2019

Why Does My Town Smell Like Nail Polish?: Using The Toxics Release Inventory To Investigate Industrial Chemical Pollutants In Elkhart County, Indiana

Magdalena Lehman
University of Montana, Missoula

Follow this and additional works at: https://scholarworks.umt.edu/etd

Part of the Environmental Studies Commons

Let us know how access to this document benefits you.

Recommended Citation
Lehman, Magdalena, "Why Does My Town Smell Like Nail Polish?: Using The Toxics Release Inventory To Investigate Industrial Chemical Pollutants In Elkhart County, Indiana" (2019). Graduate Student Theses, Dissertations, & Professional Papers. 11511.
https://scholarworks.umt.edu/etd/11511

This Thesis is brought to you for free and open access by the Graduate School at ScholarWorks at University of Montana. It has been accepted for inclusion in Graduate Student Theses, Dissertations, & Professional Papers by an authorized administrator of ScholarWorks at University of Montana. For more information, please contact scholarworks@mso.umt.edu.
WHY DOES MY TOWN SMELL LIKE NAIL POLISH?: USING THE TOXICS RELEASE INVENTORY TO INVESTIGATE INDUSTRIAL CHEMICAL POLLUTANTS IN ELKHART COUNTY, INDIANA

By

MAGDALENA CONSTANCE LEHMAN

Bachelor of Arts, Eastern Mennonite University, Harrisonburg, Virginia, 2015

Thesis Paper

presented in partial fulfillment of the requirements for the degree of

Master of Science
in Environmental Studies

The University of Montana
Missoula, MT

December 2019

Approved by:

Scott Whittenburg, Dean of The Graduate School
Graduate School

Neva Hassanein, Chair
Environmental Studies

Robin Saha
Environmental Studies

Elizabeth Putnam
Biomedical and Pharmaceutical Sciences
Using TRI to Investigate Air Pollutants in Elkhart County

Lehman, Magdalena, M. S., Fall 2019

Environmental Studies

Why Does My Town Smell Like Nail Polish?: Using The Toxics Release Inventory To Investigate Industrial Chemical Pollutants In Elkhart County, Indiana

Chairperson: Neva Hassanein

This thesis investigates 2017 industrial chemical air pollution in Elkhart County, Indiana starting with data from the Environmental Protection Agency’s Toxics Release Inventory (TRI) and Risk-Screening Environmental Indicators model (RSEI). TRI requires facilities across the United States to report release amounts for certain chemicals known to cause adverse human health impacts. A related database, the RSEI model adds context to release amounts by modeling for toxicity and exposure. The resulting RSEI score approximates relative risk among releases. In combination, these tools are intended to allow communities to identify risks and provide oversight of point-source industrial chemical pollution in their neighborhoods. In this thesis I explore the limitations and capacities of these data for proactively addressing pollution in my home community of Elkhart County where manufacturing remains a cornerstone of the local economy.

In Elkhart County, styrene and cobalt arose as primary concerns based on rankings from TRI and RSEI respectively. While styrene emissions come from a number of facilities located throughout the County, Kennametal Stellite is the only facility to release cobalt. RSEI scores indicate cobalt as the greater concern, but a review of health assessments published by U.S. government and international agencies suggests that styrene lacks a sufficient risk assessment due to outdated research backing its RSEI toxicity weight. As a final method of investigation, this study mapped RSEI geographic micro-data with the Center for Disease Control’s Social Vulnerability Index and found where vulnerable neighborhoods have the added burden of the heaviest toxicity-weighted concentrations of chemicals in the County. Overall this research reflects what a concerned community member like myself may learn from these data. I now know that styrene warrants further research and cobalt releases from Kennametal pose serious health risks to the surrounding community and vulnerable populations in particular.
Using TRI to Investigate Air Pollutants in Elkhart County

Acknowledgements

I could not have completed this work without the encouragement of my home community in Elkhart County, Indiana and the support of my new community in Missoula, Montana. The following people have been essential.

Neva Hassanein for her guidance, words of support, advocacy on my behalf, and inspiring commitment to the fight for healthier, more resilient communities.

My thesis committee, Neva, Robin Saha, and Liz Putnam, for insights that will ensure the integrity of my work as I move towards acting on my new knowledge.

My grandma, Alice Lehman, and many others in the Goshen community including Paul Steury, Amy Thut, Twila Albrecht, Phil Metzler, and Aaron Kingsly for sharing their local expertise and making my work feel important.

Michael Ash for providing access and guidance to the toxicity concentration data for my maps.

Cheryl and Tobin Miller-Shearer for providing warm hospitality, ensuring I was properly clothed during Missoula winters, and giving me a family away from home.

Dan Spencer and Susan Elliott for advising me from my graduate school application to my graduation.

My parents, Tim and Jan Lehman, who gave me the space to devote myself to this work.

My friends in the Environmental Studies program, who have graciously listened to me talk incessantly about pollution in my hometown for the last year, and reminded me to find joy and fun in this work.

Finally, I would like to acknowledge the financial resources that made my work possible including a teaching assistant position and Brainerd Fellowship.
Why Does My Town Smell Like Nail Polish?:
Using the Toxics Release Inventory to Investigate Air Pollutants in Elkhart County, Indiana

Magdalena Lehman

University of Montana
Using TRI to Investigate Air Pollutants in Elkhart County

TABLE OF CONTENTS

Table of Contents…………………………………………………………………………………………..v  
List of Tables and Figures………………………………………………………………………………..vii  
List of Acronyms………………………………………………………………………………………….ix  
Chapter 1: Introduction………………………………………………………………………………………….1  
  Attitudes Towards Pollution and Industry in Indiana......................................................3  
  Industrial Legacy of Elkhart County, Indiana.................................................................6  
Chapter 2: Literature Review…………………………………………………………………………...12  
  The Development and Uses of the Toxics Release Inventory..........................................13  
  Situating Elkhart County.................................................................................................18  
Chapter 3: Methods………………………………………………………………………………………….23  
  Defense of Methods........................................................................................................24  
  Data Compilation...........................................................................................................29  
  Analysis Steps...............................................................................................................34  
    Using TRI and RSEI data to rank and calculate proportions........................................34  
    Chemical literature review........................................................................................35  
    Mapping toxicity concentrations with the Social Vulnerability Index.........................35  
Chapter 4: Results…………………………………………………………………………………………..38  
  Using TRI and RSEI Data to Rank and Calculate Proportions.......................................38  
    Results from Toxics Release Inventory..........................................................................38  
    Results from Risk-Screening Environmental Indicators Model.....................................45  
  Chemical Literature Review.........................................................................................51  
    Cobalt..........................................................................................................................53  
    Styrene........................................................................................................................56  
  Mapping Toxicity Concentrations with the Social Vulnerability Index.........................60  
  Styrene and Cobalt Releases in a National Context.......................................................71  
Chapter 5: Discussion and Concluding Thoughts.................................................................72  
  Interpreting Results.......................................................................................................72  
    Drawing meaning from the TRI and RSEI rankings..................................................73  
    Findings from the chemical literature review............................................................74  

Using TRI to Investigate Air Pollutants in Elkhart County

LIST OF TABLES AND FIGURES

Tables

Table 1. Descriptions of Fields Found in the 2017 Toxic Release Inventory Data for Elkhart County, Indiana ................................................................. 30

Table 2. Descriptions of Fields Found in the 2017 Risk-Screening Environmental Indicators Model Data for Elkhart County, Indiana ..................................................... 31

Table 3. Descriptions of Fields Found in the 2017 Risk-Screening Environmental Indicators Model Micro-data for Elkhart County, Indiana ........................................ 32

Table 4. Descriptions of Fields Found in the Center for Disease Control’s Social Vulnerability Index Shapefile ................................................................................. 33

Table 5. Toxics Release Inventory 2017 Reported Pounds of Release in Elkhart County, IN by Medium of Release .................................................................................. 39

Table 6. Toxics Release Inventory 2017 Reported Pounds of Release in Elkhart County by Chemical ........................................................................................................ 40

Table 7. Toxics Release Inventory 2017 Reported Pounds of Air Releases in Elkhart County by Facility ........................................................................................................ 42

Table 8. Toxics Release Inventory 2017 Reported Pounds of Air Releases in Elkhart County by Industrial Sector .................................................................................. 43

Table 9. Toxics Release Inventory 2017 Reported Pounds of Air Releases in Elkhart County by Parent Company .................................................................................. 45

Table 10. Risk-Screening Environmental Indicators 2017 Modeled Score for Air Releases in Elkhart County, Indiana by Chemical ......................................................... 47

Table 11. Risk-Screening Environmental Indicators 2017 Modeled Score For Air Releases In Elkhart County, Indiana By Facility ......................................................................... 49

Table 12. Risk-Screening Environmental Indicators 2017 Modeled Score For Air Releases In Elkhart County, Indiana By Parent Company ............................................ 50

Table 13. Risk-Screening Environmental Indicators 2017 Modeled Score For Air Releases In Elkhart County, Indiana By Industrial Sector ............................................. 51
Using TRI to Investigate Air Pollutants in Elkhart County

Figures

Figure 1. Locations of Toxic Release Inventory facilities reporting 2017 air releases in Elkhart County, Indiana ........................................................................................................63

Figure 2. Toxicity-weighted 2017 concentrations of styrene in Elkhart County, Indiana by U.S. Census tract ........................................................................................................64

Figure 3. Toxicity-weighted 2017 concentrations of cobalt in Elkhart County, Indiana by U.S. Census tract ........................................................................................................65

Figure 4. Aggregate toxicity-weighted 2017 concentrations of chemicals in Elkhart County, Indiana ........................................................................................................66

Figure 5. Center for Disease Control Social Vulnerability Index scores in Elkhart County, Indiana Census tracts for summed socioeconomic status, household composition, and minority status themes ..................................................................................68

Figure 6. Comparison by U.S. Census tracts in Elkhart County, Indiana of aggregate toxicity-weighted chemical concentrations with Social Vulnerability Index sum of themes 1, 2, & 3 ...........................................................................................................70
Using TRI to Investigate Air Pollutants in Elkhart County

**LIST OF ACRONYMS**

ATSDR – Agency for Toxic Substances and Disease Registry  
CAS – Chemical Abstract Service  
CDC – Center for Disease Control  
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act  
CNS – Central Nervous System  
EPA – Environmental Protection Agency  
EPCRA – Emergency Planning and Community Right to Know Act  
IARC – International Agency for Research on Cancer  
IDE M – Indiana Department of Environmental Management  
IRIS – Integrate Risk Information System  
ISDH – Indiana State Department of Health  
MRL – Minimum Risk Level  
NATA – National Air Toxics Assessment  
NTP – National Toxicology Program  
OSHA – Occupational Safety and Health Administration  
RfC – Reference Concentration  
RSEI – Risk-Screening Environmental Indicators  
SVI – Social Vulnerability Index  
TRACI – Tool for Reduction and Assessment of Chemicals and Other Environmental Impacts  
TRI – Toxics Release Inventory  
VOC – Volatile Organic Compounds
Chapter 1: Introduction

My first summer home from college I went on a run, but turned to walk back after only two blocks because the air outside my parents’ house smelled like nail polish. My hometown of New Paris in northern Indiana probably smelled like nail polish my entire childhood, but it must have been one of those ambient smells that you grow accustomed to after years of living there. New Paris’s population of just under 1,500 people barely qualifies as a town and is, in fact, unincorporated with no local governing body. I have come to learn that, despite the town’s size, four industrial facilities report the release of thousands of pounds of chemical pollutants to the surrounding air every year. In surrounding Elkhart County, those numbers rise to 68 facilities with a total amount of chemical release reaching over a million pounds in a single year (TRI).

At the start of this research, one million pounds of chemical releases deemed “toxic” by the Environmental Protection Agency (EPA) did not mean much to me. The total number says nothing of which chemicals, who releases these chemicals, where they come from, who may be affected by them, or what protentional health risks they pose. These questions taken together formed my broader research questions: what does over one million pounds of toxic chemicals released every year in my home community mean for us? Answering these who, what, where, and when questions consequently helped in answering a second broad question: where should pollution reductions efforts start to protect the health of my home community.

The following chapters detail my efforts to investigate and understand the polluted air where I grew up in Elkhart County, Indiana. This first chapter provides context about the study
Using TRI to Investigate Air Pollutants in Elkhart County

site by exploring attitudes towards industrial pollution in Indiana and outlining a brief history of the rise of industry in Elkhart County. The next chapter reviews the two essential data sets for investigating chemical pollutants in the County and looks at how other researchers have approached similar questions. I relied heavily on the Environmental Protection Agency’s (EPA) Toxics Release Inventory (TRI) that compiles self-reported data about chemical releases from industrial facilities across the country. I looked specifically at 2017 air releases—the most recent data available—from facilities located in Elkhart County, Indiana. TRI is a powerful data set that informs other EPA tools like the Risk-Screening Environmental Indicators (RSEI) model. RSEI adds context by assessing risks based on exposure modeling and toxicity multipliers. In the third and fourth chapters I respectively explain my methods and outline the results using both data sets to identify which facilities and chemical releases may be of greatest concern. Finally, I conclude with discussion of how my results fit in a broader context and what they may mean for my home community.

In the 1980s toxics activists throughout the country demanded the right to know what substances may endanger their health where they work, live, and play. Lawmakers and the EPA responded with the Toxics Release Inventory and Risk-Screening Environmental Indicators model. The data contained in these tools do not themselves provide oversight of polluters, but, rather, leave oversight to communities. Following in the footsteps of other activists who have asked questions about their community, found answers, and demanded change, this research also serves as a reflection of what a concerned community member may uncover and accomplish with access to data.

Pollution in Elkhart County, Indiana in some ways tells a much broader story about small communities throughout the old rust belt which remain heavily reliant on manufacturing. I chose
Using TRI to Investigate Air Pollutants in Elkhart County

to investigate this particular place because it is my place. It is a place my family has been tied to for generations and where I myself grew into an adult. I want to see Elkhart County be a resilient community where there is no longer a question about whether living there and breathing the air can endanger your health. I want to know that my friends and family are safe there and that if I move back long-term, I am not making a choice between my health and my home.

**Attitudes Towards Pollution and Industry in Indiana**

The decision to study pollution in Indiana comes partly from personal connection, but Indiana seems to be in particular need of research and activism. Elkhart County is not much different from many other areas of Indiana that are both rural and industrial, and so serves as a reflection of issues facing the state generally. Indiana reported the greatest amount of toxic releases per square mile in 2016 of any state or territory before dropping to third in 2017 (“TRI Explorer: Indiana fact sheet”, 2016). Besides the well-studied and widely known issues in Gary, Indiana (Hurley, 1995), lesser known places such as Evansville in southern Indiana and Franklin in central Indiana have recently garnered media attention for their toxic environments.

A 2016 *USA Today* article, “Meet America’s Super Polluters,” reported on a study by the Center for Public Integrity where researchers found, “More toxic pollution from utility coal plants was sent into the air within 30 miles of Evansville than around any other mid-sized or large American city in 2014…” (Hopkins, J. S., 2016). The article goes on to describe cases of asthma exacerbation and other health impacts from particulate matter in the region and the frustrating lack of state-level action on the issue. When asked for comment, the Indiana State Department of Health (ISDH) replied that pollution was outside their focus area and the Department of Environmental Management (IDEM) replied that they had no health professionals on staff (Hopkins, J.S., 2016).
Using TRI to Investigate Air Pollutants in Elkhart County

More recently, the community of Franklin, Indiana, (population 25,000) has made national headlines as nearly 25 children have been diagnosed with rare forms of cancer in the last 10 years with twenty-five more cases occurring in the surrounding County (Bowman, 2018). At the request of community members, ISDH twice investigated the community as a possible cancer cluster, but concluded that it was not. Mothers, who are part of a new community organization “If it Was Your Child,” have enlisted the help of a New Jersey based non-profit to help conduct research. So far they have found elevated levels of trichloroethylene, commonly known as TCE, and other toxic chemicals in several homes tested in an attempt to find possible causes (Bowman, 2018, 5). Bolstered by the new evidence, the Franklin community’s fight for recognition is ongoing. The responses of ISDH and IDEM to the issues in Franklin and Evansville reveal a concerning failure by the state to link pollution and health in Indiana.

These two stories somehow found the attention of major news outlets and public outcry, but plenty of cases fly under the radar. Elkhart County has their own case of highly elevated levels of TCE exposure that only those knowledgeable about the community’s environmental issues seem to know about. In the 1980s, Johnson Controls accidently dumped a truckload of TCE, which they used as a degreasing agent in the manufacturing of air conditioning parts. The company discovered contaminated soils and waters in 1991 which have since made their way towards a nearby residential neighborhood where ongoing testing has found highly elevated vapors in home basements. Thus far, there seems to have been no health surveying of current or former residents and the neighborhood’s battle with IDEM and Johnson Controls for an adequate clean-up plan continues (Kline, 2019; Goshen Green Drinks, personal communication, September 10, 2019). Community members near the site have become rightfully suspicious of cleanup promises over the years. Johnson Controls sold the property in the mid-2000s and the
Using TRI to Investigate Air Pollutants in Elkhart County

new owner attempted to convert the property for other uses. Knowing the buildings contained asbestos, the owner allowed a local man to do the demolition in exchange for salvaged parts. After demolition, the pair conspired to transport an estimated 200 truckloads of asbestos laden debris across town to a local farm where they illegally buried the material. In 2016, the EPA conducted emergency remediation of the debris that remained on the original site. Two years later, residents filed a lawsuit against the responsible parties for endangering their health and failing to inform them of the asbestos contamination in the first place (Schneider, 2018).

