CDPH
Chicago Department of Public Health

CHICAGO CUMULATIVE IMPACT ASSESSMENT

CHICAGO ENVIRONMENTAL JUSTICE INDEX METHODOLOGY

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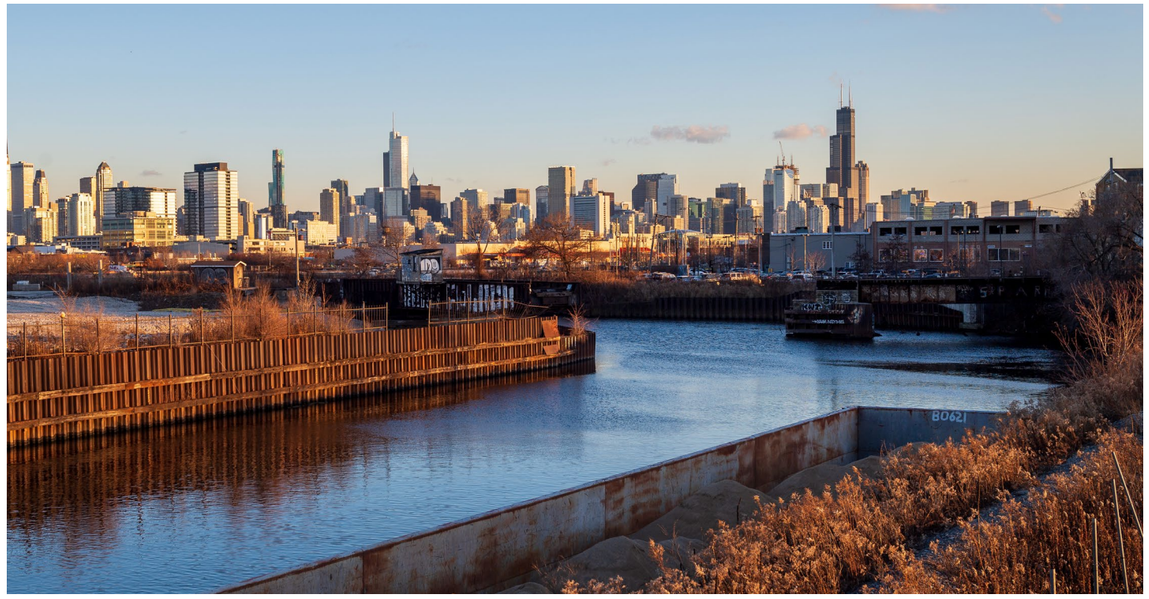

Cumulative impacts are the totality of chemical and non-chemical stressors that a community experiences. Stressors are due to the combination of environmental burden, health conditions and social factors. Cumulative impact assessments, unlike risk assessments, measure the overall burden affecting health and quality of life, not just quantifying the probability of a health outcome or injury due to a single pollutant or source.

Chicago is burdened by environmental problems and sources of pollution in ways that vary across the city. Some Chicagoans are also more vulnerable to the effects of pollution than others because of their health status and/or living conditions. Using the CalEnviroScreen framework and building upon the 2020 Air Quality & Health Index (AQHI), a cumulative impact assessment has been conducted by the Data & Methods Working Group (DMWG) that identifies the communities in Chicago most burdened by pollution and most vulnerable to its effects. The Chicago Environmental Justice (EJ) Index has been developed which produces a relative, rather than absolute, measure of cumulative impact; and provides a baseline assessment and methodology that can be expanded upon and updated periodically as important additional information becomes available.

This document provides an overview of the Chicago EJ Index methodological approach, which relies on the use of indicators to measure environmental exposures and conditions as well as sensitive populations and socioeconomic factors. This appendix also outlines the ways in which community input and co-design were integrated throughout the process. Detailed technical documentation of the Chicago EJ Index will be published by the end of 2023.

DEFINITIONS

ADVISORY COUNCIL MEMBERS were subject matter experts (SMEs) invited to participate in the indicator selection process. SMEs included persons from federal, state and local government agencies, EJ organizations, research and academic institutions, and planning organizations.

CENSUS TRACTS are small, relatively permanent statistical subdivisions of a country. Census tracts generally have a population size between 1,200 and 8,000 people, with an optimum size of 4,000 people. Census tract boundaries generally follow visible and identifiable features.

DASHBOARD INDICATORS were recognized by DMWG as important environmental, health or socioeconomic measures

but did not meet the definition for Chicago EJ Index components, following correlation and sensitivity analyses were not included in the Chicago EJ Index, or were measures that needed additional literature review or continued refinement before inclusion in the Chicago EJ Index.

ENVIRONMENTAL CONDITION INDICATORS are based on the locations of toxic chemicals in or near communities.

ENVIRONMENTAL EXPOSURE INDICATORS are based on measurements of different types of pollution that people may come into contact with.

