Title: Five-Year Trends in PFAS Contamination (2021-2025) in Maine Drinking Water Wells Around Sludge and Septage Sites Using Statewide Data from the Maine Department of Environmental Protection

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REV-1, 8/28/26, Spreadsheet calculation corrections.

ABSTRACT:
In 2016, the State of Maine became aware of PFAS contamination in a drinking water well in West Kennebunk[1], Maine. Since then, significant PFAS contamination of drinking water wells in Maine has been discovered through the "PFAS Soil and Groundwater Investigation at Sludge and Septage Land Application Sites"[3], completed by the Maine Department of Environmental Protection (MEDEP). The MEDEP has been taking PFAS samples in drinking water wells near sludge and septage sites since January of 2017[6]. In the fall of 2025, I discussed with the MEDEP the possibility of evaluating statewide PFAS sample data to date, to look for PFAS contamination trends in PFAS contaminated drinking water wells. With thorough supportive assistance from the MEDEP, in late 2025 and early 2026 I received spreadsheet data of PFAS sample test results for all samples taken by the MEDEP or their contractors around sludge and septage land application sites (~220,000 PFAS parameter test results)[4]. All of the samples were taken from drinking water wells throughout Maine[4]. This report describes the methodology used to identify trends in PFAS concentration in drinking water wells throughout the State of Maine over a five-year period: 2021-2025. Results include:

1. Trend graphs for PFAS 6 and PFOS independently, for 99 and 126 wells respectfully, that had sample results in each of those five years.
2. The percentage of those wells with increasing trends of PFAS6 or PFOS concentration over the five-year period 2021-2025.
3. Graphs showing PFAS trends for a subset of those wells with at least one sample over 1000 ppt (parts per trillion) PFAS 6 or PFOS, and for the subset of wells with at least one sample over 10,000 ppt PFAS 6 or PFOS.

Conclusions and Recommendations are included.
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INDEX

ACRONYMS/DEFINITIONS

KSTD: Kennebec Sanitary Treatment District

MCL: Maximum Contaminant Level

MEDEP: Maine Department of Environmental Protection

PFAS 6: Maine's interim drinking water standard of 20 ppt (parts per trillion) for the Sum of 6 PFAS (PFOA, PFOS, PFNA, PFHxS, PFHpA, and PFDA).[3]

PPT: Parts Per Trillion

BACKGROUND

In 2016, THE MEDEP became aware that a drinking water well in West Kennebunk, Maine tested positive for PFAS.[1] This set off the discovery of significant PFAS contamination of drinking water wells in numerous locations and communities in the State of Maine. Much of the PFAS contamination of drinking water wells in Maine has been the result of land-spreading of wastewater treatment plant sludge and septage. From 1981 to 1996, 40,027 cubic yards of PFAS contaminated wastewater treatment sludge from the Kennebec Sanitary Treatment District (KSTD) were land-spread on approximately two hundred acres next to the Howe Road in Fairfield, Maine.[2] In 2023, for 21 wells on or near the Howe Road, the average drinking water well PFAS 6 contamination level was 12,851 parts per trillion (ppt), making the Howe Road the most PFAS contaminated road in the State of Maine.[2] From 1980 to 2003, 149,934 cubic yards of PFAS contaminated wastewater treatment sludge from the KSTD were land-spread in the town of Fairfield alone[2]. During this same time, a total of 293,651 cubic yards of PFAS contaminated wastewater treatment sludge from the KSTD were land-spread in Fairfield and fifteen other central Maine towns.[2] For perspective, 293,651 cubic yards of wastewater treatment sludge will fill 20,975 average size dump trucks carrying 14 cubic yards each. As of January 15, 2025, the Maine DEP had installed 495 PFAS removal treatment systems on drinking water wells.[3]

PFAS chemicals are known as "Forever Chemicals" because they persist in the environment for decades. As a resident living on Howe Road in Fairfield, Maine, the most PFAS contaminated street in the State of Maine, and as a Professional Engineer having spent almost twenty years working for the State

of Maine Drinking Water Program, I am very interested in how long the PFAS contamination will last in my area and in my well water. The Maine DEP has collected water samples from PFAS contaminated wells since January of 2017[6]. In 2025, I decided to pursue an evaluation of statewide trends in drinking water well PFAS contamination levels using test data from the MEDEP, collected since PFAS contamination was discovered in Maine drinking water wells.

DATA SOURCE AND USE, WORKING SPREADSHEET SPECIFICS

In the fall of 2025, I discussed with the MEDEP the possibility of getting a database of all PFAS tests taken on drinking water wells in Maine in areas near land-spread sludge sites. With PFAS samples having been taken from numerous drinking water wells in Maine over several years now, I wanted to see if any trends could be seen, and whether they are increasing or decreasing. Upon my request, the MEDEP sent me a large EXCEL file in December of 2025 (~220,000 samples results), and an updated file in the spring of 2026. All of the PFAS samples were collected by the MEDEP or their contractors around sludge or septic sites.[4] Each "Sample Point Number" corresponded to a unique well/sample location and all of the samples were taken from drinking water wells, not public water supply wells.[4]

After working with the data extensively, I recognized that the data for November and December of 2025 were not included in this first EXCEL file sent from the MEDEP. So, around March of 2026, I asked the MEDEP for an updated file that included all of the data from 2025.

