A Review of Stakeholder Feedback and Indicator Analysis for the Maryland Environmental Justice Screening Tool

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ABSTRACT

Background. A wealth of research has shown that communities of color and low-income populations have been disproportionately burdened by environmental hazards and locally unwanted land uses (LULUs) including incinerators, power plants, landfills, and other pollution- intensive facilities. Unfortunately, the State of Maryland has made little progress in constructing tools to assess and address environmental injustice and related health issues. The National Center for Smart Growth has begun developing a new mapping tool for Maryland—Maryland EJSCREEN—that highlights the prevalence and frequency of environmental hazards and LULUs and their health risks for nearby populations.

Goal. The long-term goal is to use this tool to highlight areas with environmental justice issues and areas that need additional investments. The tool should be used in permitting, regulatory, zoning, and development decisions.

Objectives. This project's objectives are to collect information on environmental, social, economic, exposure, and health indicators that should be included in the Maryland EJSCREEN tool; obtain feedback from stakeholder groups on indicators that should be included in the tool and prioritized; and demonstrate the utility of the EJSCREEN tool.

Approach. In collaboration with the Partnership in Action Learning in Sustainability (PALS), we performed a literature review of economic, social, environmental, exposure, and health indicators identified as important by several Prince George's County community members and stakeholders in a series of demonstration workshops. Stakeholders included residents from the Port Towns, Environmental Action Council members, the Environmental Justice legislative team, and the Commission on Environmental Justice and Sustainable Communities. Flashcards, posters, and surveys were distributed to community members and stakeholders to gather valued feedback about necessary indicators that were acceptable to be highlighted in Maryland EJSCREEN.

Results. We found that the demonstration workshops were effective in soliciting feedback from residents, advocates, health practitioners, policymakers, and other stakeholder groups.

Importance to Public Health. This tool can be used by local residents to advocate for new policies, better enforcement, and public health improvements. It can also be used by government officials to build healthier, greener, more equitable, and more sustainable communities.

INTRODUCTION

The National Center for Smart Growth has initiated the development of a mapping tool for the State of Maryland, known as Maryland EJSCREEN, that will be used to examine and address environmental injustice and related health issues throughout the state.
Specifically, the tool will highlight the prevalence and frequency of environmental hazards and health risks for nearby populations.

Since the 1970s, environmental justice research has illustrated siting disparities of environmental hazards and locally unwanted land uses (LULUs) in communities of color (Adamkiewicz et al., 2014; Brown, 1994; Kabisch and Haase, 2014; Stretesky and McKie, 2016; Schulz et al., 2016). Specifically, neighborhoods of color and low-income populations repeatedly attract noxious facilities that threaten the social, environmental, and physical health of local residents (Mohai and Saha, 2015; Ard, 2015; Cushing et al., 2015; Brender et al., 2011; Schulz et al., 2016). There are a sufficient number of environmental components that drastically affect the physical and social well-being of a population: proximity to hazardous waste sites, exposure to air and water pollution, residential crowding, high levels of ambient noise, the work environment, and the quality of local schools (Cushing et al., 2015; Brown, 1994; Brender et al., 2011; Jerrett et al., 2004).

Communities of color and low-income populations regularly face a disproportionate burden of exposure to unhealthy environmental conditions and environmental risk in the United States, especially when compared to affluent and white communities (Cushing et al., 2015; Casagrande et al., 2011). Differential exposure to environmental pollution leads to differential rates of environmentally sensitive diseases such as cancer and asthma (Cushing et al., 2015; Brender et al., 2011).

Two existing tools work to combine environmental and demographic indicators to increase public knowledge of the principle aspects of a given environment: EJSCREEN and CalEnviroScreen. EJSCREEN is an environmental justice mapping and screening tool created by the United States EPA (USEPA, 2017). It combines environmental and demographic indicators into EJ indexes (USEPA, 2017). Indicators include:

- Lead Paint
- Ozone
- Traffic Proximity and Volume
- Percent Low-Income
- Percent Minority
- Individuals under age 5 (USEPA, 2017)

EJSCREEN can help users identify potential environmental quality concerns; support policy changes in a given community; and compare selected locations to the rest of the state, region, or nation (USEPA, 2017).

Similarly, the CalEnviroScreen mapping tool was created to identify California communities that are disproportionately burdened by pollution sources (CalEnviroScreen, 2017). In this tool, indicators are broken down by types of pollution, such as exposure and environmental effect indicators and population characteristics (i.e., sensitive populations and socioeconomic factor indicators) (CalEnviroScreen, 2017). The overall CalEnviroScreen score is calculated from the general score for aforementioned indicator categories (See Figure 1) (CalEnviroScreen, 2017).

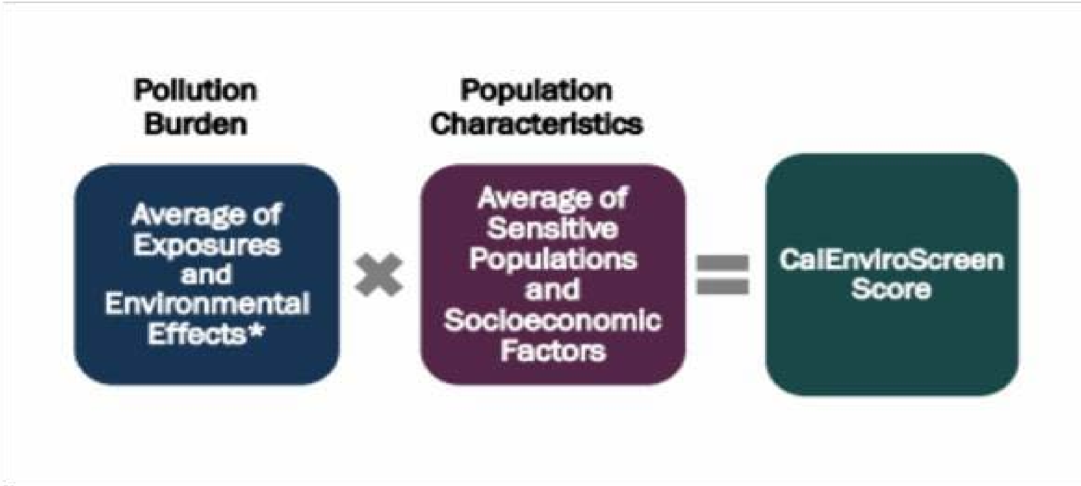

Figure 1. CalEnviroScreen Scoring Procedure

In Maryland, staff at the National Center for Smart Growth, faculty at the School of Public Health, and staff at the Maryland Environmental Health Network have collaborated to build the Maryland Environmental Justice Screening Tool using the model of the EPA's EJSCREEN tool and CalEnviroScreen.

To gather indicator information for the Maryland EJSCREEN tool, we collaborated with PALS to perform a literature review of economic, social, environmental, exposure, and health indicators identified as important by residents in Prince George's County and other stakeholders in a series of demonstration workshops.

For example, the MD EJSCREEN tool will enable stakeholders to assess the correlation between air pollution exposure and the percentage of non-white individuals. Studies have shown that non-Hispanic Blacks are consistently found in communities with poor air quality (Miranda, 2011; King, 2015; Mohai et al., 2009). Fine particulate matter ($PM_{2.5}$) transports toxic substances such as lead, sulfates and metals, that can penetrate deeply into the respiratory system (Miranda, 2011). Long-term exposure to $PM_{2.5}$ decreases respiratory efficiency, exacerbates asthma symptoms, and increases hospital visits, cardiovascular disease, morbidity and mortality (Janssen, 2011; Mikati et al., 2018). Research demonstrates the association between exposure to particulate matter and cancer risk in low-income communities of color (Morello-Frosch et al., 2006). Specifically, African-American, Hispanic, and Asian populations experience higher lung, breast, and liver cancer risks compared to their White counterparts (Morello-Frosch, 2001; Puett et al., 2014; Deng et al., 2017). Potential disparities in burden, exposure, risk, and health among sociodemographic groups in Prince George's County and in Maryland illustrate the importance and need for the Maryland EJSCREEN tool.

Problem Statement

Maryland residents have limited knowledge about the distribution of environmental hazards and their potential effects on health and quality of life. This is partly due to the absence of tools to map and visualize data that can clearly identify the distribution of risk factors across different sociodemographic groups. The Maryland EJSCREEN tool was built to educate Maryland residents on the potential disparities within and across communities, to highlight local community concerns, and to potentially be used for state and local policymaking.

Currently, the tool is in the development stage and as such, its developers are still smoothing out issues with its design, functionality, and interactive capabilities. One of the developers' objectives is to use stakeholder feedback to build an early version of the mapping tool that can be used by multiple stakeholders at the state level, in local communities such as Bladensburg, and by agencies including the Prince George's County Department of the Environment (DOE).

METHODS

To develop, improve, and determine which environmental, population, and health indicators would be included in the Maryland EJSCREEN tool, feedback was obtained from Prince George's County stakeholders in a series of demonstration workshops. Stakeholders included residents from the Port Towns, Prince George's County Environmental Action Council (EAC) members, the Environmental Justice legislative team, and the Commission on Environmental Justice and Sustainable Communities. At the workshops, posters listing different indicators were displayed and surveys were distributed to gather feedback about which indicators were necessary and acceptable to be highlighted in the Maryland EJSCREEN tool.

The initial stakeholder meeting was held with the Prince George's County Environmental Action Committee, a group that provides feedback on environmental concerns to the Prince George's County Department of the Environment. Their feedback was documented on flashcards to be reviewed and added to the list of indicators in the Maryland EJSCREEN tool.

Subsequent meetings used posters and surveys to gather data from stakeholders. To determine an indicator's necessity for the EJ mapping tool, posters highlighting their were displayed at the Bladensburg Waterfront Park, and participants were asked to rank the importance of each indicator. Four colored stickers were used to represent essential indicators and unimportant or nonessential indicators and were tallied to quantify feedback from the stakeholders. Unfortunately, there was a lack of consistency in the significance of each colored sticker. To account for this issue, we removed the essential/nonessential value from each sticker, and instead counted the number of stickers on each indicator to reflect the significance of each indicator.