INDEX INDICATORS are environmental, health or socioeconomic data measures included in the Chicago EJ Index. Index indicators will also be included in the the Chicago EJ Index Data Dashboard as individual “dashboard indicators.”

PERCENTILES are calculated from the ordered values for all indicators for all census tracts in Chicago. Each census tract’s percentile rank for a specific indicator is relative to the ranks for that indicator in the remaining census tracts in Chicago. A census tract’s percentile for a given indicator is the percentage of census tracts with lower values of that indicator. A percentile does not describe the magnitude of the difference between two census tracts. For example, a census ranked in the 80th percentile is not necessarily eight times more impacted than a census tract ranked in the 10th percentile.

SENSITIVE POPULATION INDICATORS measure the proportion of people in a community who may be more severely affected by pollution due to their age or existing health conditions.

SOCIOECONOMIC FACTOR INDICATORS are conditions that may increase people’s stress or make healthy living difficult, causing them to be more vulnerable to the effects of pollution.

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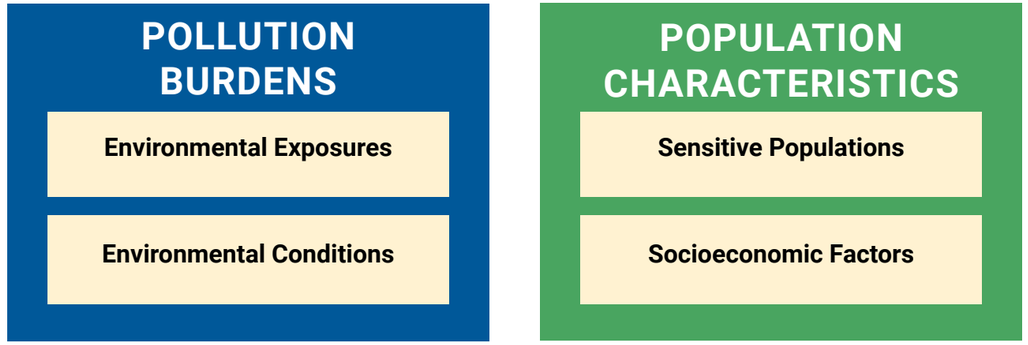
MODEL METHODOLOGY

The DMWG used the findings of the **Landscape Assessment Summary** and **Initial Community Input Summary**, along with input received from Chicago Environmental Justice Network (CEJN) to select a methodology for the Chicago EJ Index. CEJN and DMWG co-chairs recommended using the CalEnviroScreen methodology to be consistent with and to build on the previously developed AQHI. The Chicago EJ Index model is place-based and consists of components representing pollution burden and population characteristics as contributors to cumulative impacts at the census tract level.

Figure 1. Chicago EJ Index Components



The model uses 28 indicators (see Table 2) representative of exposures, public health or environmental conditions, socioeconomic factors, and sensitive populations that contribute to environmental stressors or community vulnerability. The output of the model is a score that represents the cumulative impact of a census tract relative to all other tracts in the City of Chicago. To calculate the final score, each indicator is assigned a score based on the relative impact in each census tract. The individual indicator scores are averaged for the group of indicators in each component (environmental exposures, environmental conditions, sensitive populations, and socioeconomic factors). The component scores are combined to produce the Chicago EJ Index score using the equation below:

Figure 2. Chicago EJ Index Equation

*Environmental Conditions is weighted half as much as the Environmental Exposures because the Condition indicators represent ***risk*** of exposure, whereas Exposure indicator represent ***actual measured*** exposures.

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The Chicago EJ Index Score is the value assigned to each census tract, which is used to rank cumulative burden in the city. The maximum score for a given census tract is 100. Table 1 provides an example of how the Score is calculated for a given census tract in Chicago.

Table 1. Chicago EJ Index Score Calculation for Census Tract 17031010100 (part of Rogers Park Community Area)

	Pollution Burden		Population Characteristics	
Census Tract 17031010100	Environmental Exposure Indicators	Environmental Conditions Indicators	Sensitive Populations Indicators	Socioeconomic Factor Indicators
Component Score	0.3148	0.2396 x 0.5 = 0.1198	0.5116	0.5586
Average of Component Score	0.4346 ÷ (1 + 0.5) = 0.2897 *Pollution Burden is calculated as the average of its two component scores, with the Environmental Conditions component weighted ½ as much as Exposures.*		1.070 ÷ 2 = 0.5351 *Population Characteristics is calculated as the average of its two component scores.*	
Scaled Component Scores	(0.2897 ÷ 0.7278) x 10 = 3.981 *Pollution Burden percentile is scored by the Citywide maximum Pollution Burden score, for a maximum possible score of 10.*		(0.5351 ÷ 0.8453) x 10 = 6.331 *Population Characteristics percentile is scored by the Citywide maximum Population Characteristics score, for a maximum possible score of 10.*	
CEJI Score	3.981 x 6.331 = 25.20 *A score of 25.20 puts this census tract in the 30th percentile, or top 70th of all Chicago EJ Index scores Citywide.*			

Any census tract with a Chicago EJ Index Score of 75 or greater, or whose Chicago EJ Index score is 70 or greater ***and*** contiguous with another census tract with a Chicago EJ Index Score of 75 or greater is designated as an EJ Neighborhood. This threshold was informed by reviewing what other jurisdictions also using the CalEnviroScreen model (California, Washington, and Colorado) utilize.