The data provided to me by the MEDEP included many PFAS analytes that are not within the scope of this evaluation. I decided to narrow this evaluation to two specific analytes: "Sum of PFAS6" (Maine's measure for evaluating the safety of water to drink, including six PFAS analytes that when combined needed to be less than 20 ppt… this is what Maine came up with for a drinking water maximum contaminant level [MCL] (or "Interim Standard") before the recent federal PFAS drinking water MCL was published in 2024[1]. PFAS 6 tests were taken in Maine since about 2021), and "PFOS_A", which is "PERFLUOROOCTANE SULFONIC ACID". I wanted to look at PFOS alone in comparison to the Sum of PFAS6 because by far, PFOS is the most significant

contaminant in the fields near the Howe Road and I believe, in all sludge spread from the KSTD in Fairfield and 15 other central Maine communities[7].

I received two "sends" of the EXCEL data file from the Maine DEP, one dated Dec 2025 and the other dated April of 2026. After doing a lot of work on the 2025 EXCEL file that included data through October of 2025, not wanting to do all of that work again to the 2026 EXCEL file, I extracted "SUM of PFAS6" data for November and December of 2025 from the 2026 EXCEL file, and added it to the 2025 EXCEL file, to make the 2025 EXCEL file complete for SUM of PFAS6. For PFOS _A, I used data only from the 2026 EXCEL file.

Upon reviewing the data for "SUM of PFAS6" and "PFOS_A", it became apparent that I should go back only as far as 2021 for data, looking at trends in data covering 2021 through 2025. See next bullet....

An important design tenet of this review was that any well included in this review needed to have at least one sample taken in each year of 2021, 2022, 2023, 2024, and 2025. Therefore, I manually excluded all wells that did not meet this criterion. This criterion also eliminated going back farther than 2021, because there were far less wells that had yearly tests going back before 2021. So, my analysis is a trend review over a five-year span, 2021-2025.

My working EXCEL file is titled "Rev 1 - Corrected - MEDEP All Through 2025 – PFAS6 and PFOS Working File.xlsx", available upon request from the author.[6] In this EXCEL file, there are 26 sheets. The sheets are methodically titled and grouped, and with the descriptions provided in Appendix A, they can be fully understood. SEE APPENDIX B.

At first, I planned to simply average all of the samples taken in each year of 2021-2025. However, each well did not have the same number of samples taken each year, and samples were not taken in the same months for each well. As a result, some wells had 20-30 samples per year, and others had one sample per year. When I first averaged all of the samples per year, I realized that some wells with many samples per year would weigh much more heavily in that year's average than others with fewer samples. As a result, I decided for each well, to average the sample results in each year, therefore resulting in

one PFAS6 or PFOS measurement per year for each well. The spreadsheets I have developed use the average of samples in each year, for each different well. With these average results per year, per well, I then found the overall average Sum of PFAS 6 level per year for all qualifying wells, 2021-2025. I did the same for PFOS.

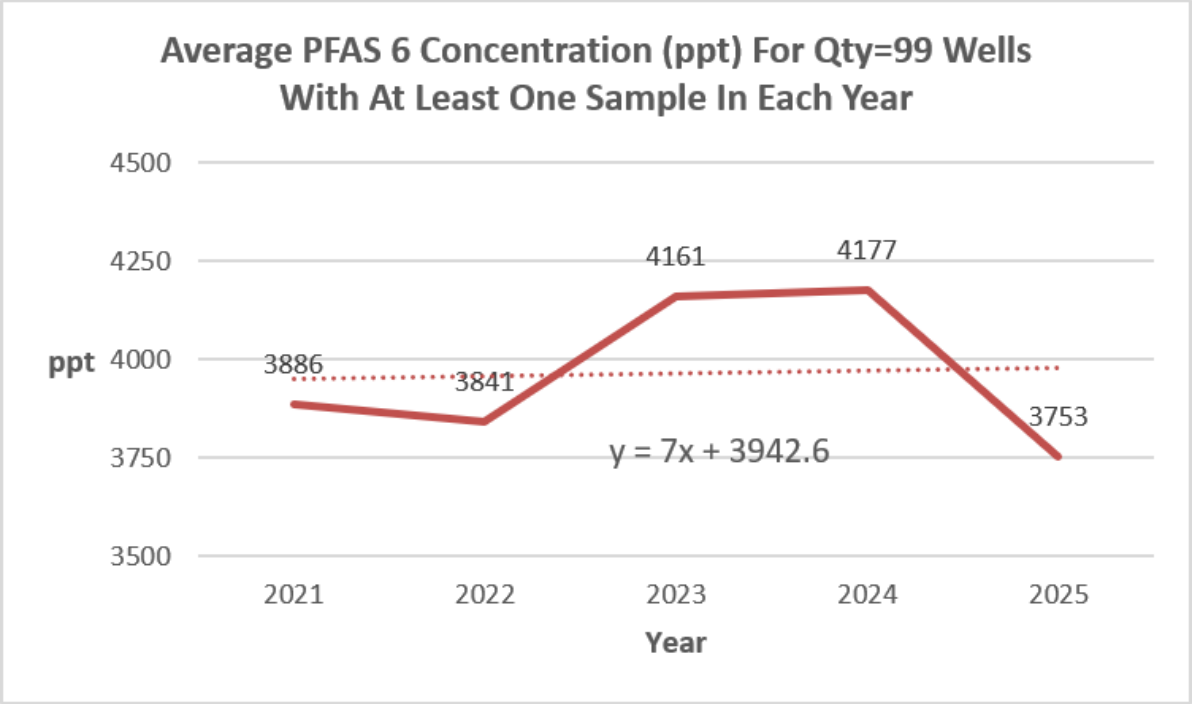
Slope Determinations: with each well having five sample results, one for each year 2021-2025, I created a line graph of these five data points, and using the EXCEL tool "Trend Line", plotted that trend line for each well. I used the same graph over and over for each well, so I did not save a graph for each well, but I did record the slope of the graph for each well. I do not think it is reasonable, with only five data points per well, to make predictions of how long it will take for a well to reduce PFAS levels over time (there is a good argument that there is not enough data yet to make reliable predictions from). However, there is value in determining and speaking to the slope of the trend line for the five data points for each well. The slope of the trend line, whether positive or negative, does suggest whether contamination rates are showing an increased trend over the last five years, or a decreasing trend.
SEE APPENDIX A.

