# Health Consultation

Evaluation of Per-and Polyfluoroalkyl Substances (PFAS) in Private Wells near the Saint Gobain Performance Plastics Site in Southern New Hampshire

SAINT GOBAIN PERFORMANCE

PLASTICS MERRIMACK, NEW

HAMPSHIRE

EPA Facility ID: NHD982746778

NOVEMBER 17, 2023

Prepared by the

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Office of Community Health and Hazard Assessment
Atlanta, Georgia 30333

**Health Consultation: A Note of Explanation**

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. To prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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# HEALTH CONSULTATION

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## Summary

## Introduction

The Agency for Toxic Substances and Disease Registry (ATSDR) evaluates community exposures and makes recommendations to prevent harmful exposures to hazardous substances in the environment. This report evaluates past and current exposures to per- and polyfluoroalkyl substances (PFAS) in private drinking water wells in five towns near the Saint-Gobain Performance Plastics facility in Merrimack, New Hampshire.

The Saint-Gobain facility's processes used several PFAS, including perfluorooctanoic acid (PFOA). In 2016, PFOA was found in groundwater near the site. Since then, the New Hampshire Department of Environmental Services (NHDES) has led sampling of public water systems and private wells in five towns surrounding the Saint-Gobain facility: Merrimack, Litchfield, Londonderry, Bedford, and Manchester. After the contamination was identified, local and state authorities also began taking several actions, including treating public water supplies and providing alternate water to some private well owners, in an attempt to reduce exposures to PFAS in drinking water.

NHDES and the New Hampshire Department of Health and Human Services (NH DHHS) asked ATSDR to do this evaluation. ATSDR staff have been working with the state since 2016 to provide health information to the public regarding PFAS exposure. This report evaluates private well data collected between March 2016 and April 2021 and provided by the state. ATSDR released a draft of this report for public comment in December 2021 and accepted comments through March 1, 2022. This report contains public comments and responses indicating how the evaluation and report were changed in Appendix C. ATSDR will release a separate report evaluating data from public water supplies in the area.

## Focus and Key Findings of ATSDR's Evaluation

ATSDR estimated exposure to PFAS and the resulting potential risk of harmful health effects from drinking well water for over 2,700 private wells in the area. ATSDR considered only drinking exposures, not breathing or skin exposures. Most PFAS do not easily evaporate from water during bathing and showering, and absorption of PFAS through skin is slow or limited. We reached the following general conclusions.

### Conclusion 1

**Drinking private well water contaminated with PFAS could increase the risk for harmful health effects for some community members, especially children.**

**Basis for Conclusion**

- Most of the private wells evaluated in the five towns of Merrimack, Litchfield, Londonderry, Bedford, and Manchester were contaminated with PFAS. PFOA was detected most frequently and at the highest concentrations, but several other PFAS were also present. ATSDR evaluated both individual PFAS and PFAS mixtures effects as detailed in the report. Estimated exposure doses in 1,063 of 2,745 wells evaluated—about 40% of the wells—were higher than minimal risk levels used for screening, and 287 of the wells had estimated exposure doses for one or more age groups that approached or exceeded effect levels in toxicological studies. Of these, 23 wells had estimated doses that approached or exceeded effect levels for all age groups. Other sources of PFAS exposure (such as from food or consumer products) could increase the risk of harmful health effects beyond the risk from the drinking water exposures alone.
- There is suggestive evidence that both PFOA and PFOS are carcinogenic, but the science on PFOA, PFOS, and other PFAS is too limited at this time to quantify risk. The cancer risk contributed by exposure to PFAS in the area is uncertain.
- Based on ATSDR's evaluation, there is a potential for higher risk of developmental effects as the most sensitive health endpoint (i.e., lowest effect level) seen in toxicological studies. The risk of developmental effects would increase as PFAS levels and exposure increase. Immune or liver effects would also be possible from exposure to the highest PFAS levels. Human research suggests other health effects possible from PFAS exposure include increased cholesterol levels, decreased vaccine response in children, changes in liver enzymes, increased risk of high blood pressure or pre-eclampsia in pregnant women, small decreases in infant birth weights, and an increased risk of kidney or testicular cancer.

**Next Steps**

- Private well owners who are still using the wells for drinking should monitor their well water quality and work with local authorities to take appropriate action to remove harmful contaminants, if needed. Residents using point-of-entry or other treatment systems to remove PFAS from private well water should have the systems maintained and checked periodically to ensure removal effectiveness.
- Residents should reduce other potential PFAS exposures by avoiding or limiting the use of products containing PFAS. Examples of products that may contain PFAS include food packaging materials, stain resistant carpets, water resistant clothing, cleaning products, and some cosmetics.
- ATSDR recommends that all residents concerned about their past exposure discuss their concerns with their health care provider. ATSDR has information for health care providers and the public at https://www.atsdr.cdc.gov/pfas/resources/index.html. ATSDR also provides guidance and tools for reducing stress and building resilience in

communities during public health responses to environmental contamination at its Community Stress Resource Center at www.atsdr.cdc.gov/stress.

- ATSDR recommends nursing mothers continue to breastfeed and contact their healthcare providers with specific concerns. ATSDR is available to consult with healthcare providers as needed. To help protect formula-fed infants from potential exposure, caregivers should use pre-mixed formula or reconstitute dry formula with water sources that meet state and federal drinking water guidelines for PFAS.
- ATSDR recommends local medical providers use ATSDR's current clinician guidance at https://www.atsdr.cdc.gov/pfas/resources/info-for-health-professionals.html as a resource for informing patients and guiding treatment. As science evolves, ATSDR will work with state and local authorities to provide area medical providers with updated information on health effects associated with PFAS exposure and recommendations for patient care.

### Conclusion 2

**People who continue to drink contaminated, untreated private well water have an increased risk for harmful health effects.**

### Basis for Conclusion

- Local authorities have taken several actions since 2016 to reduce exposures from contaminated wells, particularly those with the highest levels of PFAS. Not all well owners were provided alternate or treated water, however, and some private wells with levels of PFAS below previous or current regulatory guidelines may remain in use. Some private wells were never tested, and some well owners were offered but declined alternate water.
- Although not all wells have shown detections of PFAS, testing was limited and PFAS levels could fluctuate over time. This, along with the potential mobility of PFAS in groundwater, suggests additional private wells could be affected in the future.

### Next Steps

- Residents using point-of-entry or other treatment systems to remove PFAS from private well water should have the systems maintained and checked periodically to ensure removal effectiveness.
- Residents continuing to drink from private wells should monitor their well water quality and should work with local authorities to take appropriate action to remove harmful contaminants, if needed.
- Actions to reduce exposure (treating the water or providing alternate drinking water) are warranted for the entire community given the likelihood of past exposure, potential mobility of PFAS in groundwater, and persistence of many PFAS in the human body.

Upon request, ATSDR is available to

- discuss individual results with private well owners,
- work with NHDES and NH DHHS to identify any private wells with PFAS levels of concern that have not been addressed through previous actions,
- answer other public health questions related to the site, or
- provide technical assistance in reviewing additional data collected from the site.

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## ATSDR and the topic of this report

The Agency for Toxic Substances and Disease Registry's (ATSDR) mission is to serve the public though responsive public health actions; to promote healthy and safe environments; and to prevent harmful human exposures. This health consultation provides an evaluation of the public health implications of past and current exposures to per- and polyfluoroalkyl substances (PFAS) in private drinking water wells in five towns near the Saint-Gobain Performance Plastics facility in Merrimack, New Hampshire. The report includes recommendations to protect public health. ATSDR worked with the New Hampshire Department of Health and Human Services (NH DHHS) and the New Hampshire Department of Environmental Services (NHDES) in preparing this report.

A draft of this report was released in December 2021; it was available for public comment through March 1, 2022. The report has been revised in response to public comments received. Appendix C provides the individual public comments received and ATSDR responses.

This final report uses the same data as in the 2021 draft, and the calculations, dose estimates, and evaluation are essentially the same, but we made several changes in response to public comments. We have also attempted to clarify recommendations for community members and medical providers. We note that knowledge about PFAS is evolving and that recommendations may change in the near future. However, the overall conclusion that potential exposures to PFAS in private wells in this area are of concern is not likely to change with evolving science.

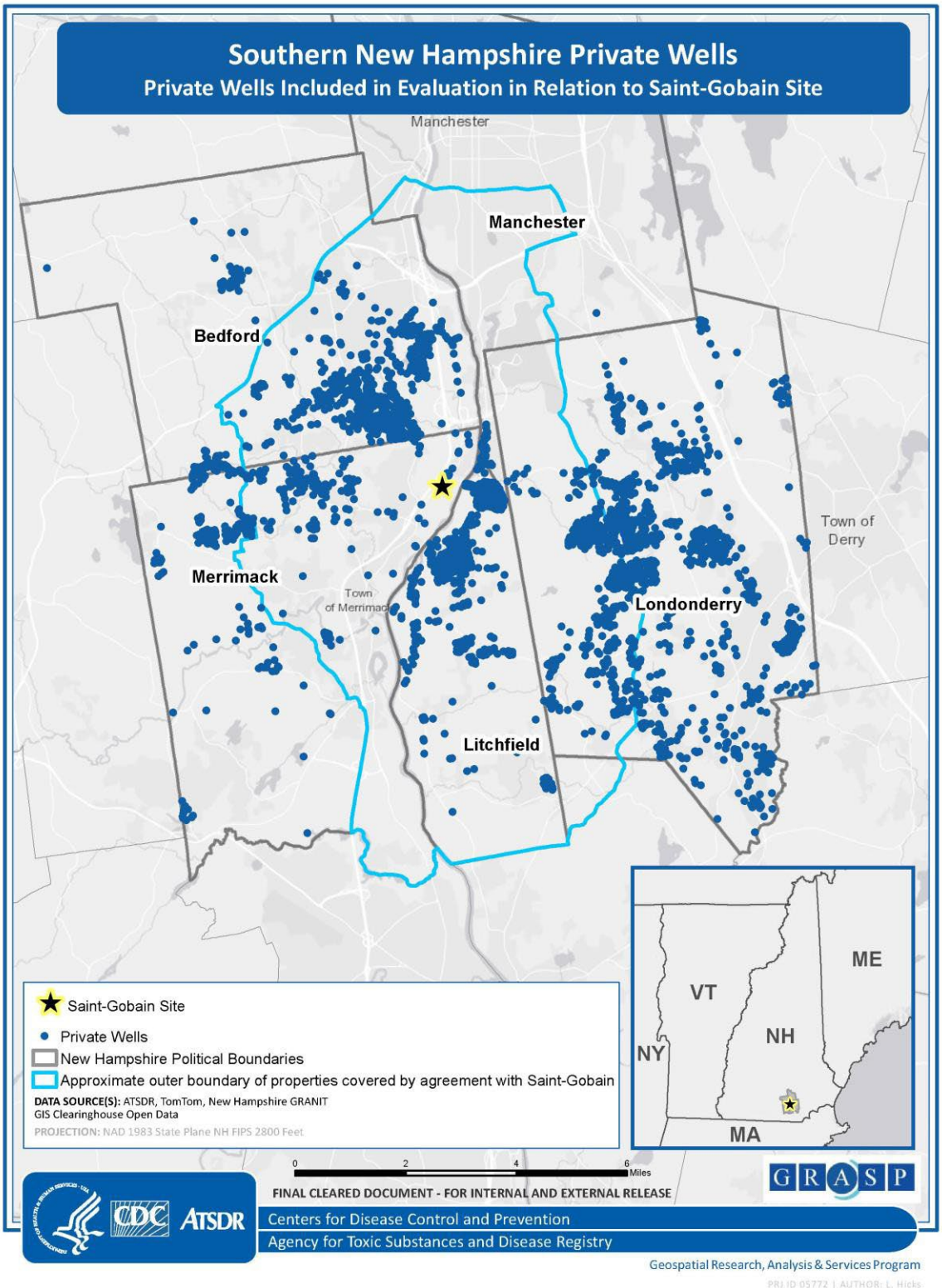
## Background and brief history of the site

The Saint-Gobain Performance Plastics facility in Merrimack, New Hampshire produces specialty coated fabrics and films for a range of industrial applications, such as heavy-duty roofing fabrics and hazardous materials-resistant clothing. In 2001, Saint-Gobain took over the operations of the Chemical Performance Fabrics (ChemFab) company, which had operated since the late 1980s. The manufacturing process uses chemical mixtures, also referred to as "dispersions," that contain several PFAS, including perfluorooctanoic acid (PFOA). Figure 1 shows the facility's location and the area evaluated in this health consultation.

In 2016, after PFOA groundwater contamination had been discovered at similar facilities in the U.S., the Merrimack Saint-Gobain facility voluntarily conducted water testing and identified PFOA present in public water-supplied tap water at the plant. Since 2016, NHDES has led efforts to conduct sampling of public water systems and private wells in five towns surrounding the Saint-Gobain facility: Merrimack, Litchfield, Londonderry, Bedford, and Manchester. Saint-Gobain is responsible for sampling within an "Outer Boundary" determined by a 2018 consent decree with NHDES [1].[1] NHDES reviews data from areas outside the Outer Boundary and may conduct additional sampling, if needed [2].

[1] The Outer Boundary as indicated on Figure 1 includes a portion of the town of Hudson, NH. At the time of the original request to ATSDR, no samples had been collected from private wells in Hudson, and it is not included in the evaluation. The general conclusions and recommendations in this report would apply to private wells in other towns, depending on the PFAS levels found.

**Figure 1. Location of the Saint-Gobain facility in relationship to the five surrounding towns for which private well data were evaluated.**



After the contamination was identified, local and state authorities began taking several actions in an attempt to reduce exposures to PFAS in drinking water. Public water suppliers began treating the water to remove PFAS. Saint-Gobain and NHDES began testing private wells in the area, and people using private wells found to exceed existing health-based drinking water standards[2] were offered bottled water, connection to the public water supply, or installation of a treatment system to remove PFAS. To date, many properties supplied with water from private wells have been or are planned to be connected to local municipal water systems or provided treatment systems [1,2,5].

Because of the time needed to negotiate solutions, changing PFAS standards during this time, and the widespread nature of the PFAS contamination in the area, these actions may have reduced but likely did not fully interrupt exposure of community members to PFAS. According to the NHDES, a significant number of residents in the Outer Boundary remained on bottled water as late as spring 2022, due to factors including timing of new ambient groundwater quality standards and ongoing negotiation between the state and a responsible party regarding the long-term remedy. Additional agreements and programs have been announced since then [5].

## How ATSDR became involved

In 2016, NH DHHS and NHDES requested assistance from ATSDR in helping assess and respond to potential health impacts from exposure to PFAS in drinking water in the area surrounding the facility [6]. Since then, ATSDR staff have been working with the state to provide health information to the public regarding PFAS exposure. The state also requested ATSDR develop health consultation reports evaluating data from public and private water supplies. These data were provided to ATSDR in late 2019; additional private well data were provided to ATSDR in 2021.

ATSDR is preparing two separate health consultation reports to address the above requests. This report focuses on private well data collected between March 2016 and April 2021. A separate report (in preparation) will evaluate data from public water supplies in the area.

## Focus of this report

This health consultation focuses on evaluating the potential impacts of exposure to PFAS in drinking water from private wells in five New Hampshire towns surrounding the Saint-Gobain site: Merrimack, Litchfield, Londonderry, Bedford, and Manchester. NHDES requested private well data from the five towns be included in the private well evaluation [7]. Although the Saint-Gobain facility appears to be the major contributor to the PFAS contamination, other potential sources of PFAS have been identified in the area. Because well sampling data alone to not allow determination of the source of contamination, the PFAS detected in private wells may or may not originate from the Saint-Gobain facility. ATSDR evaluated all the PFAS data received for the potential for harmful exposure, regardless of where the contamination originated. The conclusions and recommendations in this report are general and based on exposure estimated

[2] From 2016 until 2020, New Hampshire's drinking water standard was 0.07 micrograms per liter for PFOA, PFOS, or a combination of the two chemicals. This value was identical to the U.S. Environmental Protection Agency's (EPA's) 2016 lifetime health advisory for PFOA and/or PFOS [3]. In September 2019, the state adopted new rules with lower limits for PFOA, PFOS, PFHxS, and PFNA [4]; these rules were enjoined by a superior court judge in December 2019 in response to a lawsuit against the state but were enacted via legislation in July 2020.

from private well data; we make no attempt to attribute measured contaminants to the site or to other sources. As a non-regulatory agency, it is outside ATSDR's mandate and purview to determine the party responsible for the contamination.

For evaluating PFAS exposures from private wells, ATSDR considered only the drinking (ingestion) exposure route and did not include breathing (inhalation) or skin contact (dermal) contributions to exposure. Most PFAS, including the main ones present at this site, do not evaporate readily into the air from water, and available science indicates only a small amount of PFAS can penetrate skin from PFAS-contaminated water [8]. Therefore, inhalation and dermal exposure to PFAS from private well water during bathing, showering, or other household uses would be very small compared to ingestion exposure.

The data ATSDR obtained from NHDES included PFAS sample results only. We did not have data on any other types of potential contamination in the wells such as chemicals other than PFAS, biological contamination, or other physical indicators that may affect the suitability of the water for human consumption.

NHDES asked ATSDR to comment on potential health effects resulting from drinking water exposures to PFAS. No data describing PFAS levels in other environmental media besides drinking water near the site were provided. Although not considered in this evaluation, ATSDR notes that the following exposure pathways could contribute, possibly significantly, to the exposures estimated in this report from drinking water use.

- **Inhalation exposure to PFAS released into the air from the facility.** Groundwater contamination is presumed to have occurred due to PFAS released from air stacks at the facility depositing on soil and filtering down to the groundwater. This pathway could have been a significant source of exposure, especially in the past before emissions controls were installed.[3,4]
- **Direct contact or incidental ingestion exposure to PFAS in soil, surface water, or sediment.** People could be exposed today if they come in contact with soil, surface water, or sediment contaminated by past air releases.
- **Indirect ingestion of PFAS in biota (fish, shellfish, or plants) that may have bioaccumulated PFAS from their local environment.** Local biota may have accumulated PFAS from soil, sediment, or water, leading to indirect exposure to people who may consume fish, shellfish, plants, or other game from the local area.
- **Exposure to PFAS from consumer products in the home or community.** Most Americans have measurable PFAS in their bodies, presumably from the widespread use of PFAS in consumer products, both past and present.

More details on ATSDR's analysis of exposures possible at this site can be found in Appendix B.

[3] Please see https://www.pfas.des.nh.gov/air for background on air issues related to the Saint-Gobain facility.
[4] ATSDR is aware that in August 2023, Saint-Gobain announced the planned closure of this facility. (https://www.nhpr.org/nh-news/2023-08-23/saint-gobain-announces-closure-of-merrimack-facility-at-the-center-of-pfas-controversy). This will not affect the overall findings of the drinking water evaluation in this report.

## Stepwise discussion of ATSDR's evaluation of private well data

### Environmental sampling data handling

In October 2019, NHDES provided ATSDR with private well PFAS sampling results extracted from the database of PFAS sampling results reported to the state [9]. In April 2021, NHDES provided an updated spreadsheet containing newer results and additional PFAS component results [10]. The complete results comprise over 4,000 private well sample results from almost 2,750 different addresses in five towns. The spreadsheet included results collected between March 2016 and April 2021 and contained 56 different PFAS results fields.[5] Different laboratories and sampling events analyzed different PFAS and often used different reporting conventions for results.

To organize, tabulate, and summarize these data for our public health evaluation, ATSDR performed the following actions on the data provided by NHDES.

- As a fundamental assumption, ATSDR assumed that all sample results associated with a particular address described water from a single private well. We believe this (one well per address) to be largely correct; however, we could not verify it in all instances because some sample descriptors in the very large database were vague, incomplete, or inconsistent. This assumption is appropriate for our goal of gaining a general evaluation of the implications of PFAS in private wells in the area.
- ATSDR manually corrected address spacing issues and standardized abbreviations for street names to allow correct sorting of results by address in the database.
- Some laboratories reported certain PFAS using different conventions (some reported them as acids, and others reported the same substance as the anion of its dissociated salt). For sulfonate anion/sulfonic acid pairs, either reporting convention would result in a value that is practically equivalent (differing by the weight of a single hydrogen atom). For these PFAS, ATSDR considered values by either convention as equivalent. This practice is consistent with technical guidance developed by the Interstate Technical and Regulatory Council (ITRC) [11].
- ATSDR dropped from consideration PFAS listed in the database which were not analyzed or which had no detections[6].
- The above considerations reduced the number of PFAS to be evaluated to 25.
- About 11% of the results included field replicates or samples from more than one location (tap, outside spigot, etc.) at the same address on the same date. ATSDR followed standard practice and averaged results of field replicate samples. Also, as stated above, ATSDR considered all samples from a particular address to represent a single private well, and (if sampled on a single day) considered them as replicates. ATSDR applied a

[5] Sampling of private wells in the area has continued since ATSDR conducted this evaluation. The number of affected wells and other statistics will have changed based on actual results; however, the overall findings of this evaluation are not expected to change significantly, and the findings of this report can be used to give perspective to more recent individual well results.

[6] PFAS listed in the database which contained no analysis results were 1-Propene-1,1,2,3,3,3-hexafluoro-, dimer; perfluorobutylsulfonamide; and perfluorohexanesulfonamide. PFAS which were reported as analyzed at least once but had no detections reported in any well include 11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid; 9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid; PFODA; PFHpS Sulfonate; Perfluoro-3-methoxypropanoic acid; Perfluoro(4-methoxybutanoic) acid; PFHxDA; ETFOSE; PFDoDS; PFNS; 10:2 FTSA; EtFOSA; MeFOSA; MeFOSE; GenX (Acid or Salt); DONA; and ADONA. Please see Appendix A for full compound names, chemical formulae, and Chemical Abstract Services Registry numbers.

single latitude-longitude to all replicate samples from the address, since we only needed a general sense of the location of the private well for our evaluation.

- About 18% of the private wells had results from multiple sampling dates. For these wells, ATSDR selected the highest concentration of each PFAS detected for screening, preparing summary tables, and estimating exposure dose. The highest concentration is used because animal studies have shown that oral exposures to PFAS may have harmful health effects over relatively short periods of exposure (weeks to months). Using the highest concentration is more protective for estimating both short-term and longer-term exposures.[7]

The resulting dataset included results for up to 25 PFAS detected in water from 2,745 different private wells in the five-town area of Merrimack, Litchfield, Londonderry, Bedford, and Manchester.

### Determining the timeframe of potential exposure

Production at the facility currently operating as Saint-Gobain began in 1986. Before 1986, we assume there was no PFAS contamination in the area. We do not have any historical data showing levels of PFAS in groundwater or private wells between 1986 and 2016. To be conservative, we assume past exposure to PFAS from private wells could have occurred continuously from when the facility began operating in 1986. It would have taken some time for PFAS air emission releases to reach the groundwater and wells drawing from it, but since there are no data we assume the contamination happened instantly. The levels and composition of PFAS in groundwater and private wells likely varied over the years and could be higher or lower than those measured in recent sampling. The available data from 2016 to 2021 best represent more recent exposures.

After discovery of the PFAS contamination in private wells near the facility, Saint-Gobain and local authorities acted to protect people whose private well water contained PFAS above existing guidelines. Affected neighborhoods were eligible for free bottled water, and over 750 affected homes were offered connection to treated municipal water or fitted with point-of-entry or other treatment systems. Water line extension projects were completed in 2020. Residents who are now drinking treated water may still be exposed to PFAS at very low levels in drinking water, but the high PFAS exposures that occurred in the past are no longer occurring.

Some private well owners may have declined well water testing, and some who were eligible for connection to municipal water or a treatment system declined the offer. Ongoing testing has identified additional affected private wells in the area.[8] These residents may have ongoing exposure to PFAS as well as past exposures. Current or future residents who drink from an untreated, contaminated private well will continue to be exposed.

[7] ATSDR's screening and minimal risk levels for PFOA, PFOS, PFHxS, and PFNA are based on oral exposure over intermediate duration timeframes. ATSDR considers these to be generally protective of chronic duration oral exposures because the intermediate values are derived from serum PFAS levels that are assumed to be at steady state and not changing quickly over time, due to the years-long elimination half-lives of these particular PFAS.

[8] Other sources of PFOA and other PFAS besides Saint-Gobain have been identified in the area; ATSDR makes no source attribution in this report.

### Screening and summarizing the data

The next step in ATSDR's evaluation process is to screen the well water contaminant data against health-based, chemical-specific comparison values (CVs). This step allows ATSDR to focus attention on wells and contaminants of most potential concern by eliminating from further consideration those that are unlikely to result in harmful exposures. The CVs used in this report are concentrations of chemicals in drinking water below which no harmful health effects are expected to occur, even with continual exposure of small children and infants. CVs are not regulatory clean up values, and concentrations higher than the corresponding CV do not necessarily result in harm. As described in ATSDR's public health assessment guidance manual, ATSDR further evaluates contaminants detected at concentrations above a CV [12]. ATSDR has derived CVs called environmental media evaluation guides, or EMEGs, for four PFAS: PFOA, PFOS, PFHxS, and PFNA.

As of the date of this report, ATSDR has not derived CVs for other PFAS. However, EPA has finalized some health-based drinking water guidance or screening values for other PFAS.[9] ATSDR considered these values, when available, while evaluating PFAS for which no ATSDR CV was available. These substances are discussed qualitatively later in this report, in the section entitled "Other PFAS present in wells" beginning on page 18. Some state health-based values for other PFAS may not be included on Table 1 for various reasons (for example, if they were extrapolated from studies on a different PFAS or were not specifically developed for drinking water). Those PFAS without CVs that were detected frequently and at levels higher than the lowest PFAS CV available (0.014 µg/L for PFOS) were retained and evaluated qualitatively later in the report.

Table 1 summarizes the detections and compares the highest concentrations of each PFAS detected with its corresponding CV, if available. (New Hampshire MCLs are provided in Table 1 for perspective and comparative statistics, when available. Note, however, that all private wells were evaluated further in this report, so the use of a higher ATSDR CV for screening of some PFAS does not affect the analysis.) PFAS are listed in the table in order of decreasing frequency of detection; PFOA was detected most frequently, in 91% of the wells tested. Of the PFAS with CVs available,

- PFOA and PFOS were detected above their corresponding CVs the most frequently. PFOA was detected above its CV in 30% of the private wells, while PFOS was detected above its CV less frequently, in only 3% of the private wells;
- PFHxS and PFNA were detected above their corresponding CVs in only one well each; and
- Neither PFBS nor PFBA were detected above the CV in any well.