INDICATOR SELECTION PROCESS

The DMWG, with input from CEJN and building upon the AQHI, initially identified a total of 133 potential indicators proposed for inclusion in the Chicago EJ Index. Indicators were classified following the methodology of CalEnviroScreen and representative of one of the four components (Environmental Exposures, Environmental Conditions, Sensitive Populations, and Socioeconomic Factors).

THE DMWG CONDUCTED AN INITIAL REVIEW OF THE INDICATORS TO DETERMINE IF EACH INDICATOR:

1. **Had a reliable data source identified;**
2. **Was an independent measure of an environmental, health, or socioeconomic stressor (e.g., not duplicative);**
3. **Was relevant to the Chicago EJ Index model; and**
4. **Had data available at a sufficient geographic resolution.**

Thirty-one (31) indicators were excluded from further consideration for Version 1 of the Chicago EJ Index because they were (1) duplicative with another indicator (e.g., housing lead risk or age of housing stock was duplicative with lead poisoning levels; the latter was a determined to be a better indicator as it reflects actual childhood lead poisoning compared to risk of exposure to lead based on age of the residence); (2) not available at the optimal geographic resolution (e.g., rate of emergency room visits due to asthma is only available at the zip code level); (3) a reliable data source was not identified (e.g., rate of commitments to the Illinois Department of Corrections was unable to be located as a dataset); or (4) not relevant to Chicago EJ Index model (e.g., housing tenure, or renter-occupied housing, was considered to be an outdated measure especially for an urban area like Chicago).

DMWG members along with invited Advisory Council members then conducted an in-depth secondary analysis of each remaining indicator to identify those for inclusion in Version 1 of the Chicago EJ Index.

THE CRITERIA FOR THE SECONDARY REVIEW WERE:

1. **Indicators must be linked to national, state, or local data sources that are accurate and reliable, analytically sound, available at scale, and timely.**
2. **Indicators should represent concerns related to the inequitable distribution of pollution burden or population characteristics in Chicago.**
3. **Pollution burden indicators should relate to issues that may be potentially actionable by local, state, and/or federal departments and agencies.**
4. **Population characteristic indicators should represent demographic factors known to modify vulnerability to impacts of pollution.**
5. **Indicators should be sensitive enough to demonstrate significant spatial variability across Chicago.**
6. **Indicators combined together should provide a good representation of each component.**
7. **Indicators should align with Cumulative Impact Assessment values, Initial Community Input Summary findings and information collected from in-person community engagement events and the online survey.**

DMWG and Advisory Council members completed a pre-meeting review of the indicators in relationship to the selection criteria. Indicators without universal agreement for index inclusion identified during the pre-meeting reviews were discussed at four individual component meetings so consensus could be reached about their ultimate designation.

The DMWG recommended a total of 29 indicators for inclusion in Version 1 of the Chicago EJ Index (e.g., index indicators). Several of the proposed environmental condition indicators were combined into single indicators, such as “Proximity to Consequential Facilities” and Proximity to Polluted Sites”. Thirty-four (34) indicators were recommended as dashboard indicators. The DMWG and Advisory Council recognized that dashboard indicators may still provide significant characterization of the health, living conditions and environmental quality of Chicago’s communities. Dashboard indicators can provide contextual information at the census tract or community area level that may be useful to policymakers, advocates and community residents to better understand the conditions of a specific Chicago neighborhood. Moreover, indicators identified as needing more evaluation will be included in the Chicago EJ Index Data Dashboard for consideration of inclusion in future versions of the Chicago EJ Index. Finally, the DMWG and Advisory Council recognized that datasets for some proposed indicators do not exist, have significant data quality issues, or are not publicly available. These indicators will be recorded for future evaluation and potential data collection initiatives conducted as part of the Cumulative Impact Initiative.

To understand interactions between indicators and the impact of indicators on the model, a series of tests were conducted to further explore the underlying data. The tests ranged from simple numerical and graphical comparisons to more complex statistical analyses to determine the relative impact of indicators on the index. Following these statistical analyses, a strong correlation between Chronic Obstructive Pulmonary Disease (COPD) and several other health indicators, including Coronary Heart Disease was detected, and thusly, COPD was removed from the Chicago EJ Index but retained as a dashboard indicator. All analytic methods and findings will be described in full in the Chicago EJ Index Technical Documentation, to be released by the end of 2023.

