Assessing the State of Environmental Justice in Michigan

by

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Abstract

This study sought to address the research question, "What is the state of environmental justice in Michigan?" In doing so, the team addressed the feasibility of creating a publicly available, accessible Michigan-specific screening tool that would display environmental, social, and health data relevant to environmental justice. This research had two main components: one qualitative and one quantitative. Qualitative methodology involved conducting semi-structured, in-depth interviews with thirty environmental justice leaders in the state of Michigan. Quantitative methodology involved comparing the data and methodologies used in the US Environmental Protection Agency's (US EPA) EJScreen, California Environmental Protection Agency's (CalEPA) CalEnviroScreen, and Minnesota Pollution Control Agency's (MPCA) Story Map and What's in My Neighborhood screening tools. Publicly available social and environmental data from the US Census Bureau, US Department of Housing and Urban Development, and US EPA were spatially and statistically analyzed according to CalEPA and MPCA's methodologies. A map incorporating best practices from both agencies was created and uploaded onto ArcGIS Online to demonstrate the feasibility of creating a Michigan-specific screening tool. Results of this research demonstrate that environmental harms and goods are not equitably distributed throughout Michigan, that developing a Michigan-specific screening tool is feasible and desired, and that a screening tool must be accompanied by strong state-level policy addressing environmental justice. This study contributes to the understanding of vulnerable communities in the state, and serves as a baseline to which progress in environmental justice can be measured.

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Chapter 1. Introduction

Environmental justice, which connects the distribution of environmental harms to social characteristics, is both a field and movement. This connection has gained national attention in the last several decades through cases such as hazardous waste siting in predominantly African American Warren County, North Carolina; Hurricane Katrina in New Orleans; the Dakota Access Pipeline in the Standing Rock Indian Reservation; natural gas extraction through fracking in West Virginia; and most recently the Flint Water Crisis, all of which involve environmental harms disproportionately burdening communities that have low socioeconomic status or are predominately racial or ethnic minorities (Lee 2011; Jacobs-Shaw 2017; Bienkowski 2015; Mohai 2018). The federal government and the government of each individual state approach environmental justice differently. This report explores environmental justice in the state of Michigan: the status of relevant issues, the approach the State takes to monitoring effects of environmental harms on vulnerable communities, and opportunities the State has to advance environmental justice.

One method used to monitor environmental injustice is mapping. This study analyzes three different approaches to mapping currently used at the federal and state levels to provide a baseline and inform the adoption of an approach specific to the state of Michigan. First, the US Environmental Protection Agency, the federal agency tasked with environmental protection, attempts to address environmental justice on a national scale. One way the agency seeks to inform the process of assessing potential exposure is through its online mapping tool, EJScreen. This tool does not inform policy, but makes environmental and demographic data available in an accessible platform for professionals and members of the public to use and analyze (EPAGroups 2016). Second, the California Environmental Protection Agency uses its online tool, CalEnviroScreen, to spatially analyze impacts of environmental harm on sensitive communities (Kuruppuarachchi 2017). CalEnviroScreen is used to inform policies, programs, and activities in the state (Faust, August, Bangia, Galaviz, Leichty, Prasad, and Zeise 2017). Finally, the state of Minnesota uses its two online spatial analysis tools, Story

Map and What's in My Neighborhood, to identify communities sensitive to environmental harm (MPCA 2018).

Environmental justice is a salient issue in Michigan both currently and historically. The Flint Water Crisis made national news when residents were poisoned by drinking lead-contaminated water in 2014, and residents of communities such as Southwest Detroit have been disproportionately burdened by industrial air pollution for years (Flint Advisory Task Force 2016; Mohai 2018; CNN Library 2019; Schlanger 2016). Activists and community leaders have been gaining momentum in the struggle against environmental harms to which locals of lower socioeconomic or minority status are disproportionately exposed. In 2010, the Environmental Justice Working Group commissioned by Governor Granholm delivered a plan for promoting the equitable distribution of environmental harms and goods in Michigan (Environmental Justice Working Group 2010). The plan was never enacted by the State. Since then, Governor Snyder convened two additional groups to investigate environmental justice in the state: the Flint Advisory Task Force in 2016 and the Governor's Environmental Justice Work Group in 2018 (Flint Advisory Task Force 2016; Environmental Justice Work Group 2018). Environmental justice in Michigan is discussed in more detail in Chapter 2.

Wanting to capitalize on this momentum as well as inform advocacy channels and political activity moving forward, the Michigan Environmental Justice Coalition (MEJC) approached the University of Michigan's School for Environment and Sustainability to convene a student research team in the fall of 2017. The MEJC is a network of nonprofit organizations, academic institutions, and individual members that work towards environmental justice, community health, racial justice, and economic equality in the state of Michigan (Michigan Environmental Justice Coalition n.d.). More information on MEJC is available online at https://michiganenvironmentaljusticecoalition.wordpress.com/.

The MEJC submitted a formal proposal to the school with the seven following goals and objectives: (1) create and deliver an environmental justice assessment of the state of Michigan; (2) identify, gather, and assess environmental justice datasets to effectively evaluate the state of environmental justice in Michigan; (3) layer

social indicators of people of color communities and communities at and below the federal poverty line; explore vulnerable population subsets; (4) deliver a statistical analysis of cumulative environmental impacts on these communities; (5) integrate a community input aspect that may include surveys, interviews, focus groups; (6) develop a policy analysis congruent to the institutionalized implementation of solutions to the problem of cumulative impact; and (7) deliver a final report to the MEJC that communicates findings of the state of environmental justice that includes a physical rendering of the results, presentations, maps, and a glossy report. After the submission of this proposal, a team of three students formed under the advisement of Dr. Paul Mohai. In partnership with the MEJC, the research team finalized the research proposal and research plan.

This research proposal and plan addressed the overall question: "What is the state of environmental justice in Michigan?" In answering this question, the team also sought to explore the feasibility of developing a spatial analysis tool with data specific to the state of Michigan. To fulfill this broad goal, the research team employed a mixed-method approach with three main objectives. First, a comparative analysis was conducted to determine what Michigan-specific data was available to complete a statewide assessment of environmental justice. This stage involved comparing data used in several environmental justice screening tools, including those created by the US EPA, CalEPA, and MPCA. This analysis revealed what specific data could be used in an online environmental justice screening tool and whether the state already collected these data in Michigan.

Second, local perceptions and perspectives on statewide environmental justice were collected by conducting in-depth interviews with environmental justice leaders in the state, including scholars, professionals, and community activists. Through thirty semi-structured interviews, the research team gathered information on strengths and vulnerabilities of local communities, impacts of environmental injustice, and leaders' use of advocacy tools, including those involving online spatial analysis. The team transcribed, coded, and analyzed these data.

Third, a statewide assessment of environmental justice was conducted based on empirical data available through the US EPA's EJScreen tool, which covers the entire US. Environmental and social data specific to

Michigan was analyzed according to the methodology employed in CalEPA's CalEnviroScreen and in Minnesota's two screening tools in order to rank and display block groups in Michigan according to their environmental justice status. The results of this spatial analysis are hosted on an online platform.

This report is divided into six chapters. Chapter 2 presents a literature review focused on historical and current definitions and methods of environmental justice, along with detailed information about spatial analysis tools used by the US EPA, CalEPA, and the MPCA. Chapter 3 presents methodology used in the qualitative data analysis of this project. Methods for qualitative data analysis included outreach to the MEJC contact list, snowball contacts, and individuals who submitted a proposal to present at the MEJC's statewide Environmental Justice Summit that occurred in Flint, Michigan in September 2018. The team conducted thirty semi-structured interviews, and completed inductive thematic data analysis. Chapter 4 presents the results of the qualitative data analysis. Chapter 5 presents methodology used in the quantitative data analysis of the study. Methods for quantitative data analysis included comparing the data and methods of three sets of screening tools, accessing and preparing Michigan-specific data, and spatially and statistically analyzing Michigan-specific data according to the methodology used in CalEnviroScreen and MPCA's Story Map and What's in My Neighborhood tools. Chapter 6 presents the results of the quantitative data analysis. Chapter 7 discusses the implications of the results of this study. Chapter 8 addresses limitations of this study and provides a conclusion to the research. The Michigan Department of Environmental Quality (MDEQ) is mentioned throughout this report. It should be noted that at the end of April 2019, the MDEQ was renamed by Governor Whitmer to the Michigan Department of Environment, Great Lakes, and Energy (EGLE).

The team completed the research process in collaboration with the MEJC, attending meetings with the Coordinator and the the Coalition as a whole. Feedback from the Coordinator was incorporated throughout the project proposal and design process.

Chapter 2. Literature Review

This literature review focuses on four main topics: definitions of environmental justice, evidence and methods of analysis of environmental injustice, environmental justice in the Michigan context, and three spatial analysis tools used to evaluate the state of environmental justice. In discussing definitions of environmental justice from scholars and activists along with methods and evidence that leaders have used to document environmental injustice, this literature review seeks to provide a history of the issue along with its salience to the state of Michigan. This chapter examines three sets of spatial analysis tools: (1) EJScreen used by the US Environmental Protection Agency; (2) CalEnviroScreen used by the California Environmental Protection Agency; and (3) Story Map and What's in My Neighborhood, both used by the Minnesota Pollution Control Agency. By exploring these three tools and their uses by the agencies that created them, this literature review demonstrates that creating a spatial analysis tool specific to the state of Michigan would be feasible and helpful in continuing to monitor the state of environmental justice.

2.1 Definitions of Environmental Justice

Environmental justice is both a discipline and movement that has been fighting for the proportionate distribution of environmental goods and hazards since its inception in 1982 in Warren County, North Carolina when a group of Civil Rights activists protested the siting of toxic waste in a historically African American neighborhood (Mohai, Pellow, and Roberts 2009). Following this protest, a few major events took place that helped define and conceptualize environmental justice.

The protests in Warren County prompted a study by the US General Accounting Office in 1983 that found that three of four hazardous waste landfills examined were sited in areas that were majority African American and where families' incomes were below the poverty line (US GAO 1983). The protests also

prompted the United Church of Christ's (UCC) *Toxic Wastes and Race in the United States* report in 1987, which was the first national study showing that the percent of minority population in each zip code was the best predictor of the location of hazardous waste facilities in the country (UCC 1987). In 1990, Dr. Bunyan Bryant and Dr. Paul Mohai organized the Michigan Conference on Race and the Incidence of Environmental Hazards at the University of Michigan, which, combined with the UCC report, put environmental justice on the US EPA's radar (US EPA 1992). In 1990, Dr. Robert Bullard published *Dumping in Dixie: Race, Class, and Environmental Quality* where he used the civil rights movement to connect environmentalism with social justice and classified environmental justice concerns in terms of three different categories: procedural, geographic, and social (Bullard 1990). Also in 1990, the Indigenous Environmental Network was formed to build capacity of Indigenous communities and tribal governments (Indigenous Environmental Network n.d.). In 1991, the First People of Color National Environmental Leadership Summit met where attendees created and adopted the Seventeen Principles of Environmental Justice (see Figure 1) (US EPA 2017b; Bullard, Mohai, Saha, and Wright 2007). In 1992, a US EPA workgroup published *Environmental Justice: Reducing Risk for All Communities*, a report that proposed ten recommendations to address environmental justice, including creating an Office of Environmental Justice at the US EPA (US EPA 1992). Three years later in 1994, President Bill Clinton signed Executive Order 12898, which was the first federal policy to address environmental justice. In 2003, the US EPA issued a framework for cumulative impact assessment (US EPA 2017b). In 2007, the UCC's *Toxic Wastes and Race in the United States* report was updated after twenty years and it found that people of color were more concentrated around hazardous waste than previously reported in 1987 (Bullard, Mohai, Saha, and Wright 2007). More recently, in 2015 the US EPA released EJScreen, its online screening tool that layers social and environmental data for anyone in the country to access (US EPA 2017b). Each of these events and milestones has proved to be constructive in framing the goals and objectives of this research and the team's research builds upon the collective history of this movement.

There are many working definitions of environmental justice that organizations, scholars, activists, and the government employ. According to the US Environmental Protection Agency (US EPA), environmental justice is "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies" (US EPA 2019). However, environmental justice scholars, activists, and community members use many definitions and concepts of environmental justice in their research, writing, and activism efforts.

In October of 1991, the First National People of Color Environmental Leadership Summit took place in Washington, D.C. with over 1,000 participants. At this event the Seventeen Principles of Environmental Justice were developed. These principles stated that environmental justice involves policies free from discrimination, responsible uses of land and resources, universal protection from environmental hazards, self determination for all people, equal access to decision-making processes, education of present and future generations on environmental issues, and more (NRDC 2016). This summit was a milestone for the environmental justice movement based on its attendance and output of an authoritative definition of environmental justice from the perspective of affected citizens (Bullard 2007). The seventeen principles are listed below in Figure 1 (NRDC 2016).

WE, THE PEOPLE OF COLOR, gathered together at this multinational People of Color Environmental Leadership Summit, to begin to build a national and international movement of all peoples of color to fight the destruction and taking of our lands and communities, do hereby re-establish our spiritual interdependence to the sacredness of our Mother Earth; to respect and celebrate each of our cultures, languages and beliefs about the natural world and our roles in healing ourselves; to ensure environmental justice; to promote economic alternatives which would contribute to the development of environmentally safe livelihoods; and, to secure our political, economic and cultural liberation that has been denied for over 500 years of colonization and oppression, resulting in the poisoning of our communities and land and the genocide of our peoples, do affirm and adopt these Principles of Environmental Justice:

The Principles of Environmental Justice (EJ)

1) **Environmental Justice** affirms the sacredness of Mother Earth, ecological unity and the interdependence of all species, and the right to be free from ecological destruction.

2) **Environmental Justice** demands that public policy be based on mutual respect and justice for all peoples, free from any form of discrimination or bias.

3) **Environmental Justice** mandates the right to ethical, balanced and responsible uses of land and renewable resources in the interest of a sustainable planet for humans and other living things.

4) **Environmental Justice** calls for universal protection from nuclear testing, extraction, production and disposal of toxic/hazardous wastes and poisons and nuclear testing that threaten the fundamental right to clean air, land, water, and food.

5) **Environmental Justice** affirms the fundamental right to political, economic, cultural and environmental self-determination of all peoples.

6) **Environmental Justice** demands the cessation of the production of all toxins, hazardous wastes, and radioactive materials, and that all past and current producers be held strictly accountable to the people for detoxification and the containment at the point of production.

7) **Environmental Justice** demands the right to participate as equal partners at every level of decision-making, including needs assessment, planning, implementation, enforcement and evaluation.

8) **Environmental Justice** affirms the right of all workers to a safe and healthy work environment without being forced to choose between an unsafe livelihood and unemployment. It also affirms the right of those who work at home to be free from environmental hazards.

9) **Environmental Justice** protects the right of victims of environmental injustice to receive full compensation and reparations for damages as well as quality health care.

10) **Environmental Justice** considers governmental acts of environmental injustice a violation of international law, the Universal Declaration On Human Rights, and the United Nations Convention on Genocide.

11) **Environmental Justice** must recognize a special legal and natural relationship of Native Peoples to the U.S. government through treaties, agreements, compacts, and covenants affirming sovereignty and self-determination.

12) **Environmental Justice** affirms the need for urban and rural ecological policies to clean up and rebuild our cities and rural areas in balance with nature, honoring the cultural integrity of all our communities, and provided fair access for all to the full range of resources.

13) **Environmental Justice** calls for the strict enforcement of principles of informed consent, and a halt to the testing of experimental reproductive and medical procedures and vaccinations on people of color.

14) **Environmental Justice** opposes the destructive operations of multi-national corporations.

15) **Environmental Justice** opposes military occupation, repression and exploitation of lands, peoples and cultures, and other life forms.

16) **Environmental Justice** calls for the education of present and future generations which emphasizes social and environmental issues, based on our experience and an appreciation of our diverse cultural perspectives.

17) **Environmental Justice** requires that we, as individuals, make personal and consumer choices to consume as little of Mother Earth's resources and to produce as little waste as possible; and make the conscious decision to challenge and reprioritize our lifestyles to ensure the health of the natural world for present and future generations.

More info on environmental justice and environmental racism can be found online at www.ejnet.org/ej/

Delegates to the First National People of Color Environmental Leadership Summit held on October 24-27, 1991, in Washington DC, drafted and adopted these 17 principles of Environmental Justice. Since then, the Principles have served as a defining document for the growing grassroots movement for environmental justice.

Figure 1. The Seventeen Principles of Environmental Justice developed at the First National People of Color Environmental Leadership Summit in 1991.

Professor Bunyan Bryant defined environmental justice as "those cultural norms and values, rules, regulations, behaviors, policies, and decisions to support sustainable communities, where people can interact with confidence that their environment is safe, nurturing, and protective" (Bryant 1995, 6). Scholar Robert Kuehn built on definitions offered by Bryant, Bullard, and many others when he proposed a four-pronged definition of environmental justice that included distributive justice, procedural justice, corrective justice, and social justice. Kuehn distilled many of his ideas of environmental justice while analyzing the controversy surrounding the Shintech poly-vinyl chloride plant in St. James Parish, Louisiana, while he led the University Environmental Law Clinic, which tried to help affected residents in their struggle (Kuehn 2000). First, distributive justice referred to ensuring the same distribution of environmental goods and services to everyone and included both mitigating disproportionate burdens of environmental hazards placed on minority communities and ensuring equal access to benefits of environmental programs. Second, procedural justice referred to the fairness of and access to decision-making processes, which should be inclusive and represent all groups equally. All groups should agree on the process, especially those most affected by environmental actions. Third, corrective justice involved fairly punishing those who break the law and repairing the losses for people and groups who are damaged. Buyouts and relocation are common practices in seeking corrective justice but typically end up treating the community as the problem instead of the pollution (Kuehn 2000). Fourth, social justice referred to society meeting people's needs. The lens of social justice put issues of environmental injustice in the context of broader problems of racial and economic inequalities (Kuehn 2000). Kuehn (2000) suggested that this four-part definition of environmental justice offered "a means to ensure that environmental justice concerns are appropriately integrated into environmental decision-making" as well as "the opportunity for greater awareness of what justice means to impacted people of color and lower income communities" (57).

Scholar Steve Lerner focused his writing on the effects of environmental injustice on people of specific communities. Lerner (2010) wrote about sacrifice zones, which are areas adjacent to industry or military bases where residents experience toxic chemical exposure. People living in these areas are typically minority or

low-income, and the areas were such named because residents have to make health and economic sacrifices that white and wealthier people can better avoid. According to Lerner, sacrifice zones result from inequitable and biased land use decisions whose health impacts are often not communicated to residents of affected areas, making it impossible for them to try to move or take action in a timely manner. These unjust decisions turn citizens into activists as they force residents to organize themselves, find allies, get the attention of the media, and more, all without any compensation. Lerner emphasized that community organizers in sacrifice zones must fight against huge industries with access to many more resources than they have, including corporate lawyers who can successfully argue that residents experience adverse health effects because they are poor, lack access to healthcare, have unhealthy habits, etc, all of which blame the residents instead of the toxic pollution. In addition to bringing to light the work of community organizers in sacrifice zones, Lerner discussed the challenges to industries that seek to make profit as they make difficult decisions about where to place their facilities. Lerner (2010) demonstrated industry's predicament when he said, "Thus, wherever they choose to build, they will discomfit some community" (14). Lerner pointed out that sacrifice zones in the US are hidden from the majority of citizens as they are located off the beaten path. It is important to bring attention to residents of these communities to attempt to repair damages done and bring about equity and environmental justice (Lerner 2010).

More recently, Julian Agyeman (2008) extended these earlier notions of environmental justice to the sustainability movement through the Just Sustainability Paradigm, which is the policy architecture supporting the nexus between environmental justice and sustainability. According to Agyeman, environmentalism has not dealt well with justice and equity. The dominant narrative of sustainability is that environmentalists are saving the world for everyone equally, thus there is no need to focus on social justice. However, the notion of sustainability must be transformed to address what Agyeman defined as the equity deficit, or the fact that sustainability seeks to protect unborn future generations but doesn't protect vulnerable populations alive in the

present moment (Agyeman 2008). Agyeman's work represents a new frontier of environmental justice literature that focuses on embedding justice in already existing sustainability work and narratives.

Other scholars have written about environmental justice in terms of institutional discrimination (Saha and Mohai 2005; Mohai and Saha 2006, 2007, 2015; Mohai, Pellow, and Roberts 2009), building on Feagin and Feagin's (1986) model of discrimination that moves beyond the individual prejudice of members of society. Feagin and Feagin presented discrimination as more than just individual prejudice, but also inclusive of institutional and structural facets. According to these authors, discrimination results from people's interest in protecting their own privilege and power and from internalized colonialism, which is the historical exploitation of non-European groups by European groups that has led to current institutionalized structures that continue to exploit minority groups. This discrimination routinely manifests itself in issues of both race and class. Because it is structural and institutional, it can be unintentional and indirect, with indirect institutionalized discrimination being the most neglected type. Indirect institutionalized discrimination describes practices that have a negative effect on minority groups even when norms or rules regulating those actions were designed with no prejudice behind them. Environmental injustice committed against members of minority racial groups and people of low socioeconomic status can often be the result of institutional discrimination. Further, injustices can be committed as the result of side-effect discrimination, which describes actions taken by one institution that have a negative impact on minority groups because they are directly linked to discriminatory actions of another institution (Feagin and Feagin 1986).

Forman and Lewis of the University of Illinois at Chicago have also studied the impact of indirect forms of prejudice and white racial attitudes, specifically in the wake of Hurricane Katrina. These authors described racial apathy, or indifference towards racial inequality, and white ignorance, or white people not knowing about racial inequality, as new forms of prejudice against racial minorities. White people not caring and not knowing about racial inequality were displayed in their surprised reactions to the racialized impacts of

Hurricane Katrina. According to the authors, racial apathy and white ignorance stem from color-blind discourses and are just now starting to receive attention (Forman and Lewis 2006).

2.2 Evidence and Methods of Environmental Justice Research

Scholars have documented the existence of environmental injustice using statistical and spatial methods by analyzing the location of environmental hazards and the surrounding demographics in terms of race and socioeconomic status. The first national study directly connecting the distribution of hazardous waste sites and race was *Toxic Wastes and Race in the United States* written by the United Church of Christ, which showed that minority percentage of the population in each zip code is the best predictor of the location of hazardous waste facilities in the US (United Church of Christ 1987). Much of the scholarship following this UCC report has focused on the debate surrounding whether race and class both play a role in predicting environmental injustice, and the debate about whether minority communities or polluting facilities first appear in environmental justice communities. These two questions represent two large debates of the environmental justice movement that center around figuring out whether minority communities are targeted for new facilities as paths of least resistance, or if wealthier and white residents have an easier time moving away from facilities once property values decline. These debates seek to help explain why environmental disparities exist and have political and policy implications (Mohai 2008).

In 2007, the United Church of Christ's *Toxic Wastes and Race in the United States* report was updated and once again revealed a greater concentration of people of low socioeconomic status and people of color around hazardous sites (Bullard, Mohai, Saha, and Wright 2007). According to the research presented in this updated report, 56% of people living within 3.0 kilometers of a hazardous waste facility are people of color, while people of color make up only 30% of the US population. The 2007 report also stated that annual household incomes and housing values are lower in host neighborhoods than in neighborhoods without environmental hazards (Bullard et al. 2007). This 2007 analysis used the more accurate and improved

distance-based methods of spatial analysis described and advocated by Mohai and Saha in their 2006 article (Mohai and Saha 2006).

More recently, scholars have analyzed environmental justice using longitudinal data that covers a longer term than previous studies. Mohai and Saha (2015a) sought to analyze how present-day environmental disparities came about, which required examining demographic characteristics of host sites at the time of siting and after siting occurred. The disparate-siting hypothesis refers to environmentally hazardous sites being disproportionately placed in communities where minorities or poor people live at the time of siting. The post-siting demographic change hypothesis refers to demographic changes happening after the siting of environmentally hazardous sites when minorities and people of low socioeconomic status move into host communities and more affluent whites move away. It has been difficult for scholars to reach consensus on these hypotheses thus far because most studies have been cross-sectional, snapshot studies that reflected demographic information only at one point in time, and have used differing methods and geographic scopes. However, Mohai and Saha (2015b) presented evidence from the first national longitudinal study of environmental injustice analysis using distance-based methods that supported the disparate-siting hypothesis. Furthermore, Mohai and Saha's results indicated that socioeconomic and racial disparities around hazardous waste sites widen over time, that demographic changes in communities attract environmental hazards, and that race is a stronger predictor of environmental hazard siting than socioeconomic class (Mohai and Saha 2015b). However, they also found that, rather than triggering demographic changes after hazardous waste facilities are sited, demographic changes occur even before siting, suggesting that communities undergoing demographic changes are vulnerable to the siting of new locally unwanted land uses (LULUs). This process is likely due to eroding social capital and political clout accompanying such demographic changes (Mohai and Saha 2015b).

In addition to studying who is affected by environmental hazards, scholars are examining who is polluting the environment. Collins et al. (2016) presented the first national study to analyze the scope of variations in industrial pollution alongside inequities in exposure to this pollution. With the goal of assessing

producer disproportionalities and the degree to which specific communities are disproportionately impacted by pollution, researchers used the US EPA's Risk Screening Environmental Indicators-Geographic Microdata from 2007 and data from the US Census in 2000 to evaluate the proportional contribution of polluting facilities and their relationship to variables indicative of environmental injustice. The researchers found that outliers exist in terms of disproportional pollution emissions and that low-income populations and nonwhite populations are more likely to live in areas near these top polluters. The top polluters typically display a lack of concern for disadvantaged communities. Collins et al. (2016) reported, "They found that of the 100 worst polluters, the top ten imposed disproportionate impacts on disadvantaged communities. They found that minorities living near these ten polluters were bearing more than half of the human health risk generated in the region," (3). These results might mean that it is possible to dramatically improve environmental quality simply by regulating the top industrial polluters (Collins et al. 2016).

2.3 The Michigan Context

The environmental justice framework and methodology is especially relevant to recent events and efforts in Michigan. In 1990, Dr. Bryant and Dr. Mohai organized a conference to bring together researchers in the US studying the spatial distribution of environmental hazards and accompanying racial and socioeconomic disparities (Mohai 2008). The 1990 Michigan Conference resulted in a series of meetings between the US EPA and representatives of the Michigan Conference, later dubbed by the US EPA as the "Michigan Coalition" (Mohai 2018). These meetings, which were broadened to include other environmental justice leaders across the US, resulted in the creation of the Office of Environmental Justice in the US EPA, the National Environmental Justice Advisory Council (NEJAC), and the publication of US EPA's 1992 report *Environmental Equity: Reducing Risks for All Communities.* The latter represents the first acknowledgement by the federal government that environmental injustices exist and that government actions and policies need to address them (Mohai 2018).

In the late 1990's, community groups in Michigan filed civil rights complaints with the Office of Environmental Justice at the US EPA against permits issued by the Michigan Department of Environmental Quality (MDEQ) to Genesee Power and Select Steel in Flint, and a hazardous waste injection well in Romulus. Community groups claimed the permitting methods were discriminatory. In each case, the US EPA either did not issue a decision or found the permits were not discriminatory; however, the US EPA did encourage MDEQ to develop a policy and program to address environmental justice in the state. The agency formed a workgroup in 1998, which produced a report called *Environmental Justice Recommendations*. The recommendations were never implemented and the workgroup dissolved in 2000. The MDEQ made efforts to improve public outreach, including drafting a document called *Model Community Outreach Plan* in 2001 and asking the Environmental Advisory Council (EAC) to develop environmental justice principles for the agency. The EAC created *Recommendations for an Environmental Justice Policy for Michigan*, which the MDEQ Director and Department of Civil Rights Director submitted to Governor Jennifer Granholm in 2006 (Environmental Justice Working Group 2010).

Based on these recommendations, in 2007 Governor Granholm issued an Executive Directive addressing environmental justice. In it, Governor Granholm charged the Michigan Department of Environmental Quality and Department of Natural Resources and Environment with developing and implementing a plan to promote environmental justice in the state (Granholm 2007). The MDEQ convened the Environmental Justice Working Group, made up of representatives from state agencies, advocacy groups, academia, local tribes, and economic development and business organizations who worked for two years to develop a plan. Key elements of their plan addressed disparate impacts, integration of justice into agency activities, public participation, tribal consultation, inter-agency cooperation, and the role of local units of government (Environmental Justice Working Group 2010). The working group released their report in 2010, but according to an opinion piece published in the Detroit Free Press by two environmental justice leaders in Michigan, the State never put it into action (Turner-Handy 2016).

The state has been in the national spotlight in the wake of the Flint Water Crisis, a massive case of environmental injustice as reported by the Flint Water Advisory Task Force (FWATF) convened by Governor Rick Snyder. After emergency managers switched the Flint water supply from the Detroit water system to the Flint River in April 2014, the population of Flint, which is majority African American and low-income, was exposed to toxic levels of lead and other contaminants through the drinking water. Inadequate preparation of the staff, inadequate upgrades to the water plant, inadequate and improper sampling for water quality, disregard for evidence of water quality issues and related health effects, dismissive responses to citizen concerns, and delays in responding to evidence of exposure to water contamination all resulted in an environmental and public health disaster in Flint (Flint Water Advisory Task Force 2016). After acknowledging that an injustice had taken place, Michigan Governor Snyder assembled a task force of five members. As stated in their report, "...the magnitude of this tragedy warrants deep and detailed investigation" (Flint Water Advisory Task Force 2016, 3).

Another major environmental justice issue in Michigan is industrial air pollution in Southwest Detroit, specifically in 48217, which is often referred to as the most polluted zip code in Michigan (Lam 2010). According to a map published in a 2018 MDEQ report entitled *48217 Community Air Monitoring Project*, the 48217 zip code is surrounded by more than two dozen major industrial facilities that report air emissions to Michigan Air Emissions Reporting System (Kilmer and Williams 2018). Further, the area has more sulfur dioxide than federal standards allow, which contributes to high asthma rates of residents in the area (Schlanger 2016). Citizens continue to breathe high levels of toxic pollutants from industries such as Marathon, DTE Energy, Carmeuse Lime, and more, while officials cite difficult negotiations and major changes in operation as barriers to getting companies to reduce their emissions (Schlanger 2016). The case of industrial air pollution in Southwest Detroit received national attention when Zoe Schlanger published an article in Newsweek in 2016 about the health implications for residents (Schlanger 2016).

Rural and tribal communities also experience environmental injustice in Michigan. According to Potawatomi Nation member and scholar Kyle Whyte, pipelines often pose threats to both water quality on which Native communities rely, and the treaty rights which govern their land use (Balaskovitz 2017). Additionally, the mining efforts of companies threaten the health and environment of those who live nearby, especially members of Native American tribes (Bienkowski 2012). For example, the Keweenaw Bay Indian Community of the Lake Superior Band of Chippewa spent years fighting the construction of a nickel mine near land and water on which they depend. The mine near Lake Superior interferes with spiritual, provisional, and recreational uses of the land and has the potential to pollute groundwater, which would also affect local fish and aquatic species. Tribal leaders continue to advocate for their treaty rights to be honored during related decision-making processes (Bienkowski 2012).

Another case relevant to rural communities that made national news occurred in 1973 when a cattle feed supplement was switched with a toxic flame retardant in St. Louis, Michigan. The mistake was not discovered until a year later, after 70% of Michigan residents had been exposed to chemical contamination through their milk, eggs, and meat (Emory University 2015). The result of this chemical poisoning of polybrominated biphenyl (PBB) has impacted 9 million Michigan residents. Taxpayers have been funding the site cleanup, which is still not totally complete (Ellison 2016). As of 2017, decades after the original contamination, thyroid disease is common among men and women who were exposed (Jacobson et al. 2017). The health, ecological, and economic impacts are still experienced in and around St. Louis today (Ellison 2016).

In 2016, researchers from the University of Michigan's School of Public Health partnered with community leaders on issues related to environmental justice to analyze the distribution of environmental exposures, health risks, and social vulnerabilities in the Detroit metropolitan area. The team spatially and statistically analyzed the location of sensitive populations in terms of their proximities to hazardous land uses, exposure to air pollution, health risks, social vulnerabilities, and cumulative risk. Results showed that census tracts with greater proportions of people of color are disproportionately exposed to environmental harm,

socioeconomic vulnerability, and cumulative risk (Schulz, Mentz, Sampson, Ward, Anderson, de Majo, and Wilkins 2016).

In the wake of the Flint Water Crisis, Governor Snyder convened an Environmental Justice Work Group in February 2017 to provide recommendations to improve the environmental justice engagement of the government and its agencies (Environmental Justice Work Group 2018). The second recommendation in the work group's final report was for the State to "Develop an environmental justice screening tool in Michigan and include cumulative impacts in decision-making processes" (Environmental Justice Work Group 2018, 6). This recommendation reflects the need to assess the state of environmental justice as the State seeks to repair damage from the Flint Water Crisis, and as the MEJC seeks to establish a baseline of environmental justice in the state.

2.4 Spatial Analysis Tools: EJScreen, CalEnviroScreen, and Minnesota's Tools

Spatial analysis of locations of environmental hazards in relation to populations living nearby is an important aspect of assessing the existence and prevalence of environmental injustice. The US and many individual states have different approaches to spatial analysis of environmental justice. The US EPA's EJScreen tool (https://ejscreen.epa.gov/mapper/) is currently publicly available to environmental justice advocates and the general public all over the country (Kuruppuarachchi 2017). Aside from this national-level tool, two US states examined in this report that have varying approaches to spatial analysis include California and Minnesota. The California EPA (CalEPA) created CalEnviroScreen (https://oehha.ca.gov/calenviroscreen) with state-specific data (Kuruppuarachchi 2017). In addition, residents of Minnesota have access to several screening tools sponsored by the state's environmental quality agency, the Minnesota Pollution Control Agency (MPCA): What's in My Neighborhood (https://pca-gis02.pca.state.mn.us/wimn2/index.html) and Story Map (http://mpca.maps.arcgis.com/apps/MapSeries/index.html?appid=f5bf57c8dac24404b7f8ef1717f57d00)

(MPCA 2018). These tools provide helpful frameworks for considering a Michigan statewide spatial analysis tool in order to assess the state of environmental justice.

A. US EPA's EJ Screen

The EJScreen is a national environmental justice screening and mapping tool developed by the US EPA. The US EPA began developing this tool in 2010, had it peer reviewed in 2014, released it to the public in 2015, and updated its data in 2016 (Kuruppuarachchi 2017). The US EPA developed EJScreen in part to fulfill President Clinton's 1994 Executive Order requiring federal agencies to consider environmental justice implications of their actions (Environmental and Energy Study Institute 2016). EJScreen also supports EJ2020, the US EPA's national environmental justice strategic plan to be completed by the year 2020 (US EPA 2016).

The main focus of EJScreen is to map potential risk areas based on environmental and demographic indicators of a user-specified site (Kuruppuarachchi 2017). While this tool doesn't identify environmental justice communities, the US EPA does use it to discern communities that might need more support in terms of residents' public health and surrounding environment (EPAGroups 2016). EJScreen is also used to support US EPA's educational programs, grant distribution, and community awareness efforts, as well as to help the agency make sure its decisions uphold environmental justice (US EPA 2018a; Environmental and Energy Study Institute 2016). This tool is available to the public including citizens, agencies, and organizations (US EPA 2018a).

EJScreen employs data from the American Communities Survey at the census block group-level to examine social determinants of community members' health (Environmental and Energy Study Institute 2016). Demographic indicators displayed for each block group in the tool include:

- Percent Low-Income: "the percent of a block group's population in households where the household income is less than or equal to twice the 'federal poverty level'"

- Percent Minority: "the percent of individuals in a block group who list their racial status as a race other than white alone and/or list their ethnicity as Hispanic or Latino"
- Less than high school education: "percent of people age 25 or older in a block group whose education is short of a high school diploma"
- Linguistic isolation: "percent of people in a block group living in linguistically isolated households (a household in which all members age 14 years and over speak a non-English language and also speak English less than 'very well')"
- Individuals under age 5: "percent of people in a block group under the age of 5"
- Individuals over age 64: "percent of people in a block group over the age of 64" (US EPA 2017a)

EJScreen calculates a "Demographic Index" of each census block group. To calculate a "Demographic Index," only two of the six social indicators listed above are used: percent minority and percent low-income. The "Demographic Index" equals (% minority + % low-income)/2. The tool also displays the following eleven environmental indicators for each census block group:

- National-Scale Air Toxics Assessment (NATA) air toxics cancer risk: "lifetime cancer risk from inhalation of air toxics"
- NATA respiratory hazard index: "air toxics respiratory hazard index (ratio of exposure concentration to health-based reference concentration)"
- NATA diesel particulate matter: "diesel particulate matter level in air"
- Particulate matter (PM2.5): "PM2.5 levels in the air"
- Ozone: "ozone seasonal average of daily maximum 8-hour concentration in air"
- Lead paint indicator: "percent of housing units built pre-1960, as indicator of potential lead paint exposure"

- Traffic proximity and volume: "count of vehicles at major roads within 500 meters, divided by distance in meters"
- Proximity to Risk Management Plan (RMP) sites: "count of RMP facilities within 5 km (or nearest one beyond 5km), each divided by distance in kilometers"
- Proximity to Hazardous Waste Facilities: "count of hazardous waste facilities (TSDFs and LQGs) within 5km (or nearest beyond 5km), each divided by distance in kilometers"
- Proximity to National Priorities List (NPL) sites: "count of proposed and listed NPL - also known as superfund - sites within 5km (or nearest one beyond 5km), each divided by distance in kilometers"
- Wastewater Dischargers Indicator (Stream Proximity and Toxic Concentration): "RSEI modeled Toxic Concentrations at stream segments within 500 meters, divided by distance in kilometers (km)" (US EPA 2017a)

The tool combines the demographic and environmental information in an "Environmental Justice Index" (EJ Index), which signifies a community's overall social and environmental vulnerability (EPAGroups 2016). "EJ Indexes" are calculated individually for each environmental indicator for each block group. The "EJ Index" of each block group is the calculated product of the environmental indicator, the "Demographic Index" for the block group minus the "Demographic Index" for the US, and the population count for each block group (US EPA 2017a).