We obtained feedback from stakeholders about a number of indicators including percent non-white, individuals under age 5, myocardial infarction discharges, obesity, diesel particulate matter, and tree canopy coverage. Using the same list of indicators, surveys of community members asked them to prioritize indicators using a Likert Scale, in which a score of 1 indicated that an indicator was low priority and a score of 5 indicated it was high priority. These surveys were sent to a number of community and stakeholder groups, including the Association of Baltimore Area Grantmakers (ABAG), the Commission on Environmental Justice and Sustainable Communities, the Prince George's County Environmental Action Council (EAC), and the Environmental Justice Legislative Team.

RESULTS

The results of these stakeholder engagement activities yielded information on which indicators were most important and should be included in the Maryland EJSCREEN tool.

Tabulated results showed the following priority indicators: asthma emergency room discharges (12 votes), percent non-white (11 votes), proximity to treatment, storage and disposal Facilities (8 votes), myocardial infarction discharges (7 votes), low birth-weight infants (7 votes), particulate matter (7 votes), and pathogenic infrastructure (7 votes).

In the development of the Maryland EJSCREEN tool, community members advocated for the inclusion of these seven indicators as a way to highlight aspects of the economic, environmental, and exposure factors that can significantly alter community health. These indicators, and several others are defined in the sections that follow.

In conducting this study, we encountered problems with obtaining reliable data from the Google Surveys due to a lack of responses from attendees at stakeholder meetings. The amount of information we received for each indicator was not as complete as it could have been because a number of attendees didn't respond to the survey.

Other limitations included the accuracy of feedback from the Bladensburg stakeholder meeting. Initially, stakeholders were asked to rank the importance of each indicator based on a color coding system. However, the different meanings of each colored sticker weren't clear to all attendees. This caused confusion and so we decided to tally the number of stickers placed on each indicator rather than color code the indicators. At that same meeting, not all attendees understood the meaning of each indicator. Thus, an 'importance sticker' may have been placed on the wrong indicator.

Analysis of Indicators

Population Characteristics: Sensitive Populations

Asthma emergency room discharges. According to the Office of Environmental Health Hazard Assessment, asthma is defined as a disease that affects lung function and inhibits the breathing process (Office of Environmental Health Hazard Assessment, 2018). The causative agents of asthma are widely unknown but environmental and genetic factors are believed to be involved (Office of Environmental Health Hazard Assessment, 2018). Research has shown that asthmatic individuals are more susceptible to pneumonia, flu, and other illnesses (Office of Environmental Health Hazard Assessment, 2018; Juhn, 2014; Torres et al., 2015). Asthma emergency room discharges measure the number of individuals admitted and discharged from the hospital following an asthma attack or related upper respiratory issue (Office of Environmental Health Hazard Assessment, 2018). Asthma is a manageable disease, though its effects and symptoms are exacerbated by the presence of heavy traffic and outdoor air pollution (Office of Environmental Health Hazard Assessment, 2018).

Vulnerable non-White populations including children, the elderly and low-income individuals, tend to experience a greater burden of asthma incidences (Mitchell, 2016; Washington et al., 2017; Lieu et al., 2002). For example, African-American children experience higher asthma hospitalization rates than White children (Lieu et al., 2002). Asthma incidence rates are associated with indoor environmental exposures such as the effectiveness of ventilation systems, levels of pest infestation, the use of cleaning products, and the daily activity of the resident (Adamkiewicz et al., 2014). African-American children frequent emergency rooms due to asthma related symptoms such as breathlessness, wheezing, and chest tightness far more than than White children (Mitchell, 2016). African-American and Hispanic/Latino children also suffer worse asthma morbidity, poorer quality of life, worse asthma control, more uncontrolled symptoms, and higher prevalence rates of asthma when compared to White children (Mitchell, 2016; Washington et al., 2017). A Baltimore study found that African-American children were hospitalized twice as often as White children and admitted into the ICU 1.5 times more frequently due to asthma related symptoms (Mitchell, 2016).

Environmental and sociodemographic factors such as household income and parental education level heavily influence asthma rates in different populations (Washington et al., 2017). Economically disadvantaged communities are exposed to a more asthma triggers such as dust mites, mold spores, rodent allergens, and mildew (Washington et al., 2017). The presence of other environmental stressors such as exposure to passive cigarette smoke and stress associated with violent crime are also associated with asthma morbidity (Canino et al., 2009; Eldeiraw et al., 2016; Forno and Celedon, 2012).

Myocardial infarction discharges. Myocardial infarction discharges measure the number of individuals released from the hospital or emergency room following a myocardial infarction (MI), or heart attack (Prince George's County Community Health Needs Assessment, 2016). The strongest drivers of myocardial infarctions are poverty, high-risk environments, and the lack of access to affordable, nutritious foods (Prince George's County Community Health Needs Assessment, 2016). Poverty and high-risk environments are significant stressors on the body; able to destroy the immune and organ systems. These exposures can lead to myocardial infarctions and premature mortality (Prince George's County Community Health Needs Assessment, 2016). The lack of nutritious foods also plays a pivotal role in morbidity. Research has shown that poor health outcomes such as chronic diseases are frequently associated with a lower consumption of fruits, vegetables, and whole grains (Mead, 2008; Boeing et al., 2012).

In 2016, the myocardial infarction hospital discharge rate in Prince George’s County was 110 discharges per 100,000 residents (SPH, 2012*)*. It was reported that Anne Arundel, Montgomery, Baltimore, Howard, and Prince George’s Counties all had significantly higher myocardial infarction discharge rates than the Maryland state average of 81.8 discharges per

100,000 residents (SPH, 2012). The discharge rates for all five counties ranged from 91.7 to 190.6 discharges per 100,000 residents, an average to below average health status for local residents (SPH, 2012).

Furthermore, the rates of acute myocardial infarctions have steadily increased since 2010 (Prince George's County Community Health Needs Assessment, 2016). For instance, there were a total of 193 discharged myocardial infarctions in Prince George’s County in 2010; 203 discharges in 2011; 220 discharges in 2012; and 224 myocardial infarction discharges in 2014 (Data USA, 2017). Exposure to environmental toxicants could be a factor in the rise of myocardial infarctions in Prince George’s County.

Low birth weight infants. Low birth weight infants are defined as babies who are delivered weighing less than 2,500 grams (5.5 pounds) (Hughes et al., 2017). The probability of having a low birth weight child is higher in communities with high rates of poverty, violence, stress, maternal smoking, poor health (prenatal) care, and little or no availability of healthy food (Martinson and Reichman, 2016; Hill et al., 2016; Knopik et al., 2016). Traffic, agricultural, and industrial pollution also contribute to the risk of low birth weight infants (Fleischer et al., 2014; Basu et al., 2014). Children who are delivered at a low birth weight are more likely to develop chronic diseases later in life such as cerebral palsy, developmental delay, deafness and blindness, or they may die as infants because their bodies are not developed enough to fight infections or to proceed with natural processes such as sending oxygen to the brain or digesting food and gaining weight (Goode, 2018; Schieve et al., 2016).

Recent data reveals that the percentage of low birth weight infants has steadily declined between 2009 to 2014 (Creekmur, 2015) in Prince George’s County. For example, 10.5 percent of infants weighing less than 5.5 pounds were born in 2009 and 10.2 percent of infants were below 2,500 grams in 2010 (Creekmur, 2015). Low birth weight percentages plateaued between 2011 and 2012 at 10 percent however, the rates continued to decline in 2013 and 2014 to 9.4 percent and 9.2 percent, respectively (Creekmur, 2015). It is likely that the rate of low birth weight infants will surpass that of the state, as the average percentage of low birth weight infants in Maryland was about 8 percent between 2009 and 2014 and has not changed significantly (Creekmur, 2015).

The percentage of low birth weight infants also varies by race and ethnicity in both Prince George's County and in the state. For instance, in 2009, 13 percent of all Black, non-Hispanic children were born as low birth weight infants (Espitallier, 2009). Also, 7 percent of White non-Hispanic infants, 6.6 percent of Hispanic children and 8.1 percent of all Asian/Pacific-Islander children were low birth weight infants (Espitallier, 2009). These racial differences could be due to exposure to environmental toxicants such as air pollution in Prince George's County.

Obesity. Obesity is defined as having a total amount of body fat greater than the generally accepted 'healthy level' of fat for a particular height (Segal, 2016). The Body Mass Index (BMI) is used to collect data on the prevalence of obesity. A BMI score of 30 (kg/m^2) or above is considered severely overweight (Segal, 2016). Obese individuals have an increased risk of severe health conditions such as heart disease, hypertension, stroke, and respiratory issues (Casagrande, 2011; Hall et al., 2015; Mitchell et al., 2015). More importantly, obesity disproportionately affects populations of color, populations with high poverty rates, and adults with lower educational attainment (Segal, 2016; Wang and Beydoun, 2007; Levine, 2011).

Previous studies have shown an association between the built environment and obesity rates (Casagrande, 2011; Ewing et al., 2014). Urban sprawl, land use mix, walkability, park availability, and accessibility to physical activity related resources are features known to reduce and prevent obesity (Casagrande, 2011; Kowaleski-Jones et al., 2017; Rundle and Heymsfield, 2016). The social environment in a given community (relationships, groups, and social processes among residents) also can contribute to obesity risk (Suglia, 2016). Studies have also shown that living in a community of color correlates with environmental factors that contribute to obesity (Segal, 2016; Adkins et al., 2017).

For example, one study found that fast-food establishments were equally prevalent in both high- and low-income Black communities compared to White communities (Segal, 2016). Additionally, communities of color were less likely to have recreational facilities compared to White neighborhoods (Segal, 2016; Adkins et al., 2017).

