

‘IT’S JUST THE

If your home has HDPE plastic containers—it almost certainly does; look for the No. 2—you should know some of it may have been treated with a process called fluorination. And you might be exposing yourself to PFAS, the “forever chemicals”

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BY ESMÉ E. DEPREZ

PHOTOGRAPHS BY SHAWN MICHAEL JONES

Kyla Bennett, an ecologist and attorney in Easton, Massachusetts, subscribes to a school of thought called antispeciesism, which considers the preferential treatment of any animal species over another, humans included, to be unethical. So she's long railed against the use of chemicals to kill insects, especially over a 26-square-mile stretch of freshwater wetlands and soggy woodlands near her home. For thousands of years, the Wampanoag people sought refuge and sustenance in the area and considered it alive with spirits. Today it's called the Hockomock Swamp and retains lore of the paranormal, with reported sightings of Bigfoot and UFOs, but it's mostly a place to walk dogs and paddle canoes. It's also home to an uncommon species of mosquito that carries a rare but highly lethal brain-swelling virus called eastern equine encephalitis, or EEE. To curb its spread, state officials have long used a pesticide named Anvil 10+10, spraying it from airplanes overhead.

Bennett is 62, with a slight frame and salt-and-pepper shoulder-length curls. She cherishes the Hockomock, not least for its vernal pools, small bodies of water that ephemerally appear every spring and dry up by fall. Countless species use them to breed; her favorite is the blue-spotted salamander.

"There is something meditative about vernal pooling," Bennett says. "Putting on your waders and scouring the pools for life. I just love it."

In the early months of the Covid-19 pandemic, Bennett was stuck in bed, recovering from surgery to remove a baseball-size tumor that had been pushing against her brain. It was the first spring in 30 years she didn't visit the vernal pools. She'd kept working nonetheless, as the director of science policy at Public Employees for

Environmental Responsibility (PEER), a nonprofit government watchdog. In addition to advocating against pesticides, she'd turned her attention to an enormous class of toxic, man-made chemicals called PFAS, short for per- and polyfluoroalkyl substances.

PFAS compounds are characterized by their chains of carbon atoms bonded to fluorine atoms. The bonds are ultra-strong, ultrastable and paramount to

The consequences, which can take years to materialize, can be devastating: Researchers have linked PFAS exposure to cancers, birth defects, infertility, high cholesterol and more.

In the summer of 2020, Bennett's work on pesticides and PFAS unexpectedly converged. By then, public awareness of the dangers posed by PFAS was mounting. Researchers were finding the compounds in vastly more products than was previously understood. The film *Dark Waters* had just recounted the decades-long PFAS poisoning of towns in West Virginia and Ohio and the subsequent cover-up by chemical giant DuPont. Government agencies were tightening water advisories based on the latest science, showing smaller and smaller amounts to be unsafe.

When the drinking water in Bennett's town of Easton tested positive for the forever chemicals, it felt at first like a mystery. Easton wasn't home to any of the obvious PFAS emitters that explained contamination elsewhere, such as firefighting training facilities, military bases or chemical plants. Then, while still recovering from her surgery, Bennett thought of the Hockomock Swamp. In her mind, she overlaid a map of Massachusetts towns with PFAS-contaminated water onto a map of Anvil 10+10 sprayings. And then she felt a pang in her gut.

Over the next couple of months, a colleague of Bennett's at PEER tracked down white plastic jugs of Anvil 10+10 and shipped samples of the liquid to a Pennsylvania laboratory called Eurofins for testing. The results confirmed Bennett's suspicions: The pesticide contained PFAS compounds. And not just any PFAS. Among them was PFOA, used for decades to make countless products, including DuPont's Teflon nonstick cookware. It belonged to a subclass called long-chain PFAS, compounds found to be so dangerous that the US Environmental Protection



BENNETT IN THE HOCKOMOCK

their value in the manufacturing of semiconductors, firefighting foam, smartphones, medical devices, aircraft and solar panels. They enable consumer products to better repel water (as in raincoats), fend off stains (carpets) and resist grease (microwave popcorn bags). The persistence of those carbon-fluorine bonds, though, prevent PFAS from naturally degrading—earning them the nickname “forever chemicals.” In water, soil or blood, they just keep piling up.

Agency had moved to effectively ban them in 2015.

Bennett alerted state officials, who ran their own tests confirming the results and notified their federal counterparts. The EPA started an investigation. Clarke Mosquito, Anvil's manufacturer, examined its supply chain and found no PFAS listed among its ingredients. Months passed; everyone was stumped.

In January 2021, the EPA publicly revealed what its testing of Anvil 10+10 had pinpointed as the source of the contamination: The chemicals were migrating into the pesticide solution from the walls of the plastic containers in which it was sold. The containers had been "fluorinated." This process, buried deep in the supply chain, strengthened the plastic by exposing it to fluorine gas. But it also generated PFAS compounds, which were leaching into the liquid stored inside.

