

Multigenerational Pine River Superfund Voluntary Health Map Report

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This survey was not designed to be or considered as conclusive of high disease incidence or showing a cause-and-effect relationship with the various toxic chemicals in the environment around Saint Louis, Michigan. It is, however, suggestive of certain diseases occurring with unusual frequency in this population and points out the need for definitive studies.

INTRODUCTION:

More than 43 years ago, the Velsicol Chemical Company ended its 42-year history (1936-1978) of operation in St. Louis, Michigan. The plant was situated on approximately 52 acres west of the city's heart and flanked on three sides by the Pine River, which flows to Lake Huron to the East. A product handling mix-up at the site in the early 1970s led to the largest food contamination accident in history. Instead of sending a feed supplement called NutriMaster, a fire retardant chemical produced at the plant, FireMaster Polybrominated biphenyl (PBB) was accidentally sent to a livestock feed production plant where it was mixed into the livestock feed for beef, chicken, pork, and dairy animals and distributed to farms across the state. When the animals went to market, an estimated nine million Michigan residents consumed contaminated meat and dairy products. It took a year to track the incident. Finally, private citizens were the ones who found the cause in their self-funded investigations (Gleason, 2010) (Halbert, 1978). The PBB disaster was not the only incidence of contamination in St. Louis, Michigan. Over the years, the people who lived there had witnessed chemical dust clouds in the air for decades, smelly froth lapping at the banks and dead fish in the waters of the Pine River, dead and dying birds in their yards, peeling paint on their homes and cars, and metal window screens eaten through by the chemicals in the air. Even today, in 2022, a state fish advisory warns people not to consume fish caught from the Pine River in Gratiot County and farther downstream in Midland County (Michigan.gov, 2018). These observations led townspeople to conclude that the plant was contaminating their town, the environment, and themselves.

Many abandoned former chemical plant-owned properties and sites are scattered around town. The main facility was buried on-site without the town's consent in a deal struck with the

EPA and the State of Michigan. Decades after the plant closure testing was performed. These sites and the Pine River were found to contain large quantities of toxic chemicals. Subsequent testing found that the contamination had migrated in the river's flow and in groundwater from under the plant site. Over 200 chemicals have been documented, including DDT, TRIS, polybrominated biphenyls (PBB), and dozens of other but lessor publicized toxic chemicals on a scale far exceeding Love Canal (Bradshaw, 2018). Love Canal was only one chemical contaminant (Ellison, 2019) ("Department of Health," 1981). The site in St. Louis became one of the first Superfund sites in the nation and underwent an EPA-led remediation in the 1980s. In the early 2000s, it was found that the containment system around the site had failed. A second remediation began and is underway today. Although much contamination remains, through environmental testing and evaluation, significant progress has been made on the cleanup of these sites to protect the environment. Our community wants to know when the residents will be extended the same testing and protection, because we have experienced many health issues, including rare cancers and other diseases.

In the decades of chemical production and also in the decades since the plant has been shut down, our town has experienced the following: rising levels of DDT in fish, birds and other wildlife in the Pine River downstream; 46,000 parts per million (ppm) DDT being found in river sediment whereas less than 300 ppm is required to excavate sediments (this was in 1997)(Keon, 2015); three sites within our area to be classified as Superfund sites due to toxic chemicals; a radioactive site; multiple incomplete cleanups and containment attempts; constant seepage of abandoned hazardous toxins; inception of new toxins as a spontaneous result of abandoned toxins commingled within the various failed containments; paint being eaten off of our cars and homes due to plant activity and subsequent abandonment; children's athletic fields contaminated

with DDT; birds dropping dead in our yard found to have some of the highest levels of DDT ever recorded in wild birds (Bienkowski, 2014); toxic chemical contamination in our drinking water; areas of our front yards being fenced off due to layers of DDT and PBB filled sediments; the death of a traveling circus elephant after swimming in the river. However, no health study has been conducted on this population.

