STATE OF NEW YORK
SUPREME COURT COUNTY OF RENSSELAER

JAY BURDICK, CONNIE PLOUFFE, EDWARD PLOUFFE, FRANK SEYMOUR, EMILY MARPE, as parent and natural guardian of E.B., an infant, and, G.Y., an infant, JACQUELINE MONETTE, WILLIAM SHARPE, EDWARD PERROTTI-SOUSIS, MARK DENUE and MEGAN DUNN, individually, and on behalf of all similarly situated,

Plaintiffs,

v.

TONOGA INC., (d/b/a TACONIC),

Defendant.

AFFIDAVIT IN OPPOSITION TO DEFENDANT'S MOTION TO EXCLUDE TESTIMONY OF EXPERTS

Index No.: 00253835

STATE OF RHODE ISLAND)

COUNTY OF PROVIDENCE) ss:

DAVID A. SAVITZ, Ph.D., being duly sworn, deposes and says:

1. I am Professor of Epidemiology at the School of Public Health and Professor of Obstetrics and Gynecology and Pediatrics at the Warren Alpert Medical School of Brown University in Providence, RI. A copy of my C.V. is attached as **Exhibit A**. I make this affidavit at the request of plaintiffs in this action and in opposition to Defendant's motion to exclude my testimony.

2. As will be explained below, I was one of three epidemiologists chosen to serve on the C8 Science Panel to evaluate the probable causal link between exposure to PFOA and the development of certain diseases. I have also published eleven scientific papers in the

peer-reviewed literature regarding PFOA health effects, most focused on health effects related to pregnancy and children, which are listed and highlighted in Exhibit A. I was also asked to serve as a Peer Reviewer of the June 2018 Draft Toxicological Profile for Perfluoroalkyls (a class of chemicals that includes PFOA) by the United States Department of Health and Human Services, Agency for Toxic Substances and Disease Registry.[1] I recently chaired a scientific panel to advise the State of Michigan Science Advisory Panel on addressing the health and environmental concerns related to perfluoroalkyl substances (PFAS) exposure and provided a report entitled "Scientific Evidence and Recommendations for Managing PFAS Contamination in Michigan [2]

EPIDEMIOLOGY GENERALLY

3. Epidemiology is the study of the patterns and determinants of disease in human populations, seeking an understanding of the causes of disease in order to determine needed actions to improve the health of the public.
4. As a trained epidemiologist, we conduct and review studies of populations first to determine whether there is evidence indicative of a statistical association between some potentially causative agent and a human illness or condition. This typically requires comparing the frequency of disease in a group that has relatively elevated exposure to the frequency of disease in a group that is unexposed or has a lower level of exposure.
5. When we determine that those who are exposed have an elevated risk of disease relative to those who are not, we conduct analyses needed to make an informed judgment regarding whether it is likely that the exposure has in fact caused an elevated risk of

[1] https://www.atsdr.cdc.gov/toxprofiles/tp200.pdf
[2] https://www.michigan.gov/documents/pfasresponse/Science_Advisory_Board_Report_641294_7.pdf.

disease. While this cannot be proven with 100% certainty, the field of epidemiology has developed clear principle and methodologic tools to make a reasoned, scientifically grounded judgment. By considering alternative explanations of the association, including biases and random error, and conducting analyses to address those alternative explanations, the case for a causal interpretation can be strengthened or weakened, depending on what is found. I have developed an entire book devoted to practical strategies for making such inferences in a methodical, transparent, informative manner (Savitz DA, Wellenius GA, Interpreting Epidemiologic Evidence: Connecting Research to Applications. New York: Oxford University Press, 2016.)

6. The question of causality is central to epidemiology since the study of statistical associations alone without evaluating the causal significance offers no guidance for methods of preventing disease to improve public health. There is a continuum of evidence that can support causal inferences, with the example of smoking and lung cancer being one for which the evidence of a causal effect is compelling yet for many years was challenged with the simplistic mantra "correlation is not causation." The judgment to be made is whether the evidence of an association is or is not likely to reflect a causal impact. While scientific certainty of causality is difficult to establish with any toxicants and may take decades of study to reach this level, epidemiologists are able to make informed use of available data to address questions of causality. By considering the body of scientific evidence and interpreting it with an appreciation of the underlying methodologic strengths and limitations, reliable judgments can be made, including when a causal link is more likely than notto be present.

