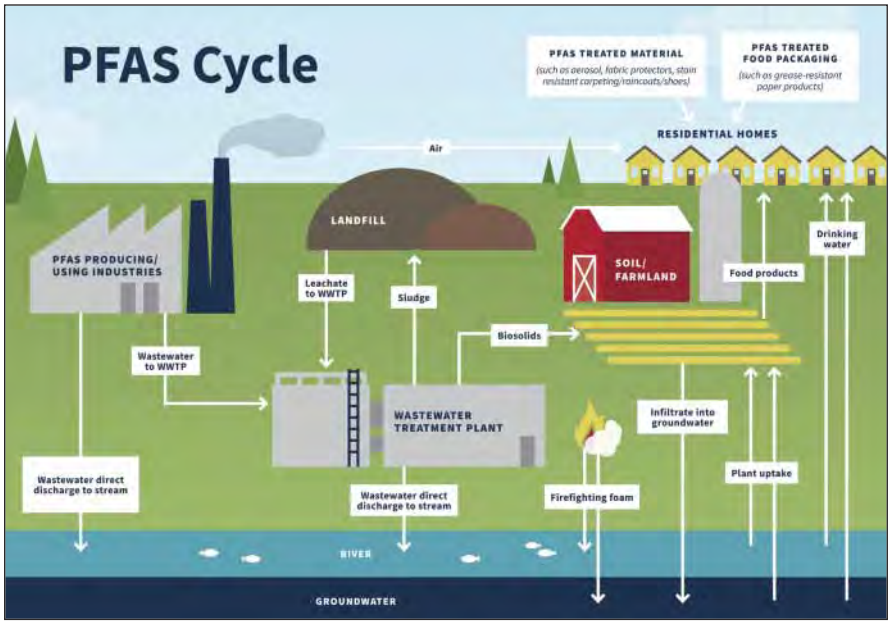
By Douglas Helmke, P.G., Water Rights / Source Water Specialist

PFAS Regulatory Update

Kansas Rural Water Association has not provided much information about the emerging "new" class of contaminants, the PFAS. The "conversation" started when the Environmental Protection Agency came to Leavenworth, Kansas, and invited the state water quality protection agencies of their Region 7 and beyond, plus others, to a community engagement event in 2018. There just wasn't that much to report then. But it appears that PFAS are not going away, so let's get started with the basics.



This graphic representation of our environment shows the cycling of PFAS compounds from industrial plants to rivers and soil and eventually to drinking water. (Graphic by Michigan Department of Environment, July 2019)

What are PFAS?

PFAS is an acronym for per- and poly-fluoroalkyl substances. A hydrocarbon is a molecule that is primarily made of hydrogen (H) and carbon (C) atoms. A hydrocarbon stripped of its hydrogen atoms and replaced with all fluorine (F) atoms is perfluorinated. A hydrocarbon molecule where one or more hydrogen atoms remain, but where at least two of the carbon atoms are attached to fluorine atoms is polyfluorinated.

The chemical bond between a carbon atom and a fluorine atom is one of the strongest known. Because of this, these molecules and the smaller remaining molecules from degradation processes, have persisted in the environment. These "forever chemical" molecules that remain usually have a "tail" of carbon and fluorine with a positively or negatively charged "head" which can be any number of different chemicals. The composition of the head determines the functional groups of these molecules, but those of most concern are the carboxylic and sulfonic acids.

More than 4,700 different PFAS compounds have been registered with the Chemical Abstract Service. The EPA lists more than 7,800 PFAS compounds. Most of these are large molecules and aren't mobile in the environment and aren't perceived to be a major threat. Public health professionals are primarily concerned, at present, with six environmentally-mobile molecules identified as PFOA, PFOS, PFHpA, PFHxS, PFNA and GenX. There will be more about these molecules later in this article. For those who enjoy chemistry and want to learn more about the chemistry of PFAS, I recommend the Per- and Polyfluoroalkyl Substances Draft Chemical Action Plan published by the Washington State Department of Ecology and Department of Health.

Where did they come from?

With World War II interrupting the importation of many traditional raw materials like rubber and silk, chemists and chemical engineers joined the war effort to develop synthetic products from the raw materials that we already had like petroleum and natural gas. The technology that resulted in the research to develop materials that would help us win the war was applied to consumer products marketed world-wide after the war.

It would be difficult to find anyone today who hasn't worn stain- and water-repellant fabrics in a winter coat, a rain suit, and breathable, waterproof boots and shoes. Millions of homes and offices have had stain-resistant carpeting installed. Who hasn't owned a skillet or a frying pan with a non-stick coating? As a teenager, I remember using a waterproofing product sprayed on the jeans I wore skiing in Colorado, as I couldn't justify the cost of "bibs" for my first ski trip to Winter Park. Foams used to smother the fires and possible combustion of fuels and other flammable liquids have probably been used at every airport that has a specialized fire-fighting department. All of these products contained, or used PFAS, in their creation.