The output of EJScreen includes both a map and report depicting the environmental indicators, demographic indicators, and "EJ Indexes" for each block group in user-selected communities of analysis. The map outputs are color coded for ease of interpretation, and resulting tables showing environmental indicators, demographic indicators, and "Environmental Justice Indexes" allow comparisons to average scores across the state, region, and country (Kuruppuarachchi 2017).

There are several main strengths and limitations of EJScreen. The output of the tool provides a detailed map and report that can be used for analysis of almost any area in the United States. Results allow users to compare different communities based on several screening indices. Further, users can add connecting technology, add their own data, and download the data used in the tool. However, the US EPA maintains that this tool should not be used for decision-making or to identify the location of environmental justice communities. Instead, it is limited to highlighting places that might be in need of further review. Additionally, while the tool is publicly available, it is only available in English, limiting who can actually use it. Finally, EJScreen does not provide information on actual exposure that communities experience, it only provides information on residents' potential for exposure (Kuruppuarachchi 2017).

The following images show the results and outputs of EJScreen when used to examine the location of the Stringfellow Acid Pits in Jurupa Valley, California. Note that while presenting a Michigan example would be ideal, a site in California was chosen to facilitate the side-by-side comparison of EJScreen and CalEnviroScreen results. As CalEnviroScreen only shows census tracts in the state of California, a site from that state is examined.

Figure 2. The national scope of data presented by EJScreen. Census block groups are color-coded based on "Environmental Justice Index" scores.

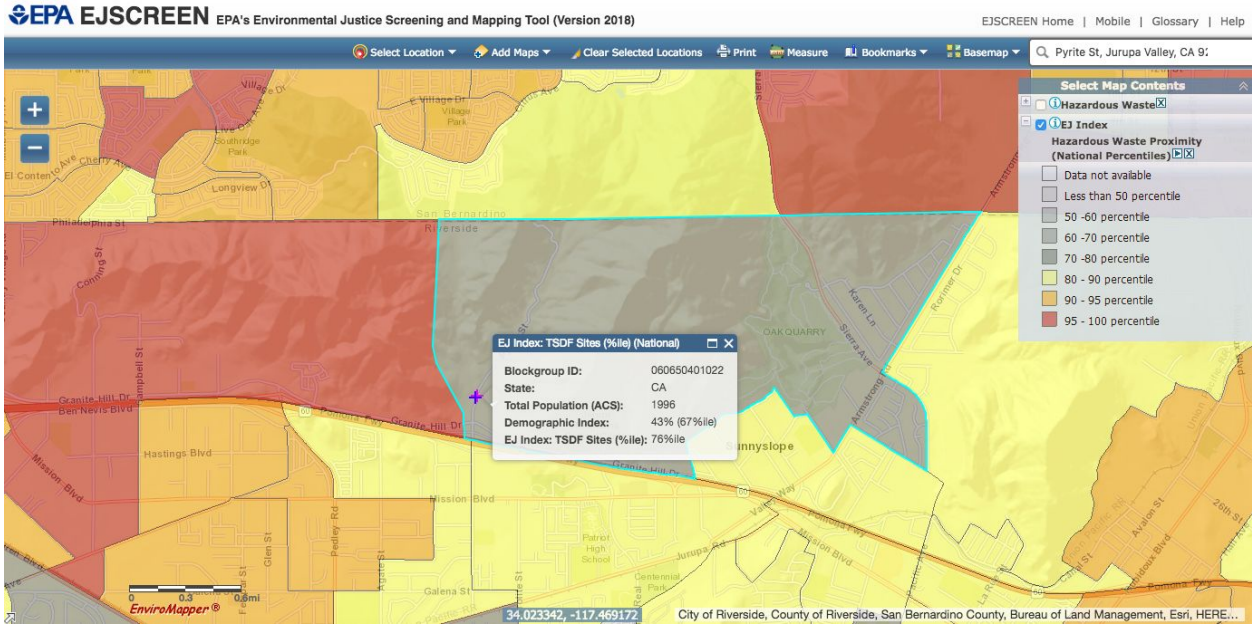


Figure 3. The census block (outlined in light blue) that hosts the Stringfellow Acid Pits in Jurupa Valley, California (designated with a blue "+"). Census block groups are color-coded based on "Environmental Justice Index" scores of Proximity to Hazardous Waste Facilities.

Figure 4. The report generated by EJScreen comparing the "Environmental Justice Indexes" for the area within three miles of the Stringfellow Acid Pits in Jurupa Valley, California to state, regional, and national scores.

These three figures show the outputs users can generate using EJScreen, the scope and scale of analysis possible, and the presentation of data both as maps and as graphs. Figure 2 demonstrates the national scope of the EJScreen tool for conducting spatial analysis, as it has social and environmental data on every state in the US. Figure 3 demonstrates that the census block that hosts the Stringfellow Acid Pits is in the 70-80th percentile in the country in terms of potential exposure of vulnerable communities to hazardous waste. Figure 4 compares the "Environmental Justice Index" scores of the block containing the acid pits to scores across the state, region, and country, and demonstrates that the block is relatively high in terms of disproportionate superfund proximity, hazardous waste proximity, and wastewater discharge indicators for the state, region, and country. These outputs from EJScreen demonstrate a potential vulnerability of the community that hosts the toxic waste in Jurupa Valley. These data could be helpful in analyzing the case of the dumping as a potential instance of environmental injustice.

B. CalEPA's CalEnviroScreen

While EJScreen allows for the analysis of any state or region in the US, CalEnviroScreen provides more localized analysis of California. CalEnviroScreen is an environmental health screening tool used in the state of California that was developed by the California Environmental Protection Agency (CalEPA) and the California Office of Environmental Health Hazard Assessment (OEHHA) (Kuruppuarachchi 2017). CalEnviroScreen is the largest statewide public screening tool in the United States both in terms of geographic scope and the level of detail provided by the data. The tool originated from a 2010 CalEPA report describing the need for underlying science and general methods for identifying communities that face multiple sources of pollution in the state. The development process of CalEnviroScreen was transparent and involved public input, as the first draft of the tool was released in 2012 for public review and comment. Following twelve public workshops and over 1,000 comments, the first version of this tool was released to the public in 2013. A second version of the tool using updated data was released in 2014, and a third version, the current iteration, was released in January 2017. The

latest version includes two new measures capturing cardiovascular disease and the effects of high housing costs on low-income households (Faust et al. 2017).

CalEnviroScreen was developed, in part, to fulfill CalEPA's 2004 Environmental Justice Action Plan, which called for the development of guidance to analyze the impacts of multiple pollution sources on communities throughout the state. It is currently being used to direct state and local resources to revitalization efforts in disadvantaged communities, and to conduct statewide evaluations of environmental impacts on vulnerable communities. One of the most notable uses of the tool to date has been to inform CalEPA's identification of "disadvantaged communities," as mandated by the Senate Bill 535, which was passed into law in 2012 and requires at least 25% of funds earned from the state's cap-and-trade program to be invested in "disadvantaged communities" (Faust et al. 2017; CalEPA 2017). The tool is also used to inform AB 1550, which was passed into law in 2016 and requires at least 25% of funds from the Greenhouse Gas Reduction Fund to be invested in "disadvantaged communities" (OEHHA 2017). To designate "disadvantaged communities" in terms of environmental justice, CalEPA determines the highest scoring 25% of census tracts in the state on CalEnviroScreen, as well as 22 additional census tracts that score in the highest 5% of the "Pollution Burden" calculation but do not have an overall CalEnviroScreen score due to unavailable socioeconomic or health data (OEHHA 2017).

CalEnviroScreen displays data at the census tract scale and provides a score for each tract that is calculated by multiplying a "Pollution Burden" score with a "Population Characteristics" score (Faust et al. 2017). "Pollution Burden" indicators are divided into two categories: "Exposure" and "Environmental Effects." The first category, "Exposures" includes data on the following indicators:

- Ozone Concentrations: "mean of summer months (May-October) of the daily maximum 8-hour ozone concentration (ppm), averaged over three years (2012 to 2014)"
- Particulate Matter 2.5 Concentrations: "annual mean concentration of PM2.5 (average of quarterly means, micrograms/cubed meter), over three years (2012 to 2014)"

- Diesel Particulate Matter Emissions: "spatial distribution of gridded diesel PM emissions from on-road and non-road sources for a 2012 summer day in July (kg/day)"
- Drinking Water Contaminants: "drinking water contaminant index for selected contaminants"
- Pesticide Use: "total pounds of selected active pesticide ingredients (filtered for hazard and volatility) used in production-agriculture per square mile, averaged over three years (2012 to 2014)"
- Toxic Releases from Facilities: "toxicity-weighted concentrations of modeled chemical releases to air from facility emissions and off-site incineration (averaged over 2011 to 2013)"
- Traffic Density: "sum of traffic volumes adjusted by road segment length (vehicle-kilometers per hour) divided by total road length (kilometers) within 150 meters on the census tract boundary (2013)" (Faust et al. 2017)

The second category, "Environmental Effects" includes data on the following indicators:

- Cleanup Sites: "sum of weighted sites within each census tract (data downloaded December 2016)"
- Groundwater Threats: "sum of weighted scores for sites within each census tract (data downloaded December 2016)"
- Hazardous Waste Generators and Facilities: "sum of weighted permitted hazardous facilities and hazardous waste generators within each census tract (permitted hazardous waste facilities was downloaded December 2016, hazardous waste data is from 2012-2014)"
- Impaired Water Bodies: "summed number of pollutants across all water bodies designated as impaired within the area (2012)"
- Solid Waste Sites and Facilities: "sum of weighted solid waste sites and facilities (as of December 2016)" (Faust et al. 2017)

The tool calculates a "Pollution Burden" score for each tract based on the average percentiles of the seven "Exposure" indicators and the five "Environmental Effects" indicators. "Environmental Effects"

indicators are given half the weight of the "Exposure" indicators. The average "Pollution Burden" score is divided by ten and rounded one decimal place. Final "Pollution Burden" scores range from 0.1 to 10 (Faust et al. 2017). This equation is displayed below.

[(Avg % for Exposure Indicators) + (0.5 x Avg % for Environmental Effects Indicators)] / (1+ 0.5)

"Population Characteristics" indicators are also divided into two categories: "Sensitive Populations" indicators and "Socioeconomic Factors." The first category, "Sensitive Populations" includes data on the following indicators:

- Asthma Emergency Department Visits: "spatially modeled, age-adjusted rate of emergency department (ED) visits for asthma per 10,000 (averaged over 2011-2013)"
- Cardiovascular Disease (Emergency Department visits for Heart Attacks): "spatially modeled, age-adjusted rate of emergency department (ED) visits for AMI per 10,000 (averaged over 2011-2013)"
- Low Birth Weight Infants: "percent low birth weight (averaged over 2006-2012)" (Faust et al. 2017)

The second category included in "Population Characteristics" is "Socioeconomic Factors" and includes data on the following indicators:

- Educational Attainment: "percent of the population over age 25 with less than a high school education (5-year estimate, 2011-2015)"
- Housing Burdened Low Income Households: "percent of households in a census tract that are both low income (making less than 80% of the HUD Area Median Family Income) and severely burdened by housing costs (paying greater than 50% of their income to housing costs) (5-year estimates, 2009-2013)"
- Linguistic Isolation: "percent limited English-speaking households (2011-2015)"

- Poverty: "percent of the population living below two times the federal poverty level (5-year estimate, 2011-2015)"
- Unemployment: "percent of the population over the age of 16 that is unemployed and eligible for the labor force, excludes retirees, students, homemakers, institutionalized persons except prisoners, those not looking for work, and military personnel on active duty (5-year estimate, 2011-2015)" (Faust et al. 2017)

The tool calculates a "Population Characteristics" score for each census tract by averaging the percentiles for the "Sensitive Populations" indicators and the "Socioeconomic Factors" indicators. The calculated average percentile is divided by 10. Final "Population Characteristics" scores range from 0.1 to 10 (Faust et al. 2017). This equation is displayed below:

(Avg % for Sensitive Population Indicators + Avg % for Socioeconomic Factor Indicators) / 2

The "Pollution Burden" score and the "Population Characteristics" score are both scaled by the statewide maximum scores. To scale the "Pollution Burden" score, the calculated "Pollution Burden" percentile for each tract is divided by the highest "Pollution Burden" score for any tract in the state, then multiplied by ten. To scale the "Population Characteristics" score, the calculated "Population Characteristics" percentile for each tract is divided by the highest "Population Characteristics" score for any tract in the state, then multiplied by ten. A final CalEnviroScreen Score is calculated for each census tract by multiplying the "Pollution Burden" score by the "Population Characteristics" score of each tract (Faust et al. 2017). The maximum score for each tract presented in CalEnviroScreen is 100 (Kuruppuarachchi 2017). After each tract's "Pollution Burden" score is combined with its "Population Characteristic" score, geographic areas are ordered from highest to lowest

based on overall scores (Faust et al. 2017). See Appendix A for a map displaying the final statewide results, as calculated and displayed on CalEnviroScreen (Faust et al. 2017).

Outputs of CalEnviroScreen include a map and a report of indicator scores of each tract. For ease of interpretation, maps are color coded based on overall scores: census tracts with darker red colors have higher scores, indicating higher pollution burdens and population vulnerabilities than census tracts with yellow to green colors. Outputs also include issue profiles, community comparison tables, and links to additional information about environmental justice issues to which communities are exposed (Kuruppuarachchi 2017).

There are several strengths and weaknesses to the CalEnviroScreen tool. This tool provides users with maps and reports on most census tracts in the state and allows users to compare exposure potential and vulnerability of different census tracts. Further, it puts health and environmental data in a usable form for the public. Users can add connecting technology and have the ability to download the data (Kuruppuarachchi 2017). The tool is also available for use in Spanish, making it more easily accessible by native Spanish speakers in the state and nation (OEHHA n.d.). However, this spatial analysis tool is limited by the fact that users are not able to add their own data, and by data gaps that exist in certain census tracts in the state (Kuruppuarachchi 2017).

The following images show the output and results of spatial analysis in CalEnviroScreen of the Stringfellow Acid Pits in Jurupa Valley, California.

Figure 5. Display of statewide CalEnviroScreen scores, which combine the "Pollution Burden" and "Population Characteristics" scores for each census tract in the state. Scores are color coded based on vulnerability of census tracts.

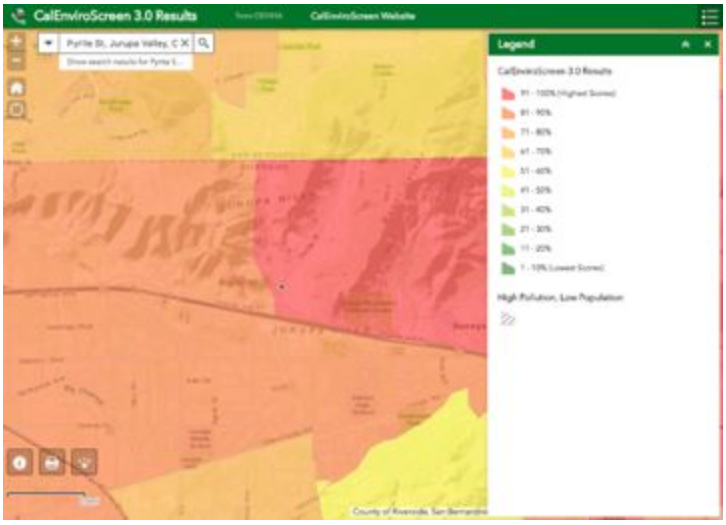
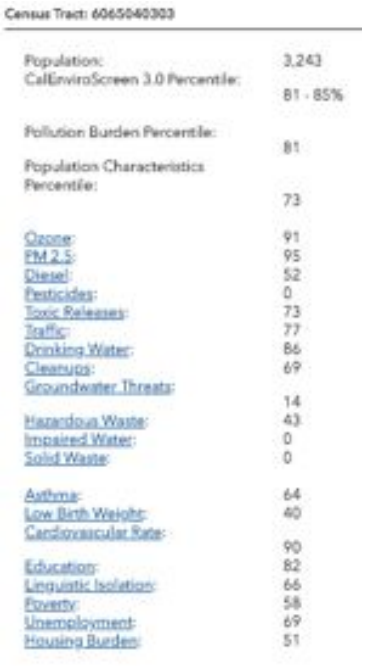


Figure 6. The census tract containing the Stringfellow Acid Pits in Jurupa Valley, California (designated with a blue circle). Based on this display, the reader can identify that the CalEnviroScreen score for this tract is in the 91-100 percentile for the state.



Census Tract: 6065040303	
Population:	3,243
CalEnviroScreen 3.0 Percentile:	81 - 85%
Pollution Burden Percentile:	81
Population Characteristics Percentile:	73
Ozone:	91
PM 2.5:	95
Diesel:	52
Pesticides:	0
Toxic Releases:	73
Traffic:	77
Drinking Water:	86
Cleanups:	69
Groundwater Threats:	14
Hazardous Waste:	43
Impaired Water:	0
Solid Waste:	0
Asthma:	64
Low Birth Weight:	40
Cardiovascular Rate:	90
Education:	82
Linguistic Isolation:	66
Poverty:	58
Unemployment:	69
Housing Burden:	51

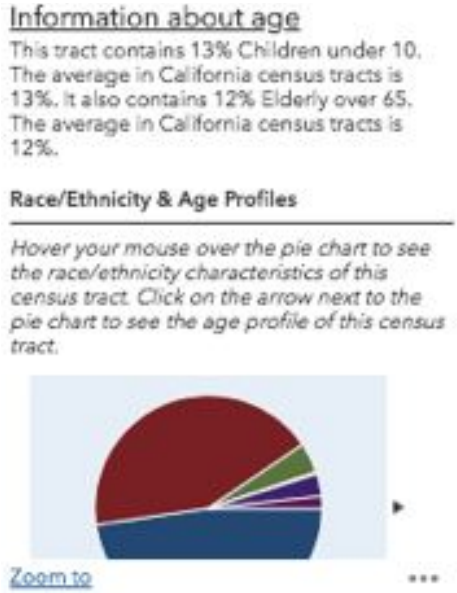


Figure 7 (left)**.** The report generated by CalEnviroScreen depicting each "Pollution Burden" indicator score and Population Characteristics" indicator score for the census tract containing the Stringfellow Acid Pits.
Figure 8 (right)**.** The report generated by CalEnviroScreen depicting age and the breakdown of the race/ethnicity of the census tract containing the Stringfellow Acid Pits.

Figure 5 depicts the state-wide scope of the spatial analysis capabilities of CalEnviroScreen. Results are color coded based on each tract's CalEnviroScreen score. Figure 6 demonstrates that the census tract containing the Stringfellow Acid Pits is in the 91-100 percentile in the state in terms of its CalEnviroScreen score. Figure 7 reports that the tract containing the acid pits is currently home to over 3,000 residents, is especially susceptible to exposure to ozone and PM2.5, and is vulnerable in terms of cardiovascular disease, education, and linguistic isolation. Figure 8 reports that the vast majority of the population in this tract is either white or Hispanic. Outputs from CalEnviroScreen can be used to determine if the dumping of toxic waste in Jurupa Valley has made the community disproportionately more vulnerable in terms of exposure to environmental hazards.

Analyzing the case of the Stringfellow Acid Pits in Jurupa Valley, California demonstrates several of the strengths and limitations of both EJScreen and CalEnviroScreen and allows a comparison of both tools. Both tools present information to users in the form of color coded maps, along with reports with information on

specific geographic regions. Color coding makes these map outputs user-friendly and accessible for analysis, while the tables and reports facilitate the comparison of areas across the state and country. Both tools combine social and environmental indicators and compare similar data categories including data on environmental hazards and on population vulnerability (Kuruppuarachchi 2017).

There are five major differences between EJScreen and CalEnviroScreen. First, the tools operate at different scales. While EJScreen allows spatial analysis of any state or region in the country and permits users to compare justice concerns across different states, CalEnviroScreen allows environmental justice analysis only in California (Kuruppuarachchi 2017).

Second, the data used in CalEnviroScreen is more detailed than the data used in EJScreen, permitting users to conduct a more thorough analysis of environmental justice concerns. Pollution data that users can analyze in CalEnviroScreen that they cannot using EJScreen include pesticide exposure, and drinking water versus wastewater threats versus impaired water, as opposed to the single water category presented in EJScreen. Social and health characteristics that users can analyze in CalEnviroScreen that they cannot using EJScreen include potential for contracting asthma, low birth weight of infants, unemployment, and housing burden (Kuruppuarachchi 2017). An objective of this project is to determine how much of these kinds of data are available in the state of Michigan through a data gap analysis.

Third, EJScreen allows spatial analysis at the census block level, while CalEnviroScreen allows analysis at the census tract level (Environmental and Energy Study Institute 2016; Faust et al. 2017). It is important to conduct spatial analysis at a level as small as the census tract or block group level, as environmental justice is such a localized issue that can vary at levels as small as neighborhoods (Environmental and Energy Study Institute 2016).

Fourth, the US EPA does not use EJScreen to identify environmental justice communities, while the CalEPA uses CalEnviroScreen to identify “disadvantaged communities” (Environmental and Energy Study Institute 2016; CalEPA 2019). The guidelines used by CalEPA to determine disadvantaged communities can be

applied to other areas in the country. However, this difference in willingness to use spatial analysis tools to identify communities where environmental justice issues are occurring means that EJScreen use and results do not directly have policy impacts and implications, while CalEnviroScreen use and results do.

Fifth, CalEnviroScreen provides a ranking of census tracts in the state based on cumulative impacts, as reflected in CalEnviroScreen scores. CalEnivroScreen displays this ranking through the color coding of tracts. On the other hand, EJScreen does not provide a ranking of areas at any geographic scale. EJScreen calculates "EJ Indexes" separately for each environmental indicator instead of based on potential cumulative exposure.

C. Minnesota's Tools

A third set of relevant environmental justice screening tools comes from the State of Minnesota, where government resources have been allocated to create two web-based tools for visualizing the spatial patterns of environmental justice communities in Minnesota. These tools have been created by, or with support of, the Minnesota Pollution Control Agency (MPCA). Similar to the Michigan Department of Environmental Quality, the MPCA enforces environmental regulations and issues permits to industrial sources of pollution. However, MPCA does not regulate drinking water systems like MDEQ or CalEPA. Also unlike California and Michigan, Minnesota has several state departments and agencies that address issues related to environmental quality instead of just one. These departments and agencies include MPCA as well as the Department of Health's Environmental Health Division (MPCA 2015).

Minnesota has created two separate screening tools that both use various datasets to identify "areas of environmental justice concern." The first is an interactive Story Map that shows "areas of environmental justice concern" in the state, using census tract boundaries to define areas. The second tool is the What's in My Neighborhood web-based mapping and text-based search tool that also displays data at the census tract level. These two screening tools were formally created and hosted by the state government.

The 'Story Map' tool uses ESRI's ArcGIS Online platform to show the "areas of environmental justice concern" within the state of Minnesota so that users can identify census tracts that might warrant additional attention in terms of environmental justice. Areas of concern in Minnesota are defined as either having "at least 40% of people reported income less than 185% of the federal poverty level," "50% or more people of color," or "federally recognized tribal areas" (MPCA n.d.) The tool displays data on the following indicators as separate layers:

- People in poverty: census tracts where "at least 40% of people reported income less than 185% of the federal poverty level"
- People of color: census tracts where "at least 50% of the people identify as people of color"
- Tribal areas: "federally recognized US Census Bureau's tribal areas"
- Language: allows users to "zoom in to a specific area identified as an 'area of concern for environmental justice' and see the top three languages spoken by non-English speakers" (MPCA n.d.)

The What's in My Neighborhood tool provides information on various sites of environmental interest, including feedlots and solid waste facilities. In addition to facility data, there is data on air and water quality, and information relevant to permits. This tool does not provide any analysis of socio-economic or health data surrounding the sites of environmental interest (MPCA n.d.).

Though there is no technical document with detailed information on the datasets, this tool displays data relevant to the following indicators:

- Air quality
- Environmental review
- Feedlots
- Hazardous waste
- Investigation and cleanup

- Pollution prevention
- Solid waste
- Subsurface sewage treatment systems (SSTS)
- Stormwater
- Tanks
- Water quality (MPCA n.d.)

Considering Minnesota's use of environmental justice screening tools alongside that of the US EPA and CalEPA is helpful as Minnesota is also a Great Lakes state with a size similar to that of Michigan.

2.5 Environmental Justice According to US EPA, California, Minnesota, and Michigan

The US EPA, CalEPA, MCPA, and MDEQ all define and conceptualize environmental justice differently. All agencies define environmental justice as a concept, while several agencies also define criteria for identifying environmental justice areas and/or communities.

According to the US EPA, "environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies." The US EPA does not currently define environmental justice areas and/or communities (US EPA 2019).

California both defines environmental justice and employs criteria for identifying "disadvantaged communities." California defines environmental justice in its government code § 65040.12 (2013) as "the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies." CalEPA defines "disadvantaged communities" in the introduction of the *Designation of Disadvantaged Communities Pursuant to Senate Bill 535*. The definition states, "CalEPA is designating the highest scoring 25% of census tracts from

CalEnviroScreen 3.0 as disadvantaged communities. Additionally, 22 census tracts that score in the highest 5% of CalEnviroScreen's Pollution Burden, but do not have an overall CalEnviroScreen score because of unreliable socioeconomic or health data, are also designated as disadvantaged communities" (CalEPA 2017).

The Minnesota Pollution Control Agency also defines environmental justice as a concept and provides criteria for identifying areas of concern. MPCA defines environmental justice in its *Environmental Justice Framework Report* as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies." Further, "the Agency considers a census tract to be an area of concern for environmental justice if it meets one or both of these demographic criteria: the number of people of color is greater than 50%; or more than 40% of the households have a household income of less than 185% of the federal poverty level." Additionally, the MPCA considers communities within Tribal boundaries as "areas of environmental justice concern" (MPCA 2018).

Finally, the State of Michigan defines environmental justice as a concept. According to *Executive Directive No. 2007-23* signed by Governor Granholm in 2007, environmental justice is defined as "the fair, non-discriminatory treatment and meaningful involvement of Michigan residents regarding the development, implementation, and enforcement of environmental laws, regulations, and policies by this state" (Granholm 2007). The State of Michigan does not currently provide criteria for identifying communities vulnerable to environmental injustice.

This information on history, definitions, methods, and perspectives on environmental justice provides a framework for this research and project. The next chapter of the report discusses the methodologies used in the qualitative analysis of this study, which involved completing and analyzing interviews with thirty environmental justice leaders in the state.

Chapter 3. Qualitative Analysis Methodology

This chapter describes the methodologies the research team used for qualitative data collection and analysis. As mentioned in the introduction, the qualitative portion of this study relies on information gathered from a diverse group of actors involved in environmental justice in Michigan including scholars, professionals, and community activists. For the purpose of brevity, the authors address this diverse group of interviewees as "environmental justice leaders" throughout this document.

3.1 Qualitative Research Questions

The qualitative portion of this project sought to answer the following research questions:

- What is the state of environmental justice in Michigan?
- What are the salient environmental risks and impacts environmental justice leaders in Michigan know about, perceive, and experience?
- How do environmental justice leaders view and use data and assessment tools?

3.2 Sampling Strategy

To address these specific questions, the research team interviewed thirty environmental justice leaders in the state of Michigan. The researchers employed a convenience sampling technique utilizing contacts provided by the MEJC, as well as a snowball sampling technique. Both processes are explained below. Interviewees fell into three different interview samples.

The first sample consisted of MEJC members. The MEJC provided a list of its membership at the start of the outreach process. The research team reached out to all 22 contacts on the list via email. When members

responded, interviews were scheduled. When a week passed with no response, the team followed up via email a total of three times for each MEJC member. The research team interviewed 12 members of the MEJC (n=12).

The second interview sample consisted of snowball contacts collected from the MEJC members interviewed by the research team. The final question asked of each interviewee was if they could recommend another environmental justice leader in the state of Michigan. MEJC interviewees provided 17 new contacts. The team reached out to all 17 contacts via email and interviewed eight (n=8).

The third interview sample consisted of individuals who submitted a proposal to present at the MEJC's statewide Environmental Justice Summit that occurred in Flint, Michigan in September 2018. This sample was added to the outreach process in an effort to capture greater geographic diversity across the state of Michigan. The MEJC provided a list of names and contact information of these individuals who submitted proposals. The team reached out to all 26 applicants via email and interviewed ten of them (n=10). See Table 1 below for a summary table of interview samples and sizes.

Interview Sample	**Number of People Contacted**	**Size of Sample (N)**	**Response rate**
MEJC Members	22	12	55%
Snowball Contacts	17	8	47%
Summit Presentation Applicants	26	10	38%
Total	**65**	**30**	**46%**

Table 1. Size of interview samples.

3.3 Design and Implementation of In-Depth Interviews

To answer the research questions delineated in this section, the team developed a semi-structured interview guide to elicit the knowledge, perspectives, and experiences of Michigan environmental justice leaders (see Appendix B). The guide consisted of two sets of interview questions: one for leaders who self-identified as

currently residing or working in areas affected by environmental justice issues and the other one for professionals, scholars, and activists who are not currently affected by environmental injustice but work with, advocate for, study with, or represent these communities in some capacity.

Both sets of questions underwent multiple reviews. First, the interview guide was reviewed by the project advisor, Dr. Paul Mohai, as well as other faculty at SEAS. Second, the researchers incorporated feedback from the MEJC. Lastly, the researchers conducted three pilot interviews with emerging leaders in Michigan with relevant experience working alongside MEJC. Feedback from the three pilot interviews was integrated, and some questions were clarified to ensure comprehension.

Once the interview guide was finalized, interviews were scheduled with respondents either in person, when possible, or over the telephone. If interviewing in person, the respondents were offered to conduct the interview at the University of Michigan Detroit Center, the University of Michigan Dana Building in Ann Arbor, or a location of their choice. If conducting the interview over the phone, a conference call number was provided.

All participants were provided with detailed information about the study and privacy considerations. The research team obtained informed consent from all participants through a process approved by the University of Michigan's Institutional Review Board (IRB). The outreach methods and examples of email outreach scripts were also approved by the IRB. The researchers strived to maintain high standards of ethical conduct throughout the design and implementation of the interviews.

The interview guide was divided into three parts and was designed to last from thirty minutes to an hour. First, the respondents were asked about their involvement in environmental justice. Second, questions were asked to assess strengths of environmental justice communities, available resources, as well as recent advances for environmental justice in the state. Participants were also asked about salient risks and impacts associated with environmental issues, and how these affect the day to day lives of affected community members.

Finally, a set of questions was asked regarding assessment tools and processes used to gather and disseminate information about risks and impacts.

The interviews were recorded on the interviewer's password-protected phone after obtaining consent from each participant. These recordings were then transcribed and saved in a password protected private university account within 72 hours of the interview. The recordings were subsequently deleted from the phone. A subset of the interviews were transcribed by the transcription service Rev.com following the same timeline. At the conclusion of the interview, participants were provided with a small gift symbolizing the gratitude of the researchers for their participation. In accordance with IRB guidelines, this gift was not utilized as a recruitment tool, as the participants had not been informed about it before scheduling the interview. Immediately following each interview, the interviewer wrote a memo capturing perceived salient themes, notes about the interaction, and preliminary interpretations of the interviewee's responses.

The interviews yielded rich information about the state of environmental justice in Michigan, as well as advances and challenges of advocacy for environmental justice issues and communities. Furthermore, leaders provided insights about how a Michigan-specific assessment tool could be of assistance to leaders in the study and advocacy of these issues.

3.4 Interview Data Analysis

The researchers adopted an inductive approach to qualitative data analysis drawing from Grounded Theory, which allows for the interpretation of data without having a predetermined hypothesis (Charmaz 2014). This approach was selected as this study was exploratory in nature and it was important to allow the participants to determine the salient concerns regarding environmental justice in the state of Michigan.

The first analytical step was to develop a codebook by identifying patterns in the data and organizing these patterns into themes and subthemes. An initial codebook was developed based on the interview questions with two sections, one devoted to information about the state of environmental justice in Michigan, and the

second section devoted to responses about informational tools. Each of the three samples (MEJC members, summit applicants, and snowball respondents) had a separate codebook and their responses were coded separately. Responses from the three separate codebooks were then compared in order to identify differing patterns across the three groups. Differences across these three codebooks were minor; therefore, all codebooks were then combined into one final codebook that reflected themes and subthemes that were consistent across samples. The results and trends gleaned from this codebook, as well as the minor differences found across codebooks, are discussed in Chapter 4.2 Prominent Interview Themes.

The research team coded each of the thirty interviews manually. For each of the thirty interviews, team members highlighted information relevant to the research questions and labeled it with short descriptive phrases (codes), as described by the authors of the *Fundamentals of Qualitative Data Analysis textbook* (Miles et al. 2014). After coding each interview, the team reviewed the accompanying memo written by the interviewer at the time of the interview to ensure the inclusion of relevant information. Codes were added to the three different codebooks according to which sampling frame the interviewee was from. Themes, subthemes, and codes were then compared across codebooks. A minority of codes and subthemes that captured differences across samples were noted and are discussed in Chapter 4. Themes, subthemes and codes that were consistent across all three codebooks were combined into one comprehensive codebook to capture data from all three samples. While the codebook is kept confidential, the results are displayed in the following chapter. The next step in qualitative data analysis was to create matrices displaying the overall patterns for notable themes and subthemes based on code frequencies.

The final step in the interview data analysis was analyzing the word frequency from interview transcripts. Because major differences across samples were not found during the first step of analysis described above, the team conducted the word frequency analysis for all thirty interviews as one combined sample. To complete this analysis, a word frequency chart was generated using NVivo, a qualitative data analysis software. This chart lists the 100 most used words in all interviews. With this information, a word cloud was created,

displaying the 100 most used words. Questions asked by the interviewer were removed from the transcripts to generate this chart and word cloud.

Chapter 4. Qualitative Analysis Results

This chapter presents results of qualitative data analysis. The results of qualitative data analysis take the form of a word cloud displaying the top 100 most frequently used words during interviews, and a discussion of prominent themes and subthemes conveyed during interviews including matrices displaying these themes and subthemes when helpful for data visualization.

4.1 Word Frequency Cloud

The team used NVivo, a qualitative data analysis program, to create a word cloud displaying the top 100 most frequently used stemmed words from the responses of the thirty interview transcripts. As mentioned in Chapter 3, differences in the thematic analysis of the three samples were minimal, thus word frequency analysis was conducted for all interviews as one combined sample. Words only related to the interview process but not directly related to the research question "What is the state of environmental justice in Michigan?" were removed, such as the following words: inaudible, yes, got, and probably. The size of the words in the word cloud is proportional to the relative frequency with which they were used: words that appear larger in the word cloud were used more frequently than words that appear smaller. For a list of the top 100 words used in the thirty interviews, see Appendix C. The resulting word cloud is displayed below in Figure 9.

Figure 9. Top 100 most frequently used words from interviews with thirty environmental justice leaders in Michigan.

4.2 Prominent Interview Themes and Subthemes

The interview coding process illuminated broad themes concerning the state of environmental justice in Michigan and leaders' use of tools. Each broader theme was further broken down into subthemes, which are listed below in Table 2.

Themes	Subthemes	
Community Assets	Recent Wins	
	Community Strengths	
	Resources	
Community Vulnerabilities	Risks and Impacts	Environmental Risks and Impacts
		Socioeconomic Risks and Impacts
		Health Risks and Impacts
	Forms of Environmental Injustice	Procedural Injustice
		Distributive Injustice
		Corrective Injustice
	Barriers to Advancing Environmental Justice	
Tools	Existing tools	
	EJScreen Use	
	Michigan Tool Recommendation	
	Reporting Mechanisms	

Table 2. Themes and subthemes of interview data.

Themes and subthemes were consistent across the three samples (MEJC members, summit applicants, and snowball contacts). The only difference found across samples was that summit applicants did not mention as many air quality risks and impacts as MEJC members and snowball contacts did, potentially because summit applicants were more representative of rural areas. This inconsistency could be indicative of the differences between rural and urban environmental concerns, where air quality concerns might be more relevant in urban areas, and all other concerns might be relevant to both rural and urban areas. A quote from an interview with an

environmental justice leader in Michigan spoke to the importance of addressing environmental justice in general:

"Well environmental justice encompases, just, it's intersectional. It's just about every other issue that goes on. It has to do with the climate change. It has to do with water quality. It has to do with industrial agriculture. It has to do with how we exploit animals and human labor in the making of our food, growing it, distributing it, even at the restaurants. Environmental justice is about living wage. It's about children's brains not developing to their full capacity. It is about education and it's not something that should be relegated to another topic on the agenda. It is the agenda. And if we don't deal with the whole environment as a whole and adjust this issue as well, we're gonna be in pretty sad shape, if we don't kind of reverse some of these things that we're doing today."

