PFAS Pollution in the Choctawhatchee River Basin: What Is It, How Dangerous Is It, and What Can Be Done About It?

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WHAT ARE PFAS CHEMICALS?

The per-and polyfluoroalkyl substances (PFAS) are a group of chemicals used to make fluoropolymer coatings and products that resist heat, oil, stains, grease, and water. PFAS are a group of synthetic chemicals that continue to be released into the environment throughout the lifecycle of manufacturing, processing, distribution in commerce, use and disposal (EPA, 2021). PFAS is included in clothing, furniture, adhesives, food packaging, heat-resistant non-stick cooking surfaces, and insulation. PFAS also includes perfluoro-octane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA). PFOS and PFOA are both fluorinated organic chemicals that are water and lipid resistant. PFOA (Teflon) initially was made by DuPont and was used in part to make non-stick cookware. PFOS was made by 3M and saw use in treatment of carpet, upholstery and fabric to make them stain resistant and or waterproof. Production of both PFAS and PFOS by these two companies began to be phased out in the early 2000's and are no longer produced in the U.S. However, there are hundreds of other PFAS compounds that are still manufactured here and most if not all pose health problems for humans and other organisms that are exposed. And, these earlier PFAS compounds are still in imported products and are being released to the environment. They are found virtually everywhere, including in the blood and bodies of most all human beings across the entire planet.

It is these health concerns of these compounds and their persistence in the environment, causing them to be labeled as "forever chemicals", that gives rise to the seriousness of our PFAS problem.

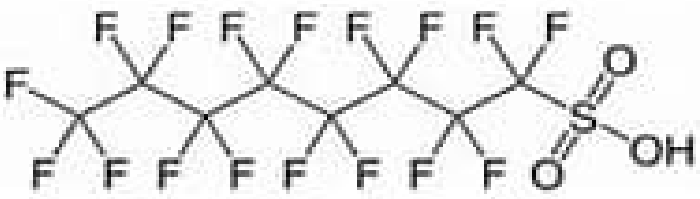


Image 1 PFOS Chemical Structure

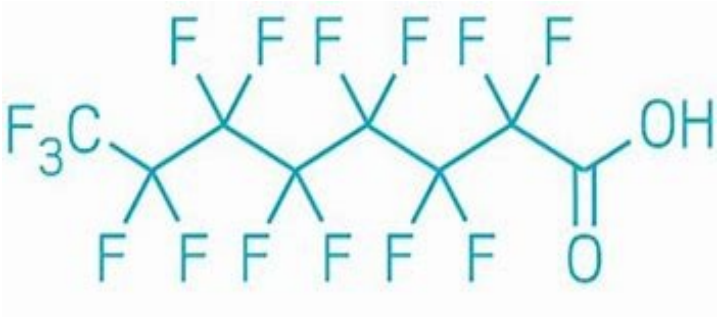


Image 2 PFOA Chemical Structure

Looking back , the first PFAS were invented in the 1930s and their development increased in the 1960s. As far back as 1950, studies conducted by 3M showed that PFAS could pollute people's blood. By the 1960s, animal studies conducted by 3M and DuPont revealed that PFAS chemicals could pose health risks. In the 1980s, both companies linked PFAS to cancer and found elevated cancer rates among their own workers.

So, many people have been exposed to PFAS chemicals and these chemicals are known to present health risks to those exposed. There are numerous health risks and the extent of these risks are by no means fully known.

What Are Some of the Known or Suspected Risks from PFAS Exposure?

There are over 10,000 PFAS compounds and the USEPA estimates that there are more than 600 PFAS chemicals in commercial use. Exposure is greatest for firefighters who have used foam agents containing PFAS and workers in facilities manufacturing PFAS or products containing PFAS. Everyone has likely had some exposure from drinking water, food wrappers and containers coated with PFAS to repel grease and water, contact with products that contain PFAS and critically people (and animals) eating fish containing PFAS.

PFAS can impact health at very low levels typically parts per trillion (PPT), even very low PPT concentrations, even undetectable concentrations when one looks at lifetime exposure in drinking water. Given the potential for PFAS compounds to be concentrated in fish tissue even non-detectable PPT water concentrations could produce levels in fish that put consumers at risk .

