

Investigation of Cancer Rates
Near Two Superfund Sites
in Memphis, Shelby County, Tennessee

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Executive Summary

In February 2024, the U.S. Environmental Protection Agency (EPA) sought to address concerns of unusual patterns of cancer from residents living near two Superfund sites in Memphis, Shelby County, Tennessee. EPA requested assistance from the Agency for Toxic Substances and Disease Registry (ATSDR) and the Tennessee Department of Health (TDH) to address these concerns. This request prompted this investigation by TDH's Environmental Epidemiology Program (EEP) and Tennessee Cancer Registry (TCR).

TCR followed the Centers for Disease Control and Prevention (CDC) standards² to investigate the occurrence of specific cancer types near two Superfund sites: the Former Custom Cleaners and the Memphis Defense Depot. The investigation utilized cancer cases with diagnoses dates from 2010 to 2019.

The investigation included multiple phases, per CDC guidelines:⁶

Initiation Phase: Memphis community members reached out to EPA about cancer and environmental concerns near two Superfund sites.

Phase 1: Communication was established between the community and relevant partners. TDH identified specific cancers of interest.

Phase 2: The TCR used advanced statistical methods to check for any unusual patterns of cancer near the Superfund sites. Specifically, the TCR looked for higher than usual cancer counts and cancer rates while considering environmental, geographical, and other factors to determine the need for further evaluation. TCR used CDC's "Decision Making Form for Examining Unusual Patterns of Cancer and Environmental Concerns" to assess criteria for proceeding with the analysis. This form is attached as Appendix A.

Results: Standardized incidence ratios (SIRs) were less than 1.00 for non-Hodgkin's lymphoma (NHL) and urinary system cancers near Former Custom Cleaners, as well as for female reproductive cancers near the Memphis Defense Depot. SIRs could not be calculated for leukemias, esophageal cancers, liver and intrahepatic bile duct cancers near Former Custom Cleaners, or for brain cancers around the Memphis Defense Depot due to low case counts. Hot spot analyses identified one hot spot with 90% confidence for esophageal cancers within the northernmost census tract analyzed for the Former Custom Cleaners location; however, this hot spot was within within a census tract geographically furthest away from the site relative to the other census tracts in the analysis. One cold spot with 90% confidence was identified for brain cancers in a census tract near the Memphis Defense Depot.

Conclusion: TCR's analysis of cancer cases from 2010-2019 did not provide evidence of higher occurrences of cancers of interest near either of the two Superfund sites.

Introduction to Cancer

Cancer occurs when cells in the body grow and spread uncontrollably.³ Cancer isn't just one disease. There are more than 100 types of cancer.³

A cancer cluster is defined as “a greater than expected number of the same or etiologically related cancer cases that occurs within a group of people in a geographic area over a defined period of time.”²

Each type of cancer is different, so seeing different types of cancer in a group of people, like lung, breast, or pancreatic cancer, doesn't necessarily mean there's a problem. We usually get concerned when we notice a lot of cases of the same type of cancer or similar kinds of cancers more often than expected. This is when we may look more closely to try to understand what's going on.²

Investigation Phases





Initiation of Investigation:

Residents of Memphis, Shelby County, Tennessee, expressed concerns to the U.S. Environmental Protection Agency (EPA) about potentially higher-than-normal cancer rates near two Superfund sites. EPA requested the Agency for Toxic Substance and Disease Control's (ATSDR) involvement. ATSDR coordinated with the Tennessee Department of Health's (TDH) Environmental Epidemiology Program (EEP) and Tennessee Cancer Registry (TCR). TDH performed the investigation, guided by the Centers for Disease Control and Prevention (CDC) standards.



Phase 1: Designating Points of Contact and Gathering Information

Per the CDC's guidelines for investigating potentially unusual patterns of cancer, the initial phase included designating contacts for community members and organizations involved and gathering information about environmental concerns and cancer concerns.⁶ Based on what we learned, we identified cancers of interest for each of the two Superfund sites.

- *Designating Points of Contact*

The EPA, TCR, ATSDR, EEP, Tennessee Department of Environment and Conservation (TDEC), and Shelby County Health Department (SCHD) met and established points of contact for the entirety of the investigation to provide knowledge in their respective areas of expertise. The EPA remained in direct contact with the community.