Heel-dragging, inaction, and prioritizing economics over human health often wins out from the state-level to small, locally owned businesses in Indiana. In her book, *Strangers in their Own Land: Anger and Mourning on the American Right*, Arlie Russell Hochschild (2016) offers a possible explanation rooted in politics. The book attempts to understand Tea Party voters in Louisiana through the “keyhole” issue of environmental pollution and her observations throughout are frighteningly familiar. Take out the cajun and bayou references, and she describes many of the attitudes towards the environment I have observed over the years in Indiana. A 2012 study cited by Hochschild looked at TRI data and voting histories and found that red states are more likely to be polluted than blue ones (Hochschild, 2016, p. 79; O’Connor, 2012). Indiana certainly seems to demonstrate this fact. In 2016, the same year the state had the greatest amount of toxic chemical emissions, 88 of 92 counties voted for Donald Trump—many overwhelmingly so (Indiana Election Results, 2017). Hochschild explored this phenomena further by looking beyond party lines to understand whether pollution did or did not correlate with environmental concerns and attitudes towards regulation. Using the General Social Survey (run by the National Opinion Research Center) and RSEI scores, Hochschild found that, “the higher a person’s exposure to pollution, given their residence, the more likely the individual was to think the
Using TRI to Investigate Air Pollutants in Elkhart County

United States is, in general, *overreacting* to the issue” (Hochschild, 2016, 277-279). There is no concrete evidence that this statement can be applied to attitudes in Elkhart County, but it raises questions for future study.

All these anecdotes serve to illustrate environmental attitudes in Indiana and Elkhart County. I gather that when it comes to pollution in Elkhart County, barely anyone is looking. After a year of study and many conversations, I have found no community groups or individuals investigating ongoing chemical releases nor pushing for their reduction. Over one hundred years of manufacturing in Elkhart County has left the landscape dotted with brownfield sites and a communal sense that we are contaminated. TRI and RSEI data offer a unique opportunity to look at ongoing pollution and press for proactive changes that can greatly improve environmental health.

**Industrial Legacy of Elkhart County, Indiana**

These attitudes towards pollution and industry in Elkhart Count are rooted in its history. On an overcast November day I traveled to the Elkhart County Historical Museum to learn about the rise of industry in the area. The large, 20th century brick building originally served as a small town high school, but the day I visited the halls remained eerily quiet. Not finding anyone at the front desk, I wandered the exhibits for nearly 45 minutes before a staff member realized they had a visitor. The newer, recently updated, exhibits use trendy graphics and story boards to tell the story of the Pottowatami and Miami people who made semi-permanent settlements along the Elkhart River. I learned that the name Elkhart comes from a Miami myth about an Elk’s heart. I also peeked at an unfinished exhibit telling of the atrocities committed against these indigenous tribes. In contrast, the older exhibits are chock full of artifacts that use placards filled with recognizable family names to draw interest through genealogy. Wading through these, I began to
Using TRI to Investigate Air Pollutants in Elkhart County

find an overarching story that helps answer the how and why questions about the community I see today.

The railroad arrived in Elkhart County in 1851—the same year my own family history in the County began with the arrival of my great great great great grandfather (Elkhart County Historical Museum). The railways crisscrossing the County were, and to some extent continue to be, the major rail line connecting East Coast population hubs with Chicago and beyond to the West. As a crossroads, Elkhart County became uniquely positioned to capitalize on the manufacturing boom taking place across the rust belt in the middle of the 19th century.

By the time the railway arrived, manufacturing already had a foothold in the region using the power of the Elkhart River and its tributaries. Towns cropped up around flour, timber, brick, and shingle mills. After the railroad, manufacturing diversified. A major furniture industry began operations in the 1870s and continued to be the largest employer in one small town for nearly a hundred years. Around the same time, the City of Elkhart became the largest population center in the County due largely to niche manufacturing industries like certain pharmaceuticals and musical instruments (Elkhart County Historical Museum). At one time the city was home to nearly 60 instrument manufacturing companies and in 1969 accounted for the production of 40% of the world’s musical instruments (Corley, 2010; Elkhart County Historical Museum).

Like many other cities and towns in the midwest, the lure of plentiful manufacturing jobs attracted people from around the country. A large African American population settled in the city of Elkhart during the Great Migration—loosely defined as the period from 1910s-1960s when southern blacks fleeing sharecropping and Jim Crow sought manufacturing work in the Northeast and Midwest. Also seeking manufacturing jobs, white workers fleeing poverty in Appalachia arrived from Kentucky and West Virginia. The influx of people fueled already latent racial
Using TRI to Investigate Air Pollutants in Elkhart County

tensions and added to the sad history of race relations in Indiana. The city of Goshen and other towns through the County became “sundown” towns, or places that people of color knew to be dangerous after sunset. My dad even has the 1960s neighborhood housing covenant for our old house in Goshen that prohibited renting or selling to black people. To this day, the County remains largely segregated where the city of Elkhart remains the African American population center.

Walking around the historical society museum, one aspect of Elkhart County’s history was conspicuously absent, the Recreational Vehicle (RV) industry, possibly because RVs have a museum devoted entirely to the history of the industry. Standing in stark contrast to the history museum, the Recreational Vehicle/Manufactured Home Hall of Fame (RV/MH Hall of Fame) loomed against the flat, open landscape with a parking lot and building style that reminded me more of a professional sports stadium than a museum. A maintenance worker shoveling the sidewalk greeted me before I could enter asking which RV company I represented. After clarifying and buying my admission ticket, I made my way through two massive exhibition halls displaying 50 or 60 RVs that showed the development of the industry dating back to its roots as canvas pop-up trailers pulled by Model T Fords. While Elkhart County’s band instrument businesses largely broke up and outsourced production in the 1960s, the RV industry has shown remarkable staying power in the face of globalization (Elkhart County Historical Museum).

Today, more than 80% of RVs sold in the United States are made in Elkhart County according to reporting by the New York Times (Tackett, 2018). The museum rightfully calls Elkhart the “RV Capital of the World” and the money generated from the industry was on full display.

RV manufacturing in Elkhart County developed in the 1930s fueled by a combination of rail and highway access, plenty of water resources, and proximity to Detroit auto manufacturing
Using TRI to Investigate Air Pollutants in Elkhart County

(Hesselbart, 2017, p. 19). Many of the tires and other shared parts needed for both automobiles and RVs were already being manufactured regionally. RV sales took off alongside the post-World War II economic boom in the United States that allowed for leisure time and spending. When the war began, the greater Elkhart County region claimed around 50 manufacturers which grew to over 300 by 1970 (Hesselbart, 20017, p. 38). In the 1960s, RV companies began to employ more workers than any other industry in the area (Hesselbart, 2017, p. 54). Companies making trailer beds, fiberglass shower stalls, motor parts, cabinetry, and dozens of other component parts sprang up all over the area. The region’s dependence on RVs first reared its nasty side during the energy crisis in the 1970s marked by layoffs, factory closures, and consolidation due to buyouts (Hesselbart, 2017, p. 38). The industry eventually recovered, but, unsurprisingly, an economy based on a luxury item acutely feels the ups and downs of economic trends and has experienced a boom-bust cycle alongside the general U.S. economy ever since. The 2008 Recession served as a reminder of how dependent the region continues to be as Elkhart County experienced one of the highest unemployment rates in the nation—near rates not seen since the Great Depression. In 2009, Elkhart County’s unemployment rate topped out at 19.6%. The industry recovered with a boom however. Unemployment swung to one of the lowest rates in the nation at 2.2% by April of 2018 (FRED economic data, 2019). The massive slow down and explosive recovery prompted two visits from President Barack Obama, bracketing either end of his presidency.

RV manufacturing brings together an unlikely workforce that reflects the somewhat odd demographics of Elkhart County. The industry has been an important part of keeping a sizeable Amish community in the area who were originally drawn by fertile farmlands and their strong connections to the Mennonite community (many Amish, who decide to leave their church and
Using TRI to Investigate Air Pollutants in Elkhart County

adopt modern conveniences, including my own grandfather’s family, end up joining the Mennonite church. As their population outgrew available farmland, many Amish went to work in RV factories or become entrepreneurs themselves in supporting industries making custom parts. In driver’s education I did not learn to merge onto a highway, but I did learn to safely pass a buggy on a narrow county road. Mexican immigrants are the most recent group to join the Amish and Mennonites, African Americans, and whites from Appalachian mining heritage. Like band instruments and other manufacturing before it, the promise of high-wage manufacturing jobs in the RV industry drew Mexican and other Latinx immigrants to the city of Goshen, where they have formed strong communities on the northside of the city. Many Mexican restaurants and markets make up the downtown businesses and the local high school now graduates over 50% first or second generation Latinx immigrants. In a typical RV factory you can find rows of outlets where the Amish charge their cell phones (no electricity at home, but, yes, they have cell phones!) and taco trucks in the parking lot.

Today, Elkhart County is home to over 205,000 people. Non-Hispanic whites make up a majority of the population, but Hispanic, Latino, Black, mixed persons, and other minorities account for just over 25% of residents. The U.S. Census does not separate out the Amish community as a minority group, but their numbers are hidden in numbers like the 18.8% of the population for whom English is a second language and the nearly 20% of those over the age of 25 without a high school diploma (“U.S. Census: Quick Facts”, January 15, 2020). In 2018 an estimated 13.3% of the population lived below the poverty line (FRED, January 15, 2020).

Heavy manufacturing, agriculture, economics, and the demographics of Elkhart County all converge to form its political landscape and attitudes towards pollution. Overall, the County leans heavily conservative with liberal pockets in the more populous and diverse cities of Elkhart
Using TRI to Investigate Air Pollutants in Elkhart County

and Goshen. The county’s heavy economic dependence on the RVs and history of racial tension mean things can get ugly when the economy takes a downturn. During the 2008 recession for example, white, laid-off blue collar workers scapegoated the Latinx community for their woes and I watched as many participated in xenophobic protests and shouting matches at the county courthouse. General conservatism and heavy reliance on manufacturing combine to create a laissez-faire attitude toward pollution and great skepticism about any kind of pollution regulation. Growing up I frequently heard phrases like “it hasn’t hurt me yet” from people like my boss at a summer painting job who said something along these lines as we scraped what was likely lead paint from the side of a house.

In this context I am investigating the industries upon which the economic well-being of my community depends. In Indiana, the more immediate consequences of economics often win out over consideration of factors like the connections between pollution and community health. This short-sited view to economics fails to realize the ways in which decisions that allow unfettered pollution shift the costs from manufacturers to their workers and surrounding communities in the form of costly—both figuratively and literally—health consequences. My investigation seeks to use community-right-to-know tools like TRI and RSEI to start a conversation from a different perspective with a fuller understanding of the risks my community takes as we continue to pollute the air we breathe. The starting point for such a conversation is knowledge of the risks. In the TRI and RSEI data I have found a compelling argument that the health risks posed by pollution in Elkhart County should not be accepted as “normal.” My findings on the specific chemicals and facilities that pose the largest risks can also help guide a second conversation: what will we do about it?
Chapter 2: Literature Review

In order to begin understanding pollution in my hometown, I am reliant on a long history of community activists before me. Many histories of the modern American environmental movement begin with the preservation and conservation work of the early 20th century, but environmental activism focused on environmental health predates those efforts. People began to see the dirty consequences of rapid industrialization in the United States as early as the second half of the 19th century. An early pioneer of this kind of industrial health activism, Alice Hamilton grew up about an hour from my hometown in Fort Wayne, Indiana in the 1870s. She went on to live and work at Hull House in Chicago where Hamilton’s work hearing the concerns of factory workers prompted her to investigate the health problems they faced. Hamilton accomplished a few firsts in her lifetime: first to conduct a state sponsored investigation of industrial hazards and first female professor at Harvard for a first of its kind industrial hygiene program (Gottlieb, 1993, p. 49-51). Hamilton and her lifetime of work pioneered environmental public health research methods and offered some of the first critiques of rapid urbanization through the lens of industrial pollution.

Rachel Carson continued this work from an ecological perspective with her publication of *Silent Spring* in 1962 (Gottlieb, 1993, p. 81). “In a period when the question of pollution was only just beginning to receive significant public attention, Carson argued that public health and the environment, human and natural environments, were inseparable,” writes environmental historian Robert Gottlieb about the context for Carson’s work (Gottlieb, 1993, p. 84). Carson influenced and changed the thinking of many people in her time and her work is credited with helping to create the public will for the formation of the Environmental Protection Agency and the passage of huge pieces of environmental legislation in the 1970s including the Clean Water
Using TRI to Investigate Air Pollutants in Elkhart County

Act, Clean Air Act, the National Environmental Policy Act, and many other pieces of legislation whose purpose was to, “control the environmental by-products of the urban industrial order” (Gottlieb, 1993, p. 125).

Lois Gibbs, another oft-cited female leader concerned with the health impacts of hazardous waste, called for justice in her home community of Love Canal. Like Hamilton and Carson before her, Gibbs highlighted the connection between public health and legacy pollution. Her leadership helped pass the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as Superfund legislation, in 1980 (Gottlieb, 1993, p. 186-188). Trying to use the new rights and protections outlined in the previous decade, largely female led anti-toxics networks sprung up all over the country. These groups sought to expand the scope of CERCLA legislation to include toxics-right-to-know laws (Gottlieb, 1993, p. 175, 191). The wealth of data made publicly accessible by these laws has allowed me to investigate the pollution my home community faces.

The Development and Uses of the Toxics Release Inventory

Efforts by anti-toxics activists led Congress to pass the Toxics Release Inventory (TRI) in Section 313 of the Emergency Planning and Community Right to Know Act (EPCRA) passed during reauthorization of CERCLA in 1986. The Inventory compiles information on point-source pollutants through required self-reporting by industrial facilities based on an EPA determined list of toxic chemicals. Facilities report only when they meet a certain release threshold designated per chemical or chemical group. Under TRI, facilities report an estimated total amount released for each chemical and some basic characteristics of that release. These characteristics include whether the release was on or off-site and whether it was to the land, water, or air. Increasing the robustness of data, TRI has more recently expanded beyond release information to include the
Using TRI to Investigate Air Pollutants in Elkhart County

classical recycling, energy recovery, and treatment activities of facilities. EPCRA also requires
public dissemination of this data, and the first summary report released in 1989 gave
unprecedented public access to toxic release information. Through the years new information
technologies have made this data increasingly easier to access, search, analyze, and use in
combination with other tools. In 1998 the EPA released a downloadable TRI data explorer,
which eventually evolved into the web-based tools available today. Along the way, other
iterations and tools integrated TRI data with mapping technologies allowing individuals and
community groups direct access to information about industries in their neighborhood
(“Timeline of toxics release inventory”, n.d.).

Despite the efforts of grassroots anti-toxics groups, EPCRA requires mandatory
reporting, but does not in any way mandate pollution reductions. “The data are not tied to
specific regulations or permits but are intended for public accountability and transparency,” write
Miller and Muir (2015, p. 25). Actual pollution reduction is thus dependent on public activism
and the responsiveness and willingness of industry. Facilities may be motivated to reduce their
releases by pressure from outside groups, desire to avoid bad publicity, and/or recognition of cost
savings. In its 30 years of existence researchers have attempted to answer the question, does this
model work? This question depends on a second question—work for whom? Looking at TRI
data from 1988 (first reporting year) to 2012, total on-site releases of toxic chemicals have
dropped about 77% (Miller and Muir, 2015, p. 25). While some researchers point to the
reductions since implementation of TRI as a resounding success (Fung, A. & O’Rourke, D.,
2000), this statistic provides only a partial picture of emissions. Real reductions have been made
over a 25-year time span, but mostly from large, heavily polluting facilities, which found
themselves under increased scrutiny through headline-making “dirty one hundred” lists. Collins,
Munoz, and JaJa (2016) adopt the term “toxic outliers” to describe facilities that account for a disproportionate amount of the hazard posed to a particular community. In contrast, facilities that reported releases under 100,000 pounds in 1988 have actually seen a net increase in toxic releases over the same 25 year time span (Miller and Muir, 2015, p. 29). Reductions from toxic outliers on the national stage suggests the ability of community knowledge of hazards to pressure their reduction. Since many communities do not have the resources, knowledge, or political will to provide oversight however, small industries have often flown under the radar and been left to self-assess their responsibility and make minimal efforts to reduce emissions (Gamper-Rabindran, S., 2006). This certainly may be the case in Elkhart County. I have found no indication that past or present community groups have utilized TRI data to provide oversight of our industrial facilities.

The Toxics Release Inventory gave unprecedented access to data, and academic researchers have taken advantage. Researchers have used TRI in a number of ways, which generally fall into one of five large categories: epidemiology, economic analysis, policy effectiveness, environmental justice, and prioritization for pollution reduction efforts. Using TRI’s geographic elements, epidemiologists examine associations between estimated exposure to chemical releases and particular health outcomes at the national, state, and regional levels (Boeglin, Wessels, & Henshel, 2006; Hendryx, Luo, & Chen, 2014; Hendryx, & Luo, 2012; Gong, et al., 2018). Economic researchers use TRI to inform theories about corporate responsibility or look at the ways TRI reporting has affected businesses and local economies (Hamilton, 1995; Delmas & Blass, 2010; Delmas & Montiel, 2009). In a similar vein, many policy researchers have evaluated the self-reporting model of TRI to assess its effectiveness and practicality for pollution reduction and whether it may serve as a model for other oversight
Using TRI to Investigate Air Pollutants in Elkhart County

programs (Miller and Muir, 2015; Gamper-Rabindran, S., 2006; Konar & Cohen, 1997; Khanna, 2001). Perhaps the largest use of TRI data comes from the field of environmental justice (EJ) which Chakraborty describes in the introduction to the Routledge Handbook of Environmental Justice as, “[the] unequal and differentiated positioning, which typically places the heaviest environmental burdens upon marginalized, disadvantaged, and less powerful populations” (2018, p. 2). Also drawing on the geographic elements of TRI, researchers have evaluated questions of equity in the distribution of risk for hazardous chemical exposure (Collins, Munoz, & JaJa 2016; Mennis & Jordan, 2005; Morello-Frosch et al., 2002; Perlin et al., 1995; Bowen, et al., 1995; Wang & Feliberty, 2010). Finally, researchers have studied how TRI data can be used to look at relative contamination and aid government agencies and oversight groups in prioritizing their efforts for reducing pollution (Lim, Lam, & Schoenung, 2010; Lim, Lam, & Schoenung, 2011).