Table 2. Chicago EJ Index Indicators

Component	Indicator
Environmental Exposures	Air Toxics All-Organ Hazard Index
	Air Toxics Cancer Risk
	Childhood Lead Poisoning
	Diesel Particulate Matter (PM)
	Ozone
	Particulate Matter 2.5 (PM2.5)
	Air Toxics All-Organ Hazard Index
	Traffic Proximity and Volume
Environmental Conditions	Proximity to Consequential Facilities
	Proximity to Freight Rail Lines
	Proximity to Hazardous Waste Facilities
	Proximity to Polluted Sites
	Proximity to Risk Management (RMP) Sites
	Proximity to TRI Facilities
	Proximity to Wastewater Discharge
Sensitive Populations	Asthma
	Coronary Heart Disease
	Disability
	Low Birthweight
	Old Age
	Young Age
Socioeconomic Factors	Housing Burdened, Low Income Households
	Less than High School Education
	Linguistic Isolation
	Low Income
	No Health Insurance
	People of Color
	Unemployment

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Table 3. Dashboard Indicators (not including Index Indicators)

Environmental	Health Status	Socioeconomic Status
Construction & Demolition Reprocessing Facilities	Breast Cancer Incidence	Food Insecurity
Dry Cleaning Facilities	Cancer Incidence	Historical, Red-Lined Districts
IDOT Designated Truck Routes	Chronic Obstructive Pulmonary Disease	Housing Vacancy Rate
Impaired Surface Waters	Colon Cancer Incidence	Jobs by Industry Sector
Industrial Corridors	Diabetes	Lack of Internet Access
Lack of Recreational Parks	Ever Cancer	Major Crime
Land Use	Hypertension	Population Density
Metal Platers	Life Expectancy	Vacant Lots
Motor Vehicle Repair/Autobody Shops	Lung Cancer Incidence	Walkability
Publicly Owned Treatment Facilities	Obesity	
Scrap Metal Facilities	Poor General Health	
Tree Canopy	Poor Mental Health	
	Poor Physical Health	
	Colon Cancer Incidence	