- *Historical and Current Information about Superfund Sites*

At this stage, it was important to review past investigations and understand the historical context. A Health Consultation prepared by TDH, published in 2021, evaluated the Former Custom Cleaners Superfund site. TDH concluded in the report exposure to contaminants at the site were not expected to harm the health of the community members living, attending school, playing, or working

near the site. The report included a recommendation for ongoing monitoring of the site and was a valuable resource for this investigation.

- Read the full report:
[Health Consultation – Former Custom Cleaners NPL Site](#)
- Learn more about the EPA’s monitoring of the Former Custom Cleaners site: [FORMER CUSTOM CLEANERS | Superfund Site Profile | Superfund Site Information | US EPA](#)

TDH had not done recent projects for the Memphis Defense Depot. There are historical documents.

- Learn more about TDEC’s monitoring of the Memphis Defense Depot, also known as Defense Depot of Memphis, Tennessee (DDMT):
[Defense Depot - Memphis, TN \(DDMT\) | TDEC Division of Remediation](#)
- Learn more about the EPA’s monitoring of the Memphis Defense Depot:
[MEMPHIS DEFENSE DEPOT \(DLA\) | Superfund Site Profile | Superfund Site Information | US EPA](#)

- *Identifying Cancers of Interest*

Community members expressed interest in evaluating female reproductive cancers and brain cancers in proximity to the Memphis Defense Depot Superfund site. As such, the analysis for Memphis Defense Depot focused on these two cancer types.

According to EPA, community members expressed a more general concern about potentially higher numbers of cancer cases near Former Custom Cleaners but did not identify specific cancers of concern. EEP consulted scientific literature to identify which cancer types are more commonly associated with exposure to the types of drycleaning chemicals found at the site. These cancer types included: non-Hodgkin’s lymphoma, leukemias, esophageal, liver and intrahepatic bile duct, and urinary system cancers including bladder, kidney, and renal pelvis cancers.

The analysis included all cases of these cancer types diagnosed and living within the analyzed areas during the 10-year period of 2010-2019. Data collected during this period met the highest national standards of data completeness and quality according to the CDC and the North American Association of Central Cancer Registries (NAACCR).



Phase 2: Reviewing Criteria and Data to Determine Continued Evaluation

Per CDC guidelines⁶, TCR utilized the “Decision Making Form for Examining Unusual Patterns of Cancer and Environmental Concerns,” attached as Appendix A, to determine if continued evaluation was warranted. Cancer-specific and Superfund site-specific standardized incidence ratios (SIRs) were calculated to determine if the observed number of cases significantly exceeded the expected number of cases for individuals diagnosed during the investigation period of 2010-2019 [Table 1]. Analyzing the 10-year period from 2010 to 2019 allows us to gather sufficient cancer case counts for statistical analysis, while also ensuring we focus on the most recent decade, as census tract boundaries change every ten years.

- *Understanding Standardized Incidence Ratios (SIRs)⁴*

An SIR is a ratio that helps us compare the actual number of cancer cases we observe in a specific area to what we would expect based on broader data.

Here’s how it works:

- **Observed Cases:** This was the number of cancer cases we found in the specific area we investigated, which included the Superfund sites and nearby neighborhoods.
- **Expected Cases:** This was the number of cancer cases we would normally expect to see in the same area based on average rates for all of Shelby County.
- The SIRs were calculated by dividing the observed cases by the expected cases.

If observed cases were less than 11, an SIR was calculated but was not presented (i.e. was suppressed) in this report to inhibit its possible use to derive personal information of cases.

How to interpret the SIR:

- If an SIR was less than 1.00, then this indicated the observed number of cases did not exceed the expected number of cases.

- If an SIR, including any that were suppressed, was greater than 1.00, then we would have looked to something called the 95% confidence interval and p-value. These are both measures of statistical confidence. If the 95% confidence interval did not include 1.00 and the p-value was less than 0.05, this would have indicated the difference between observed and expected cases was statistically significant and unlikely due to chance. If this had occurred, it would have signaled us to take a closer look. If a suppressed SIR met the above criteria, we would have used a different analysis type to be able to showcase the exceedance within this report.

In addition to SIR calculations, Superfund site-specific and cancer-specific age-adjusted rates for cases diagnosed during the investigation period of 2010-2019 were calculated and subjected to hot spot analyses.