ATSDR has not derived or fully reviewed other states' substance-specific, health-based CVs at this time. For this evaluation, we qualitatively discuss results and possible health effects for all PFAS without CVs listed in Table 1 that were detected frequently and at higher levels that the lowest ATSDR PFAS CV available, 0.014 µg/L for PFOS.

[9] Standards and guidance values for PFAS are changing rapidly; values in this report were updated in September 2023.

**Table 1. Summary of PFAS detected in private well sampling near the Saint-Gobain Merrimack, NH facility, 2016-2021 listed in order of decreasing frequency of detection – see Appendix A for full compound names and chemical information**

| PFAS* | # of wells with detections / # tested (%) | Maximum† concentration (µg/L) | PFAS-specific comparison value (CV) or New Hampshire maximum contaminant level (NH MCL)‡ (µg/L) | CV source‡ | # / % of wells with results above CV or NH MCL *(% rounded to nearest whole number)* |
|---|---|---|---|---|---|
| PFOA | 2,498 / 2,745 (91%) | 1.6 | 0.021<br>0.012 | ATSDR intermediate child EMEG‡<br>New Hampshire MCL** | 825 / 30%<br>1,380 / 50% |
| PFHxA€ | 1,905 / 2,509 (76%) | 0.42 | 3.5 | ATSDR child RMEG‡ | 0 / 0% |
| PFPeA€ | 1,682 / 2,494 (67%) | 0.23 | none | No CV available§ | n/a |
| PFHpA€ | 1,819 / 2,740 (66%) | 0.42 | none | No CV available§ | n/a |
| PFBS | 1,578 / 2,739 (58%) | 0.14 | 2.1 | ATSDR child RMEG‡ | 0 / 0% |
| PFOS | 1,445 / 2,745 (53%) | 0.12 | 0.014<br>0.015 | ATSDR intermediate child EMEG‡<br>New Hampshire MCL** | 71 / 3%<br>67 / 2% |
| PFHxS | 1,424 / 2,742 (52%) | 0.24 | 0.14<br>0.018 | ATSDR intermediate child EMEG‡<br>New Hampshire MCL** | 1 / 0%<br>27 / 1% |
| PFBA | 1,180 / 2,455 (48%) | 0.14 | 7 | ATSDR child RMEG‡ | 0 / 0% |
| PFPeS | 176 / 839 (21%) | 0.012 | none | No CV available§ | n/a |
| PFNA | 288 / 2,742 (11%) | 0.085 | 0.021<br>0.011 | ATSDR intermediate child EMEG‡<br>New Hampshire MCL** | 1 / 0%<br>2 / 0% |
| 4:2 FTSA | 42 / 831 (5%) | 0.0035 | none | No CV available§ | n/a |
| 6:2 FTSA€ | 51 / 1,750 (3%) | 0.57 | none | No CV available§ | n/a |
| PFDA | 57 / 2,429 (2%) | 0.0058 | none | No CV available§ | n/a |
| PFHpS | 37 / 1,750 (2%) | 0.0094 | none | No CV available§ | n/a |
| FOSA€ | 18 / 1,170 (2%) | 0.059 | none | No CV available§ | n/a |
| PFTeDA | 25 / 1,890 (1%) | 0.0040 | none | No CV available§ | n/a |
| Perfluoro-3,6-dioxaheptanoic acid | 7 / 615 (1%) | 0.00098 | none | No CV available§ | n/a |
| PFTrDA | 12 / 1,890 (0.6%) | 0.0065 | none | No CV available§ | n/a |
| EtFOSAA | 5 / 994 (0.5%) | 0.0028 | none | No CV available§ | n/a |
| Perfluoro(2-ethoxyethane)sulfonic acid | 2 / 615 (0.3%) | 0.00067 | none | No CV available§ | n/a |
| PFDoDA | 7 / 2,429 (0.3%) | 0.0074 | none | No CV available§ | n/a |

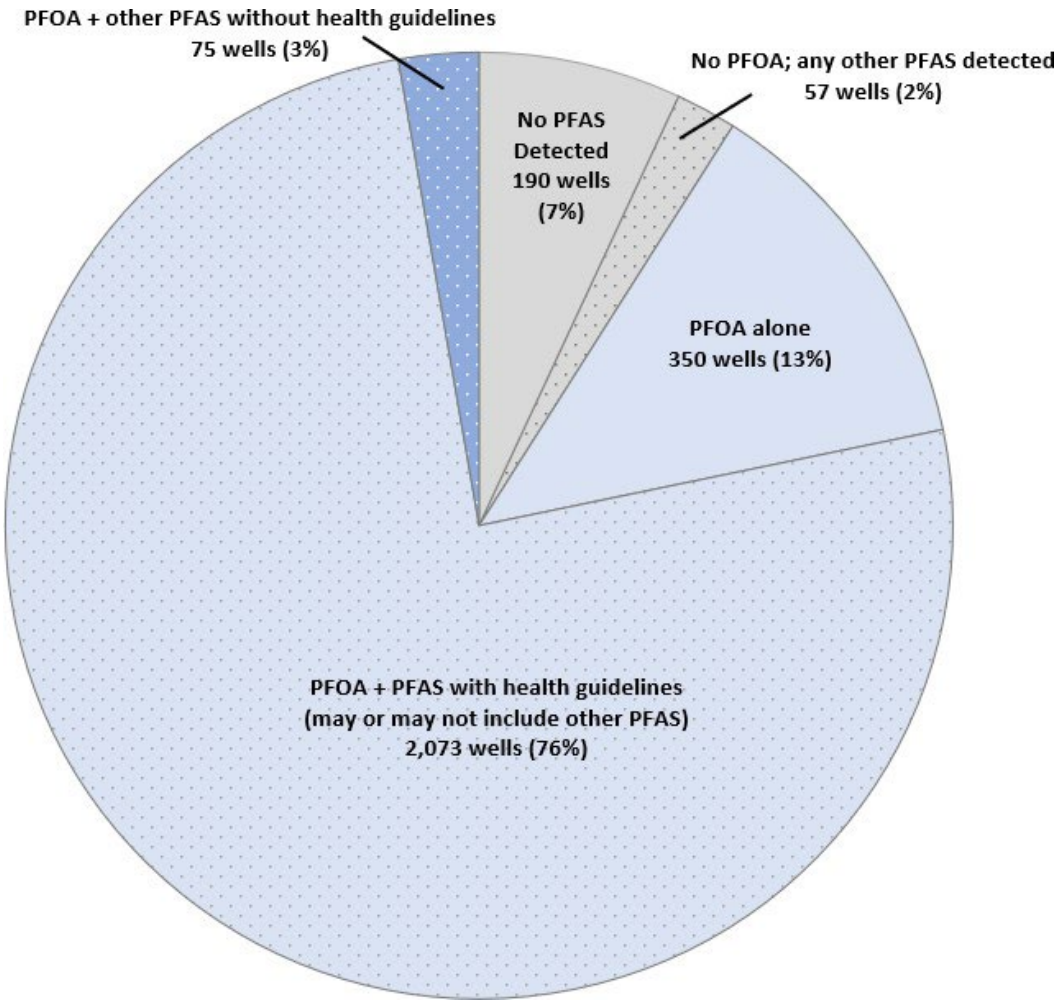
| PFAS* | # of wells with detections / # tested (%) | Maximum† concentration (µg/L) | PFAS-specific comparison value (CV) or New Hampshire maximum contaminant level (NH MCL)‡ (µg/L) | CV source‡ | # / % of wells with results above CV or NH MCL *(% rounded to nearest whole number)* |
|---|---|---|---|---|---|
| PFUnDA | 7 / 2,429 (0.3%) | 0.0048 | none | No CV available§ | n/a |
| 8:2 FTSA€ | 4 / 1,750 (0.2%) | 0.044 | none | No CV available§ | n/a |
| MeFOSAA | 2 / 1,055 (0.2%) | 0.0017 | none | No CV available§ | n/a |
| PFDS | 1 / 1,287 (0.1%) | 0.002 | none | No CV available§ | n/a |

# - number µg/L – micrograms per liter CV – comparison value n/a – not applicable

*See Appendix A for full compound names and chemical information.
Shaded cells indicate PFAS that exceeded the corresponding comparison value.
†Field replicates collected on the same sample date were averaged to obtain a single result. ATSDR considered all samples from a particular address to represent a single private well, and (if sampled on a single day) considered them as replicates. Thus, maximum concentration refers to the highest concentration representing any of the 2,745 private wells and could itself be an average of more than one result collected from that well on a single day.
‡ATSDR CV. EMEG = environmental media evaluation guide (developed from ATSDR intermediate minimal risk level). RMEG = reference dose media evaluation guide (developed from EPA reference dose). If no ATSDR CV is available, CVs from other sources may be used. As new studies become available, CVs can change. Please see Appendix B for more information about comparison values used in this evaluation.
**NH MCL = New Hampshire maximum contaminant level, shown for perspective with ATSDR CV. Please note, all wells and all PFAS were retained for further evaluation, so any differences between the CV and MCL will not affect the overall evaluation.
§No substance-specific, health-based drinking water screening value was identified. Those substances detected more frequently and at concentrations higher than the lowest PFAS CV available (0.014 µg/L for PFOS) are evaluated qualitatively.
€Substance evaluated qualitatively.

The PFAS detected in private wells varied in composition as well as concentration. As Figure 2 illustrates, PFOA was the most frequently detected PFAS in the private wells. However, in over three-fourths of the wells, one or more other PFAS were also detected. Private wells with multiple PFAS detected contained between 2 and 13 different PFAS.

**Figure 2. Frequency of PFAS detection in private wells near the Saint-Gobain site in Merrimack, New Hampshire**




PFOA was the most frequently detected PFAS in 2,745 private wells in the five towns surrounding the Saint-Gobain site in Merrimack, New Hampshire. Many wells showed detections of other PFAS.

Because multiple PFAS were present in many wells, we considered the potential for health effects from exposure to mixtures as well as individual PFAS. Further details are presented below.

### Estimating PFAS exposure doses; comparison with health guidelines

The next step of ATSDR's process is to estimate exposure doses for each contaminant. Exposure dose is the amount of contaminant that could get in a person's body for a specified situation. The estimated dose is expressed on a body weight basis (in amount of contaminant per kilogram of

body weight per day) to allow comparison with relevant health guidelines presented in the same units.

Appendix B details how we estimated exposure doses in this report. We used ATSDR standard guidance to estimate exposure doses for age groups ranging from birth through adulthood and who consumed water at rates ranging from typical (i.e., average) to high-end (i.e., 95$^{th}$ percentile) for each age group [13,14]. We assumed daily consumption of water containing the highest contaminant concentration measured in each well. We estimated exposure doses on a well-by-well basis. Further details, example calculations, and a summary of results are in Appendix B.

Health guidelines used in this report are ATSDR *minimal risk levels* (MRLs) or *reference doses* developed by other organizations. MRLs and reference doses represent a dose of a single contaminant that is unlikely to result in harmful health effects, to even the most sensitive groups, over the timeframe of exposure. Doses less than the MRL or reference dose are unlikely to result in harmful noncancer effects, while higher doses are evaluated more thoroughly to determine whether harmful health effects are possible.

ATSDR has derived intermediate oral MRLs for four PFAS: PFOA, PFOS, PFHxS, and PFNA [8]. These oral MRLs are based on different studies in which animals were exposed to the substance for between 2 weeks and one year–considered an intermediate duration. ATSDR uses these intermediate oral MRLs to evaluate chronic exposures lasting longer than one year, as well [8]. ATSDR also used reference doses developed by EPA to evaluate PFHxA, PFBS, and PFBA [15,16]. A summary of the derivation of these health guidelines is included in Appendix B.

For the drinking water exposures evaluated in this report, the highest estimated doses are for children from birth to one year old who drink high-end amounts of water (that is, more water than 95% of their age group). Table 2 presents the highest exposure doses estimated for those PFAS with health guidelines available. Because the drinking water CVs used for screening earlier in this report are developed from health guidelines using assumptions for this same sensitive group (children from birth to one year old who drink high-end amounts of water), the summary in Table 2 shows similar results as in Table 1. Calculating the doses is needed, however, for further evaluation of the potential exposures for all age groups and drinking water consumption patterns, as will be discussed later.

As shown in Table 2, hundreds of private wells had estimated doses of PFOA higher than the MRL. A smaller number of wells (less than a hundred) had estimated PFOS doses exceeding its MRL, and only one or none of the wells had any PFHxS, PFNA, PFHxA, PFBA, or PFBS doses exceeding their respective health guidelines.

The next section discusses general health implications of PFAS exposure and how ATSDR uses information from human epidemiology and animal toxicology studies in evaluating impacts from PFAS exposures on community's health. Immediately following this section, we discuss implications from exposures to individual PFAS detected in the private wells at this site. In the "PFAS mixtures evaluation" section beginning on page 20, we consider the possibility for health effects from exposures to mixtures of PFAS in private wells.

**Table 2. Summary of highest estimated doses of PFAS (for birth to 1-year old children with high-end water consumption) from private wells near the Saint-Gobain Merrimack, NH facility**

| PFAS* | Highest estimated dose in any well†, µg/kg/day | Health guideline, µg/kg/day | Health guideline | # of wells with dose exceeding health guideline‡ |
|---|---|---|---|---|
| PFOA | 0.230 | 0.003<br>0.0061 | ATSDR intermediate MRL<br>NH reference dose [4] | 825 |
| PFOS | 0.017 | 0.002<br>0.003 | ATSDR intermediate MRL<br>NH reference dose [4] | 71 |
| PFHxS | 0.034 | 0.020<br>0.004 | ATSDR intermediate MRL<br>NH reference dose [4] | 1 |
| PFNA | 0.012 | 0.003<br>0.0043 | ATSDR intermediate MRL<br>NH reference dose [4] | 1 |
| PFHxA | 0.06 | 0.5 | EPA reference dose [17] | 0 |
| PFBA | 0.020 | 1 | EPA reference dose [16] | 0 |
| PFBS | 0.020 | 0.3 | EPA reference dose [15] | 0 |

µg/kg/day = micrograms per kilogram body weight per day MRL = minimal risk level # - number

*See Appendix A for full compound names and chemical information.

†Highest dose is for children from birth up to one year old who drink high-end (95th percentile) amounts of water every day. Doses are generally lower for those who drink less water or who weigh more and thus have a lower dose per body weight. See Appendix B for assumptions and a more detailed summary, including doses estimated for other age groups and water consumption assumptions.

‡highest estimated dose (birth up to one-year-old age group with high-end drinking water consumption) exceeds MRL.

### Noncancer health effects from exposure to PFAS

Numerous human epidemiology studies have examined associations between various harmful health effects and serum levels of PFAS in exposed workers, residents exposed to high levels of PFAS released by facilities, and people exposed to background levels of PFAS. The weight of evidence suggests links between PFAS exposure and several harmful noncancer health effects in humans, including increased cholesterol levels, changes in liver enzymes, decreased vaccine response in children, increased risk of high blood pressure or pre-eclampsia in pregnant women, and small decreases in infant birth weight [8,18,19]. Due to several limitations described below, ATSDR's evaluation cannot predict the likelihood of the above health effects from a given exposure. Therefore, although use of human data are generally preferred, evaluation of PFAS exposure uses guidelines based on animal study effect levels for sensitive health endpoints [8]. Exposures over these levels have an increasing risk of health effects.

The human epidemiology studies are valuable in identifying potential hazards associated with PFAS exposure; however, most of them were not designed to show causality, and there were some inconsistencies in findings across the studies. In addition, most studies did not adequately characterize the environmental exposure levels and routes of exposure that produced the observed effects, and most studies involved potential exposures to multiple PFAS at once [8,18]. For these reasons, ATSDR relies on experimental toxicology studies on animals, which have greater ability to control and measure exposures and examine specific biological mechanisms, as the primary basis for evaluating health risks related to PFAS exposure. This introduces uncertainty because humans and other species process PFAS differently. Rather than using

simple dose extrapolation, the nominal doses to which animals are exposed should be converted, whenever possible, to *human equivalent doses* to relate animal toxicity data to possible effects in humans.

The primary noncancer effects observed in toxicological studies on animals exposed to PFAS include developmental toxicity, immune toxicity, and liver toxicity [8,20,21].[10] Other effects, typically observed at higher doses, include weight loss and changes in the microscopic structure of reproductive tissues or the thyroid gland. Not all of these effects were seen across all PFAS tested, and effect levels varied. However, in general, the sensitive targets of toxicity identified in laboratory animals are similar to those observed in human epidemiology studies [8].

***Note on intermediate versus chronic health guidelines used in this evaluation.***

ATSDR's current MRLs for PFOA, PFOS, PFNA, and PFHxS are all based on intermediate-duration studies, and thus the MRLs are most applicable to intermediate duration exposures of less than one year. To date, ATSDR has considered these intermediate MRLs to be generally protective for chronic exposures of greater than one year duration because of the following factors:

- In developing the intermediate MRLs, ATSDR assumed the time weighted average PFAS serum concentration used to represent the dose in animal toxicological studies reflected a steady state. ATSDR's dose-response modeling to identify corresponding serum concentrations in humans also assumes a steady state.
- Because PFOA, PFOS, PFNA, and PFHxS are eliminated very slowly from the body, once they reach a steady state, the concentration will not change much over time, even over longer time periods.

These factors may not apply to other PFAS, especially those with shorter elimination half-lives, and ATSDR is aware of EPA's proposed updated chronic oral reference doses for PFOA and PFOS. These values have been reviewed by EPA's Science Advisory Board and have completed a public comment period but have not yet been finalized. Until noncancer chronic guidelines are adopted for use in ATSDR assessments, ATSDR will continue to use the intermediate MRLs to assess exposures but will take a more conservative approach in its overall conclusions to ensure protection for communities exposed to PFAS.

***Individual PFAS exposure evaluation***

*PFOA*

PFOA was detected in over 90% of the private wells; reported concentrations ranged from 0.0003 µg/L to 1.6 µg/L. Drinking the most-highly contaminated water would result in doses ranging from about 0.05 to 0.20 µg/kg/day for various age groups with high-end water consumption rates (more than 95% of their age group). These doses greatly exceed the corresponding MRL for PFOA of 0.003 µg/kg/day. Age groups with typical water consumption (that is, about average for their age group) would have doses about a third to a half as high as those with high consumption, but still exceeding the MRL for the highest PFOA concentrations.

[10] Not all liver effects observed in rodent studies are considered relevant for humans. ATSDR generally uses the criteria published by Hall et al. in 2012, which is based on an expert panel workshop convened by the European Society of Toxicological Pathology, to discern human toxicological relevance of liver effects observed in rodent studies [21].

The toxicology literature has identified several potential health effects from PFOA exposures. A brief summary of the PFOA-specific developmental, immune, and liver effects considered the primary effects observed in animals exposed to PFAS is presented below.

- **Developmental effects.** Skeletal changes and increased activity levels were observed in offspring of mice fed PFOA during pregnancy [8,22,23]. These effects occurred at a human equivalent dose of 0.82 µg/kg/day. The study showing skeletal changes is the basis for ATSDR's intermediate MRL.
- **Immune effects.** A lowered antibody response to applied antigens was observed in mice exposed to PFOA in drinking water [24,25]. This effect occurred at a human equivalent dose of 3.3 µg/kg/day.
- **Liver effects.** Studies on monkeys and rodents have reported signs of liver damage following exposure to PFOA [26–30]. Not all rodent liver effects are considered relevant to humans, and not all studies contain enough information to calculate human equivalent doses [8]. The lowest-effect human equivalent doses for liver effects that could be calculated and appear to be relevant to humans range from about 4 to 20 µg/kg/day in rodent and monkey studies [28–30].

Other sensitive effects, such as changes in mammary gland development observed in mice exposed to low levels of PFOA, have been observed [31]. The biological significance of the finding is uncertain (the changes did not appear to harm milk production or survival of the offspring), and ATSDR has not evaluated the quantitative potential for such effects [8].

In this evaluation, 825 properties had private wells in which estimated PFOA doses for small children were higher than the MRL. Moreover, 201 of the properties had estimated PFOA doses that approach effect levels determined in toxicology studies and would increase the risk of developmental, immune, or liver effects in all age groups. As PFOA concentrations increase, the risk of developmental, immune, or liver effects increases. In addition, mixtures effects may have contributed to risk: most of the wells with PFOA had other PFAS detected as well.

Many homes with private wells have been provided alternate water and connection to a public water source or point-of-entry treatment systems. These actions would have reduced exposures; however, higher and more harmful exposures likely occurred in the past. Exposures could still occur from low levels of PFOA remaining in alternate or treated water sources, from PFOA in contaminated wells that were not tested or whose owners declined alternate water or treatment, or from exposure to other sources of PFOA in the environment. Homeowners using private wells should monitor their well water quality and work with local authorities to take appropriate action to remove harmful contaminants, if needed.

### *PFOS*

PFOS was detected in about 53% of the private wells; reported concentrations ranged from 0.0004 µg/L to 0.12 µg/L. Drinking the most-highly contaminated water would result in doses ranging from about 0.004 to 0.02 µg/kg/day for various age groups with high-end water consumption rates. These doses exceed the corresponding MRL for PFOS of 0.002 µg/kg/day.

Age groups with typical water consumption would have doses about a third to a half as high as those with high consumption, but still exceeding the MRL for some age groups at the highest PFOS concentrations. The toxicology literature has identified several potential health effects from PFOS exposures. A brief summary of the PFOS-specific developmental, immune, and liver effects considered the primary effects observed in animals exposed to PFAS is presented below.

- **Developmental effects.** Offspring of rats exposed to PFOS by gavage before mating, during gestation, and after giving birth showed delays in eye opening and a transient decrease in body weight [32,8]. These effects, which are the basis for ATSDR's intermediate MRL, occurred at a human equivalent dose of 2.1 µg/kg/day.
- **Immune effects**. Mice exposed to PFOS by gavage at a human equivalent dose of 0.031 µg/kg/day showed decreased resistance to influenza A virus infection [33]. In two reports from another study, mice exposed to a human equivalent dose of 0.41 µg/kg/day of PFOS by gavage had a decreased immune response to sheep red blood cells [34,35]. ATSDR believes that the immune effect level of concern from PFOS exposures lies somewhere between the human equivalent effect levels of these two studies.
- **Liver effects**. Monkeys exposed to PFOS were found to have increased liver weights and other hepatic changes at a human equivalent dose of 10 µg/kg/day [36].

Other sensitive effects, such as changes in glucose metabolism in mice fed a high-fat diet [37] or changes in levels of estradiol, a female reproductive hormone, in male monkeys [36], have been observed upon exposure of animals to low levels of PFOS. The biological significance of these changes is uncertain, and ATSDR has not evaluated the quantitative potential for such effects [8].

In this evaluation, 71 properties had private wells in which estimated PFOS doses for small children were higher than the MRL. Moreover, about 40 of the properties had estimated PFOS doses that approach effect levels determined in toxicology studies and could increase the risk of immune effects.

Many homes with private wells have been provided alternate water and connection to a public water source or point-of-entry treatment systems. These actions would have reduced exposures; however, depending on the level of contamination in the private well, higher and more harmful exposures may have occurred in the past. Exposures could still occur from low levels of PFOS remaining in alternate or treated water sources, from PFOS in contaminated wells that were not tested or whose owners declined alternate water or treatment, or from exposure to other sources of PFOS in the environment. Homeowners using private wells should monitor their well water quality and work with local authorities to take appropriate action to remove harmful contaminants, if needed.

*PFHxS*

PFHxS was detected in about 52% of the private wells; reported concentrations ranged from 0.0002 µg/L to 0.24 µg/L. Drinking the most-highly contaminated water would result in doses ranging from about 0.008 to 0.03 µg/kg/day for various age groups with high-end water

consumption rates. The highest estimated dose exceeds the corresponding MRL for PFHxS of 0.02 µg/kg/day. Age groups with typical water consumption would have doses about a third to a half as high as those with high consumption – doses that all fall below the MRL. The toxicology literature has identified health effects from PFHxS exposures, including;

- **Thyroid effects**. Thyroid changes were observed in adult male rats exposed to PFHxS at a lowest-effect level corresponding to a human equivalent dose of 7.3 µg/kg/day [8,38,39]. This finding is the basis for ATSDR's intermediate MRL for PFHxS.

Few of the limited studies on PFHxS have shown an association between PFHxS exposure and developmental, immune, or liver effects considered the primary effects observed in animals exposed to PFAS. No developmental or reproductive effects were reported at any dose tested in the rat study that observed thyroid changes [8,38,39]. A few epidemiological studies have suggested that PFHxS exposure is associated with immune-related effects; however, findings are complicated by co-exposures of study subjects to additional PFAS, particularly PFOA and PFOS, and no toxicological studies on immune effects of PFHxS have been identified [8,40]. Finally, PFHxS exposure has been shown to cause liver effects in rats and mice [8].

In this evaluation, one property had a private well in which the estimated PFHxS dose for small children was higher than the MRL. However, the estimated dose for the highest PFHxS concentration is orders of magnitude below the effect level for thyroid effects determined in toxicology studies. Exposure to PFHxS alone in private well water is unlikely to increase the risk of either thyroid effects or developmental, immune, or liver effects. Because PFHxS was almost always detected with one or more other PFAS, we evaluated the potential for PFHxS exposure to contribute to mixture effects.

Many homes with private wells, including those with the highest concentrations of PFHxS, have been provided alternate water and connection to a public water source or point-of-entry treatment systems. Exposures could still occur from low levels of PFHxS remaining in alternate or treated water sources, from PFHxS in contaminated wells that were not tested or whose owners declined alternate water or treatment, or from exposure to other sources of PFHxS in the environment. Homeowners using private wells should monitor their well water quality and work with local authorities to take appropriate action to remove harmful contaminants, if needed.