CHICAGO EJ INDEX MAP

Figure 3. Chicago EJ Index Map with Industrial Corridors

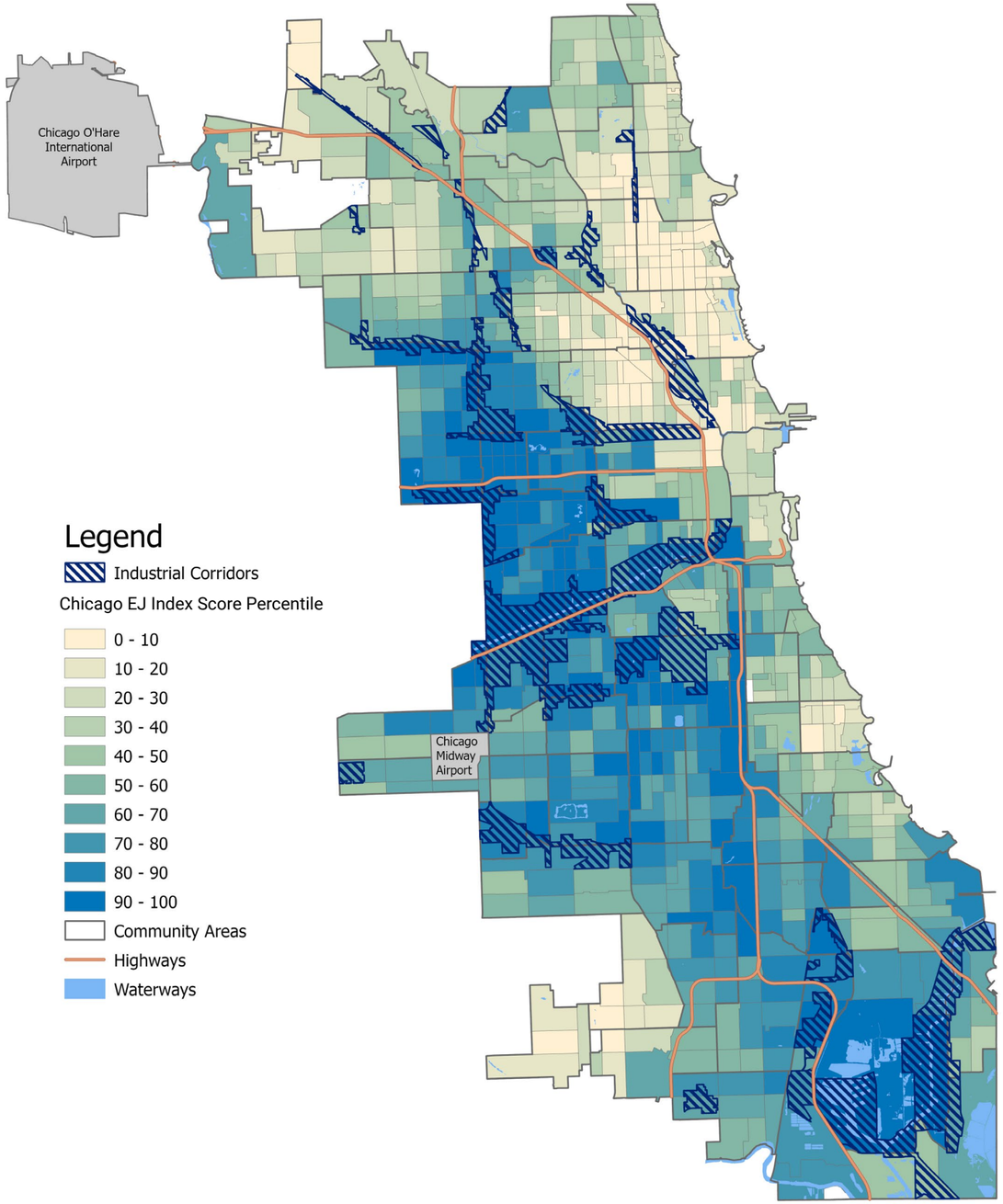

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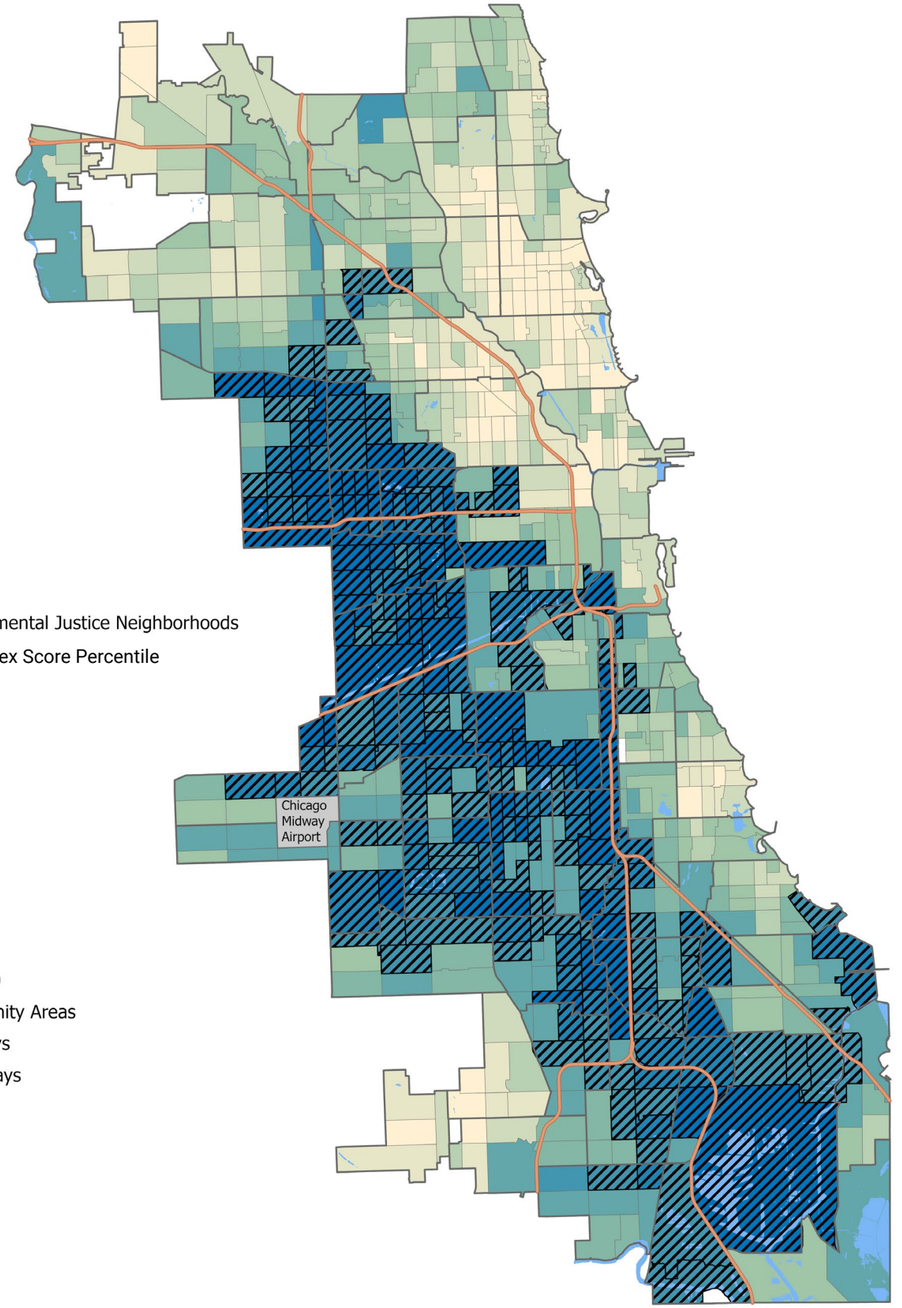
Figure 4: Chicago EJ Index Map with Designated EJ Neighborhoods