- *Calculating Age-adjusted Incidence Rates for Cancers of Interest*
Adjusting for age ensures the differences in incidence are not due to the differences in the age distribution of the populations. This is a necessary step in calculating cancer statistics since age is a critical predictor of cancer.⁸
 - Incidence rates were adjusted to the U.S. 2000 Standard Population by 19 age-groups to produce age-adjusted incidence rates.⁸ Age-adjusted rates were generated in the SEER*STAT statistical software utilizing TCR data. For data quality purposes, duplicates and those unable to be geocoded were removed from the analysis.
- *Conducting Geospatial Hot Spot Analyses*
A hot spot analysis is a complex mapping and spatial statistical analysis technique used to identify clustering of events, such as cancer occurrence. These analyses look for areas with elevated rates of cancer where cases appear to group together (cluster), so-called “hot spots.” These analyses also identify areas with lower than expected cancer incidence rates known as cold spots.
 - Age-adjusted incidence rates were subjected to “hot spot analyses” using ArcGIS software, which was developed and is administered by Environmental Systems Research Institute (ESRI).

For statistical stability, a sufficient sample size (population) is required. For this type of analysis, 30 units, in this case census tracts, are required.

- A 2.75-mile radius from each of the two Superfund sites was used, resulting in 34 census tracts surrounding Former Custom Cleaners site and 30 census tracts surrounding the Memphis Defense Depot site. [Figure 1].