Current peer-reviewed scientific studies have shown that exposure to certain levels of PFAS may lead to:

- Reproductive effects such as decreased fertility or increased high blood pressure in pregnant women.
- Developmental effects or delays in children, including low birth weight, accelerated puberty, bone variations, or behavioral changes.
- Increased risk of some cancers, including prostate, kidney, and testicular cancers.
- Reduced ability of the body's immune system to fight infections, including reduced vaccine response. Interference with the body's natural hormones.
- Increased cholesterol levels and/or risk of obesity

However, health effects associated with exposure are difficult to specify (EPA[2], 2022).

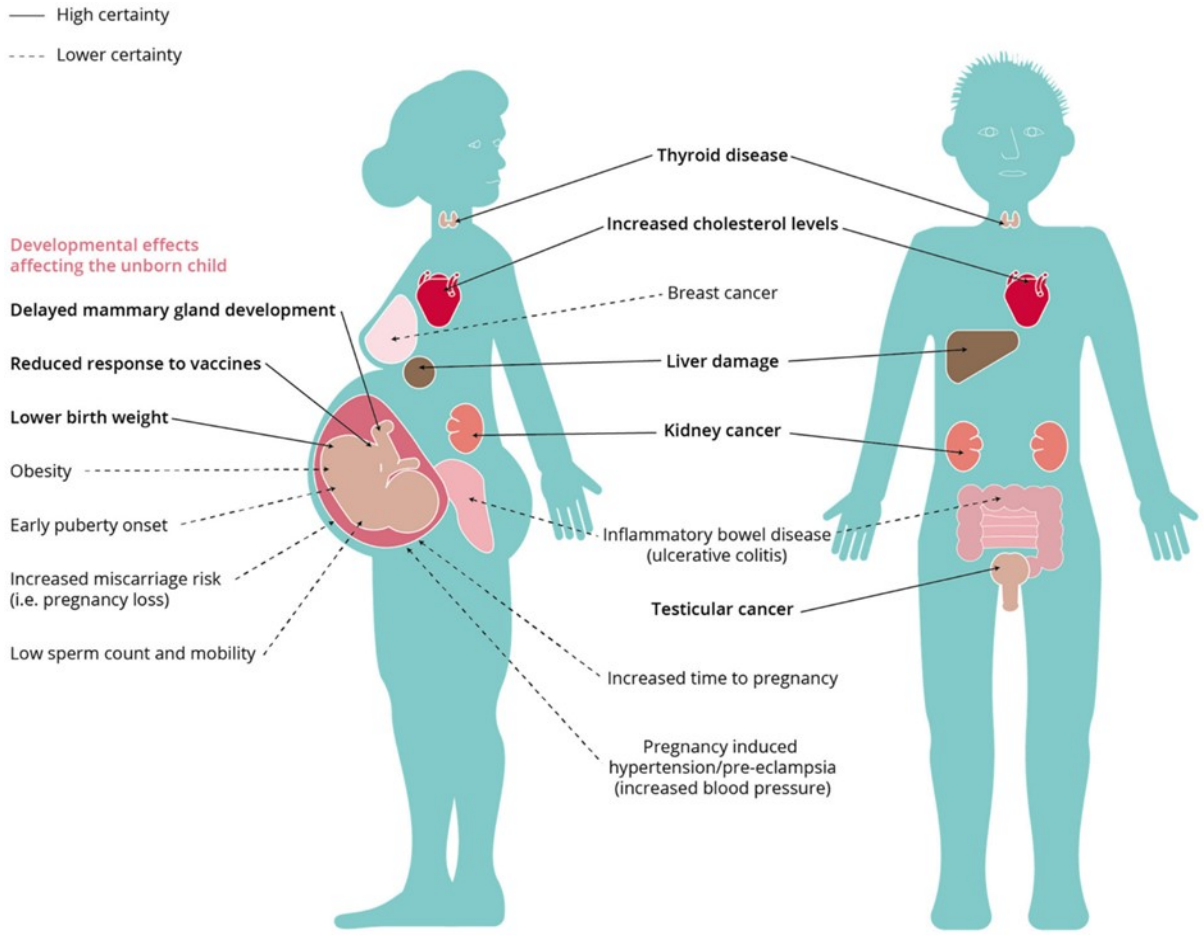


Image *Effects of per- and polyfluoroalkyl substances on human health from Environ Toxicol Chem.manuscript; available in PMC 2021 Mar 1. Published in final edited form as: Environ Toxicol Chem. 2021 Mar; 40(3): 606–630. Published online 2020 Dec 7.:10.1002/etc.4890*