This quote acknowledges the significance of these data and research and sets the stage for the following presentation of the results of interview data analysis. Results are described in terms of broad themes and more specific subthemes.

Community Assets

The "community assets" theme describes advantages and benefits interviewees experience as a result of living in or working with communities affected by environmental injustice. This theme includes the subthemes "recent wins," "strengths," and "resources."

Community Assets: Recent Wins

The first subtheme that comprises the "community assets" theme is "recent wins." When asked about recent wins Michigan residents of communities impacted by environmental justice have experienced, the most common response was that communities have seen an increase in awareness about and engagement with environmental justice issues. According to participants, community members have been bridging divides between factions by creating coalitions across diverse groups with varying cultures, languages, racial and ethnic backgrounds, and issue priorities (water, food, and air). Participants also referred to community members

changing their engagement strategies and narratives as a recent win. Several participants spoke of increasing funding sources, in addition to Community Benefits Agreements.

Interviewees discussed recent wins involving government and industry, noting recent favorable decisions regarding permits, zoning changes, and other requests to expand industrial activities in areas impacted by environmental justice. Participants noted the newly formed positions of Environmental Justice and Tribal Liaison at the Michigan Department of Environmental Quality (MDEQ) and the Environmental Justice Ombudsman in the Governor's office as wins. Further, according to interview participants, the Michigan Department of Environmental Quality (MDEQ) has been changing its procedures to provide more space in public hearings and increase communication with community advocates. Several participants discussed local government officials who supported the community and have increasingly advocated for environmental justice through actions such as lawsuits. Finally, interviewees mentioned increased communication with the government as a recent win.

Community Assets: Strengths

The second subtheme that comprises the "community assets" theme is "strengths." When asked about strengths of communities that experience environmental injustice in Michigan, the most common responses described characteristics of community members. Interviewees described community members as resilient, creative, resourceful, and possessing strong cultural values and positive attitudes. One participant spoke to the creative nature of residents when they said, *"Creativity is one thing, not just what people call art, but I guess you could say social creativity, which involves creating different independent projects."* Many participants also highlighted the strong connection to nature, high engagement in pro-environmental behaviors, and positive relationships among community members. Data also described communities impacted by environmental injustice as having strong grassroots movements with fruitful community meetings and effective community organizations. Collaboration between community organizations was mentioned as a community strength.

Finally, participants expressed a high attachment to place and pride in their communities, highlighting desirable physical attributes of their regions along with meaningful historical significance of their neighborhoods.

Community Assets: Resources

The third subtheme that comprises the "community assets" theme is "resources." When asked about advocating for communities impacted by environmental injustice, the most commonly mentioned resource was community organizations, followed by pro-bono legal assistance and health clinics. Funding for these community organizations was also described as a resource. Government resources mentioned by interviewees included the involvement of the US EPA along with local and state representatives who support the advancement of environmental justice. Further, participants noted the importance of national organizations and movements that bring attention to environmental justice issues and may provide funding and tools. Several environmental justice leaders mentioned academic resources, including community-academia partnerships, published academic studies, community based participatory research, and spatial analysis tools developed by academics. Additionally, participants cited the law or legal processes, such as Community Benefits Agreements, as resources.

Communication tools were often mentioned by interviewees. These tools included social media, community telephone lists, and networking opportunities with other community members and organizations. Participants mentioned resources that directly aid residents including water filters, water stations, gardens, cooling centers, transportation, and translation services. Finally, environmental testing, monitoring, and remediation were included as resources.

Community Vulnerabilities

The "community vulnerabilities" theme describes sensitivities or challenges interviewees experience as a result of living in or working with communities affected by environmental injustice. This theme includes three categories of subthemes. The first category describes risks and impacts discussed by the interviewees and includes the subthemes "environmental impacts," "socioeconomic risks and impacts," and "health risks and

impacts." The second category describes three different forms of environmental injustice and includes the subthemes "procedural injustice," "distributive injustice," and "corrective injustice." The third and final subtheme describes "barriers to advancing environmental justice."

Community Vulnerabilities: Environmental Risks and Impacts

While risks and impacts are broken down into three different subthemes, it should be noted that participants stressed the interrelatedness of environmental, socioeconomic, and health risks and impacts. In describing how these types of impacts are connected, one interviewee said, *"We get a lot of volunteers from more affluent communities who ask us 'Well, why are you talking about this? That doesn't have anything to do with environment.' We have to explain to them why minimum wage or why issues around racial justice are also important because I think they are linked very intimately with what's going on in the communities."* A detailed list of codes for each of these subcategories of risks and impacts have been displayed in Tables 6, 7, and 8.

The first subtheme that comprises the category of risks and impacts in the "community vulnerabilities" theme is "environmental impacts." Many interviewees spoke about the legacy of pollution resulting from manufacturing, highlighting the concentration of industry in low-income and minority areas. They described industry as encroaching on people and in residential areas, and mentioned that pollution is currently increasing in these areas. The environmental justice leaders often spoke of effects of pollution on surrounding water, air, land, and food. Some spoke in general terms while others listed specific facilities and specific toxins of interest. The most commonly mentioned impacts were decreased air and water quality. For example, in describing air quality issues one participant said, *"Our home is always, always getting dust from somewhere. We have to clean it. There's always dust. Also, the smell in the neighborhood. Sometimes it gets really foul smell, especially around the school. When it rains, it really, really is so bad. On certain days it really is bad when it rains."* In discussing water quality issues, another interviewee said, *"The mercury pollution affects our relationship with the fish that we can no longer eat indiscriminately. Pregnant women, some of them are advised that they should never eat fish. Others*

maybe once a month at the most. This has been a really big part of our culture." Data analysis indicates that water issues impact different communities in varying ways.

Environmental Risks and Impacts				
Air	**Water**	**Land and Food**	**Pollution Sources**	**Pollutants**
Decreased air quality Rail traffic Vehicle traffic Truck routes Particulate matter Vapor intrusion (trichlocene, TCE) Dust Odors Poor indoor air quality	Lead in water Water runoff Groundwater quality Surface water quality Poor water quality Pharmaceuticals in water supply Climate change	Contaminated soil Changing landscape Less green space Lack of access to the outdoors Increasing impervious surfaces Heat waves Transport of toxic materials through residential areas Commercial fishing impacts on tribal fishing operations Food contamination Waste/garbage Noise pollution Vibrations Demolitions	Oil refineries Pipelines Power plants Hazardous waste facilities Landfills Wastewater treatment plants Superfund sites Military bases Mining operations Large agricultural operations CAFOs Incinerators Fracking/natural gas operations Steel mills Chemical plants Cement/asphalt plants Salt mines Dry cleaning Tanneries Coal based facilities	Sulfur dioxide Nitrogen oxide Neurotoxins Petroleum coke Coal ash Fire retardant/PBB PCBs DBTs DDE DDT PFAS Petroleum Mercury pollution Microplastics Lead Lead paint

Table 3. Environmental risks and impacts.

Community Vulnerabilities: Socioeconomic Risks and Impacts

The second subtheme that comprises the category of risks and impacts in the "community vulnerabilities" theme is "socioeconomic risks and impacts." Participants stressed the significance of socioeconomic risks and impacts stating that these can create additional barriers that compound the inability of community members to deal with environmental impacts. For example, participants cited difficulty in accessing health care when experiencing health impacts resulting from environmental exposure. One interviewee referred to the intersection of economic risks and environmental impacts when they stated, *"People don't have access to*

health care services. They don't have access to the financial wealth that they need to live a more healthy life. Having a clean environment is part of that as well." Another leader spoke to these connections whey they said, *"Not only are they exposed to more pollution than they should be, and certainly more than the state average, they also have less access to health care."*

The most salient socioeconomic risks and impacts discussed were poverty, unemployment, and underemployment. Other economic impacts mentioned were missing work days as a result of illness, water shutoffs, and agricultural losses due to contamination. Many participants also referenced gentrification, housing insecurity, and living in areas with mixed residential and industrial zoning designations that place residents too close to polluting industries. Participants noted how the economic power of communities has changed throughout the years. For example, one interviewee said, *"This was a place in which everyday people could have a high standard of living. You didn't have to go to college. You could work and earn a living and buy a car and buy a house and raise your family and stuff like that. Now, you see all the people fighting all over the country for living wages and such. We don't have that anymore."*

Environmental justice leaders also spoke of impacts on children specifically and noted that schools are often located near industries. Children at these schools are exposed to industrial pollution and experience increased school absences due to respiratory illness and experience decreased educational attainment. Other socioeconomic impacts result from political processes such as disinvestment in neighborhoods and political disenfranchisement. Participants described neighborhoods that lack city services such as trash removal, recycling, and public transportation. Interviewees also cited a lack of resources provided to assist with relocation to neighborhoods where city services are available. They noted how, in addition to waste and lack of connection between residents in communities, crime and violence were common. The crime and violence they experienced in their neighborhoods often resulted in physiological and psychological health impacts. Finally, leaders discussed social impacts of racial discrimination, inability to participate in cultural practices, and destruction of archeological remains belonging to indigenous populations.

Socioeconomic Risks and Impacts				
Economic	**Housing**	**Education**	**Political**	**Social**
Poverty Un/under-employment Missing work days Lack of economic power of communities Agricultural losses Lack of healthcare access Lack of healthy food access Food insecurity Water shutoffs High water prices Damaged water lines and appliances Lack of access to free bottled water/clean water Privatization of water Energy poverty Lack of access to transportation Digital divide	Blight Housing insecurity Lowered housing values Gentrification Racial segregation Mixed residential and industrial zoning	Lower educational attainment Missing school days School-to-prison pipeline Inadequate transitions to college and adulthood	Political disenfranchisement Lack of city services Disinvestment	Racial discrimination Violence Crime High proportion of foreign language speakers Lack of archaeological evaluations of indigenous cultural artifacts Mining in sacred/historical grounds Impacts on cultural or religious practices

Table 4. Socioeconomic risks and impacts.

Community Vulnerabilities: Health Risks and Impacts

The third subtheme that comprises the category of risks and impacts in the "community vulnerabilities" theme is "health risks and impacts." During interviews, participants provided detailed information about diseases and symptoms community members experience as a result of environmental exposure. The most cited health conditions included asthma and cancer. Cited less often were cardiovascular disease, diabetes, and endocrine disruption, among others. Some common symptoms interviewees mentioned included headaches, nausea, and breathing difficulties. According to participants, these conditions frequently result in high hospitalization rates, disability, and death. Multiple participants had suffered personal losses they attributed to growing up and living in areas affected by environmental injustice, and some of them disclosed

having survived cancer and other serious health conditions. For example, one interviewee described the prevalence of asthma among their peers when they said, *"I played a lot of sports in high school and there would always be somebody who had asthma, there would be three or four people who actually had medication and they would have the inhaler for the team. Things like that… I'm starting to make sense as to why."*

A distinct subset of health risks and impacts were categorized as emotional or psychological in nature and are considered an emergent subtheme, as the research team did not anticipate gleaning this set of responses. According to several participants, emotional and psychological impacts receive insufficient attention and are often ignored by government officials. Interviewees described experiencing feelings of hopelessness, sadness, frustration, and fatigue on a regular basis as a result of perceived lack of environmental protection for vulnerable communities. They described trying to advance environmental justice for many years without witnessing many results and feeling like they were ignored by their elected officials. Additionally, many interviewees discussed the emotional ramifications of having gone through illnesses themselves or of having experienced the loss of property or loved ones. For example, one leader stated, *"I also think there is a fatigue and a sense of hopelessness on the part of a lot of people that are like 'We fought these battles before. I've been to your public meetings. I've gone to your events and nothing changes… people feel like they are fighting an insurmountable battle.'"* This emergent theme highlights the impact of living through and witnessing environmental injustice on people's mental health. All health risks and impact mentioned are listed below in Table 5.

Health Risks and Impacts			
Health Symptoms	**Health Diseases and Disorders**	**Psychological Symptoms**	**Psychological Disorders**
Breathing difficulties Headaches Immune system decline Muscle-skeletal effects Respiratory effects Eye irritation Nausea from fumes and odors	Developmental disorders Endocrine disruption Cancer Obesity Diabetes Asthma Respiratory illnesses Autoimmune disease Cardiovascular disease Death Disability Hospitalization Organ failure Hearing impairment	Increased stress Hopelessness Powerlessness Disheartenment Increased fear Fatigue Burnout Sadness Frustration Sense of urgency	Pediatric behavioral impacts of exposure to neurotoxins Post Traumatic Stress Disorder (PTSD)

Table 5. Health risks and impacts.

Community Vulnerabilities: Procedural Injustice

The first subtheme that comprises the category of forms of environmental injustice in the "community vulnerabilities" theme is "procedural injustice." These responses refer to a lack of access to decision-making processes. The two most frequently cited issues were a lack of governmental transparency and a lack of information provided to communities by government and industry. Participants also commonly highlighted erosion of democratic processes, discussing the appointment of emergency managers whose decisions supercede those of democratically elected officials, the continued use of redistricting or gerrymandering by politicians to restrict the political power of vulnerable communities, and the passing of bills that create oversight mechanisms that limit the decision-making power of governmental agencies. For example, one participant addressed the erosion of democracy when they stated, *"One of the root causes of creating barriers towards achieving environmental justice is the lack of democracy. Flint Water Crisis is the perfect example of what happens with local communities. Their democracy is taken away from them. You're seeing that happen through the standard*

administration for many years in terms of emergency management and how communities are... decision-making power is taken from them."

Participants also frequently stated that communities are unable to participate in decision-making process and do not feel heard by the government. They expressed a lack of trust in governmental agencies. For example, one interviewee discussed feeling like their concerns with industry are not heard when they said, *"Community members sit down and try to talk and say these are the things that are actually happening, these are the things that need to be discussed, and none of their comments are taken into consideration. They [industries] just get a slap on the hand, no fines, and go on with their business."*

Specific barriers to participation in decision-making include lack of time, lack of advertising of public comment periods, lack of adequate space in public hearings, lack of translation of documents, and lack of community representation on industry and governmental committees. Finally, some participants pointed out that certain populations are further excluded from decision-making. Native Americans are excluded based on lack of jurisdiction of historic indigenous lands, and immigrant populations, such as migrant farmers, are excluded based on lack of citizenship.

Community Vulnerabilities: Distributive Injustice

The second subtheme that comprises the category of forms of environmental injustice in the "community vulnerabilities" theme is "distributive injustice." These responses refer to a disproportionate distribution of environmental benefits and harms. Participants stated that pollution is unequally distributed and that low-income and communities of color bear the burden of most pollution emitted in Michigan. One interviewee stated, *"All of these [impacts] are generally to people that didn't cause the problems, but now are paying the price. That's an environmental justice issue."*

Examples of disproportionate distribution of environmental harms included presence of fracking in poor areas and the construction of an international bridge in a low-income and minority community. Further, participants discussed the disproportionate impact incinerators in Michigan have on low-income populations,

African Americans, and children who live in close proximity. Additionally, interviewees expressed that the communities most impacted by dependence on fossil fuels are the communities with the least amount of capital to address associated problems. Furthermore, participants discussed the notion that state agencies do not recognize that communities impacted by environmental injustice are not provided with adequate public health resources and are therefore not on equal footing with those communities that are not impacted by environmental injustice.

Examples of disproportionate distribution of environmental benefits included priority to clean water given to business over people, community clean-ups occuring in gentrified neighborhoods, incinerators burning trash from outside communities, earnings from energy productions leaving communities where the energy is produced, and unequal business ownership opportunities given to people of color.

Community Vulnerabilities: Corrective Injustice

The third subtheme that comprises the category of forms of environmental injustice in the "community vulnerabilities" theme is "corrective injustice." These responses address a lack of meaningful reparations to compensate residents who experience environmental injustice. Participants stated that there is insufficient individual compensation for damages. One example was that individuals were not provided with sufficient assistance to relocate to healthier communities. Additionally, interviewees expressed that Community Benefits Agreements do not provide sufficient benefits.

Further, leaders reported that people and industries were not being properly fined or prosecuted for noncompliant or criminal polluting activities. One participant spoke to this lack of corrective justice when they said, *"It's just frustrating that the people aren't getting justice, even when it's clear that they were harmed, and that their homes were harmed. Their properties were harmed. Their bodies were harmed. And it is still that difficult to get any sort of recourse for them."*

Finally, interviewees highlighted the lack of speed of corrective processes. Two examples cited several times were that rural farmers are still litigating the contamination of cattle feed by fire retardant, and that Flint residents are still engaged in legal proceedings for government negligence during the Flint Water Crisis.

Community Vulnerabilities: Barriers to Advancing Environmental Justice

The third and final subtheme that comprises "community vulnerabilities" theme is "barriers to advancing environmental justice." This subtheme is emergent, as the research team was not anticipating related responses. Data included in this theme takes the form of a long list of barriers individuals and organizations experience in attempting to promote environmental justice in Michigan. The most commonly cited barrier was lack of funding. This barrier is related to several different needs of individuals and organizations. Some interviewees mentioned a lack of government funding for city services or response to environmental issues. Others mentioned funding as a barrier to industries installing pollution prevention measures. Others discussed a lack of funding as a result of the government lowering taxes for corporations. Many participants also spoke of a general lack of funding for environmental justice issues, as many funders seem reluctant to fund projects and initiatives related to social justice.

A second prominent barrier mentioned was a lack of capacity of communities impacted by environmental injustice. Specific examples of a lack of capacity included lack of time, money, transportation, childcare, accessibility (due to disabilities), and compensation. One participant spoke to their lack of time and financial resources when they said, *"You are asking people who don't have a lot of time or resources to spend their limited time and resources getting legal support, getting technical support, showing up for hearings, which is just something they are not capable of doing."* Another participant commented on the general lack of capacity of communities when they said, *"Most of the people [advocates] don't get paid. You're just volunteering. It's difficult to be able to be present for a lot of stuff. Let's say somebody like me. I don't have a car, and I live in a transportation desert and I don't have a regular income. If people want you to come to a meeting, you have to figure out how to get to the meeting. I bicycle a lot, but if it's raining, I can't take my bike, or if it's too cold, I can't take my bike. If I*

don't have... sometimes some of the meetings and things they feed you and some of the things they don't. If you don't have money to eat, and you have to spend your money to get to someplace, then you don't have anything to eat at the meeting. You might have to go without eating. To sit through a meeting. But sometimes they have food."

A third commonly mentioned systemic barrier to advancing environmental justice was that vulnerable communities feel the government ignores them and their needs. This barrier was mentioned in relation to participants' perception of the strong influence of money in politics and decision-making processes. Interviewees reported a lack of political will to advance environmental justice and a feeling that the government places "money over people." One participant spoke to the feeling of being ignored by the government when they said, *"There are overarching themes of corporate entities and state and federal government not really doing their job and kind of looking the other way and ignoring the health of citizens and residents."*

According to environmental justice leaders, faulty decision-making procedures lead to pro-business revitalization strategies, commodification of essential environmental goods like water, and the privatization of city services and public infrastructures. Additionally, participants highlighted the lack of a state environmental justice plan and a lack of both a definition of environmental justice and criteria to distinguish environmental justice communities. An interviewee spoke to the lack of a state-level plan when they said, *"The problem is that it is all ad hoc, so it first of all forces the environmental justice community to ask for these things every single time as opposed to the DEQ by default just providing them and it's never clear what's adequate and what's sufficient. Which vital documents should be translated, and which shouldn't. Which populations count as EJ communities and which don't, what amount of time, is there a ceiling, what appropriate amount of time should you ask for in addition to these circumstances, there is no uniformity to the application of EJ in terms of the DEQ because there is no document to go off of."* Finally, participants reported some barriers that specifically affect environmental organizations. These barriers include a lack of diversity, divided community efforts, and a perceived divide between urban and rural communities.

Tools

The "tools" theme describes tools that leaders use or with which leaders are familiar. This theme includes subthemes "Existing tools," "EJScreen use," "Michigan tool recommendation," and "reporting mechanisms."

Tools: Existing Tools

The most commonly mentioned tools were EJScreen, the Michigan Department of Environmental Quality, community organizations, and existing environmental laws and policies. The matrix below provides a comprehensive list of all tools mentioned during the thirty interviews.

Tools			
Instruments	**Technical**	**Organizations**	**Legal**
Written record (articles, books, news, social media posts, government reports) Photoshop (designing materials) Text tree system Email system Phone outreach Mail campaign/survey Door-to-door outreach Media Social media Newsletters PowerPoint Websites Music Art Community created media Photos Events Community based participatory research Citizen science Popular education Story mapping Community asset mapping	Mapping tools Expert consultation Health, technology, and engineering analysis Modeling Soil testing Monitors in homes/schools/churches Drones flying over agricultural areas Data Academic partnerships EJScreen (https://www.epa.gov/ejscreen) NIH tox map (https://toxmap.nlm.nih.gov/toxmap/app/) CAPHE study (http://caphedetroit.sph.umich.edu) Toxics Release Inventory (TRI) data (https://www.epa.gov/toxics-release-inventory-tri-program/tri-data-and-tools) Fractracker https://www.fractracker.org/map/national/	Department of Environmental Quality (MDEQ) Department of Health and Human Services United States Environmental Protection Agency (US EPA) Michigan Civil Rights Commission Local government State agencies Community organizations Community input Grants School curriculum Local library Coalitions Alliances	Pro-bono lawyers Environmental laws Local law Civil rights law Elliott-Larsen Civil Rights Law Policy Freedom of Information Act (FOIA) Lobbying

Table 6. Matrix displaying all tools mentioned during interviews.

Tools: EJScreen Use

When asked about utilization of US EPA's EJScreen in particular, the majority of participants said they had not used or were not aware of it. Of those who had used it, 50% reported having used it recently and 50% reported they had either not used it recently or had only used it a few times. The main reasons leaders had not used EJScreen were either lack of awareness or difficulty learning to use it. Many reported that trainings on how to utilize the tool would be helpful. Most participants were unable to comment on whether they thought EJScreen accurately measures the risks and impacts of communities.

Tools: Michigan Tool Recommendation

When asked about their thoughts on the Environmental Justice Workgroup's recommendation to create a spatial analysis tool specific to the state of Michigan (Environmental Justice Work Group 2018), a majority of the participants stated that they were familiar with the recommendation, and in favor of the creation of a tool. There were a few participants who were not aware of this recommendation and one participant who was not interested in the creation of a tool. Several participants stated that the creation of the workgroup and the recommendations delivered were not necessary given that there was an existing environmental justice plan created in 2010. Their opinion was that the recommendations distracted from the implementation of such plan.

A majority of respondents provided a caveat to the creation of the tool, stating that although a tool measuring cumulative impacts would be beneficial in terms of better measuring risks and impacts, the tool would not be effective in advancing environmental justice unless it was used to inform policy and legal parameters such as a clear definition of what constitutes an environmental justice community. According to interviewees, rules and regulations accompanying this tool would have to be developed by the State.

Finally, participants provided information regarding the reasons they thought a environmental justice screening tool specific to Michigan would or would not be helpful. Several participants shared recommendations for the tool design. These results are organized and visualized in Table 7 below.

Leaders' Considerations for a Michigan Screening Tool		
Reasons it Would be Helpful	**Reasons it Would not be Helpful**	**Recommendations for Design of the Tool**
*Would provide access to data on cumulative impacts Could better represent EJ issues specific to Michigan communities Could define EJ communities Other states have developed tools Could include health data Importance of data in advancing EJ Bridge quantitative and qualitative divide Funded by and maintained by DEQ Bring issue informally to the State Provides some evidence Good for policy and legislative development Good for sociological research and analysis Need for a regional approach	*Only helpful legally if legal standards are in place A tool is only as good as the data you have to work with it Digital divide Lack of political will People not knowing how to use the results Lack of causal analysis Information may be harmful to community	Needs to display cumulative impacts Include indoor air quality Display Native boundaries and heritage sites Definitions (such as English proficiency) are compatible with US Department of Justice and US EPA User-friendly interface Easy for general public to interpret User-friendly for non-native English speakers Built in tutorial or instructional video Dictation available (accessibility options) Use small spatial scale that you are able to increase to larger scales (county, tri-county) Could have social media reporting mechanism (signal detection) Need parsed data

Table 7. Matrix displaying all considerations for a Michigan-specific environmental justice screening tool mentioned during interviews.
*This was the most frequently mentioned reason.

Tools: Reporting Mechanisms

A second recommendation of the Governor's Environmental Justice Workgroup was to develop a reporting mechanism so impacted communities could report environmental incidents (Environmental Justice Work Group 2018). Interview participants were asked about processes that community members currently use to report an impact or exposure such as dust, contaminated waters, etc. The majority of participants did not know of a clear and efficient way to report these issues. Participants often cited MDEQ's emergency phone line, but expressed that it was not efficient or transparent, and that there was poor follow up. Other participants expressed that a clear way to report issues and receive follow up was non-existent. Other frequently cited

processes included contacting community or environmental organizations, or contacting local governments, including tribal governments. All reporting mechanisms currently available to Michigan residents according to interviewees are listed in the table below.

Ways to Report Environmental Issues
MDEQ emergency number
EJ organizations
Local governments
Tribal governments
Elected representatives
Neighborhood associations
Community-developed apps
211, 311, 411
US EPA (dismantled)
Police
Health department
Social media
Law firms
DTE (about gas)
Community leaders
MI Public Service Commission

Table 8. All currently available reporting mechanisms in the state of Michigan.

A summary of themes, subthemes, and most frequently mentioned codes from all thirty interviews with environmental justice leaders is displayed below in Table 9.

Themes	**Subthemes**		**Most Frequently Mentioned Code**
Community Assets	Recent Wins		*Increased community engagement/action*
	Community Strengths		*Positive community relationships*
	Resources		*Community organizations*
Community Vulnerabilities	Risks and Impacts	Environmental Impacts	*Poor air quality*
		Socioeconomic Risks and Impacts	*Gentrification*
		Health Risks and Impacts	*Cancer*
	Forms of Environmental Injustice	Procedural Injustice	*Lack of government transparency*
		Distributive Injustice	*Pollution in communities of color*
		Corrective Injustice	*Lack of prosecution of polluters*
	Barriers to Advancing Environmental Justice		*Lack of funding*
Tools	Existing Tools		*EJScreen*
	EJScreen Use		*Has not used*
	Michigan Tool Recommendation		*In favor of tool*
	Reporting Mechanisms		*MDEQ emergency hotline*

Table 9. Summary of all themes, subthemes, and most common codes from interviews.

Chapter 5: Quantitative Analysis Methodology

This chapter describes the methodologies the research team used for quantitative data collection and analysis. Quantitative methodologies included comparing screening tool used by the US Environmental Protection Agency (US EPA), Minnesota Pollution Control Agency (MPCA), and California Environmental Protection Agency (CalEPA); accessing and preparing Michigan-specific social and environmental datasets; and statistically and spatially analyzing these datasets according to methodologies used by MPCA and CalEPA. Each step of these quantitative methodologies is described below.

5.1 Quantitative Research Questions

The quantitative portion of this study sought to answer the following research questions:

- What data can be used to quantify the state of environmental justice in Michigan?
- How accessible and available are data relevant to environmental justice?
- What gaps exist in the data regarding availability and accessibility?
- What is the feasibility of developing a Michigan-specific environmental justice screening tool based on the availability of relevant data?
- What could the application of such a screening tool reveal about the state of environmental justice in Michigan?

To answer these questions, the research team compared the data and methodologies used in screening tools from the United States Environmental Protection Agency (US EPA), the California Environmental Protection Agency (CalEPA), and the Minnesota Pollution Control Agency (MPCA). Through this comparison, the team identified the data that was both relevant and accessible for analysis of environmental

justice in Michigan, as well as data that was not available or accessible. The team prepared social data from the US Census Bureau's American Community Survey (ACS) and US Department of Housing and Urban Development's Community Housing Survey, as well as environmental data from US EPA's EJScreen for analysis in ESRI's ArcMap according to two methodological approaches. The first approach utilized the MPCA's methodology. The second approach utilized CalEPA's methodology without and with race and ethnicity data, respectively. Finally, the team created a map that incorporates best practices of both agencies to deliver a comprehensive assessment of the state of environmental justice in Michigan.

Following the comparative analysis of data and methodologies, as well as the creation of a map that reflects the state of environmental justice in Michigan, the team uploaded datasets used in their final map onto ArcGIS Online to create a Michigan-specific screening tool. This map can be accessed at: http://bit.ly/MI_EJscreen.

5.2 Comparison of Screening Tools

A matrix was created to compare the indicators used in the screening tools from US EPA, CalEPA, and MPCA. In this matrix, indicators used by US EPA, CalEPA and MPCA were compared. EJScreen indicators were used as a baseline because its data is openly accessible and routinely updated. The furthest-left column of the matrix consisted of a list of indicator categories: environmental, socioeconomic, and health. Environmental indicators were further divided into three subcategories: air quality, water quality, and pollution. The specific indicators were then listed under the three categories and subcategories. The three agencies' spatial analysis tools were listed in the top row of the matrix so that the presence or absence of each indicator could be clearly noted for each tool. Then, the "metric" and "source" for each indicator were listed for each of the three screening tools. The "metric" column for each indicator contained additional information explaining what exactly the indicator was measuring. The "source" column contained information on the agency responsible for publishing the data and the most current year of available data. See Table 10 below for the general setup of this matrix.

Tool	US EPA EJScreen		CalEPA CalEnviroScreen		MPCA			
					Story Map		What's in my Neighborhood	
Indicator	**Metric**	**Source**	**Metric**	**Source**	**Metric**	**Source**	**Metric**	**Source**
Environmental Indicators								
Air Quality								
Ex: Ozone								
Socioeconomic Indicators								
Income								
Ex. 200% of FPL*								
Health Indicators								
Ex. Asthma								

Table 10. Skeleton of the matrix comparing indicators used in agencies' screening tools.
**Federal Poverty Level*

By setting up the matrix in this way, the team could visually compare the indicators used in all three agencies' tools. When an indicator was found to be present in a screening tool, the cell containing that indicator was shaded green in the matrix. For environmental indicators, the team used two shades of green, light and dark, to distinguish between those indicators that represented discrete counts of polluting facilities and quantifiable risk of exposure, respectively. Alternatively, when an indicator was found to be absent from a screening tool, the cell containing that indicator was shaded pink. Cells for the subcategories themselves, such as "Health Indicators," were also shaded to reflect whether that subcategory was included in the agency and/or screening tool's methodology.

As an illustrative example, EJScreen uses an environmental indicator containing data on National Air Toxics Assessment (NATA) Air Toxics Cancer Risks. Based on how this indicator is listed in the EJScreen technical documentation, it is categorized under the category "Environmental Indicators" and subcategory "Air Quality" (US EPA 2017a). The row for NATA Air Toxics Cancer Risks reflects that the indicator is present in EJScreen, but not in CalEnviroScreen or in Minnesota's tools, as shown by the respective green and pink shading in Figure 10 below. Further, the row is shaded dark green, which reflects that this indicator is a quantifiable measure of risk of exposure. It is also of note that "Air Quality" is absent from Minnesota's "Story Map" tool as shown by the pink shading below. See Appendix D for the complete matrix.

	US EPA's EJ Screen		Cal EPA's CalEnviroScreen		Minnesota PCA's			
					Story Map		What's In My Neighborhood	
Indicator	Metric	Source	Metric	Source	Metric	Source	Metric	Source
Environmental Indicators								
Air Quality							Permits for facilities that emit air pollutants	MPCA
NATA Air Toxics Cancer Risks	lifetime cancer risk from inhalation of air toxics	EPA NATA (2011)						

Figure 10. Sample of indicator comparison matrix.

5.3 Identification of Usable Data

In addition to comparing the data present in each of the three screening tools of interest, the availability and utility of supplemental, Michigan-specific data was assessed. Relevant state departments and agencies were contacted regarding the accessibility of environmental and health data. Emails were sent to the Michigan Department of Health and Human Services and the Michigan Department of Environmental Quality to request access to specific datasets. As discussed later in more detail, the team was unable to obtain useful

information within a timely manner for the purposes of this study. Ultimately, the decision was made to use open-access data from the US EPA's EJScreen, US Census Bureau's American Community Survey (ACS), and the US Department of Housing and Urban Development's (HUD) Comprehensive Housing Affordability Strategy (CHAS) survey for the analysis.

5.4 Preparation of Social and Environmental Data

The team had to find and prepare the social and environmental data before they were able to statistically and spatially analyze it. Social and environmental data were prepared separately. It should be noted that the various agencies from which data were gleaned use different names for the indicators they use in their screening tools. For example, while EJScreen uses an indicator called "Less than high school education," CalEnviroScreen uses an indicator called "Educational Attainment," both of which measure percent of the population over age 25 whose education is less than a high school diploma.

5.4A. Social Data

First, the research team downloaded US census tract cartographic boundaries at a 500 kilometer resolution from the US Census Bureau. These data came in the form of a shapefile within a geodatabase that could be used in ESRI's ArcMap spatial analysis program. A field was added to the shapefile and titled "Original Area." Using the "Field Calculator" function in ArcMap, the team set the new field equal to the "Shape Area" to create a replicated column for area of each tract. In addition to that shapefile, a shapefile for "American Indian/Alaska Native Areas/Hawaiian Home Lands" was downloaded at the same resolution of 500 kilometers.

Next, the team prepared the data for social indicators, referred to as "Population Characteristics" by CalEPA and "Demographic Criteria" by MPCA. The team used the US Census Bureau's American FactFinder to find and isolate data specific to the state of Michigan for each of the social indicators used in either CalEnviroScreen or the MPCA's screening tools. These data are downloadable online in an Excel file and

represents five-year estimates that cover the years 2013 to 2017. These data were selected because they are newer than the EJScreen social data, which cover years 2011 to 2015. The most recent CHAS data from the US Department of Housing and Urban Development, which were used to quantify housing burden, cover years 2011 to 2015 and were derived from custom US Census Bureau.

Next, the team applied the methodology for excluding data based on the margin of error of each "Population Characteristic" calculation in each geographic unit referenced in the CalEnviroScreen's technical document. While MPCA and US EPA did not use such a rigorous elimination method for ensuring the accuracy of US Census data, the team decided to apply CalEPA's method to all social data they analyzed.

This process involved comparing the estimate of the "Population Characteristic" of interest to the margin of error for that geographic unit. For each block group, the team compared the calculated estimate of the social indicator to the standard error for the total population of that block group. Next, the team compared the standard error of each block group to the criteria used by CalEPA to determine the accuracy of the data contained in each unit. Standard error was calculated by dividing the margin of error of the unit's total population by 1.645, the statistical value associated with the 90% confidence interval for a given estimate. The comparison then involved dividing the standard error of each unit by its estimate for a specific social indicator and accepting that unit's data only if the resulting value was either below 50% or if that unit's standard error was less than the average standard error for all units for that indicator estimate.

As an illustrative example, the social indicator unemployment was calculated for each block group by subtracting the number of non-institutionalized persons 16 years and older who were not employed from the total number of non-institutionalized persons 16 years and older. This calculation was the estimate for unemployment. The margin of error of the total population was given for each individual block group in number of persons. This number was divided by the total population number to give a margin of error as a percent. This number was then divided by 1.645 to get the standard error. This standard error was then divided by the estimate described earlier to get a resulting proportion. When that value was greater than 50%, the

variable was excluded unless that block group's standard error was less than the average standard error of that indicator for all block groups.

For each social indicator, the data exclusion rate was high. For example, for the social indicator unemployment 65% of all block groups were excluded through the application of this method. More than half of the social indicators had exclusion rates above 50%. For this reason, the team did not use the block group level for analysis of social indicators.

Given the lack of accuracy present for data at the block group level, the team assessed the exclusion rate of data at the census tract level. It should be noted that census tract is the level of analysis used by CalEPA for the agency's CalEnviroScreen tool. The team used the same process detailed above for data at the census tract level instead of the block group level. For more than half of the social indicators, including unemployment, the percentage of excluded census tracts was below 10%. For this reason, the team decided to analyze social indicators at the census tract level instead of the block group level.

The team then compiled one master file with calculations for the social indicators for each Michigan census tract, leaving blank the values of indicators in census tracts where the inclusion criteria was not met. The social indicators that the team analyzed are listed below in Table 11 along with their Variable IDs, as assigned by the US Census Bureau. Finally, the team uploaded this master Excel file into ArcGIS. Data on "Population Characteristics" was joined to the census tract boundary file using the geoID of each census tract as a key. The joined data was then exported as a new layer.

Indicator Name	Description of Indicator	US Census Variable ID
Percent Minority	Percent minority (100% minus % non-Hispanic white)	B03002
Educational Attainment	Percent of the population over age 25 with less than a high school education	B15003
Poverty	Percent of the population living below two times the federal poverty level	S1701
Unemployment	Percent of the population over the age of 16 that is unemployed and eligible for the labor force, excludes retirees, students, homemakers, institutionalized persons except prisoners, those not looking for work, and military personnel on active duty	S2301
Linguistic Isolation	Linguistic isolation (percent of households who speak English as a second language less than "very well")	B16001
Housing Burdened Low-Income Households	Housing burden data from the US Department of Housing and Urban Development (HUD) (percent of households in a census tract that are both low-income (making less than 80% of the HUD Area Median Family Income) and severely burdened by housing costs (paying greater than 50% of their income to housing costs))	N/A

Table 11. Social indicators and their assigned variable IDs.