Many of the first EJ studies used spatial methods that included simple hazardous facility presence or absence analysis. More sophisticated mapping tools later allowed improved study methods that could begin accounting for magnitude in hazard distance approaches (Chakraborty, 2018, p. 176; Mohai and Saha, 2006, p. 390; Mohai et al, 2011; Ash & Fetter, 2004). TRI data allowed researchers to include for the first time some approximate for volume of release that distinguished super polluting facilities from smaller ones (Chakraborty, 2018, p. 176-180). While vastly improving analysis, amounts from TRI alone still did not tell the full story as it neglected any indication of relative toxicity, environmental fate, or potential for human exposure.

Within environmental justice (EJ) studies, TRI data have been used with spatial analysis methods, which have become more sophisticated alongside the development of increasingly powerful tools, like the Risk-Screening Environmental Indicators (RSEI) model. The EPA’s development of the RSEI model in the late 1990s addressed some of these shortcomings (“RSEI
Using TRI to Investigate Air Pollutants in Elkhart County

model reference document history”, n.d.). RSEI uses TRI amounts and assigns a toxicity-weighted multiplier based on health and toxicology research of human exposure. The model additionally considers chemical fate, transport, and human exposure assumptions to arrive at an estimated dose. In modeling air releases for example, RSEI considers factors such as stack height, wind patterns, the chemical’s decay properties, and routes of human exposure. Finally, RSEI modeling considers population data to estimate the size of a potentially exposed population. The toxicity-weighted chemical amount, modeled dose, and exposed population are then multiplied in the following formula to create a RSEI Score (“Understanding RSEI Results”, n.d.).

\[
RSEI \text{ Score} = \text{toxicity weight} \times \text{exposed population} \times \text{estimated dose}
\]

The final RSEI score is valuable for evaluating the risk of a chemical release in relation to another, but has little meaning on its own. The score allows for comparison of potential community health risk across such factors as geographic regions, facilities, or chemicals.

The most accessible form of RSEI data is a RSEI score calculated for a single facility or a single chemical release by a facility that can be aggregated across a desired geographic region and scale (i.e. aggregated by state, county, or Census blocks). These data can easily be accessed by the public from an online dashboard tool. Version 2.3.7, the most current version of the dashboard (at time of writing last updated October 8, 2019), includes data from TRI reporting year 2017 which can be manipulated and filtered to provide an overview of a particular community. The dashboard also immediately puts results in context by automatically providing comparison across similar geographies (i.e. county or state). RSEI modeling also yields a particularly powerful, but difficult to use, set of geographic microdata. Rather than aggregating by facility or release, RSEI microdata models a toxicity-weighted chemical concentrations for
Using TRI to Investigate Air Pollutants in Elkhart County

810 meter x 810 meter gridded cells covering the entire United States. The chemical amount, its toxicity, and fate are modeled for each chemical released from each facility yielding a toxicity-weighted estimated concentration for each “receptor” grid-cell. Releases can then be aggregated for all chemicals from all facilities that may affect a particular grid cell. The fine geographic scale of these data allow for neighborhood-level analysis anywhere in the United States, but also makes the data set so vast that, in general, only researchers have the access or know-how for using the data. Further complicating its use, the microdata grid lays somewhat arbitrarily so significant calculations must be done to convert to geographies like political boundaries or U.S. Census tracts that allow for comparison with population and other data (“RSEI Geographic Microdata”, n.d.).

RSEI adds significant power to the TRI data for community analysis, but the tools are best used together (Lim, Lam, and Schoenung, 2010; 2011). RSEI modeling relies on certain assumptions that, while based on extensive scientific research, assigns toxicity weights that can appear more certain than they may be in reality. For some chemicals, the effects of exposure to human health remains insufficiently studied or without reliable, current methods to be known at all. Analysis using both data types thus remains important.

Situating Elkhart County

The community characteristics and geographic scale of Elkhart County make it a somewhat unusual case amongst studies using RSEI and TRI. Jayajit Chakraborty, an editor of the Routledge Handbook of Environmental Justice published in 2018, reviewed the development of spatial methods for understanding environmental risk. Taking a closer look at the studies cited in this broad overview of research spanning the three decades since development of environmental justice as a field, reveals an interesting pattern. Many studies take place on a
nation-wide or state-wide scale, and all those remaining studies that concern a more focused
geography center around major U.S. cities or counties with major cities like, to name a few, St.
Louis, Seattle, Chicago, Los Angeles, and Phoenix (Chakraborty, 2018, p. 185-189). Notably
absent are studies of places like Elkhart County with two cities that both have populations under
55,000.

Unlike the major metropolitan areas studied, Elkhart County is a space with markers of
both rurality and urbanity including a moderately sized and diverse population, farms and a rural
cultural identity, and a significantly polluting industrial sector. Elkhart County, with a population
of approximately 200,000 people, cannot be easily classified as either rural or urban. The United
States Department of Agriculture classifies counties using a “rural continuum code” that indexes
on a 1-9 scale. The continuum designates counties with metropolitan areas of 1 million or more
as a one and counties with an urban population of less than 2,500 not adjacent to any
metropolitan areas as a 9. Elkhart County is designated a three—in a metro area of less than
250,000 people (USDA, 2013). While highly industrialized, farmland and Amish buggies still
dot the landscape, giving the place a rural cultural identity. The city of Elkhart’s population of
52,000 makes it the largest city in the County, but locals also consider collections of 20 or so
houses like the community of Foreaker its own town. Blanketed by an industrial park to the north
but looking out over cornfields to the east and west, my elementary school further illustrates the
pairing of industry with makers of rurality.

Spatial studies using RSEI and TRI data to look at disproportionate hazardous burdens on
minority and low-income populations often neglect focusing on rural and small-town
dimensions, but EJ studies as a whole recognize the importance. The *Journal of Rural Studies*
devoted an entire issue in 2016 to the intersection of rural and environmental justice studies. In
Using TRI to Investigate Air Pollutants in Elkhart County

the issue’s introduction, Loka Ashwood and Kate MacTavish bring the two fields together under 19th century political theorist Alexis de Tocqueville’s concept of “tyranny of the majority.” In an environmental context, the utilitarian logic that allows tyranny of the majority justifies the placement of hazards in places that are economically poor, resource rich, and sparsely populated. The logic goes that these places need the jobs and developmental boost and any potential consequences will not affect that many people. The minority itself can adapt this thinking as, “those who may receive limited benefits none-the-less support schemes that perpetuate their own vulnerability” (Ashwood & MacTavish, 2016, p. 274). This logic can lead to rural targeting and overburdening of environmental hazards. Traditional EJ studies that look at class and race also recognizes the tension between majority and minority, and, as a whole, have contended that “minority sacrifice to majority interest is fundamentally unacceptable” (p. 273). de Tocqueville’s concept of tyranny of the majority unites injustice based on class, race, and rurality under a single framework.

While not always explicitly acknowledged, the rural dimensions of environmental justice have been explored in numerous case studies of communities where grass roots activism developed to demand a healthier environment. In his book Sacrifice Zones: The Front Lines of Toxic Chemical Exposure in the United States, Steve Lerner (2010) collects the stories of communities around the country who organized because their houses smelled of lighter-fluid or their kids were getting sick. Lerner terms these communities “sacrifice zones” and characterizes them generally as, “semi-industrialized areas—largely populated by African Americans, Latinos, Native Americans, and low income whites—where a dangerous and sometimes lethal brand of racial and economic discrimination persists” (Lerner, 2010, p. 2). Lerner provides accounts of four communities tackling air pollution: Port Arthur, Texas, Corpus Christi, Texas, Addyston,
Ohio and Marietta, Ohio. The largest of these, Corpus Christi with a population of 326,000 residents hardly qualifies it as a major city nor do the 944 residents in the smallest, the unincorporated town of Addyston, Ohio. All of these communities organized to demand pollution reductions and clean-up efforts because the consequences of industry became unacceptable to local residents. Something key ties these communities together—they organized because they knew their community was contaminated. Similar to Lerner’s “sacrifice zones,” Michael R. Edelstein uses the language of “contaminated communities” to talk about pollution burdened places. Edelstein defines a contaminated community a little more strictly as, “any residential area located within or proximate to the identified boundaries for a known exposure to pollution” (Edelstein, 2004, p. 9). The communities described in Lerner’s book knew they were contaminated due to some triggering event like the rise of community health issues or news of a major hazardous spill. Many communities may be contaminated, but, without investigation, that contamination may be unknown. TRI and RSEI data offer a method for proactive pollution studies that researchers seem to overlook and underutilize for non-metropolitan, semi-industrialized geographies.

Finally, while this study draws on methods used by EJ studies it differs greatly since my primary goal is not to show that toxic chemical exposure disproportionally affects minority and low income populations. This study draws on similar mapping methods but considers EJ by looking at the convergence of toxic chemical exposure with markers of social vulnerability. The focus on convergence rather than correlation looks similar to a recent report by the Natural Resources Defense Council (NRDC). The report “Watered Down Justice” (Fedinick, 2019) maps drinking water violations with racial, ethnic, and language vulnerability by county across the entire United States. This method contends that the most vulnerable deserve special recognition
Using TRI to Investigate Air Pollutants in Elkhart County

based on three decades of evidence from traditional EJ studies that vulnerable populations tend to bear the brunt of environmental burdens. In addition, this study differs by using multiple methods of research to describe a hyper-local area. In fact, the bulk of this research draws on prioritization methods developed in a non-EJ study by Lim, Lam, and Schoenung (2010, 2011). Finally, this study approaches RSEI and TRI data to describe what sorts of health problems might arise and make informed decisions about what actions taken now can prevent future adverse outcomes.
Chapter 3: Methods

In 2017 Elkhart County had 96 Toxics Release Inventory (TRI) reporting facilities (68 of which reported an actual release amount) that released 27 different toxic chemicals to its water, land, and air (TRI, 2017). The methods described in this chapter attempt to pull multiple approaches together in order to arrive at an understanding of what the amount of toxic chemical air pollution in Elkhart County means for its residents. Developing an “understanding” requires consideration of several different factors which can be grouped into two follow up questions:

1. What industries, facilities, and chemicals pose the largest risk to the community?
2. Who is most affected and where might communities be doubly burdened by hazardous air and social vulnerability?

To answer these questions, I used TRI data and risk scores from the Risk-Screening Environmental Indicators (RSEI) Model. The first part of my analysis addressed the first question by ranking and calculating proportions to understand a chemical release relative to all releases in the County. Starting with self-reported, by facility, chemical emission amounts (in pounds) from TRI, aggregated amounts of release were calculated across a number of factors including medium of release (i.e. land, water, air), facility, industry type, and chemical. These aggregates were then used to rank and calculate proportions (percentages) of release for each category. Since analysis based on only amounts does not account for toxicity or risk of exposure, I made the same calculations with RSEI’s modeled scores. I next explored the health literature supporting RSEI’s modeled scores. This provided insight into why the two data sets yielded such different results and helped form a more complete, nuanced answer to what releases pose the largest risk to Elkhart County residents. The last part of my analysis addressed the second question by returning to the data and using Geographic Information Systems (GIS) mapping to
Using TRI to Investigate Air Pollutants in Elkhart County

create a series of choropleth maps that describe where the highest toxicity concentrations in Elkhart County are located. In addition I mapped emissions data with socio-economic indicators of vulnerability to begin describing who may be most affected by the toxic chemical pollutants. Finally, to give the numbers some context, I briefly compared the top chemicals and facilities with national data.

Defense of Methods

This study’s use of multiple analysis methods stems from the work of other researchers and early investigation into the needs and characteristics of Elkhart County. The multi-part analysis focuses specifically on chemical air emissions in the year 2017. There are a number of reasons for focusing on air including scope, community need, early stages of analysis, and the limits of modeling. Preliminary investigation, confirmed by subsequent analysis, showed that the vast majority of chemical emissions in Elkhart County were to the air. In addition, assumptions and models of hazard proximity and its links to exposure are better developed and studied for air emissions than either land or water. For example, water emissions and estimations of exposed populations must account for a multitude of complex factors such as flow, dilution, sediment settling, and varied routes of human exposure (Chakraborty, 2018, p. 184). Data from the year 2017 were chosen as a method of limiting the scope of analysis and to address community need. The historic industrial legacy of Elkhart County is largely known, and some work has already been done to assess, clean-up, and redevelop brownfield sites. Toxic release emission data uniquely allow for assessment of ongoing pollution. This study does not seek a temporal understanding of pollution in the County and instead focuses on TRI reporting year 2017—the most recent available data at the start of analysis in spring 2019.
Using TRI to Investigate Air Pollutants in Elkhart County

Limited to air releases in 2017, the ranking and calculating portion of analysis uses two different, but related, data sets due to the limits of TRI data. TRI data glaringly do not account for toxicity of chemicals, characteristics of dispersion, or routes of human exposure. Lim, Lam, and Schoenung (2010; 2011) used TRI data and toxicity-weighted models to look at methods of prioritization for informed decision making by government agencies and other oversight groups. In one study, they reviewed 2007 TRI air and water release data to identify the most polluting chemicals, industries, and US states using two different methods. First, they compiled a list of top polluting states, industry sectors, and chemicals based on pounds released. Second, the researchers utilized “toxicity potential characterization factors” from the EPA’s Tool for Reduction and Assessment of Chemicals and Other Environmental Impacts (TRACI) to weight their calculations and rankings. Taking into account toxicities, top polluting states and industries and the chemicals of greatest concern shifted considerably. For example, looking at raw amounts, Indiana ranked number three for total releases and number one for water releases (Lim, Lam, & Schoenung, 2010, 51). When accounting for toxicity using the TRACI toxicity factors, Indiana water releases seem comparatively less hazardous than other states. For cancer potential from water releases, the state dropped to number five and did not even appear in the top ten list for non-cancer and eco-toxicity (52). In another study published the following year, Lim, Lam, and Schoenung (2011) conducted a similar comparative evaluation, but this time looked at differences and similarities between two different tools—TRACI toxicity characterization factors and the Risk-Screening Environmental Indicators (RSEI) model.

Both TRACI and RSEI can be valuable tools, but my own analysis uses only RSEI modeling as an expansion of TRI. RSEI developed directly from the TRI data as a complimentary analysis tool and so shares terminology and categorization methods. TRACI
characterization factors come in the form of a downloadable Excel file that gives a multiplier for each chemical substance and various “impact categories” including, but not limited to, “human health cancer”, “human health non-cancer”, and “ecotoxicity” (Bare 2012; “Tool for Reduction”, n.d.). TRI, RSEI, and TRACI all use a numbered identifier for chemicals assigned by the Chemical Abstract Service (CAS); however, TRI reporting, and thus RSEI, additionally use chemical groups that are not part of the CAS number system. For example, lead has a CAS number, but an additional category of “lead compounds” with its own designation unique to TRI is also used. TRACI does not include characterization factors for these chemical groups. TRACI also lacks multipliers for critical chemicals in Elkhart County such as cobalt and nine other chemicals of the total 27 released in the County. Lim, Lam, and Schoenung recommend the use of both the TRACI and RSEI models “to provide complementary information for consistent and robust environmental management and policy” (2011, 2239). Unfortunately, on the scale of Elkhart County, there are too many data gaps to use the recommended combined method.

To evaluate the relationship between emissions and vulnerable populations I drew largely on spatial methods used in Environmental Justice (EJ) studies. As part of the Routledge Handbook of Environmental Justice, Chakraborty (2018) reviews the history of EJ’s spatial methodologies for estimating exposure and divides them into four different categories of analysis—Spatial Coincidence, Distance-Based, Plume-Based, and Cumulative Exposure. These four categories also roughly reflect the historic progression of spatial EJ analysis in respective order. The final analysis group, Cumulative Exposure analysis, uses simplified air-plume estimates to generate toxicity concentrations from all sources that may cumulatively affect a particular geography. For this type of analysis researchers draw on data developed by government agencies (p. 182).
Using TRI to Investigate Air Pollutants in Elkhart County

Studies classified by Chakraborty as part of this final group almost exclusively rely on two publicly available models—RSEI and the National Air Toxics Assessment (NATA). In addition to release data, NATA uses air quality monitoring station data and models mobile sources of pollution. NATA data are thus able to reflect both point and non-point sources of air pollution (“NATA Overview”, n.d.). The data are limited however, as the multi-year studies are conducted somewhat irregularly—the most recent results are from 2014—and look at a smaller list of “criteria pollutants (“NATA Overview”; Chakraborty, 2018, p. 183). NATA also differs in that the EPA recommends using NATA data for large scale analysis only (“NATA Overview”, n.d.). The modeling techniques are broader estimates than RSEI and are not meant to be used for analysis of small geographic areas. Mapping for this study follows the trends of exposure analysis in EJ studies towards the “Cumulative Exposure Analysis” by utilizing RSEI microdata that allow for localized study in a small geographic area. All the maps use RSEI toxicity weighted concentration estimates on the scale of Census tracts.