*PFNA*

PFNA was detected in about 10% of private wells; reported concentrations ranged from 0.0002 µg/L to 0.085 µg/L. Drinking the most-highly contaminated water would result in doses ranging from about 0.003 to 0.01 µg/kg/day for various age groups with high-end water consumption rates. Most of these doses exceed the corresponding MRL for PFNA of 0.003 µg/kg/day. Age groups with typical water consumption would have doses about a third to a half as high as those with high consumption – only exceeding the MRL for the youngest age group. The toxicology literature has identified several potential health effects from PFNA exposures. A brief summary of the PFNA-specific developmental, immune, and liver effects considered the primary effects observed in animals exposed to PFAS is presented below.

- **Developmental effects**. Offspring of mice exposed to PFNA by gavage during gestation showed decreased body weight gain, transient changes in liver weight, and delays in postnatal development (eye opening, signs of male and female puberty) [41,8]. These effects, which are the basis for ATSDR's intermediate MRL for PFNA, occurred at a human equivalent dose of 1.7 µg/kg/day.
- **Immune effects.** The toxicological literature on immune effects of PFNA is limited. Acute duration exposures to PFNA caused changes in the thymus or spleen (considered to be immune-related effects) in rat and mouse studies [8]. However, no longer-duration immune studies are available, and it is not known whether these changes would occur or be relevant to immune function in humans exposed for longer periods.
- **Liver effects**. PFNA exposure resulted in transient increased liver weights in pregnant mice and their offspring [41,8]. The observed liver changes do not appear to be relevant to humans.

In this evaluation, one property had a private well in which the estimated PFNA dose for small children was higher than the MRL. However, the estimated dose for the highest PFNA concentration is orders of magnitude below the effect level for developmental effects determined in toxicology studies. Exposure to PFNA in private well water is unlikely to increase the risk of developmental, immune, or liver effects. Because PFNA was almost always detected with one or more other PFAS, we evaluated the potential for PFNA exposure to contribute to mixture effects.

Many homes with private wells have been provided alternate water and connection to a public water source or point-of-entry treatment systems. Exposures could still occur from low levels of PFNA remaining in alternate or treated water sources, from PFNA in contaminated wells that were not tested or whose owners declined alternate water or treatment, or from exposure to other sources of PFNA in the environment. Homeowners using private wells should monitor their well water quality and work with local authorities to take appropriate action to remove harmful contaminants, if needed.

*PFHxA*

Although PFHxA concentrations in well water did not exceed screening levels, the following gives a brief discussion of what is known about PFHxA's health effects, so all PFAS with screening levels detected in private wells in this community are included. PFHxA was detected in about 76% of 2,509 private wells analyzed; all but 9 of the detections were in wells that also had detections of PFOA, PFOS, PFHxS, or PFNA. The highest concentration detected was 0.42 µg/L, which would result in a maximum dose to the most sensitive age group (birth up to one year old) of 0.06 µg/kg/day. This dose is well below EPA's chronic oral reference dose of 0.5 µg/kg/day based on liver effects in rats. Exposure to the levels of PFHxA detected would be unlikely to result in harmful health effects. However, EPA has recognized that "the available evidence indicates that PFHxA likely causes developmental, hematopoietic, and endocrine…effects in humans given sufficient exposure conditions." [17] Thus, exposure to PFHxA may contribute to possible health effects shared with other PFAS

detected in wells at this site. PFHxA was included in ATSDR's mixtures evaluation described below.

*PFBA*

Although PFBA concentrations in well water did not exceed screening levels, the following gives a brief discussion of what is known about PFBA's health effects, so all PFAS detected in private wells in this community are included. PFBA was detected in about 48% of 2,455 private wells analyzed; almost all detections were in wells that also had detections of PFOA, PFOS, PFHxS, or PFNA. The highest concentration detected was 0.12 µg/L, which would result in a maximum dose to the most sensitive age group (birth up to one year old) of 0.02 µg/kg/day. EPA's chronic oral reference dose of 1 µg/kg/day is based on liver and thyroid effects shown in rat studies with a human equivalent point of departure of 1,270 µg/kg/day; developmental effects were also observed in mouse studies with human equivalent doses ranging from 620—930 µg/kg/day [16]. Exposure to the levels of PFBA detected would be unlikely to result in harmful health effects. However, PFBA shares potential developmental and liver endpoints with the other PFAS evaluated, and thus may contribute to possible health effects. PFBA was included in ATSDR's mixtures evaluation described below.

*PFBS*

Although PFBS concentrations in well water did not exceed screening levels, the following gives a brief discussion of what is known about PFBS's health effects, so all PFAS detected in private wells in this community are included. PFBS was detected in about 58% of 2,739 private wells analyzed; almost all of the detections occurred in wells that also had detections of PFOA, PFOS, PFHxS, or PFNA. The highest concentration detected was 0.14 µg/L. EPA developed sub chronic and chronic oral reference doses for PFBS based on a mouse study showing thyroid effects in mice at a benchmark human equivalent dose of 95 µg/kg/day. By applying uncertainty factors to this dose, EPA derived a chronic oral reference dose of 0.3 µg/kg/day [15]. The highest concentration of PFBS detected in the private wells would result in a maximum dose to the most sensitive age group (birth up to one year old) of 0.02 µg/kg/day. Exposure to the levels of PFBS detected would be unlikely to result in harmful health effects. However, PFBS shares potential developmental endpoints with the other PFAS evaluated, and thus may contribute to possible health effects. PFBS was included in ATSDR's mixtures evaluation described below.

*Other PFAS present in wells.*

As discussed above, other PFAS for which no CVs were available were detected in some private wells. Not enough is currently known about health effects of other PFAS to allow a quantitative evaluation of their contribution, if any, to harmful health effects. Some of these PFAS were detected infrequently at low levels (below the lowest PFAS CV available, 0.014 µg/L for PFOS) and are not discussed further.[11] The below discussion provides additional qualitative information

[11] These other PFAS are PFTeDA (detected in 25 wells at a maximum concentration of 0.0040 µg/L); PFTrDA (detected in 12 wells at a maximum concentration of 0.0065 µg/L); PFDoDA (detected in 7 wells at a maximum concentration of 0.0074 µg/L); PFUnDA (detected in 7 wells at a maximum concentration of 0.0048 µg/L); PFDA (detected in 57 wells at a maximum concentration of 0.0058 µg/L); PFDS (detected in 1 well at a concentration of 0.002 µg/L); PFHpS (detected in 37 wells at a maximum concentration of 0.0094 µg/L); PFPeS (detected in 176

about the other PFAS most commonly detected in the private wells. Full compound names can be found in Appendix A.

PFHpA was detected in about 66% of 2,740 private wells analyzed; all detections were in wells that also had detections of PFOA, PFOS, PFHxS, or PFNA. The highest concentration detected was 0.42 µg/L. At this time, too few studies have been conducted on PFHpA to be able to evaluate possible health effects from its ingestion. The chemical structure of this PFAS (a short carboxylic acid chain of fewer than eight carbon atoms) suggests possibly faster elimination from the human body and lower potential for bioaccumulation compared to other PFAS [8]. However, given the lack of information, ATSDR cannot make definitive health conclusions regarding PFHpA exposure at this time.

PFPeA was detected in about 67% of 2,494 private wells analyzed; all detections were in wells that also had detections of PFOA, PFOS, PFHxS, or PFNA. The highest concentration detected was 0.23 µg/L. At this time, too few studies have been conducted on PFPeA to be able to evaluate possible health effects from its ingestion. The chemical structure of this PFAS (a short carboxylic acid chain of fewer than eight carbon atoms) suggests possibly faster elimination from the human body and lower potential for bioaccumulation compared to other PFAS [8]. However, given the lack of information, ATSDR cannot make definitive health conclusions regarding PFPeA exposure at this time.

6:2 FTSA was detected in about 3% of 1,750 private wells analyzed; all detections were in wells that also had detections of PFOA, PFOS, PFHxS, or PFNA. The highest concentration detected was 0.57 µg/L. At this time, too few studies have been conducted on 6:2 FTSA to be able to evaluate possible health effects from its ingestion [8]. Given the lack of information, ATSDR cannot make definitive health conclusions regarding 6:2 FTSA exposure at this time.

8:2 FTSA was detected in fewer than 1% of 1,750 private wells analyzed; all detections were in wells that also had detections of PFOA, PFOS, PFHxS, or PFNA. The highest concentration detected was 0.044 µg/L. At this time, too few studies have been conducted on 8:2 FTSA to be able to evaluate possible health effects from its ingestion [8]. Given the lack of information, ATSDR cannot make definitive health conclusions regarding 8:2 FTSA exposure at this time.

FOSA was detected in about 2% of 1,170 private wells analyzed; all detections were in wells that also had detections of PFOA, PFOS, PFHxS, or PFNA. The highest concentration detected was 0.059 µg/L. At this time, too few studies have been conducted on FOSA to be able to evaluate possible health effects from its ingestion [8]. Given the lack of information, ATSDR cannot make definitive health conclusions regarding FOSA exposure at this time.

wells at a maximum concentration of 0.012 µg/L); EtFOSAA (detected in 5 wells at a maximum concentration of 0.0028 µg/L); MeFOSAA (detected in 2 wells at a maximum concentration of 0.0017 µg/L); Perfluoro(2-ethoxyethane)sulfonic acid (detected in 2 wells at a maximum concentration of 0.00067 µg/L); Perfluoro-3,6-dioxaheptanoic acid (detected in 7 wells at a maximum concentration of 0.00098 µg/L); and 4:2 FTSA (detected in 42 wells at a maximum concentration of 0.0035 µg/L).

### *PFAS mixtures evaluation*

Many wells contained detections of multiple PFAS. For mixtures, ATSDR recommends a tiered approach to determine whether further evaluation of mixture effects is necessary [42]:

- In Tier 1, a hazard quotient is calculated for each of the identified contaminants. The hazard quotient is the ratio of the estimated dose of a contaminant and its corresponding noncancer or cancer-based health guideline. For the PFAS assessed in this report, we can only evaluate mixtures using noncancer health guidelines.[12] Mixtures of contaminants with hazard quotients greater than 0.1 are carried forward for Tier 2 analysis.

  Table 3 shows that for the private wells evaluated in this report, PFOA, PFOS, PFHxS, PFNA, and PFHxA all had hazard quotients greater than 0.1 in some wells. PFBA and PFBS had hazard quotients lower than 0.1 in all wells and are not carried forward to Tier 2. This Tier 1 analysis identified five PFAS in 1,101 wells to be included in the Tier 2 analysis.[13] See Appendix B for further details.

**Table 3. Tier 1 (hazard quotient) analysis of PFAS in private wells near the Saint-Gobain Merrimack, NH facility**

| PFAS | Highest estimated hazard quotient in any well† | Number of wells with hazard quotient ≥0.1‡ | Number of those wells at least one other PFAS with hazard quotient ≥0.1‡ | Include PFAS in Tier 2 mixtures evaluation? |
|---|---|---|---|---|
| PFOA | 76 | 2,362 | 1,101 | Yes |
| PFOS | 9 | 1,097 | 1,088 | Yes |
| PFHxS | 2 | 34 | 33 | Yes |
| PFNA | 4 | 24 | 24 | Yes |
| PFHxA | 0.12 | 1 | 1 | Yes |
| PFBA | 0.02 | 0 | Not applicable | No |
| PFBS | 0.07 | 0 | Not applicable | No |

†Hazard quotient is the highest dose (for children from birth up to one year old with high-end water consumption) divided by the minimal risk level or reference dose listed in Table 2. Individual contaminants with hazard quotient greater than one are evaluated further, and those wells with more than one PFAS hazard quotient greater than 0.1 are included in the Tier 2 mixtures evaluation.
‡Numbers of wells are not additive, since some wells contained multiple PFAS.

- In Tier 2, for multi-component mixtures, all hazard quotients (regardless of the target organ) are summed to obtain a hazard index. Mixtures with a hazard index greater than 1 are carried forward to Tier 3 analysis. Tier 2 analysis assumes that doses are additive. Of the 1,101 properties with private wells evaluated in Tier 2, 672 of them had a hazard index greater than 1 and were evaluated further.

[12] Intermediate MRLs based on noncancer effects are available for PFOA, PFOS, PFHxS, and PFNA. Reference doses based on noncancer effects are available for PFHxA, PFBA, and PFBS from EPA. No finalized cancer slope factors exist for PFAS at the time of this report. Potential cancer effects are discussed later in this report.
[13] Of the 1,644 wells not included in further mixtures analysis, we note that 1,035 of them included detections of other PFAS for which no health guidelines exist. ATSDR cannot evaluate the potential mixture effects of these other PFAS.

- Tier 3 analysis is a detailed analysis of potential mixture effects, considering, for example, shared target toxicities of each mixture component, sensitive subpopulations, or more refined estimates of potential exposure to the mixture.

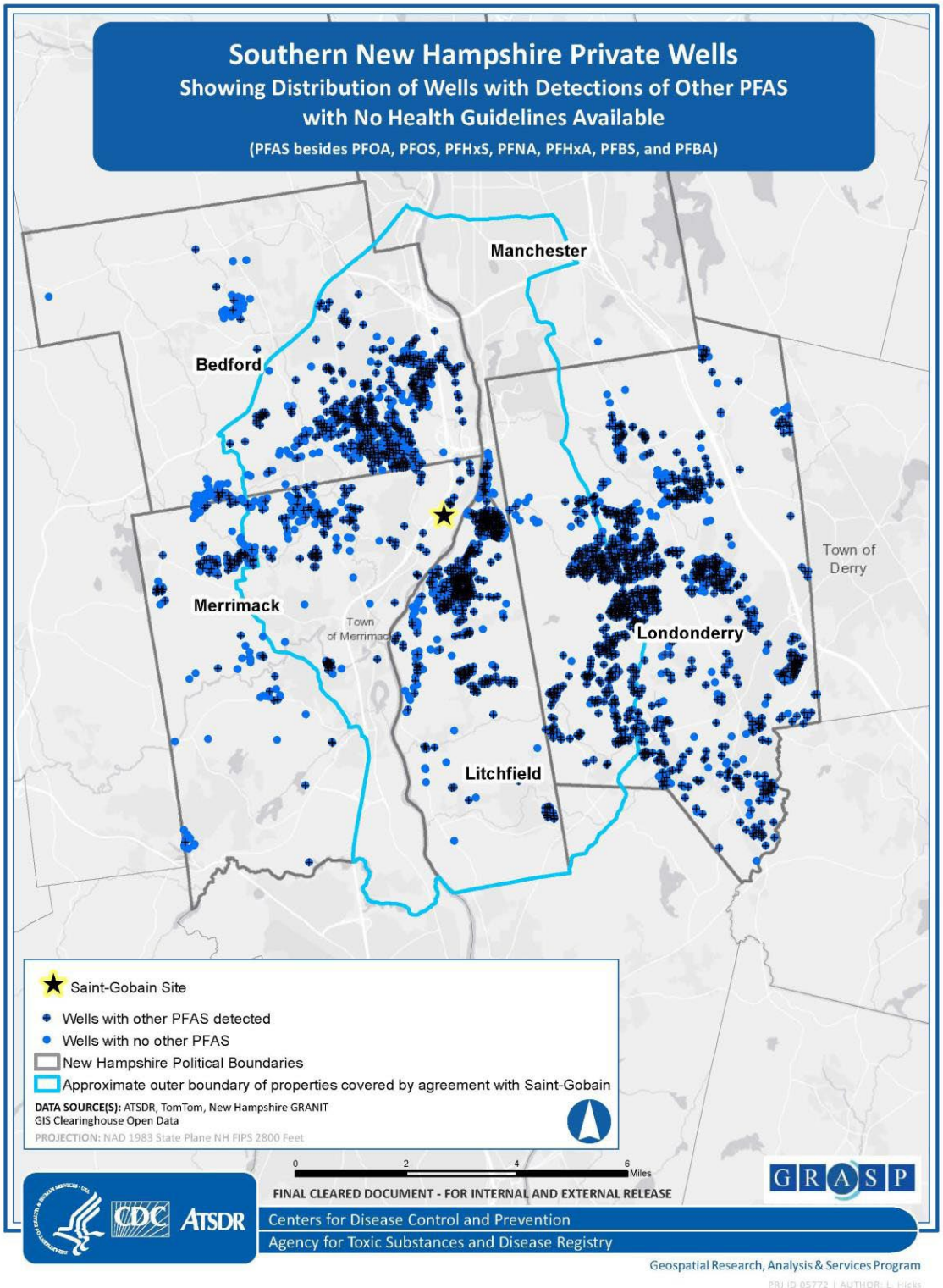
Discussion of our findings from the mixtures analysis follows. More information about ATSDR's mixtures evaluation process is in Appendix B, beginning on page B-7.

Of the 1,101 private wells with potential mixture effects, 672 wells had a hazard index greater than 1 and were evaluated further. Toxicological literature suggests that PFOA, PFOS, PFHxS, PFNA, and PFHxA may share some sensitive endpoints such as developmental, immunological, and liver effects. ATSDR evaluated potential health implications from exposure to mixtures of these four PFAS by adding the estimated doses of PFOA, PFOS, PFHxS, PFNA, and PFHxA for each well. Because PFOA is the main PFAS driving public health concern at this site, we compared the summed dose to the PFOA effect levels to determine the possibility for harmful health effects.

This comparison identified 65 additional wells of concern that were not identified through the individual PFAS analysis. Exposure to contaminants in water from these wells could increase the risk of harmful developmental, immune, or liver effects, with increasing risk as overall doses increase. In addition, most of the wells assessed for mixture effects contained PFOS, which could contribute to immune effects at lower concentrations than those observed for PFOA alone.

The presence of other PFAS (besides those that could be evaluated quantitatively) lends uncertainty to the health evaluation. Figure 3 shows the wells in the area, indicating those with detection of other PFAS not included in the mixtures evaluation due to a lack of toxicological information. Most of these other PFAS were detected along with PFOA, PFOS, PFHxS, PFNA, PFHxA, PFBS, and PFBA in private wells, and scientists do not know how their presence may affect health implications of exposure to the mixture. Also, many of the wells' analyses included only a limited number of the other PFAS, so it is possible that some wells contained other PFAS which were not analyzed. ATSDR recommends all private wells remaining in use in the area be tested regularly for a full range of PFAS and other applicable water quality parameters.

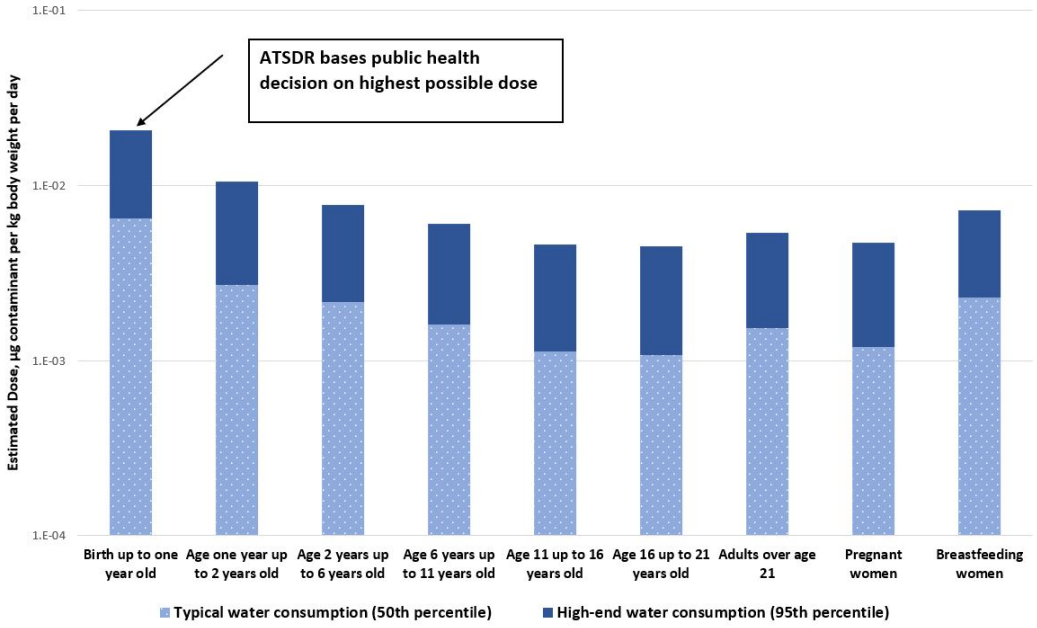
**Figure 3. Distribution of private wells near the Saint-Gobain site in Merrimack, NH with other PFAS that could not be evaluated quantitatively through mixtures framework**



***Summary - noncancer health effects***

ATSDR makes its public health recommendations to protect the most highly exposed and sensitive group—in this case, children between birth and one year of age who drink higher amounts of water from their private well. Other groups and those who consume more typical amounts of water will have less exposure, and thus less risk. The potential health implications from drinking from a particular private well depend not only on the levels of PFAS present, but also on the age of the child or adult drinking and how much water they drink. This concept is depicted in Figure 4, which shows how the dose calculated for one contaminant concentration varies for different age groups consuming different amounts of water every day – either typical water consumption, referring to the 50th percentile consumption rate for the age group, or high-end water consumption, referring to the 95th percentile consumption rate for the age group [14].

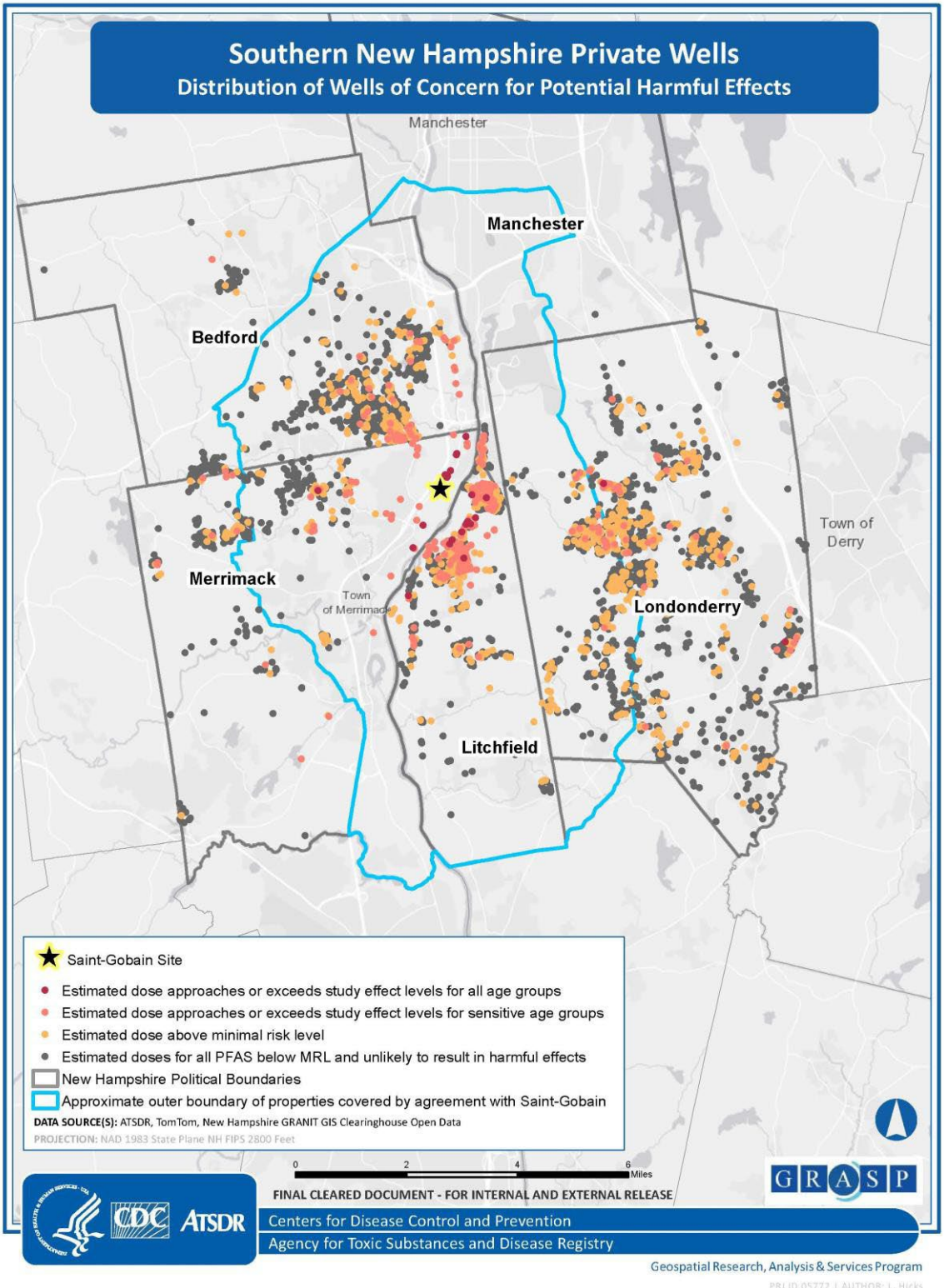
**Figure 4. How age group and water consumption affect estimated dose at a set contaminant concentration (0.1 micrograms per liter example)**




In 1,063 private wells in the five towns evaluated, the estimated dose to the most sensitive age group drinking a high-end amount of water every day was higher than the MRL. In 287 of those private wells, the estimated dose to the most sensitive age group approached or exceeded effect levels seen in toxicological studies, indicating an increased risk for harmful health effects. In 23 wells, estimated doses for **all** age groups approached or exceeded study effect levels. Harmful effects possible include developmental, immune, and liver effects, with risk increasing as contaminant levels and dose increase. Figure 5 shows the spatial distribution of private wells included in this evaluation and those that this evaluation showed to have a potentially increased risk of harmful health effects for past exposures. [14] Wells with the potential for resulting in harmful effects are present in each of the five towns included in the evaluation. Many of those

[14] As stated earlier, most affected private wells in the area have been connected to a treated public water source or provided point-of-entry treatment systems, reducing harmful exposures. Exposures could still occur from low levels of PFAS remaining in alternate or treated water sources, from PFAS in contaminated wells that were not tested or whose owners declined alternate water or treatment, or from exposure to other sources of PFAS in the environment.

**Figure 5. Distribution of private wells of concern for potential harmful health effects near the Saint-Gobain site in Merrimack, NH**



with the highest resulting estimated exposure doses appear to be concentrated in the areas closer to the Saint-Gobain facility.

