Thanks to Nikki Fitzgerald for these answers. I really appreciate the expertise she brings to this area given her extensive research on PFOA's. To amplify this I would explain that the half life of a chemical in the human body is the number of years before only half of a dose remains. In other words if you absorb 10 grams of a substance, and the half-life is 2 years, then at the 2 year mark you will still have 5 grams remaining in your body. It is hard to get good data on PFOA's but it is known that Rhinelander has PFOA levels in their drinking water that measure about 172. The EPA limit is set currently at 70. There is in my opinion very little science as to what this limit should actually be, but some chemicals have been determined to have no acceptable presence in drinking water A number of states have set limits considerably lower than the EPA limit. I have been told that the EPA has considerably more data on PFOA's in drinking water supplies that they have not currently released. I don't know why it is not available. Most of the reverse osmosis systems have a carbon pre-filter so they should get most of the organics like atrazine (think 2-headed frogs) and all the other pesticides and herbicides. In addition to taking out the heavy metals like lead and mercury, the reverse osmosis should take the iron stain out of toilets etc. Of course, a reverse osmosis system is more expensive than a 20 dollar Instapure charcoal filter on the kitchen tap.

See my answers to Mark's questions regarding perfluoroalkyl substances (PFAS) below:

1) How many forever chemicals are out there?
There are thousands of PFAS out there. Of these thousands we only have toxicity data on maybe 30 at the most.

2) how hard is it to determine toxicity?
Extremely difficult! Toxicity testing on animals/organisms is very expensive (a few grand for a simple test on bacteria up to millions of dollars for animal tests). The tests can also take a lot of time (months to years), especially if you are looking at chronic toxicity.

It is much more difficult to draw toxicity conclusions from humans since we cannot knowingly feed humans potentially toxic chemicals. In order to draw definitive conclusions from humans we generally have to wait until a disaster happens and then study what happens to the humans after. For example in order for a chemical to be listed as a known carcinogen, some humans had to have been exposed to that chemical and gotten cancer from it.

For example, TCE is a known carcinogen because workers at a manufacturing plant were using it to wash their dishes and then got cancer. Similar compounds are only expected carcinogens because they cause cancer in animal studies but humans did not ingest them in large amounts so there was no 'human study'

In regards to PFAS, there was a very comprehensive study out of Parkersburg, West Virginia (see the Netflix Documentary the Devil we Know or the blockbuster movie Dark Waters). Essentially, DuPont was releasing high concentrations of one type of PFAS, perfluorooctanic acid (called C8 in the movie and documentary) into the local river/water supply. The people were drinking it for years so they were able to look at the diseases that these people carried. The population they were able to study was over 100,000 so the conclusions were very concrete. Without a large sample size, it can be difficult to study human effects because of the confounding factors that you mentioned in the document that you wrote. For example PFOA was attributed to high cholestrol. As you know there are many other factors in addition to PFOA exposure that can cause high cholestrol such as diet and genetics. Other diseases that this study was able to link to PFOA include ulcerative colitis, pregnancy-induced hypertension, thyroid disease, testicular cancer, and kidney cancer. If you watch the documentary they also show that PFOA is suspected of causing birth defects. Luckily only very few children had these birth defects so the statistics were not strong enough to definitively link birth defects to PFOA exposure, though it is likely that PFOA was the cause.

3) How can people on forest be exposed?
99% of all humans have PFAS in their blood and everyone has probably had it in their blood since before they were born. In fact, all babies are born with about 200 synthetic chemicals in their blood.

Generally the highest exposures occur in people that work with PFAS in manufacturing or in people that are drinking contaminated water. Most water contamination comes from factories (like Dupont who was producing teflon pans) or from releases of fire-fighting foams used to

battle gasoline-powered fires (airports, air force bases, and some fire fighting stations are REQUIRED to have these foams on site). Water can also be contaminated from landfill leachates.

Products that contain PFAS that people on Forest Lake may use include Scotch Guard and other stain-repellents (this comes on nearly ALL carpets and furniture, unless you specifically purchased a PFAS-free carpet), water repellents (ex:GorTex on rain jackets), ski wax (think the wax you use on cross country or downhill skis), car waxes and polishes, food packing (pizza boxes, McDonald's wrappers), flaking teflon pans (once they put the PFAS on the pan, it generally stays there), and hydraulic fluids in cars.

4) how long can it last in the human body?
They only have this data for 15 compounds at the most. The half-life for compounds that have 8 carbons is about 5 years, while compounds that have 4 carbons have a shorter half-life of a few years (maybe 2?).

5) how do you clean it up?
This is probably the worst part of the problem. PFAS are extremely stable compounds so they are really difficult to break down. They were initially 'discovered' when researchers were working on the atomic bomb. In order to remove them from the water, you can use an activated carbon filter but not all carbons work well and in order for them to work efficiently they need to be replaced much more often. I also do not think the carbon products that you buy at the store work well. I think nanofiltration or reverse osmosis will also work, but you may just be contaminating your septic field depending on where the reject water goes. Other technologies that remove PFAS are EXTREMELY energy intensive or generate waste products that need to be incinerated so it is not something that you could use at home.

The EPA also has some good information about the known PFAS compounds https://www.epa.gov/pfas/basic-information-pfas

Nicole JM Fitzgerald, PhD
Postdoctoral Fellow
Civil and Environmental Engineering
Colorado School of Mines