For PFAS6, 36 Field Duplicates were 2% of the total 1683 PFAS6 samples included in the analyses. For PFOS, 48 Field Duplicates were 2% of the total 1933 PFOS samples included in the analyses. Field duplicates are additional samples with standard sampling variation expected. Therefore, "Field Duplicate" samples were included in these analyses.

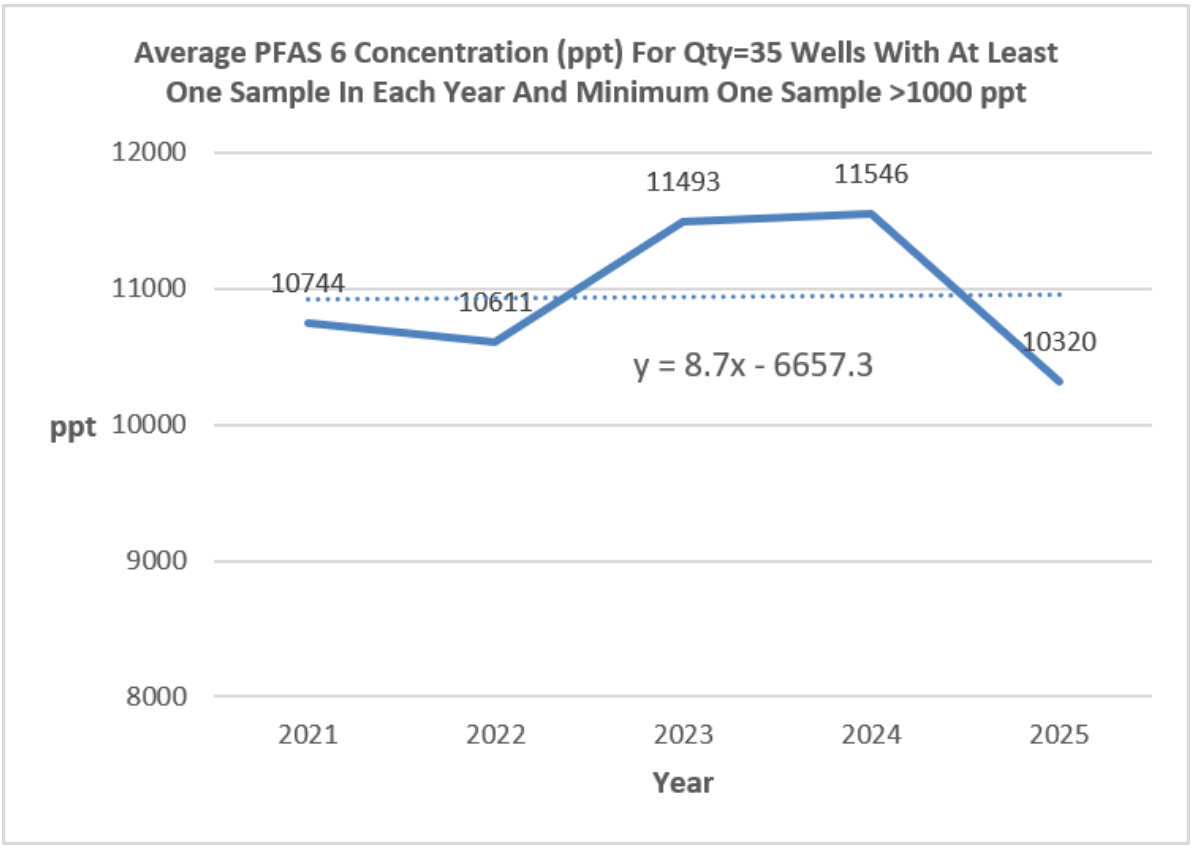
RESULTS

1. Graph I: Average **PFAS 6** Concentration (ppt) for Qty=99 Wells with at least One Sample in Each Year
2. Graph II: Average **PFAS 6** Concentration for Qty=35 Wells with at least One Sample in Each Year and Minimum One Sample >1000 ppt
3. Graph III: Average **PFAS 6** Concentration for Qty=18 Wells with at least One Sample in Each Year and Minimum One Sample >10,000 ppt
4. Graph VI: Average **PFOS** Concentration (ppt) for Qty=126 Wells with at least One Sample in Each Year
5. Graph V: Average **PFOS** Concentration for Qty=20 Wells with at least One Sample in Each Year and Minimum One Sample >1000 ppt
6. Graph VI: Average **PFOS** Concentration for Qty=9 Wells with at least One Sample in Each Year and Minimum One Sample >10,000 ppt
7. Graph VII: **Maine Worst Drought Level by Year (2021-2025)**
8. Table: **PFAS 6 AND PFOS TRENDS IN MAINE DRINKING WATER WELLS 2021-2025**