Moreover, African-Americans in Prince George's County have a high obesity rate, and are currently facing an obesity epidemic (Sogie-Thomas, 2018). In 2014, 38.9 percent of Black, non-Hispanic residents in Prince George's County were categorized as obese and 35.9 percent of Black, non-Hispanic residents were deemed overweight (Prince George's County Community Health Needs Assessment, 2014). This rate declined slightly to 38.1 percent in 2016; however, there is still a significant racial disparity in obesity in both Prince George's County and the state (Sogie-Thomas, 2018). The absence of meaningful change in respect to obesity is likely due to the ineffectiveness of County efforts to address obesity disparities, and further points to a need for greater collaboration between the County's health department and other agencies in promoting obesity prevention (Sogie-Thomas, 2018).

Chronic respiratory disease. Chronic respiratory diseases are defined as diseases that impact the function of the lungs (Prince George's County Community Health Needs Assessment, 2015) such as chronic obstructive pulmonary disease (COPD), bronchitis, and asthma (Prince George's

County Community Health Needs Assessment, 2015). The leading cause of COPD is smoking; however, research has shown that environmental tobacco smoke exposure appears to cause both new cases of asthma and COPD (Eisner, 2005). Environmental tobacco smoke contains carcinogenic irritants; it can lead to chronic irritation of the airway and to obstruction due to inflammation (Eisner, 2005; Schick and Shusterman, 2016). Indoor exposure to volatile organic compounds—released from household furnishings and products—also exacerbate respiratory and cancer risk (Adamkiewicz et al., 2014).

Research has also demonstrated that predominantly non-White and low-income populations live closer to locally unwanted land uses (LULUs) including Toxic Release Inventory (TRI) facilities and heavily traveled highways (Eisner, 2005; Mohai and Saha, 2015). Traffic emissions play a significant role in air quality and there is evidence of a causal relationship between exposure to traffic-related air pollution and the incidence of impaired lung function and respiratory disease (Boehmer, 2010; Bowatte et al., 2017; Hamra et al., 2015), which will be discussed extensively later on in this document.

According to the US EPA, African-Americans have elevated exposure to poor air quality, directly correlating with their higher rates of lung cancer and COPD (Mitchell, 2016; Brown, 1994) compared to other populations.

Diabetes. Diabetes occurs when the levels of glucose (sugar) in the blood are far above normal (Diabetes, 2014). Diabetes is the result of the pancreas' inability to either create or maintain insulin production—both resulting in a buildup of glucose in the bloodstream (Diabetes, 2014). If unmanaged for years, this disease causes life- threatening conditions such as heart disease, blindness, kidney failure, and lower leg amputations (Diabetes, 2014).

Among Black and Asian non-Hispanic residents, diabetes continues to be a leading cause of death (Prince George's County Community Health Needs Assessment, 2016). In 2014, about 11.5 percent of all adults in Prince George’s County were expected to have diabetes—13.7 percent of White, non-Hispanic residents and 13.4 percent of Black, non-Hispanic residents (Prince George's County Community Health Needs Assessment, 2016). There is a disparity in the diabetes-related mortality rate; Black, non-Hispanic residents have a higher age-adjusted death rate than their White counterparts (Prince George's County Community Health Needs Assessment, 2016). In 2014, the rate of death due to diabetes complications was higher in Prince George’s County (11.5 percent) compared to the state (10.2 percent), and to the United States (10 percent) (Prince George's County Community Health Needs Assessment, 2016).

Population Characteristics: Socioeconomic Factors

Percent non-white. Prince George’s County is the largest and wealthiest majority African-American County in the United States (Sogie-Thomas, 2018). African-Americans are 61.6 percent of Prince George’s County’s population. The ethnic composition of Prince George’s County also includes 156,102 (17.0 percent) Hispanic residents, 125,885 White residents (13.8 percent), and 39,512 Asian residents (4.34 percent) (DataUSA, 2017). Not only do African-Americans make up the majority of the County’s population, they also are the group with the highest poverty rate, followed by Hispanic residents (DataUSA, 2017).

Additionally, high concentrations of non-white, low-income residents in a given area often coincides with elevated instances of environmental injustice (Mohai and Saha, 2007). Communities of color frequently endure disproportionate exposures to hazardous land uses such as landfills, incinerators, publicly-owned treatment works (POTWs), Toxic Release Inventory

(TRI) facilities, and other LULUs (Corburn, 2017; Wilson, 2008).

There are several reasons why environmental injustice may occur in a particular community. Economic factors often drive large industries to site hazardous facilities in areas with inexpensive land (Mohai and Saha, 2007). This commonly results in disparate post-siting demographic changes; affluent whites tend to move out and people of color and low-income groups move in (Mohai and Saha, 2007).

Sociopolitical factors drive environmental inequality because poor, non-White residents have less access to high ranking decision-makers compared to their affluent, White counterparts (Mohai and Saha, 2007).

Finally, siting a hazardous facility in disadvantaged communities can be deliberate—populations of color seldom push back or have political leverage resist large corporations when disparate siting occurs (Mohai and Saha, 2007; Mohai and Saha, 2015).

Research repeatedly demonstrates the disproportional siting of toxic waste facilities and other hazardous land uses in non-White and economically disadvantaged communities (Stretesky, 2016). Instances of environmental injustice can be seen in most if not all densely populated cities—locations with small- to large-sized hazardous waste generators invariably have increased Black, Hispanic, and Asian population percentages (Mohai and Saha, 2007; Brown, 1994).

Percent low-income. Low-income residents are highly vulnerable to environmental risks (Schulz et al., 2016). More importantly, non-White, low-income children and elderly people are disproportionately exposed to indoor and outdoor pollutants such as NO_2 (Clark et al., 2014).

As of 2015, 9.3 percent of the County's population lived below the poverty line, significantly lower than the state average of 14.7 percent (DataUSA, 2017). The poverty threshold varies by family size and the number of related children in a household under 18 years old (DataUSA, 2017). In 2015, the poverty thresholds for a family of four and six were $24,257 and $32,542, respectively (DataUSA, 2017). If total family income is beneath poverty threshold, every member of that family is classified as living in poverty (DataUSA, 2017).

Moreover, the largest racial/ethnic group living in poverty in Prince George's County is African-Americans, followed by Hispanic/Latino residents (DataUSA, 2017). In 2015, 47.9 percent of Black residents in the County were impoverished, followed by 21 percent of all Hispanic/Latino residents (DataUSA, 2017). The rate of poverty in a particular community dramatically affects most, if not all, aspects of the built and the social environment such as educational quality, environment health, and quality of life (Orfield, 2005). Low-income communities of color don't receive the same rights to a clean and safe environment as wealthier and whiter communities (Wilson, 2008). Research has shown that low-income populations are more exposed to health-threatening environmental contamination compared to wealthier populations (Massey, 2004). For instance, low-income communities of color are disproportionately burdened by hazardous waste sites, landfills, polluting industrial facilities and incinerators (Anguelovski, 2016; Massey, 2004; Mohai and Saha, 2015). Cumulative pollution exposure in low-income communities is roughly three to four times higher than wealthier communities—a recurring pattern throughout the United States (Massey, 2004).

The interplay between race, income, and hazardous air quality has been studied since the early 1970s (Brown, 1994). Research from 1971 has shown that low-income populations and people of color have higher exposure rates compared to their white populations (Brown, 1994). Low-income, non-white communities also experience higher rates of respiratory diseases such as asthma and bronchitis, as well as increased rates of breast cancer and leukemia (Corburn et al., 2006; Massey, 2004; Pickett and Wilkinson, 2008). Other research has shown that low-income houses have levels of chemical agents that can cause adverse health effects. The detrimental agents include pesticides, pest allergens, combustion byproducts, and secondhand smoke (Adamkiewicz et al., 2014). Low-income communities also experience higher levels of stress that can result in poor physical and mental health (Mountney, 2012; Santiago et al., 2011).

Due to limited economic resources and lack of political representation, low SES groups are more likely to be affected by environmental injustice. For example, People with low incomes have an increased likelihood of being in contact with toxic chemicals (Bevc et al., 2007; Tufts, 2001; Payne-Sturges and Gee, 2006). This is due to the fact that many low-income individuals live neat LULUs. Their exposure to environmental contamination increases their risk of developing chronic illnesses such as cancer, asthma, COPD, and cardiovascular disease, among others (Brook et al., 2010; Keeler et al., 2002; Tufts, 2001).

Individuals under the age of 5. This socioeconomic factor is significantly important as children below the age of five are one of the most susceptible groups to negative social and environmental conditions (WHO, 2017; Landrigan, 2011). Unfortunately, one in four deaths of children under the age of 5 are due to toxic environments (WHO, 2017). Young children are especially vulnerable because they have an underdeveloped immune systems, smaller bodies, and are continuously developing vital organs (WHO, 2017).

As of 2015, children under the age of 5 made up 6.3 percent of the population in Prince George's County (DataUSA, 2017). Children under the age of five who are exposed to indoor and outdoor air pollution and second-hand smoke have an increased risk of childhood pneumonia, chronic respiratory diseases, heart disease, stroke, and cancer (WHO, 2017; Lanphear, 2005). In addition, children in low-income families suffer increased health disparities compared to children from higher income families (Barrett, 2015). These children live in stressful environments full of pollution, noise, crowding, and poor housing, that dramatically affects areas of the brain associated with attention, memory, and language—skills needed for academic success (Brooker, 2011; Luby, 2013). They also are more likely to develop chronic stress that affects their physical and emotional health (Brooker, 2011; Hair, 2015).

Children in low-income communities risk being affected by the environment due to windows of susceptibility when they are more vulnerable to exposure to toxic agents. For instance, exposure to carbon monoxide while in the womb can damage neuropsychological performance, and decrease short-term memory recall and motor performance (Calderón-Garcidueñas et al., 2016; Calderón-Garcidueñas et al., 2008). Children are more susceptible to toxic chemicals because their bodies are rapidly changing and haven't built an immunity to fight toxis agents (CDC, 2012). Exposure to these agents at a young age will cause neuroinflammation, respiratory inflammation, and a degradation of the blood-brain barrier (BBB) (Calderón-Garcidueñas et al., 2016; Calderón-Garcidueñas et al., 2008). The blood-brain barrier carries blood to the brain and spinal cord tissue, while protecting the substances that flow into the capillaries (Calderón-Garcidueñas et al., 2016; Calderón-Garcidueñas et al., 2008). When the blood-brain barrier is degraded, hazardous substances are free to enter the bloodstream and cause irreparable damage such as childhood cancer, asthma, and immune deficiencies (Calderón-Garcidueñas et al., 2016; CDC, 2012; Calderón-Garcidueñas et al., 2008).