The vast majority of PFAS were—and remain—virtually unregulated. By this time, though, the EPA had worked for years to cut off production of PFOA and similar long-chain PFAS for the sake of public and environmental health. The discovery that fluorination continued to generate them anyway undermined the agency's painstaking work and placed whomever was responsible in violation of US law.

The EPA eventually determined that just one company in the US was to blame: Inhance Technologies LLC. The Houston-based company was small, with \$46 million in annual revenue in 2018 and only a few hundred employees. Yet it had built a domestic monopoly in fluorination over four decades, and with 20 facilities worldwide, it was a dominant global player as well.

More than two-and-a-half years later, Inhance continues to fluorinate plastics, despite a demand from the EPA to stop and a lawsuit by the US Department of Justice. The public, meanwhile, remains largely in the dark about the toxic PFAS generated in the process, even as the EPA has learned that fluorination's reach goes far beyond mosquito spray.

Inhance doesn't publicly disclose its customers but says it fluorinates more than 200 million plastic items every

year. Those items touch virtually every facet of the US economy. They're used to hold weedkillers, gasoline, household cleaners, cosmetics and shampoo. It's not just plastic bottles: Inhance treats caps, trigger sprayers, mascara wands, fuel tanks, syringes, the cold packs used to transport vaccines and the industrial-size drums that store bulk ingredients prior to bottling. Its customers include providers of water-treatment chemicals, manufacturers of medical disinfectant and co-packers of bulk fragrances. Food companies and large soda companies have used Inhance for decades. A 2018 investor presentation seen by *Bloomberg Businessweek* listed some of the world's most recognizable consumer brands as end users of the company's treated plastics, including Bath & Body Works, Bayer, BMW, Estée Lauder, Husqvarna and L'Oréal. Fluorinated plastics, and the PFAS they contain, are likely on store shelves everywhere and in every American home.

Fluorine gas is highly toxic, corrosive and noxious. It's the most reactive element on Earth, and as such, it virtually never exists on its own. It was first derived in 1886 from another gas, hydrogen fluoride, but industrial scale production didn't take off until the 1940s to support the Manhattan Project's development of the atomic bomb. A chemist named Stephen Joffre later recognized the commercial practicality of the effect of fluorine on plastic. Joffre worked for Shulton, the inventor of Old Spice and other perfumes and toiletries. A patent he won in 1957 cited the "surprisingly improved impermeability" and superior odor-trapping ability of fluorinated bottles of Old Spice aftershave lotion.

In 1983, William Brown and Edwin Ballard founded Fluoro-Seal, which later became Inhance Technologies. The pair had worked at a company then called Air Products & Chemicals, an industrial provider of fluorine gas with a minor interest in fluorination. They saw a bigger opportunity: leveraging fluorination as a solution to problems that had arisen as the use of plastics grew. When stored in containers made

of conventional plastic, certain liquids, such as solvents and gasoline, could permeate the walls. The bottles and their labels would deteriorate and grow distorted, and fumes would evaporate out. Fluorinating plastic strengthened its barrier properties, allowing companies to harness the lightness and cheapness of modern packaging.

Air Products' expertise was in-mold fluorination, which introduces fluorine gas as containers get made. Brown and Ballard seized upon a more profitable technique called post-mold fluorination, which exposes containers to the gas after they're made. That process has barely changed in the 40 years since. Inhance's direct customers are typically packaging suppliers. They send Inhance containers and other parts made primarily of high-density polyethylene, or HDPE, one of the most commonly used types of plastic. The company loads them into a heated reaction chamber the size of a one-car garage. Pumps suck out the air to create a vacuum, and fluorine gas flows in. Fluorine atoms replace hydrogen atoms on the plastic's surface, creating a Teflon-like layer a few microns deep, inside and out. Workers then remove the newly fluorinated plastics from the chamber and ship them back to the packaging suppliers or on to bottle fillers. Eventually they enter commerce.

As plastics increasingly replaced glass and metal, Brown and Ballard consolidated their market power by mass-producing fluorine gas in-house. That lowered costs, boosted profitability and erected a barrier to entry, ultimately leaving the company as the nation's sole post-mold fluorinator of plastics.

Brown and Ballard began by serving the agricultural chemicals industry, then expanded to cosmetics, flavorings, fragrances, food storage, fuel tanks and pharmaceuticals. By 1999 the company had 11 US factories, as well as facilities, either jointly owned or licensed, in Australia, England, France, Germany, Indonesia, Malaysia and Mexico. By 2004, according to its website at the time, it pegged the number of bottles, containers and "articles of all shapes and sizes" it had treated at 1.5 billion. ▶

◀ In 2012, Brown and Ballard sold Fluoro-Seal to Arsenal Capital Partners, a private equity firm in New York. The company rebranded itself as Inhance and named Andrew Thompson, an operating director at Arsenal with a doctorate in polymer chemistry, as its chief executive officer. In 2017, Thompson expanded the company's reach to South America, and the following year Arsenal sold Inhance to Aurora Capital Partners, a private equity firm in Los Angeles. Today, Inhance presents itself as a leader in sustainability and touts how fluorinated plastics remain recyclable.