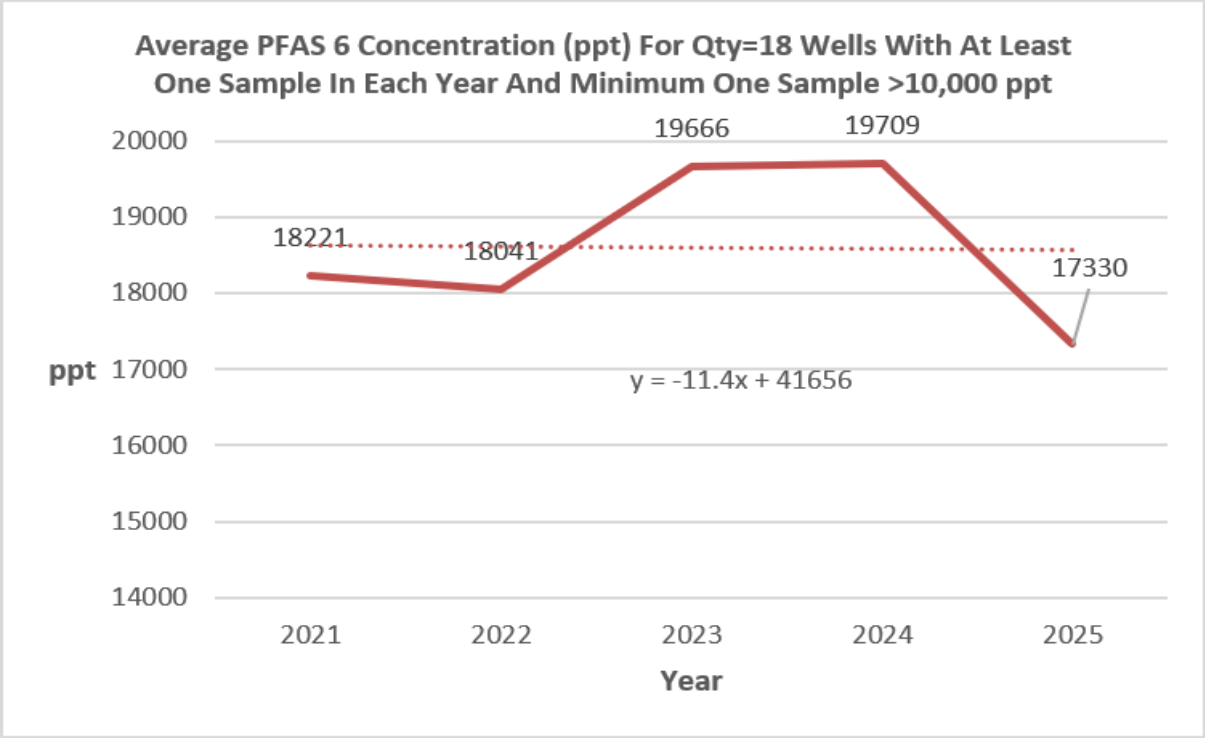
GRAPH I



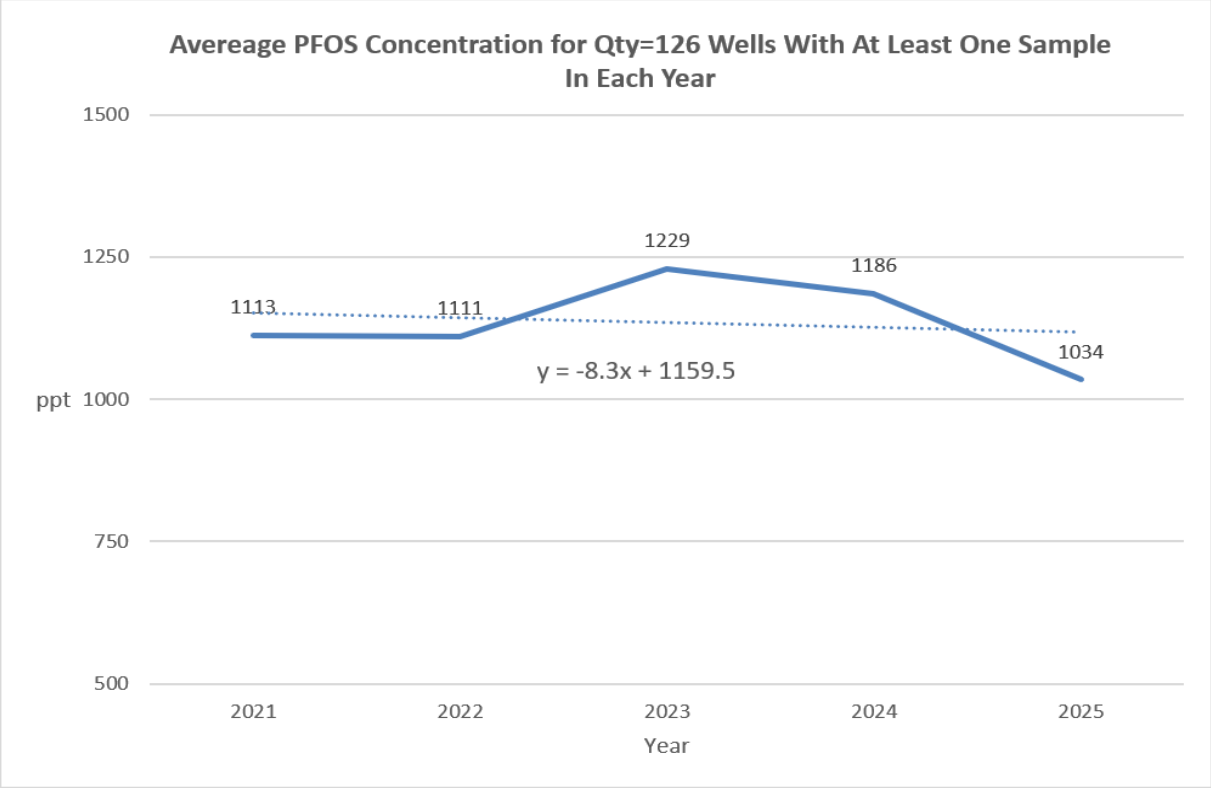
GRAPH II



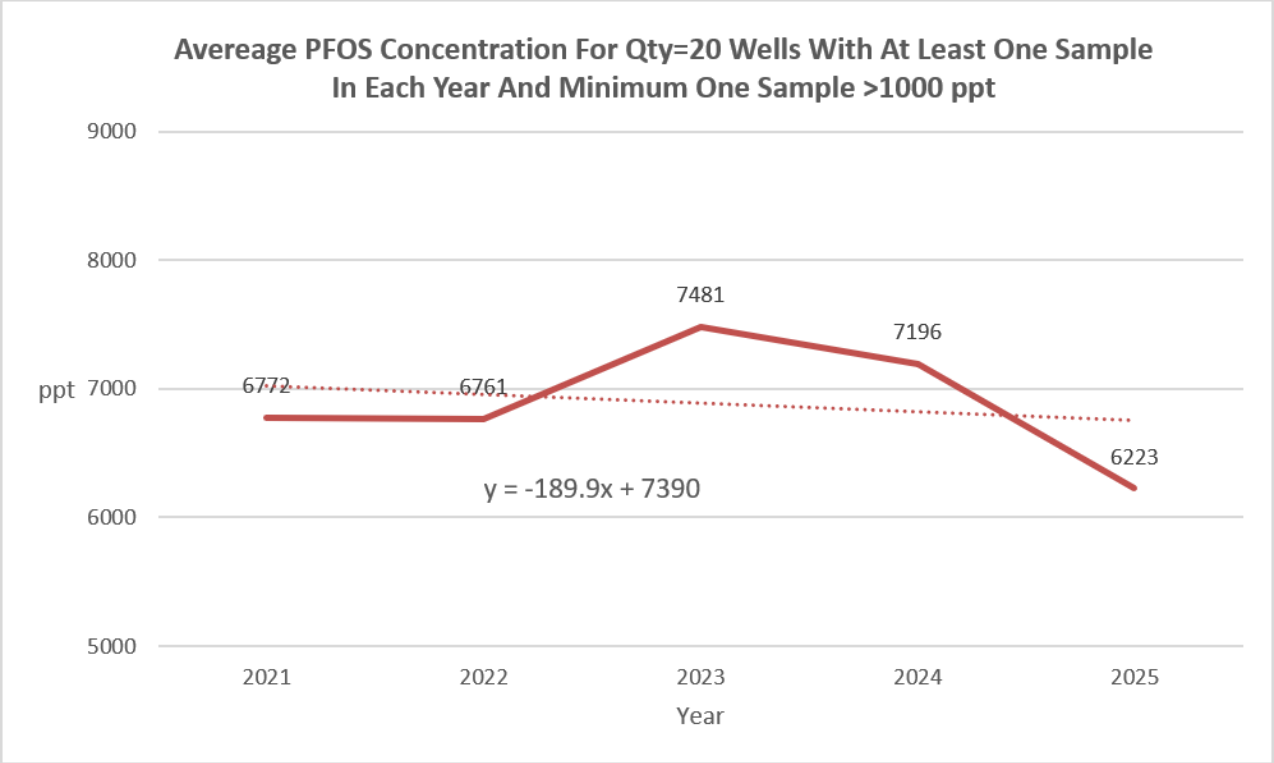
GRAPH III



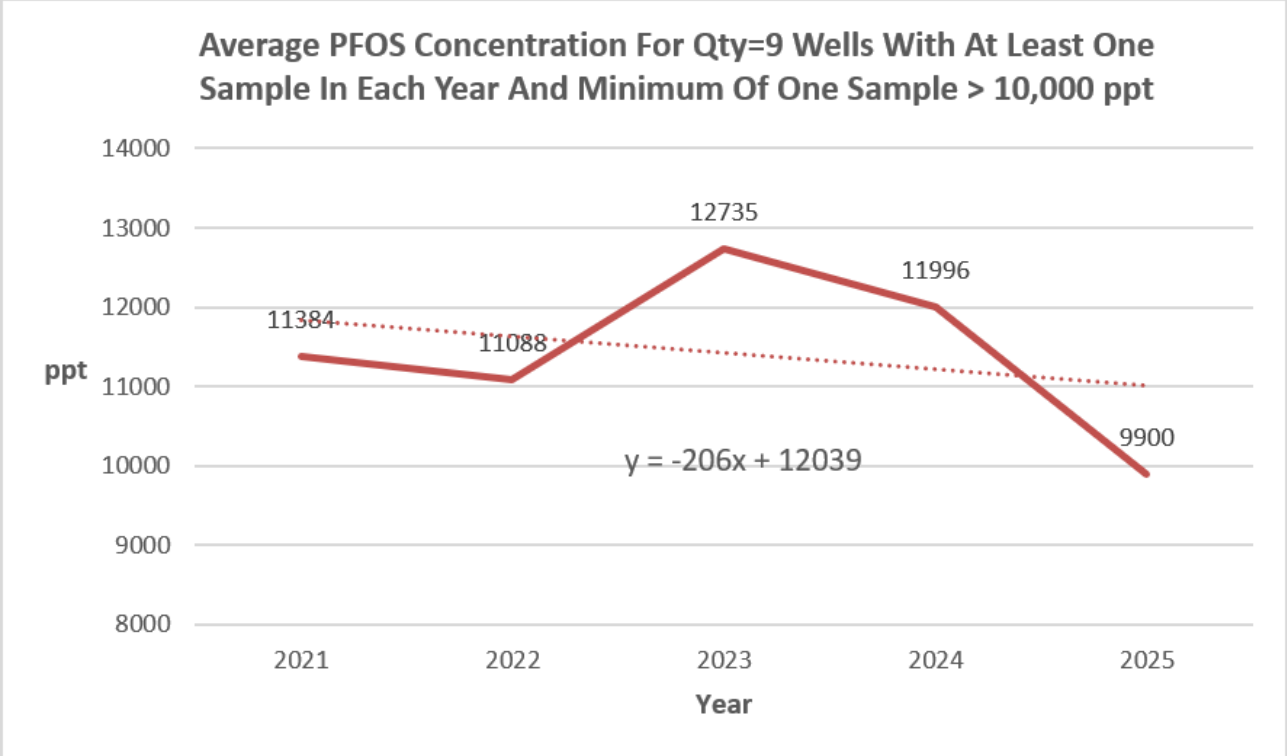
GRAPH IV



GRAPH V



GRAPH VI



GRAPH VII[5]

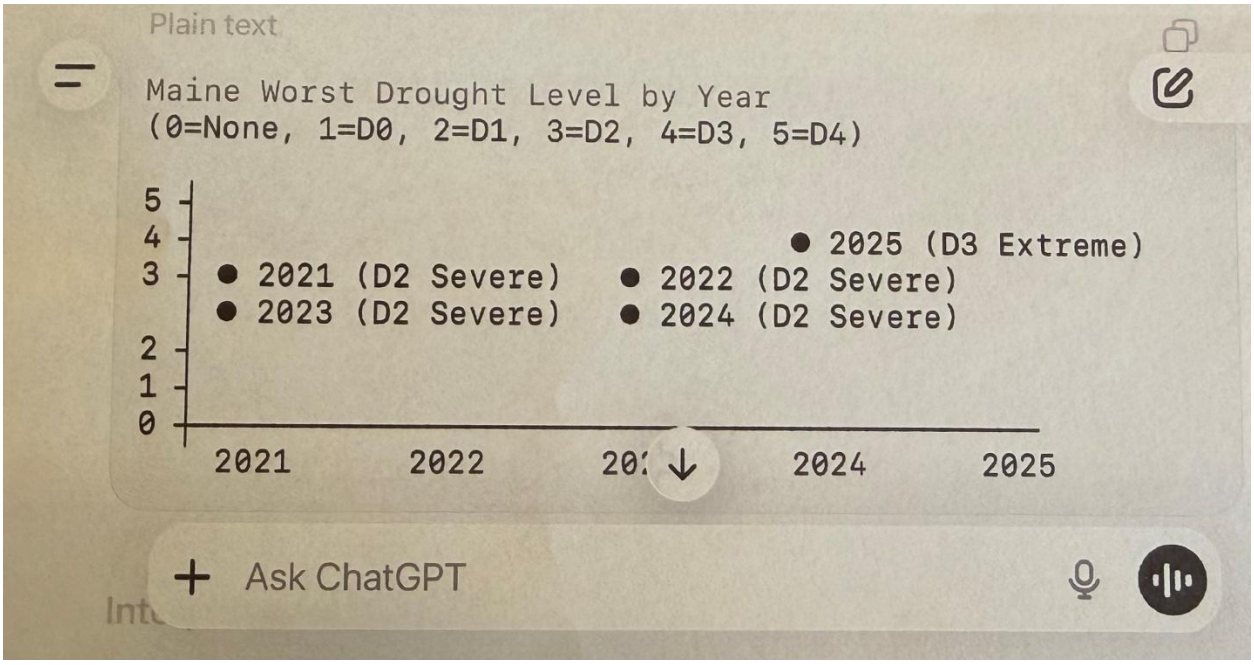


TABLE I

PFAS 6 AND PFOS TRENDS IN MAINE DRINKING WATER WELLS 2021-2025

	PFAS 6	PFAS 6 Wells > 1000 ppt	PFAS 6 Wells >10,000 ppt
# of Wells	99	35	18
# of Wells with Increasing Slope	59	19	7
% of Wells with Increasing Slope	60%	54%	39%
# of samples	1683	970	532
	PFOS	PFOS Wells > 1000 ppt	PF Wells >10,000 ppt
# of Wells	126	20	9
# of Wells with Increasing Slope	77	10	3
% of Wells with Increasing Slope	61%	50%	33%
# of samples	1933	608	287

CONCLUSIONS

For 99 drinking water wells in the State of Maine, from 2021 through 2025, with 1683 samples taken on those wells, 60% of the wells show a five-year increasing trend in PFAS 6 contamination.

For 126 drinking water wells in the State of Maine, from 2021 through 2025, with 1933 samples taken on those wells, 61% of the wells show a five-year increasing trend in PFOS contamination.