Why Should You Be Concerned

It is difficult if not impossible to estimate increases in cancer and other diseases due to chemical exposure. It may take years of exposure before the onset of cancer or other diseases. If we look at U.S. cancer rates over time we find:

- While overall cancer cases continue to rise, the rate of new cases per 100,000 has decreased over the past 20 years. This trend is underscored by annual cancer deaths. There are likely some reasons for this in particular fewer people are smoking.
- The cancer mortality rate has fallen by more than 27% between 1999 and 2019 and nearly half of all new cancer cases come from four cancer types. The mortality rates have fallen due to earlier detection and improved treatments.
- Cancer rates are generally higher in industrialized countries due to higher pollution rates

The incidence rates of number of cancer type are increasing including breast and testicular cancers, two of the types that may be associated with PFAS exposure (National Institute of Health, n.d.).

PFAS chemicals are yet a new class of hazardous pollutants. Their persistence in the environment make them sort of like lead pollution, they are simply not going to go away in the environment, they simply do not break-down. The longer we delay in removing them from use, the higher levels we will be exposed to and the greater the health impacts will be.

If we look at cancer and a number of other diseases caused by environmental pollutants we find that in many instances the rates of occurrence are generally increasing. There are some exceptions such as for lung cancer in part from a reduction in the percentage of the population smoking and air quality regulations. The picture is also complicated because statistics are often in the form of cancer deaths. Fortunately, earlier detection and improved treatments has resulted in lower rates of death from many cancers. That however tends to ignore the long time frame, years if not decades for many cancers, before exposure leads to disease.

What Is Currently Being Done About Risks from PFAS?

The USEPA has established a roadmap for moving forward on PFAS. Water quality criteria have been established for a small number of PFAS compounds and EPA is working on others. The USEPA has directed states to require public water systems to monitor for PFAS and has increased the number of PFAS compounds for which they test. A grants program to help states deal with PFAS has been established by the USEPA. All of these actions are part of the USEPA PFAS Strategic Roadmap (EPA, 2021).

Public input is still being taken so this strategic road map is likely to change thus the detail will not be presented here. A reality is that the USEPA finds itself in a box. As unfortunately is the case in our system, health risks of products are too often ignored for far too long. Chemical companies produce and sell products without adequate consideration of and testing for health and ecological impacts. Subsequently when impacts begin to be known the profit-maximizing corporations delay action long past the time when the health and ecological issues are known. The list of chemicals for which this is the case is long, far too long - DDT, hexachlorophene, Polychlorinated by-phenols (PCBs), triclosan and triclocarban, bisphenol A, glyphosate (Roundup) and in the U.S. we still use 25 dangerous pesticides banned in other countries (Hunter, 2020).

Once a chemical is produced and is in common use in the U.S. it is difficult to ban or restrict its use. PFAS compounds are utilized in so many products that Choctawhatchee Riverkeeper doubts the political will exists to ban use of these chemicals as the risks should warrant. Only when the public gets angry and loud about the problem will anything be done. The absence of an abundance of caution being applied to the production

and use of potential hazardous chemicals results in an undue burden of chemical pollution on people and the environment. In a very real sense citizens and the environment are being used as guinea pigs.