### Cancer effects from exposure to PFOA and other PFAS

Analysis of human epidemiological studies on PFOA exposure suggest that PFOA exposure is associated with some types of cancer, including kidney, testicular, and prostate cancers; a causal relationship has not been proven [8,43–46]. Animal studies have shown some evidence that PFOA might cause several cancers, including liver, testicular, kidney, forestomach, thyroid, and pancreatic cancers [8,47,48]. Although we do not know if cancer at these sites in animals results from a mode of action that is relevant to humans, an association between PFOA exposure and kidney and testicular cancers have been shown in both human and animal studies.

Based on available information, EPA has concluded that there is suggestive evidence of carcinogenic potential of PFOA in humans [45]. The International Agency for Research on Cancer (IARC) has classified PFOA as possibly carcinogenic to humans based on limited evidence in humans, including a positive association observed for cancers of the testis and kidney, and on limited evidence in experimental animals [46].

For PFOS, EPA has concluded that there is suggestive evidence of its carcinogenic potential based on limited evidence of liver cancer in rats [49]. Little to no information is currently available on the carcinogenicity of PFNA, PFHxS, or other PFAS.

Currently, ATSDR cannot estimate a quantitative cancer risk for PFOA, PFOS, or other PFAS. At this time, carcinogenic potential for most PFAS has not been fully assessed, and the science is too limited to quantify risk.[15] The cancer risk contributed by exposure to PFAS in the area is uncertain.

## Summary of health outcome and biomonitoring investigations specific to the Merrimack area

### NH DHHS cancer incidence studies

Concerns about cancer risks led the NH DHHS to review cancer incidence in the town of Merrimack in a 2018 report [50]. Between 2004 and 2014[16] in Merrimack, there were no statistical differences between observed diagnoses of any type of cancer and the number expected based on New Hampshire standard cancer incidence rates.

In December 2021, NH DHHS released newly analyzed data on cancer rates in Merrimack. A press release stated, “The analysis of data from the New Hampshire State Cancer Registry found a higher than expected number of people with kidney and renal cancers in Merrimack between 2009 and 2018 than would typically be observed in a town of similar size in New Hampshire. There is not sufficient information available at this time to draw any conclusions about the individuals who have kidney and renal cancer in Merrimack and any specific exposure.” [51]

[15] In 2016, EPA used data from a rat study of PFOA exposure and testicular cancer to calculate a provisional PFOA oral cancer slope factor of $7\times10^{-5}$ per µg/kg/day [45]. However, this was not an official oral cancer slope factor. Findings of more recent studies suggest that the provisional cancer slope factor is no longer appropriate for estimating PFOA cancer risk, but as of this date an alternative factor has not been finalized.

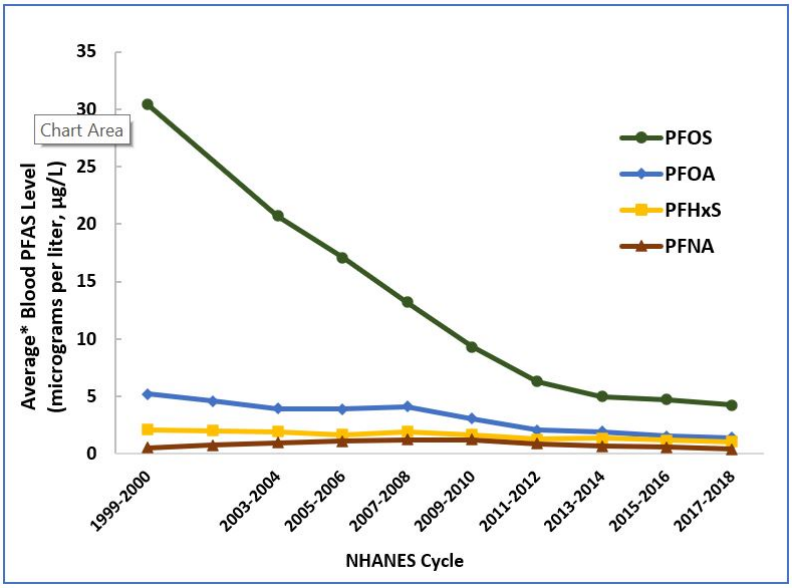
[16] Data for lung and bronchus and prostate cancer were only available through 2013.

NH DHHS cancer reviews covered a different population than evaluated in this report. The cancer review included all residents of Merrimack, not only private well users, and it did not include any residents of Litchfield, Londonderry, Bedford, or Manchester.

### PFAS levels in blood: U.S. population versus private well users near this site

PFAS are retained in the human body and can be measured in a person's blood serum. Since 1999, the National Health and Nutrition Examination Survey (NHANES) has measured blood PFAS as part of its program to evaluate the health and nutrition of adults and children in the United States [52]. As shown in Figure 6, NHANES data has shown a steady decline in serum PFOS and PFOA levels since 2002, when these substances began being phased out of production and use.

**Figure 6. Blood serum levels of the most common PFAS in people in the United States over time, as measured through the National Health and Nutrition Examination Survey**




*Average = geometric mean

Data Source: National report on human exposure to environmental chemicals, biomonitoring data tables for environmental chemicals [52]

Although science does not yet allow us to tell what levels of PFAS in serum can cause harmful health effects, blood serum PFAS levels can be useful to compare against population averages to determine if unusual exposures may have occurred.

Responding to the PFAS contamination found in private wells around the Saint-Gobain Performance Plastics facility, NH DHHS expanded an existing blood testing program to include the southern New Hampshire area. In 2016 and 2017, the state measured PFAS in the blood of 219 private drinking water well users. NH DHHS reported the findings in 2018 [53,54]. The people who participated in this blood testing likely are not representative of all users of the private wells evaluated in this report. However, this testing provided relevant data on possible exposures for the individuals who participated. We provide a brief summary of the findings, compared against NHANES data from roughly the same timeframe, below.

The NH DHHS reports state that PFOA, PFOS, and PFHxS were detected in over 95% of the people tested; these are the only PFAS for which results were discussed. As summarized in Table 4, PFOA levels in private well users' blood appeared to be elevated compared to the general U.S. population. Almost half of private well users from the NH DHHS testing had PFOA blood levels that would place them in the top 5% of exposure measured in the general U.S. population. In contrast, PFOS and PFHxS blood serum concentrations were similar to general population levels.

Because PFOA was the predominant contaminant in private well water, these blood results support the general conclusion that private drinking well water contamination could have led to elevated exposures, consistent with the findings of the evaluation in this health consultation. These findings, however, can't be used to directly predict a person's PFAS blood level from their well water PFAS concentration, or vice versa. ATSDR did not access the original data from the blood testing and has not examined the relationship between serum PFAS results and PFAS concentration in private wells used.[17] The people who participated in the New Hampshire blood testing may not be representative of all private well users in the area. In addition, a person's blood PFAS level could include exposures from various sources, including other environmental media, food, or consumer products, in addition to well water.

**Table 4. ATSDR summary of NH private well users' 2016-2017 PFAS blood testing results compared to U.S. population data**

| PFAS | NH private well users geometric mean serum concentration for 2016-17 sampling in µg/L | General U.S. population geometric mean serum concentration for survey years 2015-16, 2017-18 in µg/L | NH private well users 95th percentile* serum concentration for 2016-17 sampling in µg/L | General U.S. population 95th percentile* serum concentration for survey years 2015-16, 2017-18 in µg/L | Approximate % of NH private well users that exceeded the U.S. general population 95th percentile* |
|---|---|---|---|---|---|
| PFOA | 4.4 | 1.6, 1.4 | 26.6 | 4.2, 3.8 | 37-64% |
| PFOS | 5.4 | 4.7, 4.3 | 16.4 | 18.3, 14.6 | 1-9% |
| PFHxS | 1.3 | 1.2, 1.1 | 3.4 | 4.9, 3.7 | 1-6% |

*The 95th percentile is that blood serum concentration that 95% of the results fell below. Measured values within a given population would be expected to exceed the 95th percentile only about 5% of the time, on average.
Data sources: NH WISDOM website [54], https://www.cdc.gov/exposurereport/data_tables.html General U.S. population statistics from values reported for 2015-16 and for 2017-18 survey years reported at https://www.cdc.gov/exposurereport/data_tables.html, rounded to one decimal.

[17] The NH DHHS summary report for the southern New Hampshire private well users states, "Individuals with higher concentrations of PFOA in their private well water have higher blood PFOA levels" [53]. ATSDR did not examine the raw data to verify this statement.

## Health considerations for susceptible populations

ATSDR is committed to considering potential health effects of exposure to all groups, including those that might be unusually susceptible to environmental contamination. Pregnant women, the developing fetus, infants, children, and people of all age groups with certain pre-existing conditions might be unusually vulnerable to harmful health effects from PFAS exposure.

- Epidemiological studies suggest an association between serum PFOA levels and pregnancy-induced high blood pressure or pre-eclampsia [8]. High PFOA or PFOS levels in pregnant women's blood serum were associated with decreases in their babies' birth weights, but the changes were small and may not be clinically relevant.
- Infants may be exposed to PFAS through their mother's milk. ATSDR has developed information that summarizes scientific knowledge about PFAS and breastfeeding [55]. Breastfeeding provides many health benefits to a child, including reduced risk of ear and respiratory infections, asthma, obesity, and sudden infant death syndrome. Breastfeeding can also help lower a mother's risk of high blood pressure, type 2 diabetes, ovarian cancer, and breast cancer [55]. In general, CDC recommends breastfeeding, despite the presence of chemical toxicants [55]. The American Academy of Pediatrics states that a mother's exposure to low-level environmental chemical agents is not a contraindication to breastfeeding [56]. A woman's decision to breastfeed is a personal choice, often made in consultation with her healthcare provider. ATSDR has developed information to guide doctors in this decision-making process (See https://atsdr.cdc.gov/pfas/docs/clinical-guidance-12-20-2019.pdf).
- Infants may also be exposed to PFAS through formula made with contaminated water. In addition to exposure from water, infants could have additional exposure, such as from hand-to-mouth behavior after contacting carpets or other household items previously treated with PFAS. In this report, ATSDR based its public health decisions on infants, which would have the highest dose because of their higher water intake and smaller body weight compared to other age groups. Children exposed to contaminated water also have a greater dose of PFAS compared to adults because of higher contaminant intakes in proportion to body size, and they may also be exposed to PFAS from hand-to-mouth behavior. In children, PFAS exposure may decrease antibody responses to childhood vaccines; in general, however, decreases in disease resistance have not been found [8].
- People of all age groups with certain pre-existing conditions could be more susceptible to harm from PFAS exposures. For example, exposure to certain PFAS could increase cholesterol levels in some people [8]. A greater health impact could result if the person exposed already has high cholesterol or other risk factors for cardiovascular disease. Similarly, PFAS exposure could disproportionately affect people who already have compromised immune system or liver function or who have high blood pressure. More research is needed to understand how exposure to PFAS might affect people with pre-existing risk factors for cardiovascular and other diseases.

## Conclusions

**Drinking private well water contaminated with PFAS could have increased the risk for harmful health effects for some community members, especially children.**

Most of the private wells evaluated in the five towns of Merrimack, Litchfield, Londonderry, Bedford, and Manchester were contaminated with PFAS. PFOA was detected most frequently and at the highest concentrations, but several other PFAS were also present. ATSDR evaluated both individual PFAS and PFAS mixtures effects as detailed in the report. Estimated exposure doses in 1,063 of 2,745 wells evaluated—about 40% of the wells— were higher than minimal risk levels used for screening, and 287 of the wells had estimated exposure doses for one or more age groups that approached or exceeded effect levels in toxicological studies. Of these, 23 wells had estimated doses that approached or exceeded effect levels for all age groups. Other sources of PFAS exposure (such as from food or consumer products) could increase the risk of harmful health effects beyond the risk from the drinking water exposures alone.

There is suggestive evidence that both PFOA and PFOS are carcinogenic, but the science on PFOA, PFOS, and other PFAS is too limited at this time to quantify risk. The cancer risk contributed by exposure to PFAS in the area is uncertain.

Based on ATSDR's evaluation, there is a potential for higher risk of developmental effects as the most sensitive health endpoint (i.e., lowest effect level) seen in toxicological studies. The risk of developmental effects would increase as PFAS levels and exposure increased. Immune or liver effects would also be possible from exposure to the highest PFAS levels. Human research suggests other health effects possible from PFAS exposure include increased cholesterol levels, decreased vaccine response in children, changes in liver enzymes, increased risk of high blood pressure or pre-eclampsia in pregnant women, small decreases in infant birth weights, and an increased risk of kidney or testicular cancer.

**People who continue to drink contaminated, untreated private well water have an increased risk for harmful health effects.**

Local authorities have taken several actions since 2016 to reduce exposures from contaminated wells, particularly those with the highest levels of PFAS. Not all well owners were provided alternate or treated water, however, and some private wells with levels of PFAS below previous or current regulatory guidelines may remain in use. Some private wells were never tested, and some well owners were offered but declined alternate water.

Although not all wells have shown detections of PFAS, testing was limited and PFAS levels could fluctuate over time. This, along with the potential mobility of PFAS in groundwater, suggests additional private wells could be affected in the future.

## Recommendations

- Private well owners who are still using the wells for drinking should monitor their well water quality and work with local authorities to take appropriate action to remove

harmful contaminants, if needed. Residents using point-of-entry or other treatment systems to remove PFAS from private well water should have the systems maintained and checked periodically to ensure removal effectiveness.

- Actions to reduce exposure (treating the water or providing alternate drinking water) are warranted for the entire community given the likelihood of past exposure, potential mobility of PFAS in groundwater, and persistence of many PFAS in the human body.
- Residents should reduce other potential PFAS exposures by avoiding or limiting the use of products containing PFAS. Examples of products that may contain PFAS include food packaging materials, stain resistant carpets, water resistant clothing, cleaning products, and some cosmetics.
- ATSDR recommends that all residents concerned about their past exposure discuss their concerns with their health care provider. ATSDR has information for health care providers and the public at https://www.atsdr.cdc.gov/pfas/resources/index.html. ATSDR also provides guidance and tools for reducing stress and building resilience in communities during public health responses to environmental contamination at its Community Stress Resource Center at www.atsdr.cdc.gov/stress.
- ATSDR recommends nursing mothers continue to breastfeed and contact their healthcare providers with specific concerns. ATSDR is available to consult with healthcare providers as needed. To help protect formula-fed infants from potential exposure, caregivers should use pre-mixed formula or reconstitute dry formula with water sources that meet state and federal drinking water guidelines for PFAS.
- ATSDR recommends local medical providers use ATSDR's current clinician guidance at https://www.atsdr.cdc.gov/pfas/resources/info-for-health-professionals.html as a resource for informing patients and guiding treatment. As science evolves, ATSDR will work with state and local authorities to provide area medical providers with updated information on health effects associated with PFAS exposure and recommendations for patient care.

Upon request, ATSDR is available to

- discuss individual results with private well owners,
- work with NHDES and NH DHHS to identify any private wells with PFAS levels of concern that have not been addressed through previous actions,
- answer other public health questions related to the site, or
- provide technical assistance in reviewing additional data collected from the site.

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## References


1. State of New Hampshire. Consent decree, State of New Hampshire, Dept. of Environmental Services v. Saint-Gobain Performance Plastics Corporation. State of New Hampshire, Merrimack County, SS, Superior Court; March 2018. Available at: https://www.des.nh.gov/sites/g/files/ehbemt341/files/documents/final-cd-20180320.pdf. Accessed October 23, 2023.
2. Marts J. E-mail to J. Dyken the Agency for Toxic Substances and Disease Registry RE: ATSDR & PFAS in Private Wells in NH (and attached file "NHDES Responses to ATSDR Questions 5-6-2020.pdf"). Concord: New Hampshire Department of Environmental Services; received Wednesday, May 6, 2020 3:43 pm.
3. U.S. Environmental Protection Agency. EPA (2016e). Factsheet PFOA and PFOS Drinking Water Health Advisories. EPA Office of Water; November 2016. Available at: https://www.epa.gov/sites/production/files/2016-06/documents/drinkingwaterhealthadvisories_pfoa_pfos_updated_5.31.16.pdf. Accessed on August 27, 2020.
4. New Hampshire Department of Environmental Services. Technical background report for the June 2019 proposed maximum contaminant levels (MCLs) and ambient groundwater quality standards (AGQSs) for perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluorohexane sulfonic acid (PFHxS). June 28, 2019. Available at: https://www.des.nh.gov/sites/g/files/ehbemt341/files/documents/r-wd-19-29.pdf Accessed February 1, 2023.
5. New Hampshire Department of Environmental Services. Web site "NH PFAS Response." https://www.pfas.des.nh.gov/ Accessed November 22, 2022.
6. Chan BP. Letter to S. Williams-Fleetwood of the Agency for Toxic Substances and Disease Registry. Concord: New Hampshire Department of Health and Human Services; June 29, 2016.
7. Bennett D. E-mail to J. Dyken of the Agency for Toxic Substances and Disease Registry RE: Hello - ATSDR & PFAS in Private Wells. Concord: New Hampshire Department of Environmental Services; received Friday, November 15, 2019 12:45 pm.
8. Agency for Toxic Substances and Disease Registry. Toxicological profile for perfluoroalkyls. Atlanta (GA): U.S. Department of Health and Human Services; May 2021.
9. Bennett D. E-mail to J. Dyken of the Agency for Toxic Substances and Disease Registry RE: Hello - ATSDR & PFAS in Private Wells (and attached file "PFAS_WellDataDump_5Town_ATSDR_20191016.xlsx"). Concord: New Hampshire Department of Environmental Services; received Thursday, October 17, 2019 9:29 am.
10. Bennett D. E-mail to J. Dyken of the Agency for Toxic Substances and Disease Registry RE: New Hampshire Private Well Data Validation Feedback (and attached file "PFAS_WellDataDump_5Town_ATSDR_20210430.xlsx"). Concord: New Hampshire Department of Environmental Services; received Friday, April 30, 2021 11:36 am.
11. Interstate Technology Regulatory Council. Technical resources for addressing environmental releases of per- and polyfluoroalkyl substances (PFAS): naming conventions and use. Washington (DC): Interstate Technology Regulatory Council; updated May 2021. Available

at: https://pfas-1.itrcweb.org/2-2-chemistry-terminology-and-acronyms/. Accessed July 21, 2021.

12. Agency for Toxic Substances and Disease Registry. Public health assessment guidance manual (online). Atlanta (GA): U.S. Department of Health and Human Services; April 2022. Available at: https://www.atsdr.cdc.gov/pha-guidance.
13. Agency for Toxic Substances and Disease Registry. Exposure dose guidance for body weight. Atlanta (GA): U.S. Department of Health and Human Services; October 2016.
14. Agency for Toxic Substances and Disease Registry. Exposure dose guidance for water ingestion, version 2. Atlanta (GA): U.S. Department of Health and Human Services; October 2016.
15. U.S. Environmental Protection Agency. Human health toxicity values for perfluorobutane sulfonic acid (CASRN 375-73-5) and related compound potassium perfluorobutane sulfonate (CASRN 29420-49-3). Washington (DC): U.S. Environmental Protection Agency, Office of Research and Development. EPA Document Number: EPA/600/R-20/345F, April 2021. Available at: https://ordspub.epa.gov/ords/eims/eimscomm.getfile?p_download_id=542393 Accessed September 8, 2022.
16. U.S. Environmental Protection Agency. IRIS toxicological review of perfluorobutanoic acid (PFBA, CASRN 375-22-4) and related salts. Washington (DC): U.S. Environmental Protection Agency, Office of Research and Development. EPA Document Number: EPA/635/R-22/277Fa, December 2022. Available at: https://iris.epa.gov/static/pdfs/0701tr.pdf. Accessed May 17, 2023.
17. U.S. Environmental Protection Agency. IRIS toxicological review of perfluorohexanoic acid [PFHxA, CASRN 307-24-4] and related salts. Washington (DC): U.S. Environmental Protection Agency, Office of Research and Development. EPA Document Number: EPA/600/R-23/027Fa, April 2023. Available at: https://iris.epa.gov/static/pdfs/0704tr.pdf. Accessed September 7, 2023.
18. Agency for Toxic Substances and Disease Registry. Draft supporting document for epidemiological studies for perfluoroalkyls. Atlanta (GA): U.S. Department of Health and Human Services; March 2018.
19. Agency for Toxic Substances and Disease Registry. What are the health effects of PFAS? Atlanta (GA); 2020. Available at: https://www.atsdr.cdc.gov/pfas/health-effects/index.html. Accessed September 9, 2020.
20. National Toxicology Program. Monograph on immunotoxicity associated with exposure to perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). Research Triangle Park, NC: National Toxicology Program. 2016. Available at: https://ntp.niehs.nih.gov/whatwestudy/assessments/noncancer/completed/pfoa. Accessed October 23, 2023.
21. Hall AP, Elcombe CR, Foster JR, Harada T, Kaufmann W, Knippel A, Kuttler K, Malarkey DE, Maronpot RR, Nishikawa A, Nolte T, Schulte A, Strauss V, and York MJ. Liver hypertrophy: a review of adaptive (adverse and non-adverse) changes—conclusions from the 3rd international ESTP expert workshop. Toxicologic Pathology 40:971–994; 2012.
22. Onishchenko N, Fischer C, Ibraham WNW, Negri S, Spulber S, Cottica D, and Ceccatelli S. Prenatal exposure to PFOS or PFOA alters motor function in mice in a sex-related manner. Neurotox Res 19:452–461; 2011.

23. Koskela A, Finnila MA, Korkalainen M, Spulber S, Koponen J, Hakansson H, Tuukkanen J, Viluksela M. Effects of developmental exposures to perfluorooctanoic acid (PFOA) on long bone morphology and bone cell differentiation. Toxicol Appl Pharmacol 301:14–21; 2016.
24. DeWitt JC, Copeland CB, Strynar MJ, and Luebke RW. Perfluorooctanoic acid-induced immunomodulation in adult C57BL/6J or C57BL/6N female mice. Environ Health Perspect 116(5):644–650; 2008.
25. DeWitt JC, Williams WC, Creech NJ, and Luebke RW. Suppression of antigen-specific antibody responses in mice exposed to perfluorooctanoic acid: role of PPAR and T- and B-cell targeting. J Immunotoxicol 13(1):38–45; 2016. doi: 10.3109/1547691X.2014.996682. Epub 2015 Jan 16.
26. Quist EM, Filgo AJ, Cummings CA, Kissling GE, Hoenerhoff MJ, and Fenton SE. Hepatic mitochondrial alteration in CD-1 mice associated with prenatal exposures to low doses of perfluorooctanoic acid (PFOA). Toxicol Pathol 43(4):546–557; 2015. 10.1177/0192623314551841.
27. Loveless SE, Hoban D, Sykes G, Frame SR, and Everds NE. Evaluation of the immune system in rats and mice administered linear ammonium perfluorooctanoate. Toxicol Sci 105(1):86–96; 2008.
28. Filgo AJ, Quist EM, Hoenerhoff MJ, Brix AE, Kissling GE, and Fenton SE. Perfluorooctanoic acid (PFOA)-induced liver lesions in two strains of mice following developmental exposures: PPARα is not required. Toxicol Pathol 43(4):558–568; 2015.
29. Butenhoff JL, Kennedy GL, Frame SR, O'Connor JC, and York RG. The reproductive toxicology of ammonium perfluorooctanoate (APFO) in the rat. Toxicology 196(1–2):95–116; 2004.
30. Butenhoff J, Costa G, Elcombe C, Farrar D, Hansen K, Iwai H, Jung R, Kennedy G, Lieder P, Olsen G, and Thomford P. Toxicity of ammonium perfluorooctanoate in male Cynomolgus monkeys after oral dosing for 6 months. Toxicol Sci 69(1):244–257; 2002.
31. White SS, Stanko JP, Kato K, Calafat AM, Hines EP, and Fenton SE. Gestational and chronic low-dose PFOA exposures and mammary gland growth and differentiation in three generations of CD-1 mice. Environ Health Perspect 119(8):1070-1076; 2011.
32. Luebker DJ, Case MT, York RG et al. Two-generation reproduction and cross-foster studies of perfluorooctanesulfonate (PFOS) in rats. Toxicol 215:126–148; 2005.
33. Guruge KS, Hikono H, Shimada N, Murakami K, Hasegawa J, Yeung LWY, Yamanaka N, and Yamashita N. Effect of perfluorooctane sulfonate (PFOS) on influenza A virus-induced mortality in female B6C3F1 mice. J Toxicol Sci 34(6):687–691; 2009.
34. Dong G-H, Liu M-M, Wang D, Zheng L, Liang Z-F, and Jin Y-H. Sub-chronic effect of perfluorooctanesulfonate (PFOS) on the balance of type 1 and type 2 cytokine in adult C57BL6 mice. Arch Toxicol 85:1235–1244; 2011.
35. Dong G-H, Zhang Y-H, Zheng L, Liu W, Jin Y-H, and He Q-C. Chronic effects of perfluorooctanesulfonate exposure on immunotoxicity in adult male C57BL/6 mice. Arch Toxicol 83:805–815; 2009.
36. Seacat AM, Thomford PJ, Hansen KJ, Olsen GW, Case MT, and Butenhoff JL. Subchronic toxicity studies on perfluorooctanesulfonate potassium salt in Cynomolgus monkeys. Toxicol Sci 68(1):249–264; 2002.