Less than high school education. This indicator helps understanding differences in educational attainment in Prince George's County and communities such as Bladensburg. More than 14 percent of adults over the age of 25 living in Prince George's County have attained less than a high school education (U.S. Census Bureau, 2017). People with less than a high school education are more likely to be low income versus those who have some college or a bachelor’s degree. Individuals with lower educational attainment have higher risks of exposure to toxic agents because they may live in poor housing stock or near environmental hazards due to their lack of economic resources. Many people with a lower educational attainment also have a greater risk of poor health outcomes including heart disease, obesity, and Alzheimer's (Zimmerman, 2015; Ricceri, 2016) compared to more educated populations. They also have less access to healthy food. Unfortunately, these communities tend to have higher access to pathogenic food resources such as liquor stores, fast food restaurants, and convenience stores (Zimmerman, 2015; Hendrickson, 2006).

Linguistic isolation. Linguistic isolation is defined as a household that doesn’t speak English at home as a primary language. Often translation services can help reduce linguistic isolation. However, an individual who is linguistically isolated might not have access to translation services. According to U.S. Census Bureau data, 11.5 percent of Prince George's County residents speak Spanish as the primary language in their household (U.S. Census Bureau, 2017). Linguistic isolation may impact the ability of Spanish-speaking residents to access health care resources. The inability to communicate could lead to poor treatment, lower rates of health care use, and health disparities.

People who live in linguistically isolated neighborhoods may be adversely affected by environmental hazards and may have communication barriers with English-speakers, which can impact whether or not their voices are included or heard in local environmental decision-making processes (Teron, 2016). For example, these communities may have an increased risk of exposure to harmful toxicants due to their lack of communication with government officials during zoning discussions.

Individuals over age 64. This indicator is significant because age increases the susceptibility to environmental hazards such as carbon monoxide, particulate matter, and ozone (Cushing et al., 2015). Older adults are vulnerable to the adverse health effects of air pollution due to preexisting conditions such as cardiovascular and respiratory diseases, and asthma (Cushing et. al., 2015; Shumake et al., 2013). Other vulnerabilities in older populations reduced immune response, declined physiological metabolic processes, and increased incidences of myocardial infarction and chronic obstructive pulmonary disease (Shumake et al., 2013). These can adversely impact health and increase the risk of poor health outcomes related to toxic exposures. Additionally, healthcare costs are rising, which can prevent the elderly from receiving adequate healthcare (Access Disparity, 2015) to address comorbid conditions and treat diseases associated with exposure to toxic agents.

Unemployment. Unemployed individuals face increased risk from negative environmental and social conditions compared to individuals who are employed. This may be related to their lack of stable income to cover health care expenses. Research has demonstrated that people who are unemployed are less likely to report they have good health or have health insurance (CDC, 2013; Kraut, 2002). Unemployed individuals without access to adequate health care may not receive essential services such as checkups, counseling, and prenatal care, (Artazcoz, 2004; Mencolva, 2013; Paul, 2009). When someone is unemployed, wage loss affects their socioeconomic status (Bambra, 2010) and their ability to cover essentials such as health care. This can increase health disparities between unemployed and employed populations.

Population density. High population density and overcrowding in urban communities has a detrimental effect on all residents and the surrounding environment (WHO, 2017).
Overcrowding can also lead to hazardous living conditions, contributing to the spread of infectious disease, mold spores, and pest infestations (WHO, 2017). Housing conditions severely impact the health of the community, as studies have identified associations between housing instability, and physical and mental health (Novoa et al., 2015). For example, housing instability caused by overcrowding can induce fear, shame, lack of control, and uncertainty—all of which contribute to a snowball effect of stress, stress-induced illness and disease such as hypertension and heart disease, and in extreme cases, premature mortality (Novoa et al., 2015).

Moreover, residents may adopt unhealthy behaviors to cope with the stress of their living situations. Examples of high risk behaviors include tobacco use, alcohol consumption, and unhealthy eating—all of which contribute to adverse health outcomes such as cardiovascular disease (Novoa et al., 2015).

Pollution Burden: Exposure

Particulate matter. Exposure to airborne particulate matter (PM) can adversely affect human health, causing a number of diseases (Zereini, 2010; Kim et al., 2015; Valavanidis et al., 2008). For instance, long-term PM exposure has been linked to the occurrence of lung cancer, respiratory diseases, and arteriosclerosis (M.C.M de Kok, 2006; Jiang et al., 2016; Burnett et al., 2014; Kim et al., 2015; Kim et al., 2015; Shah et al., 2013; McCreanor et al., 2007; Medina- Ramon et al., 2008; Hoek et al., 2013; Anderson et al., 2012; Pope et al., 2004; Wang et al., 2014; Dvonch et al., 2009; Wilker et al., 2015; Sapkota et al., 2012; Wu et al., 2012; Mortimer et al., 2002; Rowangould, 2013; Meng et al., 2008). Short-term exposure, on the other hand, can lead to respiratory diseases such as bronchitis and asthma (M.C.M de Kok, 2006; Jiang et al., 2016; Broome et al., 2015; Zhang & Batterman, 2013). Particulate matter also has significant effects in vitro (M.C.M. de Kok, 2006; Miousse et al., 2015; Jia et al., 2017). Epidemiological studies have shown that particulate matter can induce adverse cellular affects such as cytotoxicity, DNA damage, and mutagenicity (M.C.M. de Kok, 2006; Valavanidos et al., 2008; Mehta et al., 2008; Valavanidas et al., 2013; Dumax-Vorzet et al., 2015); and smaller fractions of particulate matter ($PM_{2.5}$) radically increase the morbidity and mortality rates of a given population (Zereini, 2010; Xing et al., 2016; Kamarehie et al., 2017).

Moreover, $PM_{2.5}$ is especially harmful to vulnerable populations—people with heart or lung disease, children, and elderly individuals (Zhang et al., 2016; USEPA, 2017; Jiang et al., 2016; Lanki et al., 2006; Simoni et al., 2015; Meng et al., 2016). Vulnerable populations experience decreased lung function, increased respiratory symptoms, aggravated asthma, irregular heartbeat, and premature death (due to the comorbid effects of their preexisting conditions) (Abelsohn and Stieb, 2011; USEPA, 2017; Paulin et al., 2016; Inoue and Takano, 2011).

The presence of particulate matter is also detrimental to plants, animals, and ecosystems (Zereini, 2010; Rai, 2016; Ghorani-Azam et al., 2016; Cambra-Lopez et al., 2010). This is evident as the toxic characteristics of particulate matter accumulate in the environment, and are then biomagnified throughout the food chain, inevitably leading to the contamination of food, animal feed, and even drinking water (Zereini, 2010; Rai, 2016; Hill, 1997). Particulate matter is not only harmful, but difficult to regulate in urban areas because it can be released from many natural and man-made sources (mobile and stationary) (Zereini, 2010; Kampa and Castanas, 2008; Thorpe & Harrison, 2008; Brook et al., 2010; Srimuruganandam and Nagendra, 2010; Houston et al., 2014). Particulate matter also fluctuates through both time and space due to factors such as traffic, meteorological conditions, and proximity to industrial zones (Zereini, 2010; Li et al., 2017; Srimuruganandam and Nagendra, 2010; Houston et al., 2014).

Ozone. Ozone gas exists in the Earth's atmosphere and at ground level (USEPA, 2017; Seinfeld & Pandis, 2016; Zhang and Wang, 2016). There are two types of ozone—good and bad. Good ozone is the gas that naturally exists in the upper atmosphere (USEPA, 2017; Flanner et al., 2018; Froidevaux et al., 2015), which forms a protective layer that defends us from the sun's damaging ultraviolet rays (USEPA, 2017; Goswami and Haldar, 2015; Verma et al., 2015). Bad ozone is ground-level ozone formed from chemical reactions between nitrogen oxides, volatile organic compounds (VOCs), and sunlight (USEPA, 2017; Kamal et al., 2016; Waring and Wells, 2015). Ozone exposure can lead to respiratory symptoms including coughing, throat irritation, chest pains, wheezing, or shortness of breath (Kim et al., 2013; Gorguner and Akgun, 2010; Ren et al., 2016). Ozone can reduce lung function and inflame the lining of the lungs (Tager et al., 2005; Lippmann, 1989; Killburg-Basnyat et al., 2018; Lambrecht and Hammad, 2014). Prolonged exposure can cause permanent scarring of lung tissue (Lippmann, 1989; Cabella et al., 2015; Francis et al., 2016). Exposure to ozone pollution has also been shown to increase the frequency of asthma attacks, make the lungs more susceptible to infection, cause chronic obstructive pulmonary disease (COPD), and increase daily mortality (Benjamin, 2010; USEPA, 2017; Kelly and Fussell, 2011). Research has shown that asthma hospitalization rates increase for children when ozone levels are high (Grineski et al., 2010; USEPA, 2017; Lam et al., 2016).

Although the US EPA, and state and local agencies have worked to reduce ground level ozone levels, ozone exposures remain high (Bell et al., 2014; Colborn et al., 2011; Cohen et al., 2017). Ozone levels have significantly increased in the United States due to expanding transportation networks and energy consumption (Bell et al., 2014; Uddin et al., 2015; Reisi et al., 2016). A recent study reported that 2.5 million disability-adjusted life years (DALYs) are attributable to ozone worldwide (Bell et al., 2014).

However, health responses to ozone vary by age, employment, sex, race, and other factors (Bell et al., 2014; Clougherty, 2010; Malig et al., 2016). Populations sensitive to ozone exposure include those with preexisting respiratory and cardiovascular conditions, people who are active outdoors, high-poverty communities, women, and older populations (Bell et al., 2014; O'Neill et al., 2012; Quintana et al., 2015). Children are particularly vulnerable because their lungs are still developing, and they are more likely to spend time outside (Bell et al., 2014; Ergler et al., 2017; Ghosh and Hertz-Picciotto, 2014).