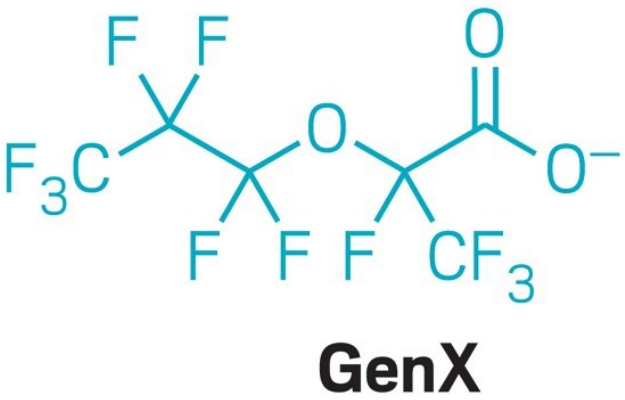
U.S. Environmental Protection Agency Lifetime Drinking Water Health Advisories

The USEPA has set Lifetime Drinking Water Health Advisories for 4 PFAS compounds or groups of compounds. The compounds and the advisories are in Parts Per Trillion (ppt).

- PFOA 0.004 ppt
- PFOS 0.03 ppt
- GenX 10 ppt
- PFBS 2000 ppt

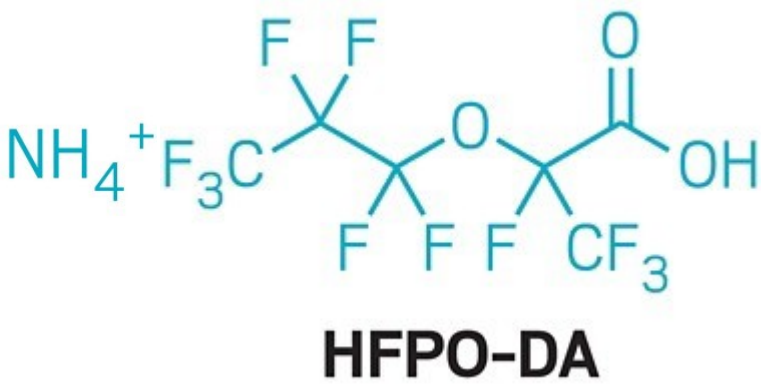
There is significant doubt about the advisories being set by the USEPA at this time. These advisories could change rapidly and significantly as they already have. EPA's initial evaluation of two compounds GenX and HPP-DA showed those compounds to more dangerous than previous assessments suggested, even more dangerous than PFOA. This suggests the already released advisories for PFOA, PFOS, GenX and PFBS likely could be reduced (Hogue, 2021).

This information perhaps reflects the tremendous pressure that the EPA is under to do the research needed to do the toxicity and health studies for these compounds. The problem is a symptom of our economic political system in which dollar concerns too often override science. Chemical companies must be held accountable for doing exhaustive toxicity and health studies before a new chemical goes into widespread production and use. In the case of PFAS chemicals the chemical companies knew about the problems with these compounds at least 25 years ago or longer. They, not the taxpayers, should face the cost of dealing with treating water to remove PFAS from drinking water systems, landfill leachate and even contaminated soil from sites were PFAS has contaminated the soil.



GenX

Image 4: Genetic makeup of GenX US EPA deems two GenX PFAS chemicals more toxic than PFOA (acs.org)



HFPO-DA

Image 5: Genetic makeup of hexafluoropropylene oxide dimer acid US EPA deems two GenX PFAS chemicals more toxic than PFOA (acs.org)

What Is the Situation Here In Alabama and What Might and Should Be Done?

As one should expect PFAS concentrations in surface waters here in Alabama are highest near major sources.

River Basin	Total PFOA (all values are in ppt)
Alabama	96.4–108 (100)
Black Warrior	2.35–40.76 (12.6)
Cahaba	8.50–29.4 (17.6)
Chattahoochee	21.4–43.5 (28.8)
Choctawhatchee	n.d.-63.8 (17.0)
Conecuh	n.d. (n.d.)
Coosa	155–237 (191)
Escatawpa	n.d. (n.d.)
Mobile Bay	8.48–56.7 (24.7)
Perdido	n.d. 6.75–29.0 (20.5)
Tallapoosa	n.d. 5.56–14.0 (9.76)
Tennessee	9.17–35.6 (20.4)
Tombigbee	n.d. 6.33–9.05 (7.94)
Yellow	n.d. (n.d.)

n.d. = not detected.