As a final step, my mapping analysis needed some measure of “socio-economic vulnerability” to overlay with exposure data. The Center for Disease Control (CDC) pulls US Census Bureau data for a Census tract level data set called the Social Vulnerability Index (SVI). The SVI greatly simplifies the process of demographic data gathering and the indexing methodology relates multi-variable markers of vulnerability into a single, comparable score based in extensive research beyond the scope of this study. The CDC originally developed SVI as a tool for community natural disaster planning and response for events like flooding and earthquakes; however, the CDC’s operating definition of risk and the demographic variables they chose for inclusion in the index have many similarities with the “disaster” of polluted air. SVI defines risk with a simple formula:
Using TRI to Investigate Air Pollutants in Elkhart County

\[
Risk = \text{Hazard} \ast (\text{Vulnerability} - \text{Resources})
\]

where Risk is the likelihood or expectation of loss; Hazard is a condition posing the threat of harm; Vulnerability is the extent to which persons or things are likely to be affected; and Resources are those assets in place that will diminish the effects of hazards (Flanagan et al., 2011, p. 1).

Applying this to air pollution, “Hazard” becomes the threat of adverse health impacts from chemical exposure. The primary categories that make up the index use available data through the Census Bureau deemed indicators of vulnerability and lack of resources. The categories and their corresponding Census indicator variables include Socioeconomic Status (income, rates of poverty, employment, and education) Household Composition/Disability (age, single-parent households, and disability), Minority Status/Language (race, ethnicity, and English-language proficiency), and Housing/Transportation (housing structure, crowding, and vehicle access). The first three of these categories seem of particular importance, but the fourth reflects the focus on time-bound disasters like floods that require an assessment of evacuation ability. The different temporal nature of pollution hazards makes the Housing/Transportation category less relevant and so my maps use an aggregate of the first three categories only (p. 4-6).

Ranking chemicals, conducting a literature review, and mapping who may be exposed considers both environmental hazard and the particular vulnerabilities of an exposed population. The EPA and other government agencies offer a wealth of information to community members who know how to navigate, manipulate, and draw meaning from the data. The goal of this study is to gather and analyze emissions, toxicity, and socio-economic data from multiple sources to understand the possible consequences of recent pollution in Elkhart County and prioritize action to reduce hazardous impacts. The multiple methods yielded results not always directly comparable; but, ultimately, the results will lead to necessarily subjective, but well-informed, recommendations for how Elkhart County should proceed in pushing for emissions reductions.
Using TRI to Investigate Air Pollutants in Elkhart County

Data Compilation

My multi-part analysis relied on four major data sets selected for Elkhart County and the most recent data year available—TRI, RSEI, RSEI Census tract micro data, and SVI. This section outlines how each data set was obtained and the basics of what variables each contained (for full data sets see appendix “data sets”). To begin, I obtained TRI data from the EPA’s TRI Explorer tool. The online tool offers guided data queries that yield results organized by specific chemicals, geographic locations, facilities, or industry type. To find a full data set that includes all these fields, I navigated to the “Fact Sheets” tab of the data explorer. Here I ran a data query for the 2017 reporting year bounded by geography. I specified Indiana under “Topic of Interest” and narrowed further by selecting Elkhart County. This generated a summary “fact sheet” that offered a starting point for understanding TRI reported pollution in the County. The page also offers several download options for more complete data. The “GEO Facility List” found under “Download the TRI Geo-Specific Tables” yielded the most relevant and complete data. The data set contained unique rows for each chemical released by each facility. For example, AACO, a facility in Elkhart County, is represented in two different rows—one for their release of Nitric Acid and another for Nitrate Compounds. Relevant column fields and their descriptions from this data set are found in Table 1 below (TRI, 2017).
### Table 1

*Descriptions of Fields Found in the 2017 Toxic Release Inventory Data for Elkhart County, Indiana*

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FacilityID</td>
<td>Uniquely assigned number to each facility used for TRI reporting</td>
</tr>
<tr>
<td>Facility Name</td>
<td>Name of an individual reporting facility</td>
</tr>
<tr>
<td>Latitude/Longitude</td>
<td>Geographic coordinates of the facility</td>
</tr>
<tr>
<td>Industry Sector Code</td>
<td>First three digits of NAICS code—the general industry sector (i.e. Plastics and Rubber, Transportation Equipment, Fabricated Metals, etc)</td>
</tr>
<tr>
<td>NAICS Code</td>
<td>Full North American Industrial Classification System (NAICS) code—an economic classification system of industry developed by the U.S. Census Bureau</td>
</tr>
<tr>
<td>Chemical</td>
<td>Name of chemical or chemical group</td>
</tr>
<tr>
<td>CAS#</td>
<td>The chemical or chemical group compound ID number—a substance classification system developed by the Chemical Abstract Service</td>
</tr>
<tr>
<td>Carcinogen</td>
<td>Binary yes/no: Identified as at least possible carcinogen</td>
</tr>
<tr>
<td>Fugitive Air</td>
<td>Pounds of air releases “that don’t occur through a confined air stream.”</td>
</tr>
<tr>
<td>Stack Air</td>
<td>Pounds of point-source air releases</td>
</tr>
<tr>
<td>Water</td>
<td>Pounds of release to surface water bodies</td>
</tr>
<tr>
<td>Underground</td>
<td>Pounds of release to land: underground injection sites</td>
</tr>
<tr>
<td>Landfills</td>
<td>Pounds of release to land: in landfills</td>
</tr>
<tr>
<td>Land Treatment</td>
<td>Pounds of release to land: land treatment</td>
</tr>
<tr>
<td>On-Site Release Total</td>
<td>Aggregate pounds of release that “include(s) emissions to the air, discharges to bodies of water, and disposal at the facility to land”</td>
</tr>
<tr>
<td>POTW - Total Transfers</td>
<td>Pounds of chemical released to Publicly Owned Treatment Works (POTW) (ie. wastewater treatment plant)</td>
</tr>
<tr>
<td>Off-Site Release Total</td>
<td>Pounds of chemicals transported for disposal</td>
</tr>
<tr>
<td>Total Transfer</td>
<td>Pounds of chemicals transported for disposal, treatment, energy recovery, or recycling</td>
</tr>
<tr>
<td>Total Releases</td>
<td>Sum of off and on-site releases</td>
</tr>
<tr>
<td>Parent Company Name</td>
<td>Parent company of an individual facility</td>
</tr>
</tbody>
</table>

Using TRI to Investigate Air Pollutants in Elkhart County

As discussed in chapter 2, RSEI data come in many forms at varying geographic levels. For ranking and calculating proportions of release, I pulled from the EPA’s “EasyRSEI Dashboard v237.” Like the TRI Explorer, this tool helps with complex data queries by geography and other variables. Under the “Location” tab, I selected for Elkhart County, Indiana. Under the “Analysis Tab,” various data fields can be selected and downloaded in table form. Limited by Elkhart County and TRI reporting year 2017, I downloaded data with the fields listed in Table 2 below (RSEI, 2017).

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FacilityID</td>
<td>Uniquely assigned number to each facility used for TRI reporting</td>
</tr>
<tr>
<td>Facility Name</td>
<td>Name of individual reporting facility</td>
</tr>
<tr>
<td>Chemical</td>
<td>Name of chemical released</td>
</tr>
<tr>
<td>RSEI Media</td>
<td>Media of release (i.e. stack or fugitive release)</td>
</tr>
<tr>
<td>RSEI Modeled Pounds</td>
<td>The pounds of release modeled by RSEI. Which includes only pounds of direct air and water release and transfers to publicly-owned treatment works. Thus, the RSEI modeled pounds may show a different amount than total TRI pounds for the same year.</td>
</tr>
<tr>
<td>RSEI Modeled Hazard</td>
<td>The amount of the chemical released multiplied by RSEI’s weighted toxicity factor.</td>
</tr>
<tr>
<td>RSEI Score</td>
<td>A modeled score where the amount of chemical released, its weighted toxicity, and its estimated dose are multiplied together. The estimated dose accounts for population size and human exposure assumptions (i.e. modeling of environmental fate like air dispersal and rates of chemical decay)</td>
</tr>
<tr>
<td>RSEI Score - Cancer</td>
<td>RSEI score for cancer effects only</td>
</tr>
<tr>
<td>RSEI Score - Non-Cancer</td>
<td>RSEI score for all other human health impacts</td>
</tr>
</tbody>
</table>


The RSEI data used to map came from disaggregated RSEI microdata. Unlike the basic tabular data obtained from the EasyRSEI dashboard, the RSEI microdata are a large and complex
Using TRI to Investigate Air Pollutants in Elkhart County

data set not publicly available. The RSEI microdata model toxicity concentrations for 810 meter
by 810 meter grid cells across the entire United States (“Ways to Get RSEI”, n.d.). For my
purposes I needed this geography converted to Census tracts—a spatial unit that could be
compared with demographic data. I obtained RSEI microdata for Elkhart County with the help of
Michael Ash, PhD—an economist at the University of Massachusetts. I received data in tabular
form with disaggregated toxicity concentrations by facility, chemical, and US Census tract. In
other words, each row is a unique entry of the toxicity concentration from a single facility of a
single chemical in a particular Census tract (Ash, personal communication, sent 2019, May 31).
Table 3 explains the fields for this data set.

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facility Name</td>
<td>Name of individual reporting facility</td>
</tr>
<tr>
<td>FacilityID</td>
<td>Uniquely assigned number to each facility used for TRI reporting</td>
</tr>
<tr>
<td>Chemical</td>
<td>Name of chemical released</td>
</tr>
<tr>
<td>CAS</td>
<td>The chemical or chemical group compound ID number—a substance classification system developed by the Chemical Abstract Service</td>
</tr>
<tr>
<td>tract_id_2017</td>
<td>US Census Tract identifying number, or “FIPS code,” in 2017</td>
</tr>
<tr>
<td>tract_id_2010</td>
<td>US Census Tract identifying number, or “FIPS code,” in 2010</td>
</tr>
<tr>
<td>Toxicity Concentration 2017</td>
<td>A toxicity weighted concentration of the chemical from a single facility in a census tract</td>
</tr>
<tr>
<td>Concentration 2017</td>
<td>A simple, un-weighted concentration of a chemical from a single facility in a census tract</td>
</tr>
</tbody>
</table>


Finally, I downloaded a Census tract-level Social Vulnerability Index data set for the
entire state of Indiana from the CDC’s website which has no tool for querying by a smaller
Using TRI to Investigate Air Pollutants in Elkhart County

geography (Center for Disease Control, 2019). The data came in the form of a geographically defined layer or “shapefile” (a common file format used in GIS mapping). To select only data for Elkhart County, I used ArcPro to select and create a new layer with only those Census tracts in Elkhart County using their FIPS codes. The tabular SVI data attached to each Census tract had disaggregated Census variables and indexed aggregates for each of the four major SVI categories (Center for Disease Control, 2016). Table 4 gives shows the fields and their descriptions.

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIPS Code</td>
<td>An 11 digit code used by the US census bureau to identify unique census tracts across the country</td>
</tr>
<tr>
<td>RPL_Theme 1</td>
<td>Percentile ranking of vulnerability score compared to census tracts across the entire United States for the Socioeconomic Status category.</td>
</tr>
<tr>
<td>SPL_Theme 1</td>
<td>Sum of variables, or the vulnerability score, for the Socioeconomic Status category.</td>
</tr>
<tr>
<td>RPL_Theme 2</td>
<td>Percentile ranking of vulnerability score compared to census tracts across the entire United States for the Household Composition category.</td>
</tr>
<tr>
<td>SPL_Theme 2</td>
<td>Sum of variables, or the vulnerability score, for the Household Composition category.</td>
</tr>
<tr>
<td>RPL_Theme 3</td>
<td>Percentile ranking of vulnerability score compared to census tracts across the entire United States for the Minority Status/Language category.</td>
</tr>
<tr>
<td>SPL_Theme 3</td>
<td>Sum of variables, or the vulnerability score, for the Minority Status/Language category.</td>
</tr>
<tr>
<td>RPL_Themes</td>
<td>Overall percentile ranking of vulnerability score compared to census tracts across the entire United States. “Overall” meaning all four categories—Socioeconomic Status, Household Composition, Minority Status/Language, and Housing and Transportation</td>
</tr>
<tr>
<td>SPL_Themes</td>
<td>Sum of all four themes (or, “categories”)</td>
</tr>
<tr>
<td>E_variable</td>
<td>Estimate of an individual variable</td>
</tr>
<tr>
<td>M_variable</td>
<td>Margin of error for an individual variable</td>
</tr>
</tbody>
</table>

Analysis Steps

Using TRI and RSEI data to rank and calculate proportions.

Starting with the TRI data set, I used Excel to aggregate pounds of release based on several categories of interest. Next, I used the aggregates to rank, graph amounts, and calculate proportions of total release. The first category—meant to give a bird’s eye view of the data—aggregated by medium of release. As mentioned, the results of this analysis showed that air releases make up 99% of the total pounds of release and thus became the focus of this study. I created a “Total Air Release” column for the data set that summed fugitive and stack releases. This new field served as the base for the rest of the TRI analysis. After selecting for only those releases with an amount of Total Air Release greater than zero, I next aggregated by the chemical field using the “consolidate” tool in Excel. This yielded a summarized amount of Total Air Releases per chemical across the entire data set. I then ranked the chemicals from greatest to least and calculated what proportion of total releases in Elkhart County each chemical comprised. I used the same technique to aggregate, rank, and calculate based on the facility, parent company, and industry sector fields.

I used nearly the same techniques of manipulation for the RSEI data as that of TRI to aggregate, rank, and calculate across the same fields. The RSEI data however, do not include all the same fields as TRI. Most importantly, there is no information about industry sector or parent companies. TRI and RSEI data do share a FacilityID field so I joined the industry sector and parent company data from the TRI data set with the RSEI data based on that field using Excel’s “vlookup” tool. When complete, I was able to aggregate, rank, and calculate proportions across all the same fields as the TRI data. Finally, I created tables of rankings and proportions as the final product for these steps.
Chemical literature review.

To increase understanding of the differences between TRI and RSEI data and investigate the possible community health consequences of the top chemicals, I conducted a basic investigation of top release chemical by amount (TRI) and by modeled risk (RSEI). This literature review of cobalt and styrene, the top chemicals from each data set, did not consolidate academic articles detailing individual health studies, but instead gathered monographs, reports, assessments, and literature reviews published by various agencies. Modeled RSEI scores use multipliers based on assessments of health studies conducted by the EPA and other federal agencies. For each chemical, I looked at the most recent reports I could find from the Integrated Risk Information System (IRIS), Agency for Toxic Substances and Disease Registry (ATSDR), and the National Toxicology Program (NTP). In addition, I looked assessments by the International Agency for Research on Cancer (IARC) to fill in gaps and compare findings with a non US government agency.

Mapping toxicity concentration with the Social Vulnerability Index.

Using ArcPro and ArcOnline software programs from the Environmental Systems Research Institute’s (ESRI) suite of ArcGIS mapping systems, I mapped RSEI microdata to create a series of six thematic maps. The final, culminating map compares RSEI microdata with the socioeconomic status, household composition, and minority status themes in the CDC’s Social Vulnerability Index. I first worked to import and organize all my necessary data into ArcPro. I prepared the data in Excel by aggregating toxicity weighted concentrations in the RSEI microdata by Census tract. I created a new sheet with fields that included only the tract_id_2017 (FIPS code) and a total toxicity weighted concentration for each of the 36 Census tracts in Elkhart County. I then aggregated toxicity weighted concentrations coming from styrene and
cobalt individually. In total, I had three new sheets with aggregated toxicity weighted concentrations for all releases, styrene releases, and cobalt releases. Next, I attached the new aggregate toxicity weighted concentration sheet to the already geographically defined SVI data by performing a data join based on the tract_id_2017 and FIPS code from the RSEI and SVI data respectively. I repeated the processes for styrene and cobalt to create a total of 3 new map layers of Census tract polygons. The final piece of data I imported into ArcPro was another sheet prepared in Excel with a facility field and their corresponding latitude and longitude. In ArcPro I created a simple x,y point layer of the facility locations.

Creating the five single variable maps was relatively straight forward. For the first map I created a simple point location map of all the TRI reporting facilities in Elkhart County. I then created four choropleth maps showing a single variable divided into five geometric classes (which showed the greatest contrast between variables). These maps included: styrene, cobalt, and aggregate toxicity weighted concentrations; and the three aggregate SVI themes. Since all these variables have been manipulated, indexed, weighted by toxicity, and mapped to Census tracts (already reflecting population density), I did not normalize by area. Experimentation with normalization yielded results skewed towards population centers for each variable. Finally, I added lakes, rivers, and townships to serve as basic geographic markers. These layers come from Indiana MAP’s layer gallery—a database maintained by the Indiana geological and water survey (Indiana MAP, 2001; Indiana MAP, 2019a; Indiana MAP, 2019b). I downloaded the shape files and clipped the layers to Elkhart County.

The final map showing SVI and total toxicity concentration took a bit more manipulation. The multi-variable mapping tool can only be found in ArcGIS Online so I first uploaded my layer. The platform’s multi-variable symbolization tool allowed the creation of a map that
Using TRI to Investigate Air Pollutants in Elkhart County

divided each variable into three classes and then used choropleth overlays to show where there was and was not convergence. Three classes for each variable gave the map a total of nine possible classes. The layer then had to be downloaded and reimported into ArcPro to match the cartographic conventions of the other five maps and include the water bodies and townships.