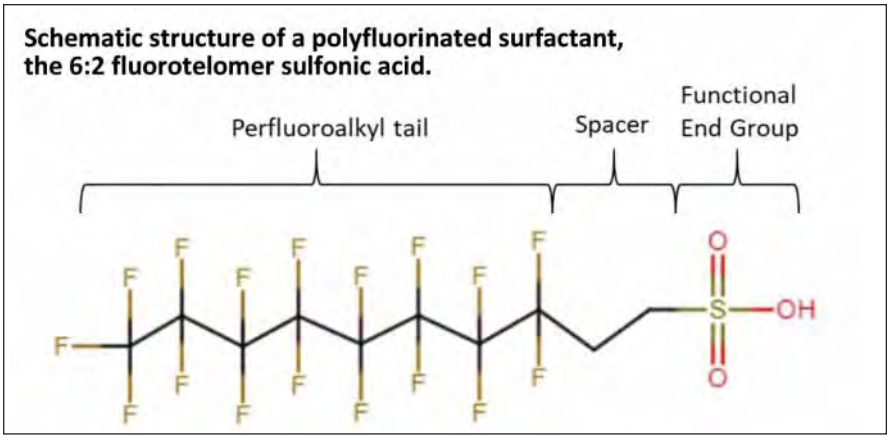
Before we go any further, let's review the individual PFAS that appear

in the environment, in a stable and mobile form, that may or may not be regulated.

The Centers for Disease Control and Testing (CDC) has measured the concentration of twelve different PFAS compounds in the blood serum of participants in the National Health and Nutrition Examination Survey since 1999. Nearly all of the participants (from ages three to adult) had some amount of perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorohexane sulfonic acid (PFHxS), perfluoroheptanoic acid (PFHpA) and perfluorononanoic acid (PFNA) in their blood serum. (GenX, a replacement for PFOA and first used in 2009, has been identified in North Carolina's environment. It was not part of the CDC survey.) These compounds have been found in soil and water worldwide. They have been found in fish and polar bears. These compounds have been able to move through the atmosphere, surface and groundwater, and food chains of wildlife, domestic animals and humans. While the distribution of these contaminants may sound alarming, the manufacturers of the compounds that degrade into these PFAS has been working to phase-out these compounds since the early 2000's. Unfortunately, China has only recently said they will also move to phase-out these PFAS. It's also encouraging that the concentrations of PFAS in the health survey participants' blood appear to be decreasing.

It would be difficult to find anyone today who hasn't worn stain- and water-repellant fabrics in a winter coat, a rain suit, and breathable, waterproof boots and shoes.

Schematic structure of a polyfluorinated surfactant, the 6:2 fluorotelomer sulfonic acid.



The chemical drawing of the perfluorooctane sulfonic acid (PFOS) molecule is shown above. PFOA, or perfluorooctanoic acid, is similarly constructed, except the head of the molecule contains a Carbon atom (C) bonded to an Oxygen atom (O) and a hydroxyl (O-H), instead of the Sulphur atom (S) bonded to two Oxygen atoms and a hydroxyl. (Graphic image from State of Washington Draft Chemical Per-and Polyfluoroalkyl Substances Draft Chemical Action Plan / October 2020, Publication No. 20-04-035).

Why are we hearing about this now?

Because studies show that these stable compounds tend to bioaccumulate and that PFAS have even been measured in breast milk and umbilical cord fluids, there is a strong push to find these PFAS pathways and to find and address the contaminant hotspots. Limited research on oral ingestion of PFAS suggests that adverse effects of ingestion could be developmental defects in fetuses and infants, cancer, liver function impacts, immunity and thyroid function impacts.

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The EPA issued a PFAS Action Plan in February of 2019 which was to explain the need for a comprehensive, multi-channel effort to understand everything that would be needed solve the problem, to include all federal agencies, state environmental departments, tribes, industry groups and associations, local communities and the public. While an explanation of the Action Plan could be an article or series of articles in itself, know that the plan addresses what is known about PFAS and what isn't known. Drinking water is believed to be the most significant source of the PFAS found in blood serum. This should cause public water utilities to be concerned about the cost of treatment upgrades and the restrictions that may be placed on wastewater discharges and the disposal of biosolids that contain PFAS.

The third Unregulated Contaminant Monitoring Rule (UCMR3) was published in 2012 which required water systems serving a population greater than 10,000 people to provide water samples to be tested for 6 PFAS contaminants. The testing results show that 1.3 percent of those systems had PFOA & PFOS greater than 70 parts per trillion (PPT).