In addition to the "Population Characteristics" analyzed by CalEPA in CalEnviroScreen, the team decided to include minority status (represented by percent minority) based on several factors. The literature discussed in Chapter 2 highlighted the importance of minority status when considering environmental justice. The MPCA also used minority status to identify that state's "areas of concern for environmental justice" (MPCA 2015). Lastly, the results of the qualitative portion of this study, discussed in greater detail in Chapter 4 of this paper, indicated that race and ethnicity are important themes to environmental justice leaders in the state of Michigan. It should also be noted that while CalEPA does not analyze minority status, the US EPA does include minority status in its calculation of environmental justice indices for its EJScreen tool. Once data on social indicators were ready, the team prepared the data on environmental indicators.

5.4B. Environmental Data

The environmental data analyzed in this study were accessed from the US EPA. A description of each variable, its unit of geographic resolution, and the most recent year accessible is available on the US EPA's website, as well as in the indicator comparison matrix available in Appendix D of this report. These indicators are similar to those that constitute the "Pollution Burden" component of the CalEnviroScreen methodology (Faust et al. 2017).

Six of the eleven indicators were present at the census block group level. Given that the social indicators were prepared at the census tract level instead of block group level due to data quality issues, further preparation was necessary to convert the block group level data to the census tract level. However, since the indicator for lead paint can be sourced from the US Census Bureau in exactly the same way as the social indicators are, the team chose to prepare that specific indicator according to the methodology discussed above in Section 5.4A. For those environmental indicators that were present at the census tract level, values were not changed. The methodology for converting census block group data to the census tract level is discussed following Table 12 below.

US EPA EJScreen			
Indicator	**Metric**	**Source**	**Geographic Unit**
National-Scale Air Toxics Assessment (NATA) Air Toxics Cancer Risks	Lifetime cancer risk from inhalation of air toxics	US EPA NATA (2011)	Census tract
NATA Respiratory Hazard Index	Ratio of exposure concentration to health-based reference concentration	US EPA NATA (2011)	Census tract
NATA Diesel Particulate Matter	Diesel particulate matter level in air (micrograms per cubed meter)	US EPA NATA (2011)	Census tract
Particulate Matter (PM 2.5)	Annual average PM2.5 levels in air obtained through a fusion of model and monitor data (micrograms per cubed meter)	US EPA Office of Air and Radiation OAR (2014)	Census tract
Ozone	Seasonal average of daily maximum 8-hour concentration in air obtained through fusion of model and monitor data (ppb)	US EPA OAR (2014)	Census tract
Traffic Proximity and Volume	Count of vehicles (AADT, average annual daily traffic) at major roads with 500 meters, divided by distance in meters (calculated from 2014 US DOT traffic data)	US Department of Transportation (DOT) (2014)	Census block group
Wastewater Dischargers Indicator (Stream Proximity and Toxic Concentration)	RSEI modeled Toxic Concentrations at stream segments within 500 meters, divided by distance in km (calculated from RSEI modeled toxicity-weighted stream	US EPA (2017)	Census block group

	concentrations)		
Proximity to Risk Management Plan (RMP) sites	Count of RMP facilities (facilities with a chemical accident management plan) within 5 km (or nearest one beyond 5 km), each divided by distance in km (calculated from US EPA RPM database)	US EPA (2017)	Census block group
Proximity to Hazardous Waste Facilities	Count of hazardous waste facilities (TSDFs and LQGs) within 5 km (or nearest beyond 5 km), each divided by distance in km (calculated from US EPA Resource Conservation and Recovery Act info database)	US EPA (2017)	Census block group
Proximity to National Priorities List (NPL) sites	Count of proposed and listed NPL - also known as superfund - sites within 5 km (or nearest beyond 5 km), each divided by distance in km (calculated from US EPA Comprehensive Environmental Response, Compensation, and Liability Information System database)	US EPA (2017)	Census block group
Lead Paint Indicator	Percent of housing units built pre-1960 (calculated based on US Census data)	American Community Survey (2013-2017)	Census block group (also available at the census tract level from US Census Bureau)

Table 12. Environmental indicators used in EJScreen (US EPA 2018b).

To begin the preparation of environmental data, the team downloaded the most recent versions of the US EPA's EJScreen data from the US EPA's website (US EPA 2018b). These data were in the form of both a geodatabase (.gdb) file and a comma-separated value (.csv) file. Both file types included data on all

environmental indicators for every census block group in the US. The team used Microsoft Excel to open the .csv file where Michigan block groups were then isolated using the Excel's "Filter" function and the State of Michigan's Federal Information Processing (FIP) code "026." Only the identifying data and original data for the environmental indicators present in EJScreen were included. All other data columns were eliminated.

The US Census Bureau's block-group level cartographic boundary shapefile, which had already been downloaded to access social data, was then uploaded into ArcMap. These data were at the 500 kilometer resolution. The EJScreen .csv file was also uploaded into ArcMap. The team then joined the EJScreen file to the block-group boundary shapefile and exported the joined datasets as a new map layer. The "Identity" function in ArcMap was then used to combine the new shapefile containing EJScreen data by block group with the shapefile containing census tracts and social indicators. The output of that process resulted in a new layer that contained the area of each block group within a census tract, the original area of each census tract, and all relevant environmental and social indicators. The team then exported this table in Excel format.

In Excel, a new column was created and set equal to the proportional area of each block group divided by the original area of the census tract that contained said block groups. This provided an area-weighted proportion of each census tract according to how much of its area was present in a given number of block groups. New columns were then made for each of the environmental indicators except for lead paint. The new values were the product of the original block group's proportional area and the block group's score for that indicator. As an illustrative example, imagine in a given census tract there were two block groups. One block group accounted for 60% of the area within the census tract. The other accounted for 40%. The first block group's score for a given indicator was multiplied by 0.6 and the latter by 0.4.

The team then created a Pivot Table in Excel from this new datafile where the data was sorted into rows by census tract ID. The column values were made to equal the sum of values for each environmental indicator. The resulting table consisted of one column of census tract IDs and subsequent columns for each indicator by census tract where the scores represented area-weighted values. The table was sorted by census tract ID in

descending order and copied into a new Excel file. That file was then uploaded into ArcMap and joined to the census tract shapefile with social indicators. The joined data were then exported to a new layer in ArcMap, which represented each census tract with scores for social indicators and area-weighted environmental indicators.

It should be noted that the area-weighted apportionment method was used due to data unavailability. The majority of EJScreen environmental indicators were available at the census tract-level; however, five of the eleven indicators were available only at the block group-level: (1) Traffic Proximity and Volume, 2) Wastewater Dischargers Indicator, 3) Proximity to Risk Management Plan (RMP) sites, 4) Proximity to Hazardous Waste Facilities, and 5) Proximity to National Priorities List (NPL) sites. To overcome this inconsistency in geographic scale, data for every indicator would need to be analyzed in its raw form, such as directly from data collection programs like the EPA's Toxic Release Inventory (TRI). However, this highly technical and labor intensive process was beyond the scope of this research project and is a step that should be undertaken by a well-resourced state agency as was done in the state of California.

Because social indicators were analyzed at the census tract level, the team had to aggregate the five environmental indicators available at the block group level to the census tract-level. Area-weighted aggregation was selected as the methodology to apportion values for those indicators to a census tract-level. The team acknowledged that there are several issues with using an area-weighted apportionment method, as it can result in the under or over-valuing of a specific indicator and is sensitive to the geographic distribution of that indicator across the unit of measurement. This decision reflected the team's most reasonable attempt to convert block group-level data to the census tract-level given constraints on the team's time and access to resources. Again, analyzing indicators in their raw form is a more desirable process and should be adopted by a well-resourced state agency in Michigan.

5.5 Spatial Analysis of Data

Social and environmental indicators for Michigan census tracts contained in the new layer were analyzed using three methodologies. The first was an application of the MPCA's methodology for identifying "areas of concern for environmental justice." The second was an application of CalEPA's CalEnviroScreen methodology used to identify "disadvantaged communities." Lastly, the final application was a combination of these two methodologies' best practices.

5.5A. Applying MPCA Methodology for "Areas of Concern for Environmental Justice"

The research team based their first analysis on the application of the methodology that MPCA uses to identify "areas of concern for environmental justice" from Minnesota's state policy on environmental justice. Criteria to define these areas were gleaned from Minnesota's 2015 - 2018 Environmental Justice Framework (MPCA 2015). Minnesota's Story Map tool is used by the Minnesota PCA during the environmental permitting process to assess whether the community surrounding the existing or proposed facility is an "area of concern for environmental justice." To make permitting decisions, MPCA assesses whether the community, measured at the census tract level, fits at least one of the following criteria:

- Percent of non-white population is at least 50%
- "More than 40% of the households have a household income of less than 185% of the federal poverty level (FPL)"
- If the facility is within the boundaries of a "tribal community" (MPCA 2015).

Based on this methodology, the team analyzed Michigan-specific EJScreen and Census data at the census tract-level. To identify tribal communities, the US Census Bureau's American Indian/Alaska

Native/Native Hawaiian Areas (AIANNH) data was used. The AIANNH data, downloaded as a shapefile, includes "federally recognized American Indian reservations, off-reservation trust land areas, and state-recognized American Indian reservations" (US Census Bureau 2019).

The "Search-by-Attribute" function in ArcMap was used to find those census tracts where either the minority population was greater than 50% or the proportion of families with a household income of less than 185% of the FPL was greater 40%. Every census tract that met at least one of those criteria was identified on this map. The resulting selection was then exported as a new layer to the map.

Next, the shapefile for "American Indian/Alaska Native Areas/Hawaiian Home Lands" was used to select only those tribal communities that are either contained within Michigan or intersecting the state's boundary. Using the "Select-by-Location" function in ArcMap, tribal communities that were either within Michigan or intersecting the state's boundary were selected. This selection was exported as a new layer to the map. To replicate Minnesota's methodology, the two new layers were displayed together on a map of Michigan. This map is shown in Appendix E.

5.5B. Applying CalEPA's Methodology for "Disadvantaged Communities"

The research team based their second application on the methodology that CalEPA used to identify "disadvantaged communities" in the state. These communities are identified as those census tracts scoring within the top 25% of all census tracts within California based on their CalEnviroScreen scores. The team calculated scores for Michigan census tracts using the social and environmental data discussed in Section 5.4. This calculation provided a relative ranking of Michigan's census tracts by the estimated environmental justice metric of the CalEnviroScreen score. The CalEPA aggregation methodology was gleaned from the CalEnviroScreen 3.0 Report (Faust et al. 2017).

This methodology used a series of weights and multiplication to combine two components, "Pollution Burden" and "Population Characteristics," to create a relative score that allows for comparison of California

communities in terms of pollution impacts and vulnerabilities. See Figure 11 below for indicators included in each component and subcomponent of the CalEnviroScreen score. The two components are each divided into two subcomponents. The "Pollution Burden" component consisted of "Exposures" and "Environmental Effects." The "Population Characteristics" component consisted of "Sensitive Populations" and "Socioeconomic Factors." The "Sensitive Populations" subcomponent of "Population Characteristics" consisted of three health-based indicators, as shown below in Figure 11. The team was unable to acquire Michigan-specific data for these three health indicators. Thus, that subcomponent was excluded, essentially making the "Population Characteristics" component and the "Socioeconomic Factors" subcomponent equivalent. This combination is shown in Figure 12.

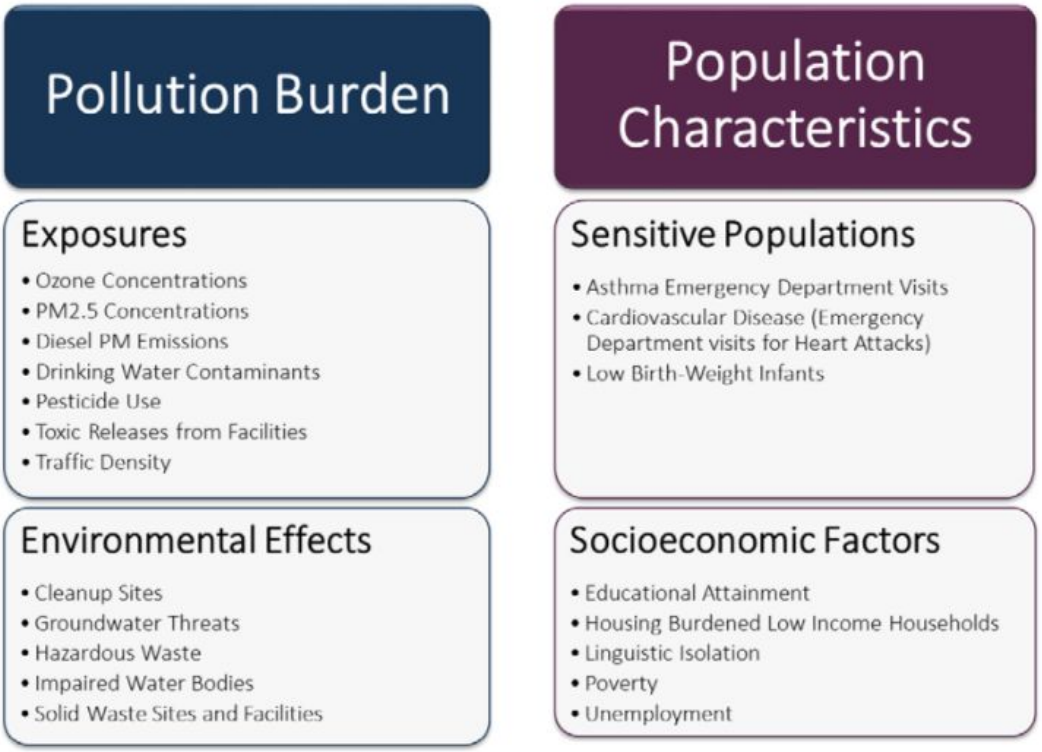


Figure 11. CalEnviroScreen score main components. Please note that this figure is taken directly from the CalEnviroScreen 3.0 Report (Faust et al. 2017).

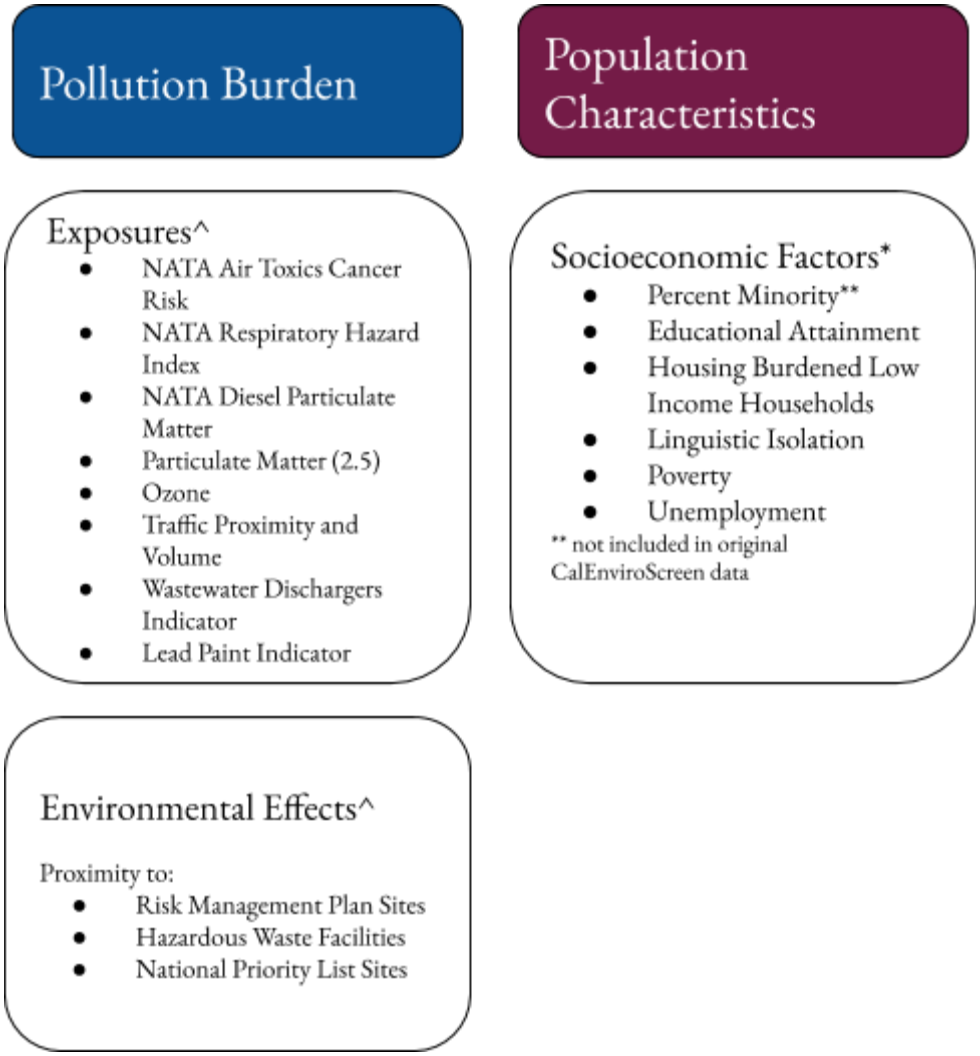


Figure 12. Main components used by the team in the Michigan-specific analysis used to calculate environmental justice scores.
^Data within these subcomponents used data from US EPA's EJScreen tool.
*The exclusion of the health-based indicators of vulnerability included in CalEnviroScreen's "Sensitive Populations" subcomponent results in an increased weighting of "Socioeconomic Factors" within the main component of "Population Characteristics" and the overall score.

As performed by CalEPA in the CalEnviroScreen tool, the team used percentiles to address the issue of different units of measurements across individual indicators. These percentile scores for each indicator in each census tract could then be used to create scores for the subcomponents and components through the averaging of scores. However, these percentile scores were relative in that the percentile score for each indicator depended

on the range of scores for that indicator across census tracts. The percentile scores did not account for magnitude. A census tract scoring at the 50th percentile was not necessarily ten times worse off than the fifth percentile, rather the 50th percentile score is a relative ranking to the range of scores across all census tracts for that indicator.

For each census tract in the state, percentiles for all individual indicators within each subcomponent ("Exposures," "Environmental Effects," and "Sensitive Populations") were averaged. For example, the percentile score for each of the three indicators listed under the "Environmental Effects" subcomponent in Figure 12 was calculated, then those three percentile scores were averaged. Then a weighted average was taken between the "Environmental Effects" and "Exposures" subcomponents to create a score for the main component of "Pollution Burden." More specifically, the "Environmental Effects" score was first weighted by half (multiplied by 0.5), then added to the "Exposures" score. This sum was then divided by 1.5 to constitute the "Pollution Burden" score. The resulting "Pollution Burden" and "Population Characteristics" scores of each census tract were then divided by the maximum value of each score observed in the state and then multiplied by ten so that scores were scaled to have a maximum value of ten. The division by maximum value helped ensure that the two main components contributed equally to the score (Faust et al. 2017). The "Pollution Burden" score was multiplied by the "Population Characteristics" score to produce the CalEnviroScreen score for each tract. Because the maximum score for both "Pollution Burden" and "Population Characteristics" was ten, the maximum CalEnviroScreen score was one hundred, as ten multiplied by ten equals one hundred. For additional details, refer to CalEnviroScreen 3.0 Report (Faust et al. 2017). See Figure 13 below for a visual representation of the formula. Again, it should be noted that the "Sensitive Populations" subcomponent of the "Population Characteristics" component was omitted by the team due to the unavailability of health-related data for Michigan.

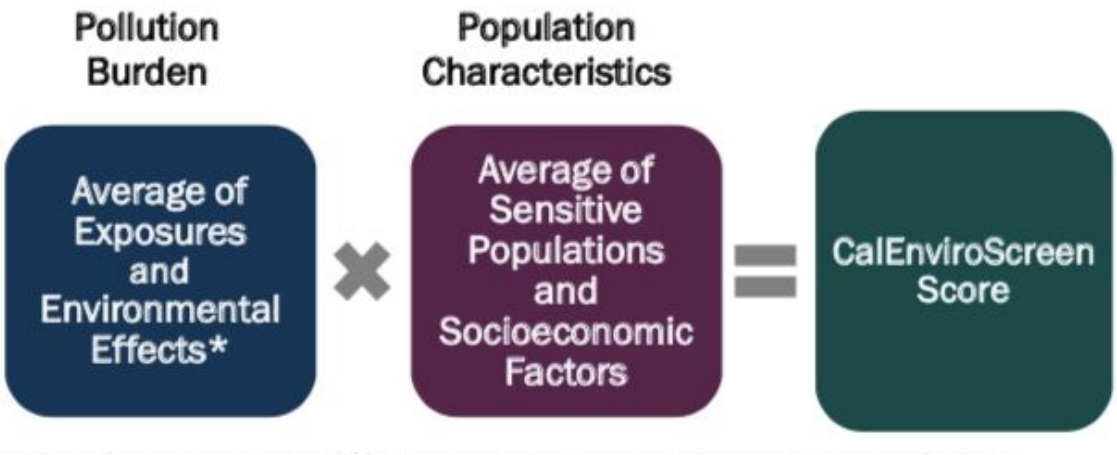


Figure 13. CalEnviroScreen calculation to obtain an environmental justice score (Faust et al. 2017).
* "Pollution Burden" is comprised of the sum of ["Exposures" score + ½("Environmental Effects" score)] all divided by 1.5.
"Populations Characteristics" score is comprised of ["Sensitive Populations" score + "Socioeconomic Factors" score] but for the team's analysis "Population Characteristics" included only the "Socioeconomic Factors" subcomponent, thus the "Population Characteristics" score equals "Socioeconomic Factors" score.

In Excel, the team calculated scores for each of Michigan's census tracts using social and environmental indicators listed in Tables 11 and 12, and Figure 12. The resulting file containing scores for each census tract was then uploaded back into ArcMap where it was joined once again to the original census tract layer using the "GEOID" attribute. Once this join was complete, the team could map each census tract by percentile and decile. This visualization was completed using the "Symbology" feature of ArcMap where the percentile value for the score was organized into deciles. The top decile was then divided into deciles to visually display the top-ten percentiles. The team also identified those census tracts whose final score fell within the top quartile (25%) of the state which reflected the methodology used by CalEPA for identifying "disadvantaged communities" (Faust et al. 2017). CalEPA also applied an additional designation for "disadvantaged communities" that may lack a sizeable population by including those census tracts who score above the 95th percentile for "Pollution Burden" but do not score in the top quartile for their overall CalEnviroScreen score (Faust et al. 2017). The results of this analysis are shown in the map in Appendix H. The third and final application of methodologies to the state of Michigan focused on best practices of Minnesota and California.

Using their best practices, the team created a map depicting the state of environmental justice in Michigan and created a state-specific environmental justice screening tool.

5.6. Utilizing Best Practices to Identify Vulnerable Communities in Michigan

With the objective of assessing the state of environmental justice in Michigan by identifying vulnerable communities, the team enhanced the approach used by CalEnviroscreen by adding tribal communities as well as race and ethnicity as social indicators. This analysis reflected best practices of MPCA, CalEPA, US EPA, and the community input shown in the results of the qualitative portion of this study.

To complete this analysis, the research team combined the tribal layer from the map created according to MPCA's methodology with the layer of calculated environmental justice scores (including racial and ethnic data) based on CalEPA's methodology by pasting copies of each layer into a new map file in ArcMap. This file included the layers of: census tracts containing land belonging to tribal communities, and results of environmental justice score calculations for each census tract including racial and ethnic data.

5.7 Creating a Michigan-Specific Screening Tool: Methods

As a final step, the team uploaded data analyzed in the map described in Section 5.6 to the ArcGIS Online (AGOL) platform to create an example of an interactive screening tool for Michigan. Steps followed included uploading the already prepared data to AGOL, which allows users to upload maps, including geodatabases and shapefile layers, for use in an online mapping application. The layers were then made publicly available. Modifications were made so that the data from the tool can be downloaded but the underlying data cannot be modified directly in the tool. While a reporting mechanism was not included in this tool, it would be relatively simple to add a geo-tagging function to the tool which would allow for spatial self-reporting of issues relevant to environmental justice.

Chapter 6: Quantitative Analysis Results

The results of the quantitative data analysis take two main forms: 1) a ranking of all census tracts in Michigan based on their environmental justice scores, the results of which are provided in a table and in color coded maps; and 2) an interactive environmental justice screening tool that provides details of the environmental conditions and socioeconomic characteristics of census tracts in Michigan. Intermediate steps to these two results involved creating an indicator comparison matrix and a list of datasets to which the team sought access. All results of quantitative data analysis are discussed below.

6.1 Ranking of Michigan Census Tracts

In order to inform which datasets and methodology the team used to assess environmental justice in Michigan, data and methodologies used by the United States Environmental Protection Agency (US EPA), California Environmental Protection Agency (CalEPA), and Minnesota Pollution Control Agency (MPCA) were compared. The full matrix comparing indicators used by US EPA, CalEPA, and MPCA is displayed in Appendix D: Indicator Comparison Matrix. Comparing the US EPA's EJScreen, CalEPA's CalEnviroScreen, and MPCA's Story Map and What's in My Neighborhood tools by indicator showed that CalEnviroScreen is the most comprehensive of the four tools in terms of the amount of data and number of indicators used. The summary of insights gained from assessing the agencies' indicator usage is displayed below in Table 13.

Summary of indicator categories covered

	Agency and Tool			
	US EPA	CalEPA	MPCA	
	EJScreen	CalEnviroScreen	Story Map	What's in My Neighborhood?
Indicator Categories				
Environmental	Used measurable exposure data for air and water quality subcategories with six and one indicators, respectively. US EPA also used a lead paint indicator. For other types of environmental burdens, such as hazardous waste facilities, the data were discrete counts of number of facilities per geographic unit. US EPA used three indicators for proximity-to-facility burdens.	Used measurable exposure data for air and water quality, as well as pesticide usage. CalEPA used four exposure indicators for air quality and one for water quality. There were two additional exposure indicators. For proximity to hazardous facilities and contaminated sites, CalEPA used five indicators.	The Story Map did not use any environmental data. This tool is used for identifying areas of concern for environmental justice and not potential for environmental exposure.	This tool used data on hazardous, permitted facilities in Minnesota. It was also the only tool to use feedlots as a facility of environmental concern.
Social	US EPA used seven variables across four social indicators which included race, ethnicity, age, poverty status, educational attainment, and linguistic isolation.	CalEPA used five variables for five social indicators poverty status, educational attainment, linguistic isolation, housing burden, and unemployment.	MPCA used race, ethnicity, tribal status, and poverty status.	This tool did not use social indicators.
Health	This tool did not use health indicators.	CalEPA used three variables for three health indicators, including asthma, cardiovascular disease, and low infant birth weight.	This tool did not use health indicators.	This tool did not use health indicators.

Table 13. Summary of indicator categories used in each tool.

As shown in Table 13, the three agencies and their tools used data across multiple dimensions of environmental justice. CalEPA's CalEnviroScreen used data for environmental, social, and health indicators. This tool was the only one to display health related data. US EPA's EJScreen used environmental and social data. MPCA's Story Map tool used social indicators to identify areas of concern, while the What's in My Neighborhood tool used permitting data to display the density of pollutive sites across the state. For the specific indicators assessed, please see Appendix D: Indicator Comparison Matrix.

The accessibility of data used in all four tools was also compared. CalEPA used some data that were not publicly available in Michigan, including low-weight births and emergency department visits for heart attacks and asthma. Additionally, CalEPA used state-specific data for several environmental indicators, such as pesticide usage and drinking water contamination. While the latter is technically available through the US EPA's Safe Drinking Water Information System (SDWIS), California used additional datasets collected by the State to supplement the SDWIS data. Minnesota also used state-specific data that was collected by the MPCA. Environmental permitting data, while technically available to the public, is not easily downloadable in a format that can be used in spatial analysis. By preparing the data for use in a mapping tool such as What's in My Neighborhood, the MPCA has made the process of assessing environmental permit data more accessible for the average citizen.

Based on the results of the comparison of screening tools, the research team sought access to additional datasets relevant to the state of environmental justice in Michigan that could be used in addition to social and environmental data publicly available through the US EPA and US Census. The team contacted the Michigan Department of Environmental Quality (MDEQ) to inquire about the availability of certain environmental datasets, such as data describing drinking water quality. Additionally, the team contacted the Michigan Department of Health and Human Services (DHHS) to inquire about the availability of certain health-related datasets, such as data describing the prevalence of cardiovascular disease. Table 14 below summarizes which specific datasets were requested.

Agency Contacted	Dataset Requested	Status of Dataset
Michigan Department of Environmental Quality	Impairment and/or quality of surface water bodies used for recreation and/or drinking water (polygon-type shapefile preferred)	Provided
	Impairment and/or quality of groundwater sources used for drinking water	Available through US Geological Survey
	Drinking water quality	Not available
	Use of high-hazard, high-volatility pesticides	Not available
Michigan Department of Health and Human Services (DHHS)	Asthma emergency department visits	Provided at the zip code scale
	Cardiovascular disease	Not available
	Low birth weight - infants	Not available

Table 14. Datasets the team requested from MDEQ and DHHS.

Representatives from both the MDEQ and DHHS responded to the team's outreach. As indicated in Table 14, the MDEQ provided data and resources related to impaired drinking water. Most of these resources, including the MDEQ's Environmental Mapper tool, used data already available from the US EPA. The other datasets the team requested, listed in Table 14, were not readily available in a usable spatial format. The DHHS provided data related to asthma, but as the data were at the zipcode level, they were not appropriate for this study. The other two datasets requested from DHHS were not available for public use. This section of the analysis answered questions about gaps in the data available for use in a Michigan-specific environmental justice screening tool. The lack of available health data in Michigan represented a gap between data used by CalEPA and what is available in Michigan. Furthermore, the lack of data on pesticides and specific drinking water

impacts limits a complete application of CalEnviroScreen to Michigan. The team ultimately decided to use EJScreen data for environmental indicators and US Census and HUD data for social indicators as they were all publicly available and accessible, although, as mentioned earlier, some of the data had to be aggregated using an area weighted apportionment to be usable for this analysis.

The first intermediate step of the team's analysis was the application of Minnesota's "areas of concern for environmental justice" methodology to the state of Michigan. This methodology included data on tribal community boundaries, as defined by the US Census Bureau, and data on poverty, race, and ethnicity. Minnesota's methodology did not rank any census tracts. Rather, this methodology sought to highlight communities where environmental justice concerns could be present. The team provided a map in Appendix E that shows the 965 census tracts that were identified by Minnesota's methodology as being "areas of concern for environmental justice." Additionally, Appendix G includes maps delineating tribal community boundaries in Michigan as well as a table with the names of the 13 Tribal areas delineated.

The second intermediate step of analysis was the application of CalEPA's CalEnviroScreen methodology to the state of Michigan using data from the US EPA, Census Bureau, and HUD. This second analysis, which provided rankings of census tracts, first excluded racial and ethnic data due to CalEPA's omission of such data. The map created based on CalEPA's methodology can be found in Appendix H. It should be noted that some census tracts fell within the top 25% (n = 686) when applying CalEPA's methodology to Michigan but were not identified as "areas of concern for environmental justice" applying MPCA's methodology (n = 275). The map highlighting these differences can be found in Appendix F displaying the location of those census tracts.

Although CalEPA does not analyze data on race and ethnicity in CalEnviroScreen, the team decided to include race and ethnicity data in their assessment of environmental justice in Michigan. As previously stated, the significance of racial and ethnic issues to environmental justice in the state of Michigan is highlighted by the qualitative analysis of this study. Furthermore, the inclusion of racial and ethnic data in both Minnesota and US

EPA's conceptualizations of environmental justice further highlights the importance of including such data. To provide a quantitative justification for the inclusion of racial and ethnic data in the formula for calculating environmental justice scores and subsequently ranking census tracts within Michigan, the team statistically compared the tract rankings in both scenarios: 1) including racial and ethnic data and 2) excluding it. A Spearman's rank-order correlation was calculated for the 2,741 census tracts within Michigan with the two variables being environmental justice scores using the CalEPA methodology 1) without racial and ethnic data and 2) with racial and ethnic data. The census tracts were ranked in such a way that there were no tied rankings. This no-tie ranking was accomplished by calculating final environmental justice scores for either method to four decimal places so that each tract had a unique score. These scores were then ranked and the Spearman rank-order correlation was calculated. The formula for this calculation is shown in Figure 14 below where "d" is the difference in ranking between the same tract for each methodology and "n" is the total number of census tracts. For this analysis, n was equal to 2,741.

$$\rho = 1 - \frac{6\sum d_i^2}{n(n^2 - 1)}$$

Figure 14. Formula for calculating Spearman's rank-order correlation.

The resulting rank-order correlation between the two methodologies was 0.992. Given this high level of correlation and the support for including racial and ethnic data from both Minnesota's environmental justice policies and the results of the team's qualitative interviews, the team decided to include racial and ethnic data in the environmental justice ranking of Michigan's census tracts. Results of this analysis are shown in Figures 15, 15a, 15b, 15c, 15d, and in Appendix I.

In addition to race and ethnicity data, many interview participants highlighted the importance of including issues specific to indigenous populations in Michigan, as they felt that such issues are usually ignored. Michigan governmental bodies are already engaged in coordinating with Michigan tribal governments for a

variety of issues including water quality (Michigan.gov n.d.). Furthermore, the United States has adopted the United Nations' Declaration on the Rights of Indigenous Peoples, a resolution passed in September 2007, which affirms that indigenous peoples "should be free from discrimination of any kind" (United Nations 2007, 3). A map highlighting the 13 tribal communities within Michigan can be found in Appendix G along with a table that summarizes the locations of those communities.

The final map of Michigan (Figure 15), as well as the maps showing several of Michigan's metropolitan areas (Figures 15a, 15b, 15c, 15d), displayed two layers from data analysis: 1) results of environmental justice score calculations for each census tract including racial and ethnic data and 2) land belonging to tribal communities. These two layers reflect the Michigan-specific application of Minnesota's sensitivity to racial, ethnic, and tribal issues; the robust ranking methodology of CalEnviroScreen; and the inclusion of relevant social data based on the results of the team's qualitative inquiry. Appendix I identifies the top quartile of ranked census tracts, including their IDs and scores.

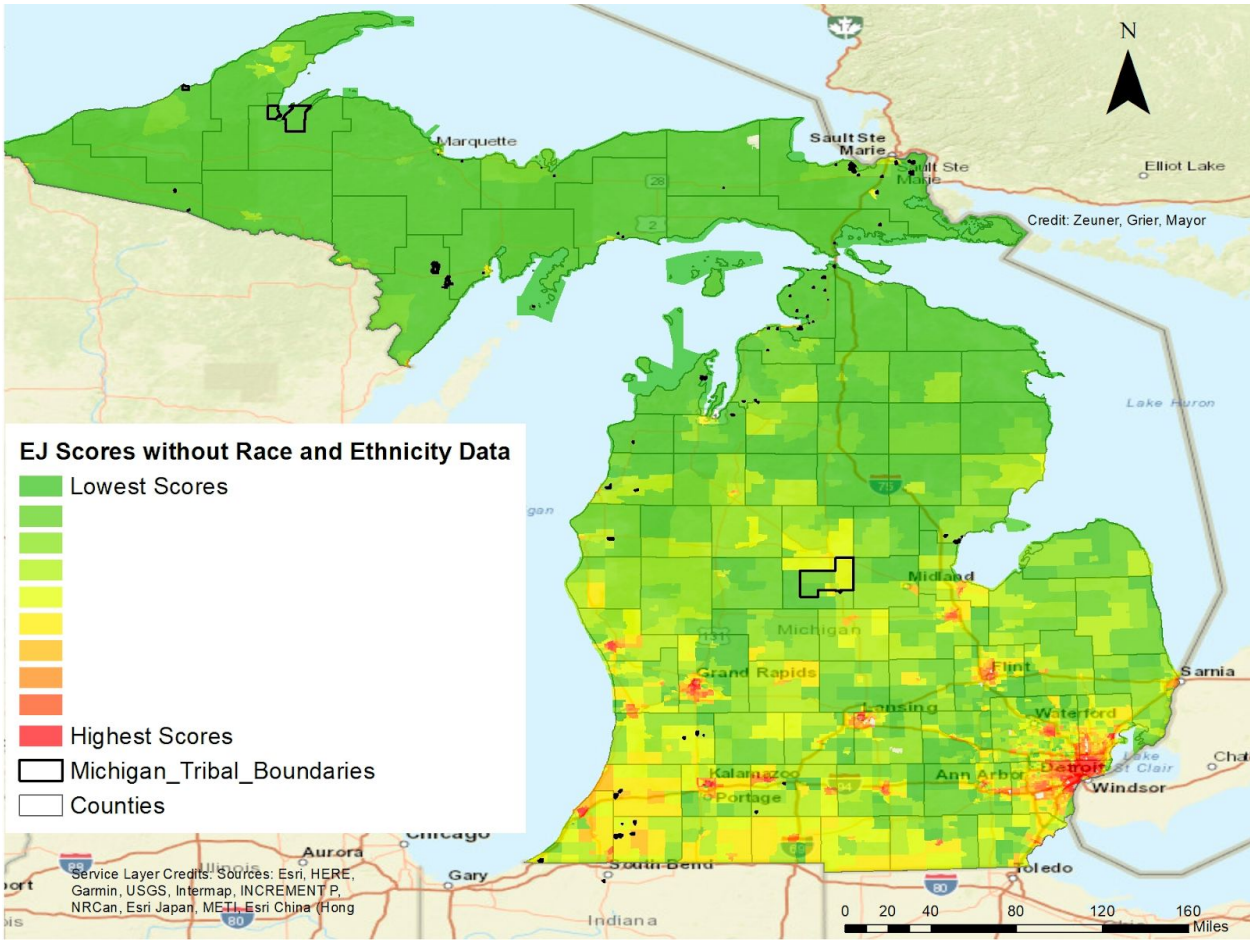


Figure 15. Final map of Michigan census tracts ranked by environmental justice scores.