The resulting Chicago EJ Index map shows that the areas of greatest concern for pollution burden and vulnerability to its effects in Chicago are located on the South and West Sides of the city. These neighborhoods are bisected by major highways with high concentrations of industry (Figure 3). Almost 30% (234) of all Chicago census tracts are designated as EJ Neighborhoods (Figure 4). More than half (41) of all Chicago community areas have at least one census tract within their boundaries that is a designated EJ Neighborhood.

COMMUNITY INPUT

The DMWG incorporated community input throughout the process of developing the Chicago EJ Index and Map. From the outset, key findings from the **Initial Community Input Summary** describing community lived experience with cumulative impact informed the development of the list of potential indicators. CEJN conducted an independent review of EJ screening tools in use; their evaluation included recommendations on how to strengthen the AQHI by including additional indicators. CDPH also conducted a People and Process landscape analysis (included in the **Landscape Assessment Summary**) to understand how other jurisdictions have included lived experience as part of EJ screening tools. Additionally, members from CEJN and People for Community Recovery (PCR) were invited to participate in and listen in on the in-depth indicator review sessions.

The DMWG also worked with the Communications and Engagement Working Group (CEWG) to develop activities for engagement sessions and questions to ask in the online survey. These activities aimed to collect information on (1) specific locations in Chicago that experience pollution and (2) ways the City can partner on meaningful approaches to data and methods for tracking, reporting, and improving cumulative impacts. During in-person engagements, community members participated in a mapping exercise, and provided feedback related to data and methods. A detailed summary and analysis of the online and in-person engagements, including analysis related to data and methods, can be found in the **Summary of Community Input Provided During Assessment** report.

THEMES SPECIFIC TO DATA AND METHODS INCLUDE:

1. **Topics and types of data that should be included in assessing and addressing cumulative impacts**
2. **Identifying and addressing data gap**
3. **Defining EJ neighborhoods**
4. **Community engagement with data**
5. **Applying data for policy**
6. **Transparency and reporting**

Using a map of the engagement neighborhood and immediate surrounding communities, community members identified where they saw pollution. Locations of pollution correlated with individual component and category maps of the Chicago EJ Index (Environmental Exposures, Environmental Conditions and Pollution Burden). See Figure 5 for an example of a heat map generated by Tetra Tech using community member input. Community members also emphasized the importance of including environmental, health and socioeconomic data to understand and monitor the effects of pollution and environmental hazards on the community.

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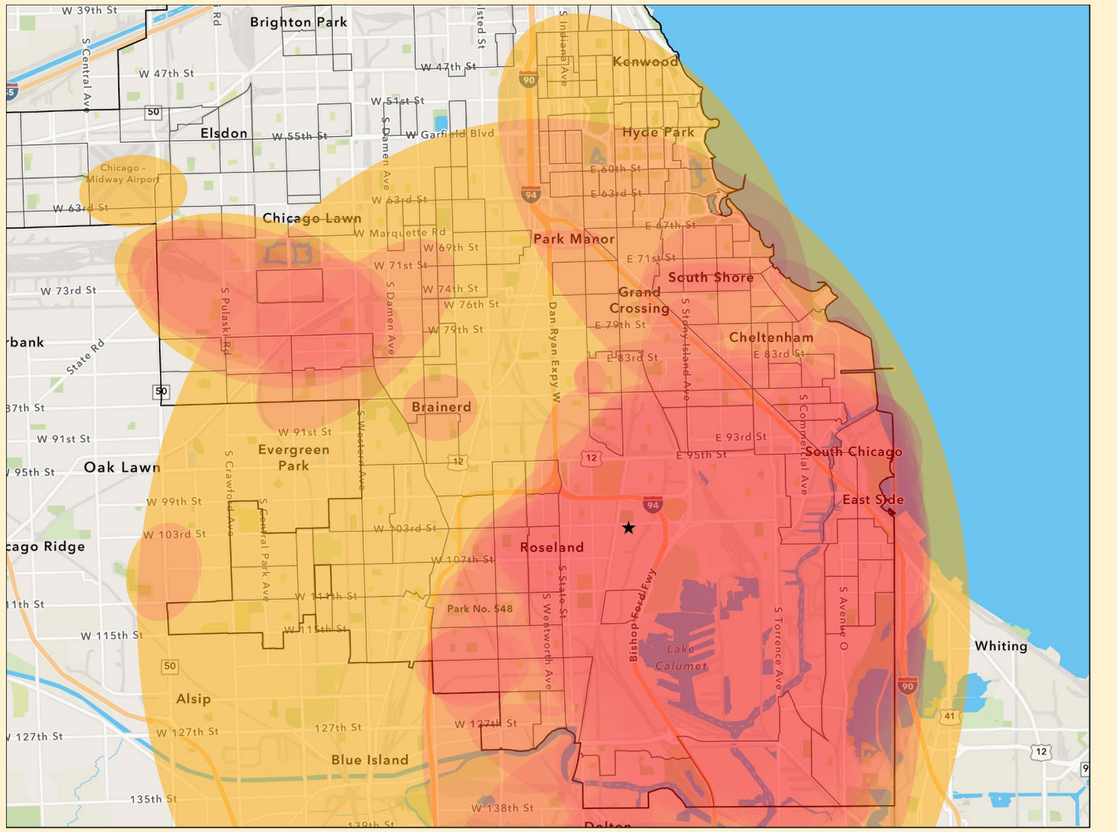
Figure 5: Heat Map of Locations of Pollution Identified by Community Members at Corliss High School Engagement Session on July 12, 2023