The chemical rankings and mapping only serve to compare chemical releases \textit{within} Elkhart County and so lack a sense of the risks in a broader context. To conclude the data analysis, I add a brief section that compares the amounts of release and risk scores from the top chemicals and facilities to data for the United States. Both the TRI and RSEI online query platforms allow for quick comparisons and individual facility profiles summarize where releases stand next to national averages.
Chapter 4: Results

As outlined in the previous chapter, I investigated pollution and its related health risks in Elkhart County, Indiana using a variety of methods all based in data from the Toxics Release Inventory (TRI) and Risk-Screening Environmental Indicators model (RSEI). This yielded, related, but not necessarily directly comparable results. Interpretations of the results and conclusions that look at each piece in relation to the other can be found in chapter five. Starting with aggregating and ranking TRI and RSEI data, this chapter outlines the results of each individual step, but draws no conclusions about the whole.

Using TRI and RSEI Data to Rank and Calculate Proportions

Results from Toxics Release Inventory.

Stack air pollution, styrene, Better Way Products, and the plastics and rubber industry all top their respective categories for un-weighted amounts of chemical release drawn from TRI data. The tables below rank the amount of chemical released in a number of different categories and provide calculations of their proportions. In this way, the chemical released in the greatest amount and the responsible actors can be identified, providing a base for prioritizing pollution reduction efforts.

Analysis began with medium of release. TRI reports the annual pounds of release for air, water, and land. As shown in Table 5, facilities in Elkhart County released 1.8 million pounds of chemicals to the air in 2017, making up over 99% of total emissions. As outlined in the defense of methods, this finding serves as part of the reasoning for focusing exclusively on air pollutants. Narrowed to air releases, facilities reported 1.5 million pounds of stack air emissions—a far greater amount than the remaining 16.6% from fugitive release. As both types of emissions are
Using TRI to Investigate Air Pollutants in Elkhart County

important to site workers and nearby residents, further analysis looked at air emissions in total and did not focus in on either stack or fugitive emissions.

<p>| Table 5 |
| Toxics Release Inventory 2017 Reported Pounds of Release in Elkhart County, IN by Medium of Release |</p>
<table>
<thead>
<tr>
<th>Medium of Release</th>
<th>Pounds of Release</th>
<th>Percentage of Total Release</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>1,822,191</td>
<td>99.3446%</td>
</tr>
<tr>
<td>Stack</td>
<td>1,519,885</td>
<td></td>
</tr>
<tr>
<td>Fugitive</td>
<td>302,306</td>
<td></td>
</tr>
<tr>
<td>Land</td>
<td>11,591</td>
<td>0.0063%</td>
</tr>
<tr>
<td>Water</td>
<td>431</td>
<td>0.0002%</td>
</tr>
<tr>
<td>Total</td>
<td>1,834,213</td>
<td>100%</td>
</tr>
</tbody>
</table>


The next category of analysis looked at the particular chemicals released. In Table 6, styrene tops the list at nearly 1.16 million pounds of release, or 63.51% of the total pounds of release in 2017. Facilities release just over 162,500 pounds of xylene, the second highest release. That is approximately one seventh the amount of styrene released. Styrene dominates the list with only nine other chemicals accounting for more than one percent of the total releases in Elkhart County.
Using TRI to Investigate Air Pollutants in Elkhart County

Table 6

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Pounds of Release</th>
<th>Percent of Total Releases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Styrene</td>
<td>1,157,273</td>
<td>63.51%</td>
</tr>
<tr>
<td>Xylene (Mixed Isomers)</td>
<td>162,517</td>
<td>8.92%</td>
</tr>
<tr>
<td>Toluene</td>
<td>102,869</td>
<td>5.65%</td>
</tr>
<tr>
<td>N-Butyl Alcohol</td>
<td>85,070</td>
<td>4.67%</td>
</tr>
<tr>
<td>Methanol</td>
<td>60,384</td>
<td>3.31%</td>
</tr>
<tr>
<td>Tetrachloroethylene</td>
<td>56,209</td>
<td>3.08%</td>
</tr>
<tr>
<td>Certain Glycol Ethers</td>
<td>41,319</td>
<td>2.27%</td>
</tr>
<tr>
<td>Methyl Methacrylate</td>
<td>37,478</td>
<td>2.06%</td>
</tr>
<tr>
<td>Methyl Isobutyl Ketone</td>
<td>36,389</td>
<td>2.00%</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>24,279</td>
<td>1.33%</td>
</tr>
<tr>
<td>N-Hexane</td>
<td>23,196</td>
<td>1.27%</td>
</tr>
<tr>
<td>16 Chemicals Accounting for &lt;1% of Total Releases Each*</td>
<td>35,208</td>
<td>1.93%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,822,191</td>
<td>100%</td>
</tr>
</tbody>
</table>


Looking at the amount of release from each facility, Better Way Products stands out as the largest emitter in the County with 378,013 pounds of release—double the next highest emitter. Collectively, the top five emitters account for 47.8% of all 2017 releases. Table 7 gives a more detailed information and provides the pounds of release for every facility accounting for greater than one percent of the total releases in Elkhart County. Releases from the remaining 47 facilities have been aggregated. Table 7 also provides the industrial sector under which the facility operates and the top two chemicals emitted by the facility in order of release amount.
The majority of releases from Betterway Products come from stack emissions of styrene. Their 351,391 pounds of styrene release makes up just over 30% of all styrene releases. Global Composites Inc Plant 4 similarly releases mostly styrene with nearly 136,000 pounds of stack air releases. The remaining top five emitters—Masterbrand Cabinets, Kountry Wood Products, and Thor Wakarusa—primarily release a different chemical or do not release any styrene. These three all release some combination of xylene, toluene, N-Butyl Alcohol, and methanol which make up the remaining top chemicals released listed in Table 6.
Using TRI to Investigate Air Pollutants in Elkhart County

<table>
<thead>
<tr>
<th>Facility</th>
<th>Pounds of Release</th>
<th>Percent Of Total Releases</th>
<th>Top 2 Chemicals Released by Facility</th>
<th>Industrial Sector of Facility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Better Way Products</td>
<td>378,013</td>
<td>20.74%</td>
<td>Styrene, Methyl Methacrylate</td>
<td>Plastics and Rubber</td>
</tr>
<tr>
<td>Global Composites Inc Plant 4</td>
<td>172,753</td>
<td>9.48%</td>
<td>Styrene, Methyl Methacrylate</td>
<td>Plastics and Rubber</td>
</tr>
<tr>
<td>Masterbrand Cabinets Inc</td>
<td>117,341</td>
<td>6.44%</td>
<td>N-Butyl Alcohol, Styrene</td>
<td>Furniture</td>
</tr>
<tr>
<td>Kountry Wood Products LLC</td>
<td>112,012</td>
<td>6.15%</td>
<td>Xylene, N-Butyl Alcohol</td>
<td>Furniture</td>
</tr>
<tr>
<td>Thor Wakarusa LLC</td>
<td>90,863</td>
<td>4.99%</td>
<td>Methanol, Toluene</td>
<td>Transportation and Equipment</td>
</tr>
<tr>
<td>Highwater Marine LLC DBA Godfrey Marine</td>
<td>81,734</td>
<td>4.49%</td>
<td>Styrene</td>
<td>Transportation and Equipment</td>
</tr>
<tr>
<td>Jayco Inc</td>
<td>78,836</td>
<td>4.33%</td>
<td>Tetrachloroethylene, Methanol</td>
<td>Transportation and Equipment</td>
</tr>
<tr>
<td>Global Composites Inc Plant 1 &amp; 2</td>
<td>73,442</td>
<td>4.03%</td>
<td>Styrene</td>
<td>Plastics and Rubber</td>
</tr>
<tr>
<td>Altec Engineering LLC</td>
<td>66,220</td>
<td>3.63%</td>
<td>Styrene, Toluene</td>
<td>Plastics and Rubber</td>
</tr>
<tr>
<td>Truck Accessories Group LLC DBA Tag Midwest</td>
<td>63,875</td>
<td>3.51%</td>
<td>Styrene</td>
<td>Transportation and Equipment</td>
</tr>
<tr>
<td>Smoker Craft Inc</td>
<td>62,927</td>
<td>3.45%</td>
<td>Styrene</td>
<td>Transportation and Equipment</td>
</tr>
<tr>
<td>Altec Engineering Inc</td>
<td>58,900</td>
<td>3.23%</td>
<td>Styrene, Toluene</td>
<td>Plastics and Rubber</td>
</tr>
<tr>
<td>Newmar Corp</td>
<td>54,802</td>
<td>3.01%</td>
<td>Xylene, Toluene</td>
<td>Transportation and Equipment</td>
</tr>
<tr>
<td>Global Composites Inc Plant 3</td>
<td>54,153</td>
<td>2.97%</td>
<td>Styrene</td>
<td>Plastics and Rubber</td>
</tr>
<tr>
<td>LTA Manufacturing LLC</td>
<td>41,166</td>
<td>2.26%</td>
<td>Styrene</td>
<td>Plastics and Rubber</td>
</tr>
<tr>
<td>Jason Industries Inc</td>
<td>40,772</td>
<td>2.24%</td>
<td>Styrene</td>
<td>Transportation and Equipment</td>
</tr>
<tr>
<td>Premier Fiberglass</td>
<td>34,639</td>
<td>1.90%</td>
<td>Styrene</td>
<td>Plastics and Rubber</td>
</tr>
<tr>
<td>Global Composites Inc Plant 6 Panel Div.</td>
<td>31,390</td>
<td>1.72%</td>
<td>Styrene</td>
<td>Plastics and Rubber</td>
</tr>
<tr>
<td>Crane Composites Inc Goshen Operations</td>
<td>26,051</td>
<td>1.43%</td>
<td>Styrene</td>
<td>Plastics and Rubber</td>
</tr>
<tr>
<td>Patrick Industries Inc DBA Adorn Door</td>
<td>21,924</td>
<td>1.20%</td>
<td>Methanol, Methyl Isobutyl Ketone</td>
<td>Wood Products</td>
</tr>
<tr>
<td>47 Facilities Accounting For &lt;1% Of Total Releases Each*</td>
<td>160,378</td>
<td>8.80%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1,822,191</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


As summarized in Table 8, the plastics and rubber industry make up the greatest proportion of releases in the County at just under one million pounds of chemicals released to the air. The next highest sector, transportation and equipment, released about half a million pounds. These two industries account for nearly all styrene emissions in the County, but also both release a number of other chemicals. The furniture industry releases a quarter million pounds, while the next highest industries all release less than 40,000 pounds each. Plastics and rubber, transportation and equipment, and furniture combined account for 95% of emissions in Elkhart County—unsurprising given that in Table 7, all but one facility accounting for more than 1% of total releases is classified in those three sectors.

<table>
<thead>
<tr>
<th>Industrial Sector</th>
<th>Pounds of Release</th>
<th>Percent of Total Releases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastics and Rubber</td>
<td>972,960</td>
<td>53.40%</td>
</tr>
<tr>
<td>Transportation Equipment</td>
<td>504,917</td>
<td>27.71%</td>
</tr>
<tr>
<td>Furniture</td>
<td>247,534</td>
<td>13.58%</td>
</tr>
<tr>
<td>Chemicals</td>
<td>35,076</td>
<td>1.92%</td>
</tr>
<tr>
<td>Wood Products</td>
<td>21,934</td>
<td>1.20%</td>
</tr>
<tr>
<td>Other</td>
<td>17,801</td>
<td>0.98%</td>
</tr>
<tr>
<td>Electrical Equipment</td>
<td>11,479</td>
<td>0.63%</td>
</tr>
<tr>
<td>Primary Metals</td>
<td>6,652</td>
<td>0.37%</td>
</tr>
<tr>
<td>Fabricated Metals</td>
<td>3,015</td>
<td>0.17%</td>
</tr>
<tr>
<td>Chemical Wholesalers</td>
<td>816</td>
<td>0.04%</td>
</tr>
<tr>
<td>Machinery</td>
<td>5</td>
<td>0.00%</td>
</tr>
<tr>
<td>Miscellaneous Manufacturing</td>
<td>3</td>
<td>0.00%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,822,191</td>
<td>100%</td>
</tr>
</tbody>
</table>


Some of the top emitting facilities in Table 7 are connected to each other through parent companies. Plant 4 of Global Composites Inc releases about 173,000 pounds of chemicals and
Using TRI to Investigate Air Pollutants in Elkhart County

makes up 9% of emissions, but four other Global Composites Inc additionally release a combined 158,985 pounds of chemicals at four other locations. While Plant 4 itself makes up 9% of total releases, emissions from all Global Composites Inc. sites combine to account for 18% of total releases as shown in Table 8. Patrick Industries is the parent company of Better Way Products, but similarly reports chemical releases at three additional facilities. This vertically integrated company releases chemicals in the Plastics and Rubber, Transportation and Equipment, and Wood Products industries which combine to make up 24% of all releases in the County. Thor Industries Inc, a recreational vehicle manufacturer integrated horizontally by buying out Jayco Inc in 2016—the 7th highest emitting facility in the County (Hesselbart, 2017, p. 105). Thor Industries’ total releases make them the third highest emitting parent company.
Using TRI to Investigate Air Pollutants in Elkhart County

Table 9

<table>
<thead>
<tr>
<th>Parent Company</th>
<th>Pounds of Release</th>
<th>Percent of Total Releases</th>
<th>Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patrick Industries</td>
<td>435,376</td>
<td>23.89%</td>
<td>Better Way Products, Carrera Custom Painting Inc, Patrick Industries Inc DBA Adorn Door, Premium Custom Painting Co</td>
</tr>
<tr>
<td>Global Composites Inc</td>
<td>331,738</td>
<td>18.21%</td>
<td>Global Composites Inc Plants 1, 2, 3, 4, &amp; 6</td>
</tr>
<tr>
<td>Thor Industries Inc</td>
<td>177,655</td>
<td>9.75%</td>
<td>Jayco Inc, Keystone Recreational Vehicle Co 840 Dutchmen, Keystone RV Co, Thor Motor Coach Inc, Thor Wakarusa LLC,</td>
</tr>
<tr>
<td>Altec Engineering Incorporated</td>
<td>125,120</td>
<td>6.87%</td>
<td>Altec Engineering Inc, Altec Engineering LLC</td>
</tr>
<tr>
<td>Fortune Brands Home &amp; Security Inc</td>
<td>117,341</td>
<td>6.44%</td>
<td>Masterbrand Cabinets Inc</td>
</tr>
<tr>
<td>Kountry Wood Products LLC</td>
<td>112,012</td>
<td>6.15%</td>
<td>Kountry Wood Products LLC</td>
</tr>
<tr>
<td>Boat Holdings LLC</td>
<td>81,734</td>
<td>4.49%</td>
<td>Highwater Marin LLC DBA Godfrey Marine</td>
</tr>
<tr>
<td>Truck Accessories Group LLC</td>
<td>63,875</td>
<td>3.51%</td>
<td>Truck Accessories Group LLC DBA Tag Midwest</td>
</tr>
<tr>
<td>Smoker Craft Inc</td>
<td>62,927</td>
<td>3.45%</td>
<td>Smoker Craft Inc</td>
</tr>
<tr>
<td>Newmar Corp</td>
<td>54,802</td>
<td>3.01%</td>
<td>Newmar Corp</td>
</tr>
<tr>
<td>LTA Manufacturing LLC</td>
<td>41,166</td>
<td>2.26%</td>
<td>LTA Manufacturing LLC</td>
</tr>
<tr>
<td>Jason Industries Inc</td>
<td>40,772</td>
<td>2.24%</td>
<td>Jason Industries Inc</td>
</tr>
<tr>
<td>Premier Fiberglass</td>
<td>34,639</td>
<td>1.90%</td>
<td>Premier Fiberglass</td>
</tr>
<tr>
<td>Crane Co</td>
<td>26,051</td>
<td>1.43%</td>
<td>Crane Composites Inc Goshen Operations</td>
</tr>
<tr>
<td>36 Companies Accounting for &lt;1% Of Total Releases*</td>
<td>116,983</td>
<td>6.42%</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,822,191</strong></td>
<td><strong>100%</strong></td>
<td></td>
</tr>
</tbody>
</table>


Results from Risk-Screening Environmental Indicators Model.

Rankings based on the RSEI scores that weight toxicity and model exposure, yield a dramatically different picture of top concerns in Elkhart County. RSEI modeling primarily focuses on air releases as exposure and environmental fate modeling for land and water releases remains so complex that reliable methods do not exist (Chakraborty, 2018, p. 184). Thus, comparison of medium of release was not possible for the RSEI data. Like TRI however, the RSEI data do divide by stack and fugitive releases. RSEI scores show an even more dramatic
Using TRI to Investigate Air Pollutants in Elkhart County

difference between stack and fugitive emissions with stack air releases accounting for 97% of the total score. Cobalt, Kennametal Stellite LP, and the primary metals industry top their respective categories. Neither cobalt nor the Kennametal facility appeared in the TRI tables except as footnotes since they accounted for too small a percentage of the pounds released (see Tables 6 and 7). The top chemicals based on the RSEI score are dramatically different than those ranked by TRI amounts. The top five from each share no chemicals in common.