7. An important point that needs to be emphasized is that in epidemiology, a negative study, e.g. a study that does not show a statistically significant association between an exposure and a specific illness, also needs to be scrutinized for its validity in suggesting there is no association. Just as for a positive indication of an association, studies that generate an absence of association are subject to biases and random error that can generate a false negative finding, i.e., failing to find an association even when a causal effect is truly present. There is no reason to automatically accept "lack of correlation" as a clear indicator of "no causal effect" any more than to accept "presence of correlation" as a clear indicator of "causal effect present." The interpretation of either result calls for a thorough assessment.
8. An overall assessment considers the full range of studies that provide pertinent information regardless of their results and integrates the full range of relevant studies. Negative studies may reflect insufficient statistical power to detect associations due to small populations or limited range of exposure, a particular challenge in studying rare diseases like cancer. Studies that do not measure exposure accurately are also more likely to fail to detect a true association that may be present, with the error in exposure estimation tending to shift measures of association towards the null value (showing little or no association).
9. Epidemiologists cannot ethically conduct experiments with controls where one group of people is intentionally exposed to a suspected toxic agent while a control group is not and then follow these groups to compare how many from each group develops a particular disease. Epidemiologists must instead study groups that have already been exposed to assess the incidence of disease in comparison to an unexposed population to determine

whether those who were more highly exposed to the toxic substance have a greater risk of disease than those not exposed. Epidemiologists may study occupational exposures, where people in a particular occupation are exposed through their work to a suspected toxicant, or community exposures, which are often more difficult to study because of the challenge in measuring exposure and possible confounders that may be associated with exposure. For this reason, the C8 Health Project was unique in that it enabled the study of nearly 70,000 people whose exposure was markedly elevated in some cases and could be reconstructed given the well-defined source of contamination. The extensive data collection on this large, highly exposed population substantially advanced our understanding of the potential human health effects of elevated exposure to PFOA.

EXPERIENCE STUDYING PFOA EXPOSURE IN HUMANS

10. C8 is a name given to perfluorooctanoic acid (PFOA), a man-made chemical used in manufacturing various consumer products including non-stick cookware, protective finishes on carpets and fabrics as well as water-resistant clothing. DuPont's West Virginia Washington Works Plant in southwest Parkersburg released PFOA into the air and Ohio River from the 1950s until the early 2000s. C8 reached drinking water supplies by entering the groundwater and was detected in six water districts near the DuPont plant in 2002. A class action lawsuit brought by the communities against DuPont resulted in a Settlement Agreement in the Wood County Circuit Court. As part of that settlement, Brookmar Inc., an independent company, was set up and conducted a yearlong survey (August 2005 - July 2006) called the C8 Health Project. The C8 Health Project gathered information through interviews and questionnaires and collected blood samples from about 69,000 people living near the Washington Works plant in West Virginia. The

settlement also established that a group of public health scientists would assess whether or not there is a probable link between PFOA exposure and disease in the community. The members of the Science Panel were jointly selected by the lawyers for the community and DuPont. The C8 Science Panel consisted of Dr. Tony Fletcher of the London School of Hygiene and Tropical Medicine, Dr. Kyle Steenland of Emory University in Atlanta and myself. We were chosen because of our long experience in designing and carrying out environmental health studies and the view of the parties in the settlement that we would be able to objectively generate and evaluate the evidence.

11. Drs. Fletcher, Steenland and I came to the C8 Science Panel as independent epidemiologists - scientists trained in gathering information to evaluate whether environmental factors may or may not be causing disease in groups of people; and remained independent and neutral throughout. The settlement paid for our work but the parties to that case did not direct what we did or how we did it. We had no belief ahead of time regarding whether or not C8 exposure affected human health.

12. The first stage in our work was to compile what was known from the research of others regarding health effects of PFOA and to design and implement the new research needed to make an informed assessment of possible health effects. These new studies on exposure to PFOA and health were conducted in the communities in the Mid-Ohio Valley.

13. As these studies were completed, we shared the results with the Court overseeing the settlement, the community of the Mid-Ohio Valley, and scientists. These results became available at different times, not all at once, and so were shared as they became available. The Panel emphasized that the results of these studies provided background and valuable

information for making an evaluation of whether there is or is not a probable link between PFOA exposure and any disease, but that evaluation was a separate phase of the Science Panel's work.