In May of 2016, the EPA established a Health Advisory for total PFOA & PFOS at 70 PPT for drinking water, limiting the lifetime exposure to these chemicals to a safe level. There is no maximum contaminant level (MCL) for total PFOA and PFOS at the time of this writing, or any of the other PFAS forever chemicals, although a MCL was anticipated to be proposed sometime in 2019. Likely in part because the EPA has not proposed a MCL, some states have taken it upon themselves to propose and in some cases adopt MCLs for drinking water and action levels for groundwater clean-up. The state of New York, for example, has proposed an MCL of ten (10) PPT for drinking water for PFOA and PFOS.

The EPA issued a Program Update to the Action Plan in February 2020, which stated that the fifth Unregulated Contaminant Monitoring Rule (UCMR5) was to be proposed in mid-2020. This monitoring was to include testing for almost 30 different PFAS. The EPA web site provides no updates

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to this rule's progress since October of 2019, however. It is unknown if COVID-19, political actions, another unknown cause, or all the above have delayed the previously stated research and enforcement schedule.

One of the 2019 Action Plan's short-term goals is to develop and validate methods to test for PFAS in media other than water. This includes solid material like sediment, soil, biosolids and tissue. It also includes various vapors such as indoor and ambient air and gases discharged from stacks. With new testing methods, a survey of the areas around PFAS manufacturing sites, airports and military facilities, and biosolid disposal sites will be possible.

What does this mean for Kansas?

Problematic for water systems are the legacy industries that used PFAS containing products. The biggest problems in Kansas will likely be for those water systems that have sources of supply close to facilities that used aqueous film forming foams (AFFF) used for firefighting. Military facilities, major airports, refineries and firefighting training facilities likely will have soils and groundwater contaminated by PFAS. Not by coincidence, the EPA held their community engagement event in Leavenworth because PFAS were found in the drinking water source (groundwater) at Fort Leavenworth at levels at many times higher than 70 PPT. The Fort is now supplied with drinking water from the Leavenworth WaterWorks which serves the city.

The Kansas Department of Health and Environment attended the event in Leavenworth, and pledged to work cooperatively with the EPA. The Missouri Department of Natural Resources said that no community water systems in their state exceeded the Health Advisory level and did not think a nationwide MCL was necessary. The web page of a national environmental watchdog shows that only three public water systems in Kansas have had detections of PFAS. They are Fort Leavenworth (2017 - 2018), Fort Riley (2016 - 2018) and the City of Great Bend (2015). The results reported for the City of Great Bend was for PFHxS which has no EPA Health Advisory limit. The concentration of PFHxS was below 70 PPT and no PFOA or PFOS were detected. Fort Riley was also under the 70 PPT Health Advisory when all PFAS were combined.

KDHE has contracted with a consulting firm to develop a state-wide inventory of possible PFAS contamination sites. It includes (possibly) every wastewater system, trash hauler, railroad derailment with a fire, airplane crashes with and without fires, etc. It is unclear if this inventory will be useful for finding PFAS contamination sites or in source water protection activities.

Conclusion

If PFAS are as persistent and pervasive as they appear, every water and wastewater system will need to understand how they will be impacted by these contaminants individually and as an industry. National Rural Water Association rightly believes that the cost of any regulation of these man-made chemicals, which are in the surface water, groundwater, wastewater and biosolids by no fault of their own, should not be borne on the backs of the water systems or their customers. Legal teams representing all parts of the PFAS-world have been gathering data and clients to influence regulatory decisions. And while researchers investigate new filters and treatment methods, including a strain of bacteria that has been found which has the capacity to break down PFAS, the application techniques and effectiveness on such small concentrations for water and wastewater treatment are not yet known. KRWA will provide news of any discoveries, decisions and actions taken by the EPA and others as information becomes available.

Routes of PFAS Exposure

(from the EPA Per- and Polyfluoroalkyl Substances (PFAS) Action Plan, 2019)

- Drinking water from public water and private water systems, typically localized and associated with a release from a specific facility (e.g., manufacturer, processor, landfill, wastewater treatment, or facilities using PFAS-containing firefighting foams);
- Consumption of plants and meat from animals, including fish that have accumulated PFAS;
- Consumption of food that came into contact with PFAS-containing products (e.g., some microwaveable popcorn bags and grease-resistant papers);
- Use of, living with, or otherwise being exposed to commercial household products and indoor dust containing PFAS, including stain- and water-repellent textiles (including carpet, clothing and footwear), nonstick products (e.g., cookware), polishes, waxes, paints, and cleaning products;
- Employment in a workplace that produces or uses PFAS, including chemical production facilities or utilizing industries (e.g., chromium electroplating, electronics manufacturing, or oil recovery); and
- In utero fetal exposure and early childhood exposure via breast milk from mothers exposed to PFAS.

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