Detection Frequency (%) Ranged from 14.9 (PFBS) to 74.3 PFOS

Viticoski et al

Choctawhatchee Riverkeeper (CRK) PFAS Data Parts Per Trillion (ppt)

Choctawhatchee River Basin

TEST SITE	PFOS	PFOA	PFAS PRIMARY 11	0THER PFAS	TOTAL PFAS	LAT	LON
PEA RIVER AT HWY 10	1.3	ND	1.3	ND	1.3	31.714548	-85.70666
PEA RIVER AT US 231	1	ND	1	ND	1	31.595223	-85.782899
WALNUT CREEK AT CR 3304	3.7	2.5	21.9	2.3	24.2	31.728739	-85.925889
WHITEWATER CREEK AT CR 224	1.5	1.9	10.7	ND	10.7	31.505745	-86.031418
LITTLE CHOC. RIVER AT CR 121	5.8	1.8	15.2	ND	15.2	31.272622	-85.647883
CHOCTAWHATCHEE RIVER AT US 84	14.2	3.8	39.3	5.8	45.1	31.275084	-85.678386
CHOCTAWHATCHEE RIVER AT HWY 92	5.3	2	14.5	ND	14.5	31.235767	-85.689681
LITTLE CLAYBANK CREEK AT U.S. 231	11.2	1.9	27.5	ND	27.5	31.458414	-85.666695
CLAYBANK CREEK AT AT US 84	21.1	6.2	62.3	13.1	75.4	31.345307	-85.615719
PEA RIVER AT COFFEE CR 147 *						31.521033	-85.868622
HURRICANE CREEK AT HUTTO PARK *						31.345307	-85.615719
HURRICANE CREEK AT HWY 134 *						31.34822	-85.614204
WEST FORK CHOCTAWHATCHEE RIVER AT HWY 27 *						31.411004	-85.534957

*Additional Data from Another Study That Is Looking at PFAS in Both Water and Foam Is Expected Soon

Comparison of Choctawhatchee River Basin and Viticoski Data for the Basin

CRK Data	Min.	Max.	Avg.	Viticoski et al Data	Min.	Max.	Avg.
PFOS	1.1	21.1	7.24	PFOS	ND	19.1	3.82
PFOA	ND	6.2	2.23	PFOA	ND	14	2.8
PFAS 11	1	62.3	21.52	PFAS 11			
Other	ND	13.1	2.36	Other			
Total	1	75.4	23.87	Total	ND	63.8	17

Data collected by Choctawhatchee Riverkeeper for surface water compares well with the Viticoski data for the watershed as indicated in the table above. Total PFAS numbers are particularly consistent between the data sets.

How Does the Situation in the Choctawhatchee Basin Compare with Other Alabama River Basins?

When compared to statewide data the average total PFAS in the Choctawhatchee is lower than in 7 river basins and above that in 6 river basins. The PFAS levels in water suggest that if drinking water were to be sourced from surface water in the basin that most if not all sources would likely need to be treated. It also suggests that PFAS levels in fish tissue may be a problem.

These PFAS numbers indicate that there are sources across Alabama and in the basin that need to be minimized or eliminated. Insufficient data both on health impacts and source concentrations make it Impossible to say which or how many wastewater treatment systems and landfills should prepare to treat wastewater and leachate to remove PFAS. There may be sites where PFAS containing firefighting foams have caused soil contamination to the extent that cleanup is warranted. In short a lot more data on PFAS is needed. PFAS in water supplies, PFAS in fish and PFAS in the blood of the most vulnerable populations.

Contamination of drinking water supplies are another issue nationally, across Alabama and perhaps some sites in the Choctawhatchee River basin. All of the public water systems in the Alabama portion of the Choctawhatchee River basin are groundwater and are from confined aquifers that one would expect are somewhat protected from surface contamination. That is a good thing as groundwater in the basin is less likely to be contaminated with PFAS than groundwater from unconfined aquifers. However, surface and groundwater systems are connected and water sources can be contaminated by PFAS in landfill leachate entering groundwater systems and waterways can discharge to groundwater. The first is a more likely source of contamination.

What Actions Should Be Taken to Address the PFAS Problem?