14. Following the research studies the next task for the C8 Science Panel was to make a judgment regarding the evidence of a causal link between PFOA and the risk of developing a disease. The Settlement Agreement between the plaintiffs and the defendant (DuPont) required that the Science Panel determine whether there is or is not a probable causal link between PFOA exposure and any disease. This determination was to be based on health research carried out by the Science Panel in the Mid-Ohio Valley population exposed to PFOA, as well as other published scientific research which could help in that assessment. Once all the studies concerned with a specific disease were completed, shared with the court, and made public, we combined those findings with those of studies done by others, including laboratory research, to make our assessment of whether or not there is a probable link between C8 exposure and that illness. The research results and the assessment of whether there is a probable causal link were completed at different times for different illnesses. For each health problem of concern, we first generated the research results, and then in a separate activity, evaluated all the evidence to make a judgment regarding whether or not there is a probable link between PFOA exposure and that illness. Our interpretation and judgment regarding the concept of "probable link" was based on the potential for a causal influence of PFOA, taking into account whether observed associations were more likely to be due to some bias or artifact versus due to a causal effect of PFOA. When we came to the conclusion that a causal effect was more

likely to be responsible, even if only slightly more likely, we determined that a probable link was present.

15. As a result of the above analyses, the C8 Science Panel came to the conclusion that there was a probable causal link between PFOA exposure and six human diseases and conditions: kidney cancer, testicular cancer, ulcerative colitis, thyroid disease, hypercholestolemia and pregnancy induced hypertension (preeclampsia). It is important to note that in performing our assigned task the C8 Science Panel was instructed to focus only on disease, not on changes in biomarkers that could potentially be used to predict future disease. As a result, we analyzed whether PFOA caused the recognized condition of "hypercholesterolemia" but not whether it generally resulted in elevation of cholesterol levels that did not yet rise to the level required to diagnose hypercholesterolemia. Similarly, the C8 Science Panel did not analyze whether elevated liver enzymes levels or uric acid levels were associated with PFOA exposure. However, many other researchers have addressed these associations as will be described in more detail below and have concluded that there is likely to be a causal link to these elevated biomarkers as well.

16. After the completion of my work on the C8 science panel, I was contacted by counsel for plaintiffs in this and another case involving PFOA drinking water contamination and asked if I would update the research done by the panel regarding probable causal links between PFOA exposure and human disease and provide my opinions on this topic. Based upon my work on the C8 Panel, my review of the scientific literature performed before, during and after the completion of that work[3], and my education, training and experience in the field of epidemiology, I have set forth below my opinions, expressed to

[3] A Bibliography of the published articles on this topic I reviewed is attached as Exhibit B.

a reasonable degree of scientific certainty, of the probable causal links between PFOA exposure and various human illnesses and conditions using similar criteria as were applied by the C8 Science Panel but including associations to biomarkers and utilizing the expanded research base that has accrued in the intervening period:

a. **Thyroid disease** – there is support in the scientific literature for a causal link between cumulative PFOA exposure and thyroid disease, specifically hyperthyroidism and hypothyroidism. Based upon my evaluation of this research, and the collective opinion of the C8 Science Panel, that it is probable exposure to PFOA is capable of causing thyroid disease in human. This causal relationship is supported by research done as part of the C8 Health Project (116)[4], with some support from the analysis of National Health and Nutrition Examination Survey (NHANES) data (74). In the analysis of the Ohio/West Virginia population, there was an association between historical PFOA exposure and increased risk of both hypothyroidism and hyperthyroidism in women but not men. However, the prospective study which began with enrollment in the C8 Health Project and identified new cases of thyroid disease going forward found a clear positive association of PFOA with hypothyroidism in men and a somewhat weaker association with hyperthyroidism in men. For hypothyroidism in women, there was a clear dose-response gradient, with the first indication of an increased risk in the third quintile of exposure which became larger in the higher exposure groups. For hyperthyroidism in woman, a dose-response relationship was found with an increase in incidence being found starting in the second quintile and continuing to

[4] Parenthetical numerical references are to articles in listed in Exhibit B.

rise with increasing exposure. For prospective cases (diagnosed after PFOA was measured), hypothyroidism among men increased starting in the third quintile and showed a consistently increasing risk with increasing exposure above that level, rising to a two-fold increased risk in the uppermost quintile.

b. **Ulcerative Colitis** - Increasing levels of PFOA are associated with increased risk of developing ulcerative colitis based on a series of studies conducted by the C8 Science Panel. Thus, it is my opinion, and the collective opinion of the C8 Science Panel, that it is probable exposure to PFOA is capable of causing ulcerative colitis. Epidemiologic studies from the C8 Science Panel, with results from the combined community and occupational cohort (99) and from the study of disease incidence in DuPont workers (100) clearly demonstrated this association. In the first study, there was a clear dose-response gradient of increasing risk with increasing cumulative exposure. Using a cumulative exposure measure of nanograms per milliliter (ng/mL), quartiles of the distribution were examined and each of the upper three quartiles was compared to the lowest. Exposures >158 ng/ml were associated with increasing risk and continued to rise with more elevated exposure. Other approaches to evaluating exposure were considered, with varying details, but all tending to show increased risk above the lowest quartile of exposure. The study of DuPont workers (100) had more limited numbers of cases (28 in total) but did find support for a positive association.