Figure 1. Areas analyzed in the Hot Spot Analyses

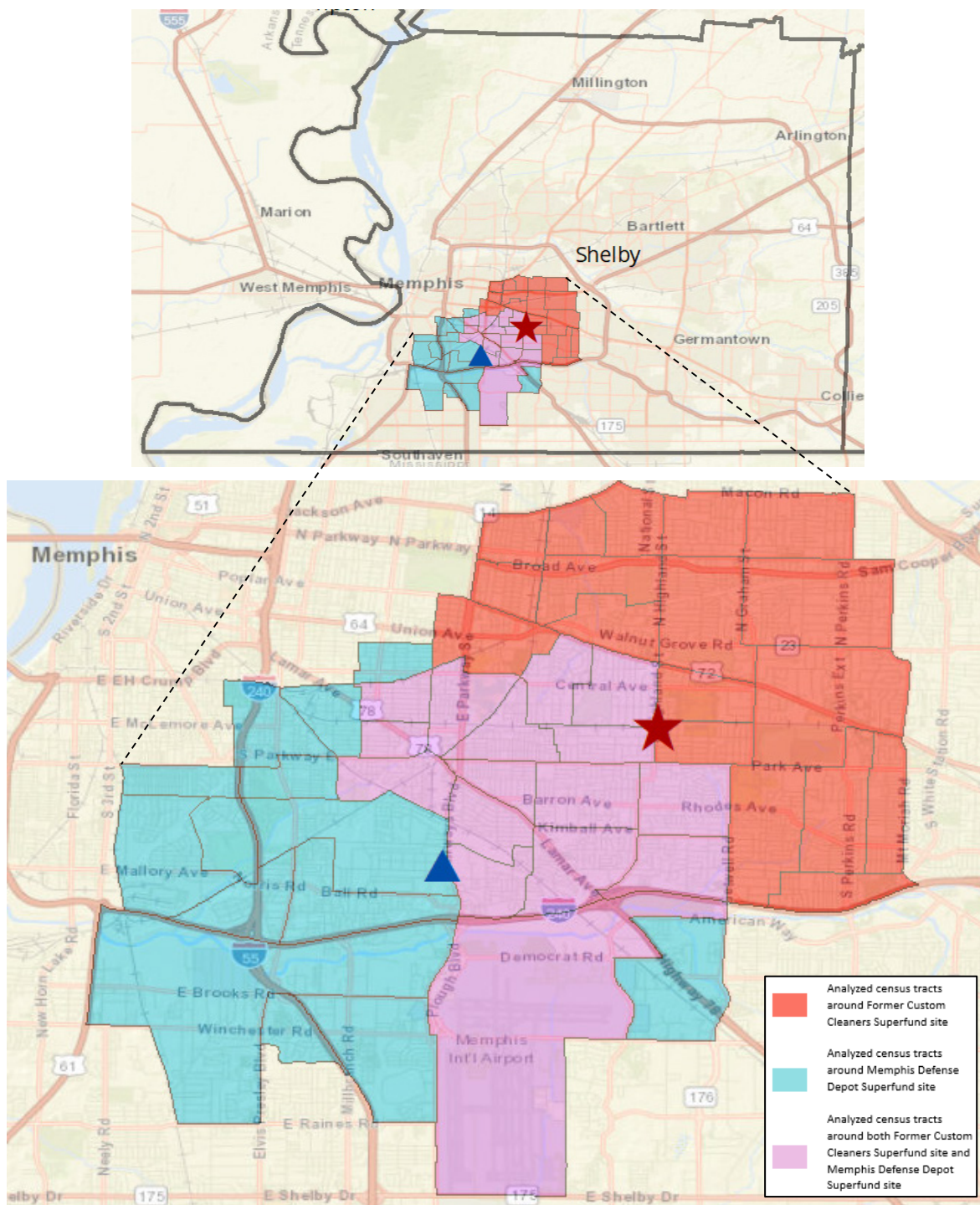


Figure 1 shows the areas analyzed in the hot spot analyses. While the two Superfund sites are close in proximity, we analyzed each separately.

▲ The blue triangle denotes the Memphis Defense Depot Superfund site. A 2.75-mile radius from the facility was used to determine the census tracts to be analyzed in the hot spot analyses (the blue and purple census tracts).

★ The red star denotes the Former Custom Cleaners Superfund site. A 2.75-mile radius from the facility was used to determine the census tracts to be analyzed in the hot spot analyses (the red and purple census tracts).

Results

- Standardized Incidence Ratios (SIRs)

In the area around the Former Custom Cleaners Superfund site, the SIRs for non-Hodgkin's lymphoma (NHL) and urinary system cancers were less than 1.00, meaning the observed cases did not exceed the expected cases. Due to the low number of cases and data suppression rules, SIRs were calculated but could not be presented for leukemias, esophageal cancers, or liver and intrahepatic bile duct cancers near Former Custom Cleaners; however, SIRs did not signal a need for further investigation [Table 1].

Around the Memphis Defense Depot, female reproductive cancers did not produce an SIR greater than 1.00, meaning the observed cases did not exceed the expected cases. The SIR for brain cancers near the Memphis Defense Depot was calculated but not presented due to low case counts and data suppression rules; however, the SIR did not signal a need for further investigation [Table 1].

Table 1. Standardized Incidence Ratios (SIRs)

Site	Cancer Type	SIR	95% CI	p-value
Former Custom Cleaners				
	Non-Hodgkin's Lymphoma	0.84	(0.48 , 1.31)	0.79
	Leukemias	^	^	^
	Esophageal Cancers	^	^	^
	Liver and Intrahepatic Bile Duct Cancers	^	^	^
	Urinary System Cancers	0.96	(0.69 , 1.28)	0.62
Memphis Defense Depot				
	Female Reproductive Cancers	0.96	(0.71 , 1.25)	0.62
	Brain Cancers	^	^	^
95% CI = 95% Confidence Interval				
^ = SIRs calculated with case counts less than 11 cases were suppressed				

- Hot Spot Analyses

Near the Former Custom Cleaners Superfund site, no hot spots or cold spots were identified for NHL, leukemias, urinary system cancers, or liver and intrahepatic bile duct cancers. One hot spot was identified with 90% confidence for esophageal cancers, meaning there was a clustering of higher rates of esophageal cancer cases, but this hot spot was geographically located furthest away from the site, as shown in Figure 2a. Because the hot spot is located furthest away from the site and there is no evidence to link this hot spot to the environmental factors near the site, this hot spot is not of concern in this analysis.

Near the Memphis Defense Depot Superfund site, no hot or cold spots were found for female reproductive cancers. One cold spot was found for brain cancers near the site, meaning there was a clustering of lower rates of brain cancer, as shown in Figure 2b.