Although Inhance says it can treat multiple types of plastic, including low-density polyethylene (LDPE) and polyphenylene ether (PPE), it mostly fluorinates HDPE. Used to make everything from milk jugs and cutting boards to underground pipes and toys, HDPE is versatile, usually opaque and more rigid than the average soda bottle, for example, which is typically made with polyethylene terephthalate, or PET, and cannot be fluorinated. It's unclear what share of HDPE produced every year gets fluorinated. Inhance has indicated that it treats 25 million pounds of "plastic packaging articles" annually, which would likely represent a sliver of total HDPE production.

Still, fluorinated plastics are ubiquitous. Inhance says it does business with more than 175 plastics suppliers and more than 500 brands. As of 2018,

according to the presentation seen by *Businessweek*, the agricultural chemical industry generated the biggest share of sales, at 40%, while the consumer market accounted for 16%.

During an April visit to the lobby of Inhance's facility in Allentown, Pennsylvania, a shelf displayed dozens of empty containers, with signage indicating at least some had been fluorinated. Among them were containers for shampoo, stain remover, gasoline, hand-cleaning wipes, hair-thickening oil, nail polish remover and juice. A sign extolled the benefits of fluorination for household and beauty applications, including food storage, laundry detergent, dish soap, liquid foundation and face moisturizers.

It's impossible for consumers to discern whether a given item has been fluorinated. The bottoms of HDPE containers are marked with a chasing arrows symbol surrounding the numeral 2. Those markings indicate only the plastic's recyclability, though. No markings or labels are required to indicate fluorination.

A scan of the ingredient list offers some clues. According to Inhance and companies that contract with it, fluorinated containers should be used to house shampoos and body washes that are organic or contain enzymes; liquid formulations with strong flavors or odors; and products made with essential oils, pine oil, lanolin and a widely used citrus derivative called d-limonene. But

even that knowledge has its limitations. Inhance fluorinates containers ranging in size from less than 2 ounces to 330 gallons. Even if a product isn't housed in a fluorinated bottle at the point of sale, it or the base ingredients used to make it may have been stored in one deeper in the supply chain. Companies may not even be aware that they or their suppliers are using fluorinated plastic.

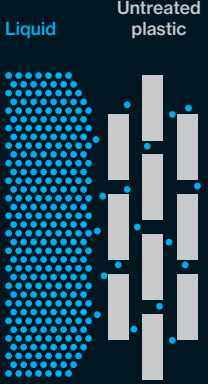
Jeff Landis, a spokesman for the EPA, says the agency "has not yet identified" PFAS contamination in any pesticide product beyond Anvil. He declined to say whether it's tested other pesticides, or any other product, housed in fluorinated HDPE. He also points out that "for some specific types of products, such as cosmetics, EPA does not have regulatory authority." A spokeswoman for Bath & Body Works confirmed it had used fluorinated plastics in the past but declined to comment on whether it still does. A spokesman for Husqvarna wouldn't address whether or not the company uses fluorinated plastic but said it's "committed to comply with or exceed all environmental standards." BMW didn't respond to multiple requests for comment. Bayer and L'Oréal declined to comment.

Thompson, the Inhance CEO, initially agreed to answer written questions but didn't respond to subsequent emails.

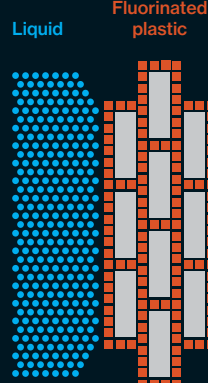
For decades most of what was known about PFAS, including their risks to human health, was kept secret by the companies that made them. The term is now used to describe an ever-expanding class of chemicals: thousands of compounds with "diverse molecular structures and physical, chemical and biological properties," according to the Organization for Economic Cooperation and Development. There's no official count of how many exist, in part because there's no universal definition.

What is known today about PFAS remains eclipsed by what is not. Modern labs can identify only a fraction of specific PFAS compounds. Advances in equipment and more sensitive testing methods, though, have brought more information into public view. The list of consumer products now known to

NON-FLUORINATED PACKAGING
 Certain liquids, such as solvents, fragrances and oils, can permeate untreated plastics.



FLUORINATED PACKAGING
 During the fluorination process, fluorine atoms replace hydrogen atoms on the surface, effectively plugging any "pores."