c. **Kidney Cancer** - There is consistent evidence of a strong association and dose-response relationship between PFOA exposure and kidney cancer and, it is my

opinion, and the collective opinion of the C8 Science Panel, that it is probable exposure to PFOA is capable of causing kidney cancer. This opinion is based on three different studies all conducted as part of the C8 Science Panel research in the Ohio/West Virginia area. The studies consist of a geographic study by Vieira et al. (112), an occupational study of mortality DuPont workers by Steenland and Woskie (98), and a cancer incidence study that combined occupational and community cohorts by Barry et al. (6). Although there is some overlap in the populations, the methods and coverage are different enough to consider these somewhat independent of one another. In the geographic study, kidney cancer was elevated only in the Little Hocking and Tuppers Plains, but not in the exposed water districts more generally compared to nearby counties. The association that was restricted to the most highly exposed water districts is a form of a dose-response gradient. Using estimated serum levels (assuming a 10-year residence in the current water district there is a clear gradient, with risk increasing above around 30 ug/l. Smoking information was not available in this study. In the occupational mortality study of DuPont workers (98), kidney cancer mortality was examined, with and without lags (in which the most recent exposure is ignored to focus on a time period in the past). Across the quartiles of exposure, each compared to a population consisting of Appalachian DuPont workers at other plants, the standardized mortality ratio (relative risk) generally increased with increasing exposure. Analyses assuming 10 and 20 year lags showed the same pattern – an increased risk of kidney cancer death in the highest exposure group, which was >2700 ppm-years for the unlagged exposure. Smoking data

was not available for adjustment in this study. Finally, the combined community and worker study of cancer incidence (6) integrated the strongest features of the previous studies, looking at incident cases rather than deaths, accounting for individual exposure histories, and adjusting for cigarette smoking unlike the other studies. Comparing the 2nd, 3rd, and 4th quartiles to the first quartile as the referent relative risk increased with increasing exposure. The increase in risk of kidney cancer incidence began around a cumulative exposure of 812 ng/ml-yr. Only one of the studies adjusted for smoking but there is little reason to suspect strong confounding given the source of the exposure.

d. **Testicular Cancer** – The epidemiological literature generated by the C8 Science Panel supports an association between PFOA exposure and an increased risk of developing testicular cancer. It is my opinion, and the collective opinion of the C8 Science Panel, that it is probable exposure to PFOA is capable of causing testicular cancer. There are two studies that address PFOA and testicular cancer, one a geographic study in Ohio and West Virginia (111) and the other the study of the combined community and occupational cohort by the C8 Science Panel (6). In the community study, the numbers of cases were limited, making the results imprecise. Only one of the districts, Little Hocking, showed an elevated risk. In the examination of estimated PFOA serum levels, the relative risks for low, medium, and high exposure groups were all below 1.0 and highly imprecise, with evidence of elevated risk in the very high group. While there was not a gradient of risk across the exposure range considered, the isolation of elevated risk in the highest exposure group is of note. The community and occupational cohort study

(6) included 32 reported incident cases of testicular cancer of which 19 were validated. Across the range of exposure, there was an increased risk of testicular cancer per log unit change in cumulative PFOA and across quartiles of exposure. Similar results were found with a 10-year lag. These two studies are both consistent with an elevated risk of testicular cancer associated with increased levels of PFOA exposure. Based on the Barry et al. (6) study, the elevated risk begins above 812 ng/ml-yr cumulative exposure but this estimate is imprecise because of the rarity of this form of cancer.

e. **Uric Acid Levels** - There is rather clear and convincing evidence that higher levels of PFOA are associated with higher levels of serum uric acid. Thus, it is my opinion that it is probable exposure to PFOA is capable of causing increased uric acid levels. This is seen in the analyses of the C8 Health Project participants (97), with notable increases in average serum uric acid levels and the risk of being above the cut point defining hyperuricemia (significantly elevated serum uric acid) across the spectrum of PFOA exposure. The increase in risk was especially strong in the lower range and reflects somewhat of a ceiling effect with less of an increase across the highest levels. An elevation in risk was clear in going from the first to the second quintile of exposure, above 11.4 ng/ml of PFOA and increasing modestly with higher exposures. Evidence of this association was corroborated in studies in children (38; 84) and adults (13; 42) in other populations.