37. Wan HT, Zhao YG, Leung PY, and Wong CKC. Perinatal exposure to perfluorooctane sulfonate affects glucose metabolism in adult offspring. PLoS ONE 9(1):e87137. Doi:10.1371/journal.pone.0087137; 2014.
38. Butenhoff JL, Chang SC, Ehresman DJ, et al. Evaluation of potential reproductive and developmental toxicity of potassium perfluorohexanesulfonate in Sprague Dawley rats. Reprod Toxicol 27:331–341; 2009.
39. Hoberman AM, York RG. Oral (gavage) combined repeated dose toxicity study of T-7706 with the reproduction/developmental toxicity screening test. Argus Research; 2003.
40. Mogensen UB, Grandjean P, Heilmann C, Nielsen F, Weihe P, and Budtz-Jorgensen E. Structural equation modeling of immunotoxicity associated with exposure to perfluorinated alkylates. Environ Health 14:47; 2015.
41. Das KP, Grey BE, Rosen MB, Wood CR, Tatum-Gibbs KR, Zehr RD, Strynar MJ, Lindstrom AB, Lau C. Developmental toxicity of perfluorononanoic acid in mice. Reprod Toxicol 51: 133–44; 2015.
42. Agency for Toxic Substances and Disease Registry. Framework for assessing health impacts of multiple chemicals and other stressors (update). Atlanta (GA): U.S. Department of Health and Human Services; February 2018.
43. Steenland K, Fletcher T, Stein CR, Bartell SM, Darrow L, Lopez-Espinosa MJ, et al. 2020 Review: Evolution of evidence on PFOA and health following the assessments of the C8 Science Panel. Environ Int. 145:106125. doi: 10.1016/j.envint.2020.106125. E-pub 2020 Sep 18.
44. Shearer JJ, Callahan CL, Calafat AM, Huang W, Jones RR, Sabbisetti VS, et al. 2021. Serum concentrations of per- and polyfluoroalkyl substances and risk of renal cell carcinoma. J Natl Cancer Inst. 113:580–7. Available from: https://doi.org/10.1093/jnci/djaa143.
45. U.S. Environmental Protection Agency. Health effects support document for perfluorooctanoic acid (PFOA); EPA 822-R-16-003. Washington (DC): U.S. Environmental Protection Agency, Office of Water; May 2016.
46. International Agency for Research on Cancer. IARC monographs on the evaluation of carcinogenic risks to humans, volume 110: some chemicals used as solvents and in polymer manufacture (chapter on perfluorooctanoic acid). Lyon (France): 2017.
47. National Toxicology Program. TR-598: Technical Report Pathology Tables and Curves - PFOA. Research Triangle Park: US Department of Health and Human Services; 2018. Available from: https://tools.niehs.nih.gov/cebs3/views/?action=main.dataReview&bin_id=13658.
48. National Toxicology Program. Technical report on the toxicology and carcinogenesis studies of perfluorooctanoic acid (CASRN 335-67-1) administered in feed to Sprague Dawley (Hsd: Sprague Dawley® SD®) rats. NTP TR 598. Research Triangle Park: US Department of Health and Human Services; 2020. Available from: https://ntp.niehs.nih.gov/ntp/htdocs/lt_rpts/tr598_508.pdf.
49. U.S. Environmental Protection Agency. Health effects support document for perfluorooctane sulfonate (PFOS); EPA 822-R-16-002. Washington (DC): U.S. Environmental Protection Agency, Office of Water. May 2016. Available from: https://www.epa.gov/sites/production/files/2016-05/documents/pfos_hesd_final_508.pdf.

50. New Hampshire Department of Health and Human Services. Cancer incidence report, Merrimack, NH. Concord (NH): New Hampshire Department of Health and Human Services, Division of Public Health Services; January 2018.
51. New Hampshire Department of Health and Human Services. Press release: NH DHHS releases updated cancer analysis for Merrimack, indicating a need for additional investigation. Concord (NH): New Hampshire Department of Health and Human Services; December 10, 2021. Accessed February 1, 2023 at https://www.dhhs.nh.gov/news-and-media/nh-dhhs-releases-updated-cancer-analysis-merrimack-indicating-need-additional
52. Centers for Disease Control and Prevention. National report on human exposure to environmental chemicals, biomonitoring data tables for environmental chemicals. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention. https://www.cdc.gov/exposurereport/data_tables.html. Accessed June 2022.
53. New Hampshire Department of Health and Human Services. Summary of the New Hampshire Department of Health and Human Services' perfluorochemical (PFC) blood testing program, 2016-2017. Concord (NH): New Hampshire Department of Health and Human Services, Division of Public Health Services; October 2017.
54. New Hampshire Department of Health and Human Services. Southern New Hampshire PFAS blood testing program data on NH Health WISDOM, results included through 8/23/17 (219 participants). Concord (NH): New Hampshire Department of Health and Human Services, Division of Public Health Services, Bureau of Public Health Statistics and Informatics.
55. Agency for Toxic Substances and Disease Registry. PFAS and breastfeeding. Atlanta (GA): 2021. Available at: https://www.atsdr.cdc.gov/pfas/health-effects/pfas-breastfeeding.html. Accessed on August 22, 2023.
56. American Academy of Pediatrics. Contraindications to breastfeeding. Available at: https://www.aap.org/en/patient-care/breastfeeding/contraindications-to-breastfeeding/. Accessed on August 30, 2023.
57. Buck RC, Franklin J, Berger U, Conder JM, Cousins IT, de Voogt P, Jensen AA, Kannan KK, Mabury SA, van Leeuwen SP. Perfluoroalkyl and polyfluoroalkyl substances in the environment: terminology, classification, and origins (supplemental data). Integrated Environmental Assessment and Management 7(4):513–541; 2011.
58. Kim S, Chen J, Cheng T, et al. PubChem 2019 update: improved access to chemical data. (PubChem CID: 114481). Nucleic Acids Res. 2019;47(D1):D1102–D1109. doi:10.1093/nar/gky1033.
59. Agency for Toxic Substances and Disease Registry. PFAS exposure assessments final report: findings across ten exposure assessment sites. Atlanta (GA): U.S. Department of Health and Human Services; September 2022. Available at: https://www.atsdr.cdc.gov/pfas/docs/PFAS-EA-Final-Report-508.pdf. Accessed November 22, 2022.

# Appendix A. Full names and chemical information for PFAS in report

**Table A1. Full names, chemical formulae, and Chemical Abstract Services Registry numbers for compounds included in the data provided to ATSDR by NHDES (listed in order of increasing total number of carbon atoms, detected substances shown in bold)**

| PFAS Abbreviation | Full Name | Chemical Formula | Chemical Abstract Services Registry Number |
|---|---|---|---|
| **PFBA** | Perfluorobutyric acid | $C_3F_7COOH$ | 375-22-4 |
| **PFBS** | Perfluorobutane sulfonate anion<br>Perfluorobutane sulfonic acid | $C_4F_9SO_3^-$<br>$C_4F_9SO_3H$ | 45187-15-3<br>375-73-5 or 59933-66-3 |
| **PFPeA** | Perfluoropentanoic acid | $C_4F_9COOH$ | 2706-90-3 |
| Perfluoro-3-methoxypropanoic acid | Perfluoro-3-methoxypropanoic acid | $C_4HF_7O_3$ | 377-73-1 |
| **Perfluoro(2-ethoxyethane)sulfonic acid** | Perfluoro(2-ethoxyethane)sulfonic acid | $C_4HF_9O_4S$ | 113507-82-7 |
| Perfluorobutylsulfonamide | Perfluorobutylsulfonamide | $C_4H_2F_9NO_2S$ | 30334-69-1 |
| **PFPeS** | Perfluoropentane sulfonic acid | $C_5F_{11}SO_3H$ | 2706-91-4 |
| **PFHxA** | Perfluorohexanoic acid | $C_5F_{11}COOH$ | 307-24-4 |
| Perfluoro(4-methoxybutanoic) acid | Perfluoro(4-methoxybutanoic) acid | $C_5HF_9O_3$ | 863090-89-5 |
| **Perfluoro-3,6-dioxaheptanoic acid** | Perfluoro-3,6-dioxaheptanoic acid | $C_5HF_9O_4$ | 151772-58-6 |
| **PFHxS** | Perfluorohexane sulfonate anion<br>Perfluorohexane sulfonic acid | $C_6F_{13}SO_3^-$<br>$C_6F_{13}SO_3H$ | 108427-53-8<br>355-46-4 |
| **4:2 FTSA** | 4:2 Fluorotelomer sulfonate anion<br>4:2 Fluorotelomer sulfonic acid | $C_4F_9CH_2CH_2SO_3^-$<br>$C_4F_9CH_2CH_2SO_3H$ | 414911-30-1<br>757124-72-4 |
| GenX | Hexafluoropropylene oxide dimer acid<br>Ammonium salt form | $C_6HF_{11}O_3$<br>$C_6H_4F_{11}NO_3$ | 13252-13-6<br>62037-80-3 |
| **PFHpA** | Perfluoroheptanoic acid | $C_6F_{13}COOH$ | 375-85-9 |
| 1-Propene, 1,1,2,3,3,3-hexafluoro-, dimer | 1-Propene, 1,1,2,3,3,3-hexafluoro-, dimer | $C_6F_{12}$ | 13429-24-8 |
| Perfluorohexanesulfonamide | Perfluorohexanesulfonamide | $C_6H_2F_{13}NO_2S$ | 41997-13-1 |
| **PFHpS** | Perfluoroheptane sulfonate anion<br>Perfluoroheptane sulfonic acid | $C_7F_{15}SO_3^-$<br>$C_7F_{15}SO_3H$ | 146689-46-5<br>375-92-8 |
| DONA / ADONA | 4,8-Dioxa-3H-perfluorononanoic acid (DONA)<br>Ammonium salt form (ADONA) | $C_7H_2F_{12}O_4$<br>$C_7H_5F_{12}NO_4$ | 919005-14-4<br>958445-44-8 |

| PFAS Abbreviation | Full Name | Chemical Formula | Chemical Abstract Services Registry Number |
|---|---|---|---|
| **PFOA** | Perfluorooctanoic acid | $C_7F_{15}COOH$ | 335-67-1 |
| **PFOS** | Perfluorooctane sulfonate anion<br>Perfluorooctane sulfonic acid | $C_8F_{17}SO_3^-$<br>$C_8F_{17}SO_3H$ | 45298-90-6<br>1763-23-1 |
| **6:2 FTSA** | 6:2 Fluorotelomer sulfonate anion<br>6:2 Fluorotelomer sulfonic acid | $C_6F_{13}CH_2CH_2SO_3^-$<br>$C_6F_{13}CH_2CH_2SO_3H$ | 425670-75-3<br>27619-97-2 |
| **FOSA** | Perfluorooctane sulfonamide | $C_8F_{17}SO_2NH_2$ | 754-91-6 |
| 9-Chlorohexadecafluoro-3-oxanone-1-sulfonic acid | 9-Chlorohexadecafluoro-3-oxanone-1-sulfonic acid | $C_8HClF_{16}O_4S$ | 756426-58-1 |
| **PFNA** | Perfluorononanoic acid | $C_8F_{17}COOH$ | 375-95-1 |
| PFNS | Perfluorononane sulfonic acid | $C_9F_{19}SO_3H$ | 474511-07-4 or 68259-12-1 |
| MeFOSA | N-Methyl perfluorooctane sulfonamide | $C_8F_{17}SO_2NH(CH_3)$ | 31506-32-8 |
| **PFDA** | Perfluorodecanoic acid | $C_9F_{19}COOH$ | 335-76-2 |
| **PFDS** | Perfluorodecane sulfonate anion<br>Perfluorodecane sulfonic acid | $C_{10}F_{21}SO_3^-$<br>$C_{10}F_{21}SO_3H$ | 126105-34-8<br>335-77-3 |
| **8:2 FTSA** | 8:2 Fluorotelomer sulfonate anion<br>8:2 Fluorotelomer sulfonic acid | $C_8F_{17}CH_2CH_2SO_3^-$<br>$C_8F_{17}CH_2CH_2SO_3H$ | 481071-78-7<br>39108-34-4 |
| EtFOSA | N-Ethyl perfluorooctane sulfonamide | $C_8F_{17}SO_2NH(C_2H_5)$ (sulfluramid) | 4151-50-2 |
| 11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid | 11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid | $C_{10}HClF_{20}O_4S$ | 763051-92-9 |
| **PFUnDA** | Perfluoroundecanoic acid | $C_{10}F_{21}COOH$ | 2058-94-8 |
| MeFOSE | N-Methyl perfluorooctane sulfonamidoethanol | $C_8F_{17}SO_2N(CH_3)CH_2CH_2OH$ | 24448-09-7 |
| **MeFOSAA** | N-Methyl perfluorooctane sulfonamidoacetic acid | $C_8F_{17}SO_2N(CH_3)CH_2COOH$ | 2355-31-9 |
| **PFDoDA** | Perfluorododecanoic acid | $C_{11}F_{23}COOH$ | 307-55-1 |
| PFDoDS | Perfluorododecane sulfonic acid | $C_{12}F_{25}SO_3H$ | 79780-39-5 |
| 10:2 FTSA | 10:2 Fluorotelomer sulfonic acid | $C_{10}F_{21}CH_2CH_2SO_3H$ | 120226-60-0 |
| ETFOSE | N-Ethyl perfluorooctane sulfonamidoethanol | $C_8F_{17}SO_2N(C_2H_5)CH_2CH_2OH$ | 1691-99-2 |

| PFAS Abbreviation | Full Name | Chemical Formula | Chemical Abstract Services Registry Number |
|---|---|---|---|
| **EtFOSAA** | N-Ethyl perfluorooctane sulfonamidoacetic acid | $C_8F_{17}SO_2N(C_2H_5)CH_2COOH$ | 2991-50-6 |
| **PFTrDA** | Perfluorotridecanoic acid | $C_{12}F_{25}COOH$ | 72629-94-8 |
| **PFTeDA** | Perfluorotetradecanoic acid | $C_{13}F_{27}COOH$ | 376-06-7 |
| PFHxDA | Perfluorohexadecanoic acid | $C_{15}F_{31}COOH$ | 67905-19-5 |
| PFODA | Perfluorooctadecanoic acid | $C_{17}F_{35}COOH$ | 16517-11-6 |

**Bold abbreviations** indicate the substance was analyzed and detected at least once in private well testing provided to ATSDR.
Data from [57,58,8]

# Appendix B. ATSDR evaluation process and details

### Exposure pathway analysis

For contaminant exposure to occur to a person, there must be an uninterrupted chain whereby the chemical moves from its source to the person's body, where harmful effect might occur. ATSDR terms this chain an *exposure pathway*. Exposure pathways consist of five elements: a contamination *source*; *transport* of the contaminant through an environmental medium like air, soil, or water; an *exposure point* where people can come in contact with the contaminant; an *exposure route* whereby the contaminant can be taken into the body; and an *exposed population* of people actually coming in contact with site contaminants [12]. ATSDR evaluates each of these five elements to determine whether exposure is occurring to community members living near a site. Exposure may occur through multiple different pathways. If exposure through a particular pathway is determined to have occurred, it does not necessarily mean that harmful health effects will occur. A chemical's ability to harm health depends on many factors, including how much of the chemical is present, how long and how often a person is exposed to the chemical, and how toxic the chemical is. Further evaluation of the specific exposure occurring is needed to determine whether the exposure could cause harmful health effects.

As described in the text beginning on page 3, this evaluation focused on PFAS exposures from the private well drinking water pathway alone. This pathway consists of the following five elements:

- **Source** – Releases of PFAS from the Saint-Gobain site into the air[18]
- **Transport** – PFAS dispersing in air, settling onto the ground, and washing down into underlying groundwater used for drinking water for private wells
- **Exposure Point** – Drinking water taps of people living in the area using private wells
- **Exposure Route** – Ingestion of drinking water provided by private wells
- **Exposed Population** – People living or working in the area who drink or drank water from private wells

This exposure pathway is considered:

- **Complete for past exposures** because the presence of PFAS used in the Saint-Gobain processes was confirmed in many wells, and people used these wells as a drinking water source.
- **Complete for current exposures** for people who continue to drink from private wells with any detection of PFAS, or for people drinking alternate or treated water with low levels of PFAS remaining.
- **Potential for current exposures** for area residents whose well water has never been tested.

[18] Although PFAS contamination of private wells in the area is believed to primarily originate from air emissions from operations of the Saint-Gobain facility, the groundwater data which we used for estimating PFAS exposure may have included detections of PFAS chemicals from other sources in the area, such as landfills, fire training facilities, or other unknown sources. Our conclusions and recommendations are general and based on exposure as described by private well data; we make no attempt to attribute measured contaminants to the site or to other sources.

ATSDR was asked to evaluate only the drinking water pathway and was not provided data describing PFAS levels in other environmental media besides drinking water near the site. Although NHDES has now posted results of sampling of some of the following, we did not consider any other potential past, present, or future exposure pathways, including

- Inhalation exposure to PFAS released into the air from the facility;
- Direct contact or incidental ingestion exposure to PFAS in soil, surface water, or sediment;
- Indirect ingestion of PFAS in biota (fish, shellfish, or plants) that may have bioaccumulated PFAS from their local environment; or
- Exposure to PFAS from consumer products in the home or community.

### Contaminant screening

In evaluating chemical contaminant data, ATSDR used comparison values (CVs) to prioritize which chemicals or which exposure points (for example, which private wells) are of most potential concern. The health-based CVs used in this report are contaminant concentrations in drinking water that are not expected to result in harmful health effects, even to a small child drinking the water every day. Exceeding a CV does not mean that health effects will occur, just that more evaluation is needed.

ATSDR develops CVs for many substances; different CVs may be developed based on noncancer or cancer health effects. In the absence of ATSDR-derived CVs, state or other agency-developed screening values may be used.

In this report, ATSDR used the following CVs for PFAS:

> *Environmental media evaluation guides (EMEGs)* for PFOA, PFOS, PFHxS, and PFNA; derived from the ATSDR intermediate minimal risk levels (MRLs) for these PFAS and representing estimated contaminant concentrations in drinking water that are unlikely to cause noncancer health effects.
>
> *Reference dose media evaluation guides (RMEGs)* for PFHxA, PFBS, and PFBA, derived from EPA's chronic oral reference dose (RfD) and representing the concentration in drinking water at which daily human exposure for a chronic duration is unlikely to result in noncancer effects.

The screening of PFAS at this site is presented in the body of the report in Table 1. PFOA, PFOS, PFHxS, and PFNA exceeded their respective CV in at least one private well.

### Estimating exposure

The potential for harmful health effects from drinking water with PFAS contamination is evaluated further by estimating the *exposure dose*, or the amount of contaminant that gets into a person's body. The exposure dose is expressed as micrograms of contaminant per kilogram of body weight of the person exposed, per day (µg/kg/day), and accounts for differing water consumption and different body weights of various age groups in the exposed population.

The exposure dose associated with drinking water with a particular concentration of a PFAS is given by the following equation:

$$\text{Dose (µg/kg/day)} = \text{PFAS concentration (µg/L)} \times \text{consumption (L/day)} \div \text{body weight (kg)}$$

ATSDR used standard guidance to determine drinking water consumption and body weight used in this equation to estimate exposure doses to various age groups; these assumptions are presented in Table B1 [13,14]. We used the highest concentration of each PFAS in each private well with the assumptions in Table B1 to estimate exposure doses. For example, a child less than one year old with high-end consumption of drinking water containing the highest concentration of PFOA (1.6 µg/L) every day will receive a PFOA dose of:

$$\text{PFOA dose} = 1.6\ \text{µg/L} \times 1.113\ \text{L/day} \div 7.8\ \text{kg} = 0.23\ \text{µg/kg/day}$$

**Table B 1. Assumed body weights and drinking water consumption for private well users in five towns near the Saint-Gobain facility in Merrimack, New Hampshire**

| Group | Body weight in kilograms | High-end (95th percentile) ingestion of drinking water in liters per day | Typical (average) ingestion of drinking water in liters per day |
|---|---|---|---|
| Children from birth up to 1 year old | 7.8 | 1.113 | 0.504 |
| Children from 1 year old up to age 2 | 11.4 | 0.893 | 0.308 |
| Children from 2 years old up to age 6 | 17.4 | 0.977 | 0.376 |
| Children from 6 years old up to age 11 | 31.8 | 1.404 | 0.511 |
| Children from 11 years old up to age 16 | 56.8 | 1.976 | 0.637 |
| Children from 16 years old up to age 21 | 71.6 | 2.444 | 0.77 |
| Adults 21 years old or more | 80 | 3.092 | 1.227 |
| Pregnant women | 73 | 2.589 | 0.872 |
| Lactating women | 73 | 3.588 | 1.665 |

Source: ATSDR exposure dose guidance documents [13,14]

## Evaluating noncancer health effects

The calculated exposure doses are then compared to an appropriate health guideline for that chemical. Health guideline values are oral human doses or air concentrations developed from toxicology or epidemiology studies that are protective of human health. Health effects are unlikely below the health guideline level. The health guideline value is based on valid toxicological studies for a chemical, with appropriate safety factors built in to account for human variation, animal-to-human differences, and/or the use of the lowest study doses that resulted in harmful health effects (rather than the highest dose that did not result in harmful health effects).

Health guidelines used in this report include ATSDR oral intermediate minimal risk levels (MRLs) for four PFAS (PFOA, PFOS, PFHxS, and PFNA) and EPA-derived oral reference doses for three other PFAS (PFHxA, PFBA, and PFBS). A description of the derivation of these health guidelines from toxicological studies is presented below.

### *PFOA*

ATSDR derived an intermediate oral MRL of 0.003 µg/kg/day for PFOA based on a developmental study that observed various endpoints in offspring of pregnant mice fed a

diet containing PFOA during pregnancy [8,23]. Physical development of the offspring was measured at 15 or 17 months by examining body weight and bone structure of sacrificed mice [23]. The study found prenatal exposure to a human equivalent dose as low as 0.82 µg/kg/day was associated with skeletal changes (altered long bone structure and decreased bone density) when compared with offspring from untreated mice. ATSDR used this dose with uncertainty factors of 10 (for use of a lower effect level), 3 (for extrapolation from animals to humans with dosimetric adjustments), and 10 (for human variability) to derive the intermediate MRL.

***PFOS***

ATSDR derived an intermediate oral MRL of 0.002 µg/kg/day for PFOS based on a developmental study that examined groups of rats exposed to PFOS by gavage before mating, during gestation, and after giving birth [32,8]. At the lowest effect level (a human equivalent dose of 2.1 µg/kg/day), offspring of the rats showed delays in eye opening and a transient decrease in body weight. ATSDR used the human equivalent dose at which none of the developmental changes occurred, 0.515 µg/kg/day, with uncertainty factors of 3 (for extrapolation from animals to humans with dosimetric adjustments) and 10 (for human variability) and a modifying factor of 10 to derive the intermediate MRL.

The modifying factor was included because of concerns that PFOS immunotoxicity may be a more sensitive endpoint than developmental toxicity. Studies on PFOS immune toxicity lacked pharmacokinetic modeling information needed to develop an MRL directly; however, they showed effects on the immune system at serum PFOS concentrations about 10-fold lower than those in the developmental study used as the basis for the MRL.

***PFHxS***

ATSDR derived an intermediate oral MRL of 0.02 µg/kg/day for PFHxS based on an intermediate-duration study that exposed male and female rats to PFHxS by gavage before, during, and after mating; adult rats and the offspring were examined for numerous development and reproductive endpoints [8,38,39]. No developmental or reproductive effects were reported at any dose tested, but thyroid changes (specifically, follicular cell damage) was observed in adult male rats at a lowest-effect level corresponding to a human equivalent dose of 7.3 µg/kg/day [8,38,39]. ATSDR used the human equivalent dose at which no harmful changes occurred, 4.7 µg/kg/day, with uncertainty factors of 3 (for extrapolation from animals to humans with dosimetric adjustments) and 10 (for human variability) and a modifying factor of 10 (for database limitations) to derive the intermediate MRL.

***PFNA***

ATSDR derived an intermediate oral MRL of 0.003 µg/kg/day for PFNA based on a developmental study in which pregnant mice were exposed to PFNA by gavage during gestation [41,8]. Offspring showed decreased body weight gain, transient changes in liver weight, and statistically significant delays in postnatal development (eye opening, signs of male and female puberty) at a lowest-effect dose corresponding to a human equivalent dose of 1.7 µg/kg/day. ATSDR used the human equivalent dose at which none of the

developmental changes occurred, 1 µg/kg/day, with uncertainty factors of 3 (for extrapolation from animals to humans with dosimetric adjustments) and 10 (for human variability) and a modifying factor of 10 (for database limitations) to derive the intermediate MRL.

***PFHxA***

EPA derived a chronic oral reference dose of 0.5 µg/kg/day based on a rat study showing decreased offspring body weight in neonatal rats at a human equivalent point of departure of 48 µg/kg/day [17]. EPA applied uncertainty factors of 3 (for extrapolation from rats to humans), 10 (for interindividual differences in human susceptibility), and 3 (for deficiencies in the toxicity database) to the point of departure to derive the oral chronic reference dose [17].

***PFBA***

EPA derived a chronic oral reference dose of 1 µg/kg/day based on rat studies showing liver and thyroid effects at human equivalent points of departure of 1,150 and 1,270 µg/kg/day, respectively [16]. EPA applied uncertainty factors of 3 (for extrapolation from rats to humans), 10 (for interindividual differences in human susceptibility), 10 (for extrapolation from a sub chronic to chronic exposure duration) and 3 (for deficiencies in the toxicity database) to the points of departure to derive the oral chronic reference dose.

***PFBS***

EPA derived a chronic oral reference dose of 0.3 µg/kg/day based on a study that showed decreased levels of serum total $T_4$ thyroid hormone in newborn mice fed PFBS at a human equivalent dose of 95 µg/kg/day. EPA applied uncertainty factors of 3 (for extrapolation from mice to humans), 10 (for interindividual differences in human susceptibility), and 10 (for deficiencies in the toxicity database) to this dose to derive the oral chronic reference dose [15].

If the estimated exposure dose for a chemical is less than the health guideline value, then the exposure is unlikely to cause a noncancer health effect in that specific situation. If the exposure dose for a chemical is greater than the health guideline, then the exposure dose is compared to known toxicological values for that chemical and is discussed in more detail in the evaluation report. These toxicological values are doses derived from human and animal studies summarized in the ATSDR toxicological profiles, reports included in EPA's Integrated Risk Information System, and in current scientific literature. A direct comparison of site-specific exposure and doses to study-derived exposures and doses that cause adverse health effects is the basis for deciding whether health effects are likely or not.

For every PFAS with an available health guideline, ATSDR calculated doses for exposure to the highest concentration measured in any private well. The doses for various age groups with high-end or typical water consumption, compared against the appropriate health guideline, are presented in Table B2.