High-density polyethylene, or HDPE, is the most commonly fluorinated type of plastic. No requirement exists for labels to indicate whether a given container has undergone the process.

contain PFAS includes not just nonstick cookware and stain-repellent carpets but also school uniforms and menstrual products, ski wax and french-fry wrappers, dental floss and waterproof mascara. The compounds have migrated into the bloodstreams of most living Americans and seemingly everywhere else researchers have thought to look: the umbilical cords of Taiwanese newborns, the breast milk of Swedish moms, chicken eggs in rural Maine, polar bears in Greenland, and even air and rainwater worldwide. The passage of time has allowed researchers to amass the human population-level data needed to link PFAS exposure with various ill effects, such as cancers, that reveal themselves only after extended periods.

Although little to no research or toxicity data exist for most of the hundreds of PFAS in use today, long-chain perfluoroalkyl carboxylates are an exception. Researchers say their backbones, comprising seven to 20 carbon atoms, help make them particularly persistent and bioaccumulative and thus problematic. (Short-chains, with fewer carbon atoms, are less well studied; results so far are disconcerting.) The most notorious long-chain is perfluorooctanoic acid, commonly known as PFOA or C8. As portrayed in *Dark Waters*, it's what sickened cows on a West Virginia farm downstream of a DuPont facility to the point that their teeth turned black, their organs turned green, and their mouths frothed with thick white goo before rendering the animals deranged, and then dead. It's what two DuPont employees worked with before giving birth to babies with disfigured faces and what lab monkeys were fed before growing so ill they had to be euthanized. Even trace amounts are so dangerous, the EPA now says, no level in drinking water is safe.

As it learned more about the dangers posed by PFOA, the agency in 2006 persuaded eight major PFAS manufacturers, including DuPont, to phase out US production and importation of the compound and its long-chain cousins. By the end of 2015, officials believed they'd succeeded. Then they used the Toxic Substances Control Act, a landmark

law passed in 1976, to ensure that none of these compounds would reenter the supply chain. They did this by banning "significant new uses" until the agency reviewed the science to ensure such uses didn't pose an "unreasonable risk to human health or the environment." The EPA solicited feedback from industry to learn about any known remaining uses of long-chain PFAS (largely by the semiconductor and small electronic component manufacturing indus-

"Our first initial thought was: It's everywhere, so we need to pay attention to this one, because this is literally going inside people's homes"

tries) and declared them exempt from the law. The fluorination of plastics—unknown at the time by the EPA to generate long-chains—wasn't exempted.

That ban had been in effect for just a few months when the EPA pinpointed fluorinated plastic as the source of the long-chains showing up in Anvil 10+10. To contain the immediate problem, officials threatened to go after Anvil's manufacturer, Clarke, if it didn't recall millions of dollars' worth of product. They told Massachusetts and 25 other states to stop using any existing stock "to minimize risks to human health and the environment." The scope of the newly identified risk posed by fluorinated plastics had yet to come into view, but officials were on guard: The agency had been excoriated for ignoring warning signs prior to the 2014 mass exposure to lead-contaminated water among residents in Flint, Michigan. Court records show that on a call with Clarke and the US attorney's office, Alexandra Dunn, an EPA assistant administrator, vowed that this PFAS incident wouldn't be her "Flint, Michigan, moment."

It was January 2021, and the Biden transition was underway. The EPA issued a subpoena to Inhance to gain a view into a company and an industry that it knew little about. Inhance responded by providing information about fluorination and business details. But in a Feb. 8 letter, obtained by *Businessweek*

in response to a Freedom of Information Act request, Inhance denied that its process was responsible for the levels or types of PFAS identified by PEER's or the agency's testing.

As winter turned to spring, the EPA was only beginning to understand how widespread the use of fluorinated plastics had become, records released by the agency show. It had determined that as much as 30% of all rigid packaging for North American crop protection was flu-

orinated. But as detailed in an EPA "strategy" memo, basic questions had yet to be answered, such as "What are the types of plastic containers that are typically fluorinated?" and "Who is doing the fluorination?" The answers weren't initially clear, partly because packaging companies that sell fluorinated containers rarely reveal that they outsource their fluorination to a single US company, Inhance.

Meanwhile, staff compiled lists of relevant trade groups, met with the Household & Commercial Products Association, and pursued meetings with "larger companies who are likely to understand or want to understand the scope of fluorination of their product containers," the EPA memo says. They talked with Unilever's cleaning and personal-care brand Seventh Generation, which was "promoting efforts" within the cleaning products industry "to better understand the situation." The agency also continued to test at its analytical chemistry lab in Fort Meade, Maryland, and confirmed again the detection of restricted long-chain PFAS in fluorinated HDPE containers.

"Our first initial thought was: It's everywhere, so we need to pay attention to this one, because this is literally going inside people's homes," says a former official who worked at the EPA at the time and requested anonymity to speak freely. "We were very, very concerned—it became an ▶

◀ extremely high-level concern.”