In addition, many of the pollutants are known or suspected carcinogens, mutagens, teratogens, embryo toxins, fetotoxins, and endocrine disruptors (Breysse, 2004) (Corbett et al., 1975). The residents of St. Louis have long complained about various health problems, including several types of cancers, neurological disorders, and congenital disabilities. They have also experienced the long-term toxic effects of chemical exposures on fertility and spontaneous abortions. They believe these rates to be abnormally high and that the chemical contamination in their town is the source.

In recent years, investigators have conducted cohort studies on the endocrine-disrupting effects of these chemicals (Curtis, et al., 2018).

The chemicals have not stayed contained within the now fenced and capped Superfund Sites littering the town. Since the plant has closed over 43 years ago, subsequently designated as a Superfund Site, the residents of St. Louis, Michigan, have witnessed this firsthand as their tips have led to the discovery of more contaminated abandoned properties designated as Superfund Sites (Lorenz, 2012). Additionally, from the decades while the chemical plant was in business, there were incidents of chemical and hazardous product mishandling at the facilities on-site and at the other properties that the company owned within the community. The only way to know if these chemicals have migrated over the decades is to test further the ground, air, water, wildlife, and properties nearby.

Finally, tests on the residents themselves are needed to conclude if they have these chemicals in their bodies. These observations did not only span current residents' lives at the time of exposure decades ago but also in their second and third-generation offspring whose only connection to St. Louis is through genetics. A recent study conducted jointly by Emory University and the University of Georgia has provided evidence that exposure to PBB can alter the genetic code in sperm and leads to health defects in children of exposed parents (Greenson, et al., 2020). Over the decades, many people in the community have requested health studies and investigations into these claims. Unfortunately, these requests have failed to gain studies or health monitoring for this population.

The toxic pollution is creating a legacy of destructive environmental impact and, more importantly, a legacy of illness to human health of current and future generations.

The development of this survey started in 2015. The survey was performed in an attempt to identify clusters of diseases in St. Louis and around the chemical plant itself. Identification of clusters of disease should help to delineate the overall scope of the problem, raise awareness and hopefully encourage private companies, academic institutions, and state or federal agencies of the need to either conduct or fund well-controlled, well-designed epidemiological studies of this population group and to establish health surveillance programs for this high-risk group.

To provide positive progress as a vehicle to connect our past, present, and future health histories and that of our ancestry and posterity, we have begun to collect our health data. For example, we believe 40 plus years of toxic exposures to the chemical plant in St. Louis, Michigan, have led to dire health consequences. Therefore, we deserve to have this data evaluated either solely upon its own or as part of a comprehensive health survey and screening, including monitoring with subsequent reports and findings communicated to us.

METHODS:

An 11-question survey was composed to compile pieces of information about illness rates of past and present residents in St. Louis, Michigan, as well as persons who worked at the chemical plant. Pooling this data was an attempt to quantify the occurrence of the carcinogenic, teratogenic, and mutagenic effects of persons living in Saint Louis for an extended period, including those carried into second and third-generation offspring. Establishing the place of residence within the town or if they reported as a chemical plant worker for each participant in the study was necessary. The primary inquiries were: "Do you have, or have you ever had, any of the following types of cancer? (Bone, Breast, Esophageal, Kidney, Liver, Lung, non-Hodgkin's, Lymphoma, Pancreatic, Stomach, Thyroid, Uterine, Other, None)," "Have you had, or do you have any other following diseases? (Bone, Breast, Kidney, Liver, Lung, Stomach, Thyroid, Uterine, Lupus, Type 1 diabetes, Amyotrophic Lateral Sclerosis (ALS), Multiple Sclerosis (MS), Parkinson's, Seizures, Migraine headaches, Other, None)," "Were you born with any of the following birth defects or conditions? (Premature birth, Cervical ribs, Cleft palate, Genital Anomalies, Hypospadias, Urinary tracts Anomalies, other, none)".