Figure 2a. Hot Spot Analysis of 34 census tracts for esophageal cancers from 2010-2019 near Former Custom Cleaners

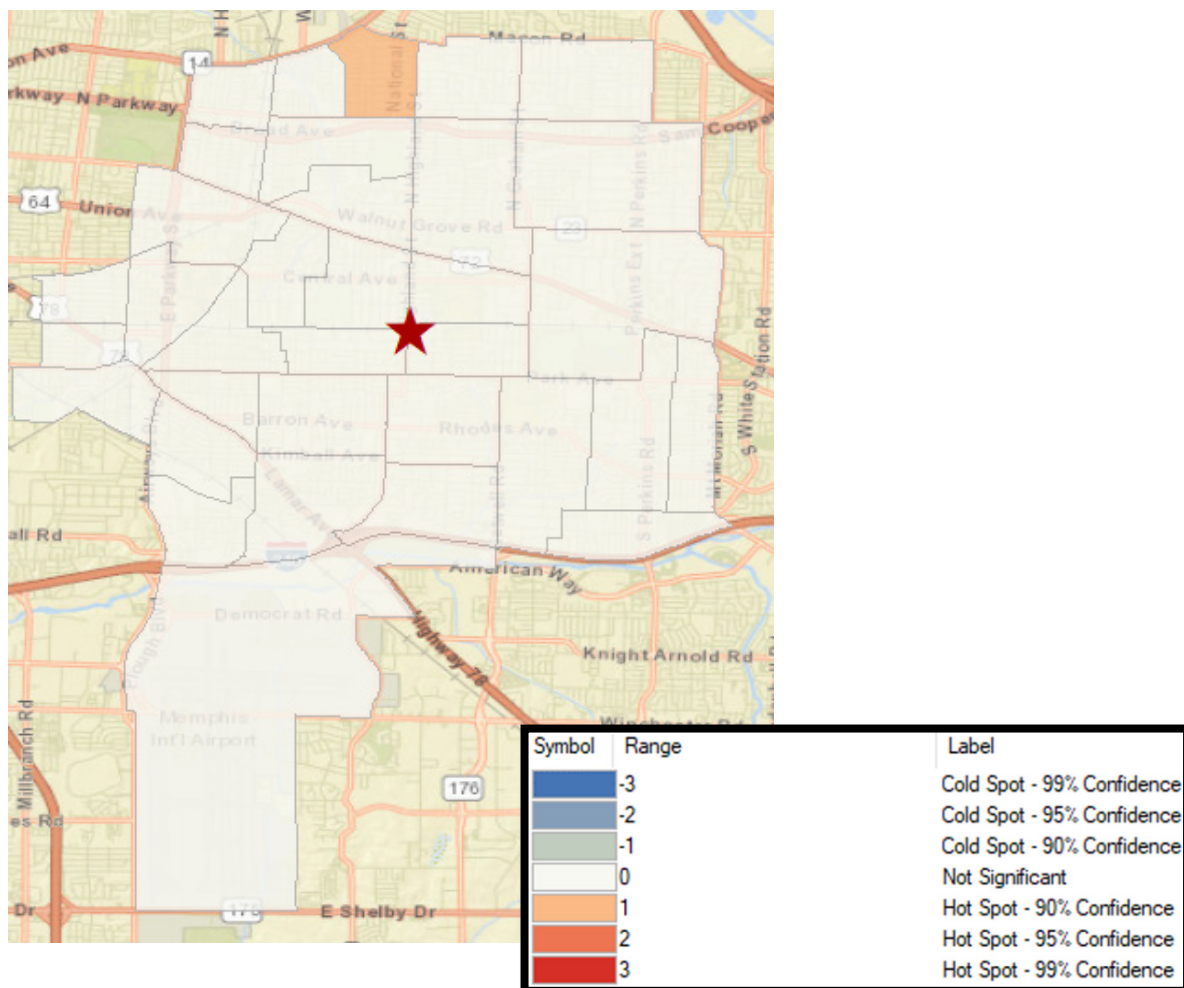


Figure 2a shows the hot spot analysis for esophageal cancer cases diagnosed from 2010-2019 for Former Custom Cleaners represented by the red star. A hot spot was identified with 90% confidence, but this hot spot was located geographically away from the facility. No hot spots of esophageal cancer cases were found near the Former Custom Cleaners.