EPA staff also conferred with the US Food and Drug Administration, which had jurisdiction over regulating chemicals in food packaging. The FDA had greenlighted the use of fluorinated plastic under specific parameters in 1983, long before it was widely understood that PFAS could cause harm. In August the FDA sent a letter to the food and beverage container industry notifying it of the PFAS-in-pesticide incident. “We are concerned that such containers could also be used in contact with food,” it wrote. (Inhance later said in a statement that its fluorinated HDPE containers “are not used as packaging for consumer food,” and less than 1% “are used by the food industry for additives or similar products.”)

Later that fall, the agency adopted its “PFAS Strategic Roadmap,” which outlined “bolder new policies to safeguard public health, protect the environment, and hold polluters accountable.” It aimed to reduce PFAS use and minimize exposure to avoid contributing to the existing, and already enormous, “environmental load.”

Inhance, meanwhile, kept forging ahead. It replaced an old factory in St. Louis with one that boosted capacity, citing “dramatically” increased demand.

In March 2022, more than a year after determining fluorinated plastic was the cause of the pesticide contamination, the EPA sent a formal “Notice of Violation” to Inhance. According to a copy obtained through a public records request, the letter told the company it was breaking US law and “must immediately cease the manufacture” of long-chain PFAS. In practical terms this meant either figuring out how to fluorinate without generating the compounds or ceasing fluorination altogether. The agency also sent an open letter to the plastics industry, warning of the potential for banned PFAS in plastic containers.

Inhance responded in an April letter, telling the EPA that it was “pleased to confirm” that it had made changes to its fluorination process that resulted in

no long-chain PFAS being “imparted.” But in the months that followed, as Inhance submitted more information, the agency remained unconvinced. That additional information, court documents show, failed to “support a determination” that Inhance’s new process didn’t generate long-chain PFAS, as the company had claimed.

Still, to customers that summer, Inhance executives denied there was a problem and downplayed the matter. “Our technology does not impart any of these chemistries that the EPA is concerned about and never has,” Jad Darsey, vice president of packaging, said in an August webinar. Regardless, added Rich Eichacker, a vice president of sales, PFAS are “in everything we know of today... It’s in your laptop, your cellphone, it’s in your kids, it’s in your dog, it’s in your water that you drink. If we were to get rid of all PFAS species today, life would cease to exist as we know it.”

Days before 2022 drew to a close, the company filed hundreds of pages of regulatory documents in a belated attempt to obtain EPA approval for its fluorination process, even as it refused to stop fluorinating while the agency reviewed them, as the law requires. In the filings, company representatives told a much different story: When it came to the “problem” of fluorination’s generation of nine different types of long-chain PFAS, including PFOA, Inhance could find “no easy solution.” Despite its recent process changes, “unfortunately, an apparently unavoidable aspect of fluorination of HDPE containers may be the unintentional formation of [long-chain PFAS] in small amounts,” Inhance wrote. The company acknowledged that some of the compounds “may migrate into the contents of those containers.”

Inhance also argued in the documents that the unintentionally formed long-chains “qualify as impurities,” making them exempt from the law. The amounts remaining are so small, the company said, they don’t present an “unreasonable risk.” (In a recent press release, Inhance equated the total amount of PFAS it generates annually “to the weight of a few grapes.”) Some of the testing

Inhance cited in its regulatory filings was conducted by Pace, a lab company partially owned by Aurora Capital, the same private equity firm that owns Inhance.

Meanwhile, the company kept on fluorinating plastics, insisting it was exempt from the law that would otherwise require it to stop. The EPA was running out of options. Agency attorneys had been conferring with the Justice Department, and on Dec. 19 the department’s Environment and Natural Resources Division took the unusual step of escalating the EPA’s cause. In a complaint filed against Inhance in the US District Court for the Eastern District of Pennsylvania, the Justice Department warned that Inhance’s manufacturing “may present an unreasonable risk of injury” to human and environmental health. It asked the court to find the company in violation of the Toxic Substances Control Act for producing multiple long-chain PFAS in the past and for continuing to do so without prior clearance.

Inhance pushed back again. Not by denying that fluorination generated PFAS—instead, the company argued in legal filings that it shouldn’t be subject to the ban on “significant new uses” of long-chains because its fluorination process wasn’t new: It had been around for 40 years. Attorneys even attached an *Oxford English Dictionary* definition of the word “new” as an exhibit.

Bennett first encountered PEER, the watchdog she now works for, in the 1990s. She was overseeing wetlands permitting and enforcement for the EPA’s New England office, and a superior tried to pressure her into changing a scientific opinion that killed plans for a container port on a small island in Maine. PEER helped her file a whistleblower complaint against the agency. She reached a settlement with the EPA, joined PEER a few years later and now helps government employees file whistleblower complaints of their own. That history informs her skepticism: Bennett was never going to be the type to hand off PEER’s test results revealing PFAS in a pesticide and trust the government to handle it.