The survey was distributed to Saint Louis, Michigan, residents, and persons who have worked at the chemical plant through various channels. The questionnaire was available to participants in both hardcopy and online format. Creating an online support group was vital to gathering participants to join the survey. The Pine River Superfund Citizen Task Force was also instrumental in helping distribute surveys. Students, volunteers, the author, and the Cutler Memorial Library collected the surveys. In addition, local news articles covered the developments of the survey and gave information as to how to participate.

Five hundred and twenty current or previous residents of Saint Louis responded to the questionnaire. Residential data for each respondent was compiled. The data was plotted on two Geographic Information System Maps (GIS), tabulating the first, second, and third generation of health information reported for each address creating a health plume map showing the disease reports for first, second and third-generation occurrence and the Saint Louis address of the resident during the time of exposure.

Problems interpreting data included individuals reporting diseases without proof of diagnosis, such as pathology reports, health records, or death certificates as confirmatory evidence. Respondent bias may also contribute to errors in reporting. The author is a fifth-generation St. Louis resident; due to this, familial or acquaintance bias may exist. Every attempt was made to identify duplications in reporting. Known duplicates were removed. An entry was removed if a participant's response did not include complete information linked to an address in St. Louis. However, this study was designed as a preliminary attempt to identify disease clusters and should be interpreted with these limitations.

The calculations use a population of 3,513 living in 1475 households in St. Louis, Michigan, as of 2014 (US Census, 2014) ("St. Louis, Michigan Population 2021", 2021). These households have existed since the decades that the chemical plant was operational and represent individuals that would have been exposed to the contaminations during the time of operations as well as since the contaminations have spread to their homes near the plant site. The last major subdivision to be built in St. Louis was Westgate. Sigourney Construction began building homes after the Clay Products Company (also owned by Fred Sigourney), which produced drain tile burnt down overnight in 1957. The calculations do not include 3,736 inmates housed in two correctional facilities built after 1998, located 1.5 miles east of town.

FINDINGS:

Respondents reported 520 residents with a total of 262 malignancies. Although the year of diagnosis was not established in all respondents and incident rates could not be calculated, several types of relatively unusual cancers were reported in surprising numbers for a town of the size of Saint Louis.

Gastrointestinal cancers were prominent (esophagus = 4, stomach = 8, liver = 6 and pancreas = 14). Also of note were breast cancers (52 cases), thyroid cancers (17 cases), kidney cancers (7 cases), lymphoma (15 cases), non-Hodgkin's lymphoma (14 cases), and bone cancers (11 cases). Respondents also shared the following types of cancers: Acute Myeloid Leukemia (AML) (4), bladder (8), brain (13), Burkitt's lymphoma (1), cervical cancer (2), Chondrosarcoma (1), Chronic Lymphatic Leukemia (CLL) (1), colon (16), endometrial (3), laryngeal (2), Leiomyosarcoma (LMS) (1), Leukemia (4), Lung (27), oral (1), Polycythemia (1), prostate (7), testicular (1), throat (1), tongue (1), Uterine (7), small cell carcinoma (1), and skin cancers (11) cases were cited.

Certain neurological diseases, as follow, appeared with some frequency and deserved further investigation: Multiple Sclerosis (MS) (19 cases), Parkinson's disease (7 cases), Amyotrophic Lateral Sclerosis (ALS) (1), and the onset of seizures with no further diagnosis (4 cases). In addition, there were 17 cases of children born with learning disabilities reported. Respondents also shared the following diseases: autoimmune hepatitis (1), brain tumors not specified (6), specified brain tumors as follows; acoustic neuromas (2), pituitary (3). Additionally reported cases of; Infertility (12), Lupus (21), Primary Biliary Cirrhosis (1), Reiters

Syndrome (1), Scleroderma (3), Type 1 Diabetes (42), Type 2 Diabetes (47), Vestibular Schwannoma (1), Wegeners Granulatisis and polyangiitis (2), cerebral palsy (1).