The census tracts shown in the map in Figure 15 are color coded according to their relative ranking with the greenest areas being in the lowest ten percent of all census tracts by environmental justice score and the reddest areas being in the highest ten percent of census tracts by environmental justice score. An overview of the map reveals the relationship between urban areas and higher values for the team's calculated environmental justice scores. Urban areas, such as Detroit, Grand Rapids, Flint, Saginaw, and Lansing, show a trend of "hot-spots" of environmental justice. Census tracts scoring in the top percentile are listed below in Table 15. See Figure 15a for a map of Detroit, Figure 15b for a map of Flint, Figure 14c for a map of Saginaw, and Figure 15d for a map of Grand Rapids.

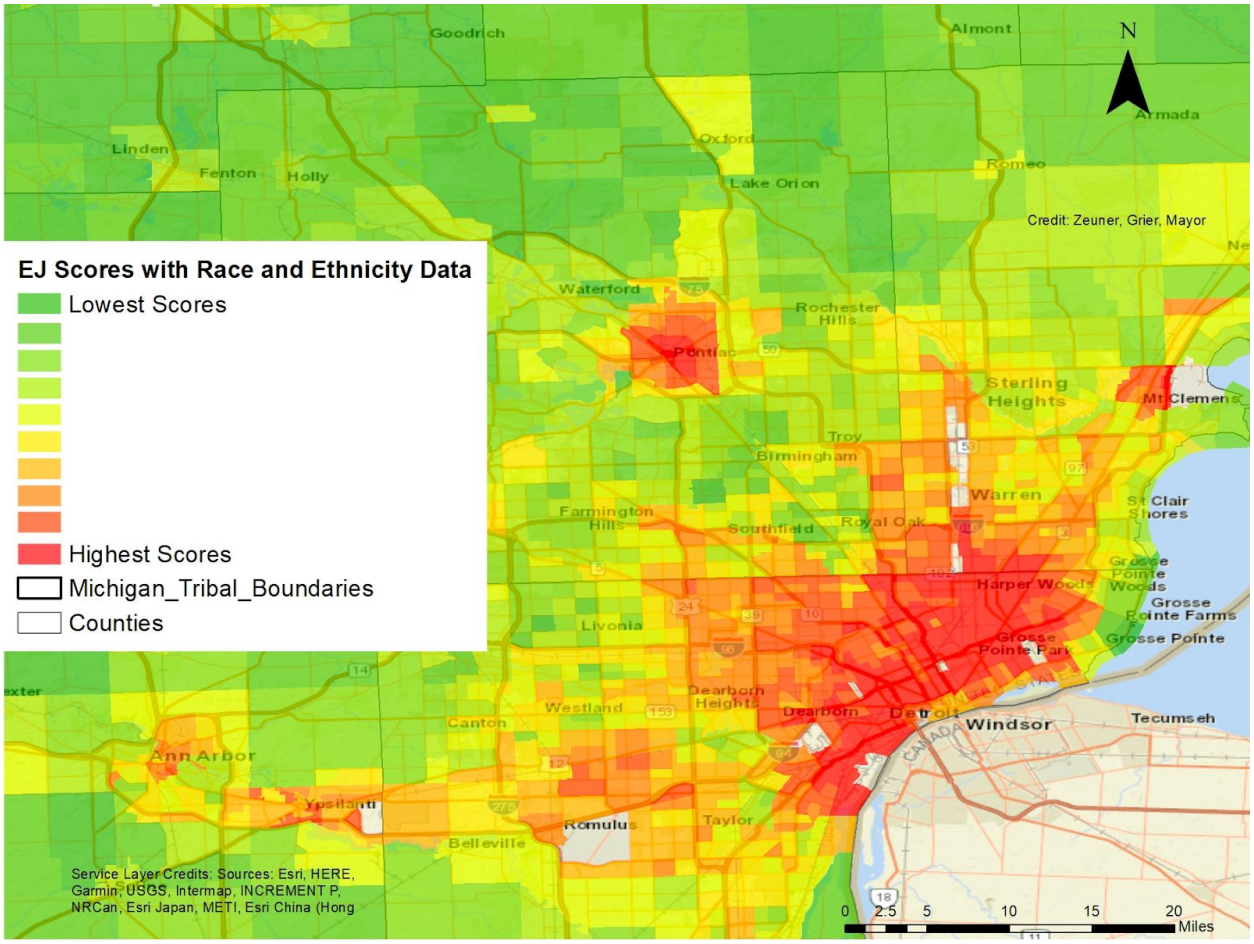


Figure 15a. Map showing Metropolitan Detroit census tracts ranked according to CalEPA's methodology (with racial and ethnic data).

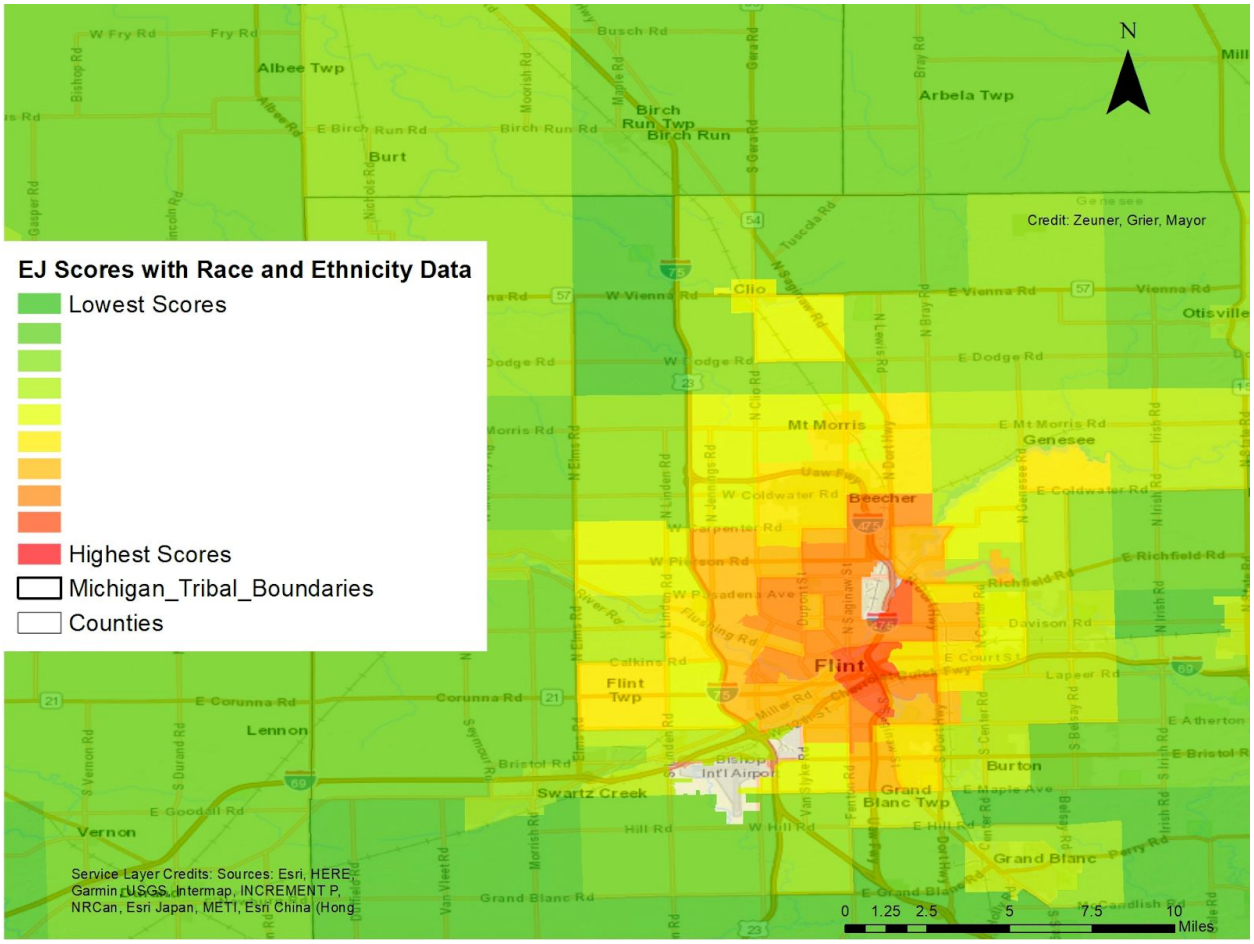


Figure 15b. Map showing Flint census tracts ranked according to CalEPA's methodology (with racial and ethnic data).

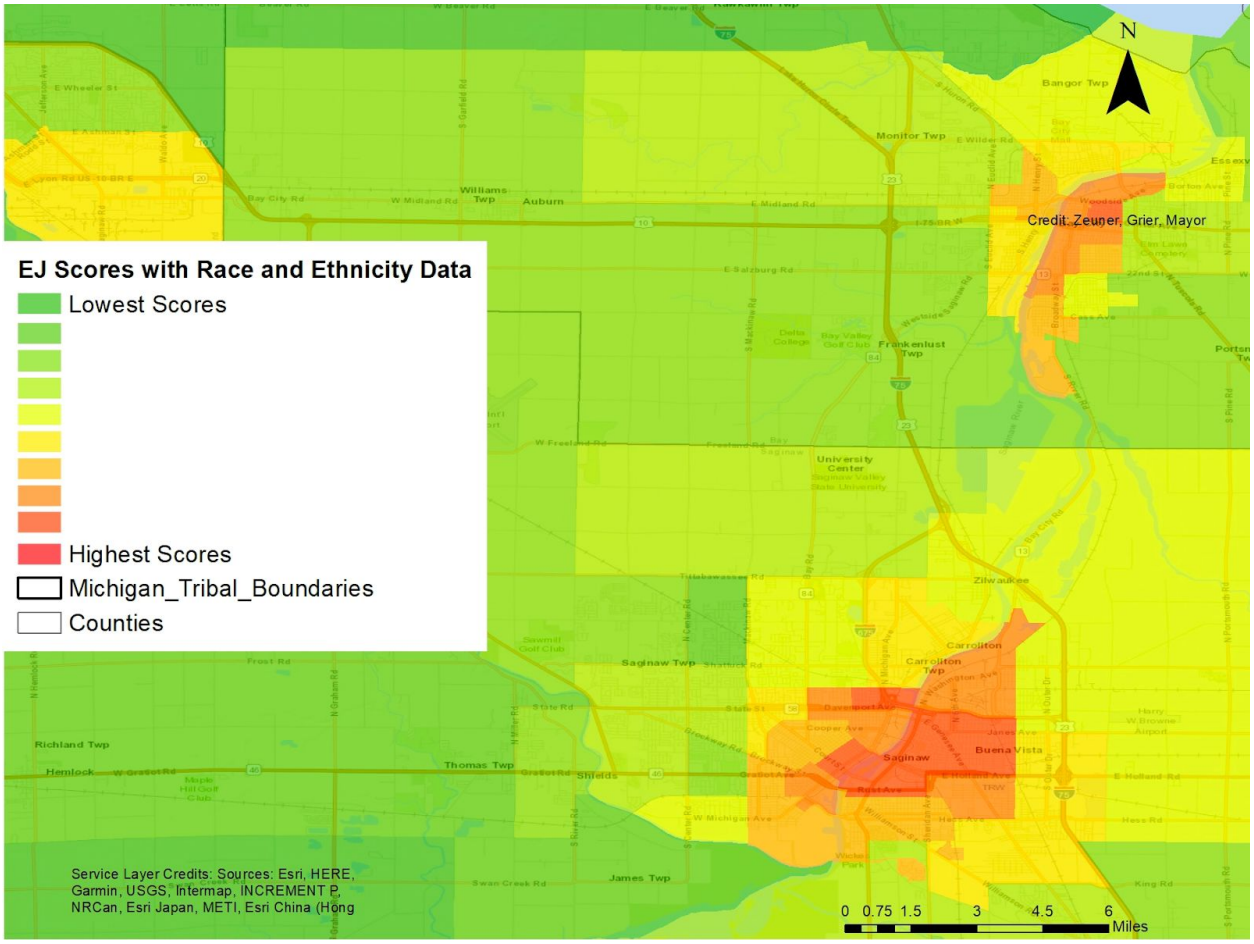


Figure 15c. Map showing Saginaw census tracts ranked according to CalEPA's methodology (with racial and ethnic data).

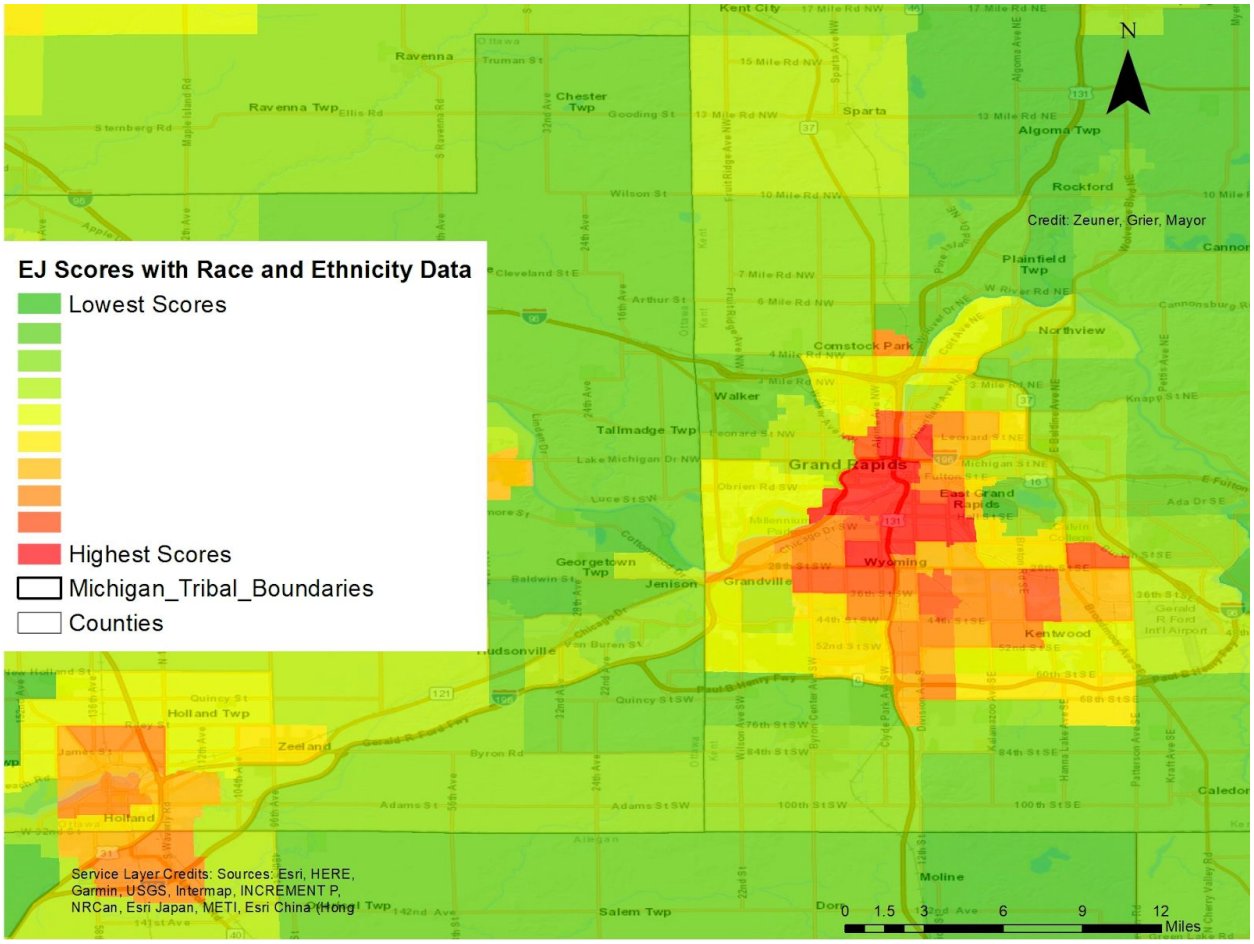


Figure 15d. Map showing Grand Rapids census tracts ranked according to CalEPA's methodology (with racial and ethnic data).

Rank	Tract	EJ Score	Percentile	County	NATA Diesel PM (µg/m3)	NATA Air Toxics Cancer Risk (unitless)	NATA Respiratory Hazard Index (unitless)	Traffic Proximity & Volume (avg. ann. daily traffic/m)
1	0039	93.9945	99.9%	KENT	1.231	46.802	2.233	4327.280
2	0002	91.9467	99.9%	KALAMAZOO	1.048	41.275	1.854	393.773
3	0003	90.1726	99.9%	KALAMAZOO	1.230	46.196	2.269	518.654
4	0038	89.5012	99.8%	KENT	1.047	46.560	2.195	1832.734
5	0040	87.7397	99.8%	KENT	0.859	41.223	1.869	2389.538
6	0036	87.6325	99.8%	KENT	1.043	48.300	2.392	918.025
7	0026	87.4281	99.7%	KENT	0.957	43.980	2.041	1554.536
8	5061	87.2077	99.7%	WAYNE	1.485	44.631	2.060	2345.817
9	5055	86.9241	99.7%	WAYNE	1.622	41.125	1.930	5852.551
10	5162	86.6946	99.6%	WAYNE	1.389	40.285	1.754	1706.873
11	0028	86.4647	99.6%	KENT	1.004	44.675	2.057	2732.171
12	5051	85.8678	99.5%	WAYNE	1.671	41.567	1.964	1352.940
13	5189	85.2947	99.5%	WAYNE	1.836	46.368	2.121	6060.611
14	5050	84.7682	99.5%	WAYNE	1.295	39.307	1.685	1083.724
15	0001	84.7631	99.4%	KALAMAZOO	0.928	40.652	1.880	611.122
16	5032	84.7490	99.4%	WAYNE	1.576	43.205	1.894	1469.199
17	5238	84.3339	99.4%	WAYNE	1.305	54.409	1.534	3034.322
18	0037	84.1566	99.3%	KENT	1.090	46.268	2.217	1110.566
19	2638	83.9774	99.3%	MACOMB	1.535	44.379	2.065	3397.491
20	5159	83.7271	99.3%	WAYNE	2.126	45.293	2.509	4970.509
21	5047	83.6454	99.2%	WAYNE	1.618	40.511	1.955	2775.179
22	5110	83.3282	99.2%	WAYNE	1.434	40.566	1.854	2414.282
23	0009	83.2441	99.1%	KALAMAZOO	1.213	43.795	2.081	620.993
24	5054	83.1436	99.1%	WAYNE	1.652	42.260	1.983	2045.796
25	5250	82.4909	99.1%	WAYNE	1.076	63.501	1.439	1732.571
26	5142	81.0785	99.0%	WAYNE	1.775	41.482	1.925	2463.292
27	5243	80.7583	99.0%	WAYNE	1.005	50.253	1.349	1931.653
28	2639	80.7419	99.0%	MACOMB	1.504	46.840	1.896	1156.880
				State Average for Indicators	0.764	31.789	1.361	687.837

Table 15. Michigan census tracts with environmental justice scores that fall in the top percentile (1%).

Rank	Tract	EJ Score	Percentile	County	Wastewater Discharge (Toxic Conc./km)	Superfund National Priority List Sites (#/5km)	Risk Management Plan Sites (#/5km)	Hazardous Waste Facilities (TSDFs) (#/5km)
1	0039	93.9945	99.9%	KENT	0.010	1.016	3.000	4.227
2	0002	91.9467	99.9%	KALAMAZOO	0.021	2.393	2.318	2.694
3	0003	90.1726	99.9%	KALAMAZOO	0.008	1.158	1.552	2.847
4	0038	89.5012	99.8%	KENT	0.004	0.889	2.133	3.848
5	0040	87.7397	99.8%	KENT	0.009	1.086	2.523	3.331
6	0036	87.6325	99.8%	KENT	0.002	0.587	1.586	4.235
7	0026	87.4281	99.7%	KENT	0.006	1.130	3.698	4.454
8	5061	87.2077	99.7%	WAYNE	0.000	0.085	5.000	2.859
9	5055	86.9241	99.7%	WAYNE	0.000	0.075	2.388	4.569
10	5162	86.6946	99.6%	WAYNE	0.000	0.056	0.854	4.923
11	0028	86.4647	99.6%	KENT	0.002	0.614	1.794	4.850
12	5051	85.8678	99.5%	WAYNE	0.000	0.083	3.360	2.800
13	5189	85.2947	99.5%	WAYNE	0.000	0.047	0.545	5.304
14	5050	84.7682	99.5%	WAYNE	0.000	0.084	2.887	2.975
15	0001	84.7631	99.4%	KALAMAZOO	0.014	2.466	1.779	2.396
16	5032	84.7490	99.4%	WAYNE	0.000	0.096	2.241	3.415
17	5238	84.3339	99.4%	WAYNE	0.343	0.042	2.925	5.451
18	0037	84.1566	99.3%	KENT	0.003	0.585	1.437	4.062
19	2638	83.9774	99.3%	MACOMB	0.000	0.057	3.623	4.099
20	5159	83.7271	99.3%	WAYNE	0.000	0.051	1.201	3.917
21	5047	83.6454	99.2%	WAYNE	0.000	0.071	1.675	3.358
22	5110	83.3282	99.2%	WAYNE	0.000	0.062	1.864	3.525
23	0009	83.2441	99.1%	KALAMAZOO	0.000	1.676	1.766	3.578
24	5054	83.1436	99.1%	WAYNE	0.000	0.077	1.459	1.918
25	5250	82.4909	99.1%	WAYNE	2.576	0.034	3.089	9.643
26	5142	81.0785	99.0%	WAYNE	0.000	0.062	1.183	3.460
27	5243	80.7583	99.0%	WAYNE	0.490	0.044	3.760	6.519
28	2639	80.7419	99.0%	MACOMB	0.000	0.098	3.132	4.333
				State Average for Indicators	0.178	0.128	0.545	0.872

Table 15. Michigan census tracts with environmental justice scores that fall in the top percentile (1%) (continued).

Rank	Tract	EJ Score	Percentile	County	Ozone (ppb)	PM 2.5 (µg/m3)	Lead Paint Indicator (% pre-1960 housing)	Percent Minority	Educational Attainment
1	0039	93.9945	99.9%	KENT	43.528	11.026	78.7%	91.9%	60.5%
2	0002	91.9467	99.9%	KALAMAZOO	44.772	11.338	78.1%	96.5%	-
3	0003	90.1726	99.9%	KALAMAZOO	44.777	11.360	69.0%	90.6%	27.0%
4	0038	89.5012	99.8%	KENT	43.523	11.028	77.5%	91.5%	55.6%
5	0040	87.7397	99.8%	KENT	43.584	11.073	76.9%	87.8%	48.2%
6	0036	87.6325	99.8%	KENT	43.449	11.030	64.6%	88.8%	40.1%
7	0026	87.4281	99.7%	KENT	43.468	11.003	69.0%	89.1%	46.3%
8	5061	87.2077	99.7%	WAYNE	44.182	11.003	93.1%	93.5%	31.8%
9	5055	86.9241	99.7%	WAYNE	44.019	11.027	90.2%	94.3%	23.2%
10	5162	86.6946	99.6%	WAYNE	43.696	11.072	90.1%	98.0%	-
11	0028	86.4647	99.6%	KENT	43.395	11.015	49.9%	84.8%	31.1%
12	5051	85.8678	99.5%	WAYNE	44.248	10.996	70.6%	93.9%	-
13	5189	85.2947	99.5%	WAYNE	43.494	11.085	-	98.1%	34.4%
14	5050	84.7682	99.5%	WAYNE	44.286	10.995	100.0%	100.0%	-
15	0001	84.7631	99.4%	KALAMAZOO	44.779	11.354	77.2%	80.4%	22.1%
16	5032	84.7490	99.4%	WAYNE	44.299	10.993	87.9%	92.0%	-
17	5238	84.3339	99.4%	WAYNE	42.800	11.152	90.2%	80.8%	35.1%
18	0037	84.1566	99.3%	KENT	43.470	11.031	86.2%	85.1%	27.5%
19	2638	83.9774	99.3%	MACOMB	44.185	11.004	79.7%	54.9%	24.2%
20	5159	83.7271	99.3%	WAYNE	43.862	11.057	88.3%	98.7%	17.9%
21	5047	83.6454	99.2%	WAYNE	43.949	11.038	92.5%	98.2%	23.7%
22	5110	83.3282	99.2%	WAYNE	43.953	11.046	73.5%	98.2%	39.2%
23	0009	83.2441	99.1%	KALAMAZOO	44.768	11.355	95.4%	44.8%	21.6%
24	5054	83.1436	99.1%	WAYNE	44.223	11.009	86.7%	96.3%	17.4%
25	5250	82.4909	99.1%	WAYNE	42.803	11.164	96.2%	60.3%	50.8%
26	5142	81.0785	99.0%	WAYNE	43.874	11.055	78.0%	99.9%	25.9%
27	5243	80.7583	99.0%	WAYNE	42.658	11.145	87.0%	78.9%	51.9%
28	2639	80.7419	99.0%	MACOMB	44.222	10.993	74.1%	40.6%	26.1%
				State Average for Indicators	42.764	10.198	42.5%	29.2%	10.9%

Table 15. Michigan census tracts with environmental justice scores that fall in the top percentile (1%) (continued). Note that "Educational Attainment" represents percent of population over age 25 without a high school diploma.

Rank	Tract	EJ Score	Percentile	County	Housing Burdened Low Income Households	Linguistic Isolation	Poverty*	Unemployment
1	0039	93.9945	99.9%	KENT	28.2%	46.5%	71.3%	15.9%
2	0002	91.9467	99.9%	KALAMAZOO	27.9%	-	64.3%	28.9%
3	0003	90.1726	99.9%	KALAMAZOO	23.9%	-	59.8%	24.8%
4	0038	89.5012	99.8%	KENT	21.4%	45.9%	75.3%	14.5%
5	0040	87.7397	99.8%	KENT	21.3%	40.4%	69.4%	14.4%
6	0036	87.6325	99.8%	KENT	28.7%	20.6%	67.7%	18.8%
7	0026	87.4281	99.7%	KENT	20.3%	34.1%	75.1%	13.5%
8	5061	87.2077	99.7%	WAYNE	36.6%	-	65.0%	23.5%
9	5055	86.9241	99.7%	WAYNE	38.8%	-	72.8%	29.5%
10	5162	86.6946	99.6%	WAYNE	33.8%	-	74.9%	34.9%
11	0028	86.4647	99.6%	KENT	23.4%	22.1%	81.5%	15.0%
12	5051	85.8678	99.5%	WAYNE	36.7%	-	73.2%	33.2%
13	5189	85.2947	99.5%	WAYNE	33.8%	-	76.3%	37.2%
14	5050	84.7682	99.5%	WAYNE	27.9%	-	69.4%	36.9%
15	0001	84.7631	99.4%	KALAMAZOO	20.1%	-	67.7%	14.9%
16	5032	84.7490	99.4%	WAYNE	27.8%	-	75.6%	19.5%
17	5238	84.3339	99.4%	WAYNE	29.7%	29.4%	72.0%	14.9%
18	0037	84.1566	99.3%	KENT	27.8%	-	58.5%	11.0%
19	2638	83.9774	99.3%	MACOMB	40.1%	-	69.2%	28.0%
20	5159	83.7271	99.3%	WAYNE	34.7%	-	71.9%	27.8%
21	5047	83.6454	99.2%	WAYNE	25.8%	-	65.7%	26.9%
22	5110	83.3282	99.2%	WAYNE	26.4%	-	70.6%	41.9%
23	0009	83.2441	99.1%	KALAMAZOO	18.4%	-	73.8%	11.6%
24	5054	83.1436	99.1%	WAYNE	27.6%	-	81.3%	35.2%
25	5250	82.4909	99.1%	WAYNE	40.5%	-	83.6%	20.9%
26	5142	81.0785	99.0%	WAYNE	27.4%	-	52.6%	28.1%
27	5243	80.7583	99.0%	WAYNE	22.9%	26.3%	59.8%	25.7%
28	2639	80.7419	99.0%	MACOMB	34.0%	-	57.5%	21.3%
				State Average for Indicators	14.3%	3.5%	30.8%	8.8%

Table 15. Michigan census tracts with environmental justice scores that fall in the top percentile (1%) (continued).
*The "Poverty" indicator is measured as percent of the population living below two times the federal poverty level.

Table 15 above lists those census tracts which scored in the top percentile of all Michigan census tracts when ranked by the environmental justice score. These census tracts had the highest environmental justice scores of any census tracts across the state. Based on CalEPA's ranking system, the team highlighted the top 25% of census tracts (n = 686). A full list of Michigan's census tracts scoring in the top 25% of environmental justice scores is provided in Appendix I: List of Top Quartile (25%) Census Tracts Ranked by EJ Score. Designating

those census tracts that are in the top quartile and/or have land area within a tribal community could be one way to identify communities in Michigan with the potential for environmental justice concerns. It should be noted that CalEPA designates the top 25% scoring tracts as "disadvantaged communities," not "environmental justice communities" as there is not only one tool or method that can be used to identify areas at risk for disproportionate environmental harm. Additionally, it is of note that CalEPA also designates tracts that score above the 95th percentile but do not have a "Population Characteristics" score as "disadvantaged." From this list, which includes the host county of each census tract, one can see that Kalamazoo, Kent, and Wayne counties host nearly all of the census tracts within the top percentile with the exception of the 19th and 28th highest scoring census tracts in Macomb county (in Southeastern Michigan).

In addition to ranking the census tracts by percentile and identifying the top quartile, the team examined the overall distribution of environmental justice scores across the state of Michigan. As shown below in Figure 16, one way to examine this distribution is by looking at the difference between the average environmental justice scores of each percentile (n = 28 census tracts per percentile) and the median environmental justice score for the state as a whole (23.314). Figure 16 shows that the bottom half of census tracts are closer to the median score while those census tracts scoring in the upper percentiles have average environmental justice scores that are further from the median score. In theory, an equitable distribution of environmental justice scores would be one in which there is little variation from the median across all percentiles (i.e. an almost horizontal line). One potential way to measure progress in environmental justice is by comparing the results of this graph over time. In a state of perfect social and environmental equality, the distance of every percentile's environmental justice score from the median environmental justice score would be zero, resulting in a flat line instead of a curve on this graph. Any movement towards a flat line away from such a steep curve would represent progress in the advancement of environmental justice. One possible quantitative measure would be to examine reductions in the standard deviation of the environmental justice score over time. In a perfectly equitable world, the standard deviation would be zero.

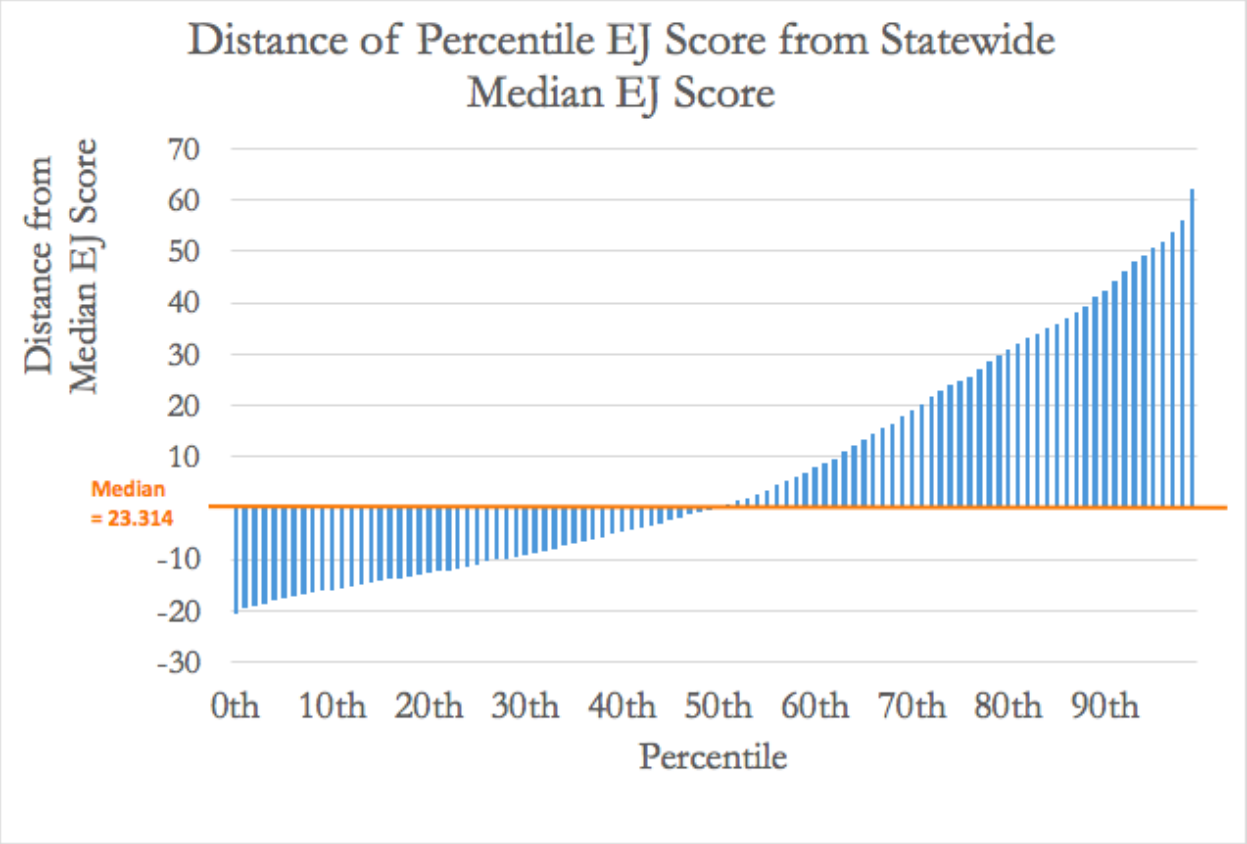


Figure 16. Graph showing the distance of the average environmental justice (EJ) score of each percentile from the statewide median EJ score.

When applying this method to quartiles, the trend that the lowest scoring census tracts are closer to the median score while the highest scoring census tracts are further from the median score remains. As shown in Figure 17, which shows the distance of quartile average distances from the median, the upper-most quartile (75%+) shows an almost 40 point difference from the state median environmental justice score. Figure 17 supports setting the threshold for identifying areas of concern at the top quartile based on the large distance between the scores of that group and the statewide median.

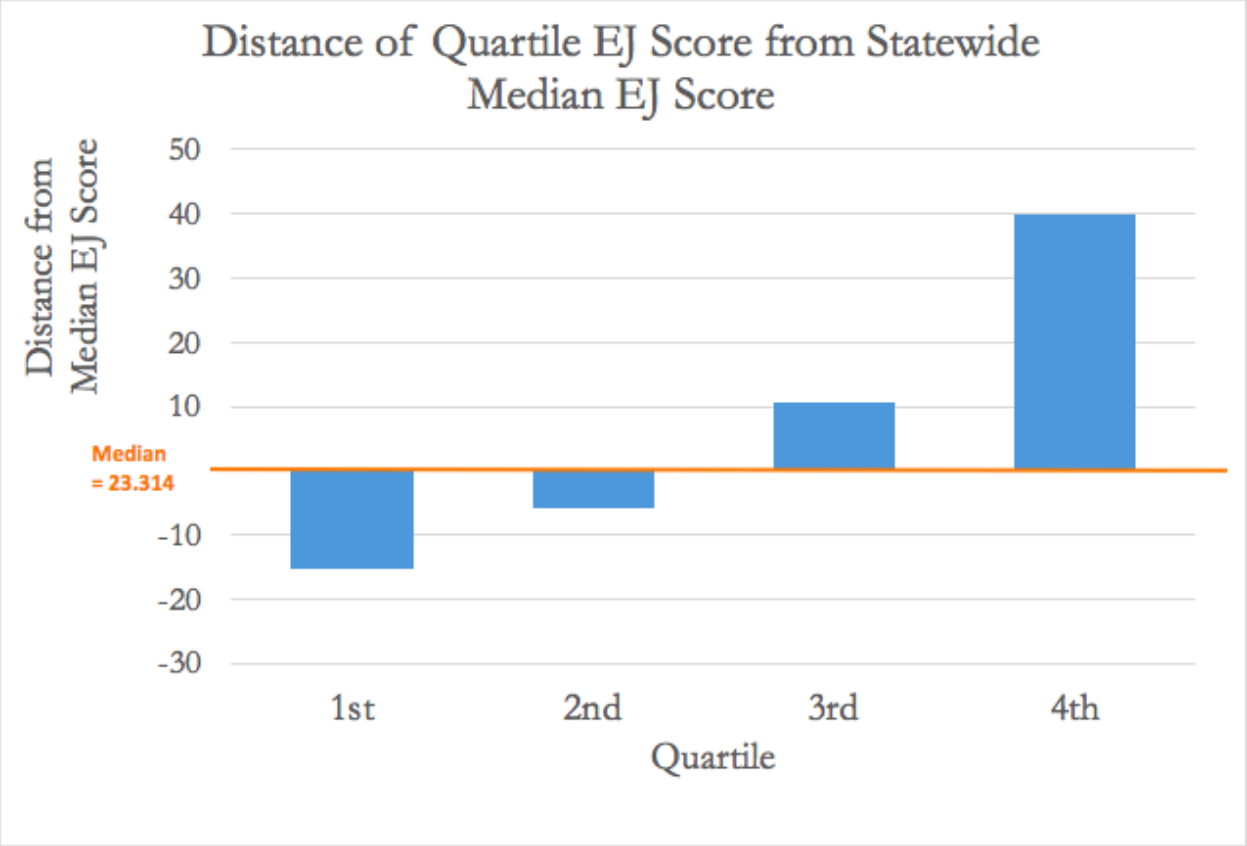


Figure 17. Chart showing the distance of the average environmental justice (EJ) score of each quartile from the statewide median EJ score.