National Air Toxics Assessment diesel particulate matter. The National Air Toxics Assessment (NATA) conducted by the Environmental Protection Agency is an ongoing comprehensive evaluation of air toxics throughout the United States (USEPA, 2017). Diesel particulate matter (DPM) is an anthropogenic pollutant and a component of diesel exhaust (OSHA, 2017; Ristovski et al., 2012; Sharma et al., 2005). It is released from diesel engines in cars, trucks, ships, trains, and heavy-duty equipment (OSHA, 2017; Benbrahim-Tallaa e al., 2012; Pronk et al., 2009). DPM is highly dangerous due to its small size and effects on human health (OSHA, 2017; Ristovski et al., 2012; Wichmann, 2007). DPM particles are 90 percent less than one micrometer, allowing it to penetrate deeper into the lungs than $PM_{2.5}$ (OSHA, 2017).

Exposure to DPM can irritate the eyes, throat, and nose, and can lead to cardiovascular and pulmonary disease, and lung cancer (USEPA, 2017; Ris, 2007; Buzea et al., 2007).

Increased DPM levels can be linked to increased levels of traffic pollution (Pratt et al., 2015; Mcentee and Ogneva-Himmelberger, 2008; Ketzel et al., 2007). Traffic emissions are the major source of air pollution in urban centers and constitute 60 percent of air pollution (LCV, 2017; Zhang and Batterman, 2013). Exposure to traffic-related air pollution, including particulate matter and other air toxics, can increase the risk of asthma, heart disease, stroke, infant mortality, and cancer in low-income communities and communities of color (LCV, 2017; Schulz et al., 2016; Tarlo et al., 2010). Inequities in transportation infrastructure may contribute to differential health outcomes observed between low- and high-income communities (Pratt et al., 2015; Lynch et al., 2004; Viner et al., 2012). Individuals in low-income areas tend to drive less, but have higher exposures and risks from on-road sources (Yu and Stuart, 2016; Pratt et al., 2015; Apelberg et al., 2005). While individuals who live in more affluent areas have lower risks, but drove more (Yu and Stuart, 2016; Pratt et al., 2015; Apelberg et al., 2005).

NATA air toxics cancer risk. The assessment allows for the estimation of cancer risk and other adverse health effects due to inhalation of particulate matter and other toxic substances (USEPA, 2017). Neighborhoods comprising predominantly non-White residents of low socioeconomic status are disproportionately exposed to air toxics and their associated health risks (Wilson et al., 2015; Morello-Frosch et al., 2006). In the United States, African-Americans experience some of the highest rates of residential segregation and exposure to environmental hazards (Morello-Frosch et al., 2006). The adverse health effects related to residential segregation include elevated risk of infant and adult mortality (Morello-Frosch et. al., 2006). Studies of toxic emissions from Toxic Release Inventory (TRI) facilities have demonstrated that ambient concentrations of hazardous air pollutants (HAPs) were associated with cancer risk levels, with communities of poor non-White residents bearing a disproportionate burden of exposure and cancer health risks (Wilson et al., 2015; Morello-Frosch et al., 2006). Environmental justice research demonstrates a positive correlation between cancer risks associated with ambient air toxics and the prevalence of overburdened racial/ethnic populations in a given area (Morello-Frosch et al., 2006).

For example, cancer risk disparities associated with hazardous air pollutants were measured in a South Carolina study. Similar to previous research, it found a strong association between racially and ethnically diverse populations and estimated cancer risk (Wilson et al., 2015).

NATA respiratory hazard index. The concentration of a hazardous substance and the level at which no adverse effects are expected is measured by the hazard quotient (HQ). An HQ of 1 signifies the maximum concentration permissible without causing harm, known as the reference concentration (RfC). An HQ less than 1 indicates that a substance's concentration is less than the RfC and thus not likely to be cancerous or cause harm. An HQ above 1 indicates a substance's concentration is greater than the RfC value and therefore more likely to cause adverse health effects. However, the severity of these effects may not scale linearly with the HQ value since substances vary in their toxicity and biological mechanisms of action.

The sum of hazard quotients that affect the same organ or organ system is measured by the hazard index (HI). Similar to HQs, the scale for the HI ranges from less than 1 (not likely to cause harm) to greater than 1 (likely to cause harm). Since the HI is based on RfCs, the potential for adverse health effects for values above 1 is not precisely known. While the toxicity of exceedances must be evaluated on a case-by-case basis, the cumulative exposure to substances such as $PM_{2.5}$, arsenic, and NO_2 are well known to be risk factors for cancers, neurological impairment, asthma, atherosclerosis, and chronic obstructive pulmonary disease (Audi et al., 2017; Chen et al., 2015; Hsu et al., 2016).

Cumulative exposure is a significant concern for environmental justice because areas with high percentage of low-income or non-White individuals are often burdened by multiple major and minor pollution sources (Amin et al., 2018; Grineski and Collins, 2018; Hajat et al., 2015).

Traffic proximity and volume. Residential proximity to areas of large traffic volume is a significant environmental health risk factor, because vehicles release a significant amount of fine particles into the atmosphere (Allen et al., 2009; Zereini, 2010; Thorpe and Harrison, 2008) as they burn fossil fuels. Traffic-related pollution sources include exhaust emissions, mechanical wear of tires and brakes, and the ejection of particles from both the pavement and unpaved road shoulders (Adamiec et al., 2016; Zereini, 2010; Kinzierski et al., 2012). Persistent traffic also impacts dust levels that are an important source of coarse particles in residential and urban areas (Pindus et al., 2016; Zereini, 2010; Lelieveld et al., 2015). Ambient particulate matter released from traffic is generally small ($<PM_{10}$), and becomes more toxic as the particles decrease in diameter (M.C.M. de Kok, 2006; Kelly and Fussell, 2012; Li et al., 2008). Research has shown that exposure to traffic-related pollution can lead to increased mortality rates and hospital admissions for patients with COPD, diabetes or heart disease, risk of myocardial infarction, incidence of infection, and lung cancer (Lee et al., 2014; Zereini, 2010; Anderson et al., 2011). Two studies verified that living close to a highway correlates with elevated health risks (Hoek, 2002) including a reduced life expectancy of 2.5 years (Zereini, 2010). Moreover, economically disadvantaged and populations of color generally bear the brunt of air pollution exposure and risk (Boehmer, 2010; Collins et al., 2016; Curran, 2017). Non-

white populations and low SES groups endure higher levels of traffic related air pollution than White residents and high SES individuals (Casey et al., 2017; Boehmer, 2010; Pearce et al., 2010; Glister, 2014; Margai, 2010). In Maryland, African-Americans are three times more likely to be at high risk for cancer due to traffic-related air pollution, while that risk decreased as the proportion of White residents increased (Apelberg et al., 2005).

Noise pollution. One of the most recurring environmental exposures in the United States is noise, (Hammer, 2014) most prominently traffic-related noise pollution in urban areas (Dzhambov, 2014; Casey et al., 2017). Research has shown that nighttime and daytime noise levels were higher in areas with higher proportions of non-white and low SES residents, with the highest noise exposures occurring in the most segregated areas (Casey et al., 2017). Exposure to noise pollution over long periods of time can cause adverse health effects such as sleep disturbance, noise induced hearing loss (NIHL), annoyance, endocrine effects, heart disease, and diminished quality of life (Hammer, 2014; Stansfield, 2003; Münzel et al., 2018). For children, increased noise levels correlate to poor school performance, which this leads to stress and misbehavior (Hammer, 2014; Woolner and Hall, 2010). Children with high exposure also exhibit decreased learning, lower reading comprehension, and reduced concentration (Hammer, 2014; Klatte et al., 2013). Moreover, noise has a number of social and psychological consequences as well. For instance, noise induced hearing loss can limit mobility, work-tolerance, self-care, work skills, and can increase isolation (Hammer, 2014; Sandrock et al., 2008; Stansfeld et al., 2005; Haines, 2003). Noise pollution is expected to continually increase in severity due to population growth, urbanization, and expansion of highway traffic (Goines, 2007; Mishra et al., 2010; Armah et al., 2010). Those most vulnerable to noise pollution are persons of color, individuals rehabilitating from injury or disease, the elderly, fetuses, and infants (Goines, 2007; Crume, 2018; Payne-Sturges and Gee, 2006).

Pollution Burden: Environmental Effects

Proximity to treatment, storage, and disposal facilities. Treatment, Storage, and Disposal facilities (TSDFs) are disproportionately distributed throughout non-White and low-income neighborhoods (Stretesky and McKie, 2016; Schulz et. al., 2016). According to CalEnviroScreen, hazardous waste facilities contain chemicals that are detrimental to the health of the surrounding population (Office of Environmental Health Hazard Assessment, 2017).

These facilities handle substances such as used automotive oil and toxic sludge generated by industrial operations (Office of Environmental Health Hazard Assessment, 2017). The relationship between race, ethnicity, and hazardous facility siting can be attributed to discriminatory decision-making; or as result of post siting demographic change—instances where residents have the economic and social means to distance themselves from undesirable environmental agents (Stretesky and McKie, 2016).

Transportation to and from disposal facilities contributes to air, water, and soil contamination (Barrett, 2015). Vulnerable groups such as children and the elderly bear more adverse health effects when exposed to pollutants (Schultz et al., 2016). For instance, studies have shown that children breathe in a greater amount of air than adults per unit of body weight, increasing their rate of contamination and the likelihood of sickness and disease (Schultz et al., 2016). Elderly individuals similarly experience adverse health outcomes, due to comorbid conditions such as cardiovascular disease and impaired lung function (Schultz et al., 2016). The compound effects of being a non-white, low-income member of a vulnerable population correlates to disproportionate pollution exposure—exaggerating rates of morbidity and mortality (Stretesky and McKie, 2016; Schulz et al., 2016). Communities of color are also less likely to have access to economic and social resources to reduce the adverse health effects associated with disproportionate exposure to pollutants (Schulz et al., 2016).