**Table B 2. Doses for age groups with different water consumption exposed to the highest concentrations measured in private wells compared to corresponding health guidelines**

| **Age group** | Dose for exposure to 1.6 µg/L PFOA, µg/kg/day (high-end \| typical consumption) | Dose for exposure to 0.12 µg/L PFOS, µg/kg/day (high-end \| typical consumption) | Dose for exposure to 0.24 µg/L PFHxS, µg/kg/day (high-end \| typical consumption) | Dose for exposure to 0.085 µg/L PFNA, µg/kg/day (high-end \| typical consumption) | Dose for exposure to 0.42 µg/L PFHxA, µg/kg/day (high-end \| typical consumption) | Dose for exposure to 0.14 µg/L PFBA, µg/kg/day (high-end \| typical consumption) | Dose for exposure to 0.14 µg/L PFBS, µg/kg/day (high-end \| typical consumption) |
|---|---|---|---|---|---|---|---|
| Children birth up to 1 year old | **0.2 \| 0.1** | **0.02 \| 0.008** | **0.03** \| 0.02 | **0.01 \| 0.005** | 0.06 \| 0.03 | 0.02 \| 0.009 | 0.02 \| 0.009 |
| Children 1 year old up to age 2 | **0.1 \| 0.04** | **0.009 \| 0.003** | 0.02 \| 0.006 | **0.007** \| 0.002 | 0.03 \| 0.01 | 0.011 \| 0.004 | 0.011 \| 0.004 |
| Children 2 years old up to age 6 | **0.09 \| 0.04** | **0.007 \| 0.003** | 0.01 \| 0.005 | **0.005** \| 0.002 | 0.02 \| 0.009 | 0.008 \| 0.003 | 0.008 \| 0.003 |
| Children 6 years old up to age 11 | **0.07 \| 0.03** | **0.005** \| 0.002 | 0.01 \| 0.004 | **0.004** \| 0.001 | 0.02 \| 0.007 | 0.006 \| 0.002 | 0.006 \| 0.002 |
| Children 11 years old up to age 16 | **0.06 \| 0.02** | **0.004** \| 0.001 | 0.008 \| 0.003 | 0.003 \| 0.001 | 0.01 \| 0.005 | 0.005 \| 0.002 | 0.005 \| 0.002 |
| Children 16 years old up to age 21 | **0.06 \| 0.02** | **0.004** \| 0.001 | 0.008 \| 0.003 | 0.003 \| 0.0009 | 0.01 \| 0.005 | 0.005 \| 0.002 | 0.005 \| 0.002 |
| Adults 21 years old or more | **0.06 \| 0.03** | **0.005 \|** 0.002 | 0.009 \| 0.004 | **0.003** \| 0.001 | 0.02 \| 0.006 | 0.005 \| 0.002 | 0.005 \| 0.002 |
| Pregnant women | **0.06 \| 0.02** | **0.004** \| 0.001 | 0.009 \| 0.003 | **0.003** \| 0.001 | 0.01 \| 0.005 | 0.005 \| 0.002 | 0.005 \| 0.002 |
| Lactating women | **0.08 \| 0.04** | **0.006 \| 0.003** | 0.01 \| 0.005 | **0.004** \| 0.002 | 0.02 \| 0.01 | 0.007 \| 0.003 | 0.007 \| 0.003 |
| *Lowest health guideline in µg/kg/day* | *0.003* | *0.002* | *0.02* | *0.003* | *0.5* | *1* | *0.3* |

µg/L = micrograms per liter µg/kg/day = micrograms per kilogram per day See Appendix A for full compound names and chemical information.
Health guideline is the intermediate MRL for PFOA, PFOS, PFHxS, and PFNA; it is the EPA chronic oral reference dose for PFHxA, PFBA, and PFBS.
Doses are rounded to one significant figure. **Doses greater than or equal to the corresponding MRL/RfD are shown in bold** (due to rounding, some unbold values appear equal to the MRL).

We calculated a dose for each PFAS measured, for each separate private well included in the dataset. Because of the large number of private wells (almost 2,750) and to protect personally identifying information, these calculations and individual results are not presented in this report.

The individual PFAS exposure doses estimated using the above process that exceeded health guidelines were evaluated by comparing them with effect levels observed in animal toxicological studies on the corresponding PFAS. This evaluation is detailed in the body of the report. In addition, because many wells contained detections of more than one PFAS, we conducted additional evaluation of the potential for mixture effects.

### Evaluating PFAS mixtures

Many wells contained detections of multiple PFAS. For mixtures, ATSDR recommends a tiered approach to determine whether further evaluation of mixture effects is necessary [42]. The three tiers as applied in this site-specific evaluation are described below.

#### *Determine which wells could exhibit mixture effects (mixtures framework Tier 1)*

In Tier 1, a *hazard quotient* is defined for each contaminant as the estimated dose divided by a noncancer or cancer-based health guideline. For the PFAS assessed in this report, only noncancer health guidelines are available.[19] For each PFAS "*i*", the hazard quotient is given by the following equation:

$$\text{Hazard Quotient}_{\text{PFAS } i} = \text{Estimated dose}_{\text{PFAS } i}\ (\mu\text{g/kg/day}) \div \text{Health guideline}_{\text{PFAS } i}\ (\mu\text{g/kg/day}),$$

where the health guideline is the contaminant-specific minimal risk level or reference dose. Mixtures containing more than one component with a hazard quotient greater than 0.1 are carried forward for Tier 2 analysis.

Table B3 summarizes the Tier 1 analysis for the private wells near the Saint-Gobain Merrimack facility. For each PFAS, the table lists the highest estimated dose (the dose to children from birth to one year old drinking high-end amounts of water every day from the private well with the highest concentration of the contaminant measured), health guideline, highest estimated hazard quotient, number of wells with a hazard quotient greater than 0.1 for that PFAS, number of those wells that had a second PFAS component with a hazard quotient greater than 0.1, and whether the PFAS should be included in additional, Tier 2 analysis. Due to a lack of health guideline values, we could not calculate hazard quotients for all PFAS.

For the private wells evaluated in this report, PFOA, PFOS, PFHxS, PFNA, and PFHxA all had hazard quotients greater than 0.1 in some wells. PFBA and PFBS had hazard quotients lower than 0.1 in all wells and are not carried forward to Tier 2. This Tier 1 analysis identified five PFAS in 1,101 private wells to be included in the Tier 2 analysis.[20]

[19] Intermediate MRLs based on noncancer effects are available for PFOA, PFOS, PFHxS, and PFNA. EPA chronic oral reference doses based on noncancer effects are available for PFHxA, PFBA, and PFBS. No finalized cancer slope factor for PFOA, PFOS, or any other PFAS exists at the time of this report. Potential cancer effects for PFOA and PFOS are discussed in this report.

[20] Of the 1,644 wells not included in further mixtures analysis, we note that 1,035 of them included detections of other PFAS for which no health guidelines exist. ATSDR cannot evaluate the potential mixture effects of these other PFAS.

**Table B 3. Tier 1 mixtures analysis summary for private wells near the Saint-Gobain Merrimack, New Hampshire facility**

| PFAS | Highest estimated dose in µg/kg/day* | PFAS-specific health guideline in µg/kg/day** | Health guideline source | Corresponding highest hazard quotient (HQ) | # of wells with HQ ≥0.1‡ | # of those wells at least one other PFAS with HQ ≥0.1‡ | Include PFAS in Tier 2 mixtures evaluation? |
|---|---|---|---|---|---|---|---|
| PFOA | 0.23 | 0.003 | ATSDR MRL | 76 | 2,362 | 1,101 | Yes |
| PFOS | 0.017 | 0.002 | ATSDR MRL | 9 | 1,097 | 1,088 | Yes |
| PFHxS | 0.034 | 0.02 | ATSDR MRL | 2 | 34 | 33 | Yes |
| PFNA | 0.012 | 0.003 | ATSDR MRL | 4 | 24 | 24 | Yes |
| PFHxA | 0.06 | 0.5 | EPA RfD | 0.12 | 1 | 1 | Yes |
| PFBA | 0.02 | 1.0 | EPA RfD | 0.02 | 0 | Not applicable | No |
| PFBS | 0.02 | 0.3 | EPA RfD | 0.07 | 0 | Not applicable | No |

MRL = intermediate minimal risk level RfD = reference dose

*Highest dose represents a small child with high-end water consumption drinking water with the highest concentration of each PFAS measured in any well.

**No health guidelines were available for other PFAS listed in Table 1. These substances were not included in any further mixtures analysis.

‡Numbers of wells are not additive, since some wells contained multiple PFAS.

*Determine hazard index for wells with mixtures (mixtures framework Tier 2)*

For the PFAS and wells carried forward to Tier 2, the next step is to calculate a *hazard index* for each well's PFAS mixture and preliminarily evaluate the potential for noncancer effects from the mixture.

The hazard index, which assumes dose additivity, is the sum of the respective hazard quotients for the well, given in this case as:

$$\text{Hazard Index} = \text{Hazard quotient (HQ)}_{PFOA} + HQ_{PFOS} + HQ_{PFHxS} + HQ_{PFNA} + HQ_{PFHxA}$$

where the subscripts indicate which PFAS the hazard quotient is calculated for. Mixtures with a hazard index greater than 1 are carried forward to Tier 3 analysis.

Figure B1 illustrates Tier 1 and Tier 2 mixtures analysis using selected de-identified private well results from this site. ATSDR evaluated 1,101 of the private wells using hazard indices described in Tier 2. Of these well, 672 had a hazard index greater than 1 and were included in Tier 3's further evaluation.

**Figure B 1. Selected data from private wells from New Hampshire database, illustrating Tier 1 and Tier 2 mixtures evaluation**

(Note: Illustrates general concept; newly available health guidelines have resulted in additional PFAS being included in mixtures evaluation)

| | | Concentration, microgram per L (ug/L) | | | | Dose for a 0-1 year old, 95%ile consumption, ug/kg/day | | | | | Hazard Quotient (based on 0-1 year old with high-end consumption) | | | | | Hazard Index |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | **Tier 1** | | | | | | | | | | |
| Well Index # | | PFOA | PFOS | PFHXS | PFNA | PFOA | PFOS | PFHXS | PFNA | Combined Dose | PFOA | PFOS | PFHXS | PFNA | +-to be evaluated for mixture effects | Hazard Index - Sum of HQs for PFOA, PFOS, PFHxS, PFNA |
| WELLS ANALYZED FOR MIXTURES EFFECTS (MORE THAN ONE HQ GREATER THAN OR EQUAL TO 0.1) | | | | | | | | | | | | | | | | |
| 1 | | 1.6 | 0 | 0.021 | 0 | 2E-01 | 0E+00 | 3E-03 | 0E+00 | 2.E-01 | **76.10** | 0.00 | **0.15** | 0.00 | + | **76.3** |
| 18 | | 0.29 | 0 | 0.092 | 0 | 4E-02 | 0E+00 | 1E-02 | 0E+00 | 5.E-02 | **13.79** | 0.00 | **0.66** | 0.00 | + | **14.4** |
| 20 | | 0.27 | 0.076 | 0.072 | 0 | 4E-02 | 1E-02 | 1E-02 | 0E+00 | 6.E-02 | **12.84** | **5.42** | **0.51** | 0.00 | + | **18.8** |
| 66 | | 0.13 | 0.0034 | 0.0088 | 0 | 2E-02 | 5E-04 | 1E-03 | 0E+00 | 2.E-02 | **6.18** | **0.24** | 0.06 | 0.00 | + | **6.5** |
| 67 | | 0.13 | 0 | 0.016 | 0 | 2E-02 | 0E+00 | 2E-03 | 0E+00 | 2.E-02 | **6.18** | 0.00 | **0.11** | 0.00 | + | **6.3** |
| 75 | | 0.124 | 0.01 | 0.004 | 0 | 2E-02 | 1E-03 | 6E-04 | 0E+00 | 2.E-02 | **5.90** | **0.71** | 0.03 | 0.00 | + | **6.6** |
| 126 | | 0.096 | 0.007 | 0.004 | 0.002 | 1E-02 | 1E-03 | 6E-04 | 3E-04 | 2.E-02 | **4.57** | **0.50** | 0.03 | 0.10 | + | **5.2** |
| 131 | | 0.095 | 0.019 | 0.0043 | 0.012 | 1E-02 | 3E-03 | 6E-04 | 2E-03 | 2.E-02 | **4.52** | **1.36** | 0.03 | **0.57** | + | **6.5** |
| 1009 | | 0.0178 | 0.0029 | 0.0014 | 0 | 3E-03 | | | | .E-03 | **0.85** | **0.21** | 0.01 | 0.00 | + | **1.1** |
| 1024 | | 0.017 | 0.0093 | 0.0026 | 0 | 2E-03 | | | | .E-03 | **0.81** | **0.66** | 0.02 | 0.00 | + | **1.5** |
| 1062 | | 0.017 | 0.0016 | 0.0035 | 0 | 2E-03 | | | | .E-03 | **0.81** | **0.11** | 0.02 | 0.00 | + | 0.95 |
| 1073 | | 0.0169 | 0.0066 | 0.004 | 0 | 2E-03 | | | | .E-03 | **0.80** | **0.47** | 0.03 | 0.00 | + | **1.3** |
| 1075 | | 0.0168 | 0.0024 | 0 | 0 | 2E-03 | 3E-04 | 0E+00 | 0E+00 | 3.E-03 | **0.80** | **0.17** | 0.00 | 0.00 | + | 0.97 |
| 1528 | | 0.0108 | 0.0087 | 0.0021 | 0 | 2E-03 | 1E-03 | 3E-04 | 0E+00 | 3.E-03 | **0.51** | **0.62** | 0.01 | 0.00 | + | **1.2** |
| 2016 | | 0.0056 | 0.0021 | 0.0016 | 0 | 8E-04 | 3E-04 | 2E-04 | 0E+00 | 1.E-03 | **0.27** | **0.15** | 0.01 | 0.00 | + | 0.4 |
| 2025 | | 0.0055 | 0.012 | 0 | 0 | 8E-04 | 2E-03 | 0E+00 | 0E+00 | 2.E-03 | **0.26** | **0.86** | 0.00 | 0.00 | + | **1.1** |
| 2347 | | 0.0023 | 0.0029 | 0.0025 | 0 | 3E-04 | 4E-04 | 4E-04 | 0E+00 | 1.E-03 | **0.11** | **0.21** | 0.02 | 0.00 | + | 0.3 |
| WELLS NOT ANALYZED FOR MIXTURES EFFECTS (ONLY ONE HQ GREATER THAN OR EQUAL TO 0.1) | | | | | | | | | | | | | | | | |
| 2 | | 1.5 | 0 | 0.0072 | 0 | 2E-01 | 0E+00 | 1E-03 | 0E+00 | 2.E-01 | **71.35** | 0.00 | 0.05 | 0.00 | | |
| 184 | | 0.075 | 0 | 0 | 0 | 1E-02 | 0E+00 | 0E+00 | 0E+00 | 1.E-02 | **3.57** | 0.00 | 0.00 | 0.00 | | |
| 223 | | 0.064 | 0 | 0 | 0 | 9E-03 | 0E | | | | **3.04** | 0.00 | 0.00 | 0.00 | | |
| 228 | | 0.062 | 0 | 0 | 0 | 9E-03 | 0E | | | | **2.95** | 0.00 | 0.00 | 0.00 | | |
| 2677 | | 0 | 0.0061 | 0 | 0 | 0E+00 | 9E | | | | 0.00 | **0.44** | 0.00 | 0.00 | | |
| 2613 | | 0 | 0.0042 | 0.0027 | 0 | 0E+00 | 6E | | | | 0.00 | **0.30** | 0.02 | 0.00 | | |
| 2649 | | 0 | 0 | 0.0257 | 0 | 0E+00 | 0E+00 | 4E-03 | 0E+00 | 4.E-03 | 0.00 | 0.00 | **0.18** | 0.00 | | |
| 2499 | | 0 | 0 | 0.0003 | 0 | 0E+00 | 0E+00 | 5E-05 | 0E+00 | 5.E-05 | 0.00 | 0.00 | 0.00 | 0.00 | | |
| 2500 | | 0 | 0 | 0 | 0 | 0E+00 | 0E+00 | 0E+00 | 0E+00 | 0.E+00 | 0.00 | 0.00 | 0.00 | 0.00 | | |

**Tier 2**

**Hazard index greater than or equal to 1 --> do Tier 3 mixture analysis**

**More than one HQ greater than or equal to 0.1 --> do Tier 2 mixture analysis**

**Only one or fewer HQ greater than or equal to 0.1 --> mixture effects unlikely**

*Refined evaluation of potential effects considering target organs and other factors (mixtures framework Tier 3)*

Tier 3 analysis is a detailed analysis of potential mixture effects, considering, for example, target toxicities of each mixture component, sensitive subpopulations, or more refined estimates of potential exposure to the mixture. The text of this report describes that the PFAS in these mixtures may target similar organ systems and may all potentially contribute to developmental, immune, or liver effects. For further evaluation, ATSDR used the combined dose of all five PFAS included in the mixtures evaluation to determine the potential for harmful health effects. Because PFOA is the main contaminant at this site, we relied primarily on toxicological information for PFOA to determine whether effects from the mixtures were likely.

**Evaluating cancer health effects**

In general, the estimated added lifetime risk of developing cancer from an oral exposure to a carcinogenic contaminant is calculated by multiplying the site-specific estimated exposure dose, averaged over a lifetime, by an appropriate cancer slope factor. ATSDR uses this quantitative risk estimate as part of a weight-of-evidence approach to decide whether exposures to cancer-causing contaminants are of concern. ATSDR describes estimated increased cancer risk qualitatively and in terms of background rates of cancer occurring in the U.S. population.

At this time, there are no appropriate cancer slope factors for any PFAS to allow a quantitative estimate of increased cancer risk from exposure to PFAS. ATSDR has discussed cancer risk associated with PFAS qualitatively in the body of the report, beginning on page 25.

## Appendix C. Public Comments Received and ATSDR Responses

This health consultation was available for public review and comment from December 15, 2021, through March 1, 2022. The document and a fact sheet summary were available for viewing or downloading from ATSDR's website.

ATSDR distributed the report and information about the public comment period electronically and announced the release to area media outlets. ATSDR also announced the release and provided a link to the report on social media. ATSDR shared and discussed the findings of the health consultation with community members at a virtual information session held February 2, 2022. Copies of the draft report and fact sheets summarizing the findings and ATSDR's process were shared during the virtual information session.

ATSDR received written comments from 9 private citizens and the New Hampshire Department of Environmental Services. The comments received are listed in their entirety below (with personal identifiers for private citizens removed). Notes and removed text are indicated in a different font in brackets. In some cases, ATSDR split the comments into numbered items for readability and clarity of inserted responses. ATSDR responses to comments are shown in *blue italicized text*.

**PCnhdes: Comments from New Hampshire Department of Environmental Services** (Dated 3/1/2022)

PCnhdes-1

This letter is intended as a public comment on behalf of the New Hampshire Department of Environmental Services (NHDES) on the Health Consultation Evaluation of Per-and Polyfluoroalkyl Substances (PFAS) in Private Wells near the Saint-Gobain Performance Plastics Site in Southern New Hampshire (EPA FACILITY ID: NHD982746778). These comments were prepared by staff in the NHDES and NH DPHS APPLETREE team.

Firstly, we would like to commend ATSDR for the thorough and well-written draft health consultation it has provided for public comment, as well as thank the agency for the time permitted to review the document. Additionally, we thank ATSDR and its staff for holding a virtual meeting with New Hampshire communities on February 2, 2022 and addressing questions they had about the document.

*ATSDR Response: Thank you for this comment.*

PCnhdes-2

NHDES and NH DPHS have the following comments on the draft Health Consultation:
1. *Global comment on naming conventions used in the document* – First, Saint-Gobain Performance Plastics uses a 'hyphen' between Saint and Gobain on their letterhead. There are instances in the draft where a hyphen is used and where it is not used. NHDES suggests for clarity referring to 'Saint-Gobain Performance Plastics (Saint-Gobain)' in the first instance and

then 'Saint-Gobain' thereafter for brevity. Second, The New Hampshire Department of Environmental Services self identifies as 'NHDES' as opposed to 'NH DES'.

*ATSDR Response: ATSDR has verified that "Saint-Gobain" is hyphenated throughout the document and replaced 18 instances of "NH DES" with "NHDES."ATSDR also confirmed the NH DHHS acronym is correct as written.*

PCnhdes-3

*2. Page I, paragraph 2* – While NHDES initially led the sampling effort in this area, Saint-Gobain's environmental consultant has collected over 2,000 samples from private wells within the Outer Boundary of the 2018 Consent Decree and has offered bottled water to residents of more than 900 properties where violations of State Ambient Groundwater Quality Standards were detected. Saint-Gobain has not sampled or offered bottled water to property owners living outside the Outer Boundary. The provision of alternative water has primarily occurred inside the Outer Boundary.

*ATSDR Response: ATSDR has reworded discussion of actions taken at the site to clarify that not all homes were provided alternate water and that exposures could still occur. Details related to provision of alternate water and boundaries have been removed since ATSDR's evaluation focuses on potential exposures of users of private wells in the general area, not on specific wells.*

PCnhdes-4

3. *Page ii, paragraph 1* – Please be more specific regarding "more than 230 out of 2,745 wells had PFAS at levels that could …" and use the exact number if it was not exactly 230 wells.

*ATSDR Response: More detailed values are now presented in findings. We found that 1,063 wells had estimated exposure doses above ATSDR's intermediate oral MRL; of these, 267 had estimated exposure doses that approach or exceed effect levels in toxicological studies for one or more age groups; and of these, 23 wells had estimated exposure doses that approach or exceed effect levels in toxicological studies for all age groups. We note that while individual well data were evaluated and used to reach our general conclusions, because of the large number of private wells in the area and the community-level purpose of our evaluation, the report does not specify potential for harm on a well-by-well basis. We are available to discuss individual well results with property owners upon request.*

PCnhdes-5

4. *Page ii, first bullet* – Please clarify here (and elsewhere as needed) the length of exposure that was used in the evaluation to determine which wells are 'not expected to have harmed health.' The current ATSDR MRLs for 4 PFAS are for intermediate exposure (14-365 days) and there has been confusion from NH readers who understand the finding to be generalized to exposures longer than 1 year. Clarification for the general reader would improve the document for interested community and legislative stakeholders.

*ATSDR Response: ATSDR's current MRLs for PFOA, PFOS, PFHxS, and PFNA are all based on intermediate-duration studies, and thus are considered intermediate MRLs applying to durations of exposures of less than one year. To date, ATSDR has considered these intermediate MRLs to be generally protective for chronic exposures of greater than one year duration because of the following factors:*

- *In developing the intermediate MRLs, the time-weighted average serum concentration was selected as the internal dose metric for dose-response modeling and dosimetry extrapolation.*
- *The derivation of the intermediate MRLs assumes a steady state of PFAS levels in both the animals in the toxicological studies and in humans potentially exposed.*
- *Once PFAS levels are at a steady state, they will not change rapidly due to the long elimination half-lives of PFOA, PFOS, PFHxS, and PFNA in humans.*

*These factors may not apply to other PFAS, especially those with shorter elimination half-lives, and ATSDR is aware of EPA's proposed updated chronic oral reference doses for PFOA and PFOS. These values have been reviewed by EPA's Science Advisory Board and have completed a public comment period but have not yet been finalized. Until noncancer chronic guidelines are adopted for use in ATSDR assessments, ATSDR will continue to use the intermediate MRLs to assess exposures. The conclusion that harmful exposures to PFAS are possible for many private wells in the area applies to both intermediate and chronic exposures.*

*We have added the above clarifying text in a section entitled "Note on intermediate versus chronic health guidelines used in this evaluation" beginning on page 13.*

PCnhdes-6

5. *Page ii, first bullet under Next Steps* – This could be two separate bullets, where one provides the recommendation to speak with physicians and a reference to ATSDR's current guidance for clinicians. The second part of this bullet, as currently written, is redundant with the subsequent Next Step to reduce exposure to other sources.

*ATSDR Response: Thank you for this comment. We have rewritten the next steps to address this and other public comments received.*

PCnhdes-7

6. *Page ii, third bullet under Next Steps* – At the end of this bullet, ATSDR states "To help protect formula-fed infants from potential exposure, caregivers should use pre-mixed formula or reconstitute dry formula with *water sources not containing PFAS*." We encourage clarifying the latter part of this sentence given the presence of low-level detects of various PFAS across this region of NH. In private wells, there are various PFAS detected below ATSDR's MRLs and NHDES standards (i.e., ambient groundwater quality standards (AGQS) or maximum contaminant levels (MCLs)). Similarly, the public water systems in these and other towns have low level detects for certain PFAS (e.g., PFBA ranging from non-detect to ~7 ng/L). As this is currently written in the draft health consult, it could be misconstrued to mean that ATSDR considered *any concentration of any PFAS* to be unsafe for use in infant formula. There is

clearly uncertainty around mixtures of PFAS and the toxicity of understudied compounds; but this should be clarified, or additional context provided.

*ATSDR Response: We have reworded this phrase (now in the fourth bullet) to "with water sources that meet state and federal drinking water guidelines for PFAS."*

PCnhdes-8

7. *Page iii, Basis for Conclusion* – Bottled water has been provided to private wells *as contamination above the NHDES AGQS* has been discovered. Not all wells were immediately addressed in 2016, and not all wells affected (e.g., that have detectable levels of PFOA or other PFAS, including wells that violate AGQS) have been provided bottled water. As of the date of this letter, alternate water provision is primarily occurring inside the Outer Boundary.

*ATSDR Response: ATSDR has reworded discussion of actions taken at the site to clarify that not all homes were provided alternate water and that exposures could still occur. Details related to provision of alternate water and boundaries have been removed since ATSDR's evaluation focuses on potential exposures of users of private wells in the general area, not on specific wells.*

PCnhdes-9

8. *Page iii, first bullet under Next Steps* – ATSDR uses the term "point-of-entry" for treatment systems, and this requires clarification. NHDES uses the term point-of-entry treatment (POET) interchangeably with a whole house treatment system, or some system that treats all water entering the house from a private well. This differs from a point-of-use (POU) that is installed under a sink that will be used for consumptive purposes and does not treat all water in the home. In the instance of this bullet, use of POET is historically correct, as this (along with connection to public water) is the permanent remedy implemented in the CD. POUs were installed on a temporary basis, and nearly all (if not all) of the early POUs have been removed or turned over to the homeowner. NHDES recommends using 'treatment' in a general sense throughout the document where it could refer to both a POET or a POU, or refer to POET or POU if recommendations pertain specifically to one treatment method versus the other.. referenced.