One of the first people she emailed

those results to, in the summer of 2020, was Graham Peaslee, a nuclear physicist at the University of Notre Dame who'd pioneered a novel technique for revealing the presence of PFAS in everyday items. "Wow," he replied. "That isn't a good place to put one's PFAS...not only for crop uptake but inhalation exposure too. Ugh." She'd met him the year before, while researching the use of PFAS to make artificial turf. By then, Peaslee had identified the compounds in firefighting gear, footwear, makeup, fast-food packaging and more.

To Peaslee, as to Bennett and the EPA, fluorinated plastics represented a new and unsettling exposure route to the most dangerous PFAS. They soon learned, however, that inside the pages of obscure chemistry journals were clues dating back more than a decade. In 2011, Amy Rand, then a doctoral student, and Scott Mabury, her supervisor in the University of Toronto's chemistry department, identified for the first time the presence of long-chain PFAS leaching from fluorinated plastic. They published their findings in the journal *Environmental Science & Technology*. The pair obtained the samples of fluorinated plastics used in their experiments directly from Inhance (then called Fluoro-Seal).

Rand says the study didn't make "the smallest of splashes" upon publication, nor did she send the results to Inhance. However, she says, at the time she published her work, the scientific community recognized that in theory, long-chain PFAS might result from fluorination. "It was fairly easy for me as an early grad student to look up" research describing that hypothetical, Rand says. "It's not complicated chemistry." Inhance, which has long billed itself as employing the world's leading fluorochemists, said in recent court filings that it wasn't aware of the PFAS formation prior to the Clarke pesticide incident. The Justice Department has since characterized the issue of what Inhance knew and when it knew it as "disputed."

Peaslee and Bennett kept in touch as

the EPA continued its testing. The pair agreed that additional, independent data was necessary to push the science further. Peaslee tapped a doctoral student working in his lab, Heather Whitehead, to analyze whether fluorinated containers could leach PFAS into food.

Whitehead and Peaslee bought fluorinated HDPE containers from a laboratory supply company, and organic



PEASLEE IN HIS LAB

olive oil, ketchup and mayonnaise in glass bottles from a national grocery store chain. First they tested just the fluorinated containers and consistently found three short-chain PFAS compounds and eight long-chains, including PFOA. They replicated the EPA's findings that PFAS leached into water and methanol and added acetone to the list. They exposed samples of the olive oil, ketchup and mayonnaise to fluorinated plastic and let them sit for a week. Another batch sat for a week inside a 122F oven.

On March 6, *Environmental Science & Technology Letters* published their peer-reviewed results. While the levels of PFAS migration varied depending on the composition of the liquids inside the containers, concentrations increased up

to 830% when stored in the heat. PFOA and other long-chains migrated into the ketchup and mayonnaise and into the olive oil in smaller amounts. Whitehead and Peaslee's study is now one of at least six showing that fluorinated containers leach long-chain PFAS. That's in addition to Inhance's own data, submitted to the EPA last year, showing the same thing.

Businessweek recently sent Peaslee bottles of shampoo from Bumble and bumble and OGX Beauty. When he pointed the beam of his particle accelerator at them to determine if the bottles had been fluorinated, both returned positive results. Further testing is underway to verify if the contents contain PFAS. A spokeswoman for OGX parent company Kenvue Inc., said neither OGX nor its supplier had a "relationship" with Inhance; she declined to say whether the company used fluorinated plastics in the past. A person familiar with Bumble and bumble's business said a subcontract it had with Inhance ended in 2017. A spokesperson for Estée Lauder, which owns Bumble and bumble, declined to say whether any of its other brands currently use fluorinated plastics.

To Peaslee, one of the most important takeaways was this: Anything stored in a fluorinated container may expose humans to harm. "It's just scarier the more we learn," he says.

Bennett and her husband, Don, moved to Easton, to an old farmhouse, in 1990. After a few years, their toddler daughter landed in the operating room to remove four intestinal polyps and later, numerous tumors throughout her body. Guilt gnawed at them: Could environmental factors have caused their daughter's plight? Could it all have been avoided?

A recent visit to the LEED-certified home the Bennetts helped design and had built in 2006 offers a glimpse into the extraordinary lengths they go to every day to live out their environmentalist ideals and avoid exposure to toxins. There are no carpets, window curtains ▶

◀ or gas-burning stoves, and the walls, made of natural clay, are unpainted. There's nothing non-organic and virtually no plastic in sight. A lifelong vegan, Bennett makes her own coconut-and-cashew yogurt to avoid plastic; even the pink and yellow tulips in a vase on the dining table were grown organically. When their daughter gets married this fall, Bennett will bring her own products for the makeup artist, given the prevalence of PFAS-laden cosmetics. "People don't realize," she says. "Just because it's legal does not mean it's safe."