Community members identified 26 specific indicators for consideration in cumulative impact assessments. A majority of those indicators (~75%) were included within the index or dashboard; or had been identified by the DMWG as a data gap to address in future iterations of the Chicago EJ Index. Six types of indicators identified from the community input not already captured by the DMWG included recycling rates, pests (cockroaches, mice, rats, etc.), groundwater, PFAs (per- and poly-fluoroalkyl substances), garbage/dumping, emissions from heating homes, and soil pollution and run-offs. Forthcoming technical documentation will address the indicators from community members in more detail.

Lastly, community members advocated for a transparent and ongoing process for tracking, monitoring, revising and updating data in partnership with affected communities. Initial steps to address this include creating an engagement plan for the Chicago EJ Index Data Dashboard and a framework for ground-truthing that build upon lessons learned from the Cumulative Impact Assessment engagement process.

DATA LIMITATIONS

The Chicago EJ Index is intended as a screening tool of cumulative impacts in Chicago communities in order to identify those communities with the greatest pollution burden and population vulnerability, recognizing those as EJ Neighborhoods and thus subject to special considerations in decision-making about zoning, permitting, enforcement, etc. There are inherent limitations in the kind of data used by the Chicago EJ Index and other screening tools. The Chicago EJ Index relies on historical data generated by different federal, state and local organizations on varying time scales, meaning that the Chicago EJ Index is not entirely reflective of current or future conditions. However, most Chicago EJ Index indicators use data collected within the last 6 years. Details on the sources and years represented by each indicator can be found in Table 4. Additionally, many indicators used to construct the Chicago EJ Index rely on estimates that involve some level of uncertainty. Where possible, measurements of uncertainty will be made available in the public-facing Chicago EJ Index Data Dashboard, such as margins of error, but this uncertainty is not factored into Chicago EJ Index calculations. Thus, when using the Chicago EJ Index, it is important to note that modest differences in tract-level rankings should not necessarily be interpreted as definitively meaningful.

ACKNOWLEDGEMENTS & NEXT STEPS

We appreciate the considerable time and effort that DMWG and Advisory Council members have devoted to this assessment. We also appreciate the input from community members we heard during the in-person community engagement sessions and from the online survey.

Work on the Chicago EJ Index continues and presents opportunities to refine the index in the future. Thus, over the next several years CDPH and OCEE plan to release a new version of the Chicago EJ Index that may include new indicators and improvements to the indicators used and the methodology employed. CDPH and OCEE remain committed to an open and public process in developing future versions of the Chicago EJ Index.

By the end of 2023, CDPH will publish a comprehensive technical document that details the data and methods used to select the Chicago EJ Index and dashboard indicators and Chicago EJ Index map. The Chicago EJ Index Data Dashboard will also be developed as an interactive online tool to visualize the Chicago EJ Index, its components, and individual indicators as well as other environmental, health and socioeconomic data measures. We anticipate completion of the Chicago EJ Index Data Dashboard in early 2024.