While a relatively small release in pounds, heavy metals like cobalt, chromium, and nickel top the RSEI score rankings in Table 10. Though styrene by far makes up the most pounds of release, styrene ranks number thirteen with a RSEI score of 187—less than 1% of the total RSEI score for the County. Facilities released only 1,149 pounds of cobalt (compared to styrene’s 1.2 million pounds), but the element and its compounds make up 90.75% of the total RSEI score. The three heavy metals—cobalt, chromium, and nickel—combine to account for just over 98% of Elkhart County’s total score.
Using TRI to Investigate Air Pollutants in Elkhart County

Table 10

<table>
<thead>
<tr>
<th>Chemical</th>
<th>RSEI Score</th>
<th>Percent of Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cobalt and cobalt compounds</td>
<td>1,006,740</td>
<td>90.65%</td>
</tr>
<tr>
<td>Chromium and chromium compounds</td>
<td>63,911</td>
<td>5.75%</td>
</tr>
<tr>
<td>Nickel and nickel compounds</td>
<td>19,706</td>
<td>1.77%</td>
</tr>
<tr>
<td>Diisocyanates</td>
<td>13,427</td>
<td>1.21%</td>
</tr>
<tr>
<td>Tetrachloroethylene (Perchloroethylene)</td>
<td>2,295</td>
<td>0.21%</td>
</tr>
<tr>
<td>Toluenediisocyanate</td>
<td>1,375</td>
<td>0.12%</td>
</tr>
<tr>
<td>16 Chemicals Accounting for &lt;0.1% of Total Score Each*</td>
<td>3,137</td>
<td>0.28%</td>
</tr>
<tr>
<td>Total</td>
<td>1,110,590</td>
<td>100%</td>
</tr>
</tbody>
</table>


* 16 Chemicals: Ethylbenzene, Manganese and manganese compounds, Lead and lead compounds, Glycol ethers, Copper and copper compounds, Xylene (mixed isomers), Styrene, n-Butyl alcohol, Zinc and zinc compounds, Methyl methacrylate, n-Hexane, Toluene, 1,2,4-Trimethylbenzene, Methyl isobutyl ketone, Mercury and mercury compounds, Methanol

The highest ranked facilities also differ fairly dramatically from TRI data. Kennametal Stellite LP tops the rankings in Table 11 with a score of 1,060,735 which accounts for 95.51% of the entire score for the Elkhart County. The next highest ranked facility’s score is less than 25,000, or nearly 45 times less than Kennametal Stellite LP. The Kennametal facility accounts for 100% of the cobalt and cobalt compounds score in the County, just over half of the total score for chromium (35,637 of 63,911), and nearly all of the score for nickel (18,358 of 19,706). Kennametal’s releases of nickel, chromium, and cobalt make up three of the top five single releases. Again referring to Table 11, Tenneco Automotive and Benteler Automotive, the second and fourth highest facility scores respectively, also release chromium and nickel. Carpenter Co releases primarily Diisocyanates and Jayco releases Tetrachloroethylene (Perchloroethylene). Both of these chemicals appear in the top five chemicals rankings by RSEI score in Table 10.
Using TRI to Investigate Air Pollutants in Elkhart County

Like the rankings by chemical, the top five RSEI scores and TRI amounts have no facilities in common.

The parent companies list in Table 12 looks very similar to that of the RSEI facility rankings. The top four facilities in Table 11 are part of parent companies with no other facilities in the County. The fifth company, Thor Industries Inc, Jayco’s parent company, adds 320 from their other facilities for a total score of 2,445. LCI is the only other company in Table 12 with multiple facilities.
Using TRI to Investigate Air Pollutants in Elkhart County

**Table 11**

*Risk-Screening Environmental Indicators 2017 Modeled Score For Air Releases In Elkhart County, Indiana By Facility*

<table>
<thead>
<tr>
<th>Facility</th>
<th>RSEI Score</th>
<th>Percent of Total Score</th>
<th>Top 2 Chemicals</th>
<th>Industrial Sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kennametal Stellite LP</td>
<td>1,060,735</td>
<td>95.51%</td>
<td>Cobalt, Chromium</td>
<td>Primary Metals</td>
</tr>
<tr>
<td>Tenneco Automotive Operating Co Inc</td>
<td>23,677</td>
<td>2.13%</td>
<td>Chromium, Nickel</td>
<td>Transportation and Equipment</td>
</tr>
<tr>
<td>Carpenter Co Elkhart Div</td>
<td>13,060</td>
<td>1.18%</td>
<td>Diisocyanate, Toluenediisocyanate</td>
<td>Plastics and Rubber</td>
</tr>
<tr>
<td>Benteler Automotive Corp</td>
<td>4,265</td>
<td>0.38%</td>
<td>Chromium, Nickel</td>
<td>Transportation and Equipment</td>
</tr>
<tr>
<td>Jayco Inc</td>
<td>2,125</td>
<td>0.19%</td>
<td>Tetrachloroethylene, Xylene (mixed isomers)</td>
<td>Transportation and Equipment</td>
</tr>
<tr>
<td>Lippert Components Inc Plants 19 26 30</td>
<td>1,064</td>
<td>0.10%</td>
<td>Chromium, Manganese</td>
<td>Fabricated Metals</td>
</tr>
<tr>
<td>Innocor Foam Technologies - Acp Inc</td>
<td>1,060</td>
<td>0.10%</td>
<td>Toluenediisocyanate</td>
<td>Plastics and Rubber</td>
</tr>
<tr>
<td>Supreme Corp</td>
<td>757</td>
<td>0.07%</td>
<td>Chromium, Nickel</td>
<td>Transportation and Equipment</td>
</tr>
<tr>
<td>Elkhart Brass Manufacturing Co Inc</td>
<td>693</td>
<td>0.06%</td>
<td>Lead, Copper</td>
<td>Primary Metals</td>
</tr>
<tr>
<td>Masterbrand Cabinets Inc</td>
<td>601</td>
<td>0.05%</td>
<td>Ethylbenzene, Glycol ethers</td>
<td>Furniture</td>
</tr>
<tr>
<td>50 Facilities Accounting For &lt;0.05% Of Total Score Each*</td>
<td>2,553</td>
<td>0.23%</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,110,589</strong></td>
<td><strong>100%</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Table 12

Risk-Screening Environmental Indicators 2017 Modeled Score For Air Releases In Elkhart County, Indiana By Parent Company

<table>
<thead>
<tr>
<th>Parent Company</th>
<th>RSEI Score</th>
<th>Percent of Total Score</th>
<th>Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kennametal Inc</td>
<td>1,060,735</td>
<td>95.51%</td>
<td>Kennametal Stellite LP</td>
</tr>
<tr>
<td>Tenneco Inc</td>
<td>23,677</td>
<td>2.13%</td>
<td>Tenneco Automotive Operating Co Inc</td>
</tr>
<tr>
<td>Carpenter Co</td>
<td>13,060</td>
<td>1.18%</td>
<td>Carpenter Co Elkhart Div</td>
</tr>
<tr>
<td>Benteler Automotive Corp</td>
<td>4,265</td>
<td>0.38%</td>
<td>Benteler Automotive Corp</td>
</tr>
<tr>
<td>Thor Industries Inc</td>
<td>2,445</td>
<td>0.22%</td>
<td>Jayco Inc, Thor Motor Coach Inc, Thor Wakarusa LLC</td>
</tr>
<tr>
<td>LCI Industries</td>
<td>1,874</td>
<td>0.17%</td>
<td>Lippert Components Inc Plants 067, 058, 83, 28, 45, 19, 26, and 30</td>
</tr>
<tr>
<td>Innocor Inc.</td>
<td>1,060</td>
<td>0.10%</td>
<td>Innocor Foam Technologies – ACP Inc</td>
</tr>
<tr>
<td>Wabash National Corp</td>
<td>757</td>
<td>0.07%</td>
<td>Supreme Corp</td>
</tr>
<tr>
<td>Safe Fleet</td>
<td>693</td>
<td>0.06%</td>
<td>Elkhart Brass Manufacturing Co Inc</td>
</tr>
<tr>
<td>Fortune Brands Home &amp; Security Inc</td>
<td>601</td>
<td>0.05%</td>
<td>Masterbrand Cabinets Inc</td>
</tr>
<tr>
<td>36 Companies Accounting for &lt;0.05% of Total Score*</td>
<td>1,423</td>
<td>0.13%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1,110,589</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>


The Kennametal facility is classified as part of the primary metals industry making that the top industrial sector by RSEI score. Four other facilities join Kennametal Stellite Inc in the primary metals sector bringing the industry total score to 1,061,432, or 95.57% of Elkhart County’s total score. As seen in Table 13, transportation equipment comes in at 2.81% and plastics and rubber, which tops the TRI industry sector rankings in Table 8, makes up 1.28%. All other industries account for less than 0.2% of the RSEI score each.
Using TRI to Investigate Air Pollutants in Elkhart County

Table 13

<table>
<thead>
<tr>
<th>Industry</th>
<th>RSEI Score</th>
<th>Percent of Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Metals</td>
<td>1,061,432</td>
<td>95.57%</td>
</tr>
<tr>
<td>Transportation Equipment</td>
<td>31,258</td>
<td>2.81%</td>
</tr>
<tr>
<td>Plastics and Rubber</td>
<td>14,264</td>
<td>1.28%</td>
</tr>
<tr>
<td>Fabricated Metals</td>
<td>1,886</td>
<td>0.17%</td>
</tr>
<tr>
<td>Furniture</td>
<td>999</td>
<td>0.09%</td>
</tr>
<tr>
<td>Electrical Equipment</td>
<td>370</td>
<td>0.03%</td>
</tr>
<tr>
<td>Chemicals</td>
<td>208</td>
<td>0.02%</td>
</tr>
<tr>
<td>Wood Products</td>
<td>149</td>
<td>0.01%</td>
</tr>
<tr>
<td>Machinery</td>
<td>24</td>
<td>&lt;0.00%</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>&lt;0.00%</td>
</tr>
<tr>
<td>Miscellaneous Manufacturing</td>
<td>1</td>
<td>&lt;0.00%</td>
</tr>
<tr>
<td>Chemical Wholesalers</td>
<td>0</td>
<td>&lt;0.00%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,110,591</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>


Chemical Literature Review

The results of the TRI and RSEI data analysis yield two top chemicals whose properties and effects on human health vary greatly. Styrene and cobalt and cobalt compounds top TRI and RSEI score rankings respectively, and a closer look at health literature begins to reveal possible reasons for such drastic differences in the two lists. Styrene, a volatile organic compound (VOC), and cobalt, an inorganic metal, are both released to the air with their primary route of human exposure being inhalation. However, the two chemicals exist in entirely different states of matter,
Using TRI to Investigate Air Pollutants in Elkhart County

persist in the environment for different lengths of time, and have health impacts that target different organs and systems (“Styrene,” 2011; “Cobalt,” 2011).

RSEI data developers determine toxicity-weights based on compilations of research by other government agencies. Researchers first look to reference concentrations (RfCs) determined by the EPA’s Integrated Risk Information System (IRIS). Styrene has been assigned an Rfc in IRIS, but cobalt has yet to be assessed. When there are information gaps in IRIS, RSEI analyzers work their way down a ranked list of other sources for toxicity data. Cobalt’s toxicity weight determination comes from a Minimum Risk Level (MRL) developed by the Agency for Toxic Substances and Disease Registry (ATSDR) (“RSEI toxicity weighting spreadsheet v2.3.7”, 2018). In the RSEI data, the toxicity weights for styrene and cobalt largely explains the dramatic difference in rankings between the RSEI and TRI data. The RSEI score is comprised of data and calculations that reflect the amount of the chemical, its toxicity, assumptions about routes of human exposure (estimated dose), and the size of the nearby population. While population and exposure multipliers play some role in the difference of RSEI scores ($toxicity \times weight \times 0.00005$ for cobalt versus $toxicity \times weight \times .00002$ for styrene), the bulk of the difference comes from the toxicity weights. RSEI modeling multiplies styrene by 3.5 whereas cobalt’s toxicity weight is 17,000,000 (“RSEI toxicity weighting spreadsheet v2.3.7”, 2018). This suggests that even a small amount of cobalt can have an outsized impact on human health compared to millions of pounds of styrene release. To understand how each chemical came by their toxicity weights, closer investigation of the underpinning health literature is needed.

Both the toxicity weights and fate modeling done by RSEI are dependent on credible and up to date research into chemical behaviors and health impacts. Toxicity weights and air dispersion modeling of chemical movement add vital information for assessing risks to
Using TRI to Investigate Air Pollutants in Elkhart County

communities; however, a closer look into the supporting research reveals some degree of uncertainty remains. The effects of some chemicals may not be adequately researched or, in some cases, still unknowable. In other words, a low RSEI score may not necessarily mean a chemical is relatively “safe.” Diving into the government reports and assessments behind toxicity weights and models allows for greater understanding of where there is near certainty and where questions may still remain.

**Cobalt.**

A chemical element, cobalt can be found as a metal in the earth’s crust, and is used largely for production of metal alloys. At the Kennametal Stellite facility, cobalt is used in the production of stellite—a metal alloy designed for resistance to corrosion and other wear (“Kennametal Stellite”, n.d.). The human body actually needs very small amounts of cobalt and the average American ingests 300 micrograms a day from food sources, but exposure through inhalation is a totally different story (Haneke et al., 2002, p. 4). Like other inhaled heavy metals, one of cobalt’s greatest dangers comes from the scarring of lung tissue that can eventually lead to respiratory failure. The severity and likelihood of these symptoms combine to give cobalt its relatively high weighted toxicity factor in RSEI modeling. The release of 1,149 pounds of cobalt in 2017 appears insignificant compared to the release of 1.2 million pounds of styrene, but the smaller amount can have outsized risks for community health.

Cobalt hasn’t been mined in the United States in over 30 years, but its use in manufacturing processes, like the production of stellite and other alloys, has been ongoing (Lunn et al., 2016, p. 7). A number of studies conducted in the US over the last 40 years have found workplace air levels of cobalt ranging from undetectable to 21 μg/m³ (Lunn et al., 2016, p. 15). The Occupational Safety and Health Administration’s (OSHA) allowable exposure is just 0.1
Using TRI to Investigate Air Pollutants in Elkhart County

mg/m$^3$ averaged over 8-hours (New Jersey Department of Health and Senior Services, 2005). The chronic inhalation MRL—the non-cancer estimate of the amount a person can inhale without a “detectable” risk to health—developed by the ATSDR is 0.0001 mg/m$^3$ (“Minimal Risk Levels”, n.d.). The OSHA standard and MRL suggest that a serious hazard exists for those workers exposed to the high end of observed cobalt levels. Occupational inhalation exposure to cobalt is the primary mode of hazardous exposure, but high levels of cobalt are also known to enter the body’s system through industrial pollution (Lunn et al., 2016, p. 11).

Unlike styrene which breaks down quickly in the atmosphere, cobalt hangs around as particulate in the air for an estimated 5-15 days and once inhaled, may not fully leave the body in a lifetime (Haneke et al., 2002, p. 4; Lunn et al., 2016, p. 34-36). One study from 1989, cited in the National Toxicology Program’s (NTP) Report on Carcinogens, found that only 17% of test subject’s initial lung burden had been eliminated in the first week and the body retained 40% of that burden after 6 months. A compilation of other studies looking at half-lives of poorly soluble metal forms of cobalt found that the first phase took place within 2-44 hours, but the next took 10-78 days with some studies finding it took even longer on the scale of years (Lunn et al., 2016, p. 36). While research on specific health impacts remains mixed, there is no doubt that cobalt foreign matter in the respiratory system causes adverse health outcomes.

The most severe health outcomes with the strongest evidence are attacks on the respiratory system. These impacts taken as a whole are broadly described as “Hard Metal Disease.” The same properties of cobalt that help make hard, corrosion resistant alloys, also threaten lung function by scarring sensitive lung tissues. Cobalt reportedly causes inflammation around the lungs and chest cavity, “firm dust lesions”, scarring, and thickening of the alveolar septa (the smallest passageway in the respiratory system that moves oxygen and carbon dioxide).
Using TRI to Investigate Air Pollutants in Elkhart County

All of these interrelated, largely irreversible, impacts combine to greatly restrict lung functioning and reduce the body’s ability to exchange carbon dioxide and oxygen. Inability to exchange oxygen can stress the cardiovascular system which increases the risk of heart attack and affects other systems and organs throughout the body. Besides direct pulmonary effects, inhalation also reportedly damages the mucosal tissue with consequences for immune function, elicits feelings of lethargy, causes occupational asthma, and increases morbidity and mortality from cardiovascular disease (Haneke et al., 2002, p. 9-24). The adverse respiratory impacts of cobalt inhalation can lead to a host of health problems and eventually even death. In summarizing their compilation of health studies for a 2002 report on cobalt toxicology, Haneke et al. described the “copious” epidemiological studies, “numerous” reviews and studies of Hard Metal Disease, and “plentiful” studies of hard metal exposure to emphasize the certainty around severe pulmonary impacts from inhaled cobalt exposure (p. 23-24).

Research on the carcinogenicity of cobalt is significantly less clear. Assessments of possible carcinogenic impacts by the NTP and the International Agency for Research on Cancer (IARC) find the body of research still lacking sufficient evidence to conclusively call cobalt carcinogenic. Published in 2016, NTP’s 14th Report on Carcinogens assessed cobalt and cobalt compounds for the first time. Reviewing human, animal, and mechanistic studies of the chemical’s link to cancer, they concluded that cobalt is “reasonably anticipated to be [a] human carcinogen” (Lunn et al., 2016, p. 135). While the review showed that “almost all cohort studies reported approximately a doubling of the risk of lung cancer mortality from exposure,” researchers found the data available from human studies “inadequate” as confounding co-exposure from other chemicals could not be ruled out (p. 66). Animal studies also showed a link with the development of lung tumors and several other types of cancer and mechanistic studies
Using TRI to Investigate Air Pollutants in Elkhart County

added to the body of evidence by showing that genotoxicity is a likely causal link of cobalt exposure for the development of cancer (p. 110, 113). IARC last reviewed cobalt in 2006 and found “limited” evidence for cancer when there is co-exposure with tungsten carbide, but considers the evidence for cobalt alone “inadequate” in human studies (Altamirano-Lozan et al., 2006, p. 132). Considering animal and mechanistic studies as well, IARC assigned cobalt a class 2b rating of “possible carcinogen” (p. 133).