Bennett knows this level of hyper-vigilance may cause some people to question her sanity. She does so herself. Take, for example, a recent grocery run during which she encountered a new brand of butter. "I agonized over whether I should buy it," she recounts. "I bought it, after hemming and hawing for about 10 minutes. I opened it when I got home, was relieved to see zero plastic, but then wondered if they are using the PFAS-free parchment paper or not. So now I have to reach out to the company and ask them. And I won't know if they are telling the truth or not. Every purchase, every decision, is a balancing act. And I hate it. I don't trust anyone anymore."

In the early days following her discovery of PFAS in pesticide in 2020, Bennett felt relieved that the EPA acted quickly to have Clarke recall its fluorinated containers of Anvil 10+10. But by 2022, as Inhance continued to fluorinate, Bennett and her colleagues at PEER grew frustrated that the agency wasn't aggressively containing what seemed like a clear public health threat. So PEER joined with the nonprofit Center for Environmental

in 2011 as a tool for the public to fight "agency capture" and "push for more vigorous law enforcement even when government agencies are more inclined to compromise or go slowly." The tactic worked: The Justice Department's case followed soon thereafter.

A few months later, in March, the EPA proposed the first national limits on PFAS in drinking water. The agency recommended a maximum limit for PFOA and another long-chain at four parts per trillion. (One part per trillion is equivalent to one drop in 20 Olympic-size swimming pools.) The EPA based that on the latest science labeling PFOA as a likely carcinogen, meaning any amount of consumption above zero could increase the risk of developing cancer. Drawing such a line in the sand, EPA Administrator Michael Regan said, would "prevent thousands of deaths and reduce tens of thousands of serious PFAS-related illnesses."

Bennett and Sussman point to that determination when criticizing the government for not pursuing Inhance more expeditiously. If there's no safe amount of PFOA to consume via drinking water, they say, logic would dictate that there's also no safe amount in mayonnaise or shampoo or body wash or stain remover or paint thinner—or any of the countless products stored in containers fluorinated by Inhance. According to an analysis produced by Bennett and Sussman and submitted to the EPA, PFOA has been consistently found in extracts and solvents in fluorinated containers in the parts-per-billion range, at levels from 33 to 1,123 times higher than the proposed limit for drinking water.

clearance to continue fluorinating (which is still pending) and brought the issue to the attention of Congress. A dozen House members have written to the EPA, calling the agency's review of that bid "a major test" of its mandate to protect the public from harmful chemicals.

Sussman remains baffled that the EPA pursued a single pesticide brand for using fluorinated plastic but has remained silent on its use by myriad consumer brands to which Americans have far more exposure. Court documents indicate the EPA obtained from Inhance, in late 2022, a list of all its customers, the intended uses of its fluorinated containers and the total number of treated containers going back five years. The agency declined to provide the list to *Businessweek*, citing its designation as "confidential business information." "The EPA has a rich and detailed understanding of the products that use fluorinated containers," Sussman says. "They're in effect keeping the public in the dark."

It's impossible, of course, to undo the decades of human and environmental exposure to PFAS. But researchers say it isn't too late to stop making the problem worse. They've begun to categorize the essentiality of various PFAS uses and to identify alternatives. One recent study, for example, considers the use of PFAS in the production of semiconductors as currently essential, given the absence of suitable alternatives. Their use in bicycle lubricants and household cleaning products, however, is not, because non-fluorinated alternatives exist and are just as effective. Ultimately, they say, innovation should lead to a future so full of safer options that no PFAS are necessary. The Biden administration cited that framework in a March 2023 report when declaring, "the long-term goal is to eliminate PFAS in all sectors to the maximum extent possible."

Are fluorinated plastics essential? Inhance cites its customers' reliance on the treated containers to comply with various regulations, including those designed to ensure the safe transport of chemicals. In regulatory filings, Inhance says the risk of toxic

"Stopping these processes bankrupts Inhance, to put it as bluntly as I can"

Health (CEH) and hired Robert Sussman, an attorney and ex-deputy administrator of the EPA, to prod the agency to move faster. In October, Sussman notified the EPA of their intention to sue Inhance, using a common component of federal environmental law known as a citizen's suit. A federal court described such suits

PEER and CEH now have plaintiff-intervenor status in the Justice Department's case, giving them the power to file motions. They recently asked the court to issue an injunction that would force Inhance to immediately stop fluorinating. They've also pressed the EPA to reject Inhance's bid for agency