There is an awareness that "extreme drought" in Maine in 2025 may have universally reduced PFAS levels in drinking water wells in 2025. My own well, from January 2021 through June of 2025, has averaged 14,408 ppt PFAS 6. On October 13th, 2025, during a time of "extreme drought" in Maine, my well's PFAS 6 concentration measured 886 ppt, more than a magnitude lower than the five-year average for my well. I contacted the MEDEP to discuss what might have caused this low value. It was suggested by a State Geologist that the sample was taken during a time of extreme drought (corroborated by Maine weather statistics[5]) where less water came down in rain to dissolve the PFAS into the underground aquifer. To test this hypothesis, it was suggested that as the drought recovery occurred in the next month's wetter period, if the PFAS concentration increased in my well water, then this would support that the drought may have caused the lower PFAS concentration in my well. The next two PFAS 6 readings in my well were 6190 ppt on 12/11/2025, and 8780 ppt on 2/2/2026. This suggests strongly that the reduction in PFAS 6 and PFOS concentrations in drinking water wells observed in the year 2025 across the State, was likely caused by the "extreme drought" in the State of Maine. This is a sobering finding for residents affected by PFAS contamination, showing the currently active PFAS contamination of drinking water; the amount of rainfall is affecting the rate at which PFAS is entering the underground aquifer; the contamination of the underground aquifer is active and occurring every day, even 20 years after the land application of PFAS contaminated sludge stopped[2]. Considering that drought conditions caused unusually low PFAS concentrations in Maine drinking water wells in 2025, this gives even more support to the validity and credibility of the increasing trends in PFAS levels in 60% of PFAS contaminated wells identified in this report; without the lower PFAS concentrations measured in 2025 due to extreme drought, PFAS levels would have been higher in 2025, further increasing the magnitude of the increasing trends in PFAS concentration in drinking water wells.