The severe respiratory impacts of cobalt are clear, but the carcinogenic status less so. IRIS has yet to do any kind of assessment of cobalt, no documents can be located for an assessment of any kind on the EPA’s site, NTP’s report on carcinogens concludes that carcinogenic effects are only “anticipated” rather than known, and IARC classifies the substance as possibly carcinogenic; however, confusingly, both the TRI and RSEI data sets list cobalt as a carcinogen (“Cobalt,” 2011; “RSEI toxicity weighting spreadsheet v2.3.7,” 2018; TRI, 2017). Since it is unevaluated by IRIS, RSEI lists the ATSDR as its source for toxicity data. The ATSDR provides no insight into why TRI and RSEI data have listed cobalt as a carcinogen and generally does not appear to have any publicly available information on how it has determined a Minimum Risk Level. Despite the alarming respiratory impacts, the confused carcinogenic status of cobalt raises questions about the highly weighted toxicity factor for cobalt.

Styrene.

Styrene is a colorless or yellowish liquid used primarily in the manufacturing of polystyrene plastics and styrene-butadiene rubber. At Better Way Products in Elkhart County, workers use styrene to coat fiberglass surfaces in the production of parts for boats and recreational vehicles. The oily substance gives off a sweet odor and evaporates quickly into an atmospheric vapor (“Styrene,” 2011). Inhalation is thus the main mode of exposure for both
Using TRI to Investigate Air Pollutants in Elkhart County

workers and the general public (IARC, 2019, p. 70). Research into the health impacts of exposure thus far confirms that workers and other exposed individuals face damage to their central nervous system (CNS) function, while research into its anticipated carcinogenic effects is ongoing.

In a factory, styrene, a Volatile Organic Chemical, quickly evaporates from the oily substance used in industrial applications to its vapor state. Workers in the fiberglass industry have the highest estimated exposures to styrene as they spray or brush styrene resins for lamination. During application and curing, as much as 10% may evaporate (IARC, 2019, p. 56). Betterway Products, the highest releaser in Elkhart County, is one such fiberglass facility where they make component parts for boats. Styrene is used for similar purposes in the RV industry for coating large surfaces. Serder et al. (2006) studied personal exposure of workers in 17 reinforced plastics manufacturing facilities in the US. They found a mean exposure of 9.14 ppm across all industry workers, but recorded a mean exposure over four times that in the RV industry. Laminators in the RV industry had a particularly high personal mean exposure of 60.6 ppm (p. 709). Serder et al. (2006) conducted their study between 1996 and 1999, which predates a joint effort of Purdue University and Indiana’s now defunct Clean Manufacturing Institute’s efforts to reduce styrene emissions in the County (p. 707; O’Mally, 2005). In 2017, the facilities in Elkhart County report most of their styrene emissions as stack emissions (1.02 million pounds stack versus 135,000 pounds fugitive) suggesting investment in powerful ventilation systems and a likely reduction in the personal exposure of RV industry workers.

Once released, the environmental persistence of styrene vapor differs significantly from cobalt. While the hard particulate matter of cobalt disperses, the element persists long-term. In contrast, styrene in the air has a half-life of just over six hours and can break down fully in 1-2
days (Rosemond et al., 2010, p. 2). The window for possible human exposure is thus greatly reduced. The quick break down also suggests that workers and people living in close proximity to a facility likely face significantly greater risks than the general population. The detectable odor threshold for styrene ranges from 0.05 ppm - 25 ppm which converts to 0.213 mg/m$^3$ - 106.5 mg/m$^3$. The IRIS assessments on which RSEI bases their toxicity weights list the reference concentration (RfC) for inhalation exposure as 1 mg/m$^3$. In other words, 1 mg/m$^3$ is considered the threshold exposure level considered “likely to be without an appreciable risk of deleterious effects during a lifetime” (IRIS, 1992, p. 4-5). Considering the odor threshold with the RfC, a person able to smell the sweet odor of styrene is not absolutely, but likely, inhaling a concentration of styrene at a level that exceeds the threshold considered to have no effect.

Styrene exposure has well-known and long established effects to the central nervous system (CNS). CNS dysfunction includes symptoms such as: slowed reaction times, memory loss, and overall impaired intellectual functioning. Studies have looked at worker populations and used psychoanalytic tests of brain function to look for signs of impaired functioning. Cited by IRIS’s styrene assessment, a 1990 study by Moller, Odkivist, and et al. used otoneurologic examination techniques and found impairment suggesting brainstem and cerebellar lesions similar to those found in patients with known brainstem or cerebellar disorders (IRIS, 1992, p. 8). The IRIS assessment deems the study “credible” and for much of the report relies heavily on its data (p. 9). Looking at the body of evidence overall, IRIS assigned “medium to high” confidence in the database for non-cancer endpoints because while there were a number of studies of long-term exposure amongst human worker populations, IRIS researchers found no chronic animal studies. This IRIS assessment, upon which the RSEI database their toxicity weight, is notably dated with no updates since 1992.
The ATSDR has more recently compiled a full report on the toxic properties of styrene (Rosemond et al., 2010). While RSEI uses IRIS’s RfC of 1 mg/m\(^3\) to weight toxicity, ATSDR’s 2010 report based on newer research sets a MRL slightly lower at 0.85 mg/m\(^3\) (0.2 ppm) for chronic exposure. The ATSDR report also compiles research across a greater number of possible health impacts and cites evidence from a far greater number of studies—the vast majority of which were published after the IRIS assessment (Rosemond et al., 2010, p. 54-61). ATSDR reports evidence of chronic exposure health impacts including decreased ability to discriminate colors, hearing loss, generally impaired sensory function, delayed reaction times, impaired attention spans and memory function, and slowed nerve conduction velocity (Rosemond et al., 2010, p. 10). Overall, the studies showed a correlation between increased adverse effects and increased number of years of exposure, but lacked evidence of whether this relationship was due to length of exposure or higher amounts of acute exposure in the past. The collection of studies also failed to provide sufficient evidence of whether the CNS effects may be permanent or improved when no longer exposed (p. 10). A large number of epidemiological studies underpin the conclusion that styrene inhalation causes CNS effects in humans, and the ATSDR considers the amount and quality of data to be “adequate” for their purposes of determining a MRL (p. 132).

While the central nervous system has been identified as the primary target effect of styrene, increasing evidence suggests the chemical is carcinogenic. Currently, the EPA has made no assessment of styrene’s carcinogenic status; however, the National Toxicology Program’s assessment of styrene in its 14th Report on Carcinogens classifies the chemical as “reasonably anticipated” carcinogen based on “limited” human studies, “sufficient” animal studies, and supporting mechanistic data (“Styrene; CASRN 100-42-5”, n.d.; Department of Health and
Using TRI to Investigate Air Pollutants in Elkhart County

Human Services, 2016, p. 1). Interestingly, the International Agency for Research on Cancer’s (IARC) recent 2019 report based their classification on the same assessment of “limited” and “sufficient,” but upgraded styrene from a “possible” to a “probable” carcinogen (IARC, 2019, p. 34). IARC ranks styrene above its designation of cobalt as a “possible” carcinogen, yet cobalt is the only of the two marked carcinogenic in the TRI and RSEI databases.

Digging into the health literature on styrene and cobalt helps explain some of the differences in their toxicity factor for RSEI modeling, but it also raises questions. The certainty of life-threatening damage done by inhaled cobalt and the relatively quick breakdown of styrene that lowers the risk of exposure by the general population is consistent with cobalt having such a drastically different toxicity factor. The confusion around carcinogenicity for both raises concerns, however. IARC’s recent upgrade of styrene from possible to probable carcinogen highlights the confusing lack of carcinogenicity evaluation by the EPA—especially in light of the EPA’s designation of cobalt as a carcinogen on comparatively shakier evidence. This calls into question the magnitude of difference between the two substances.

Mapping Toxicity Concentration with the Social Vulnerability Index

The maps presented in this section start simply with those showing single variables, but subsequent maps aggregate and combine variables to culminate in a final map of where social vulnerability and toxicity-weighted chemical concentrations converge. The first map simply shows the location of those facilities who reported air releases to TRI in 2017. The next two show the modeled concentrations of styrene and cobalt in each Census tract based on modeling that accounts for stack height, chemical movement, and general weather conditions. Figure 4 shows the aggregate toxicity-weighted concentrations for each Census tract from any facility affecting the receptor Census tract (which includes facilities that may be located outside Elkhart
Using TRI to Investigate Air Pollutants in Elkhart County

County. Figure 5 aggregates and presents the Socioeconomic Status, Household Composition and Disability, Minority Status and Language themes from the CDC’s Social Vulnerability Index (SVI). The final map uses both the SVI and aggregate toxicity-weighted concentration variables to map where they converge.

With the exception of the first map of facility locations, all maps use some version of choropleth mapping as a way to visualize amounts of a variable in a Census tract in relation to other tracts. The toxicity-weighted concentrations come from RSEI’s 2017 micro-data modeled and converted to the Census tract level. The choropleth maps of concentrations and the map of aggregated SVI themes all use five geometric class breaks to show the greatest contrast. The convergence map uses three quantile class breaks, or, in other words, three class breaks with an equal number of tracts in each class. This allows for easy visualization of where a Census tract may have one of the highest toxicity-weighted chemical concentrations and the highest vulnerability.

The first map, Figure 1, shows clustering of TRI reporting facilities around cities and towns. The city of Elkhart, the largest population center in the County, has an especially high number of facilities. This map is limited however, as it says nothing of the relative amounts or toxicity of emitted chemicals. The toxicity-weighted concentrations in the following maps show the clustering around particular, high-emitting facilities. For styrene, the Census tracts with the highest concentrations closely reflect the locations of the two facilities who release the most—Better Way Products and Global Composites Inc Plant 4 (see Figure 2). In comparing styrene and the following cobalt map (see Figure 3), take note of the dramatically different scales used for each. The highest toxicity-weighted concentration of styrene is 12.90 while the highest value for cobalt is 93,613. If mapped using the same class divisions as cobalt, all the styrene
Using TRI to Investigate Air Pollutants in Elkhart County

counts would appear white—well below the class break for the smallest cobalt classification.

The maps of cobalt and aggregate toxicity-weighted concentrations (Figure 4) appear remarkably similar which reflects the previous finding that cobalt releases makeup by far the greatest proportion of the County’s RSEI score. The Census tracts with the highest cobalt concentrations surround the location of the Kennametal Stellite LP facility. This is the only cobalt-releasing facility in Elkhart County, but cobalt from two other facilities approximately 15 miles to the south of the County also affect Census tract concentrations. While remarkably similar, the map of aggregate concentrations reflects slightly higher values than the map of just cobalt. The facilities with the top five RSEI scores are mapped as well, and show the effect of releases from Tenneco Automotive and Carpenter Co in particular.
Figure 1. Locations of Toxic Release Inventory facilities reporting 2017 air releases in Elkhart County, Indiana.
Using TRI to Investigate Air Pollutants in Elkhart County

**Figure 2.** Toxicity-weighted 2017 concentrations of styrene in Elkhart County, Indiana by U.S. Census tract.
Using TRI to Investigate Air Pollutants in Elkhart County

Figure 3. Toxicity-weighted 2017 concentrations of cobalt in Elkhart County, Indiana by U.S. Census tract.
Using TRI to Investigate Air Pollutants in Elkhart County

Figure 4. Aggregate toxicity-weighted 2017 concentrations of chemicals in Elkhart County, Indiana
Using TRI to Investigate Air Pollutants in Elkhart County

Figure 5 maps a sum of three themes in the CDC’s Social Vulnerability Index (SVI): socioeconomic status, household composition, and minority status. The highest values cluster around the urban areas of Goshen and Elkhart. In contrast, the more rural parts of Elkhart County generally appear less vulnerable. The two large census tracts to the north and south of Goshen, the County seat, have the lowest vulnerability values.
Using TRI to Investigate Air Pollutants in Elkhart County

Figure 5. Center for Disease Control Social Vulnerability Index scores in Elkhart County, Indiana Census tracts for summed socioeconomic status, household composition, and minority status themes.
Using TRI to Investigate Air Pollutants in Elkhart County

The final map (Figure 6) shows the Census tracts where aggregate toxicity-weighted concentrations and vulnerability converge. Dark brown shows where a Census tract’s values for both toxicity and vulnerability appear in the top third. Bright blue shows where there is high vulnerability, but relatively low toxicity and bright orange reflects the opposite, or where a tract has high toxicity, but relatively low vulnerability. Three Census tracts are in the highest category for toxicity and vulnerability. Most of the brown tinted (values with some degree of overlap between variables) again appear in the urban centers of Goshen and Elkhart.
Using TRI to Investigate Air Pollutants in Elkhart County

Figure 6. Comparison by U.S. Census tracts in Elkhart County, Indiana of aggregate toxicity-weighted chemical concentrations with Social Vulnerability Index sum of themes 1, 2, & 3.
Styrene and Cobalt Releases in a National Context

Styrene and cobalt stand out from the rankings based on TRI and RSEI data respectively. The data rankings and mapping only look at Elkhart County as compared to itself however. In the context of the County’s relatively small geography these two chemicals stand out, but pounds of release and a modeled score reveal little about how bad the worst releases may be. These data relative to state and national numbers can provide a broader context.

In 2017, over one million pounds of styrene ranked Elkhart County as the #2 styrene releasing county in northern Indiana, the whole state, and the nation. The County with the highest releases of styrene is also in Northern Indiana.

In 2017 the RSEI score for cobalt and cobalt compounds released in the United States totaled 39.29 million or 9% of the country’s total score for all chemicals. That was the third highest chemical category score behind chromium and ethylene oxide. The Kennametal facility’s 2017 RSEI score of 1.06 million was the fifth highest facility score in Indiana and 46,162 times the median score of all facilities in the state. Across the United States, the score was 2,342 times higher than the industrial sector median for secondary smelting, refining, and alloying of nonferrous metal (“TRI facility report: Kennametal”, n.d.). Cobalt emissions from Elkhart County’s Kennametal facility alone accounted for 1.01 million or 2.6% of the country’s total score from cobalt releases.

Looking across the United States, one million pounds of styrene release is by no means a “normal” amount nor is a RSEI risk score of over one million for the Kennametal Stellite LP facility. The following chapter considers these findings along with the rankings, literature review, and maps to draw overarching conclusions that can inform next steps for research and action in the Elkhart County community.
Chapter 5: Discussion and Concluding Thoughts

Using the Toxics Release Inventory (TRI) and Risk-Screening Environmental Indicators (RSEI) model to investigate Elkhart County, Indiana allowed me to gain understanding of the ongoing pollution where I grew up, and the analysis will inform future community action. In this last chapter, I draw conclusions about cobalt, styrene, the Kennametal Stellite LP facility, and the environmental justice implications of their spatial distribution. I also explore how the results fit into broader research that utilizes TRI and RSEI data. I go on to explore how the results are limited by time, lack of connected health data, and other factors. Throughout this section I provide examples of future research directions based on these limitations. I conclude with reflections on what I have been able to learn about my community and how that might impact my own future work.

Interpreting Results

The Toxics Release Inventory (TRI) and Risk-Screening Environmental Indicators (RSEI) rankings, chemical literature review, and maps bring a few key chemicals and players to attention. From RSEI, cobalt emissions from Kennametal Stellite LP stand out as a top priority by making up over 90% of the total score in Elkhart County. The high toxicity that can cause irreversible respiratory impacts is deeply concerning for those living near the facility. Styrene emissions, however, should not be dismissed as of little concern because of their comparatively lower risk in RSEI modeling. The sheer amount of releases reported to TRI by facilities in Elkhart County raises concerns which are compounded by the inaction of the EPA to evaluate the chemical when there is mounting evidence of its carcinogenicity. Diving into the health literature supporting RSEI’s toxicity multiplier uncovers significant gaps, which suggest that styrene’s risks have been insufficiently assessed. Assessment of chemical releases in Elkhart
Using TRI to Investigate Air Pollutants in Elkhart County

County raise general public health concerns, but mapping of toxicity-weighted concentrations along with social vulnerability data also can be used to frame the issues as one of environmental justice. The most socially vulnerable populations in Elkhart County cluster around the cities of Goshen and Elkhart, which are also home to the highest number of and most polluting facilities.

**Drawing meaning from the TRI and RSEI data rankings.**

Overall, ranking and calculating proportions of release for both datasets helps identify clear chemicals, actors, and industrial sectors that account for the majority of pollution concerns in Elkhart County. In the TRI analysis, styrene makes up a far greater proportion of release than any other chemical and Betterway Products, which releases the greatest amount of styrene, easily tops the list as the greatest polluting facility by pounds of release. While the Betterway Products facility releases nearly double the amount of chemicals as the next highest facility, the 1.16 million pounds of styrene released in the County comes from 19 different facilities. In summary, styrene stands as a clear concern because of the volume of its release; however, with the exception of Betterway Products, no single facility stands out as a clear culprit. Most of these facilities are classified in the plastics and rubber industrial sector, which unsurprisingly tops other sectors for greatest amount of chemicals released. Finally, organizing the individual facilities under their parent companies, identifies two companies that account for about 20% of the total emissions each—Patrick Industries who own Betterway Products and Global Composites Incorporated, who own five different manufacturing plants in Elkhart County. Targeting these two parent companies’ combined 40% of releases could greatly reduce overall emissions in Elkhart County.