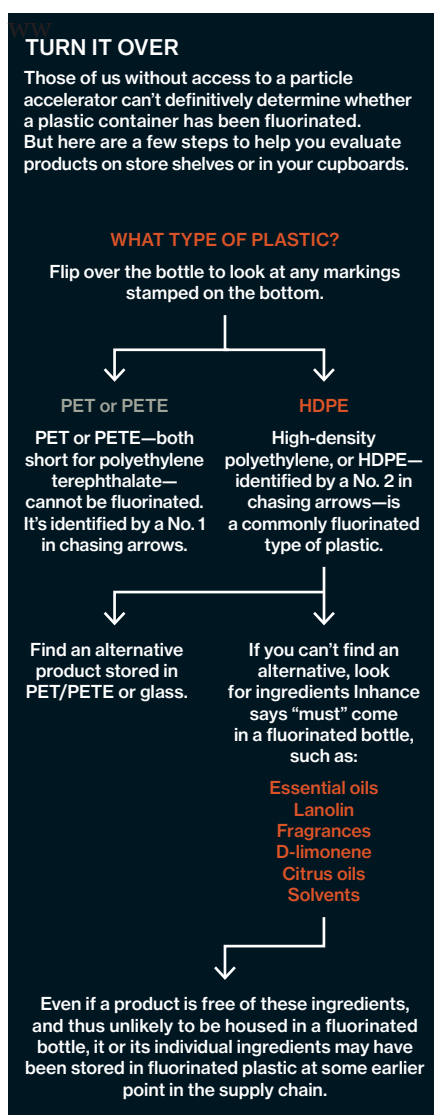
chemicals evaporating or leaking from non-fluorinated containers is “much greater” than the “limited risk” posed by its PFAS production. “Unless the nation completely shifts to metal or glass containers,” the company wrote, “fluorination needs to remain an available technology.” If fluorination doesn’t remain available, the company warned in court filings, the resulting “supply chain bottleneck would significantly derail the national economy.”

Competitors counter by pointing out that fluorination isn’t the only way to strengthen plastics. Kevin Callahan, chief operating officer at Charlotte, North Carolina-based BP Polymers LLC, for example, says his company has, since 2012, offered a nylonlike compound called Kortrax that gets added to plastic resin as it’s being extruded and molded. He says his business has grown as former Inhance customers, including Clarke Mosquito, switch to his product. Other alternatives, he says, include ethylene vinyl alcohol and a “nano-based barrier resin” manufactured by LG Chem in South Korea.

There’s another way, too, that Inhance argues fluorination is essential—as in, for the survival of the company. Putting an end to it would effectively bring its business to a “crashing halt,” Inhance has warned in court filings. “Stopping these processes bankrupts Inhance, to put it as bluntly as I can,” said Cate Stetson, a partner at Hogan Lovells, representing Inhance at a recent hearing. “This will put this company out of business.”

The Justice Department suit adds to an explosion of recent litigation targeting not only the base manufacturers of PFAS (like 3M Co. and DuPont) but also those that make products in which PFAS appear, intentionally or not. Chris Ayers, a partner at New Jersey law firm Seeger Weiss, recently filed a proposed class action against L’Oréal after finding various PFAS, including PFOA, in several of its waterproof mascara lines. That’s despite a separate legal settlement reached in 2021 that forced the company to reformulate its makeup products without the intentional

addition of PFOA. The current source of the PFOA hasn’t been determined, Ayers says. But internal documents seen by *Businessweek* contain at least some clues pointing to Inhance: It has named L’Oréal among its end users and elsewhere notes that it fluorinates mascara wands and tubes.



Last year, Clarke filed a lawsuit in Illinois state court seeking to recoup substantial losses incurred by the recall of PFAS-contaminated pesticide containers; the suit named Inhance and Clarke’s plastics suppliers as defendants. Clarke declined to comment for this story. If even a fraction of companies using fluorinated containers pull their products from the market and similarly seek legal recourse, potential liabilities could inundate

Inhance—accomplishing what the US government so far has been unable to.

Slow-moving dangers like PFAS—the kind that lack evidence of immediate and acute harm—can be the hardest for society to appreciate. This often leaves Bennett feeling as if she’s screaming into a void.

The progress being made in her hometown of Easton to address the PFAS in its drinking water, though, brings her some relief. There, officials sought to identify what caused the contamination by commissioning an independent report. It cited the spraying of PFAS-laden pesticide among potential factors; others included the presence of a landfill, a rubber company and a shoe factory, all long closed.

The town of 25,000 also installed a free filtered-water station and approved spending more than \$10 million to build three filtration plants. Water rates increased 30% to pay for them, says Connor Read, who’s been Easton’s town administrator since 2017 and also serves on Massachusetts’ PFAS task force. “It’s been expensive for the public, it’s been an enormous time commitment from public works, and it’s been a real challenge,” he says. “And we don’t expect it to go away anytime soon.” Town officials also discovered that the fire department had long used PFOA-containing firefighting foam and joined hundreds of municipalities nationwide in multi-district litigation suing manufacturers of that foam, including 3M and DuPont; settlement negotiations are ongoing.

There’s another thing, too, that’s brought Bennett relief: Her brain scans continue to be clear. She travels to Boston to get them as part of a monitoring program that began after surgeons removed her tumor, which turned out to be a rare and benign hemangioblastoma. Her doctors screened her for 84 genetic mutations that might have explained its cause and found nothing, leaving environmental risk factors at play. Such factors are hard to isolate, of course. Bennett can’t prove that PFAS exposure caused her tumor. But she isn’t willing to rule it out. **B**