It is acknowledged that five years of sample data is not enough data to make predictions on how long PFAS will remain elevated in drinking water wells in Maine. However, the data in this evaluation do show that approximately 60% of the PFAS contaminated wells have a trend of increasing PFAS contamination; 60% of the PFAS contaminated wells in Maine are not decreasing in PFAS contamination as we might hope for. Considering that the land spreading of PFAS contaminated sludge from the KSTD stopped in 2003, 23 years ago, finding that approximately 60% of PFAS contaminated drinking water wells have a trend of increasing concentration today suggests that PFAS contamination in hundreds of Maine drinking water wells will stay contaminated for many years, if not many decades, into the future. This reinforces that funding will be needed for many years to maintain PFAS removal treatment systems installed by the MEDEP over the last several years.

RECOMMENDATIONS

1. The results of this evaluation show that approximately 60% of the wells in Maine having sample data in each year, 2021 through 2025, show either no decrease or an increasing trend in PFAS concentration over those five years. Regarding how long ago the spread of wastewater treatment sludge from the Kennebec Sanitary Treatment District in Fairfield, Maine and 15 other central Maine communities stopped (Fairfield having the largest number of PFAS treatment removal systems installed by the MEDEP of any town in Maine), these trends are present twenty three years since the last land spreading of the KSTD sludge occurred in Fairfield in 2003.[2] The results of this evaluation suggest strongly that PFAS contaminated wells throughout Maine will remain contaminated for decades, some for many decades. Given that PFAS contamination of drinking water wells has occurred in many Maine communities, and the contamination was not caused by the homeowner, the State of Maine government should provide financial assistance to homeowners with PFAS contaminated wells in perpetuity, until the PFAS concentration in each contaminated drinking water well has reduced to below the Federal or State maximum contaminant level (MCL) for PFAS.

2. The MEDEP should continue this data evaluation and trend analysis annually for all drinking water wells that exceed the PFAS MCL, to record and study PFAS degradation in Maine's environment, long term.

REFERENCES

[1] Google

[2] Calculating the Amount of PFAS Currently on the Ground due to the Land-Spreading of PFAS Contaminated Waste Treatment Sludge in Fairfield, Maine; Saunders, Nathan; https://doi.org/10.31224/6397.

[3] MEDEP "Status of Maine's PFAS Soil and Groundwater Investigation at Sludge and Septage Land Application Sites, 5/15/2025", Maine.gov

[4] Email from the MEDEP, available upon request to the author.

[5] ChatGPT

[6] The author's working EXCEL file, available upon request to the author: "MEDEP All Through 2025 – PFAS6 and PFOS Working File.xlsx".

[7] Maine PFAS Map; Maine.gov

APPENDIX A

Calculation Summary

For PFAS6 calculations, I started with the EXCEL file provided by the ME DEP that included 220,000 sample results for all pretreatment PFAS samples taken by the ME DEP or their contractors, going back to 2017. I reduced this file to only SUM of PFAS6 sample results. I then identified only wells that had at least one sample in each year: 2021, 2022, 2023, 2024, 2025. This reduced the number of wells evaluated to 99 with a total of 1683 PFAS6 sample results. For each "Sample Point Number", which represented an individual drinking water well, I took the samples for that well and divided them into samples for each year: 2021, 2022, 2023, 2024, and 2025. I then averaged the samples in each year so that for every well I had one average sample result of PFAS6 for each year; five average sample results per well. After finding these average results for all 99 wells, I grouped all of the samples for each year: 99 sample results for 2021, 99 sample results for 2022, etc. I then averaged the 99 sample results for each year to obtain the five annual data points found in Graph I. For each well, I also took its five average sample results (one of each year) and plotted them on a graph in EXCEL. I added a trend line which gave me the equation and slope of the best fit line that came from those five points. Then for all 99 wells, I ordered the 99 slope values from highest to lowest to determine how many wells had best fit lines with a positive slope. A positive slope for a well suggests that the peak of contamination has not yet occurred. When this peak occurs, and what its magnitude will be is unknown. However, a positive slope at least indicates that the contamination in the well has not reduced, but has generally increased over that five-year period. I then reduced the wells to only those that had at least one sample greater than 1000 ppt, and repeated the above method to obtain Graph II and slope values for that set of wells. Finally, for PFAS6, I reduced the wells to only those that had at least one sample greater than 10,000 ppt, and repeated the above method to obtain Graph III and slope values for that set of wells. Similarly, I repeated the above calculations for only PFOS samples to get Graphs IV, V, and VI, along with slope values.

APPENDIX B

Legend and Description of Sheets in the EXCEL file "MEDEP All Through 2025 – PFAS6 and PFOS Working Field.xlsx" [6]

- **Read Me** – this information is boiler plate language provided by the Maine DEP

- **t_M_dec25_totl_request_lups** – this is the raw file from the Maine DEP that is not appended with November and December 2025 data, because this sheet includes all of the PFAS analytes, not just "SUM of PFAS6" and "PFOS" that I am interested in.