Compared to the TRI data, the chemical and actor of greatest concern stands out even more dramatically in the RSEI analysis. Cobalt release accounts for the vast majority of the
Using TRI to Investigate Air Pollutants in Elkhart County

Entire RSEI score for Elkhart County (over 90%) and Kennametal Stellite is the only facility that releases cobalt and cobalt compounds. Kennametal’s releases of chromium and nickel—also highly toxic—add to concerns about the facility and the populations living nearby. Even after aggregating facilities by their parent companies the Kennametal Stellite facility—the only Kennametal facility in the County—accounts for nearly 96% of the risk score for Elkhart County. The results of RSEI data analysis indicates the Kennametal Stellite facility, and their cobalt releases specifically, as the top concern in Elkhart County.

The high risks from cobalt and other heavy metals coming from the Kennametal facility compared to all other releases in Elkhart County suggest the facility as a “toxic outlier.” Collins, Munoz, and JaJa use this term to describe, “the smaller group of facilities who generate the majority of exposure risk” (2016, p. 2). Collins, Munoz, and JaJa assert that environmental justice studies often neglect analysis of the origins of hazards and their relative magnitudes. The authors go on to argue that this has been to the detriment of pollution reduction efforts. The presences of toxic outliers suggests that great change can be made by focused action that addresses a few bad actors rather than calling for sweeping, generalized action. While this study did not set out to establish a case study of a community with a “toxic outlier,” the results reveal the Kennametal facility as a disproportionate generator of risk and supports Collins, Munoz, and JaJa’s findings on a much smaller scale.

Findings from the chemical literature review.

The toxicity multiplier and estimates of population exposure that comprise the RSEI modeled scores suggest that cobalt should be a priority concern over styrene despite its considerably smaller pounds of release in 2017. Further investigation into the health research underpinning these toxicity weights makes prioritization a little less clear-cut however. In the
RSEI model cobalt has a toxicity multiplier of 17 million whereas the multiplier for styrene is only 3.5 (“RSEI toxicity weighting spreadsheet v2.3.7,” 2018). Styrene lacks a carcinogenicity evaluation by the EPA despite the National Toxicology Program’s designation of the substance as a reasonably anticipated carcinogen and the decision by researchers at the International Agency on Cancer Research (IARC) to upgrade the chemical from possible to probable carcinogen in 2019. RSEI modeling only considers styrene’s effects to the central nervous system for its toxicity multiplier and neglects carcinogenicity altogether. Cobalt on the other hand is identified as carcinogenic in the latest version of information about the factors behind RSEI modeling (“RSEI toxicity weighting spreadsheet v2.3.7,” 2018). Confusingly, the Integrated Risk Information System that RSEI bases their multipliers on has also not evaluated cobalt for carcinogenic properties. The uncertainty surrounding RSEI toxicity weights reaffirms the assertion by Lim, Lam, and Schoenung (2010, 2011) that using both TRI and RSEI data sets strengthens efforts to prioritize pollution reductions. The vast amount of styrene releases found in the TRI data and the questionable toxicity multipliers in RSEI suggest that risks from styrene exposure have not been properly assessed.

Despite confusion about carcinogenic status, the health research paints a disconcerting picture of what kinds of health outcomes people living near cobalt and styrene releasing facilities may face. Although styrene dissipates quickly, investigation of odor thresholds and minimum risk levels suggests that the ability to smell styrene should raise concerns that a person is exposed to a potentially harmful amount. Epidemiological studies of worker populations over the years show clear connections between styrene exposure and impaired central nervous system functioning. Those living and working near the Kennametal facility should be weary of the respiratory damage that can be caused by cobalt emissions. Scarring and decreased lung
functioning from exposure greatly impairs quality of life, can lead to greater instances of cardiovascular events, and even cause premature death.

**Interpreting the maps of toxicity concentration and social vulnerability.**

Each map of RSEI microdata and Social Vulnerability Index (SVI) data builds upon the other to explore several aspects of geospatial distribution of risk. The first map shows clustering of TRI reporting facilities near the cities of Goshen and Elkhart home to large latinx and black populations respectively (see Figure 1). To someone with a basic grasp of the characteristics communities in Elkhart County, this map is the first indication that minorities and low-income neighborhoods may be disproportionately affected by chemical releases. The final culminating map showing the convergence of toxicity weighted concentrations with SVI numbers confirms concerns that spatial distribution in Elkhart County may be a matter of environmental justice (see Figure 6).

The three choropleth maps of toxicity weighted concentrations for styrene, cobalt, and the chemical aggregate show how cobalt dominates the data. The aggregate toxicity weighted concentrations for each Census tract closely resembles the class distribution of the cobalt map—producing remarkably similar maps (see Figures 3 and 4). In both maps, the Census tracts with the highest toxicity weighted concentrations predictably cluster around the Kennametal Stellite facility located in an industrial park to the east of downtown Goshen. Benteler Automotive Corp, located in the same industrial park, also appears in the top five facilities with the highest RSEI scores and raises the toxicity weighted concentration for the Census tract even higher (see Figure 4 and Table 11). Comparing the aggregate and cobalt maps also shows the effects of the clustered Tenneco Automotive and Carpenter Co. facilities which raise their Census tract to the second highest class. The map of styrene alone looks somewhat different as the relatively low
Using TRI to Investigate Air Pollutants in Elkhart County

toxicity-weighted concentrations have minor impacts on aggregate concentrations (Compare Figures 2 and 4). The highest styrene concentration can be found near the Betterway Products facility just south of my hometown of New Paris. The next highest Census tracts cluster around the industrial parks to the west of the city of Elkhart home to several styrene releasing facilities.

The choropleth map of the socioeconomic status, household composition, and minority status themes from the SVI data (figure 5) predictably shows higher vulnerability in the cities of Goshen and Elkhart. On the whole Goshen, a college town, has a higher educated population and correspondingly greater incomes. The Census tract on the north side of Goshen in the highest vulnerability class likely reflects the largely latinx neighborhoods located there. Census tracts in the city of Elkhart likely reflect the high minority populations and generally lower incomes.

The final culminating map of where SVI and aggregate toxicity weighted concentrations converge show three Census tracts in the top third for both variables (see Figure 6). While a greater number of TRI reporting facilities are located in the more vulnerable city of Elkhart (see Figure 1), the high toxicity of cobalt emissions from the Kennametal facility in Goshen means that the north side Latinx neighborhoods carry the double burden of being among the most vulnerable with the highest potential exposure to toxic chemicals in Elkhart County. A single Census tract to the east of Elkhart joins the two tracts in Goshen as both highly toxic and highly vulnerable compared to the rest of Elkhart County. As the high toxicity weighted concentrations in all three comes disproportionately from cobalt compared to other chemicals, efforts to protect these communities means pressuring Kennametal to greatly reduce their emissions.

The rankings, literature review, and maps taken together arrive at similar conclusions. Addressing cobalt emissions from Kennametal will have the greatest impact on overall community health and do the most to relieve the double burden of high toxicity and high
Using TRI to Investigate Air Pollutants in Elkhart County

vulnerability faced by low-income neighborhoods and communities of color in Elkhart County. Looking at the facility in the context of emissions across the United States affirms this conclusion and adds a sense of urgency. The literature review, however, makes a compelling argument for why cobalt should not be the only focus. The community cannot adequately assess the risks of styrene releases because the available RSEI tool bases its calculations on data with concerning gaps. Complicating the issue further, RSEI results can easily be misread to give false assurances that the release of a chemical is relatively safe. All chemicals that require reporting by the EPA have been designated as toxic with known adverse impacts to human health.

The results of my investigation also suggest a need for more studies using TRI and RSEI data to investigate less populated areas in addition to major metropolitan areas. Styrene, a niche chemical from a niche industry, lacks significant data in EPA analysis to the detriment of the surrounding community. Hopefully this is an exception and not the rule for other communities with a different niche chemicals and industries. Community size and its resulting power, or lack thereof, could be a determining factor for how the EPA prioritizes their chemical analysis. Greater attention by researchers could also reveal a need for different or modified methods for a community defined on a similar scale. Since few other studies use RSEI and TRI to investigate communities the size of Elkhart County, answering these questions will require further research using more diverse study sites.

Limitations and Opportunities for Future Study

Lack of cases studies for niche industry communities somewhere between urban and rural like Elkhart County limit the ability to contextualize my conclusions. Many additional limitations of my work also exist. The opportunities for future research in Elkhart County are numerous and I wrap up my work with more questions than I started with. The bounds of a thesis
Using TRI to Investigate Air Pollutants in Elkhart County

project necessitated a narrowing of scope, and, like any research project, limitations to my work remain. I investigated a particular moment in a nearly two century long history of industrial activity in Elkhart County and 2017 RSEI and TRI data stand as imperfect indicator for ongoing pollution. Outside my control, the available data themselves are open to critique. TRI data and RSEI modeling rely on self-reported estimates of releases and, as I found, the studies underpinning RSEI’s health risk assessments may be lacking. This study also provides a very limited perspective on the health impacts of chemical pollution. While health literature gives some indication of what kinds of outcomes my community may expect, my work cannot connect any real world health outcomes. All of these limitations however, provide opportunities for future research.

The ongoing pollution that my work investigates tells a very small part of contamination in Elkhart County. The air in Elkhart County has been polluted by human activity at least as far back to my four times great grandfather burning virgin hardwood forests to clear space for farming. Brownfield sites dot the landscape and serve as continued sources of possible exposure to harmful chemicals. My study attempts to look at ongoing pollution exclusively in Elkhart County, but TRI and RSEI data as indicators for ongoing pollution are limited. As in the case of trichloroethylene (TCE) exposure in Goshen for instance, ongoing exposure to contaminants can come from sources created decades ago by chemical spills and purposeful dumping. My research methods are unable to account for any of this legacy pollution. TRI and RSEI data are limited to point-source industrial pollution and do not consider sources like pesticide use on cornfields or fumes from heavy traffic of diesel-fueled trucks en route to Chicago on Interstate 90. To narrow my scope, I neglected water and soil releases in order to focus more in depth on air pollution. Within air releases, I narrowed further by diving into literature for only the top chemicals from
Using TRI to Investigate Air Pollutants in Elkhart County

each data set. Other chemicals could also pose unacceptable risks, and this approach allowed no opportunities for exploring how they may interact. All of these limitations are compounding factors for public health outcomes meaning the TRI and RSEI data results show only a minimum for possible pollution in Elkhart County.

The limitations of time, sources, and medium of release provide opportunities for future research in a number of areas. Sticking with TRI and RSEI data, analysis overtime could offer a greater understanding of general trends and insight into the possible effects of cumulative exposure. Research could also take a closer look at other sources of toxic chemical exposure, like the substances and quantities found at contaminated Brownfield sites or conventional farms. To account for non-point source pollution and pollution from sources outside the County, future research could incorporate data from air, water, and soil quality measurements. These kinds of measurements could offer important complementary information as TRI gives no indication of exposure or lasting contamination and RSEI tools can only estimate.

The inability to definitively show the effects of toxic chemical releases on air quality is just one example of the built-in limitations of TRI and RSEI data. Another is that the toxics release inventory is built upon self-reported data which leaves questions about its accuracy. Marchi and Hamilton (2006) assessed the accuracy of reporting by comparing a few major pollutants that the EPA both monitors through air quality sensors and requires TRI reporting. Looking at whether reported reductions in chemical releases translated to corresponding observations at monitors, Marchi and Hamilton found that for a few chemicals, but not all, significant discrepancies arose. The results suggest that in some cases facilities may make rough, somewhat inaccurate estimates or purposefully manipulate their reported releases to show significant pollution reductions (Marchi and Hamilton, 2006, p. 73-74). TRI reported amounts
Using TRI to Investigate Air Pollutants in Elkhart County

should not be considered absolute, but can still usefully show releases relative to other facilities. RSEI data builds upon TRI so comes with the same questions about the accuracy of reporting, but has the added complication of being dependent on toxicity research for the multipliers that may not be sufficiently evaluated. As in the case of styrene, the EPA’s evaluation and assigned toxicity multiplier may lag behind the evidence which compromises a community’s ability to accurately assess risks. In the future, a broader literature review of studies about the limitations of RSEI and TRI data and alternative methods that address these limitations would greatly aid in adding context to my conclusions.

Looking at only point-source industrial air pollution from a single year makes any sort of corollary analysis with public health data difficult. While some analysis of acute effects of exposure may provide useful insights, the health literature raises chronic health impacts as far more concerning. Tying chronic health impacts to chemical releases can be much more complex since the lag time for effects to present may be decades. Exposed populations may have by that time moved away and a person has likely been exposed to a host of confounding substances. Further complicating health studies, release does not necessarily mean personal exposure to a chemical. RSEI modeling accounts for this to some extent, but necessarily simplifies their modeled estimates for data spanning the entire United States. Pulling in public health data in this study would have yielded conclusions laden with caveats. Looking into health literature for the top two chemicals attempts simply to name the possible effects of exposure, but says nothing of how Elkhart County has been impacted by release of these chemicals.

While tying future health research directly to release information could prove exceedingly difficult, a general understanding of health indicators in Elkhart County compared to other, less polluted places would greatly strengthen arguments for addressing pollution. The city
Using TRI to Investigate Air Pollutants in Elkhart County

of Goshen with a population of about 33,000 people is home to its own cancer center. While not proof of anything, this certainly raises red flags. Growing up, people wondered whether the air around them led to their illnesses, but could only base these questions on anecdotes. My research is able to confirm that carcinogenic pollution exists in my community, but can do little to confirm feelings that this translates to an unusual number of cancer cases. Outlining possible impacts provides a road map of what kinds of health impacts the community should be wary of including asthma rates, cancer, and higher instances of cardiovascular events on high release days. Future research that analyzes state and county health data for these outcomes would greatly help my community by either quelling fears or providing the evidence needed to demand action.

Finally, my own expertise limits my work. I came into this project with no background in chemistry beyond high school and little understanding of toxicology. While I was able to quickly track down data sets that let me know which chemicals the industries in my community release, the lists meant little to me. A toxicologist on the other hand may glance at the lists and have insights into how the chemicals relate to each other or make different determinations about which warrant a closer look. That said, this project is a reflection of what a concerned community member like myself with little formal training can gather. Lawmakers initially established Community Right to Know laws like the Toxics Release Inventory with the intention of turning oversight of polluting facilities over to the affected communities; however, TRI and RSEI tools only serve their purpose if they can be understood.

Concluding Thoughts

When I go for a run near my parents’ home in New Paris and smell a nail polish-like odor, I now know that nearby Smoker Craft Industries is likely using styrene to laminate the hulls of boats. I also know that I am likely being exposed to a potentially harmful amount that
Using TRI to Investigate Air Pollutants in Elkhart County

could impair my memory or even lead to cancer. Shattering my illusions that some other entity carefully watches over my environmental health, I have found that government officials use outdated research to evaluate the risks posed by styrene. I also now live with the knowledge that my aging grandparents live 1.3 driving miles from the most dangerous facility in Elkhart County, Kennametal Stellite. I find this information difficult, but powerful. Data give me a starting point to call attention to pollution so that my community can tackle the issue before high cancer rates and sick kids drive us to act.

Thanks to the generations of community health activists before me, I accessed and used TRI and RSEI data to gain a lot of powerful information about industrial facilities near my hometown. By no means exhaustive, this knowledge means I can demand, backed by evidence, significant pollution reductions at the Kennametal facility, and push government officials to update their assessments of styrene. The data offer a starting point for a much needed discussion about environmental health in Elkhart County. In the spirit of community-right-to-know, TRI and RSEI data have fulfilled their purpose. I can argue, with evidence, that the level of industrial chemical pollution in Elkhart County is not normal and should not be treated as such. The questions remains, now what?

In possession of knowledge about pollution in my community I feel I have two choices: I can choose a new, healthier home and in the process leave the people I care about in a polluted place, or, armed with my new knowledge, I can work to make Elkhart, Indiana safer. My parents have chosen to remain in Elkhart County for the last 25 years despite a sense that the air we breathed and water we drank could be harming us. At some point in my teen years they even apologized to me for raising me in a place like New Paris, but I am glad for their choice to let the tight-knit Mennonite community we were a part of trump their health concerns. In this
Using TRI to Investigate Air Pollutants in Elkhart County

community, I learned to care for others, to value the natural world, and, most importantly, that positive change does not happen on its own and often takes some kind of sacrifice. My home community helped shape my values and worldview in a way that now leads me to my current choice to take the latter of my two options—stay and try to make Elkhart County a safer place to live.
Using TRI to Investigate Air Pollutants in Elkhart County

REFERENCES


Using TRI to Investigate Air Pollutants in Elkhart County


Using TRI to Investigate Air Pollutants in Elkhart County

Public Health Service. Retrieved October 19, 2019 from


https://fred.stlouisfed.org/series/S1701ACS018039.


Using TRI to Investigate Air Pollutants in Elkhart County


Using TRI to Investigate Air Pollutants in Elkhart County


Using TRI to Investigate Air Pollutants in Elkhart County


Using TRI to Investigate Air Pollutants in Elkhart County

Office of the Report on Carcinogens Division of the National Toxicology Program.
Retrieved October 19, 2019 from


Using TRI to Investigate Air Pollutants in Elkhart County


Using TRI to Investigate Air Pollutants in Elkhart County

RSEI toxicity-data and calculations. (n.d.) Retrieved October 15, 2019, from
https://www.epa.gov/rsei/rsei-toxicity-data-and-calcualtions#calculations


Using TRI to Investigate Air Pollutants in Elkhart County


Timeline of toxics release inventory milestones. (n.d.). Retrieved from

Tool for reduction and assessment of chemicals and other environmental impacts (TRACI).


Using TRI to Investigate Air Pollutants in Elkhart County


Ways to get RSEI results. (n.d.) Retrieved September 26, 2019, from https://www.epa.gov/rsei/ways-get-rsei-results#microdata