The response to questions regarding congenital disabilities revealed 15 congenital heart defects, 10 genital abnormalities, 5 urinary tract defects, and 25 defects categorized as "other" there were 14 premature births and four stillborn births reported as well as, Lipoma (1), Ehler Danlos (1), Anophthalmia (1), bowel malformations (1), Chiari malformations (1), clubfeet (3 cases), congenital hypothyroidism (1), Epstein's Anomaly (1), esophageal atresia (1), Hemophilia FVIII (proven non-genetic) (2), Hypoplastic Left Heart Syndrome (HPLH) (1), kidney tumors (1), Klinefelter Syndrome (1), left ventricle non-compaction (1), missing eustachian tube (1), missing duct from the kidney to bladder (1), mitral valve prolapse (2) Natal teeth (full set) (2), polydactyly (1), scoliosis (2), strabismus (3), strangulated hernia (1), spina-bifida (1), vascular ring (1), VATER (1).

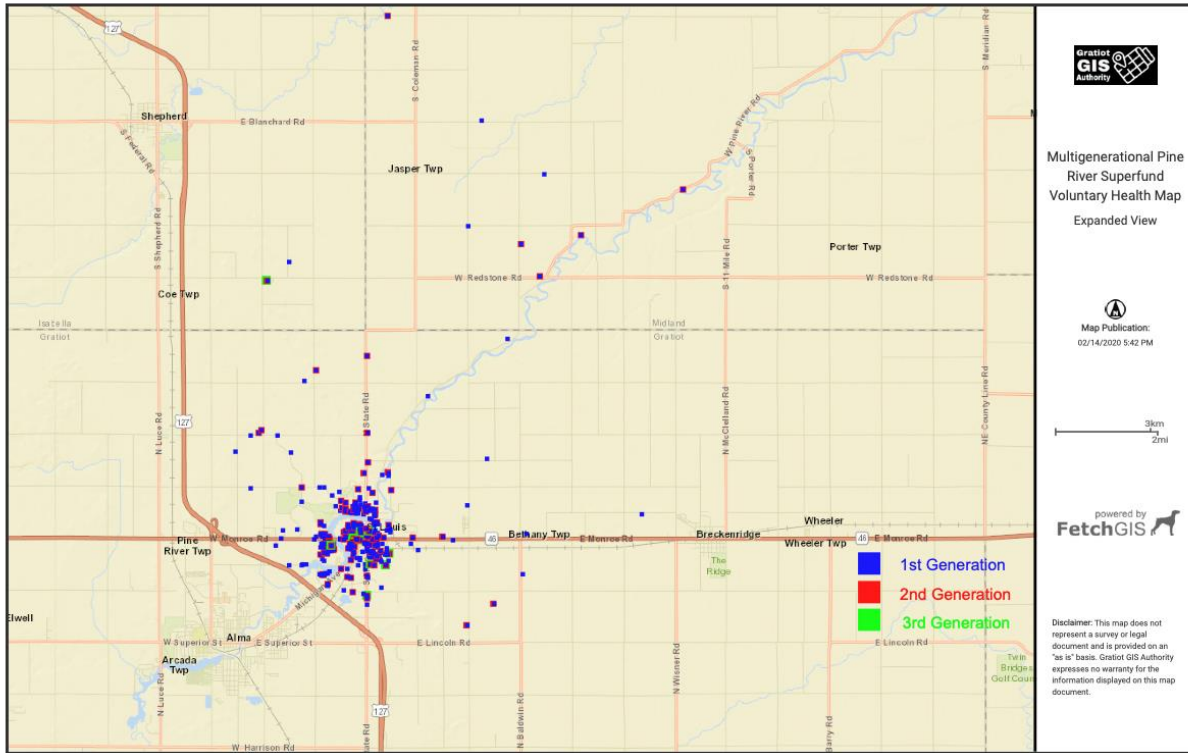
Total miscarriages reported, 62.

Hysterectomy before age 40, 11.