f. **Hyperlipidemia (high cholesterol)** – A significant number of studies have found clear associations between PFOA exposure and both total and LDL cholesterol. It

is my opinion based on these studies that it is probable that exposure to PFOA causes an increase in both total and LDL cholesterol. A preponderance of studies shows a positive association between PFOA and elevated levels of total cholesterol and LDL cholesterol, but this is not universal across studies, some of which show no association with either total or LDL cholesterol or both. Again, generalizing across a large body of studies, the most consistent and compelling association would be with total cholesterol in part because more studies have addressed this measure. This association is found in adults, children and adolescents, and pregnant women with some consistency. While an increase in average lipid levels with increasing PFOA means it is likely that hypercholesterolemia, generally defined as a total cholesterol >240 mg/dL or LDL cholesterol >110 mg/DL, will also be increased, there are fewer studies of hypercholesterolemia because much larger study populations are required. Using cross-sectional data from the C8 Health Project, Steenland et al. (95) found clear evidence that higher levels of PFOA are associated with greater risk of hypercholesterolemia, with odds ratios across exposure quartiles and with a similar pattern for LDL cholesterol. In an analysis of the community and worker cohort developed by the C8 Science Panel, Winquist and Steenland (115) again found increased risk of hypercholesterolemia when compared to the lowest quintile. An association with hypercholesterolemia was also found in National Health and Nutrition Examination Survey (NHNES) data (38) where an increased risk of elevated levels of LDL cholesterol was also found. There is a strong empirical basis for concluding that higher levels of PFOA are associated with

higher levels of total and LDL cholesterol, and that PFOA is associated with increased risk of hypercholesterolemia. An important point to note, which may explain some of the inconsistency in the findings across studies, is that the dose-response gradient shows a rapid increase in total cholesterol in the lower range of PFOA exposure but appears to plateau, with little increased risk as exposure rises further. This was true in the cross-sectional study (96) and even clearer in the cohort study in which risk increased from the first to second quintiles of PFOA exposure but did not increase further across the highest four quintiles (115). Highly exposed populations such as occupational cohorts do not consistently report associations of PFOA with cholesterol, possibly because all those studied are in the relatively high exposure range, whereas community studies of background exposure ranges more consistently identify an association. Focusing specifically on HDL cholesterol, which is inversely related to cardiovascular disease risk (higher HDL cholesterol predicts a lower risk of cardiovascular disease), fewer studies have examined the association with PFOA. The expected effect of PFOA would be to reduce HDL cholesterol levels and this has been found in some studies. In the occupational health literature, a negative association between PFOA and HDL cholesterol was found by Olsen and Zobel (67) and Wang et al. (112), but not in a number of comparable studies (e.g., 81; 86; 13). The community studies are likewise mixed in regard to an association with HDL, with the cross-sectional study of C8 Health Project participants not showing an association between PFOA and HDL cholesterol in adults (96) or children (34). An absence of association was reported for studies in community populations

with background exposure (77; 31; 30; 39). One study of children did find a reduction in HDL cholesterol with higher PFOA levels (118), and another study found higher HDL cholesterol levels with increasing exposure to PFOA during pregnancy (95). Thus, the association between PFOA exposure and lowered HDL cholesterol is less clear than that for total cholesterol or LDL cholesterol.

g. **Elevated Liver Enzymes** – There is support in the scientific literature for an association between PFOA exposure and elevation of at least some liver enzymes in the blood serum. It is my opinion that it is probable that exposure to PFOA is capable of causing an increase in liver enzyme levels in the blood. A substantial number of studies have examined the correlation between serum levels of PFOA and an array of liver enzymes. Those that are most frequently studied include ALT (alanine transferase), ALP (alkaline phosphatase), AST (aspartate aminotransferase), GGT (gamma gluatmyl transferase), bilirubin (total and direct), and CCK (cholecystokinin). Many of the studies examine the entire panel of routinely assayed liver enzymes and others do so selectively. Given the large number of enzymes and large number of studies, there are an array of results which are not entirely consistent but with some patterns present. Elevated liver enzymes usually do not indicate the presence of chronic liver disease but more often some reversible cause such as inflammation or injury to the liver that has caused leakage of liver enzymes into the bloodstream. Often elevation in liver enzymes is caused by medications (over the counter or prescription), drinking alcohol, or underlying disease such as hepatitis or heart failure. The most consistent finding is an association of PFOA with increased levels of ALT,

observed in the C8 Science Panel research (36; 17) in the National Health and Nutrition Examination Survey (68; 42), and in some of the occupational studies (82; 86; 13). While some other studies found no association, there is a clear weight of evidence in support of a positive association of PFOA with elevated ALT. Perhaps the next most commonly observed association is with PFOA and elevated GGT, found in some occupational studies (82; 86) and in the National Health and Nutrition Examination Survey (68; 42) but not in the C8 Science Panel research. Beyond that, the findings for all the other enzymes, including AST and bilirubin as the most frequently studied, are not supportive of an association with PFOA.