6.2 Interactive Michigan Environmental Justice Screening Tool

In addition to providing a list of census tracts and their ranked environmental justice scores, the team sought to create a Michigan-specific environmental justice screening tool that could demonstrate the feasibility of creating such a tool for use in areas from policy to education to activism. The team used ArcGIS Online to create a user-friendly, dynamic mapping application that could be used to efficiently gauge the state of environmental justice across Michigan as well as in any specific community in the state. This tool could be used to identify and prioritize communities of significance to environmental justice in Michigan. A link to the tool can be found here: http://bit.ly/MI_EJscreen.

To provide an example of how the team's environmental justice screening tool could be used, a scenario relevant to environmental justice is presented. Imagine an industrial facility located in census tract 0039 in Kent County, the top-ranked tract in Michigan in terms of the calculated environmental justice score. Imagine the facility already emits toxic chemicals into the surrounding air and/or water and has applied for a permit through the MDEQ to increase its industrial activity. MDEQ officials charged with deciding the status of this facility's permit could enter the address of the facility into the screening tool, resulting in Figure 18 displayed below. Based on these results, officials could see that surrounding community members are already disproportionately burdened by environmental justice issues. Figures 18 and 19 show that residents of Kent County already rank in the top decile for Linguistic Isolation, Poverty, Percent Minority, Educational Attainment, Housing Burden, Proximity to Hazardous Waste Facilities, Proximity to Risk Management Plan (RMP) sites, Proximity to National Priority List (NPL) sites, Traffic Proximity and Volume, NATA Respiratory Hazard Index, and NATA Air Toxics Cancer Risk. These results could inform the agency's permitting decision pertaining this facility. In addition, this tool could inform state-level policy similar to policies of California and Minnesota wherein a threshold is set for identifying areas at risk for environmental justice issues. The quantitative ranking of Michigan census tracts provided in this tool could help the State distinguish which census tracts might need more resources and where remediation might need to be prioritized.

In addition to State government use, the tool could also be used by local governments and community members. In the case of the permit request in Kent County community members could enter the address of the facility into the tool and examine the environmental justice implications of the proposed expansion. The results could inform their public comment and advocacy efforts. Further, local governments, such as the City of Grand Rapids, could use the tool to inform zoning, permitting, and other land use decisions. For example, the City could exclude new industrial zoning in areas where a specific environmental justice threshold is passed.

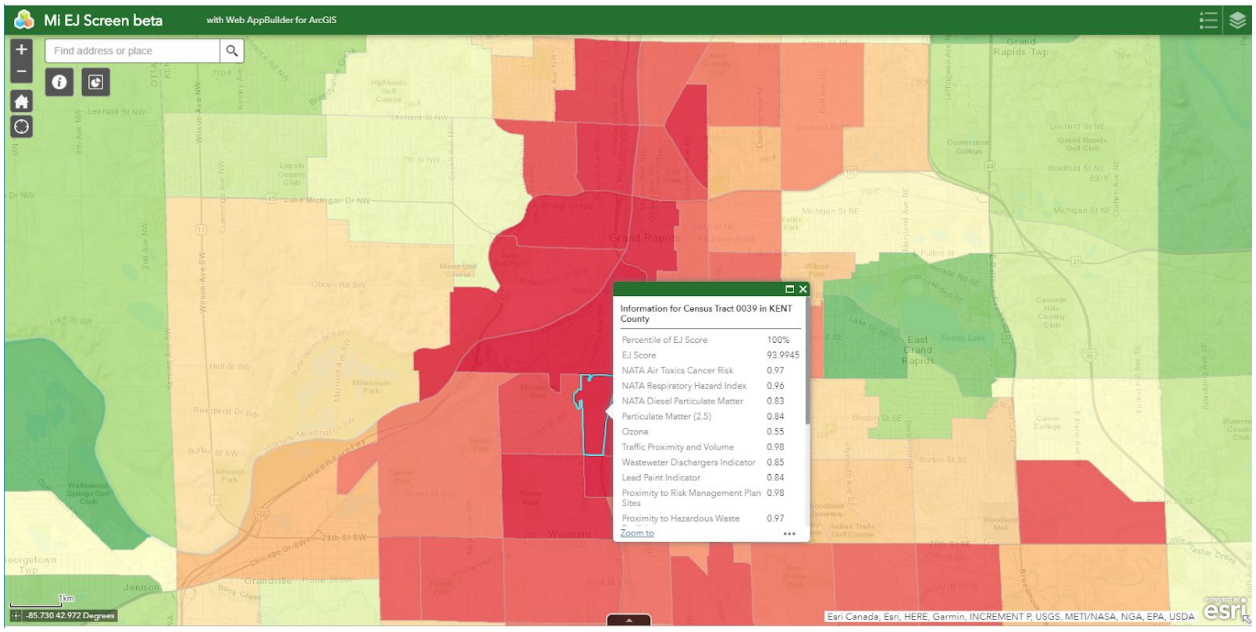


Figure 18. Screenshot of Kent County in the Michigan-specific environmental justice screening tool.

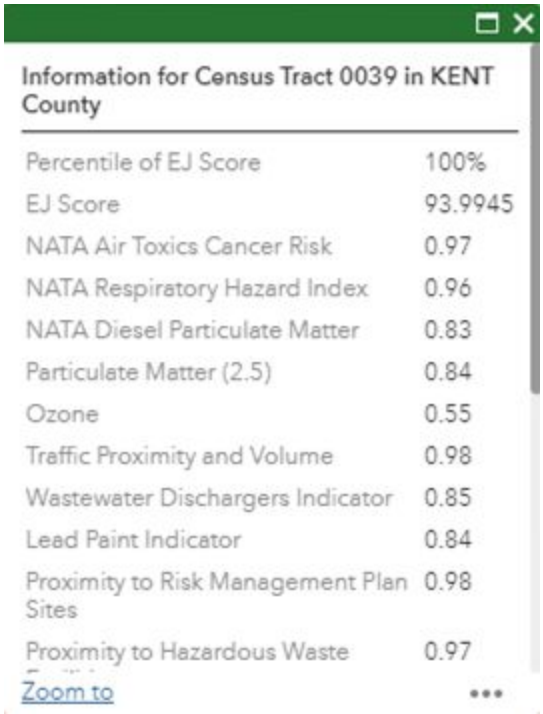


Figure 19. Ranking results for census tract 0039 in Kent County, MI.

Chapter 7. Discussion

In considering how the results of the qualitative and quantitative analyses synergistically assess the state of environmental justice in Michigan, the team came to three important conclusions. First, environmental injustice exists in Michigan. Second, developing a Michigan-specific environmental justice screening tool is feasible and desired by environmental justice leaders in the state. Third, any screening tool developed needs to have state-level policy support. Each of these implications is discussed below.

7.1 The State of Environmental Justice in Michigan

Qualitative and quantitative data analysis revealed that environmental goods and harms are inequitably distributed in the state of Michigan. An interview participant explicitly addressed the state of environmental justice in Michigan when they said, *"The state of environmental justice in those communities in Michigan at least is non-existent. If the question is how much environmental justice policy do they have access to in order to advance environmental justice and overcome environmental injustice, the answer is almost none."*

Based on interview data, environmental justice leaders perceived a statewide inequity of both access to environmental goods and protection from environmental harms that is based on both income and race. Examples of codes that spoke to inequitable access to environmental goods included clean water being provided to businesses and state employees but not residents during the Flint Water Crisis, funds being invested in cleaning up gentrified neighborhoods but disinvestment occurring in minority and low-income communities, and seeing more white than black business owners in cities. Examples of codes that spoke to inequitable protection from environmental harms included lack of consideration of indigenous populations' use of land, incinerators located in African American communities, and fracking companies working in low-income areas. Other codes that mentioned racial discrimination, such as impacts on cultural practices, lack of funding as a

barrier to advancing environmental justice; and impacts of privatization on access to resources also spoke to this disproportionate impact.

Codes from interview data provide a window into the lived experiences of those dealing with the impacts of exposure to environmental harms and limited access to environmental goods. Despite recent wins such as building coalitions across different communities, community strengths including resiliency and connection to place, and access to resources like the US EPA and academic partnerships, communities represented in the interview data are vulnerable to environmental impacts. Environmental risks and impacts, such as exposure to pollution in the air and water, are compounded by both socioeconomic impacts, such as unemployment. Additionally, health impacts, such as asthma, make communities increasingly susceptible to environmental harm. Vulnerability is exacerbated by instances of procedural injustice, such as decision-making by emergency managers instead of elected leaders; distributive injustice, such as income earned from energy production leaving communities; and corrective injustice, such as lack of compensation for damages. A long list of barriers, such as lack of transportation and feeling ignored by the government, hold back community members' efforts of improving the health of themselves and their communities.

Interview data shows that placing the burden on impacted communities to educate themselves about technical issues is unreasonable, as is the need for these communities to have to invest their already limited resources in advocating for their health and wellbeing. Participants expressed great frustration with the governing bodies they believed were elected to protect them. Participants expressed feeling neglected by these representatives who, in their eyes, should be advocating on behalf of their constituents. These perceptions of being ignored are consistent with current research that shows indifference or apathy towards people of color is a manifestation of racial and ethnic discrimination (Forman and Lewis 2006).

Another consideration is the additional burden that advocacy places on these communities in terms of increased stress. An emergent theme in the interview data showed that community advocates expressed a considerable amount of emotional and psychological impacts. Previous research has shown that stress increases

susceptibility to disease, which further compounds vulnerability for members of these communities (Schulz and Northridge 2004).

The spatial analysis of social and environmental indicators demonstrates the existence of environmental injustice in Michigan. The map created according to best practices of both CalEPA and MPCA shows hotspots where low-income communities and communities with greater concentration of racial and ethnic minorities experience greater exposure to environmental risk and impacts. The presence of these hotspots indicates an inequitable distribution of environmental harms. The observation that every census tract in Michigan does not experience the same amount of environmental risk and exposure, and the observation that there are such differences in environmental justice scores across the geography of the state point to the existence of environmental injustice in Michigan. While this point does not represent support for a uniform dispersion of the current pollution burden across the state, it does recognize that a non-uniform pattern of environmental harms that is related to spatial patterns of social characteristics is both relevant and meaningful to the discussion of environmental justice in Michigan. Furthermore, the analysis of how environmental justice scores were distributed across percentiles and quartiles provided additional support for the claim that environmental injustice exists in Michigan. The difference between the statewide median environmental justice score and the scores of the highest scoring tracts is larger than the difference between the statewide median and the lowest scoring tracts, indicating the high relative vulnerability of communities scoring above the state median.

Finally, this assessment provides a baseline of information that will need to be updated in the future and against which progress in advancing environmental justice can be measured. The Environmental Justice Work Group's ninth recommendation proposed that the State create an annual report that evaluates the "current state of environmental justice conditions" yearly to monitor progress (Environmental Justice Work Group 2018). The Michigan specific tool created by the research team could inform this process.

7.2 Development of a Michigan-Specific Environmental Justice Screening Tool

One way the State could advance environmental justice is by adopting, maintaining, and using a screening tool such as the one developed in this study with Michigan-specific data. Qualitative and quantitative data analysis spoke to the desire, possibility, and potential use of such a tool. There are multiple approaches the State of Michigan could take to develop a tool, two of which are represented by the screening tools used in Minnesota and California.

Story Map used by the MPCA displays which census tracts are low-income, minority, or belonging to a tribal nation to identify areas that might be of concern for environmental justice. While the MPCA does not explicitly measure and quantify environmental exposure, the What's in My Neighborhood tool does provide important environmental information on permits. These tools allow the State of Minnesota to address the potential for the social determinants of environmental injustice, and are linked to policy and decision-making. Identifying vulnerable census tracts based on income, race, and tribal status is a fundamental step the State of Michigan could take in developing an environmental justice screening tool. All three indicators would be relevant to Michigan.

The State of Michigan could look to CalEPA as an example for other aspects of developing an environmental justice screening tool. CalEnviroScreen used by CalEPA displays health data along with environmental and social data, unlike MPCA's tools or EJScreen. The State of California also collects its own environmental data to display on CalEnviroScreen; several state agencies worked with CalEPA to aggregate relevant data for use in the tool. The fact that CalEPA has access to data relevant to the environmental issues in the state and specifically collected by agencies at work in the state makes their screening tool more robust, thorough, and comprehensive than it would be without this state-specific data. By CalEPA collecting its own

raw data to be used in analysis of environmental justice, it avoids having to employ data aggregation methods, such as area-weighted apportionment used in this study. Similarly, the MDEQ should consider collecting relevant Michigan-specific data in house that can be used to analyze environmental justice at the appropriate geographic scale.

Further, in addition to displaying data relevant to health, environmental, and social indicators, CalEnviroScreen calculates an environmental justice score for every census tract in the state, which allows the comparison of census tracts in terms of cumulative impacts instead of just one indicator at a time. The State of California uses the data and results displayed in CalEnviroScreen to inform the development and implementation of its environmental justice policy. The State of Michigan could look to California in terms of collecting relevant, state-specific data pertinent to health and environmental exposure, and using this data to calculate an environmental justice score for every census tract in Michigan.

Adapting best practices from MPCA and CalEPA to develop a Michigan-specific environmental justice screening tool is possible, as demonstrated by the Michigan-specific screening tool developed by this research team. EJScreen presented a starting point for accessible, usable, and relevant data. The research team used these data, along with data from the US Census Bureau and HUD, to calculate an environmental justice score for every census tract so that cumulative impacts could be analyzed and considered instead of considering impacts one indicator or permit at a time. The State could adopt and maintain this screening tool and develop it according to additional community input. The State could also move towards prioritizing the collection and management of additional relevant data. Interagency cooperation in Michigan would facilitate the collection and use of such data.

The development of a Michigan-specific environmental justice screening tool that displays cumulative impacts is desired by environmental justice leaders in the state. One of the recommendations of the Governor's Environmental Justice Work Group was to "Develop an environmental justice screening tool in Michigan and include cumulative impacts in decision making processes" (Environmental Justice Work Group 2018). The

group that proposed this recommendation consisted of representatives of the environmental, business, environmental justice, tribal, and academic communities, along with the State and local governments. Interview data from this research also indicated that leaders supported the development of such a tool.

It is crucial for the State to consider cumulative impacts of environmental exposures. According to interview participants, many Michigan residents experience exposure to multiple environmental harms at one time - air pollution, contaminated water, limited access to food, etc. One interviewee addressed the importance of cumulative impacts when they said, *"And each one of those industries gets treated like it's operating in a vacuum when it's getting its permit. And so that's not how we live. We live the messy, cumulative total of all of that."* It is essential that the State address cumulative impacts that residents encounter at one time and over the span of their lives, as each exposure comes with its own risks and impacts.

The tool should also incorporate community and public input to ensure the indicators are relevant to community members and that community members are able to access, use, and make sense of the data. One interview participant spoke to the importance of ensuring the data displayed resonates with residents' experience when they said, *"I consider community input, and then see what the data has to say about it. Because the data is not as reliable as actually people, what people are dealing with."* In comparison, every iteration of CalEnviroScreen has incorporated public comment, and several indicators have been added based on input from community members (Faust et al. 2017). One potential way to incorporate community input could be following the recommendation from the Environmental Justice Work Group to create an external advisory committee that includes community representatives (Environmental Justice Work Group 2018). Furthermore, the tool should be available in languages that are prevalent in the state, such as Spanish and Arabic, which are spoken by over 270,000 people and 111,000 people in Michigan, respectively (US Census Bureau 2015).

In addition to a screening tool, environmental justice leaders expressed a desire for a formalized reporting mechanism to communicate emerging environmental issues directly to the State. This desire is consistent with another recommendation from the Environmental Justice Work Group, which suggested the

establishment of a "petition process" that residents could utilize to communicate and seek action for emerging health and environmental issues in residents' communities (Environmental Justice Work Group 2018). This reporting mechanism could be connected to or hosted on the same platform as the screening tool.

7.3 Policy Support

While there was clear support among interviewees for the development of an environmental justice screening tool, there also seemed to be agreement that a screening tool is not enough to advance environmental justice in the state. A tool would only be helpful in informing and advancing environmental justice if it was used to advise state-level policy that addressed the disproportionate impact of environmental harm and access to environmental goods that exists across the state. In comparison, both Minnesota and California use screening tools that are embedded within and supported by state-level policy. Michigan needs strong state-level environmental justice policy.

Based on qualitative data analysis, there are some environmental justice issues that are not easily captured by a screening tool, and policy must be created to address these components of residents' experiences. There is not a clear indicator that can capture many of the barriers gleaned from qualitative data analysis, such as lack of funding, lack of time, or feeling ignored by the government. State-level policies might be able to address these barriers better than a screening tool could. Additionally, having clear legal processes to follow would relieve the need for community members to advocate for specific developments one by one or ad hoc, diminishing the burden currently placed on individuals and environmental justice organizations in terms of investment of resources including money, time, and effort. Clear procedures could also diminish uncertainty regarding steps to take in the event of environmental harm, with the potential of relieving the added stress that community members experience as a result of experiencing procedural injustices. There is also the potential for a tool to leave out relevant impacts based on inaccessibility or unavailability of data. Having strong policy to

protect Michigan communities from disproportionate environmental exposure would be significant in case a screening tool could not capture aspects of the experience.

A clear direction for future research is analyzing the political process in Michigan as compared to other states in terms of supporting and advancing environmental justice. Future research could examine policies in other states that use environmental justice screening tools, and analyze how screening tools and state-level policy can work together to support communities. Future research could also focus on the expansion of collection and dissemination of health, environmental, and social data that are relevant to environmental justice. There were several datasets used by other states in their screening tools that the research team was unable to find or access for Michigan.

Chapter 8. Conclusion

The state of Michigan has a long history of manufacturing and industrial activity that has contributed to both the economic development of the state as well as to a culture of strong grassroots movements advocating for environmental quality along with state residents' health and wellbeing. Additionally, there is a long history of correlation between environmental harms and low-income, minority, and indigenous communities. The state of environmental justice in Michigan today can be traced back to these historical factors that shaped the culture and identity of different factions of society in Michigan. Through this research, the team provided evidence that environmental injustice is prevalent in Michigan. However, this study also provides evidence that significant steps can be taken to address environmental inequities.

Essential steps to advancing environmental justice include the adoption, maintenance, and use of a screening tool that identifies communities at risk based on cumulative impacts. This Michigan-specific screening tool could incorporate community input, and could be used to develop policies that assure the equal distribution of environmental goods and harms. The tool could also be revised and improved through the years, as data collection practices change and as the needs of Michigan constituents evolve. Another essential step includes creating a reporting mechanism that allows members of these communities to communicate emerging environmental justice issues through a simple, accessible, yet formal process directly to the State. This mechanism should be accompanied by consistent action and follow-up to correct the issues reported.

There are several limitations to this study. In terms of data collection, interviews were only conducted with thirty environmental justice leaders in Michigan. These perspectives could be supplemented with interviews from additional leaders and community members, along with governmental and industry representatives, to gain a more nuanced perspective on social, environmental, and health issues. Quantitative data collection was weighted toward air quality indicators due to the differences in data availability between air and water quality. This weighting toward air quality could be addressed through the incorporation of more

water quality indicators, and indicators that capture additional environmental issues. Further, quantitative data analysis is limited by the observation that many risks and impacts described by interviewees are not included in the indicators used in spatial analysis, such as indoor air quality, sea level rise, pipeline leaks, increased heat events, or access to green space among others. The presence or absence of indicators and types of indicators can skew the results of spatial and statistical analysis, making it imperative that risks and impacts identified by community members in all parts of the state are included in the tool in order avoid any geographical misrepresentations. Another need that was emphasized by community members but was not incorporated in the tool was a self-reporting mechanism. Future work could focus on adding a geo-tagging function to the tool which would allow for spatial self-reporting of issues relevant to environmental justice. Additionally, regular updating of the tool's data on an annual (or otherwise appropriate) basis was not addressed by the team.

Finally, during the course of this study, the University of Washington's Department of Environmental & Occupational Health Sciences developed a spatial analysis tool modeled after CalEnviroScreen but specific to the state of Washington in collaboration with Front and Centered, a coalition of community organizations; the Washington State Department of Health; the Washington State Department of Ecology; and the Puget Sound Clean Air Agency. This Washington Environmental Health Disparities Map (https://fortress.wa.gov/doh/wtn/WTNIBL/) is one of the newest tools to emerge in environmental justice (University of Washington 2019a). The Washington State Department of Health hosts the tool, which was released after a two year process during which developers gathered input from community groups through eleven listening sessions (University of Washington 2019b). This report does not analyze Washington's approach and methodology, but it is worth noting that this tool is the latest development in state-level spatial analysis of environmental justice.

Additional research should be conducted to analyze how to better integrate policies and tools for the advancement of environmental justice in the state of Michigan. Researchers could examine the approaches of other states that have taken steps to integrate environmental justice considerations in their agencies' operations,

as well as examining any further guidance from the Environmental Protection Agency. Additionally, future studies could build off of this one, incorporating supplemental statistical and other forms of analyses to further characterize the state of environmental justice in Michigan. Such analyses could explore how specific indicators differ between the top twenty five and bottom seventy five percent of census tracts or how sensitive the scoring system is to changes in specific variables. These analyses could provide further nuance into this baseline assessment of environmental justice in the state.

In summary, this report provides a baseline of information about the state of environmental justice in Michigan that can be used to measure progress, or lack thereof, in the future. The report also provides different approaches to screen for environmental justice vulnerabilities, delineating the trade offs between the different approaches. In addition, based on the concerns of leaders interviewed for this project, and their emphasis on cumulative impacts and the intersection of environmental, socioeconomic, and health impacts, the team utilized a combined approach to create a Michigan-specific screening tool that could be adopted, revised based on community input and the availability of additional data, maintained, and utilized to screen for and address environmental injustice in the state.

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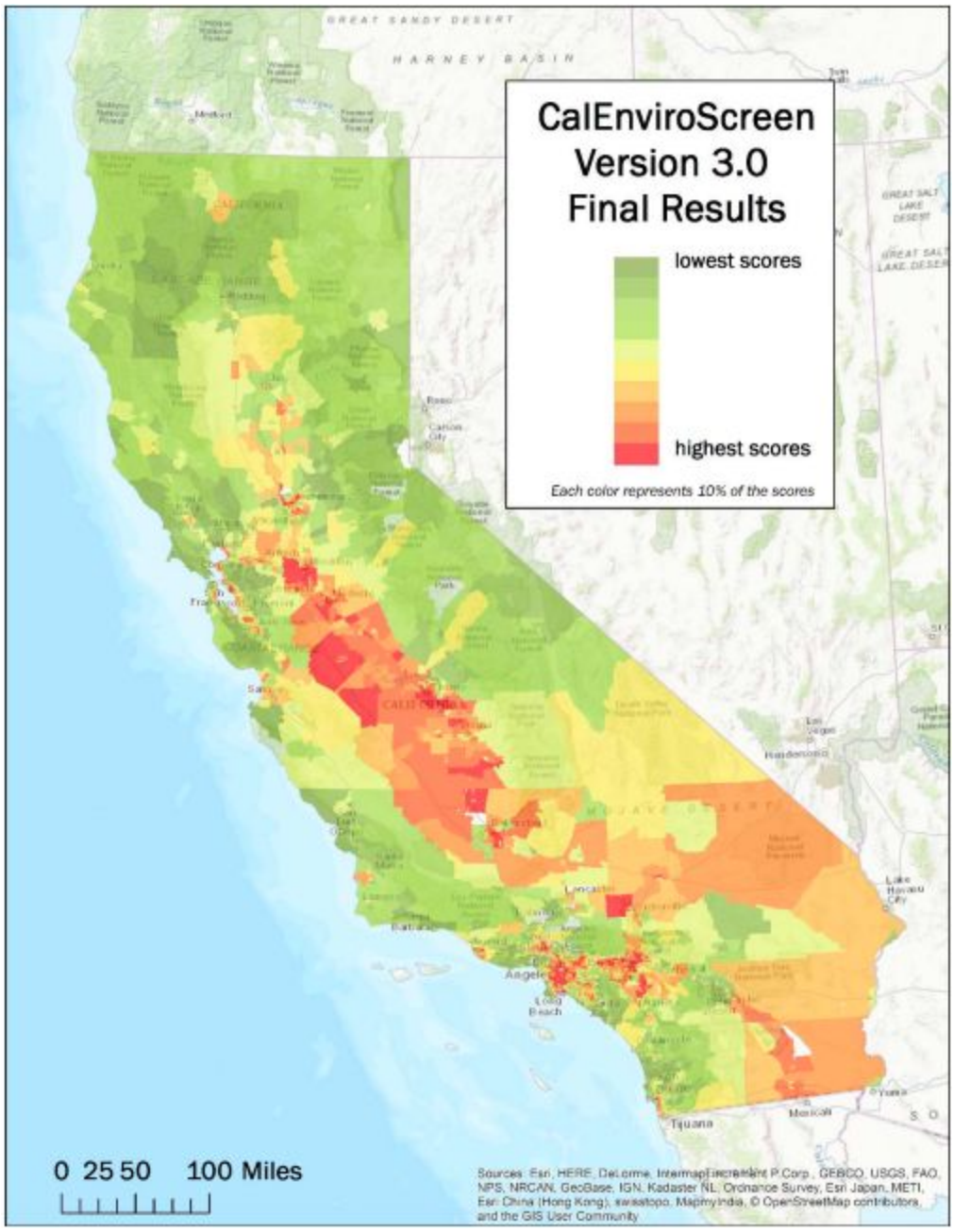
Appendices

Appendix A: CalEnviroScreen Results



Appendix B: Interview Guide

Interviewer:

Good morning/afternoon Ms./Mr. _____, we are a group of University of Michigan students working with the Michigan Environmental Justice Coalition to assess the state of environmental justice in Michigan. In order to conduct this assessment, we will be reviewing what kind of data are currently being collected in the State of Michigan in comparison to other states that have comprehensive tools to conduct environmental justice screenings or assessments. We also want to make sure that the environmental justice issues that are important for the affected communities are incorporated into our assessment.

As someone involved in environmental justice issues, we would like to ask you some questions about the environmental justice issues taking place in the community you live in, work in, advocate for, or know about. Your input about current issues and the experiences of community members will help us to incorporate more complete information into our assessment, or to point out the limitations of the assessment and provide recommendations for future data collection practices.

The interview will take approximately 30 minutes to an hour. Participation in the study will be over after the interview. However, you may be contacted within six months of the interview for a follow-up.

If you do not feel comfortable answering any of the questions you can let us know and we will move on to other questions. You may also end the interview at any point, for any reason. The information we collect with this and other interviews will be used to assist the evaluation of environmental justice in Michigan.

The interview requires consenting to audio recording. The interviews will be digitally recorded using software on a digital audio recording device that will be used solely for this study. The digital audio recordings will be transcribed within 72 hours of the interview and then immediately destroyed. All recordings will have your unique identifying code on all documents and data files after signing consent on this document.

We will keep your information confidential by securely storing all physical and digital copies of study materials. All hard copies of study data will be converted to digital PDF's, protected by password and encryption, only accessible to the researchers and our faculty advisor. The code key will be stored as a password-protected, encrypted digital file on my password-protected, personal computer.

Only information that is void of all direct identifiers will be shared, this may include direct quotes from this interview. Please do not provide personal information that could be used to identify you, or a relative, during this interview. This may include landmarks, names, and other personally specific information. While all attempts will be made to remove such information from the transcribed files, there is a risk that your identity could be determined from your responses. On a related note, please try to refrain from stating information that could be used to identify friends, family members, or other third parties as this puts those individuals at risk of breaching confidentiality.

Raw digital copies of audio recordings will never be sent to outside researchers. The results of this research may be published or used for teaching or other educational outlets, like academic presentations. Again, identifiable information will not be used for these purposes. If you would like a copy of the finished research, please let us know and this can be made available to you at no cost.

We would also like to store some of the information from this study for future use related to environmental justice in the State of Michigan. The information to be stored for future use includes only the transcribed audio, or manually-typed records from study interviews. This information will be labeled with a code and will not include your name or direct identifiers. This information will be stored in a password-protected or locked file.

Before we move on, do you have any questions?

After answering questions, if applicable

Now we are ready to ask for your consent to participate in this interview.

We will turn on the audio recording device to record your response to consent in participation of this study. Is this okay?

Turn on audio recording device after receiving confirmatory response

If you would like to participate in this study, are over the age of 18 years old, and understand all the information that has been explained to you today, will you please state your name, today's date, and the following sentence:

"I understand the information that has been presented to me and I consent to participating in this study."

record participant

We appreciate your participation and patience with this important process very much. Let's move on to the interview.

Ice breaker

1. How did you become involved in Environmental Justice?
2. Can you tell me if you currently live or work in a community in Michigan that is affected by environmental justice issues?

<u>If participant lives or works in an affected community:</u>

Getting to know/ gaining trust:

1. How long have you lived/worked in your community?

2. Tell me about family or friends that live/work in this community?
3. Besides residing/working here, tell me about other things that you do or experience in your community?

Positive aspects of the community:

4. Describe some things you like about your community?
5. What about things in your community that others seem to like?

Challenges in the community:

6. What are some of things you wish were different in your community?
    a. Walk me through your most recent challenge?
7. Do you know of other people that face the same or similar challenges?

Impacts of the challenges:

8. What are some ways these challenges affect your day to day life?
9. What resources are you aware of that could help you or others with these issues?

Advocacy tools:

10. Tell me about any information or tools that you have used to advocate for your community.
    a. What are they?
    b. How have you used them?

11. Are you aware of and familiar with the 33 recommendations of the Governor's EJ Work Group Report released this past March? Yes or no?

    a. One of the recommendations from the report was to:

    "2. Develop an environmental justice screening tool in Michigan and include cumulative impacts in decision making processes"

    This tool would be similar to EPA's EJScreen and California's CalEnviroScreen that gather information about environmental and social indicators that may show which communities might be at risk of disproportionate environmental impacts.

    What are your thoughts on this recommendation?

12. Have you used a tool like EPA's EJScreen to find out about environmental issues in your community?
    a. If yes:
        i. How recently? How frequently? *If not recently or frequently go to b*

ii. Tell me about a recent time when you used it. What impacts did it help you identify?
iii. Earlier in the interview you mentioned some of the challenges you experience in your community. How well do you think the tool is able to capture those challenges?
iv. If you worked for the EPA and had the power to change this tool, what would you change/add/subtract?

b. If no, not recently, or not frequently:
i. Are there any reasons that have prevented you to use this tool?

13. Is there a way for community members to report an issue related to environmental justice?
    a. To whom would they report?
    b. What are your thoughts on this process?

14. Are there any issues that you think are important for our study that I have not asked you about?

15. Can you tell me if you know of other EJ advocates that you think could contribute to our study?
    a. If yes. Can you provide their names and contact information?

<u>If participant does not live or work in an affected community, but is a professional, scholar or community activists involved in either capacity in Environmental Justice in Michigan.</u>

Getting to know/ gaining trust:

1. How long have you been involved in environmental justice?
2. Tell me about some common or salient issues people experience in EJ communities in Michigan?

Positive aspects of EJ communities or the State:

3. What is going well in terms of environmental justice in Michigan?
    a. Have there been any recent wins?

EJ Challenges:

4. What are some of the challenges Michigan residents face because of living/working in communities affected by environmental justice issues?
    a. Walk me through a recent challenge that you may have helped with or learned about?
5. Do you know of other communities or areas in Michigan that face the same or similar challenges?

Impacts of the challenges:

6. What are some ways these challenges affect the day to day lives of residents of affected communities?
7. What resources are you aware of that could help Michigan residents with these challenges?

Advocacy tools:

8. Tell me about any information or tools that you have used to advocate for those communities.
    a. What are they?
    b. How have you used them?

9. Are you aware of and familiar with the 33 recommendations of the Governor's EJ Work Group Report released this past March? Yes or no?

    a. One of the recommendations from the report was to:

    "2. Develop an environmental justice screening tool in Michigan and include cumulative impacts in decision making processes"

    This tool would be similar to EPA's EJScreen and California's CalEnviroScreen that gather information about environmental and social indicators that may show which communities might be at risk of disproportionate environmental impacts.

    What are your thoughts on this recommendation?

10. Have you used a tool like EPA's EJScreen to find out about environmental issues in those communities?
    a. If yes:
        i. How recently? How frequently? *If not recently or frequently go to b*
        ii. Tell me about a recent time when you used it. What impacts did it help you identify?
        iii. Earlier in the interview you mentioned some of the challenges people experience in EJ communities. How well do you think the tool is able to capture those challenges?
        iv. If you worked for the EPA and had the power to change this tool, what would you change/add/subtract?

    b. If no, not recently, or not frequently:
        i. Are there any reasons that have prevented you to use this tool?

11. Is there a way for community members to report an issue related to environmental justice?
    a. To whom would they report?
    b. What are your thoughts on this process?
12. Are there any issues that you think are important for our study that I have not asked you about?

13. Can you tell me if you know of other EJ advocates that you think could contribute to our study?
    a. If yes. Can you provide their names and contact information?