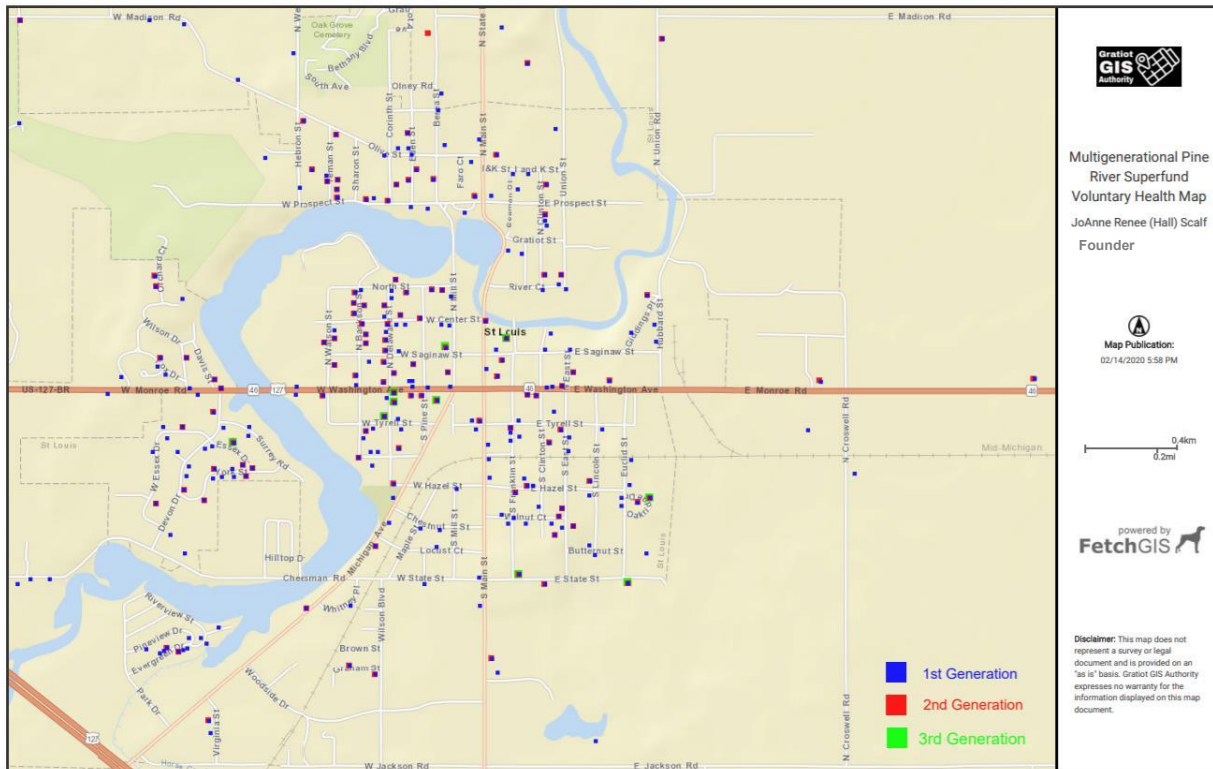
Cancer Cases reported in the St. Louis, Michigan survey