Moreover, disposal facilities often leach toxicants such as mercury, that can cause irritation to the skin, discoloration of the nails, and corrosion of the mucous membranes (Park, 2012). Furthermore, treatment, storage, and disposal facilities often contain other contaminants such as polychlorinated biphenyls (PCBs), which causes cancer, neurological deficits, and endocrine disruption (USEPA, 2017).

Proximity to major direct water discharges. Proximity to major direct water discharges measures the contamination of surface water (USEPA, 2015). There are two ways of contaminating surface water: direct or indirect discharges from industrial, commercial, agricultural, or residential sites (USEPA, 2015). Individuals who live near direct water discharges can be exposed to water contaminants through direct ingestion (i.e., drinking toxic water) or indirect ingestion (i.e., consuming foods made with the contaminated water) (USEPA, 2017).

Other exposure pathways include incidental ingestion, (e.g., swallowing water while swimming or kayaking), dermal contact (e.g., during a bath or shower), and inhalation of contaminated water vapors during showering (USEPA, 2017). Water pollutants cause adverse health and ecological effects however, the magnitude and severity of exposure varies due to the concentration of the contaminant, pathway of exposure, and the contaminant’s toxicity (USEPA, 2015).

Lead paint. This indicator measures the percent of houses built before 1960 (USEPA, 2017). Lead paint exposure in the home is still significantly high, due to the fact that the number of homes in the United States that contain lead based paint is unknown (USEPA, 2017). The burden of adverse health effects due to lead contamination disproportionately affects socioeconomically disadvantaged communities (Leech et al., 2016).

Children are the most vulnerable population for lead exposure due to their contact with old toys, spending large amounts of time on the floor, and their inevitable hand-to-mouth habits (USEPA, 2015; Bianchi, 2015). For instance, lead painted surfaces are known to chip, peel, or contain a chalky residue (USEPA, 2017). The lead particles are then carried and spread throughout the home adhering to hands, arms, and clothes, and leading to the ingestion of the particles (USEPA, 2015). In addition, if an older home is under renovation, particles will disperse via ambient air causing inhalation and or ingestion of lead (USEPA, 2015).

The health effects of lead are particularly damaging to children due to their undeveloped immune and organ systems (Bianchi, 2015; Schnur, 2014). In fact, the adverse health effects of lead toxicity can impact nearly every organ system in the body (Leech et al., 2016; Reuben et al., 2017). Lead is known to cause chronic effects such as loss of appetite, decreased IQ, behavioral problems, growth impediments, and hearing complications (Bianchi, 2015, Schnur, 2014; Lanphear et al., 2005). Children tend to have increased blood lead levels due to their hand-to-mouth tendencies and an undeveloped blood-brain barrier (Bianchi, 2015, Schnur, 2014). Lead toxicity is also attributed to adverse health effects in adults, since it has been discovered that lead is a risk factor for cardiovascular disease (Lanphear et al., 2018).

Chronic exposure to lead is also known to cause hypertension, atherosclerosis, and cardiovascular disease mortality (Lanphear et al., 2018).

More importantly, studies have shown that burden of lead toxicity is strongly associated with both race and income (Muller et al., 2018; Casagrande et al., 2011; Lanphear et al., 1996; Tong, 2014). Poor populations of color, especially children, bear the greatest risk disparity due to their exposure to lead contaminated agents such as paint chips, house dust, and dilapidated flooring (Muller et al., 2018; Bellinger, 2016; Lanphear et al., 1996).

Lead exposure was emphasized as a significant public health issue in 2014 when the water crisis in Flint, Michigan was publicized. This crisis involved the transportation of water from the Flint River, through a lead filled and largely aging water system, to thousands of homes (Muller et al., 2018). Researchers found that home lead levels were well above US EPA limits and that the highest concentrations of lead were found in disadvantaged neighborhoods (Muller et al., 2018). The rate of lead poisoning in non-White populations is a recurring example of environmental inequities experienced by economically disadvantaged families (Tong, 2014).

Proximity to risk management plan sites. Risk management plan sites include sites that have been contaminated by harmful chemicals and must be cleaned up by government or property owners (Office of Environmental Health Hazard Assessment, 2017). This environmental indicator is important because economically disadvantaged neighborhoods, and predominantly non-White communities, often live near these sites and residents are disproportionately exposed to hazardous chemicals, compared to those living farther away (Office of Environmental Health Hazard Assessment, 2017).

The location of risk management plan sites is significant, because chemicals within the facilities or soil can leach into surrounding communities, effectively contaminating residents and causing a number of diseases and adverse health effects (Office of Environmental

Health Hazard Assessment, 2017). Studies have found toxic heavy metals (e.g., lead, arsenic, cadmium, and chromium) from house dust and pesticides in the blood of residents living near the contaminated sites (Office of Environmental Health Hazard Assessment, 2017). Exposure can lead to numerous negative health outcomes such as skin cancer, lung cancer, bladder cancer, neurological damage, kidney disease, and bone disease (Cabral et al., 2015; Hu et al., 2012; Naujokas et al., 2013). Exposure to pesticides can cause neurological damage, cancer, asthma, and may even increase the risk of developing Parkinson's disease or diabetes (Gilden et al., 2010; Kim et al., 2017; Moretto and Colosio, 2011).

Proximity to NPL sites. The National Priorities List (NPL) is a database of all sites suspected or known to be contaminated by hazardous substances. The primary intent of the NPL is to advise the US EPA on sites requiring immediate attention and sites that warrant further investigation. Included within the NPL is the US EPA's list of Superfund sites. Superfund sites have elevated levels of toxic chemicals such as lead, arsenic, PCBs, and asbestos (Orr, 2002; Ghosh, 2004; Bartelt-Hunt, 2006). Management and cleanup of these sites is funded and organized by the federal government, and NPL sites are sorted into four categories:

- Proposed sites are identified as potential candidates for cleanup.
- Withdrawn sites pose no real threat to human health and have been removed by the US EPA.
- Final sites are identified as hazardous by the USEPA's Hazard Ranking System (HRS).
- Deleted sites have successfully achieved cleanup goals.

There are 25 NPL sites in Maryland—one is proposed, four are deleted, and the rest are final.

Although environmental justice can be measured in various ways, one way used in several studies is the proximity of non-white groups to Superfund sites (Maranville et al., 2009; Bhat, 2005; Petrie, 2006). In 1987, the United Church of Christ (UCC) discovered that

60 percent of African Americans in Warren County, NC lived near toxic landfills (UCC, 1987). Since then, there have been numerous studies corroborating this conclusion, establishing it as a real and serious issue, and also revealing the limited progress made through past decades (Kramar et al., 2018; Amin et al., 2018; Ethnicity et al., 2012; Maranville et al., 2009). In addition, 20 years after the 1987 landmark Toxic Wastes and Race report, researchers found that the correlation between a high concentration of African-American populations and landfills had remain unchanged (UCC, 2007).

The relationship between sociodemographic composition and proximity to Superfund sites extends beyond race and ethnicity into other socioeconomic factors such as education and income. Low-income and families with limited educational attainment are more likely to live in areas with Superfund sites (Burwell-Naney et al., 2013; Payne, 2006; Smith, 2009; Denq, 2000; Smith, 2007).

Proximity to highly trafficked areas. Chronic exposure to air pollution from highly trafficked areas contributes to the prevalence of adverse health effects including lung cancer, cardiorespiratory disease, cardiovascular disease, increased BMI, and premature mortality (Jerrett et. al., 2014; Barone-Adesi et. al., 2015; Kelly et al., 2015; Houston et. al., 2014). Studies conducted between 2000 and 2012 suggest that poor communities of color are disproportionately exposed to traffic-related air pollution (Houston et. al., 2014). However, there is contradicting data concerning the association between pollution exposure and socioeconomic status. One study found little association between pollution exposure and economic status (Goodman et al., 2011), while others found that the rate of exposure increased as socioeconomic status increased (Houston et. al., 2014; Havard et al., 2011).

A recent case study conducted in port-adjacent low-income communities in Los Angeles California assessed how air pollution from diesel truck traffic impacted diverse racial/ethnic and socioeconomic populations (Houston et al., 2014). Residential proximity to highly trafficked areas will increase adverse health effects such as asthma, reduced lung function, adverse birth outcomes, and pulmonary mortality (Allen et. al., 2009; Houston et al., 2014; Salam et. al., 2008). Previously conducted studies indicate that communities of color are disproportionately exposed to traffic-related pollution, and this was reiterated when results showed that neighboring African-American and Pacific Islander residents endured increased exposure to traffic particle pollution (Houston et al., 2014). Moreover, Hispanic residents were discovered to bear higher traffic exposure but decreased risk of particulate matter contact and residents with lower socioeconomic status experienced lower traffic-related pollution exposure rates (Houston et al., 2014). Further research is needed for a comprehensive understanding of the disparities in traffic-related particulate matter exposure (Houston et al., 2014).

Additional Indicators

Pathogenic and salutogenic infrastructure. Pathogenic infrastructure refers to any feature of the built environment that increases a population’s vulnerability to chemical and non-chemical stressors leading to adverse health outcomes. These health outcomes can be influenced through direct methods (e.g., high concentration of fast food restaurants in a neighborhood leading to increased rates of obesity) or indirect methods (e.g., pawn shops and check cashing facilities contributing to a cycle of poverty). Pathogenic infrastructure is especially common in low-income neighborhoods, where healthy food is less accessible and fresh produce is of lower quality (Bell et al., 2013; Wilson, 2010). In addition, the wide availability of fast food, which food tends to be more energy dense and of lower nutritional quality, facilitates overconsumption and leads to obesity (Kearney, 2010). Financially strained families are more likely to buy this cheap, energy-dense food to maximize their calories per dollar and stave off hunger (DiSantis et al., 2013).

Other pathogenic infrastructure that is overly abundant in poor neighborhoods includes liquor stores, tobacco shops, casinos, pawn shops, gun stores, and check cashing facilities (Wilson, 2010; Dennis and Momper, 2012; Townshend, 2016). These businesses have turned poverty into an industry and manipulate vulnerable populations to the point of dependency.