The National Effort

Nationally the USEPA and the CDC should be working to create water quality advisories and eventually criteria for PFAS. The USEPA has started that process with its PFAS roadmap. That process is necessary and addresses PFAS already out in the environment. CRK believes that process is likely to move to slowly, is not addressing critical exposure sources, is paying too little attention to the problem other that of public water supplies and is not a final, satisfactory solution.

The biggest flaw in the establishing of water quality advisories and criteria one or even a few PFAS compounds at a time assures that the process will be very slow and that falls into the trap set by the PFAS manufacturers. It appears that the industry moved to create and use PFAS compounds that would perhaps stay in the body less time, be more easily broken down in the body and in the environment. The problem with this is the toxicity, carcinogenic properties and other health effects, are due in large part to the highly electronegative nature of fluorine and molecules that contain it. Making smaller molecules and making molecules that break down a little faster probably will not reduce the overall dangerous nature of PFAS compounds in a meaningful way.

The USEPA should set advisories based on total PFAS concentration or on totals for several groups of PFAS and look at phasing in PFAS bans for most uses. EPA should evaluate the risks and benefits of every use and every product that contains PFAS. It should be rather easy to ban many uses such as coatings on food packaging, use in paints, use in pesticides. But it should be on the producers to demonstrate that there are zero alternatives to PFAS uses or products and that products are essential or production should be banned.

The funding made available to states to the EPA for managing PFAS problems seems huge. There is a billion in the infrastructure bill, 3.4 billion in drinking water State loan funds (SRF) and 3.2 billion in Clean Water Funds going to the states. However, that is probably a drop in the bucket compared to the ultimate need. The companies that knew about the dangers of PFAS long ago and have profited and still profit from making and selling PFAS should, not unlike the tobacco companies, be held responsible for funding much of the PFAS cleanup effort (EPA[2] , 2022).

The State Effort

Alabama/ADEM, in response to USEPA direction, is stepping up requirements for water systems to test for more PFAS compounds. That is much needed. ADEM should also require landfill operators to test leachate and groundwater for PFAS compounds and soil and groundwater should be sampled and tested at locations

where firefighting training was done using PFAS containing soils. ADEM should also add PFAS compounds to its fish tissue analysis program and focus initially where surface water concentrations are higher. Fish tissue results should be added to existing fish consumption advisories.

The state might also consider setting its own criteria for PFAS compounds, similar groups of PFAS compounds or total PFAS if the USEPA does not speed up that process. Alabama might consider filing suit against companies whose manufacture or use of PFAS have caused significant contamination of surface water or groundwater. Funds secured should be applied to reducing PFAS in water supplies and treating wastewater and landfill leachate to reduce further water pollution. Finally, Alabama might seek to ban use of PFAS compounds in the state unless the use is essential with no alternative and ceasing use would not endanger public health.

In order to begin to facilitate the needed actions the state should create a map containing WWTP locations, landfill locations, drinking water surface water intake and well locations. A map has been drafted for Choctawhatchee Riverkeeper and is Figure 6.

Local Actions That Might Be Taken

Local water systems are testing for PFAS compounds and need to continue doing so. Where elevated PFAS concentrations are found water systems with multiple existing or potential water sources should switch to the least polluted source available. Technologies for removal of PFAS compounds primarily involve filtration. Filtration should be applied until and unless better technologies are developed. Critically, the filter media should not be burned or landfilled as both of these are poor solutions as PFAS can be returned to the environment. PFAS can be removed from some filtration media using appropriate technologies. The recovered PFAS will need to be destroyed. It is likely that there will soon be reliable and affordable methods for destruction of recovered PFAS compounds (Morris, 2022).

Some households may want to employ home filters and communities might choose to help people select, purchase and install effective home filters. It is uncertain and probably unlikely that the Alabama Legislature will choose to ban PFAS or PFAS products from being made or imported into Alabama. Municipalities likely do not have authority to ban chemical use bit they might want to work to change that to protect their citizens.

Concerned Individuals

Persons concerned about public health and the environment might consider following the national and state efforts to clean up PFAS. They might join or follow the efforts citizen environmental organizations working on the PFAS issue.