Cancer type	Survey # cases reported	Survey % of total cases	National EXPECTED NEW CASES*	National % of total expected cases(M+F)**	SURVEY # cases expected survey	OR
BREAST	52	19.85%	255180	15.01%	39.32	1.32
GASTROINTESTINAL CANCERS						
COLON	16	6.11%	95,520	5.61%	14.70	1.09
ESOPHAGEAL	4	1.53%	16940	1.00%	2.62	1.53
LIVER	6	2.30%	40710	2.39%	6.26	0.95
PANCREAS	14	5.34%	53670	3.16%	8.29	1.69
STOMACH	8	3.05%	28000	1.65%	4.32	1.85
KIDNEY	7	2.70%	63990	3.76%	8.85	0.79
LYMPHOMA	15	5.73%	8260	0.49%	1.28	11.72
NON-HODGKINS LYMPHOMA	14	5.34%	72240	4.25%	11.14	1.26
LUNG	27	10.31%	222500	13.09%	34.29	0.79
THYROID	17	6.50%	56870	3.35%	8.77	1.94
UTERINE	7	2.70%	61380	3.61%	9.45	0.74
ACUTE MYELOID LEUKEMIA	4	1.53%	21380	1.26%	3.30	1.21
BLADDER	8	3.05%	79030	4.65%	12.18	0.66
CHRONIC LYMPHOCYTIC LEUKEMIA	1	0.39%	20110	1.18%	3.09	0.32
SKIN	11	4.20%	95360	5.61%	14.69	0.75
BONE*(PRIMARY+METASTATIC)	11	4.20%				
PROSTATE	7	2.70%	161300	9.49%	24.86	0.28
LEIOMYOSARCOMA	1	0.39%	NOT REPORTED	NOT REPORTED		
TONGUE	1	0.39%	16400	0.96%	2.51	0.40
BRAIN	13	5.00%	23800	1.40%	3.66	3.55
TESTICULAR	1	0.39%	8850	0.52%	1.36	0.73
OTHER	17	6.50%				
TOTAL CANCER CASES REPORTED	262					

Multigenerational Pine River Superfund Voluntary Health Map Full View.



Multigenerational Pine River Superfund Voluntary Health Map Close View.



DISCUSSION:

This survey gathered voluntary health data collected from 520 persons who lived in St. Louis, MI, or persons who worked at the now defunct chemical plant in town. This group of individuals who were residents of St. Louis and living when the chemical plant was operational gave them the highest likelihood of being exposed. It also gave the high probability that their exposures would be higher than that of the general public whose town does not have an operational chemical plant within proximity. In 1976, the Michigan Department of Health and Human Services (MDHHS) enrolled approximately 4,000 Michigan residents in a Michigan Long-Term PBB Study program. They compiled the original batch of participants from farmers to chemical plant workers and others with a high probability of PBB exposure risk. The database, now known as The Michigan PBB Registry, was eventually transferred to Emory University. The Michigan PBB Registry maintains an extensive statewide database of participants exposed from the PBB accident discovered in 1973. This statewide database includes only a fraction of the residents of St. Louis. Most of the Michigan participants within that database were exposed to one chemical, PBB, for approximately one year. In contrast, the residents of St. Louis were exposed to over 200 chemicals for as long as 83 years. The plant operated from 1936 to 1978 and then was buried on-site, leaving chemicals behind in their town, and cleanup is still continuing. Therefore, this survey represents the residents' wishes in St Louis, Michigan, to participate in an experiment. Their aim is to have their questions about health problems answered. Specifically, do they have high rates of cancer, congenital disabilities, neurological diseases?

Also, this survey is subject to several limitations. First, medical and death records could not be reviewed, so this survey relies solely on self-reporting. Because of the experiences the

residents of St. Louis have endured for many years due to the plant, its closure, and the ongoing contaminations and cleanups across town, participants with poor health might have a high motivation of participation which could alter results. Others might be despondent with no motivation to participate, which could also alter the results. Finally, there is a potential for several biases in reporting. This survey allowed participants to report deceased loved ones as long as they provided accurate diagnoses. Given the opportunity to report deceased loved ones, participants might be motivated to report a relative's information and accidentally report incorrect information. The author is a 5th generation St. Louis resident offering the opportunity for familial and acquaintance bias. Finally, many residents have moved out of the area in the forty years since the plant closed, making it difficult for the author and volunteers to invite them to participate.

This survey report and maps present a human health plume map that mirrors the chemical contamination exposure plume, lending some credence to the proposed connection between the chemical contamination of the area with the diseases reported in the survey.

This survey found higher numbers of cancers, other diseases, conditions, infertility, and congenital disabilities than what would be expected in an average population of this size (Hogue et al., 1998). There was also a suggestion of a multi-generational component of certain diseases and conditions reported. (Data and Statistics on Birth Defects, 2020), (Marcus, 2021), (Small et al., 2009), (Small et al., 2011).