Figure 2b. Hot Spot Analysis of 30 census tracts for brain cancers from 2010-2019 near Memphis Defense Depot

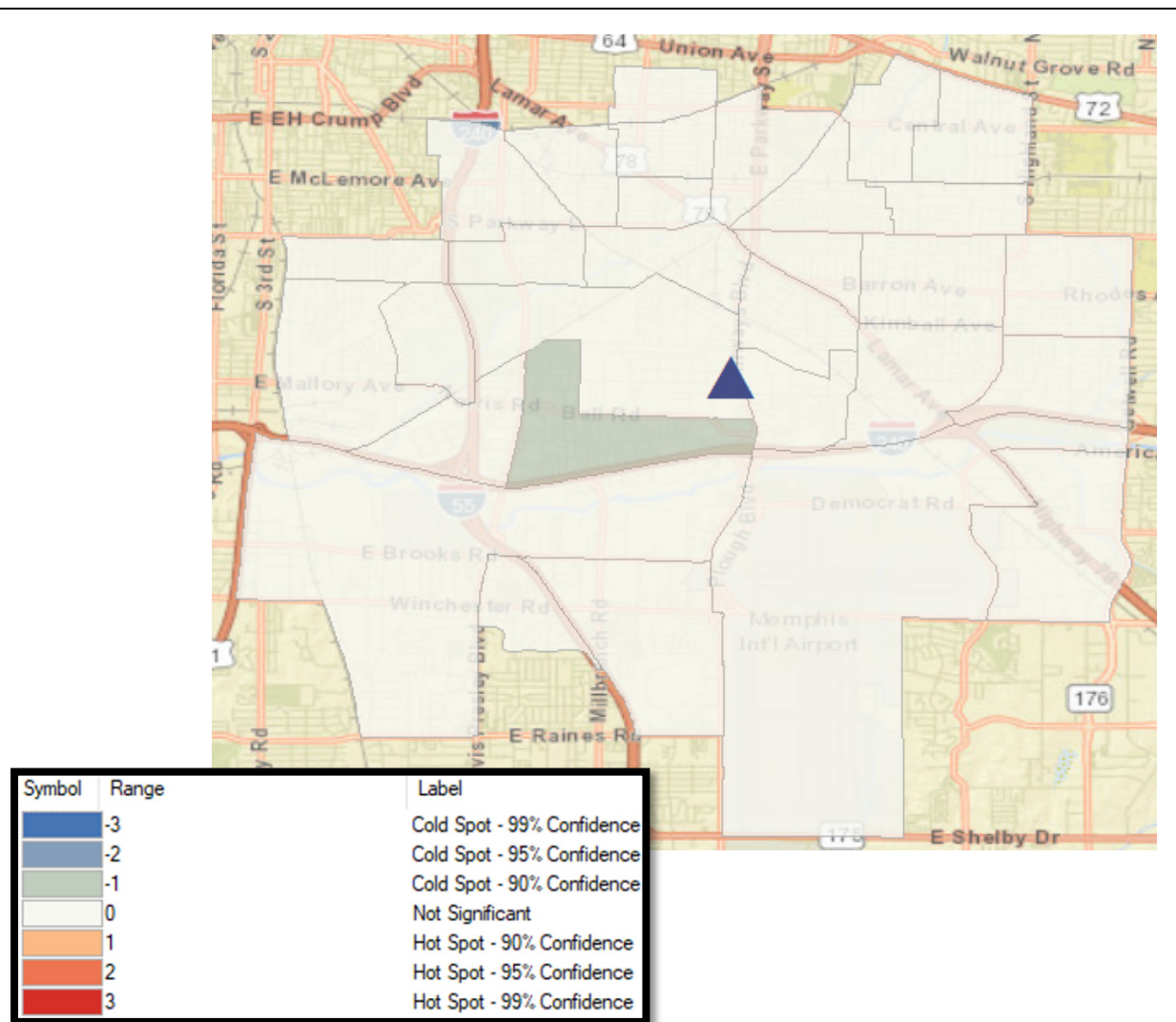


Figure 2b shows the hot spot analysis for brain cancer cases diagnosed from 2010-2019 near the Memphis Defense Depot. A cold spot of brain cancer cases was found with 90% confidence near the Memphis Defense Depot.



Concluding the Investigation

In conclusion, the analyses did not provide evidence of higher occurrences of cancers of interest near the two Superfund sites.

Community concerns about environmental sites are often complex and long-term. Routine environmental monitoring of the Superfund sites by the EPA is expected to continue. TDH, TDEC, and SCHD are available for continued conversations about environmental or community concerns.