In contrast, salutogenic infrastructure refers to physical, economic, natural, social, and spiritual features of the environment that foster health and nourish wellness (Antonovsky, 1987; MacDonald, 2005). Examples of salutogenic infrastructure include schools, supermarkets, grocery stores, parks, green space, and medical facilities (Hutson and Wilson, 2011).

Tree canopy coverage. Canopy coverage is the layer of leaves, branches, and stems of trees that cover the ground when viewed from above. It is measured as a percentage and functionally refers to the quantity and quality of trees in a specific geographic area. Neighborhoods with an abundance of trees benefit from a multitude of positive, protective and aesthetic features.

While impervious surfaces like parking lots, roofs and roads, absorb and re-radiate heat into the surroundings (Nuruzzaman, 2015), greater tree canopy coverage increases shade over these surfaces, retains more moisture, and decreases wind speeds, which in turn reduce air temperatures and decrease cooling costs for homes and cars (Ulmer, 2016). Shade also protects against harmful UV radiation. It is projected that the 100 million trees planted in residential areas across the United States save about $2 billion annually in reduced energy costs (Butry, 2009). Tree canopy also improves air quality by filtering out an estimated 740,000 tons of air pollution each year (Nowak et al. 2006). In addition, more coverage reduces rainwater runoff and the need for expensive stormwater treatment systems while also improving water quality.

Healthy trees can have an aesthetic impact on a neighborhood and promote outdoor activities, leading to increased property values and commercial benefits (Coutts and Hahn, 2015; McPherson et al., 2011; Tyrväinen et al., 2005). Studies of the relationship between urban tree canopy and socioeconomic factors have shown that while correlations between race and canopy coverage are sometimes difficult to determine, there is a direct relationship between income and tree coverage (Schwarz et al., 2015).

Brownfields. Brownfields are abandoned commercial or residential properties that are expensive to redevelop due to the presence of hazardous substances (USEPA, 2017). These sites can contain toxic chemicals such as PCBs, lead, asbestos, arsenic, and petroleum hydrocarbons (Mathieu et al., 2014). Exposure to these compounds can result in respiratory infections, cancer, neurological damage, asthma, and cardiovascular disease (Ryan et al., 2017; Cabral et al., 2015; Hu et al., 2012; Naujokas et al., 2013). Brownfields are the remnants of an industrial past, which persist in neighborhoods that depended on factories to thrive (Litt et al., 2002; Sugrue, 2005; Xie, 2015). Moreover, abandoned buildings are more commonly found in poorer, less educated neighborhoods with higher proportions of African-Americans (Miller et al., 2011; Walker et al., 2010). Without proper maintenance, these building can become hazardous to the health of the local population. Mapping these sites would be helpful to stakeholders in planning possible clean-up and redevelopment projects, which could provide numerous benefits including the generation of more sustainable communities (Donaldson, 2018).

Proximity to railroads. Concentrations of particulate matter from diesel engine combustion and coal dust from coal trains have been reported around railroads tracks (Jaffe et al., 2015). Railroad tracks often run through residential zones and exposure to these toxicants can have several implications on human health such as asthma, chronic bronchitis, and stroke

(Sydbom et al., 2001; Ristovski et al., 2012). The health impacts of railroads on communities they transect depend on the cargo being transported. Residents may also have concerns about the possibility of injury. In 2017, there were 1,190 train derailments across the country and five deaths resulting from train accidents. The majority of train-related fatalities were caused by pedestrian trespassing in which the train was not at fault. In 2017, there were 575 deaths from trespassing; one in four were suicides and 59.4 percent involved alcohol and/or drugs (USDOT, 2017). While the Maryland Department of Transportation creates a annual strategic goods movement plan, the report fails to include disparities in exposure to particulates and noise pollution due to hazardous chemicals or health impacts of certain goods movement activity along transport routes.

Wetlands and waterways. The wetlands and waterways indicators refer to areas that are saturated by water, either permanently or seasonally (e.g., swamps, marshes, estuaries, lakes, rivers, etc.). The quality of Maryland's wetlands and waterways is monitored by several federal, state, and local agencies including the US EPA, the United States Geological Survey (USGS), and the Maryland Department of Natural Resources (DNR). This indicator could include data from monitoring sites, the location and scope of restoration efforts in Maryland's Non-Tidal Wetland Mitigation Program, and the distribution of funding provided through the Federal Clean Water Act Section 319(h).

The health of waterways impacts the health of local ecosystems and the quality of the water used for daily activities such as cooking, cleaning, and personal hygiene. The DNR performs long term monitoring and shallow water monitoring in the Chesapeake Bay and its tributaries. It also maps impaired waterways and provides GIS data on surface water quality statewide. Current restoration efforts have been slow to improve waterways health due to the expanding population and growing land use. In addition, the distribution of federal grant funds and other wetland projects reveal clear disparities in relation to race and to a lesser extent, poverty. In Maryland, areas with higher populations of non-Whites receive little to no wetland projects funding(Dernoga et al., 2015; Frye et al., 2013; Goldman and Needelman, 2015).

Types of air pollution sources. There are four main types of air pollution sources: mobile sources (e.g., cars, trucks, and buses), stationary sources (e.g., power plants, concrete plants, and factories), area sources (e.g., agricultural areas, cities), and natural sources (e.g., wildfires, wind-blown dust). Mobile sources release the greatest quantities of pollutants and the primary mobile source of pollution is the automobile. Stationary sources, also known as point sources, have high concentrations of pollutants. Point sources can have greater health effects within the surrounding community (NPS, 2018).

Sources of pollution can be further divided into major and minor sources. The threshold for major source hazardous air pollutants (HAPs) such as benzene, chloroform, perchloroethylene, and methylene chloride, is 10 tons/year for a single HAP or 25 tons/year for any combination of HAPs (US EPA, 2018). Anything below these thresholds is considered a minor source of air pollution except in certain non-attainment areas.

Wildlife and sediment data. Monitoring the health status of local wildlife is a good measure of the quality of the surrounding environment. In particular, essential or sentinel species serve as ecological health indicators. Oysters are a sentinel species in the Chesapeake Bay and as the number of oysters diminishes, so does the health of the Bay (Higgins et al., 2013; Waldbusser et al., 2010). One factor that affects the health of these sentinel species is sediment in the water or land ecosystem (Keeler et al., 2012). Harmful chemicals and compounds such as mercury, lead, and PCBs are released from industrial, residential, and commercial sources can become trapped in the sediment (Saija et al., 2016). Contaminated sediment can affect human health as well, either through direct contact or through consumption of the animals living in these contaminated environments (Drenner et al., 2013; Guptra and Sharma, 2013; Yeganeh et al., 2013).

Health and environmental advocacy groups. The ability of residents to influence positive change is proportional to the level of social capital within their communities, defined by the amount of social resources available in a community. Several studies have reported a strong, inverse correlation between social capital and health inequalities (Kawachi et al., 2008; Dahl and Malmberg-Heimonen, 2010). Social capital has been observed to be an important buffer from the negative effects of low socioeconomic status, particularly among the most disadvantaged communities (Uphoff et al., 2013; Mithen et al., 2015). One factor that promotes social capital is the presence of advocacy groups that facilitate policy changes by giving a political voice to marginalized members of the community. To take full advantage of these advocacy groups, residents must know which advocacy groups are located in their area. Environmental health, maternal and child health, healthcare access, and human rights are examples of topics promoted by advocacy groups.

Prince George's County Specific Indicators

Community members and stakeholder groups from Prince George's County have provided the majority of the feedback for the Maryland EJSCREEN tool. As a result, there have been several requests for indicators to include more specific county data that relates to priority concerns among Prince George's County residents. Particularly, requests have been made for data related to crime and safety, commercial sites, major/minor sources, area sources, zoning, parks and green space, community resources, and environmental monitoring efforts. None of the following indicators are currently available in the tool but their addition is being considered per the community's request.

Crime and Safety. County residents have shown an interest in more detailed data regarding the kind of crimes being committed and safety resources available to them. Data for crimes, including violent crimes (e.g., homicides, rapes, assaults) and non-violent crimes (e.g., burglary, DUIs) can be collected from a variety of government sources including the Prince George's County Transforming Neighborhoods Initiative (TNI), the Prince George's County police department (PGPD), the FBI, the CDC, and the National Highway Traffic Safety Administration (NHTSA). Suggested safety indicators are road safety (i.e., pedestrian and bicyclist fatalities) and emergency services (i.e., the location of police and fire stations). Data on safety indicators is primarily collected from local government sources as well as from the TNI report.

Table 1: Crime Indicators in Order of Relative Severity

Indicator	Description	Source
Homicide	Number of reported murders	PGPD, 2015
Rape	Number of reported rapes using both the new and revised definitions of rape	FBI, 2016 (very limited)

Domestic violence	Number of reported incidents of domestic violence	N/A
DUIs	Number of reported incidents of driving under the influence and the number of fatalities from DUIs	CDC, 2016 (limited)
Burglaries	Number of reported incidents of breaking and entering, with statistics for both residential and commercial incidents	PGPD, 2015
Gun-related incidents	Number of reported incidents involving guns, including assaults with weapons and assaults with shooting	PGPD, 2015

Table 2: Safety Indicators

Indicator	Description	Source
Pedestrian fatalities	Number of fatalities reported in accidents involving vehicles and pedestrians	NHTSA, 2016
Bicyclist fatalities	Number of fatalities reported in accidents involving vehicles and bicyclists	NHTSA, 2016

Police stations	Number and location of police stations, including district stations and supports	PGcounty.gov, 2015
Fire stations	Number and location of fire stations, including all stations, with or without ambulances or medical units	PGcounty.gov, 2015
Detention facilities	Number and location of county, state, federal, and immigration detention facilities	PGcounty.gov/ Maryland.gov, 2014

Commercial Sites. County stakeholders have suggested several commercial sites should be added to the tool, including community assets (e.g., churches, grocery stores, farmers' markets) and community pathogens (e.g., liquor stores, pawn shops, payday lenders, quick loan facilities). Other suggested sites such as thrift stores, dollar stores, and nightclubs are more neutral but have the potential to become pathogenic depending on their location, concentration, and clustering. Mapping these local commercial properties can be useful in better understanding the geographic location of pathogenic and salutogenic features of different communities in Prince George's County.