A cluster of rare cancers and illnesses exists. For example, Chondracamia is a rare form of primary bone cancer .2% of bone cancers are primary. Burkitt's lymphoma is a rare non-Hodgkins lymphoma; it accounts for 0.3 - 1.3% of all non-Hodgkin lymphomas. Leiomyosarcoma (LMS) is a rare form of cancer in smooth muscle tissue. Soft tissue sarcomas

account for 1% of all adult cancers in the U.S. Chronic Lymphatic Leukemia (CLL) is a rare form of cancer. It accounts for only 1% of all cancers. Acute Myeloid Leukemia (AML) is a rare form of leukemia, accounting for only 1% of all cancers (National Organization for Rare Disorders, 2021).

Neurological diseases reported in high concentrations were Multiple Sclerosis (M.S.) at 19 cases, Parkinson's disease at 7 cases, Amyotrophic Lateral Sclerosis (ALS), Autoimmune hepatitis, Scleroderma at 3 cases, Type 1 Diabetes at 42 cases reported, Type 2 Diabetes at 47 cases reported, Brain tumors, Lupus, Reiters Syndrome, Granulomatosis with polyangiitis (GPA), formerly known as Wegeners Granulatisis and polyangiitis (Walton et al., 2020) (Ingre, 2015)(Cleveland Clinic, 2022)(Mayo Clinic, 2019)(Mayo Clinic, 2020).

Observed individually the pattern of rare illnesses could be challenging to note but seen together in one community of this size appears to be alarmingly high.

Select portions of this report were presented in poster board format at the "*From PBB to PFAS*" symposium on the campus of the University of Michigan on February 20, 2020. Support for this event was sponsored by the National Institute of Environmental Health Science (grant P30ES017885), National Institutes of Health. In addition, many generous co-sponsors provided support for this event. The author solely and fully funded this survey. University of Michigan School of Public Health Lifestage Environmental Exposures and Disease Center (M-LEEd) provided a modest travel reimbursement to the author to attend.

CONCLUSION:

In conclusion, the results of this survey suggest higher levels of many cancers, including a cluster of gastrointestinal cancers such as Colon cancer, Esophageal cancer, Pancreatic cancer, and Stomach cancer. This cluster and the cases of Liver cancer suggest the chemicals present in St. Louis, Michigan, might be contributing to cancer rates. Neurological illnesses present at high rates in St. Louis, Michigan. Additionally, it suggests a high level of diseases with clusters of rare diseases and congenital disabilities in the population.

The persistently high levels of PBB and other chemical contamination in St. Louis have a long biological half-life. No other community has experienced this unique combination and level of toxic contamination. The toxic waste left in St. Louis has created a Petri dish of contamination commingling and co-existing parallel with humans. In some areas, testing has found toxic chemicals have commingled so long that they have transformed into dense non-aqueous phase liquids or DNAPL. DNAPLs are denser than water and do not dissolve in water, making them persistent pollutants. Therefore, long-term exposure is most likely widespread in this unique population. Environmental contaminations to the food supply also contribute to the possibility of continued exposures. Many chemicals with similar molecular structures are in production and widely used today. Answering the community's questions about their health status would most likely benefit other communities. This population would benefit from testing to see how much contamination is present in their bodies. Additionally, communities with no such contaminations could be saved from a similar fate when this community is provided with the answers it seeks.

By creating this survey, report, and a long-term health plume that mirrors a chemical exposure plume at the time of contamination and tracks three generations, we hope to transform

the current cultural understanding of chemical exposure from a one-time event into a multi-generational legacy event.

We feel we have accomplished this goal.

There is a significant need for a thorough, well-controlled epidemiological study of this population group and the establishment of surveillance programs for cancers and other diseases where early interventions result in a more promising outcome.

Consent was established with each respondent.

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