h. **Immune System Effects** - Several studies support an association between PFOA exposure and immune response. Based upon these studies, it is my opinion that it is probable that exposure to PFOA can affect the immune response to pathogens. While there are a number of studies of indicators of PFOA and immune function, fewer studies considered PFOA exposure and actual infectious disease. In a study of prenatal exposure and early childhood illness in Denmark (29), no association was observed overall or for boys alone, but for girls, there was a gradient of increasing risk of infectious disease with a clear dose-response gradient across quartiles of PFOA. Another Danish study (14) evaluated prenatal PFOA levels in relation to infectious diseases among children ages 1-4. Across three levels of PFOA exposure, there was a gradient of increasing risk for fever, but not for cough, nasal discharge, diarrhea, or vomiting. A study from Japan (80) had small numbers that limited ability to examine the one infectious disease considered,

otitis media (ear infection) for which they found an adjusted odds ratio showing increased incidence. Self-reported influenza infections and colds among participants in the C8 Health Project did not indicate an association between PFOA level and risk of these diseases (71). In the National Health and Nutrition Examination Survey data, a positive association was found for PFOA and risk of rhinitis but a negative association for the risk of mumps and rubella (105). Although the numbers of cases were small, a Norwegian study reported a modest association between PFOA and episodes of colds and gastroenteritis and a negative association with rubella antibodies (36). The possibility of PFOA being associated with increased risk of infection is supported indirectly by some research suggesting elevated levels of PFOA are associated with a weaker response to influenza vaccination (57), though another study noted a more favorable response to influenza vaccination with higher PFOA levels (106). Several studies have reported a decreased response to vaccine to prevent diphtheria (a bacterial respiratory disease) associated with higher PFOA levels (43; 61; 45). It is difficult to draw any firm conclusions given the diversity of conditions examined and inconsistent results. It seems plausible that there is some increase in infections in relation to PFOA serum levels, but the research does not allow pinpointing of one type or another due to the varying results across studies. It is not even clear at this point whether viral or bacterial infections would be most likely to be affected if there is an effect.

i. **Preeclampsia, Pregnancy Induced Hypertension** – There is some evidence in the published literature for an association between PFOA exposure and the

incidence of preeclampsia or pregnancy induced hypertension. Our study of the C8 community showed an increased risk for preeclampsia. (89). Another study of this population showed a weak association between PFOA exposure and pregnancy induced hypertension. (16). Based upon these studies, it is my opinion and the collective opinion of the C8 Health Panel that exposure to PFOA is capable of causing preeclampsia and pregnancy induced hypertension.

17. In addition to the above adverse health effects that I believe more probably than not are related to PFOA exposure, there are a number of other health conditions that are under study and may reach this threshold in the future. These include the following:

    a. **Prostate Cancer** – There is limited evidence supporting an association between PFOA exposure and risk of prostate and ovarian cancers. In the study by Hardell et al. (51), the association between PFOA and prostate cancer was divided by family history. Since family history predisposes to prostate cancer at a younger age, this has indirect relevance to an age-specific effect. They did find that PFOA above the median was associated with increased risk of prostate cancer in the subgroup with a family history of prostate cancer. Overall, there is little information to assess whether or not the association between PFOA and prostate cancer differs by age. The relationship of PFOA to prostate specific antigen (PSA) was examined by Ducatman et al. (22) and stratified by age, with weak evidence that there was a positive association among younger men (20-49). PSA level is considered a marker for the development of prostate cancer, although the accuracy of this marker has been questioned in recent years.

b. **Ovarian Cancer** – There is limited evidence supporting an association between PFOA exposure and ovarian cancer. The only evidence addressing PFOA and ovarian cancer comes from the geographic study by Vieira et al. (111) and the analysis of combined community and occupational cohort by Barry et al. (6). Vieira et al. (111) identified 48 cases of ovarian cancer and found elevated risks in the Little Hocking and Belpre water districts. Examining estimated serum levels of PFOA, and dividing the population into quartiles, there was evidence of an association In contrast, the cohort study (6) which included 43 confirmed cases found no association with a continuous measure of PFOA exposure.