Additional Information and Resources:

Learn About Cancer

Cancer isn't just one disease but a group of over 100 different ones, all marked by cells in the body growing and spreading uncontrollably.³ Each type of cancer is different, so seeing different types of cancer in a group of people, like lung, breast, or pancreatic cancer, doesn't necessarily mean there's a problem. We usually get concerned when we notice a lot of cases of the same type of cancer or similar kinds of cancers more often than expected. This is when we need to look more closely to try to understand what's going on.⁶

- Learn more about cancer at [Cancer | Cancer | CDC](#).
- Learn more about brain cancer at [Brain Tumors and Brain Cancer | Johns Hopkins Medicine](#).
- Learn more about esophageal cancers at American Cancer Society's website: <https://www.cancer.org/cancer/types/esophagus-cancer.html>
- Learn more about female reproductive cancers at CDC's website: <https://www.cdc.gov/gynecologic-cancer/about/>
- Learn more about leukemias at American Cancer Society's website: <https://www.cancer.org/cancer/types/leukemia.html>
- Learn more about non-Hodgkin's lymphoma at American Cancer Society's website: <https://www.cancer.org/cancer/types/non-hodgkin-lymphoma/about/what-is-non-hodgkin-lymphoma.html>
- Learn more about urinary system cancers:
 - Bladder cancers: [Bladder Cancer Basics | Bladder Cancer | CDC](#)
 - Kidney and Renal Cancers: <https://www.cdc.gov/kidney-cancer/about/index.html>

Learn About Investigations of Unusual Patterns of Cancer:

A cancer cluster is defined as “a greater than expected number of the same or etiologically related cancer cases that occurs within a group of people in a geographic area over a defined period of time.”² The inclusion of “etiologically related” in the definition takes into consideration that some cancers develop similarly in terms of risk factors, causes, or origin. “For example, exposure to the sun can cause skin cancer.”²

The purpose of this investigation is to see if there are more cancer cases than expected in a particular geographic area.²

Even when an increase in cancers is identified, establishing a link between a potential environmental contaminant and an increase in cancer rates is unlikely⁷ because:

1. Cancer is not one disease, but a group of more than 100 diseases that may have different causes, latency periods before symptoms appear, presentations and effects on the body, and more.
2. Cancer is common. 1 in 2 men and 1 in 3 women will be diagnosed with cancer in their lifetime.¹
3. Cancer is usually not caused by one thing, but is caused by a combination of things including ⁶:
 - Age
 - Gender
 - Behavior (e.g., smoking, drinking, diet, and exercise habits)
 - Genetics
 - Environmental factors
4. There is a natural variation in rates of cancer.
5. Other factors influence rates of cancer such as:
 - Access to healthcare
 - Rates of screening for cancer
 - Socioeconomic-related factors like education, income, and more

Limitations of Investigations of Unusual Patterns of Cancer:

- Small sample sizes of cancer case counts can result in unstable age-adjusted incidence rate calculations.⁶
- Cluster investigations rely on geospatial analyses which are dependent on existing administrative borders, like zip codes, county lines, or census tracts.⁶ The geographic borders, selected with high uncertainty, define the population in the investigation and make it susceptible to “sharpshooter fallacy” or “clustering illusion” which refers to the idea of drawing a target after the bullets are shot.⁵ Anytime data are collected, clusters may be seen. In some cases, patterns could be identified where there really are none and we might focus on the similarities while ignoring differences which can lead to false conclusions.⁵
- This investigation is an ecological study, meaning it analyzes groups of individuals. Because ecological studies do not analyze people individually, ecological studies cannot claim to determine a specific cause of disease.⁶

* It is important to acknowledge that, while improvements to the methodology are underway, the results from investigations of unusual patterns of cancer may be relatively unreliable due to the small sample sizes, wide confidence intervals, and consequently

unstable age-adjusted rates. These factors contribute to the limitations of the findings when compared to other types of studies.^{6,7}

*To learn more about CDC's guidelines, see Figure 2 in "Guidelines for Examining Unusual Patterns of Cancer and Environmental Concerns" (CDC, 2022). You may view or download the publication here: <https://www.cdc.gov/cancer-environment/media/pdfs/Guidelines-for-Examining-Unusual-Patterns-of-Cancer-and-Environmental-Concerns-h.pdf>

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