*ATSDR Response: We have reworded this statement here and elsewhere in the report to refer to "Residents using point-of-entry or other treatment systems to remove PFAS from private well water should…"*

PCnhdes-10

9. Page 1, first paragraph under 'Background...' The manufacturing process at Saint-Gobain uses chemical mixtures, also referred to as 'dispersions', that contain several PFAS, including PFOA. The amount of PFOA in the mixtures used at the facility has changed over time.

*ATSDR Response: Edit accepted.*

PCnhdes-11

10. *Page 1, last paragraph* – A significant number of residents in this 5-town area living within the Outer Boundary of the 2018 Consent Decree remain on bottled water due to other factors. This includes the timing of wells tested after 2019 when lower enforceable Ambient Groundwater Quality Standards went into effect and ongoing negotiations between the State and a responsible party 2017 regarding the long-term remedy. Some public water systems within the Outer Boundary are treated for PFAS. ATSDR may receive comments from community members about the phrasing of this paragraph and NHDES is aware of the issue and is working towards a long-term solution for these individuals.

*ATSDR Response: ATSDR has reworded the discussion of actions taken at the site on pages 1-2 to clarify that not all homes were provided alternate water and that exposures could still occur. We have referenced more recent agreements and programs announced by NHDES since the publication of the draft report, although we note that the situation is still changing.*

PCnhdes-12

11. Page 1, footnote #2 – New standards went into effect in September 2019 with lower limits for PFOA, PFOS, PFHxS, and PFNA. In December 2019, a superior court judge enjoined these standards in response to a lawsuit against the State. These standards were adopted via legislation in July 2020, when they once again became enforceable.

*ATSDR Response: We have added additional information on enforcement of the state standards to this footnote, which now appears on page 3.*

PCnhdes-13

12. *Page 3, paragraph 3* – See comment #5 regarding POE versus POU treatment systems.

*ATSDR Response: We have reworded language to say "fitted with point-of-entry or other treatment systems" where appropriate throughout the document.*

PCnhdes-14

13. *Page 4, footnote* – There is a double period after perfluorohexanesulfonamide.

*ATSDR Response: Thank you. Correction made.*

PCnhdes-15

14. *Page 5, top bullet* – ATSDR states "The highest concentration is used because exposures to PFAS may have harmful health effects over relatively short periods of exposure (weeks to months);" regarding use of the maximum concentration for well water data. Please clarify if this refers to external (oral doses) exposures or internal (serum doses) exposures having harmful effects on a timescale of weeks to months.

*ATSDR Response: In light of this and other public comments received, we have rephrased the final sentence quoted (now at the bottom of page 5) to "The highest concentration is used because animal studies have shown that oral exposures to PFAS may have harmful health effects*

*over relatively short periods of exposure (weeks to months). Using the highest concentration is more protective for estimating both short-term and longer-term exposures," with a footnote on page 6 that says, "ATSDR's screening and minimal risk levels for PFOA, PFOS, PFHxS, and PFNA are based on oral exposure over intermediate duration timeframes. ATSDR considers these to be generally protective of chronic duration oral exposures because the intermediate values are derived from serum PFAS levels that are assumed to be at steady state and not changing quickly over time, due to the years-long elimination half-lives of these particular PFAS."*

PCnhdes-16

15. *Page 5, footnote* – This should be clarified to include that other sources of PFOA and PFAS have been identified in the area.

*ATSDR Response: Thank you. We have changed the footnote (now footnote 8 on page 6) to read "Other sources of PFOA and PFAS besides Saint-Gobain have been identified in the area; ATSDR makes no source attribution in this report."*

PCnhdes-17

16. *Page 6, last sentence first full paragraph* – Units should be µg/L for PFOS.

*ATSDR Response: Thank you; we have made this correction.*

PCnhdes-18

17. *Page 10, paragraph 4* – ATSDR provides an explanation of Table 2 and the sensitive receptor selected for comparisons, then Table 2 provides the EMEG in µg/L for each of the comparable PFAS. Several community groups have stated that they are interested in having the individual EMEGs listed for each age group for each PFAS, in part because of the partial availability presented in this table. A supplemental Table of EMEGs might address this concern for community groups interested in comparison against other guidance values. Alternatively, ATSDR needs to explain why these values are typically not presented in such a format.

*ATSDR Response: Since Table 1 rather than Table 2 presents EMEGs, we assume the second line of this comment is referring to Table 1. Table 2 shows health guidelines, that is, the applicable MRL or reference dose in micrograms per kilograms per day, to compare with the doses calculated for the sensitive group with the highest estimated dose. For chemicals with MRLs, ATSDR has a standard process to calculate child drinking water EMEGs in micrograms per liter used for comparison values (as presented in Table 1). The process uses standard, conservative assumptions based on a small child to obtain a drinking water concentration that is unlikely to cause harmful effects in this sensitive group and is thus protective of all age groups. ATSDR does not typically calculate EMEGs for different age groups; rather doses are calculated to compare with the MRL or other health guideline.*

*Table 2 presents the doses for the most sensitive age group with a high-end drinking water consumption exposed to the highest concentrations measured for each PFAS. For more detail, Appendix B's Table B-2 presents estimated doses for other age groups and drinking water consumption (these doses are compared against the same health guideline doses as the sensitive group shown in Table 2).*

PCnhdes-19

18. *Page 11, Table 2* – ATSDR could state more explicitly that the table is for exposures of children/infants in the table's top text. While this is described in the footnote, the top text might be misunderstood to be adults.

*ATSDR Response: We have changed Table 2's title to "Summary of highest estimated doses of PFAS (for birth to 1-year old children with high-end water consumption) from private wells near the Saint-Gobain Merrimack, NH facility." We have also clarified the table footnote to indicate that Appendix B contains a more detailed summary, including doses estimated for other age groups and water consumption assumptions.*

PCnhdes-20

19. *Pages 11*-16 - The affected communities are keenly interested in greater clarity about the associated health risks for those with exposure to PFOA and other PFAS. As a state agency, we understand the role and limitations of ATSDR's MRLs and how these are derived. However, the draft language about health outcomes is vague and confusing for the general audience. It is also not clear how exposure above the MRLs relates to listed health outcomes. We suggest simplified messaging focusing on summarizing some of the science with a focus on findings in human studies. One approach that has been suggested by community groups is to relate the language in the health consultation to the health outcome and effects described in ATSDR's Guidance to Clinicians.

*ATSDR Response: Thank you for this comment. We have added clarifying language to the introductory section on page 12 listing possible health effects to explain why the evaluation focuses on sensitive health endpoints found in animal studies. We have also reiterated possible health effects found for PFAS from human studies (consistent with ATSDR's current clinician guidance) as part of the "Basis for Conclusion" in the summary and conclusion sections.*

PCnhdes-21

20. *Page 22, footnote* – The threshold for PFAS contamination should be clarified here.

*ATSDR Response: ATSDR has reworded this footnote, so this comment no longer applies. Footnote 13 (on current page 23) now reads "As stated earlier, most affected private wells in the area have been connected to a treated public water source or provided point-of-entry or other treatment systems, reducing harmful exposures. Exposures could still occur from low levels of PFAS remaining in alternate or treated water sources, from PFAS in contaminated wells that were not tested or whose owners declined alternate water or treatment, or from exposure to other sources of PFAS in the environment."*

PCnhdes-22

21. *Page 24, last two paragraphs* – NH DHHS has updated the cancer report and determined there was an increased incidence of kidney/renal cancers for the Merrimack area and this should be cited in reference to the Merrimack cancer report: https://www.dhhs.nh.gov/dphs/cdpc/nhcccp.htm *[ATSDR note: the link cited in the comment no longer exists, see response below.]*

*ATSDR Response: We added to this section (at top of current page 27), "Recently, NH DHHS updated the cancer report. The analysis of data from the New Hampshire State Cancer Registry found a higher than expected number of people with kidney and renal cancers in Merrimack between 2009 and 2018 than would typically be observed in a town of similar size in New Hampshire [51]." We added a reference to a press release from NH DHHS regarding the report (the link in the comment no longer exists).*

PCnhdes-23

22. *Pages 25*-26 – ATSDR should clarify which communities and areas were represented by NH DHHS's blood testing effort in Southern NH. There is MVD specific data, and southern NH data and it is unclear where there is overlap or the extent that these overlap with the outer areas of the PFAS investigation and therefore lower concentrations of PFAS in private wells. ATSDR somewhat acknowledges this in the footnote on page 26, but further clarification would benefit the discussion here.

*ATSDR Response: For its summary of the NH blood testing, ATSDR used NH DHHS reports [53,54] and reported data presented as "private well owner" data, not Merrimack Village District (MVD) data. We did not have information on the geographical extent of the private well owner data or any raw data. We made no attempt to verify the reported values, as directly linking these results with well water data provided to ATSDR was outside the scope of this report.*

PCnhdes-24

23. *Page 27, first bullet* – What is ATSDR's definition of excessive, for women exposed to excessive PFAS?

*ATSDR Response: We have reworded this sentence to read, "Epidemiological studies suggest an association between serum PFOA levels and pregnancy-induced high blood pressure or pre-eclampsia [8]." The reference is to the 2021 ATSDR toxicological profile for PFAS.*

PCnhdes-25

24. *Page 27, third bullet* – The last statement does not leave a reader clear about the implication for childhood vaccines. Is ASTDR suggesting an effect on the efficacy of childhood vaccines, or does the reduced antibody response have a specific interpretation from ASTDR?

*ATSDR Response: According to the 2021 ATSDR toxicological profile for PFAS, several PFAS have been associated with decreased antibody response to vaccines, but in general, decreases in disease resistance have not been found. The last statement in this bullet has been rephrased to include this information, "PFAS exposure may also decrease children's antibody responses to childhood vaccines; in general, however, decreases in disease resistance have not been found [8]."*

PCnhdes-26

25. *Page 29, Recommendations* – There is significant concern from community members that the recommendations from ATSDR do not include subsequent exposure assessment or need for further study. Under *A Note of Explanation*, ATSDR states that a health consultation may recommend further study through exposure assessment, exposure studies or providing education to healthcare providers. As the draft is written, there is no mention of these activities under the recommendations, and it would be beneficial for ATSDR to state whether these activities are or are not recommended. This is not intended to request a commitment from ATSDR for activities, rather clarity if this exposure scenario merits further investigation by regional partners such as academic institutions, NGOs, or other partnerships.

*ATSDR Response: At this time, there is no recommendation for biological exposure assessment or a health study in the Southern New Hampshire area because it is already known that the levels of PFAS and estimated exposures there could increase the risk of harmful effects. Reducing exposure to the extent possible now is most important to protect public health.*

*The levels of PFAS in private wells in Southern New Hampshire and potential exposures are comparable to several other sites across the United States. ATSDR recently completed exposure assessments at 10 sites to learn about relationships between exposure and serum levels [59]. In addition, ATSDR and cooperative partners are currently analyzing data from two health studies, the Pease Study and the Multi-site Study at seven other sites across the United States, examining relationships between PFAS exposure and health effects. The results from both the exposure assessments and the health studies will be generalizable to other communities with PFAS-contaminated drinking water.*

PCnhdes-27

26. *Page 29, Recommendations* – Similarly, an explicit recommendation for or against healthcare provider education would be beneficial here and likely help to direct efforts to assist the community. NH DHHS has performed extensive outreach already to healthcare providers across the State going back to 2015, including direct messaging and webinars for providers; development of resources for affected community members to utilize in advocating for their health; working with the local NH Medical Society, Pediatric Environmental Health Specialties Unit (PEHSU), and the Northern New England Poison Center (NNEPC) to increase communication and resources to providers, including consultative services; promoting ATSDR resources; etc. It would be helpful, therefore, for ATSDR to provide some commentary around recommendations for effective healthcare provider outreach and include activities and resources that ATSDR is directly involved with.

*ATSDR Response: Thank you for this suggestion. ATSDR supports additional healthcare provider education in the area. We have added the following recommendation to the summary and recommendations sections: "ATSDR recommends local medical providers use ATSDR's current clinician guidance at https://www.atsdr.cdc.gov/pfas/resources/info-for-health-professionals.html as a resource for informing patients and guiding treatment. As science evolves, ATSDR will work with state and local authorities to provide area medical providers with updated information on health effects associated with PFAS exposure and recommendations for patient care." In 2020, CDC, ATSDR, and the National Institute of Environmental Health Sciences (NIEHS) contracted the National Academies of Science, Engineering, and Medicine (NASEM) to produce a report that includes suggestions for updating ATSDR's clinician guidance for PFAS. The report was released in August 2022, and ATSDR is currently reviewing the report's public health recommendations and updating its clinician guidance.*

PCnhdes-28

27. *Page 29, Recommendations* – It would help if recommendations were clearer about who residents and specific stakeholders need to work with to follow ATSDR's recommendations. For example, the recommendation for residents to contact their physicians is clear. But what is unclear, within this health consultation, is that ASTDR has guidance for clinicians to which clinicians should refer. This could be more plainly stated in the recommendations section. Similarly, recommendations specific to different stakeholders (e.g., residents, local public health agencies, academic research entities, healthcare providers, etc.) could be more explicit.

*ATSDR Response: We have added a link to ATSDR's current clinician guidance to appropriate recommendations. We recognize that some of the report's recommendations, particularly those regarding providing alternate water or further well monitoring, are not explicit as to who is responsible. The exact authorities and responsibilities in this area are quite complex and may change pending agreements between the state and different stakeholders. Since state and local agencies have the most knowledge of these site-specific matters, we have phrased those recommendations generally.*

PCnhdes-29

28. *Recommendations, page 29* – On a related note, specific guidance from ATSDR both for health care providers and for affected persons in the community should be mentioned and linked in the Health Consultation. These should include accessible, current materials that are sortable by need (community members, providers, researchers, elected officials, etc.). As ongoing healthcare provider education about PFAS exposure and potential health impacts continues to be important at a local and national level, it is important that readers understand how ATSDR specifically will work directly with communities and ensure providers are aware of and have access to the most up to date science and medical recommendations. Again, this could be addressed by a recommendation for providers to follow ATSDR's guidance related to PFAS and also highlight what ATSDR is doing to help promote or conduct outreach to healthcare providers.

*ATSDR Response: We have added the following recommendation to the summary and recommendations sections: "ATSDR recommends local medical providers use ATSDR's current clinician guidance at https://www.atsdr.cdc.gov/pfas/resources/info-for-health-professionals.html as a resource for informing patients and guiding treatment. As science evolves, ATSDR will work with state and local authorities to provide area medical providers with updated information on health effects associated with PFAS exposure and recommendations for patient care." In 2020, CDC, ATSDR, and the National Institute of Environmental Health Sciences (NIEHS) contracted the National Academies of Science, Engineering, and Medicine (NASEM) to produce a report that includes suggestions for updating ATSDR's clinician guidance for PFAS. The report was released in August 2022, and ATSDR is currently reviewing the report's public health recommendations and updating its clinician guidance.*

PCnhdes-30

29. *Page 29, first bullet* – See comment #2 above.

*ATSDR Response: ATSDR has added information on its clinician guidance on PFAS to the recommendation. (We assumed "comment #2" referred to issues raised in comments PCnhdes-27 through PCnhdes-29 above.)*

PCnhdes-31

30. *Page 29, fourth bullet* – See comment #5. Again, this appears to be remediation guidance that reflects a concern for dermal exposure at these residences.

*ATSDR Response: ATSDR is not sure what this comment is referring to. We did not consider dermal exposure to PFAS in this evaluation. The bullet referenced in the comment refers to point-of-entry systems. Please see response to comment PCnhdes-9.*

PCnhdes-32

31. *Page B-2*, *Exposure pathway* – NHDES recently sampled waterbodies in Southern NH to determine concentrations of PFAS in recreationally harvested fish. Sampling was limited to composite fish tissue samples, two species per lake across 14 lakes. This included surface water and sediment concentrations of PFAS from waterbodies within and outside of the Saint-Gobain Investigation area. Full details are available at: https://www4.des.state.nh.us/nh-pfas-investigation/?p=1405 *[ATSDR note: the link cited in the comment no longer exists; see response below.]*

*ATSDR Response: We have changed the language on page B-2 to clarify that we were asked to evaluate only the drinking water pathway and were not provided data on PFAS in other environmental media besides drinking water. We also added a statement that "Although NHDES has now posted results of sampling of some of the following, we did not consider any other potential past, present or future exposure pathways, including…"*

*ATSDR prepared this health consultation in response to a request to evaluate drinking water exposures in the Southern New Hampshire private wells. Our findings recognize that other*

*exposure pathways may contribute to harmful exposures to PFAS. ATSDR is willing to provide technical assistance reviewing the additional media sampled, upon request.*

PCnhdes-33

32. *Page B*-3, *Table B 1* – See comment #11. A combined table with these values or a subsequent table listing the EMEGs could address comment #11.

*ATSDR Response: Table B 1 lists ATSDR's standard assumptions for body weight and drinking water consumption for the various age groups evaluated in the report. EMEGs are not developed for each age group; instead, ATSDR uses the child EMEG as a conservative screening level for all age groups.*

PCnhdes-34

We thank ATSDR for the opportunity to comment on the draft Health Consultation and commend the extraordinary work it has conducted with the communities across Southern New Hampshire. If you have any questions regarding our comments, please contact us using the information in the signature below.

*ATSDR Response: Thank you for the comments.*

**PCpc1: Comments from private citizen 1** (dated 2/26/22)

PCpc1-1

**Comment #1:**

**Statement-1:** The Introduction, page "i", states: *"This report evaluates past and current exposures to per-and polyfluoroalkyl substances (PFAS) in private drinking water wells.";* and *"Since the discovery of the contamination, state and local officials have taken several actions to reduce exposures, **including treating public water supplies** and providing alternate or treated water to affected private well owners."*

**Statement-2:** *The "Basis for Conclusion" following Conclusion #2 on page "iii" states: "Since 2016, …more than 750 private wells in the area **have been switched to treated public water**..."*

**Statement-3:** The "Background and brief history" on page "1" states: *"Since the discovery of the contamination, local actions have reduced exposures to PFAS in drinking water. **Public water supplies within the Outer Boundary are treated to remove PFAS.** People using private wells found to exceed state health-based drinking water standards2 were offered bottled water, **connection to the public water supply**, or installation of a treatment system to remove PFAS. Hundreds of properties supplied with water from private wells have been connected to local municipal water systems or provided treatment systems [1,2,4]."*

In addition to the above three statements, there are numerous other similar citations and statements about treated public water being supplied to connected private well owners that should be revised. They are too numerous to list individually here. The fact is that there was

ongoing exposure for private wells that have been connected to public water systems as recent as October 2021. The statement that providing treated [public] water to affected private well owners has occurred since the discovery of the contamination [in 2016] is inaccurate, and should be stricken everywhere stated above, in the final report.

I am [PII removed], and I can tell you that ALL MVD well water was non-compliant with the NH DES PFAS MCLs, specifically, with PFOA ranging between 12 and 40 ng/L (ppt) in the distribution system, versus NH DES MCL of 12 ppt. This contaminated water continued to be served in the MVD system, until two improvements were completed. One was the activation of PFAS treatment at MVD wells 4/5 in October 2020. That upgrade represented PFAS treatment of only about 25% of all of MVD distribution system water. Next, in October 2021, all remaining MVD untreated wells were closed and supplemental water began to be purchased from Nashua's Pennichuck water system by MVD. Nashua's Pennichuck water does contain detectable PFAS compounds but is compliant with the four PFAS compounds regulated by the NH DES. Therefore, to say that serving treating public water to affected private well owners since the discovery of PFAS contamination, is simply not true! The affected private well owners in Merrimack that were connected to MVD water, really only first saw about 25% treated water after October 2020, and then 100% treated water after October 2021.

Perhaps these above references made throughout the report are a result of the difference between MRLs and MCLs. If that is the case, I find it to be misleading, since the general public does not understand the differences. Please refer to my comment #5 below.

*ATSDR Response: ATSDR agrees that rephrasing is needed to better describe timing of actions and possible levels of PFAS remaining in wells and water supplies remaining in the community after 2016. Since 2016, public water systems serving the area were treated to reduce PFOA and PFOS to the standards at that time, 70 ng/L (0.07 µg/L). PFAS at lower levels could have been present in the public water system, in water treated by a point of use or entry system, and in private wells not provided alternate water, so it is true that exposures for private well owners were not interrupted completely. We do, however, note that for private wells with the highest levels of PFAS, switching to the public water or other alternate water would have greatly reduced the exposure and thus the risk. We have attempted to rephrase relevant sections of the report for clarity and accuracy.*

PCpc1-2

**Comment #2:**

Footnote #2 on page "1" states: "*From 2016 until 2020, New Hampshire's drinking water standard was 0.07 micrograms per liter for PFOA, PFOS, or a combination of the two chemicals. This value is identical to the U.S. Environmental Protection Agency's (EPA's) lifetime health advisory for PFOA and/or PFOS [3]. In September 2019, the state adopted new rules with lower limits for PFOA, PFOS, PFHxS, and PFNA; these rules were enacted via legislation in July 2020.*"

This can be interpreted as implying that PFOA up to 70 ppt is safe, since the footnote #2 is referenced in the above Statement-3 regarding the provision of treated public water to private

well owners. This 70 ppt level directly conflicts with the ATSDR's own MRL for PFOA, which is lower than 70 ppt.

*ATSDR Response: Thank you for this comment. We have rephrased various sections of the report to clarify that exposures for private well owners were not interrupted completely by the provision of alternate water or treatment systems. Please see the response to the previous comment.*

PCpc1-3

**Comment #3:**

The report is misleading, and can be misinterpreted where statements are made as to the PFAS exposure being minimized, in several instances, because the following were not evaluated:

- Inhalation (from Saint-Gobain's unfiltered air borne emissions, of breathing of contaminated soil / dust)
- Direct contact (soil, surface water, sediment ingestion or physical contact)
- Food chain (fish, game, vegetables irrigated with PFAS contaminated water)

Although the omissions of these evaluations is stated in the report, it is not obvious, and the headline conclusions and discussions fail to amplify this missing evaluation. The omission of these other exposure pathways call the entire report's conclusions to be questionable.

*ATSDR Response: Thank you for this comment. We have added additional details in the section describing other potential exposure pathways at this site (on page 4 of the report) commenting on the possible additional contributions of other pathways to the exposures evaluated in the report.*

*The report was focused on private well water exposures, at the request of the state. The report found that drinking water from many of the private wells in the area could have increased the risk for harmful health effects. The levels of PFAS in area wells were quite high. Any additional exposure from other pathways such as those mentioned by the commenter would only add to the concern. NHDES has noted (see comment above) that it has collected data on PFAS in local fish, surface water, and sediment. ATSDR is available to provide technical assistance in reviewing those data or data from other environmental media, upon request.*

PCpc1-4

**Comment #4:**

Footnote #4 on page 5 is appalling! It states: *"Other sources beside Saint-Gobain exist in the area; ATSDR makes no source attribution in this report."*

Do you find the following facts to be a simple coincidences?:

- Page 6: *"PFOA was detected most frequently, in 91% of the wells tested."* PFOA was the main contaminant used by Saint Gobain! For PFOA to show up in 91% of private wells tested and NOT be attributed to Saint Gobain is ridiculous!

- The 2017 DHHS blood evaluation of MVD customers concluded that the average blood PFOA level was double the national average, and blood PFOA concentrations increased for those living closer to saint Gobain.
- NH Science and Public Health Co-Founders study, "Risk of Cancer in a Community Exposed to Per- and Poly-Fluoroalkyl Substances," published in Environmental Health Insights, found that Merrimack residents experienced a significantly higher risk of at least four types of cancer compared to US incidence rates or demographically similar New England towns with no documented PFAS contamination in the drinking water supply.

The pieces of the puzzle are all in front of us! They clearly indicate that saint Gobain emissions are the cause for the above bulleted items. It is not coincidence. It is Saint Gobain! To state otherwise is to ignore the facts that are in plain sight. There are no other PFOA sources significant enough to have caused the above bulleted items.

*ATSDR Response: As noted by NHDES (see comment above), other sources of PFOA and PFAS besides Saint-Gobain have been identified in the area. The area is quite large in areal extent, and PFAS have been used in various applications since the 1950s, so this is not surprising. Figure 5 showing private wells with PFAS levels high enough to result in harmful doses does show many wells clustered close to the Saint-Gobain facility, suggesting it is a major source of contamination of private wells in the area. However, ATSDR's conclusions are based on the sampling data and estimated exposures. Based on NHDES input, we have rephrased the footnote (now footnote 8), "Other sources of PFOA and PFAS besides Saint-Gobain have been identified in the area; ATSDR makes no source attribution in this report." We have also added clarifying language to the text starting on page 3 under Focus of this report that reads, "Although the Saint-Gobain facility appears to be the major contributor to the PFAS contamination, other potential sources of PFAS have been identified in the area. Because well sampling data alone do not allow determination of the source of contamination, the PFAS detected in private wells may or may not originate from the Saint-Gobain facility. ATSDR evaluated all the PFAS data received for the potential for harmful exposure, regardless of where the contamination originated. The conclusions and recommendations in this report are general and based on exposure estimated from private well data; we make no attempt to attribute measured contaminants to the site or to other sources. As a non-regulatory agency, it is outside of ATSDR's mandate and purview to determine the party responsible for the contamination."*

PCpc1-5

**Comment #5:**

My understanding is that this ATSDR report uses MRLs to evaluate PFAS exposure, not drinking water MCLs. My understanding is that MRLs are representative of short-term 1-year exposure, not long-term exposure. Basing conclusions on short-term MRLs in a community where many people have lived and drank their well water for a lifetime is just inaccurate and misleading. I could not find anywhere in the report that explains this inconsistency. Please correct me if I misunderstand the above differences between MRLs and MCLs.