18. It is important to note that as more research is conducted on PFOA exposed populations, more evidence has accumulated suggesting associations between PFOA and human illness. Because drinking water has only recently become a focus of attention for PFOA contamination and because a testing of both public and private drinking water sources had detected significant levels of PFOA in many locations across the United States, it is highly likely that more research will be done that may add to support for an association between PFOA and adverse human health effects in the future.

19. Based upon my research, specifically including my work on the C8 Science Panel, my review of the medical, scientific and epidemiological literature, as well as my education, training and experience as an epidemiologist, it is my opinion to a reasonable degree of scientific certainty that elevated PFOA exposure increases the risk of the development of certain diseases and conditions referenced above. The question of a lower limit for this effect is not resolved at present but there is evidence that even in the exposure ranges near the background levels, elevated risks may be present, particularly for developmental

immune disorders but possibly for other conditions[5] Even at current US "background" levels, studies have repeatedly suggested biological effects on the immune system with negative effects being seen with increasing PFOA blood levels. Studies of Norwegian children (46) , a study from the Danish National birth Cohort (29) and a study of children in the Faroe Islands (43) have all shown negative immune response with increasing PFOA blood levels at or near U.S. background levels. Because PFOA demonstrates adverse biological effects even near "background" levels, evidence does not exist for establishing a level of PFOA exposure below which no negative effects can be assured. While it is true that evidence of increased incidence of disease for some conditions listed above were only seen in the highest exposed groups, for other outcomes such as elevated cholesterol and ulcerative colitis, increased risks were present in the near-background exposure range. It is unclear whether exposures at or below background are associated with all of the diseases causally linked to PFOA exposure, but since a dose- response relationship has emerged for a number of the associated illnesses, what is clear is that as exposure increases above background so does risk of harm.

20. Of note about the exposures involved in the Ohio River Valley studied in the C8 Health Project is that they varied by community to a significant extent. Little Hocking, OH had very high levels of PFOA in its municipal water supply and the population there had correspondingly higher PFOA levels in their blood. The other communities studied, Lubeck, WV, Tupper Plains, OH and Mason County, WV had variably elevated levels,

[5] In the Michigan report "Scientific Evidence and Recommendations for managing PFAS Contamination in Michigan" we concluded that the current EPA health advisory limit of 70 ppt for drinking water might not be sufficiently protective because increases in ulcerative colitis, some cancers and other health effects have been reported for exposures predicted in people consuming water containing this level of PFOA. https://www.michigan.gov/documents/pfasresponse/Science_Advisory_Board_Report_641294_7.pdf, at p. 11.

much lower but still substantially elevated above background levels of PFOA in their municipal water supplies and again residents of those communities had levels of PFOA in their blood that corresponded to the levels in their drinking water source when tested (Shin et al., 2011). Accordingly, the almost 70,000 people who participated in the C8 project had a wide range of exposures to PFOA and a wide range of PFOA blood levels.

21. [redacted][6]

22. I have been informed that the defense attorneys in their legal memorandum reference the Cancer Incidence Investigation 1995-2014 conducted by the NYS Department of Health

[6] Participation in the C8 Health Project required that minimum 12 month exposure to drinking water of 500 ppt or greater. NYSDOH had no such requirement and people in Petersburgh who did not drink from a contaminated well were likely included in those tested. The class definition in this case requires that the person with PFOA in their blood above 1.86 ug/L also consumed contaminated drinking water from a private well or the Petersburgh municipal water system. Therefore, comparison of the mean blood levels in the C8 Health Project communities to the subset of people in Petersburgh who meet the class definition is more appropriate than comparing the mean of all people tested to the C8 Health Project community levels. Moreover, because we do not know at this point how many of the people above 1.86 ug/L in the NYSDOH testing would not meet the class definition, the mean of 41.98 ug/L likely understates the true class mean once the class is identified.