Table 3. Commercial Sites in Order of Relative Benefit to the Community

Indicator	Description	Source
Farmers market	Number of indoor or outdoor markets selling produce and other locally produced goods	PGcounty.gov, 2017

Grocery stores	Number and location of grocery stores including Giant, Costco, Whole Foods, Safeway	NAICS, 2018
Reuse centers	Number and location of centers selling used furniture and appliances	NAICS, 2018
Thrift stores	Number and location of centers selling used clothing and apparel	NAICS, 2018
Dollar stores	Number and location of dollar stores	NAICS, 2018
Convenience stores	Number and location of convenience stores, including CVS, 7-Eleven, and gas stations	NAICS, 2018
Night clubs	Number and location of nightclubs including dance clubs, bars, and strip clubs	NAICS, 2018
Liquor stores	Number and location of stores selling alcohol	NAICS, 2018
Pawn shops	Number and location of pawn shops	NAICS, 2018

Major/ Minor Sources. Proximity to, and quantity of, toxic sites has been a major concern for community members throughout the demonstration process for MD EJSCREEN. Besides word-of-mouth, County residents have limited tools for learning about the types of toxic sites in their neighborhoods as well as the contaminants released at these sites. There are four Superfund sites in the County and seven brownfields among private properties that are contaminated by and/or releasing hazardous chemicals and substances. Superfund sites the County have contaminated soil, sediment, surface water and groundwater with petroleum and hazardous chemicals including arsenic, benzene, chloroform, lead, PCE, TCE, naphthalene, iron, and manganese. There has been some clean-up progress at each site including groundwater treatment, removal of contaminated soil, and capping of contaminated areas (USEPA, 2017). However, none of the seven the brownfields have started clean-up. Two sites have reported contaminants such as VOCs, SVOCs, and PAHs but contaminants on the other five sites are still unknown (USEPA, 2017).

Table 4. Major/Minor Sources

Indicator	Description	Source
Superfund sites	Number and location of sites reporting to the EPA containing hazardous substances, including contaminants and cleanup status	EPA, 2017
Brownfields	Number and location of abandoned/unused sites contaminated by hazardous substances, including contaminants and cleanup status	EPA, 2017
Landfills	Number and location of capped and uncapped landfills	PGcounty.gov, 2017
Concrete plants	Number and location of concrete plants, including batching plants, crushing plants, and block plants	EPA, 2011

Asphalt plants	Number and location of asphalt plants	EPA, 2011
Vehicle junk yards	Number and location of vehicle junk yards	EPA, 2011

Area Sources. County residents and stakeholders have expressed concerns about the high number of diesel vehicles in several neighborhoods, including Bladensburg. Exposure to DPM can irritate the eyes, throat, and nose, and can lead to cardiovascular and pulmonary disease and lung cancer (USEPA, 2017; Ristovski et al., 2012; Pope and Dockery, 2006). While there is knowledge about the dangers of diesel combustion, there is little information on the quantity of diesel sites in Prince George's County.

Table 5. Area Sources

Indicator	**Description**	**Source**
School bus parking lots	Number and location of parking lots for overnight storage of diesel engine school buses	PGCPS, 2018
Waste disposal truck lots	Number and location of parking lots for overnight storage of waste disposal trucks	PGcounty.gov
Heavy vehicle rentals	Rental businesses for industrial fleets/trucks/vehicles, busses, limousines, etc.	N/A
Heavy vehicle storage	Storage areas for industrial fleets/trucks/vehicles, buses, limousines, etc.	N/A

Heavy vehicle fueling stations	Fueling stations for industrial fleets/trucks/vehicles, buses, limousines, etc.	EPA, 2011
Heavy vehicle repair stations	Repair stations for industrial fleets/trucks/vehicles, buses, limousines, etc.	EPA, 2011

Zoning. Zoning has been a major topic in community demonstration meetings. Stakeholders are primarily worried about the zoning regulations that apply to their own neighborhoods as well as how they might use the Maryland EJSCREEN tool to influence future policy changes regarding zoning areas and regulations. Special exceptions to zoning standards have been abused in the County; zoning officials don't always use valid scientific evidence or recognize environmental justice issues during the decision-making process. The ongoing zoning rewrite needs to consider both the health of the residents and the health of the environment to make all communities greener, cleaner, more equitable, and more sustainable.

Table 6. Zoning

Indicator	Description	Source
Zoned industrial area – I1	Light intensity industrial zone for manufacturing, assembling, or processing of refined goods	PG County.gov
Zoned industrial area – I2	Heavy intensity industrial zones	PG County.gov

Parks and Green Space. Stakeholders have expressed the importance of the EJSCREEN tool to include extensive data related to both the built environment and the natural environment, including ecologic amenities. Green space can act as a positive indicator of health in non-White neighborhoods (Payne-Sturges and Gee, 2006). However, several studies have shown that non-White and low-income communities have less access to green spaces (Jennings et al., 2015). While the tool already has some indicators related to the natural environment, the following indicators are not yet included and were highly recommended by the community.

In the future, the tool will focus more on assessing exposure to salutogenic features and ecologic amenities. For instance, it will be able to quantify the amount of green space available in each neighborhood. Green space such as parks, along streams, trails, street trees, and community gardens are beneficial to the ecosystem in many ways (Wolch, 2014; Mitchell and Popham, 2008; Kabisch and Haase, 2014). The effects of green space are filtered air, pollution removal, infiltrated stormwater, and attenuated noise (Wolch, 2014). Local parks increase physical activity levels, reduce psychological stress, anxiety, and depression (Dadvand et al., 2016). Lack of access to such spaces have been linked to premature mortality (Wolch, 2014; Dadvand et al., 2016). In reference to green space and environmental justice, green space can skyrocket property values, leading to gentrification and displacement of non-White residents (Wolch, 2014; Mitchell and Popham, 2008).

Table 7. Parks and Green Space

Indicator	Description	Source
Parks	Number and location of federal, state, and municipal parks, including national parks, local parks, playgrounds, biking and walking trails, etc.	PAD-US, 2016

Recreational areas	Green spaces used for recreation, including soccer fields, baseball fields, tennis courts, basketball courts, golf courses, etc.	PG County Department of Parks and Recreation
Street trees	Mapping of, and information on, every street tree in the county	N/A

Community Resources. Community resource indicators include data on housing sites for sensitive populations (seniors and homeless), food sustainability projects, places of worship, schools, libraries, and historic sites. Also included is the Transforming Neighborhood Initiative (TNI), a community improvement effort organized by the County government. Its purpose is to improve the quality of life for individuals across the county who face significant economic, educational, health, and public safety concerns. Other indicators also increase quality of life and promote community building and social capital.

Table 8. Community Resources

Indicator	Description	Source
Public housing sites	Government housing sites providing affordable rent to low-income families, the elderly, and persons with disabilities	HUD, 2016

Senior citizen housing	Apartments, homes, or communities for the elderly providing independent living, assisted living, or specialized care	N/A
Places of worship	Sites of spiritual community gathering (e.g. churches, mosques, synagogues)	N/A
Historic sites	Historical landmarks, monuments, buildings, etc.	National Register of Historic Places, 2018
Libraries	Number and location of public and private libraries	PGCounty.gov
Community gardens and urban farm sites	Public spaces used to plant flowers, fruits, and vegetables to create sustainable communities	N/A
Schools	Public schools including elementary, middle, and high schools; charter schools; and special centers	PGCPS, 2018
TNI area zones	Location of Transforming Neighborhood Initiative (TNI) zones (nine in total)	PG County.gov

Environmental Monitoring Efforts. Stakeholders have suggested that information be provided on the actual monitors and studies used to collect environmental health data. So far, requests have been made to map the locations of two monitoring programs: the MDE air monitoring sites and the DC DOEE sediment study test sites.

Table 9. Environmental Monitoring Efforts

Indicator	Description	Source
MD air monitoring sites	Location of air quality monitoring sites operated by the Department of the Environment	Maryland Department of the Environment
DC DOEE sediment study test sites	Location and outcomes of the DC Department of sediment studies on the Anacostia River	DC Department of Energy and Environment

RECOMMENDATIONS AND CONCLUSION

To create a holistic report, it is imperative to involve key stakeholders in environmental justice efforts. For instance, when ranking environmental justice indicators, engaging all stakeholders will help public health officials direct their focus and efforts toward matters that directly concern residents. To allow active and meaningful engagement, it was recommended that all surveys be sent out early in the development process, to provide ample time for all stakeholders to ask questions and complete the surveys. It was also recommended that all stakeholders be provided with background information on the indicators to eliminate any confusion. Finally, additional environmental indicators such as pathogenic infrastructure, tree canopy coverage, and brownfields should be included in the final Maryland EJSCREEN tool.

The USEPA's EJSCREEN and CalEnviroScreen inspired the creation of this new tool and both are referenced and referred to throughout tool development and evaluation. However, while EJSCREEN offers useful data related to demographics and environmental indicators, the specificity and relevance of the data can vary significantly due to EJSCREEN's broad national focus.

In contrast, CalEnviroScreen provides specific data on population characteristics and pollution burdens for the state of California and has been an excellent model for the MD EJSCREEN tool. However, CalEnviroScreen still had several data gaps, including the prevalence of lead paint, NATA respiratory hazard index, and proximity to risk management plan sites. The MD EJSCREEN tool builds on the framework of both the EPA's EJSCREEN and CalEnviroScreen while also filling gaps and providing Maryland-specific data.

Overall, this project has created an essential foundation for development of the MD EJSCREEN tool. The tool has the potential to effectively inform Maryland residents on factors in their immediate environment that cause adverse health effects, as well as steps they can take to improve their quality of life. Using the tool, residents will be able to learn more about environmental conditions in their local communities and how those conditions relate to environmental justice issues. The tool should also be beneficial for advocacy groups and civically engaged citizens who can use it to influence policymakers and promote visible environmental and social change using clear and concrete data.

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