Appendix C: Word Frequency Chart

Word	Length	Count	Weighted Percentage	Similar Words
people	6	1011	1.75%	people, peoples
think	5	795	1.37%	think, thinking, thinks
community	9	730	1.26%	communities, communities', community
knowing	7	636	1.10%	know, knowing, knows
just	4	593	1.02%	just
works	5	515	0.89%	work, worked, working, works
environmentally	15	493	0.85%	environmental, environmentalism, environmentally
get	3	459	0.79%	get, gets, getting
ones	4	458	0.79%	one, ones
lot	3	455	0.79%	lot, lots
issues	6	445	0.77%	issue, issued, issues
going	5	369	0.64%	going
wells	5	365	0.63%	well, wells
justice	7	363	0.63%	justice, justices
waters	6	337	0.58%	water, watered, waters

detroit	7	296	0.51%	detroit, detroiter, detroiters
now	3	289	0.50%	now
coming	6	282	0.49%	come, comes, coming
means	5	261	0.45%	mean, meaning, means
right	5	256	0.44%	right, rightly, rights
city	4	254	0.44%	cities, city
states	6	252	0.44%	state, states, stating
michigan	8	251	0.43%	michigan
using	5	248	0.43%	use, used, useful, usefulness, uses, using
times	5	239	0.41%	time, times, timing
want	4	237	0.41%	want, wanted, wanting, wants
look	4	234	0.40%	look, looked, looking, looks
living	6	231	0.40%	live, lived, lives, living
trying	6	230	0.40%	tri, tried, try, trying
talk	4	230	0.40%	talk, talked, talking, talks
needs	5	220	0.38%	need, needed, needs
seeing	6	220	0.38%	see, seeing, sees
kinds	5	217	0.37%	kind, kinds

health	6	210	0.36%	health
ways	4	209	0.36%	way, ways
years	5	206	0.36%	year, yearly, years
making	6	191	0.33%	make, makes, making
impact	6	190	0.33%	impact, impacted, impactful, impacting, impacts
call	4	187	0.32%	call, called, calling, calls
thing	5	187	0.32%	thing
area	4	186	0.32%	area, areas
parts	5	183	0.32%	part, partly, parts
organizing	10	182	0.31%	organ, organic, organics, organization, organizations, organize, organized, organizer, organizers, organizing
good	4	172	0.30%	good
tools	5	171	0.30%	tool, tools
happening	9	168	0.29%	happen, happened, happening, happenings, happens
group	5	168	0.29%	group, groups
helps	5	167	0.29%	help, helped, helpful, helping, helps

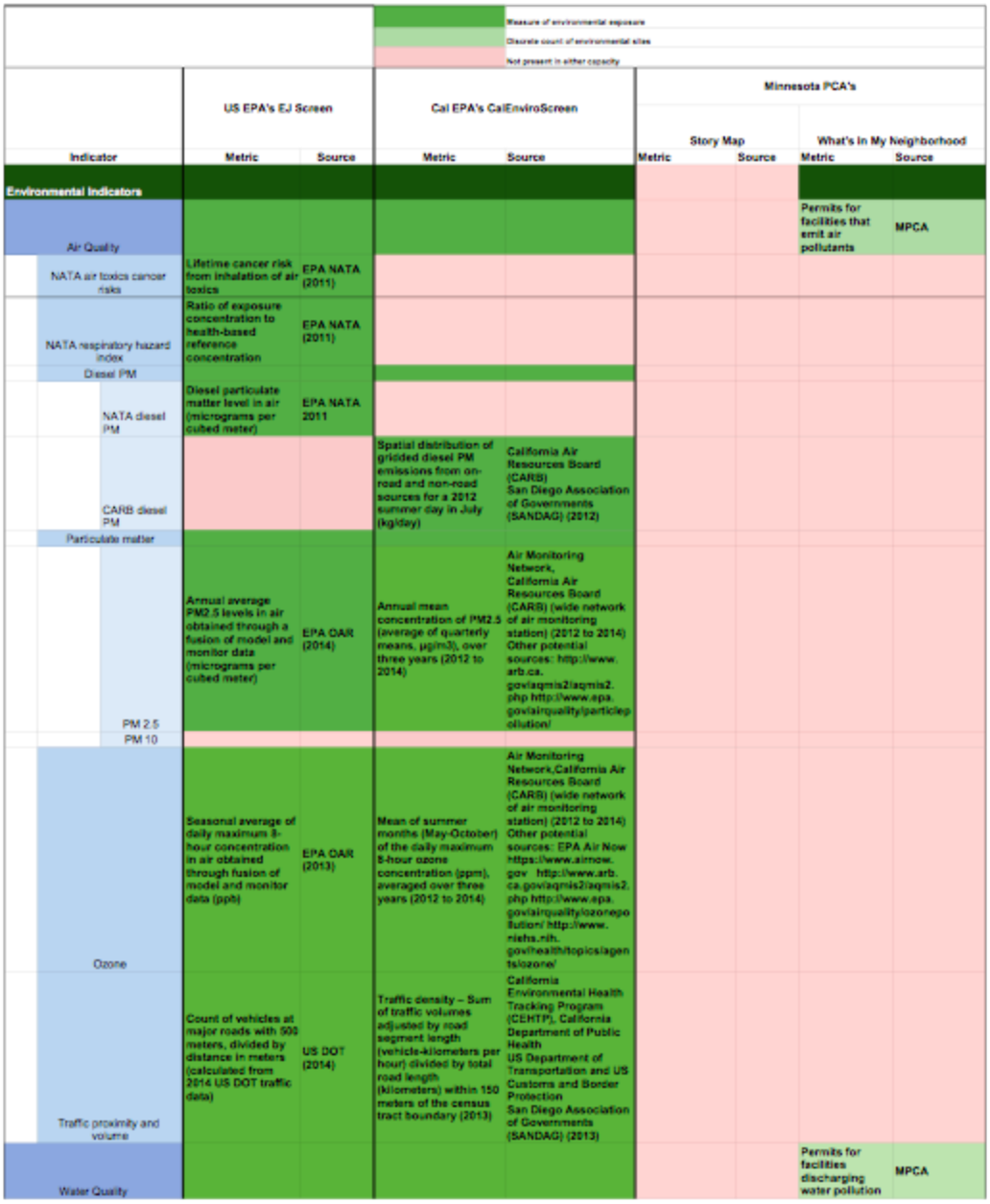
air	3	164	0.28%	air
information	11	156	0.27%	inform, informal, informally, information, informational, informed, informing
differently	11	154	0.27%	differ, difference, differences, different, differently, differing
around	6	149	0.26%	around
still	5	136	0.23%	still
taking	6	136	0.23%	take, takes, taking
public	6	134	0.23%	public, publication, publications, publicity, publicly
started	7	132	0.23%	start, started, starting, starts
problem	7	131	0.23%	problem, problems
level	5	129	0.22%	level, levels
pollution	9	128	0.22%	pollutant, pollutants, polluted, polluters, polluting, pollution
food	4	128	0.22%	food, foods
neighborhood	12	124	0.21%	neighborhood, neighborhoods
flint	5	123	0.21%	flint

done	4	117	0.20%	done
industry	8	115	0.20%	industrial, industrialized, industries, industry
data	4	115	0.20%	data
meetings	8	114	0.20%	meet, meeting, meetings, meets
able	4	114	0.20%	able
places	6	113	0.20%	place, placed, places, placing
always	6	113	0.20%	always
quality	7	113	0.20%	quality
change	6	113	0.20%	change, changed, changes, changing
permit	6	111	0.19%	permit, permits, permitted, permitting
resources	9	109	0.19%	resource, resources
understand	10	106	0.18%	understand, understandable, understanding, understands
terms	5	106	0.18%	term, terms
involves	8	105	0.18%	involve, involved, involvement, involves, involving
accessible	10	103	0.18%	'access', access, accessed, accessibility, accessible

big	3	103	0.18%	big
dearborn	8	103	0.18%	dearborn
day	3	99	0.17%	day, days
certain	7	98	0.17%	certain, certainly
challenge	9	97	0.17%	challenge, challenged, challenges, challenging
feel	4	96	0.17%	feel, feeling, feelings, feels
lead	4	96	0.17%	lead, leading, leads
money	5	96	0.17%	money
question	8	96	0.17%	question, questionable, questioning, questions
report	6	96	0.17%	report, reportable, reported, reporter, reporting, reports
school	6	96	0.17%	school, schools
move	4	92	0.16%	move, moved, moving
sort	4	91	0.16%	sort, sorts
funds	5	90	0.16%	fund, funded, funding, funds
homes	5	89	0.15%	home, homes
another	7	87	0.15%	another
greatly	7	87	0.15%	great, greatly
river	5	86	0.15%	river, rivers

new	3	84	0.15%	new
housing	7	84	0.15%	house, housed, houses, housing
concerns	8	83	0.14%	concern, concerned, concerns
hear	4	82	0.14%	hear, hearing, hearings, hears
person	6	82	0.14%	person, personal, personally

Appendix D: Indicator Comparison Matrix



				Measure of environmental exposure					
				Discrete count of environmental sites					
				Not present in either capacity					
		US EPA's EJ Screen		Cal EPA's CalEnviroScreen		Minnesota PCA's			
						Story Map		What's In My Neighborhood	
Indicator		Metric	Source	Metric	Source	Metric	Source	Metric	Source
Environmental Indicators									
Air Quality								Permits for facilities that emit air pollutants	MPCA
	NATA air toxics cancer risks	Lifetime cancer risk from inhalation of air toxics	EPA NATA (2011)						
	NATA respiratory hazard index	Ratio of exposure concentration to health-based reference concentration	EPA NATA (2011)						
	Diesel PM								
	NATA diesel PM	Diesel particulate matter level in air (micrograms per cubed meter)	EPA NATA 2011						
	CARB diesel PM			Spatial distribution of gridded diesel PM emissions from on-road and non-road sources for a 2012 summer day in July (kg/day)	California Air Resources Board (CARB) San Diego Association of Governments (SANDAG) (2012)				
	Particulate matter								
	PM 2.5	Annual average PM2.5 levels in air obtained through a fusion of model and monitor data (micrograms per cubed meter)	EPA OAR (2014)	Annual mean concentration of PM2.5 (average of quarterly means, µg/m3), over three years (2012 to 2014)	Air Monitoring Network, California Air Resources Board (CARB) (wide network of air monitoring station) (2012 to 2014) Other potential sources: http://www.arb.ca.gov/aqmis2/aqmis2.php http://www.epa.gov/airquality/particlepollution/				
	PM 10								
	Ozone	Seasonal average of daily maximum 8-hour concentration in air obtained through fusion of model and monitor data (ppb)	EPA OAR (2013)	Mean of summer months (May-October) of the daily maximum 8-hour ozone concentration (ppm), averaged over three years (2012 to 2014)	Air Monitoring Network,California Air Resources Board (CARB) (wide network of air monitoring station) (2012 to 2014) Other potential sources: EPA Air Now https://www.airnow.gov http://www.arb.ca.gov/aqmis2/aqmis2.php http://www.epa.gov/airquality/ozonepollution/ http://www.niehs.nih.gov/health/topics/agents/ozone/				
	Traffic proximity and volume	Count of vehicles at major roads with 500 meters, divided by distance in meters (calculated from 2014 US DOT traffic data)	US DOT (2014)	Traffic density – Sum of traffic volumes adjusted by road segment length (vehicle-kilometers per hour) divided by total road length (kilometers) within 150 meters of the census tract boundary (2013)	California Environmental Health Tracking Program (CEHTP), California Department of Public Health US Department of Transportation and US Customs and Border Protection San Diego Association of Governments (SANDAG) (2013)				
	Water Quality							Permits for facilities discharging water pollution	MPCA

	Non-Potable Water Quality			Summed number of pollutants across all water bodies designated as impaired within the area (2012)	303(d) List of Impaired Water Bodies, State Water Resources Control Board (SWRCB) (2012) http://www.waterboards.ca.gov/rwqcb2/water_issues/programs/TMDLs/303dlist.shtml			Permits for facilities discharging water pollution	MPCA
	Surface Water Bodies							Permits for facilities discharging water pollution	MPCA
	Groundwater Sources							Permits for facilities discharging water pollution	MPCA
	Drinking Water Quality			Drinking water contaminant index for selected contaminants	Drinking Water Systems Geographic Reporting Tool, California Environmental Health Tracking Program, California Department of Public Health (CDPH) http://ceht p.org/page/water/water_system_map_viewer Public Water System Location Data Permitting/Inspections/Compliance/Monitoring/Enforcement (PICME) database, California Department of Public Health Safe Drinking Water Information System, US Environmental Protection Agency http://water.epa.gov/scitech/datait/databases/drink/sdwisfed/index.cfm Water Quality Monitoring Database, CDPH http://www.cdph.ca.gov/certlic/drinkingwater/Pages/EDTlibrary.aspx Domestic Well Project, Groundwater Ambient Monitoring and Assessment (GAMA) Program, State Water Resources Control Board http://www.waterboards.ca.gov/water_issues/programs/gama/domestic_well.shtml Priority Basin Project, GAMA Program, State Water Resources Control Board and US Geological Survey http://www.waterboards.ca.gov/water_issues/programs/gama/priority_basin_projects.shtml (2005-2013)			Information on Community Water Systems	MPCA
	Wastewater Dischargers Indicator	toxicity-weighted stream concentrations at stream segments within 500 meters, divided by distance in km (calculated from RSEI modeled toxicity-weighted stream concentrations)	EPA (2017)					Permits for facilities discharging water pollution	MPCA
Pollution								Permits for polluting facilities and those facilities that treat, store, or dispose of hazardous waste	MPCA
	Sub-Surface Sewage Treatment Systems							Permitting for SSWT's (septic systems) which must be registered with MPCA	MPCA

Hazardous Waste Facilities								Permits for hazardous waste facilities (including RCRA)	MPCA
	Proximity to Risk Management Plan (RMP) sites	Count of RMP facilities (facilities with a chemical accident management plan) within 5 km (or nearest one beyond 5 km), each divided by distance in km (calculated from EPA RPM database)	EPA (2017)						
	Proximity to Hazardous Waste Facilities	Count of TSDF's or LQG's within 5 km (or nearest beyond 5 km), each divided by distance in KM (calculated from EPA RCRA Info database)	EPA (2017)	Sum of weighted permitted hazardous waste facilities and hazardous waste generators within each census tract. (Permitted hazardous waste facilities was downloaded December 2016., Hazardous waste data is from 2012-2014.)	EnviroStor Hazardous Waste Facilities Database and Hazardous Waste Tracking System, Department of Toxic Substances Control (DTSC) http://www.envirostor.dtsc.ca.gov/public/data_download.asp http://hwts.dtsc.ca.gov/ (Permitted hazardous waste facilities was downloaded December 2016., Hazardous waste data is from 2012-2014.)			Sites that have permits for TSDF's	MPCA
	Proximity to National Priorities List (NPL) sites	Count of proposed and listed NPL sites (Superfund: National Priorities List) within 5 km (or nearest beyond 5 km), each divided by distance in km (calculated from EPA CERCLIS database)	EPA (2017)					Information related to clean-up and investigation sites, including NPL sites	MPCA/EPA
Lead paint indicator		Percent of housing units built pre-1960 (calculated based on Census data)	ACS (2011-2015)						
Solid waste sites and facilities				Sum of weighted solid waste sites and facilities (as of December 2016).	Solid Waste Information System (SWIS) and Closed, Illegal, and Abandoned (CIA) Disposal Sites Program, California Department of Resources Recycling and Recovery, CalRecycle Hazardous Waste Tracking System, Department of Toxic Substances Control (DTSC) http://calrecycle.ca.gov/SWFacilities/Directory/ http://www.calrecycle.ca.gov/SWFacilities/CIA/ http://hwts.dtsc.ca.gov/ (2016)			Permitting for facilities that process solid wastes	MPCA
Feedlots								Presence of a feedlot (point-level data) - sites that meet criteria for MPCA registration (10 animals near shore, more than 50 animals inland).	Minnesota Department Agriculture
Use of certain high-hazard high-volatility pesticides				Total pounds of selected active pesticide ingredients (filtered for hazard and volatility) used in production-agriculture per square mile, averaged over three years (2012 to 2014).	Pesticide Use Reporting, California Department of Pesticide Regulation (DPR) http://www.DPR.ca.gov/docs/pur/purmain.htm (2012 to 2014)				

	Toxic releases from facilities			Toxicity-weighted concentrations of modeled chemical releases to air from facility emissions and off-site incineration (averaged over 2011 to 2013)	Risk Screening Environmental Indicators (RSEI) US Environmental Protection Agency (US EPA) Toxic Release Inventory (TRI) Mexico Registry of Emissions and Pollutant Transfer (RETC) http://www.epa.gov/oppt/rsei/pubs/rsei_methodology_v2.3.1.pdf http://www.epa.gov/oppt/rsei/pubs/rsei_users_manual_v2.3.1.pdf http://www.epa.gov/tri/index.htm http://www.epa.gov/oppt/rsei/pubs/technical_appendix_a_toxicity_v2.3.1.pdf http://www.semarnat.gob.mx/temas/gestion-ambiental/calidad-del-aire/registro-de-emisiones-y-transferencia-de-contaminantes-retc (2011 to 2013)			Permitting information for facilities that release toxic substances, via water or air, as required by MPCA.	MPCA
	Groundwater threats from leaking underground storage sites and cleanups			Sum of weighted scores for sites within each census tract. (Data downloaded December 2016) The nature and the magnitude of the threat and burden posed by sites maintained in GeoTracker vary significantly by site type (e.g., leaking underground storage tank or cleanup site) and status (e.g., Completed Case Closed or Active Clean up). The indicator takes into account information about the type of site, its status, and its proximity to populated census blocks.	GeoTracker Database, State Water Resources Control Board (SWRCB) http://geotracker.waterboards.ca.gov/ (2016)			Information on permitted sites, such as underground tanks, that are known to be leaking or have leaked in the past.	MCPA
	Toxic cleanup sites ("brownfields")			Sum of weighted sites within each census tract. (Data downloaded December 2016) Since the nature and the magnitude of the threat and burden posed by hazardous substances vary among the different types of sites as well as the site status, the indicator takes both into account. Weights were also adjusted based on proximity to populated census blocks.	EnviroStor Cleanup Sites Database, Department of Toxic Substances Control (DTSC) http://www.envirostor.dtsc.ca.gov/public/ US Environmental Protection Agency, Region 9 Region 9 NPL Sites (Superfund Sites) Polygons https://edg.epa.gov/clipship/ (2016)			Clean-up sites, including brownfields, are included in MPCA's tool to show where such activity is occuring.	MPCA
Socio-economic Indicators									
	Less than high school education	Number or percent of people age 25 or older in a block group whose education is short of a high school diploma	ACS (2011-2015)	Percent of the population over age 25 with less than a high school education (5-year estimate, 2011-2015)	American Community Survey US Census Bureau http://www.census.gov/acs/www/http://factfinder2.census.gov/ (2011-2015)				
	Income								
	Poverty			Percent of the population living below two times the federal poverty level (5-year estimate, 2011-2015)	American Community Survey US Census Bureau http://www.census.gov/acs/www/http://factfinder2.census.gov/ (2011-2015)	At least 40% of people reported income less than 185% of the federal poverty level	US Census - ACS		

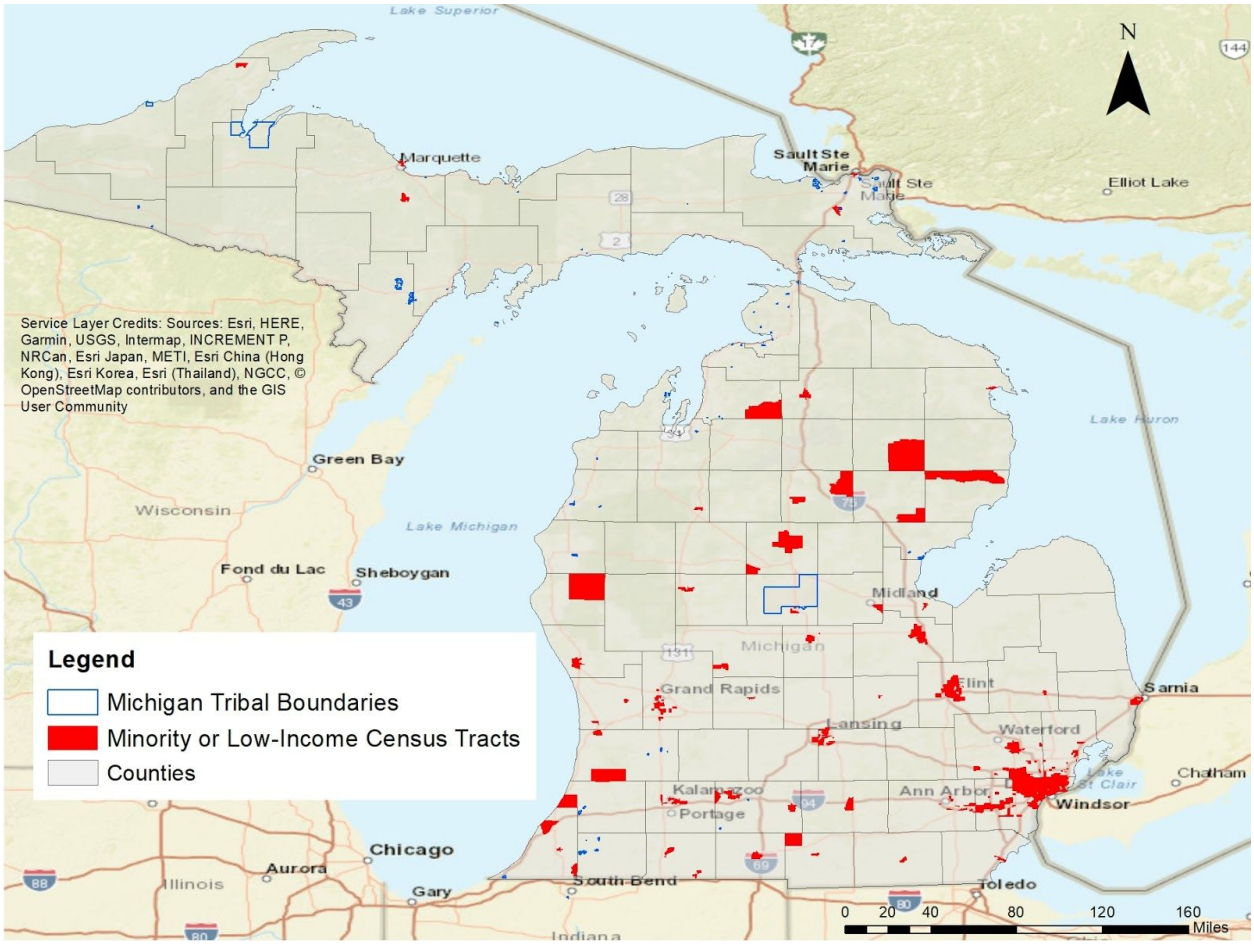
		Housing burdened low income households			Housing Burdened Low Income Households. Percent of households in a census tract that are both low income (making less than 80% of the HUD Area Median Family Income) and severely burdened by housing costs (paying greater than 50% of their income to housing costs). (5-year estimates, 2009-2013)	Housing and Urban Development Comprehensive Housing Affordability Strategy American Community Survey US Census Bureau https://www.huduser.gov/portal/datasets/cp.html#2006-2013 (2009-2013)				
		Low-income	Number or percent of a block group's population in households where the household income is less than or equal to twice the federal poverty level	ACS (2011-2015)			At least 40% of people reported income less than 185% of the federal poverty level	US Census - ACS		
	Employment									
		Unemployment			Percent of the population over the age of 16 that is unemployed and eligible for the labor force. Excludes retirees, students, homemakers, institutionalized persons except prisoners, those not looking for work, and military personnel on active duty (5-year estimate, 2011-2015)	American Community Survey US Census Bureau http://www.census.gov/acs/www/http://factfinder2.census.gov/ (2011-2015)				
	Minority									
		Race	Number or percent of individuals in a block group who list their racial status as a race other than white alone and/or list their ethnicity as Hispanic or Latino	ACS (2011-2015)			50% or more people of color	US Census - ACS		
		Ethnicity	Number or percent of individuals in a block group who list their racial status as a race other than white alone and/or list their ethnicity as Hispanic or Latino	ACS (2011-2015)			50% or more people of color	US Census - ACS		
		Tribal Status					Federally-recognized tribal communities	US Census		
	Language									
		Linguistic isolation	Number or percent of people in a block group living in a household in which all members age 14 years and over speak a non-English language and also speak English less than "very well"	ACS (2011-2015)	Percent limited English-speaking households, (2011-2015)	American Community Survey US Census Bureau http://www.census.gov/acs/www/http://factfinder2.census.gov/ (2011-2015)				
		Languages spoken					Top three non-English languages spoken in a given environmental justice area of concern	Census Data (ACS)		
	Age									
		Individuals under 5	Number or percent of people in a block group under the age of 5	ACS (2011-2015)						
		Individuals over age 64	Number or percent of people in a block group over the age of 64	ACS (2011-2015)						
Health Indicators										

	Asthma emergency department visits			Spatially modeled, age-adjusted rate of emergency department (ED) visits for asthma per 10,000 (averaged over 2011-2013).	California Office of Statewide Health Planning and Development (OSHPD) California Environmental Health Tracking Program (CEHTP) California Department of Public Health http://www.oshpd.ca.gov/HID/Products/EmerDeptData/ http://www.cehtp.org/pra/asthma (2011-2013)				
	Cardiovascular disease			Spatially modeled, age-adjusted rate of emergency department (ED) visits for AMI (heart attacks) per 10,000 (averaged over 2011-2013)	California Office of Statewide Health Planning and Development (OSHPD) California Environmental Health Tracking Program (CEHTP) Environmental Health Investigations Branch, California Department of Public Health http://www.oshpd.ca.gov/HID/Products/EmerDeptData/ http://www.cehtp.org/page/heart_attack/				
	Low birth-weight infants			Percent low birth weight, (averaged over 2006-2012)	California Department of Public Health (CDPH) http://www.cdph.ca.gov/data/dataresources/requests/Pages/BirthandFetalDeathFiles.aspx (2006-2012)				

Appendix E: Minnesota Pollution Control Agency's Methodology Applied to Michigan Census Tracts

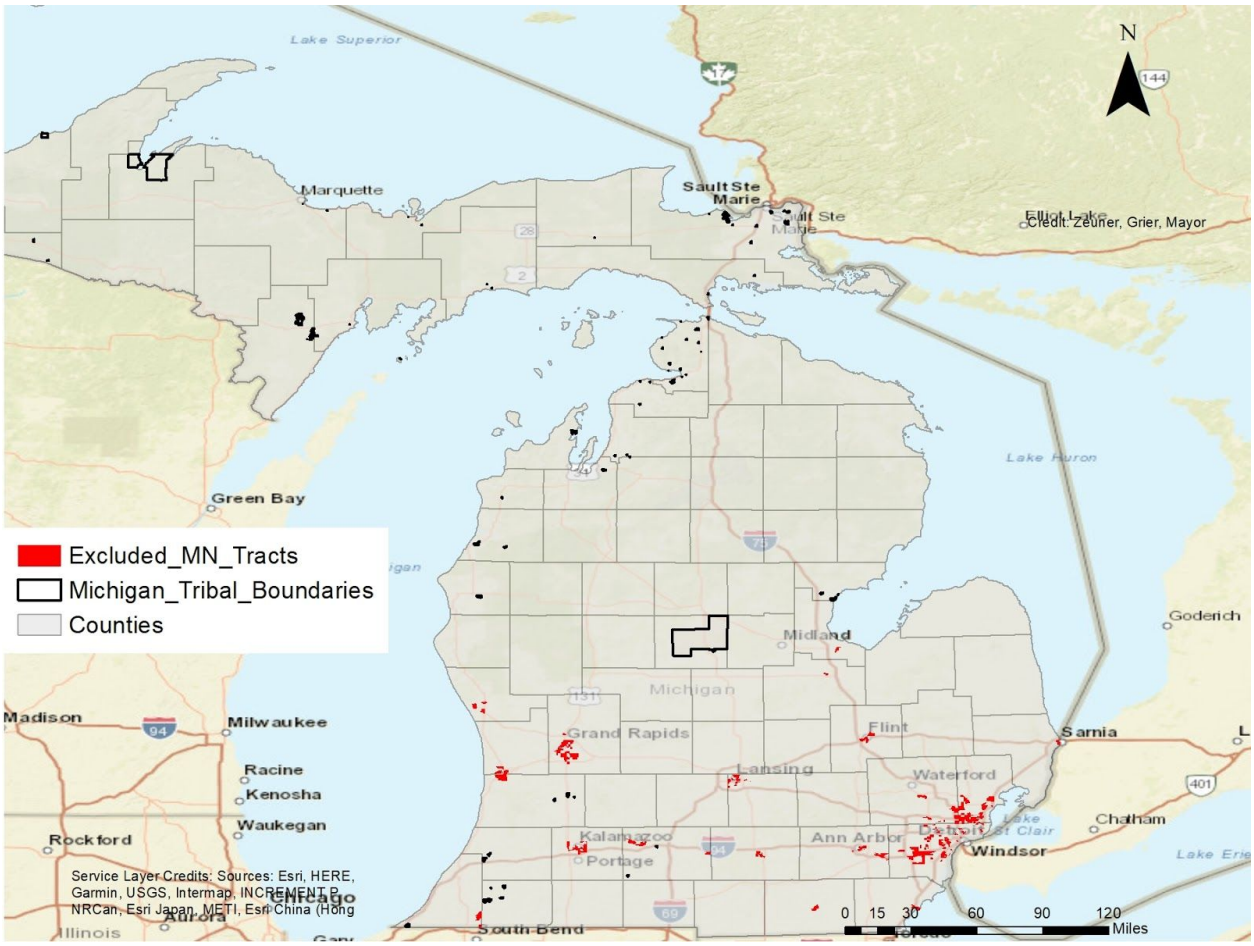
This map shows Michigan census tracts, which would be identified as "areas of concern for environmental justice" when applying the MPCA methodology of meeting at least one of the following criteria:

- *Percent of non-white population is at least 50%.*
- *"More than 40% of the households have a household income of less than 185% of the federal poverty level (FPL)."*
- *If the facility is within the boundaries of a "tribal community" (MPCA 2015).*



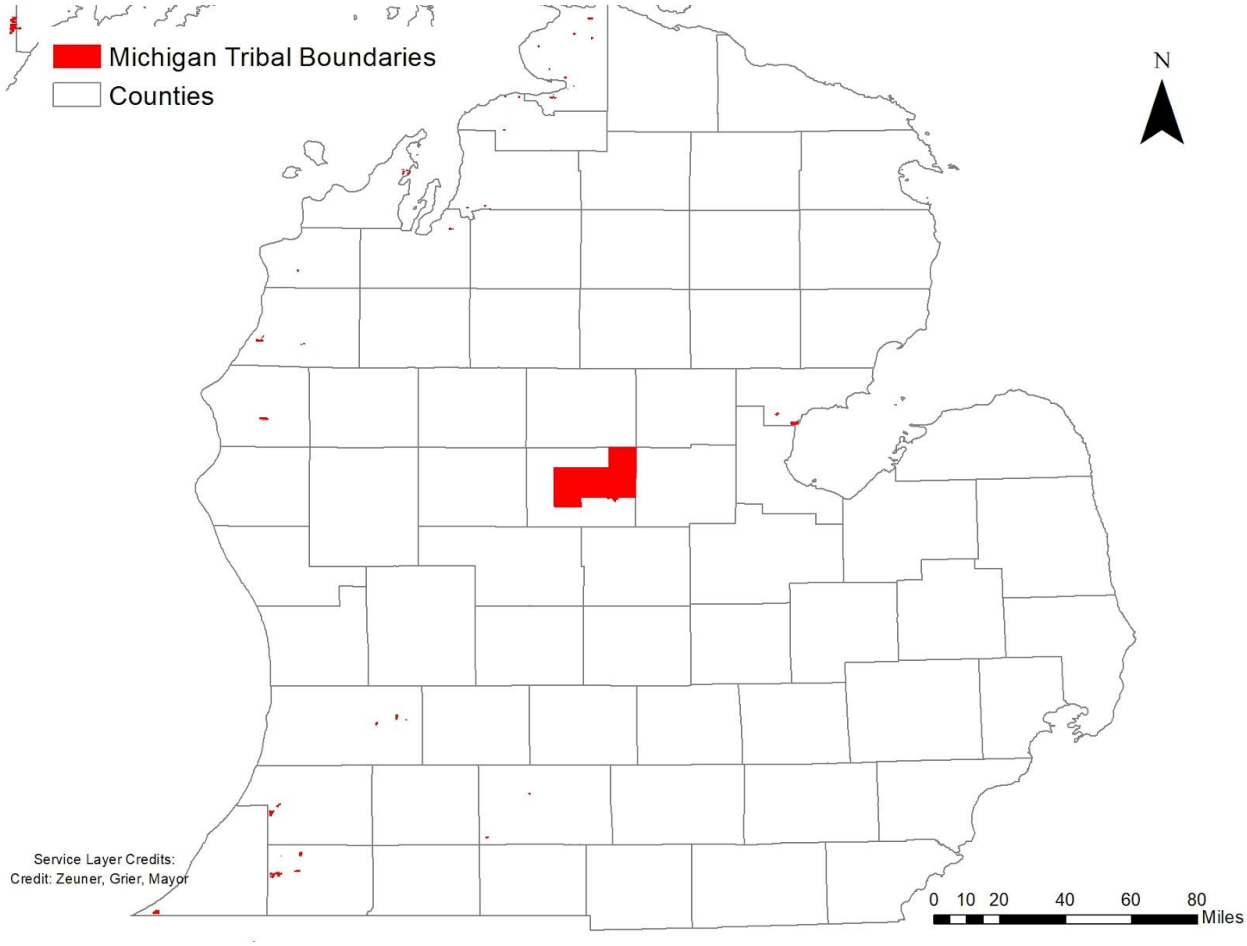
Appendix F: Comparing MPCA and CalEPA Methodologies

This map shows Michigan census tracts which would NOT be identified as "areas of concern for environmental justice" when applying the MPCA methodology but that ARE included in the top quartile of census tracts as ranked by an environmental justice score (calculated using CalEPA's methodology with race and ethnicity data).

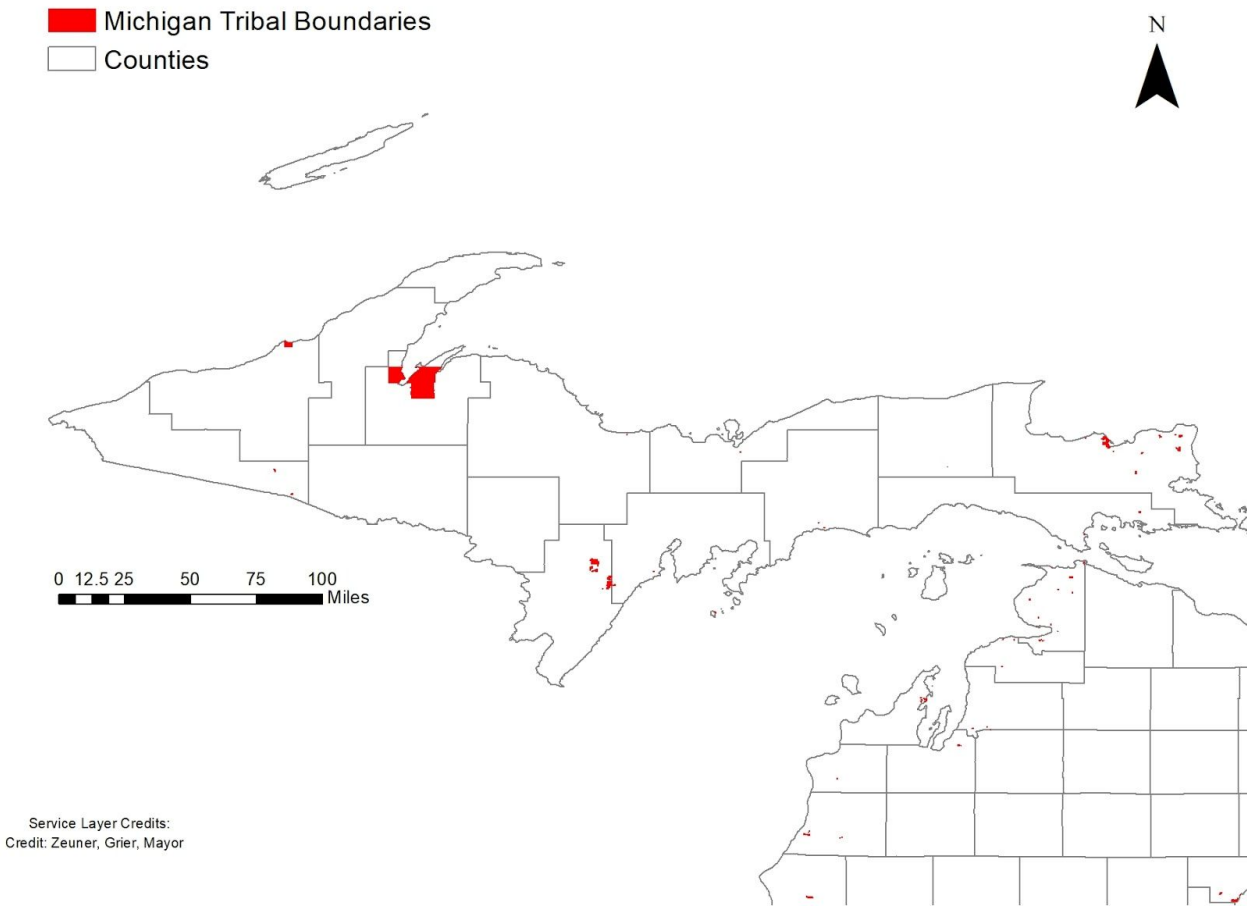


Appendix G: Tribal Areas within Michigan

This map shows the tribal areas throughout the Lower Peninsula of Michigan as defined by "federally recognized American Indian reservations, off-reservation trust land areas, and state-recognized American Indian reservations" (US Census Bureau 2019).



This map shows the tribal areas throughout the Upper Peninsula of Michigan as defined by "federally recognized American Indian reservations, off-reservation trust land areas, and state-recognized American Indian reservations" (US Census Bureau 2019).