for the Village of Hoosick Falls in May of 2017 in support of the position that there is insufficient evidence that PFOA exposure is harmful.[7] This report provides data on cancer incidence in the Hoosick Falls community. Such information is routinely collected by the state cancer registry and can be used for general surveillance purposes. It is not designed to be nor is it useful for etiologic studies of the potential effect of an environmental toxicant on diseases in the population. There are several reasons that it is not suitable for such purposes: 1) There is no exposure information other than the person resided in a community with elevated levels of PFOA in the water at the time of diagnosis with no information on how long they resided in that community, and no direct information on the levels of PFOA in the water over the period that the person lived there or even a basis for estimating cumulative PFOA exposure. For example, if someone were exposed to the elevated levels of PFOA in the water and moved prior to diagnosis, such cases would not be included in the tabulation; 2) There is no information on other potential causes of these cancers that may need to be taken into account to isolate any effect of PFOA, which might mask true associations or generate spurious associations; 3) The numbers of events for the cancers of particular interest are simply too small to be informative. As a scientific contribution to the previously conducted studies examining potential health effects of PFOA exposure, there is no added value to this analysis. It is entirely reasonable to tabulate and share the data as a general description of the community's health experience but it simply is not suitable for inferring cause and effect relationships in this population or more generally.

[7] It is noteworthy, that Ms. Dell, defendant's epidemiology expert, does not argue that the Hoosick Falls Cancer Incidence Investigation has any scientific relevance or even mention it at all in her affidavit.

23. With regard to the motion to exclude my testimony, my understanding is that the only affidavit submitted by an expert in support of that motion is the affidavit by Ms. Linda Dell. Ms. Dell's affidavit does not state that my conclusions and the conclusions of the C8 Science Panel with regard to probable causal relationship between exposure to PFOA and the diseases and biomarkers I have discussed above are not generally accepted in the field of epidemiology or that my methodology in analyzing the various studies was novel or different from the approach epidemiologists are trained to follow in reaching such conclusions. Rather, Ms. Dell states that she disagrees with my conclusions (and the conclusions of the other epidemiologists on the C8 Science Panel) about the causal association between PFOA exposure and these diseases and biomarkers. (Dell Affidavit, ¶4). Paragraphs 5-9 of her affidavit espouse general concepts of epidemiology with which I generally agree, but she does not provide any specific application of these concepts in reaching her contrary conclusions regarding PFOA general causation or assert that my opinions are in any way inconsistent with these general concepts. In fact, she fails to mention PFOA or any of the hundreds of published studies on PFOA exposure and human disease in any of these paragraphs. In the remaining paragraphs of her affidavit (10-12), she accurately recites the findings of the C8 Science panel that kidney cancer, testicular cancer, ulcerative colitis, thyroid disease, hypercholesterolemia and pregnancy induced hypertension (preeclampsia) were found to have a probable causal link to PFOA exposure. She does not take issue with these findings but affirmatively states that over 30 papers have been published using the C8 data showing these causal links.

24. Although Ms. Dell does not challenge either my opinions or my methodology as novel or not generally accepted in the field of epidemiology, I will nonetheless state unequivocally that my approach with the C8 Panel and in coming to the opinions stated herein was based upon generally accepted principles practiced in this field and that my opinions regarding the causal link between PFOA exposure and human health effects is also not novel or unique but is within the mainstream of opinions in my field. My opinions and conclusions are also supported by the June 2018 Draft Toxicological Profile for Perfluoroalkyls which states: "The available epidemiology studies suggest links between perfluoroalkly exposure and several health outcomes.." listing hepatic effects, cardiovascular effects, endocrine effects, immune effects, reproductive effects and developmental effects linking PFOA exposure in each of these adverse health outcomes.[8] The 2018 report by the Health Effects Subcommittee of the New Jersey Water Quality Institute supporting the lowering of the maximum amount of PFOA that should be permitted in drinking water to 14 ppt. also succinctly states what I believe be the consensus view of epidemiologists and public health experts about PFOA:

> In summary, associations of PFOA with numerous health endpoints have been found in human populations with evidence supporting criteria for causality for some endpoints. These health endpoints include both non-carcinogenic effects in the general population and both non-carcinogenic effects and cancer in communities with drinking water exposure. The epidemiologic data for PFOA are notable because of the consistency between results among human epidemiologic studies in different populations, the concordance with toxicological findings from experimental animals, the use of serum concentrations as a measure of internal exposure, the potential clinical importance of endpoints for which associations are observed, and the

[8] https://www.atsdr.cdc.gov/toxprofiles/tp200.pdf, at p. 25.

observation of associations within the exposure range of the general population.[9]

DAVID A. SAVITZ, Ph.D.

Sworn to this 9

day of April, 2019

Notary Public

THEODORE HOWARD
Notary Public, State of Rhode Island
My Commission Expires
November 15, 2021

[9] https://www.state.nj.us/dep/watersupply/pdf/pfoa-appendixa.pdf, Executive Summary, pp. 8-9; See also, https://www.michigan.gov/documents/pfasresponse/Science_Advisory_Board_Report_641294_7.pdf.