- **PFAS6 Only** – this sheet includes data for all of 2021-2025 and only data for SUM of PFAS 6 sample results. I used this spreadsheet to reduce the wells (by Sample Point Number) to only those that had at least one sample in each year of 2021, 2022, 2023, 2024, and 2025.

PFAS6 Only Avgs Yearly – An important decision was made here. At first, I planned to simply average all of the samples taken in each year of 2021-2025. However, each well did not have the same number of samples taken each year, and samples were not taken in the same months for each well. As a result, some wells had 20-30 samples per year, and others had one sample per year. When I first averaged all of the samples per year, I realized that some wells with many samples per year would weigh much more heavily in that year's average than others with fewer samples. As a result, I decided for each well, to average the sample results in each year, therefore resulting in one measurement per year for each well. The spreadsheets I have developed use the average of samples in each year, for each different well. With these average results per year, per well, I then found the overall average Sum of PFAS 6 level per year for all qualifying wells, 2021-2025. I did the same for PFOS. The graph is included on this sheet, far right.

- **PFAS6 Only Slope Per Well** – With each well having five sample results, one for each year 2021-2025, I created a line graph of these five data points, and using the EXCEL tool "Trend Line",

plotted that trend line for each well. I used the same graph over and over for each well, so I did not save a graph for each well, but I did record the slope of the graph for each well. I do not think it is reasonable, with only five data points per well, to make predictions of how long it will take for a well to reduce PFAS levels over time (there is a good argument that there is not enough data to make reliable predictions). However, there is value in determining and speaking to the slope of the trend line for the five data points for each well. The slope of the trend line, whether positive or negative, does suggest whether contamination rates are showing an increased trend over the last five years, or a decreasing trend. The important point is that the spreading of wastewater treatment sludge near the Howe Road in Fairfield, Maine was stopped in 1996, yet there are still some wells that are showing a trend of increasing PFAS 6 contamination over the last five years. If anything, this finding shows that PFAS levels in this area are not all decreasing as we would tend to think they would be. In these wells, contamination is trending to be worse over time. The list of "slopes" is to the far right of the sheet.

- **PFAS6 Only Old** – this sheet is of no value now, but I didn't want to delete it. This sheet includes averaging all of the data in each year, regardless of how many samples taken per well, taken in different months. The averages calculated in this sheet results in weighing some wells with many samples more heavily in the yearly average than wells with fewer samples. This plan was superseded by averaging samples for each year for each well (two sheets earlier).

- The next two sheets are the same analysis as above for SUM of PFAS 6, except these two sheets are only for wells that have at least one sample that is at or exceeds 1000 ppt SUM of PFAS 6 (any one sample > 1000 ppt… not an annual average > 1000 ppt).

  - **PFAS6 Only AVGs Yearly > 1000 ppt** (Graph to far right)
  - **PFAS 6 Only >1000 ppt Slope Per Well** (Slopes listed to far right)

- The next two sheets are the same analysis as above for SUM of PFAS 6, except these two sheets are only for wells that have at least one sample that is at or exceeds 10,000 ppt SUM of PFAS 6 (any one sample > 10,000 ppt… not an annual average > 10,000 ppt).

    - **PFAS6>10,000 ppt AVGs Yearly** (Graph to far right)
    - **PFAS6>10,000 ppt Slope Per Well** (Slopes listed to far right)

I did the same analyses again but for PFOS, or "PFOS_A" as it is listed in the spreadsheet, specifically PERFLUOROOCTANE SULFONIC ACID.

    - **PFOS Only**
    - **PFOS Only – AVGs Yearly** (Graph to far right)
    - **PFOS Only – Old**
    - **PFOS Only Slope Per Well** (Slopes listed to far right)

- The next four sheets are the same analysis as above for PFOS, except these four sheets are only for wells that have at least one sample that is at or exceeds 1000 ppt PFOS (any one sample > 1000 ppt… not an annual average > 1000 ppt).

    - **PFOS Only >1000 ppt**
    - **PFOS Only >1000 ppt AVG Yearly** (Graph to far right)
    - **PFOS Only >1000 Slope Per Well** (Slopes listed to far right)
    - **PFOS Only >1000 ppt Old**

- The next four sheets are the same analysis as above for PFOS, except these four sheets are only for wells that have at least one sample that is at or exceeds 10,000 ppt PFOS (any one sample > 10,000 ppt… not an annual average > 10,000 ppt).

    - **PFOS>10,000 ppt**
    - **PFOS>10,000 ppt Avgs Yearly** (Graph to far right)
    - **PFOS>10,000 Slope Per Well** (Slopes listed to far right)

- **PFOS Only >10,000 ppt OLD**

The following four sheets are specific to wells on the Howe Road in Fairfield, Maine. On the Howe Road in Fairfield, I identified twelve wells that had "SUM of PFAS6" and "PFOS" samples taken in each year, 2021-2025. The following four sheets are in the same form as previous sheets, and they specifically evaluate these twelve drinking water wells on the Howe Road in Fairfield, Maine.

- **Howe Rd PFAS6 AVGS Yearly** (Graph to far right)
- **Howe Rd PFAS6 Slope Per Well** (Slopes listed to far right) (Qty=3 or 25% with increasing **PFAS6** trend, 30 years after sludge spreading stopped in 1996)

- **Howe Rd PFOS AVGS Yearly** (Graph to far right)
- **Howe Rd PFOS Slope Per Well** (Slopes listed to far right) (Qty=5 or 42% with increasing **PFOS** trend, 30 years after sludge spreading stopped in 1996)