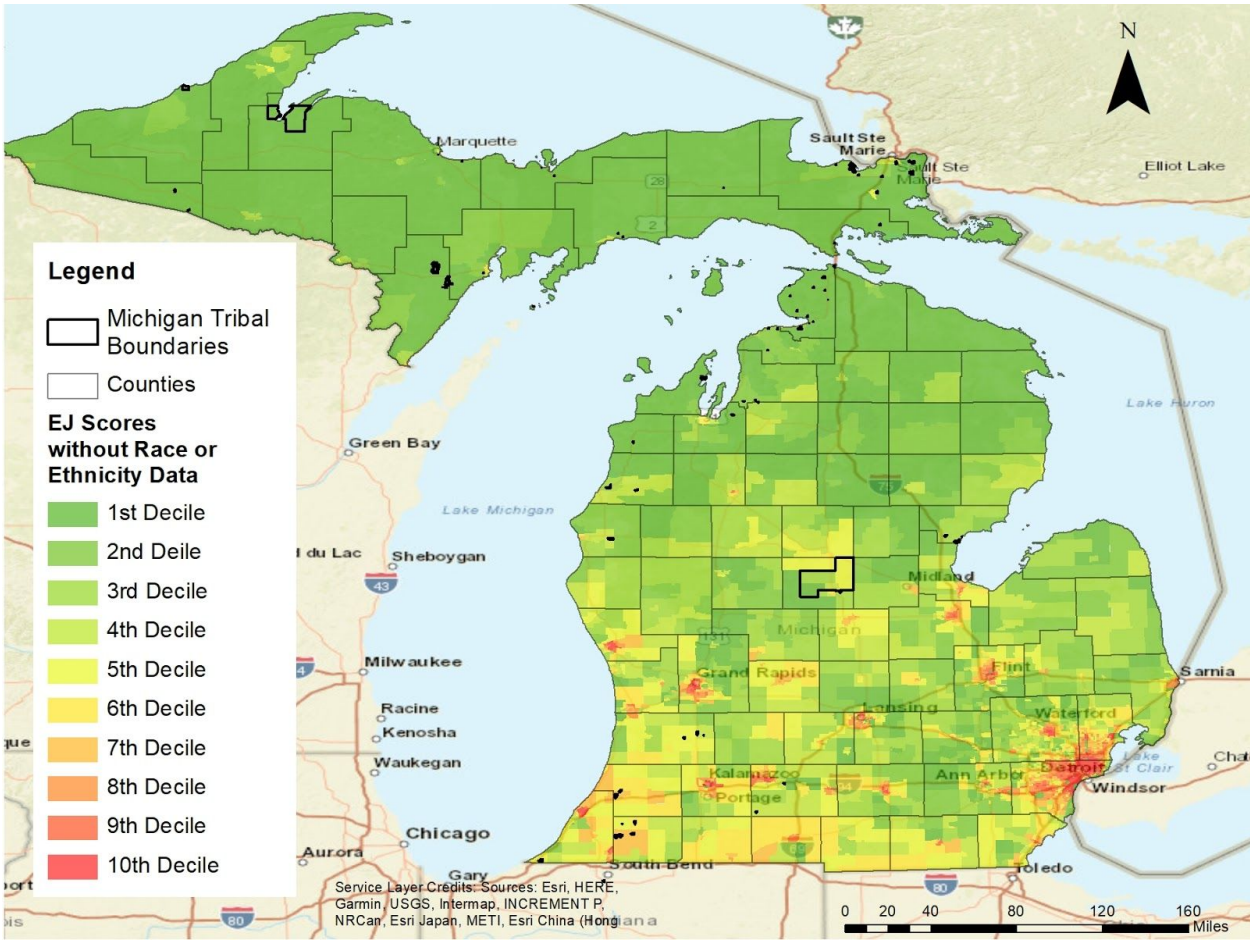


This table shows the thirteen tribal communities represented in the analysis based on data from the US Census Bureau. Area in square kilometers as well as county(ies) location is shown.

Tribal Name	Area (sq. km)	Counties
Huron Potawatomi	843.67	Calhoun
Little Traverse Bay	4,835.48	Charlevoix, Cheboygan, Emmet
Hannahville	23,675.19	Delta, Menominee
Lac Vieux Desert	1,084.32	Gogebic
L'Anse	238,227.45	Baraga
Isabella	564,779.59	Isabella
Pokagon	13,822.13	Berrien, Cass, Van Buren
Sault Ste. Marie	5,078.77	Alger, Chippewa, Mackinac, Schoolcraft
Little River	4,608.16	Manistee, Mason
Bay Mills	14,254.16	Chippewa
Ontonagon	9,679.64	Ontonagon
Match-e-be-nash-she-wish Band of Pottawatomi	2,299.53	Allegan
Grand Traverse	3,358.20	Antrim, Benzie, Charlevoix, Grand Traverse, Leelanau

Appendix H: California's CalEPA Methodology Applied to Michigan

Statewide map showing Michigan census tracts ranked according to CalEPA's methodology (without racial or ethnic data). Note that the map displayed in Figure 14 in Chapter 6 shows Michigan census tracts ranked according to CalEPA's methodology including racial and ethnic data, along with tribal boundaries.



Appendix I: List of Top 25% Michigan Census Tracts Ranked by Environmental Justice Score

Rank	Tract	EJ Score	Percentile	County
1	0039	93.994	99.9%	KENT
2	0002	91.947	99.9%	KALAMAZOO
3	0003	90.173	99.9%	KALAMAZOO
4	0038	89.501	99.8%	KENT
5	0040	87.740	99.8%	KENT
6	0036	87.633	99.8%	KENT
7	0026	87.428	99.7%	KENT
8	5061	87.208	99.7%	WAYNE
9	5055	86.924	99.7%	WAYNE
10	5162	86.695	99.6%	WAYNE
11	0028	86.465	99.6%	KENT
12	5051	85.868	99.5%	WAYNE
13	5189	85.295	99.5%	WAYNE
14	5050	84.768	99.5%	WAYNE
15	0001	84.763	99.4%	KALAMAZOO
16	5032	84.749	99.4%	WAYNE
17	5238	84.334	99.4%	WAYNE
18	0037	84.157	99.3%	KENT
19	2638	83.977	99.3%	MACOMB
20	5159	83.727	99.3%	WAYNE
21	5047	83.645	99.2%	WAYNE
22	5110	83.328	99.2%	WAYNE
23	0009	83.244	99.1%	KALAMAZOO
24	5054	83.144	99.1%	WAYNE
25	5250	82.491	99.1%	WAYNE
26	5142	81.079	99.0%	WAYNE
27	5243	80.758	99.0%	WAYNE
28	2639	80.742	99.0%	MACOMB
29	5245	80.624	98.9%	WAYNE
30	5049	80.590	98.9%	WAYNE
31	0002	80.489	98.9%	KALAMAZOO
32	5334	80.483	98.8%	WAYNE
33	0010	80.275	98.8%	KALAMAZOO
34	5035	80.177	98.7%	WAYNE
35	5033	80.089	98.7%	WAYNE
36	5234	80.082	98.7%	WAYNE
37	2640	79.966	98.6%	MACOMB
38	5232	79.916	98.6%	WAYNE
39	0005	79.890	98.6%	BERRIEN
40	5052	79.799	98.5%	WAYNE
41	5224	79.742	98.5%	WAYNE
42	5161	79.581	98.5%	WAYNE
43	5248	79.349	98.4%	WAYNE
44	5067	79.150	98.4%	WAYNE
45	5258	79.055	98.3%	WAYNE
46	5143	78.974	98.3%	WAYNE
47	5145	78.911	98.3%	WAYNE
48	5039	78.901	98.2%	WAYNE
49	5247	78.535	98.2%	WAYNE
50	5793	78.407	98.2%	WAYNE
51	5163	78.362	98.1%	WAYNE
52	5741	78.326	98.1%	WAYNE
53	5062	78.265	98.1%	WAYNE
54	5233	78.264	98.0%	WAYNE
55	5225	77.992	98.0%	WAYNE
56	5204	77.974	97.9%	WAYNE
57	5521	77.874	97.9%	WAYNE
58	5333	77.874	97.9%	WAYNE
59	5044	77.795	97.8%	WAYNE
60	0031	77.774	97.8%	KENT
61	2683	77.735	97.8%	MACOMB
62	0019	77.707	97.7%	KENT
63	5081	77.697	97.7%	WAYNE
64	5255	77.574	97.7%	WAYNE
65	5075	77.407	97.6%	WAYNE
66	5065	77.389	97.6%	WAYNE
67	5048	77.253	97.5%	WAYNE
68	5004	77.119	97.5%	WAYNE
69	5119	77.059	97.5%	WAYNE
70	5121	76.981	97.4%	WAYNE
71	5740	76.952	97.4%	WAYNE
72	0005	76.840	97.4%	MUSKEGON
73	5107	76.819	97.3%	WAYNE
74	5273	76.789	97.3%	WAYNE
75	5240	76.688	97.2%	WAYNE
76	5114	76.680	97.2%	WAYNE
77	5795	76.588	97.2%	WAYNE
78	5220	76.494	97.1%	WAYNE
79	5105	76.489	97.1%	WAYNE
80	0032	76.444	97.1%	KENT
81	5068	76.367	97.0%	WAYNE
82	5272	76.216	97.0%	WAYNE
83	5345	76.198	97.0%	WAYNE
84	5324	76.198	96.9%	WAYNE
85	5063	76.182	96.9%	WAYNE
86	5080	76.052	96.8%	WAYNE
87	5249	76.023	96.8%	WAYNE
88	5104	76.006	96.8%	WAYNE
89	5136	75.919	96.7%	WAYNE
90	0020	75.751	96.7%	KENT
91	5036	75.596	96.7%	WAYNE
92	5066	75.444	96.6%	WAYNE
93	5173	75.389	96.6%	WAYNE
94	5160	75.347	96.6%	WAYNE
95	5031	75.343	96.5%	WAYNE
96	5222	75.181	96.5%	WAYNE
97	5188	75.082	96.4%	WAYNE
98	0135	74.991	96.4%	KENT
99	5219	74.921	96.4%	WAYNE
100	5112	74.794	96.3%	WAYNE

Rank	Tract	EJ Score	Percentile	County
101	0068	74.779	96.3%	INGHAM
102	1422	74.719	96.3%	OAKLAND
103	2632	74.686	96.2%	MACOMB
104	5223	74.587	96.2%	WAYNE
105	0013	74.570	96.2%	KENT
106	5254	74.495	96.1%	WAYNE
107	5242	74.420	96.1%	WAYNE
108	5530	74.409	96.0%	WAYNE
109	5791	74.373	96.0%	WAYNE
110	0012	74.354	96.0%	MUSKEGON
111	5335	74.352	95.9%	WAYNE
112	5528	74.324	95.9%	WAYNE
113	0027	74.310	95.9%	KENT
114	0004	74.293	95.8%	BERRIEN
115	0042	74.260	95.8%	MUSKEGON
116	5106	74.255	95.8%	WAYNE
117	2681	74.251	95.7%	MACOMB
118	5538	74.246	95.7%	WAYNE
119	5043	74.230	95.6%	WAYNE
120	0015	74.221	95.6%	KENT
121	5326	74.181	95.6%	WAYNE
122	5260	74.149	95.5%	WAYNE
123	0006	74.144	95.5%	BERRIEN
124	5034	73.977	95.5%	WAYNE
125	5180	73.816	95.4%	WAYNE
126	5186	73.801	95.4%	WAYNE
127	5218	73.780	95.4%	WAYNE
128	0015	73.689	95.3%	KALAMAZOO
129	0004	73.660	95.3%	MUSKEGON
130	1416	73.610	95.2%	OAKLAND
131	5013	73.571	95.2%	WAYNE
132	5141	73.500	95.2%	WAYNE
133	0003	73.495	95.1%	BERRIEN
134	5122	73.484	95.1%	WAYNE
135	5078	73.465	95.1%	WAYNE
136	0021	73.428	95.0%	BERRIEN
137	5213	73.425	95.0%	WAYNE
138	0006	73.292	95.0%	CALHOUN
139	5129	73.220	94.9%	WAYNE
140	5166	73.216	94.9%	WAYNE
141	5231	73.150	94.8%	WAYNE
142	5168	73.103	94.8%	WAYNE
143	2471	73.074	94.8%	MACOMB
144	5156	72.989	94.7%	WAYNE
145	0041	72.892	94.7%	CALHOUN
146	0015	72.859	94.7%	KALAMAZOO
147	5215	72.792	94.6%	WAYNE
148	0005	72.741	94.6%	KALAMAZOO
149	5006	72.678	94.5%	WAYNE
150	5241	72.666	94.5%	WAYNE
151	5069	72.656	94.5%	WAYNE
152	1417	72.622	94.4%	OAKLAND
153	5331	72.558	94.4%	WAYNE
154	5003	72.465	94.4%	WAYNE
155	0043	72.401	94.3%	MUSKEGON
156	5261	72.384	94.3%	WAYNE
157	5203	72.317	94.3%	WAYNE
158	0006	72.280	94.2%	MUSKEGON
159	5221	72.209	94.2%	WAYNE
160	5265	72.130	94.1%	WAYNE
161	5322	72.077	94.1%	WAYNE
162	5330	72.007	94.1%	WAYNE
163	5256	71.991	94.0%	WAYNE
164	5798	71.974	94.0%	WAYNE
165	0018	71.951	94.0%	KALAMAZOO
166	5524	71.924	93.9%	WAYNE
167	5139	71.920	93.9%	WAYNE
168	5011	71.894	93.9%	WAYNE
169	5072	71.781	93.8%	WAYNE
170	5336	71.666	93.8%	WAYNE
171	5012	71.528	93.7%	WAYNE
172	5522	71.502	93.7%	WAYNE
173	5175	71.450	93.7%	WAYNE
174	5342	71.448	93.6%	WAYNE
175	0003	71.424	93.6%	MUSKEGON
176	5185	71.392	93.6%	WAYNE
177	9851	71.372	93.5%	WAYNE
178	0035	71.261	93.5%	KENT
179	5070	71.216	93.5%	WAYNE
180	5184	71.171	93.4%	WAYNE
181	5523	71.086	93.4%	WAYNE
182	5262	71.044	93.3%	WAYNE
183	2589	71.041	93.3%	MACOMB
184	5308	71.004	93.3%	WAYNE
185	0003	70.985	93.2%	CALHOUN
186	1424	70.915	93.2%	OAKLAND
187	5792	70.854	93.2%	WAYNE
188	5343	70.757	93.1%	WAYNE
189	0022	70.748	93.1%	BERRIEN
190	5303	70.653	93.1%	WAYNE
191	5113	70.649	93.0%	WAYNE
192	2642	70.632	93.0%	MACOMB
193	5319	70.556	92.9%	WAYNE
194	5123	70.511	92.9%	WAYNE
195	0013	70.503	92.9%	MUSKEGON
196	5534	70.479	92.8%	WAYNE
197	5264	70.271	92.8%	WAYNE
198	5332	70.223	92.8%	WAYNE
199	5536	70.037	92.7%	WAYNE
200	5263	69.969	92.7%	WAYNE

Rank	Tract	EJ Score	Percentile	County
201	4106	69.916	92.7%	WASHTENAW
202	5531	69.901	92.6%	WAYNE
203	5042	69.896	92.6%	WAYNE
204	5079	69.892	92.5%	WAYNE
205	5040	69.780	92.5%	WAYNE
206	5327	69.779	92.5%	WAYNE
207	0002	69.777	92.4%	CALHOUN
208	5010	69.680	92.4%	WAYNE
209	5211	69.567	92.4%	WAYNE
210	5786	69.155	92.3%	WAYNE
211	5318	69.142	92.3%	WAYNE
212	0008	69.117	92.2%	KENT
213	2684	68.971	92.2%	MACOMB
214	5002	68.921	92.2%	WAYNE
215	5137	68.904	92.1%	WAYNE
216	5257	68.821	92.1%	WAYNE
217	5532	68.808	92.1%	WAYNE
218	5365	68.772	92.0%	WAYNE
219	5071	68.572	92.0%	WAYNE
220	0066	68.546	92.0%	INGHAM
221	0011	68.483	91.9%	JACKSON
222	1421	68.459	91.9%	OAKLAND
223	5001	68.381	91.8%	WAYNE
224	5073	68.362	91.8%	WAYNE
225	5126	68.184	91.8%	WAYNE
226	5372	67.970	91.7%	WAYNE
227	5317	67.956	91.7%	WAYNE
228	5341	67.835	91.7%	WAYNE
229	5391	67.802	91.6%	WAYNE
230	5362	67.761	91.6%	WAYNE
231	5772	67.601	91.6%	WAYNE
232	5366	67.504	91.5%	WAYNE
233	5124	67.474	91.5%	WAYNE
234	1423	67.440	91.4%	OAKLAND
235	5796	67.341	91.4%	WAYNE
236	0008	67.329	91.4%	INGHAM
237	5363	67.244	91.3%	WAYNE
238	5797	67.137	91.3%	WAYNE
239	1420	67.109	91.3%	OAKLAND
240	5311	66.957	91.2%	WAYNE
241	5301	66.803	91.2%	WAYNE
242	0004	66.774	91.2%	SAGINAW
243	5041	66.726	91.1%	WAYNE
244	5005	66.697	91.1%	WAYNE
245	5153	66.681	91.0%	WAYNE
246	0020	66.596	91.0%	INGHAM
247	5743	66.528	91.0%	WAYNE
248	0014	66.400	90.9%	MUSKEGON
249	5455	66.333	90.9%	WAYNE
250	5339	66.207	90.9%	WAYNE
251	4111	66.184	90.8%	WASHTENAW
252	5304	66.183	90.8%	WAYNE
253	5738	66.148	90.8%	WAYNE
254	2636	66.138	90.7%	MACOMB
255	0133	66.121	90.7%	KENT
256	5533	66.063	90.6%	WAYNE
257	5361	65.989	90.6%	WAYNE
258	5064	65.902	90.6%	WAYNE
259	2621	65.806	90.5%	MACOMB
260	5392	65.623	90.5%	WAYNE
261	5378	65.517	90.5%	WAYNE
262	5214	65.477	90.4%	WAYNE
263	5706	65.468	90.4%	WAYNE
264	2450	65.437	90.4%	MACOMB
265	5456	65.425	90.3%	WAYNE
266	5316	65.364	90.3%	WAYNE
267	2634	65.331	90.2%	MACOMB
268	5373	65.327	90.2%	WAYNE
269	2400	65.306	90.2%	MACOMB
270	5315	65.247	90.1%	WAYNE
271	5007	65.202	90.1%	WAYNE
272	1810	65.189	90.1%	OAKLAND
273	5383	65.187	90.0%	WAYNE
274	5014	65.156	90.0%	WAYNE
275	5074	65.107	90.0%	WAYNE
276	5202	65.091	89.9%	WAYNE
277	5390	65.000	89.9%	WAYNE
278	0005	64.915	89.8%	CALHOUN
279	5015	64.873	89.8%	WAYNE
280	5396	64.857	89.8%	WAYNE
281	2625	64.825	89.7%	MACOMB
282	1427	64.807	89.7%	OAKLAND
283	5735	64.722	89.7%	WAYNE
284	2624	64.687	89.6%	MACOMB
285	2803	64.626	89.6%	BAY
286	5305	64.552	89.5%	WAYNE
287	5385	64.495	89.5%	WAYNE
288	0007	64.450	89.5%	SAGINAW
289	5369	64.392	89.4%	WAYNE
290	5009	64.356	89.4%	WAYNE
291	1753	64.303	89.4%	OAKLAND
292	5708	64.162	89.3%	WAYNE
293	0019	64.099	89.3%	SAGINAW
294	5368	64.035	89.3%	WAYNE
295	5737	64.002	89.2%	WAYNE
296	2452	63.967	89.2%	MACOMB
297	0014	63.933	89.1%	KENT
298	5008	63.925	89.1%	WAYNE
299	0004	63.864	89.1%	MUSKEGON
300	0028	63.564	89.0%	GENESEE

Rank	Tract	EJ Score	Percentile	County
301	5352	63.492	89.0%	WAYNE
302	0007	63.454	89.0%	INGHAM
303	5402	63.318	88.9%	WAYNE
304	2587	63.292	88.9%	MACOMB
305	0006	63.203	88.9%	INGHAM
306	5344	63.087	88.8%	WAYNE
307	5020	63.035	88.8%	WAYNE
308	5152	63.032	88.7%	WAYNE
309	5734	63.022	88.7%	WAYNE
310	0029	62.976	88.7%	GENESEE
311	5856	62.961	88.6%	WAYNE
312	0016	62.948	88.6%	KENT
313	5132	62.886	88.6%	WAYNE
314	5736	62.838	88.5%	WAYNE
315	2637	62.691	88.5%	MACOMB
316	0002	62.671	88.5%	JACKSON
317	5169	62.632	88.4%	WAYNE
318	1415	62.597	88.4%	OAKLAND
319	5364	62.530	88.3%	WAYNE
320	0017	62.509	88.3%	SAGINAW
321	5386	62.501	88.3%	WAYNE
322	0022	62.336	88.2%	GENESEE
323	4123	62.284	88.2%	WASHTENAW
324	0044	62.280	88.2%	INGHAM
325	5394	62.252	88.1%	WAYNE
326	0142	62.227	88.1%	KENT
327	0006	62.209	88.1%	SAGINAW
328	5775	62.144	88.0%	WAYNE
329	0205	62.112	88.0%	BERRIEN
330	4108	62.064	87.9%	WASHTENAW
331	5302	62.045	87.9%	WAYNE
332	5347	61.996	87.9%	WAYNE
333	5423	61.973	87.8%	WAYNE
334	5354	61.955	87.8%	WAYNE
335	5371	61.874	87.8%	WAYNE
336	5426	61.826	87.7%	WAYNE
337	4003	61.803	87.7%	WASHTENAW
338	0138	61.731	87.7%	KENT
339	0012	61.659	87.6%	JACKSON
340	1751	61.606	87.6%	OAKLAND
341	5424	61.603	87.5%	WAYNE
342	5832	61.395	87.5%	WAYNE
343	5346	61.376	87.5%	WAYNE
344	5367	61.353	87.4%	WAYNE
345	5309	61.236	87.4%	WAYNE
346	1414	61.160	87.4%	OAKLAND
347	1409	61.114	87.3%	OAKLAND
348	0006	61.106	87.3%	KALAMAZOO
349	5770	61.090	87.2%	WAYNE
350	5370	61.072	87.2%	WAYNE
351	0036	61.066	87.2%	CALHOUN
352	5417	61.027	87.1%	WAYNE
353	0126	61.022	87.1%	KENT
354	0030	60.992	87.1%	KENT
355	5458	60.992	87.0%	WAYNE
356	5388	60.990	87.0%	WAYNE
357	5668	60.989	87.0%	WAYNE
358	0008	60.893	86.9%	SAGINAW
359	0038	60.854	86.9%	GENESEE
360	0029	60.772	86.8%	KENT
361	0613	60.759	86.8%	LENAWEE
362	5314	60.687	86.8%	WAYNE
363	5355	60.660	86.7%	WAYNE
364	0126	60.501	86.7%	KENT
365	5401	60.490	86.7%	WAYNE
366	5425	60.481	86.6%	WAYNE
367	0043	60.474	86.6%	INGHAM
368	5387	60.469	86.6%	WAYNE
369	4101	60.437	86.5%	WASHTENAW
370	0138	60.426	86.5%	KENT
371	5167	60.412	86.4%	WAYNE
372	5337	60.371	86.4%	WAYNE
373	5323	60.365	86.4%	WAYNE
374	0137	60.266	86.3%	KENT
375	0021	60.246	86.3%	INGHAM
376	5439	60.135	86.3%	WAYNE
377	5312	60.104	86.2%	WAYNE
378	2559	60.057	86.2%	MACOMB
379	5457	60.034	86.2%	WAYNE
380	0013	60.022	86.1%	SAGINAW
381	0010	59.995	86.1%	JACKSON
382	2305	59.975	86.0%	MACOMB
383	1724	59.943	86.0%	OAKLAND
384	5785	59.904	86.0%	WAYNE
385	5357	59.878	85.9%	WAYNE
386	5709	59.778	85.9%	WAYNE
387	0018	59.742	85.9%	SAGINAW
388	5771	59.701	85.8%	WAYNE
389	2635	59.647	85.8%	MACOMB
390	0023	59.628	85.8%	GENESEE
391	5350	59.612	85.7%	WAYNE
392	5164	59.565	85.7%	WAYNE
393	5440	59.498	85.6%	WAYNE
394	5780	59.395	85.6%	WAYNE
395	5418	59.334	85.6%	WAYNE
396	0026	59.308	85.5%	GENESEE
397	0009	59.297	85.5%	SAGINAW
398	2865	59.260	85.5%	BAY
399	0033	59.249	85.4%	INGHAM
400	5413	59.227	85.4%	WAYNE

401	0017	59.227	85.4%	GENESEE
402	5393	59.212	85.3%	WAYNE
403	5460	59.208	85.3%	WAYNE
404	5739	59.188	85.2%	WAYNE
405	2611	59.097	85.2%	MACOMB
406	5516	59.039	85.2%	WAYNE
407	5353	58.991	85.1%	WAYNE
408	0011	58.929	85.1%	KALAMAZOO
409	5685	58.915	85.1%	WAYNE
410	5414	58.843	85.0%	WAYNE
411	2561	58.840	85.0%	MACOMB
412	5453	58.824	85.0%	WAYNE
413	0006	58.796	84.9%	JACKSON
414	5422	58.779	84.9%	WAYNE
415	5351	58.763	84.8%	WAYNE
416	5154	58.761	84.8%	WAYNE
417	0013	58.694	84.8%	JACKSON
418	5461	58.691	84.7%	WAYNE
419	5403	58.661	84.7%	WAYNE
420	0009	58.646	84.7%	KENT
421	5705	58.627	84.6%	WAYNE
422	5381	58.618	84.6%	WAYNE
423	4001	58.562	84.5%	WASHTENAW
424	5459	58.560	84.5%	WAYNE
425	5019	58.542	84.5%	WAYNE
426	5395	58.521	84.4%	WAYNE
427	0067	58.512	84.4%	INGHAM
428	5404	58.449	84.4%	WAYNE
429	0136	58.444	84.3%	GENESEE
430	0015	58.373	84.3%	GENESEE
431	5389	58.334	84.3%	WAYNE
432	5376	58.318	84.2%	WAYNE
433	5773	58.210	84.2%	WAYNE
434	5411	58.124	84.1%	WAYNE
435	2557	58.072	84.1%	MACOMB
436	4002	58.051	84.1%	WASHTENAW
437	0025	57.984	84.0%	KENT
438	0127	57.975	84.0%	KENT
439	0044	57.928	84.0%	INGHAM
440	5017	57.841	83.9%	WAYNE
441	0045	57.831	83.9%	KENT
442	0001	57.801	83.9%	SAGINAW
443	2413	57.772	83.8%	MACOMB
444	4119	57.759	83.8%	WASHTENAW
445	8318	57.670	83.7%	MONROE
446	8319	57.640	83.7%	MONROE
447	2628	57.589	83.7%	MACOMB
448	2454	57.580	83.6%	MACOMB
449	2807	57.553	83.6%	BAY
450	1815	57.401	83.6%	OAKLAND
451	0020	57.347	83.5%	GENESEE
452	5397	57.325	83.5%	WAYNE
453	5313	57.324	83.5%	WAYNE
454	5438	57.275	83.4%	WAYNE
455	1716	57.246	83.4%	OAKLAND
456	5421	57.241	83.3%	WAYNE
457	5704	57.173	83.3%	WAYNE
458	4117	57.169	83.3%	WASHTENAW
459	5469	57.151	83.2%	WAYNE
460	0021	57.133	83.2%	KENT
461	0209	57.133	83.2%	BERRIEN
462	5408	57.129	83.1%	WAYNE
463	0136	57.059	83.1%	KENT
464	2629	57.049	83.1%	MACOMB
465	0008	57.038	83.0%	MUSKEGON
466	0249	56.899	83.0%	OTTAWA
467	5016	56.866	82.9%	WAYNE
468	5669	56.858	82.9%	WAYNE
469	5670	56.820	82.9%	WAYNE
470	0023	56.804	82.8%	BERRIEN
471	5375	56.804	82.8%	WAYNE
472	1814	56.622	82.8%	OAKLAND
473	0032	56.575	82.7%	INGHAM
474	0011	56.562	82.7%	GENESEE
475	0055	56.537	82.7%	KALAMAZOO
476	5415	56.505	82.6%	WAYNE
477	5710	56.451	82.6%	WAYNE
478	1981	56.386	82.5%	OAKLAND
479	1425	56.298	82.5%	OAKLAND
480	5837	56.297	82.5%	WAYNE
481	0013	56.289	82.4%	CALHOUN
482	0020	56.264	82.4%	BERRIEN
483	2553	56.213	82.4%	MACOMB
484	5377	56.201	82.3%	WAYNE
485	4005	56.199	82.3%	WASHTENAW
486	5451	56.180	82.2%	WAYNE
487	2680	56.119	82.2%	MACOMB
488	0222	56.095	82.2%	OTTAWA
489	2451	56.025	82.1%	MACOMB
490	2556	55.891	82.1%	MACOMB
491	2558	55.889	82.1%	MACOMB
492	5165	55.886	82.0%	WAYNE
493	4021	55.849	82.0%	WASHTENAW
494	5737	55.778	82.0%	WAYNE
495	5466	55.715	81.9%	WAYNE
496	4022	55.708	81.9%	WASHTENAW
497	0001	55.673	81.8%	INGHAM
498	5018	55.622	81.8%	WAYNE
499	5742	55.464	81.8%	WAYNE
500	0032	55.371	81.7%	GENESEE

Rank	Tract	EJ Score	Percentile	County
501	5405	55.338	81.7%	WAYNE
502	5356	55.316	81.7%	WAYNE
503	5462	55.266	81.6%	WAYNE
504	2586	55.258	81.6%	MACOMB
505	0616	55.235	81.6%	LENAWEE
506	2583	55.214	81.5%	MACOMB
507	1725	55.200	81.5%	OAKLAND
508	0046	55.179	81.4%	KENT
509	5407	55.165	81.4%	WAYNE
510	0140	55.038	81.4%	KENT
511	2620	55.024	81.3%	MACOMB
512	0613	55.014	81.3%	LENAWEE
513	5454	54.991	81.3%	WAYNE
514	2564	54.949	81.2%	MACOMB
515	5467	54.936	81.2%	WAYNE
516	5437	54.923	81.2%	WAYNE
517	0026	54.919	81.1%	CALHOUN
518	5464	54.860	81.1%	WAYNE
519	5412	54.846	81.0%	WAYNE
520	2562	54.838	81.0%	MACOMB
521	1752	54.769	81.0%	OAKLAND
522	0017	54.769	80.9%	KALAMAZOO
523	2588	54.731	80.9%	MACOMB
524	0258	54.698	80.9%	OTTAWA
525	0147	54.666	80.8%	KENT
526	2563	54.656	80.8%	MACOMB
527	0010	54.621	80.8%	KENT
528	5207	54.545	80.7%	WAYNE
529	0069	54.518	80.7%	JACKSON
530	0007	54.405	80.6%	GENESEE
531	6260	54.391	80.6%	SAINT CLAIR
532	5779	54.383	80.6%	WAYNE
533	2627	54.362	80.5%	MACOMB
534	1426	54.254	80.5%	OAKLAND
535	0012	54.250	80.5%	INGHAM
536	5554	54.207	80.4%	WAYNE
537	2323	54.164	80.4%	MACOMB
538	0065	54.036	80.4%	INGHAM
539	1413	54.029	80.3%	OAKLAND
540	5774	53.986	80.3%	WAYNE
541	0134	53.969	80.2%	KENT
542	5442	53.930	80.2%	WAYNE
543	5427	53.831	80.2%	WAYNE
544	5409	53.812	80.1%	WAYNE
545	4112	53.763	80.1%	WASHTENAW
546	0324	53.734	80.1%	ALLEGAN
547	5855	53.709	80.0%	WAYNE
548	0026	53.681	80.0%	INGHAM
549	5468	53.671	80.0%	WAYNE
550	0007	53.668	79.9%	CALHOUN
551	5452	53.649	79.9%	WAYNE
552	5443	53.646	79.8%	WAYNE
553	5664	53.587	79.8%	WAYNE
554	0014	53.366	79.8%	GENESEE
555	2617	53.320	79.7%	MACOMB
556	0004	53.318	79.7%	GENESEE
557	2566	53.272	79.7%	MACOMB
558	5842	53.212	79.6%	WAYNE
559	5776	53.149	79.6%	WAYNE
560	0041	53.116	79.5%	INGHAM
561	2619	53.110	79.5%	MACOMB
562	1603	53.084	79.5%	OAKLAND
563	0035	52.974	79.4%	INGHAM
564	2582	52.971	79.4%	MACOMB
565	0008	52.969	79.4%	GENESEE
566	0002	52.938	79.3%	SAGINAW
567	0018	52.876	79.3%	KALAMAZOO
568	2610	52.691	79.3%	MACOMB
569	0029	52.675	79.2%	KALAMAZOO
570	5859	52.659	79.2%	WAYNE
571	5818	52.605	79.1%	WAYNE
572	0129	52.487	79.1%	KENT
573	5514	52.413	79.1%	WAYNE
574	5428	52.407	79.0%	WAYNE
575	0207	52.399	79.0%	BERRIEN
576	2257	52.381	79.0%	MACOMB
577	0114	52.253	78.9%	KENT
578	1713	52.218	78.9%	OAKLAND
579	1816	52.159	78.9%	OAKLAND
580	2316	52.156	78.8%	MACOMB
581	1410	52.104	78.8%	OAKLAND
582	0009	52.080	78.7%	JACKSON
583	5441	52.069	78.7%	WAYNE
584	1611	52.004	78.7%	OAKLAND
585	2317	51.985	78.6%	MACOMB
586	0016	51.962	78.6%	GENESEE
587	5665	51.881	78.6%	WAYNE
588	5541	51.846	78.5%	WAYNE
589	5717	51.826	78.5%	WAYNE
590	5435	51.799	78.5%	WAYNE
591	5520	51.773	78.4%	WAYNE
592	0012	51.575	78.4%	GENESEE
593	0143	51.535	78.3%	KENT
594	2221	51.525	78.3%	MACOMB
595	0004	51.447	78.3%	INGHAM
596	5848	51.434	78.2%	WAYNE
597	2804	51.432	78.2%	BAY
598	0009	51.323	78.2%	GENESEE
599	5436	51.297	78.1%	WAYNE
600	0122	51.245	78.1%	GENESEE

Rank	Tract	EJ Score	Percentile	County
601	1813	51.231	78.1%	OAKLAND
602	2416	51.150	78.0%	MACOMB
603	5434	51.147	78.0%	WAYNE
604	0040	51.100	77.9%	GENESEE
605	4042	51.070	77.9%	WASHTENAW
606	5410	50.998	77.9%	WAYNE
607	0010	50.973	77.8%	CALHOUN
608	0020	50.959	77.8%	SAGINAW
609	0006	50.928	77.8%	GENESEE
610	5831	50.853	77.7%	WAYNE
611	1974	50.800	77.7%	OAKLAND
612	1622	50.630	77.7%	OAKLAND
613	2421	50.363	77.6%	MACOMB
614	4107	50.329	77.6%	WASHTENAW
615	0026	50.273	77.5%	MUSKEGON
616	2324	50.220	77.5%	MACOMB
617	0037	50.212	77.5%	GENESEE
618	2308	50.107	77.4%	MACOMB
619	0021	50.102	77.4%	MUSKEGON
620	2417	50.060	77.4%	MACOMB
621	0037	50.049	77.3%	INGHAM
622	5170	50.038	77.3%	WAYNE
623	5733	50.009	77.2%	WAYNE
624	5718	50.000	77.2%	WAYNE
625	0036	49.975	77.2%	GENESEE
626	5157	49.891	77.1%	WAYNE
627	4120	49.846	77.1%	WASHTENAW
628	5432	49.749	77.1%	WAYNE
629	0135	49.700	77.0%	GENESEE
630	5862	49.623	77.0%	WAYNE
631	2412	49.542	77.0%	MACOMB
632	6250	49.499	76.9%	SAINT CLAIR
633	0010	49.491	76.9%	SAGINAW
634	0306	49.400	76.8%	SHIAWASSEE
635	5778	49.382	76.8%	WAYNE
636	0001	49.348	76.8%	MUSKEGON
637	5830	49.283	76.7%	WAYNE
638	0027	49.237	76.7%	GENESEE
639	5542	49.217	76.7%	WAYNE
640	0033	49.170	76.6%	KENT
641	0322	49.164	76.6%	ALLEGAN
642	2476	49.164	76.6%	MACOMB
643	0202	49.138	76.5%	EATON
644	0053	49.136	76.5%	INGHAM
645	4026	49.087	76.4%	WASHTENAW
646	0010	49.064	76.4%	GENESEE
647	0016	49.024	76.4%	SAGINAW
648	0141	48.966	76.3%	KENT
649	2309	48.955	76.3%	MACOMB
650	2552	48.786	76.3%	MACOMB
651	5465	48.743	76.2%	WAYNE
652	5719	48.692	76.2%	WAYNE
653	2623	48.685	76.2%	MACOMB
654	0011	48.635	76.1%	SAGINAW
655	0252	48.555	76.1%	OTTAWA
656	5463	48.495	76.0%	WAYNE
657	5683	48.403	76.0%	WAYNE
658	4105	48.392	76.0%	WASHTENAW
659	1621	48.388	75.9%	OAKLAND
660	5406	48.386	75.9%	WAYNE
661	5171	48.332	75.9%	WAYNE
662	0013	48.298	75.8%	GENESEE
663	0036	48.295	75.8%	INGHAM
664	5721	48.216	75.8%	WAYNE
665	4103	48.159	75.7%	WASHTENAW
666	4140	48.151	75.7%	WASHTENAW
667	0212	48.095	75.6%	BERRIEN
668	5555	48.084	75.6%	WAYNE
669	5724	48.064	75.6%	WAYNE
670	2408	47.970	75.5%	MACOMB
671	5649	47.963	75.5%	WAYNE
672	4110	47.960	75.5%	WASHTENAW
673	5857	47.943	75.4%	WAYNE
674	0022	47.935	75.4%	KENT
675	5836	47.895	75.4%	WAYNE
676	0002	47.855	75.3%	GENESEE
677	0035	47.750	75.3%	CALHOUN
678	5430	47.736	75.2%	WAYNE
679	2314	47.730	75.2%	MACOMB
680	6240	47.712	75.2%	SAINT CLAIR
681	0013	47.639	75.1%	KALAMAZOO
682	5701	47.627	75.1%	WAYNE
683	0011	47.590	75.1%	KENT
684	0041	47.583	75.0%	KENT
685	4130	47.562	75.0%	WASHTENAW
686	1454	47.556	75.0%	OAKLAND