the water, and make as informed decisions as possible.

As stated at the beginning of these questions, this information is just intended to try and provide materials and references for your consideration and to house this information in one place. They are not a statement of advocacy, just information as is known from the stated reports. Updates will be made as warranted.

Water Analyses (https://www.ncwater.org/basins/Cape_Fear/GenXDataspreadsheet.pdf)

It is obvious from these values at the Chemours Facility that additional discharge was occurring from another source. Chemours reported this and said they would stop that discharge too. Discharge was stopped on July 12, 2017

HFPO-DA (GenX) Analysis June - July 2017

FRO Location	06/19/2017 results		06/26/2017 results		07/03/2017 results ppt		07/12/2017 results		7/17/2017 results		7/24/2017 results		QA Comments[1, 2, 3]
	Test America	EPA RTP, NC	Test America	EPA RTP, NC	Test America[4] 98957	EPA RTP, NC	Test America 99190	EPA RTP, NC	Test America 99305	EPA RTP, NC	Test America 99530	EPA RTP, NC	
Hoffer WTP Raw	N/A	N/A	N/A	N/A	13	4	<10	<10	<10	<10	<10		**EPA 7/03**: Below Limit of Quantitation (LOQ) of 10 ppt **TestAmerica 7/03:** SURR REC 24%, IS Low **TestAmerica 7/12:** SURR REC 25%, IS Low **EPA 7/12:** Below Limit of Quantitation (LOQ) of 10 ppt **EPA 7/17**: Below Limit of Quantitation (LOQ) of 10 ppt
Chemours outfall 002	39000	21760	19000	15250	30000	21530	3300	2430	830	713	150		**TestAmerica 6/19:** 50X dilution, DUPs 41000 and 36000 [13% RPD], SURR RECs 45 and 48%, MS DNR, IS Low for DUP and MS **EPA 6/19:** 20X dilution **TestAmerica 6/26:** 50X dilution, DUPs 18000 and 21000 [15.4% RPD], MS DNR **EPA 6/26:** 20X dilution **EPA 7/03**: 20X dilution **TestAmerica 7/03:** 50X dilution, DUPs 31000 and 28000 [10.2% RPD], MS DNR, IS Low **TestAmercia 7/12:** 10X dilution **EPA 7/12:** 20X dilution **EPA 7/17:** 20X dilution **TestAmerica 7/17**: 2X dilution, DUPs 850 and 810 [5% RPD], MS 88%, MS SURR REC 107% **TestAmercia 7/24:** DUPs 150 and 152 [3% RPD], MS 105%, MS SURR REC 73%
Bladen Bluffs Raw	580	501	36	31	240	168	310	77	70	54	51		**EPA 6/19:** 5X dilution **TestAmerica 6/26:** SURR REC 33%, IS Low **TestAmerica 7/03:** SURR REC 22%, IS Low **TestAmerica 7/12:** SURR REC 24%, IS Low
Bladen Bluffs Raw Duplicate	590		33										
Bladen Bluffs Finished	790		76		190		95		76	59	35		**TestAmerica 6/19:** 2X dilution, SURR REC 14%, IS Low **TestAmerica 7/03:** SURR REC 34%, IS Low **TestAmerica 7/12:** SURR REC 36%, IS Low
Smithfield Foods Well Field	<10		<10		<10		<10		<10	<10	<10		**TestAmerica 6/19:** SURR REC 9%, IS Low **EPA 7/17:** Below Limit of Quantitation (LOQ) of 10 ppt

WIRO Location	06/22/2017 results		06/29/2017 results		07/06/2017 results ppt		7/13/2017 results		7/20/2017		7/27/2107		QA Comments[1, 2, 3]
	Test America	EPA RTP, NC	Test America	EPA RTP, NC	Test America 99020	EPA RTP, NC	Test America 99263	EPA RTP, NC	Test America 99470	EPA RTP, NC	Test America	EPA RTP, NC	
International Paper Raw	810	703	73	41	160	158	110	60	86	74			**TestAmerica 6/22:** DUPs 810 and 810 [0%RPD], MS 101% **EPA 6/22:** 5X dilution **TestAmerica 6/29**: SURR REC 20%, IS Low **TestAmerica 7/06:** SURR REC 35%, IS Low **TestAmerica 7/13:** SURR REC 23%, IS Low
International Paper Raw DUP						162							
International Paper Finished	690	523	140	111	110	80	31	17	38	34			**TestAmerica 6/22:** SURR REC 45%, IS Low **EPA 6/22:** 5X dilution **TestAmerica 6/29**: SURR REC 19%, IS Low **TestAmerica 7/06:** SURR REC 48%, IS Low
NW Brunswick WTP Finished	910	695	51	52	150	125	110	51	83	69			**EPA 6/22**: 5X dilution **TestAmerica 6/29:** SURR REC 24%, IS Low **TestAmerica 7/13**: SURR REC 36%, IS Low
Pender Co. 421 WTP Finished	340	269	160	112	81	68	100	75	120	100			**TestAmerica 6/22:** SURR REC 8%, IS Low **EPA 6/22:** 5X dilution **TestAmerica 6/29:** SURR REC 43%, IS Low **TestAmerica 7/13:** SURR REC 41%, IS Low
LCFWSA Raw	830	629	67	72	150	119	130	88	67	57			**TestAmerica 6/22:** IS Low **EPA 6/22:** 5X dilution **TestAmerica 6/29:** SURR REC 24%, IS Low **TestAmerica 7/06:** SURR REC 33%, IS Low **TestAmerica 7/13:** SURR REC 24%, IS Low; MS 114%, MS SURR REC 18%, IS Low **TestAmerica 7/20:** MS 107%, MS SURR REC 67%
LCFWSA Raw DUP								89					
CFPUA Sweeney Finished	1100	726	110	100	97	87	110	81	120	95			**EPA 6/22:** 5X dilution **TestAmerica 6/29:** SURR REC 40%, IS Low **TestAmerica 7/13:** SURR REC 45%, IS Low
CFPUA – ASR Well	820	588	400	336	190	148	120	84	120	94			**EPA 6/22**: 5X dilution **TestAmerica 6/29:** SURR REC 25 %, MS 118% REC, IS Low **EPA 6/29:** 2X dilution **TestAmerica 7/13:** SURR REC 42%, IS Low
Wrightsville Beach Well No. 6										<10			**EPA 7/17:** Below Limit of Quantitation (LOQ) of 10 ppt
Wrightsville Beach Well No. 11	26	27	24	28	28	24	29	<10	44	37			**TestAmerica 6/22**: DUPs 26 and 25 [3.9% RPD] **TestAmerica 6/29**: SURR REC 34%, IS Low **TestAmerica 7/06:** MS 109%, MS SURR REC 60% **EPA 7/12:** Below Limit of Quantitation (LOQ) of 10 ppt

QA samples (Blanks, Duplicate & Spikes)

[1] The TestAmerica laboratory performs an isotope dilution methodology which employs internal standards which are arestable isotopically labeled analogs of the target analytes added to the sample prior to extraction. Physical and chemical properties of each labeled compound are virtually the same as its unlabeled native analog, thus any losses of the target compound that may occur during sample preparation or determinative steps will be mirrored by a simlar loss of the labeled standard. A recovery correction is then applied to sample results.

[2] Except where noted the associated MB, low-level LCS, mid-level LCS/LCSD and MS recoveries were in control for TestAmerica data. QC data not yet reported for EPA.

[3] The internal standard/surrogate is added to samples prior to the extraction step.

References for Further Reading (These are not all of the websites/references within the above summary; however, some of the are important references to keep in mind in this discussion)

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