*ATSDR Response: ATSDR's current MRLs for PFOA, PFOS, PFHxS, and PFNA are all based on intermediate-duration studies, and thus are considered intermediate MRLs applying to durations of exposures of less than one year. To date, ATSDR has considered these intermediate MRLs to be generally protective for chronic exposures of greater than one year duration because of the following factors:*

- *In developing the intermediate MRLs, ATSDR assumed the time weighted average PFAS serum concentration used to represent the dose in animal toxicological studies reflected a steady state. ATSDR's dose-response modeling to identify corresponding serum concentrations in humans also assumes a steady state.*
- *Because PFOA, PFOS, PFNA, and PFHxS are eliminated very slowly from the body, once they reach a steady state, the concentration will not change much over time, even over longer time periods.*

*These factors may not apply to other PFAS, especially those with shorter elimination half-lives, and ATSDR is aware of EPA's proposed updated chronic oral reference doses for PFOA and PFOS. These values have been reviewed by EPA's Science Advisory Board and have completed a public comment period but have not yet been finalized. Until noncancer chronic guidelines are adopted for use in ATSDR assessments, ATSDR will continue to use the intermediate MRLs to assess exposures. The conclusion that harmful exposures to PFAS are possible for many private wells in the area applies to both intermediate and chronic exposures.*

Thanks for the opportunity to provide these comments. I trust that they will be taken into consideration, and the final report will be revised to incorporate these and the many other comments received.

*ATSDR Response: Thank you for taking the time to read and provide comments on this report. We have considered and made changes based on all comments received.*

**PCpc2: Comments from private citizen 2** (dated 2/27/22)

PCpc2-1

RE: Introduction

Please consult with NHDES to update this introduction as it reads as if the contamination investigation is complete. ATSDR evaluated data for 2745 wells, of which approximately 750 were remediated by connection to public water and a few were given POET systems. The homes connected to public water will still have PFAS exposure as all of our water sources in the area have PFAS contamination at varying levels with all of Merrimack public water wells consistently testing at above NH MCLs. Only the 2 wells closest to Saint Gobain that were over the federal HA have been remediated at this time. The private well contamination investigation continues to grow, there are 3644 PFAS contaminated private wells included in the current Saint Gobain work plan. None of these wells are with a plan for remediation, many have been provided bottled water for over 2 years. Of these 3644 wells in the current state directed work plan, which began in October of 2019, only 2098 have this far been sampled. Of the 2098 wells sampled, 2042 have been found to be contaminated at various levels above the NH MCLS and

NHDES has determined all to be the responsibility of Saint Gobain. The point made several times in this health consult that Saint Gobain is not the sole responsible party is in direct conflict with the state of NH assignment of responsibility.

*ATSDR Response: ATSDR recommends continuing investigation and monitoring of private wells in the area. We have rewritten several areas of text to recognize that exposures have not been completely interrupted and that exposure is still possible. As noted above, ATSDR's conclusions are based on the sampling data and estimated exposure doses. It is not within ATSDR's mandate or purview to determine the party responsible for the contamination.*

PCpc2-2

There should be a more developed section in the beginning stating that although this consultation only analyzed drinking water, other pathways of exposure exist in our communities. Ingestion, inhalation and dermal absorption must be noted as pathways of exposure that are present in our communities. Please list local food and produce, soil, dust and the use of area compost made from biosolids as cautions for additional exposure.

*ATSDR Response: Thank you for this suggestion. We have added additional details in the section describing other potential exposure pathways at this site (beginning on page 4 of the report) commenting on the possible additional contributions of other pathways to the exposures evaluated in the report.*

PCpc2-3

RE: Conclusion One:

The initial statement says before actions began in 2016 to reduce exposures, drinking from PFAS contaminated private wells could have increased the risk for harmful effects for some community members and then goes on to state that only 230 of the 2745 wells analyzed are of concern and the results for the others are not expected to have harmed health. Given that we know we have had exposure for decades, and the bioaccumulative nature of legacy PFAS as evidenced by the significantly elevated blood levels in a serum sampling of private well users in this area of focus, I strongly disagree with this statement. The following points will support my point and the need for aligning this consultation with the health science based water standards that NH has incorporated and other states have also been adopting. Every state that sets out to create health science based MCLs for PFAS finds critical endpoints and toxicological studies to support a significantly lower number than the EPA and the ATSDR utilize for directing states. This is not only irresponsible, it is appalling.

*ATSDR Response: ATSDR has rephrased the conclusions and basis for conclusions. We have included data illustrating the widespread nature of the PFAS in private wells, i.e., "Estimated exposure doses in 1,063 of 2,745 wells evaluated—about 40% of the wells—were higher than minimal risk levels used for screening." We also added a recommendation that "Actions to reduce exposure (treating the water or providing alternate drinking water) are warranted for the entire community given the likelihood of past exposure, potential mobility of PFAS in*

*groundwater, and persistence of many PFAS in the human body." ATSDR's assessment of the potential for health effects applies to both intermediate and chronic exposures.*

PCpc2-4

1- The phrase low level was repeatedly used despite the EPA being clear in recent months that PFOA and PFOS are likely carcinogens. We also see the EPA acknowledgment that the current federal HA is magnitudes higher than it should be and states that have used sound science to determine much lower MCLs than the federal HA are recognized as valid.

*ATSDR Response: The report acknowledges possible cancer risk, but we could not quantify the risk because appropriate finalized cancer slope factors are not available (ATSDR does not determine carcinogenicity or develop slope factors to quantify risk). ATSDR has rephrased much of the language in the report to recognize evolving science and take a more conservative approach. However, we note that the overall conclusion, that many private wells had levels of PFAS that could result in harmful exposures, is the same.*

PCpc2-5

2- The consult stated the most vulnerable population of infants/children were the standard but the MRLs utilized were for intermediate exposure, defined as 4-12 months. According to a statement by NHDES in a January 2018 CIR, communities have had steady exposure to PFAS for at least 15 years. Our exposure has been collective, bioaccumulative and has been /is inclusive of both past and present PFAS formulations used, emitted and discharged.

*ATSDR Response: ATSDR's current MRLs for PFOA, PFOS, PFHxS, and PFNA are all based on intermediate-duration studies, and thus are considered intermediate MRLs applying to durations of exposures of less than one year. To date, ATSDR has considered these intermediate MRLs to be generally protective for chronic exposures of greater than one year duration because of the following factors:*

- *In developing the intermediate MRLs, ATSDR assumed the time weighted average PFAS serum concentration used to represent the dose in animal toxicological studies reflected a steady state. ATSDR's dose-response modeling to identify corresponding serum concentrations in humans also assumes a steady state.*
- *Because PFOA, PFOS, PFNA, and PFHxS are eliminated very slowly from the body, once they reach a steady state, the concentration will not change much over time, even over longer time periods.*

*These factors may not apply to other PFAS, especially those with shorter elimination half-lives, and ATSDR is aware of EPA's proposed updated chronic oral reference doses for PFOA and PFOS. These values have been reviewed by EPA's Science Advisory Board and have completed a public comment period but have not yet been finalized. Until noncancer chronic guidelines are adopted for use in ATSDR assessments, ATSDR will continue to use the intermediate MRLs to assess exposures. The conclusion that harmful exposures to PFAS are possible for many private wells in the area applies to both intermediate and chronic exposures.*

PCpc2-6

3- The focus on the Health consult was overall kept on the 4 legacy PFAS and while I appreciate the acknowledgement of mixtures, from an exposure perspective the discussion was not well developed and not helpful to the average person. We are exposed as a class and our risk must consider the total sum of all PFAS as there hasn't been one ever proven as safe and similar health effects are seen repeatedly in studies. The recent EPA proposal to group PFAS in subclasses based on similar characteristics illustrates the awareness of this point.

*ATSDR Response: ATSDR agrees that it would be helpful if PFAS could be assessed as a class. At this time there is not enough scientific information to do this. We support efforts to develop such procedures.*

PCpc2-7

4- The consultation was narrow in its scope of critical endpoints and I know a more robust application can be made as I was engaged in the process that NH underwent in setting MCLs that could withstand scientific and legal scrutiny. In the introductory conclusion section which is as far as many people will read, there was not a thorough listing of health conditions known to be associated with PFAS exposure. This is very important to fully list as since people are being left on their own to monitor their own health, they should at least have a thorough list of what to watch for.

*ATSDR Response: Thank you for this comment. We have added clarifying language to the introductory section on page 13 listing possible health effects to explain why the evaluation focuses on sensitive health endpoints found in animal studies. We have also reiterated possible health effects found for PFAS from human studies (consistent with ATSDR's current clinician guidance) as part of the "Basis for Conclusion" in the summary and conclusion sections.*

PCpc2-8

5- The conclusions of the consultation minimize the harm as well as leave people without supports or resources. The recommendation that PFAS impacted populations should take to their PCPs while the ATSDR Region One is well aware that there is no physician education and support in place for PFAS exposure/environmental health impacts is absolutely outrageous, not to mention unethical.

*ATSDR Response: Thank you for this suggestion. ATSDR supports additional healthcare provider education in the area. We have added the following recommendation to the summary and recommendations sections: "ATSDR recommends local medical providers use ATSDR's current clinician guidance at https://www.atsdr.cdc.gov/pfas/resources/info-for-health-professionals.html as a resource for informing patients and guiding treatment. As science evolves, ATSDR will work with state and local authorities to provide area medical providers with updated information on health effects associated with PFAS exposure and recommendations for patient care." In 2020, CDC, ATSDR, and the National Institute of Environmental Health Sciences (NIEHS) contracted the National Academies of Science, Engineering, and Medicine (NASEM) to produce a report that includes suggestions for updating ATSDR's clinician guidance for PFAS. The report was released in August 2022, and ATSDR is currently reviewing the report's public health recommendations and updating its clinician guidance.*

PCpc2-9

To conclude, the description of the role of ATSDR, the expectation of our communities and state, and the needs of every PFAS impacted community are at extreme odds with our experience. When residents learn that their families and neighbors have been drinking contaminated water and breathing contaminated air for years, they need timely and ongoing support. When residents can do their own research, talk to others and see health impacts and patterns in their communities that are similar to other PFAS communities and polluters are protected while we are not protected or supported, it creates further distrust in government. The question I am left with, is who is this report intended for? Our residents have waited years for information as to our health risks and decisions such as the use of a chemical specific comparison value and utilizing an intermediate MRL in formulating these health consultations are significantly out of touch with our reality.

*ATSDR Response: We are sorry for what your community has experienced. In preparing this report, ATSDR used its most current guidance and evaluation procedures to evaluate the potential for harmful exposures in the community. We recognize that the science on PFAS is developing rapidly, and we update our internal guidance and procedures regularly to reflect changing science. The overall conclusion—that harmful exposures are possible from private wells in the area—is unlikely to change with evolving science. We are committed to increasing healthcare provider awareness of PFAS exposure and are currently evaluating updates to our clinician guidance on PFAS.*

PCpc2-10

In the initial note of explanation, there is statement that consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure trends in adverse health outcomes, conducting biological indicators of exposure to assess exposure, and providing health education for health care providers and community members. Those are the actions that we have needed since 2016. A health survey could easily be conducted so residents voices have a presence in this process where what we see and know is not being looked at. PFAS chemicals are harmful at much lower levels than our federal agencies acknowledge and in industry impacted communities such as we see in this area, the true exposure profile is not considered and health patterns are ignored while we are told to wait for the research that will never be there as we are not being studied.

Thank you for reviewing my points which are by no means exhaustive.

*ATSDR Response: At this time, there is no recommendation for biological exposure assessment or a health study in the Southern New Hampshire area. It is already known that the levels of PFAS and estimated exposure doses there could increase the risk of harmful effects. Reducing exposure to the extent possible now is most important to protect public health.*

*The levels of PFAS in private wells in Southern New Hampshire and potential exposures are comparable to several other sites across the United States. ATSDR recently completed exposure assessments at 10 sites to learn about relationships between exposure and serum levels [59]. In addition, ATSDR and cooperative partners are currently analyzing data from two health studies,*

*the Pease Study and the Multi-site Study at 7 other sites across the United States, examining relationships between PFAS exposure and health effects. The results from both the exposure assessments and the health studies will be generalizable to other communities with PFAS-contaminated drinking water.*

**PCpc3: Comments from private citizen 3** (dated 2/27/22)

PCpc3-1

1. Page ii: "...are not expected to have harmed health. However, this conclusion is uncertain. Many wells were sampled only once..."
The conclusion is that the remaining wells were not expected to harm health. This is qualified immediately by noting that statement is uncertain and why. The statement "...are not expected to have harmed health" should not be there at all. Rather, it should simply be that it is not possible to draw a conclusion about the safety or not of the wells considering the small sampling size and unknown PFAS fluctuations. (Note: this comment also applies to the same statement made on page 28 of the report).

*ATSDR Response: ATSDR has removed this basis for Conclusion 1. As indicated in recommendations resulting from Conclusion 2, ATSDR recommends actions to reduce exposures in the entire area. This is due in part to uncertainties related to limited sampling, fluctuating PFAS levels, and typical mobility of PFAS in groundwater.*

PCpc3-2

2. Following the first comment (1), for the first bullet of "Next Steps", if it is not possible to accurately assess safety of the remaining wells, perhaps it is prudent to suggest all well owners discuss their exposure or possible exposure with their health care providers and not just those who had unsafe levels in this small window of time.

*ATSDR Response: ATSDR agrees with this comment and has rephrased the recommendation/ next steps.*

PCpc3-3

3. General comment for Summary: This report is very dense, and many may just look to the Summary for the bottom line rather than getting through the detailed methods. It's important to show in the Summary either a summary of or page reference to the noncancer health effects from exposures to PFAS.

*ATSDR Response: Thank you for this suggestion. We added a summary of health endpoints our evaluation found to be most likely from exposure at this site and a list of other possible health effects possible from PFAS exposure to the Basis statements for Conclusion 1 in the summary and conclusions sections.*

PCpc3-4

4. Page 3, Focus of this report: It's made very clear throughout that the report only looks at PFAS from drinking water and not other routes. However, could a statement be made, if

known, regarding the possibility of inhalation from the outside air near the Saint Gobain plant? For example, the report states here that PFAS don't easily evaporate from drinking water; but they are emitted from the facility directly into the air (stated on page B-1, Source). Could a person inhale them when outside, and is this route a health concern? While the focus of the report is the drinking water, it would be good to indicate what the other viable/possible routes of exposure are in this particular situation from this particular facility and not just list them as not considered for this report. In other words, don't let the narrow focus of this report preclude you from stating what is needed for a comprehensive evaluation on the health effects of PFAS in this community.

*ATSDR Response: We have added additional details in the section describing other potential exposure pathways at this site (on page 4 of the report) commenting on the possible additional contributions of other pathways to the exposures evaluated in the report.*

*The report was focused on private well water exposures at the request of the state (a separate report will evaluate the public water supply). The report found that drinking water from many of the private wells in the area could have increased the risk for harmful health effects due to PFAS. Any additional exposure from other pathways such as those mentioned by the commenter would only add to the concern. ATSDR is available to provide technical assistance in reviewing data from other environmental media, upon request.*

PCpc3-5

5. Page 5, Determining the timeframe of potential exposure: The report states there is an assumption of exposure beginning c. 1986, however, it can't be proven and levels could have been higher or lower than those measured recently. Here, or elsewhere, could there be a statement made about how the potential long-term exposure to PFAS (30 years for a life-long resident) could impact someone's health?

*ATSDR Response: We have added additional language to this paragraph to clarify the reasoning behind assumptions made. Production using PFAS began in 1986, so there was no potential for contamination before that date. It would take some time for the area groundwater to become contaminated, but to be conservative we do assume that people could have been exposed from 1986 on. Noncancer effects from long-term exposures and increased cancer risk are both potential concerns from this type of long-term exposure. At this time ATSDR is unable to quantify the cancer risk due to a lack of appropriate, finalized cancer slope factors.*

PCpc3-6

6. Page 11, Estimating PFAS exposure doses; comparison with health guidelines: Please show the comparison between the health guidelines used for the study and New Hampshire's MCLs.

*ATSDR Response: Thank you for this suggestion. We have added New Hampshire MCLs to Table 1. We also note that use of these MCLs for screening would have changed the count of wells exceeding screening values in the table, but it would not have changed our evaluation because we evaluated all the wells and all PFAS (that is, we did not actually "screen out" any wells or contaminants).*

**PCpc4: Comments from private citizen 4** (dated 2/28/2022)

PCpc4-1

1. As I read the advice to consult with our doctors I am totally dismayed. We have told you on zoom calls that the local medical community has received little or no guidance as to what to do.

*ATSDR Response: ATSDR supports additional healthcare provider education in the area. We have added the following recommendation to the summary and recommendations sections: "ATSDR recommends local medical providers use ATSDR's current clinician guidance at https://www.atsdr.cdc.gov/pfas/resources/info-for-health-professionals.html as a resource for informing patients and guiding treatment. As science evolves, ATSDR will work with state and local authorities to provide area medical providers with updated information on health effects associated with PFAS exposure and recommendations for patient care." In 2020, CDC, ATSDR, and the National Institute of Environmental Health Sciences (NIEHS) contracted the National Academies of Science, Engineering, and Medicine (NASEM) to produce a report that includes suggestions for updating ATSDR's clinician guidance for PFAS. The report was released in August 2022, and ATSDR is currently reviewing the report's public health recommendations and updating its clinician guidance.*

PCpc4-2

2. The document clearly states that wells were sampled 1x and yet you are making lifetime decisions while people with wells may have children that have developmental delays.

*ATSDR Response: In the revised report (Conclusion 2), ATSDR recommends actions to reduce exposures in the entire area. This is due in part to uncertainties related to limited sampling, fluctuating PFAS levels, and typical mobility of PFAS in groundwater.*

PCpc4-3

3. I agree residents should reduce further exposure but remember we had private wells testing in the 100's in 2016 and who knows for how long. It seems late and inadequate response

*ATSDR Response: Your comment is noted. We recognize that harmful exposures likely occurred to members of the community before the PFAS groundwater contamination was identified in 2016 and that actions taken then may have been based on guidelines and standards that are not considered protective today.*

PCpc4-4

4. In your second conclusion you state "Residents drinking from private wells that were never tested, or who were offered but declined alternate water, may experience harmful health effects if they drink water with high PFAS concentrations." This seems to ignore the contaminated water they drank in the past. Remember these are known as "forever chemicals". Our exposure has been collective, over many years of a product that is bio-cumulative and has been in our waster in the past and present.

*ATSDR Response: We agree with this comment. We have reworded Conclusion 2 to recognize this comment and others received. It now reads, "People who continue to drink contaminated, untreated private well water have an increased risk for harmful health effects." We also added, "Actions to reduce exposure (treating the water or providing alternate drinking water) are warranted for the entire community given the likelihood of past exposure, potential mobility of PFAS in the groundwater, and persistence of many PFAS in the human body" as a recommendation following from this conclusion.*

PCpc4-5

5. Also, please clarify how people know if they have had harmful exposure if people cannot get blood tests. We agree that one sampling of water does not paint a true picture.

*ATSDR Response: This report used standard practice to gain an estimate of potential exposures to determine if the PFAS in private wells could have led to harmful exposures in the community. The general exposure estimation in this report cannot and is not intended to predict an individual's exposure. A blood test can show how much PFAS is in a person's blood. However, as has been pointed out by other commenters, there are many other potential exposure pathways for PFAS, so an individual's blood test result may or may not reflect exposure from private well water alone. In addition, how blood serum PFAS results relate to possible health effects is unknown and, as with many environmental chemicals, may never be fully elucidated. Blood tests for PFAS do not provide information as to whether the exposure is related to a current health problem or related to any future health problem. Additionally, they do not provide information for treatment. Blood test results will not predict or rule out the development of future health problems related to a PFAS exposure.*

PCpc4-6

6. There are many gaps and advice you have overlooked

*ATSDR Response: For this community-level assessment, ATSDR evaluated only private well PFAS data provided by the state. ATSDR focused its evaluation on the most important exposures with the greatest potential risk to health and provided actionable recommendations on those. ATSDR considers the level of detail appropriate for this community-level assessment.*

PCpc4-7

There is no mention of finding out that you and your family have been drinking contaminated water and the undue stress that this community has had to endure.
This document includes advise that concerned citizens have been telling their neighbor for years. There is nothing in this document about breathing the output from Saint Gobain.
Those of us on town water or who have neighbors with contaminated wells are deeply dismayed that after all this time, that this little amount of advice comes from you.
We have received no help or support.

*ATSDR Response: ATSDR recognizes that the experience of long-term environmental contamination, such as PFAS in drinking water, can contribute to psychological and social stress in affected communities. While it is normal for some community members to feel stress in these situations, chronic stress can affect their health. In Fall 2020, ATSDR launched the*

*Community Stress Resource Center (www.atsdr.cdc.gov/stress) to provide guidance and tools for reducing stress and building resilience in communities during public health responses to environmental contamination. We have added information on ATSDR's Community Stress Resource Center to our recommendations.*

*We have also provided a link to ATSDR's current clinician guidance for PFAS in the report's revised recommendations. In 2020, CDC, ATSDR, and the National Institute of Environmental Health Sciences (NIEHS) contracted the National Academies of Science, Engineering, and Medicine (NASEM) to produce a report that includes suggestions for updating ATSDR's clinician guidance for PFAS. The report was released in August 2022, and ATSDR is currently reviewing the report's public health recommendations and updating its clinician guidance.*

PCpc4-8

My friend, [PII removed] put it well when she said

"In the initial note of explanation, there is statement that consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure trends in adverse health outcomes, conducting biological indicators of exposure to assess exposure, and providing health education for health care providers and community members. Those are the actions that we have needed since 2016. A health survey could easily be conducted so residents voices have a presence in this process where what we see and know is not being looked at. PFAS chemicals are harmful at much lower levels than our federal agencies acknowledge and in industry impacted communities such as we see in this area, the true exposure profile is not considered and health patterns are ignored while we are told to wait for the research that will never be there as we are not being studied. "

*ATSDR Response: At this time, there is no recommendation for biological exposure assessment or a health study in the Southern New Hampshire area. It is already known that the levels of PFAS and estimated exposure doses there could increase the risk of harmful effects. Reducing exposure to the extent possible now is most important to protect public health.*

*The levels of PFAS in private wells in Southern New Hampshire and potential exposures are comparable to several other sites across the United States. ATSDR recently completed exposure assessments at 10 sites to learn about relationships between exposure and serum levels [59]. In addition, ATSDR and cooperative partners are currently analyzing data from two health studies, the Pease Study and the Multi-site Study at 7 other sites across the United States, examining relationships between PFAS exposure and health effects. The results from both the exposure assessments and the health studies will be generalizable to other communities with PFAS-contaminated drinking water.*

PCpc4-9

Quite frankly, I am very tired from trying to fight a major corporation for clean water. If I put harmful chemicals in the water and air, after it has been determined there are health risks, I would probably be committing a crime. A major corporation does it and you give us advice that

we have basically figured out. You just put an agency title behind it. This has been a heart wrenching experience.

*ATSDR Response: ATSDR recognizes that many community members have experienced stress from this situation. We developed the Community Stress Resource Center (www.atsdr.cdc.gov/stress) provide guidance and tools for reducing stress and building resilience in communities during public health responses to environmental contamination.*

**PCpc5: Comment from private citizen 5** (dated 12/22/2021)

This is beyond shameful at any point in time, especially in 2021! This blatant criminal contamination activity by Saint Gobain Performance Plastics needs to be permanently halted. The company needs to be prosecuted & fined to the fullest extent of the law, leading to a permanent closure of the company.

*ATSDR Response: ATSDR acknowledges your comment. ATSDR is a non-regulatory agency and cannot make or enforce laws.*

**PCpc6: Comment from private citizen 6** (dated 12/26/2021)

I read the ATSDR report for New Hampshire private wells contaminated with PFOA by Saint Gobain. Why weren't public water consumers covered in this report? Both public water and private well residents have been negatively impacted by the PFOA contamination. I urge you to speak for us all. We are one community and we all have contaminated water.

*ATSDR Response: Because of differences in how people are exposed between private wells and public water systems (which may blend and distribute water widely), ATSDR is conducting separate analyses for private wells versus public water in the area. ATSDR will soon release a separate report evaluating public water exposures. That report will be available for public comment just as this one was.*

**PCpc7: Comment from private citizen 7** (dated 12/27/2021)

I've lived in [redacted] NH for 71 years, drinking the water from this town.
I have kidney cancer I've been fighting for the last [redacted], I've already had one kidney taken out and fighting to save the other kidney which also has cancer in it.
I've had [redacted] operations already because the cancer keeps jumping to different places in my body. My name is [redacted], I live less than 2 miles from [redacted].

*ATSDR Response: We are sorry to hear of your health problems. Our evaluation cannot say whether any one person's health condition was caused by their exposure, but we do note that some studies have shown an association between PFAS exposure and kidney cancer. We advise you to continue your physician's recommended treatment and wish you well.*

**PCpc8: Comment from private citizen 8** (dated 12/25/2021)

My husband and I have lived in [redacted] as well as our [redacted]. I had a kidney transplant in [redacted] and my husband has prostate cancer since [redacted]. What course of action should we need to look into?

*ATSDR Response: We are sorry to hear of your and your husband's health problems. Our evaluation cannot say whether any one person's health condition was caused by their exposure. We advise you to continue your physicians' recommended treatment plans and wish you both well.*

**PCpc8: Comment from private citizen 8** (dated 2/28/2022)

A major deficiency of the report is the lack of inhalation analysis. I don't believe that this is not an important exposure pathway.

*ATSDR Response: As described in the section beginning on page 3 of the report, most PFAS, including the main ones present at this site, do not evaporate readily into the air from water. Therefore, inhalation exposure to PFAS from water during bathing, showering, or other household uses would be very small compared to ingestion exposure.*

*We did not evaluate inhalation of PFAS in the air near the Saint-Gobain site because the state asked us to focus on drinking water exposures. We added additional details in the section describing other potential exposure pathways at this site (on pages 4-5 of the report) commenting on the possible additional contributions of other pathways to the exposures evaluated in the report. Any additional exposure from other pathways, including inhalation, would only add to the concern found from drinking water exposures. ATSDR is available to provide technical assistance in reviewing data from other environmental media, upon request.*