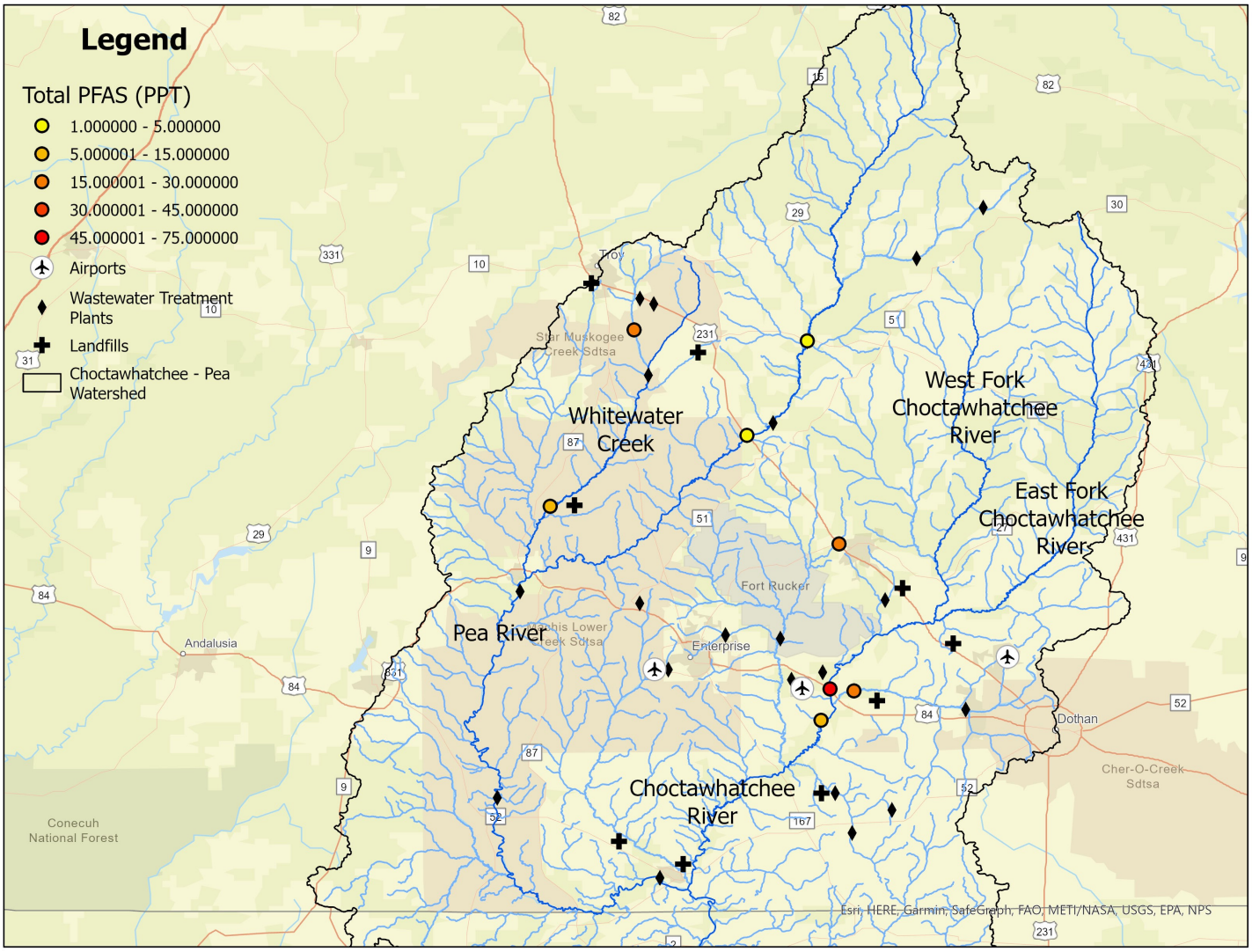


Figure 6 Map Showing Current Data and Potential PFAS Sources in the Alabama Portion of the Choctawhatchee River Basin (Note: This map does not include closed landfills as location for many if not most of those landfills is not readily available).

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