Table 4. Chicago EJ Index Indicators with Definitions, Data Sources and Years

Component	Indicator	Definition	Data Source	Year
Environmental Exposures	Air Toxics All-Organ Hazard Index	The sum of hazard quotients for toxics that affect the same target organ or organ system. Because different air toxics can cause similar adverse health effects, combining hazard quotients from different toxics is often appropriate. As with the hazard quotient, exposures below a Hazard Index (HI) of 1.0 likely will not result in adverse noncancer health effects over a lifetime of exposure. An HI equal to or greater than 1.0, however, doesn't necessarily suggest a likelihood of adverse effects.	US EPA Hazardous Air Pollutants, downloaded via AirToxScreen	2019
	Air Toxics Cancer Risk	The probability of contracting cancer over the course of a lifetime, assuming continuous exposure (assumed in AirToxScreen to be 70 years).	CDPH Lead Poisoning Prevention Program	2019
	Childhood Lead Poisoning	Percent of children ages 1-5 with blood lead level at or above 5 micrograms per deciliter	CDPH Lead Poisoning Prevention Program	2018-2022
	Diesel Particulate Matter (PM)	A mixture of particles that is part of diesel exhaust. US EPA lists diesel exhaust as a mobile-source air toxic due to the cancer and noncancer health effects linked to exposure to whole diesel exhaust. Diesel PM (expressed as grams diesel PM/m3) has been used as a surrogate exposure measure for whole diesel exhaust.	US EPA Hazardous Air Pollutants, downloaded via AirToxScreen (2019)	2019
	Ozone	Ozone summer seasonal average of daily maximum 8-hour concentration in air in parts per billion	US EPA's Office of Radiation, obtained via US EPA EJScreen	2019
	Particulate Matter 2.5 (PM2.5)	PM2.5 levels in air, µg/m3 annual average	US EPA's Office of Radiation, obtained via US EPA EJScreen	2019

Component	Indicator	Definition	Data Source	Year
Environmental Exposures	Traffic Proximity and Volume	Count of vehicles (AADT, average annual daily traffic) at major roads within 500 meters, divided by distance in meters (not kilometers)	Calculated from 2020 US Department of Transportation traffic data, obtained via US EPA EJScreen	2020
Environmental Conditions	Proximity to Consequential Facilities	Sum of proximity-weighted consequential facilities (Classes III, IVA, IVB and V recycling; Outdoor storage of raw materials, as a principal use; Warehousing, wholesaling, and freight movement; Waste-related uses; Coke and coal bulk material uses; Container storage; Windrow composting; Freight terminals; Manganese bearing material uses; Intensive manufacturing, production, and industrial service) within each census tract.	Chicago Metropolitan Agency for Planning (CMAP), CDPH Environmental Permit database, Chicago Department of Business Affairs & Consumer Protection (BACP) Business Licenses - Current and Active database	2015 (CMAP), 2023 (CDPH, BACP)
	Proximity to Freight Rail Lines	Sum of proximity-weighted freight rail lines within each census tract	IL Department of Transportation (IDOT)	2019
	Proximity to Hazardous Waste Facilities	Sum of proximity-weighted Resource Conservation and Recovery Act (RCRA) Transport, Storage, and Disposal Facilities (TSDFs) and Large Quantity Generators (LQGs) within each census tract	US EPA RCRAInfo Database	2022
	Proximity to Polluted Sites	Sum of proximity-weighted Superfund, Brownfields, and Active Illinois Site Remediation Program (SRP) sites within each census tract	US EPA SEMS database, US EPA Assessment, Cleanup and Redevelopment Exchange System (ACRES), IL EPA Agency SRP Database	2022 (SEMS, ACRES), 2023 (SRP)
	Proximity to Risk Management (RMP) Sites	Sum of proximity-weighted RMP sites within each census tract	US EPA RMP database	2022
	Proximity to TRI Facilities	Sum of proximity-weighted TRI facilities within each census tract	US EPA Facility Registry Service Interests	2022

Component	Indicator	Definition	Data Source	Year
Environmental Conditions	Proximity to Wastewater Discharge	RSEI modeled toxic concentrations at stream segments within 500 meters, divided by distance in kilometers (km)	Calculated from RSEI modeled toxic concentrations to stream reach segments, obtained via US EPA EJScreen	2020
Sensitive Populations	Asthma	Percent of adults who report ever having been told by a doctor, nurse or other health professional that they had asthma, and they still have asthma	CDC PLACES	2020
	Coronary Heart Disease	Percent of adults who report ever having been told by a doctor, nurse, or other health professional that they had angina or coronary heart disease	CDC PLACES	2020
	Disability	Percent of civilian, noninstitutionalized population with a disability.	US Census Bureau ACS 5-year Estimate	2017-2021
	Low Birthweight	Percent of singleton births where infants are born weighing less than 2,500 grams	IDPH Birth Certificate Files	2013-2017
	Old Age	Percent of population aged 65 and older.	US Census Bureau ACS 5-year Estimate	2017-2021
	Young Age	Percent of population aged 17 and younger	US Census Bureau ACS 5-year Estimate	2017-2021
Socioeconomic Factors	Housing Burdened, Low Income Households	Percent of households with annual income less than $75,000 who are considered burdened by housing costs (pay greater than 30% of monthly income on housing expenses)	US Census Bureau ACS 5-year Estimate	2017-2021
	Less than High School Education	Percent of population (age 25+) with no high school diploma	US Census Bureau ACS 5-year Estimate	2017-2021
	Linguistic Isolation	Percent of households in which everyone age 14 years or older speak a non-English language and also speak English less than “very well”	US Census Bureau ACS 5-year Estimate	2017-2021

Component	Indicator	Definition	Data Source	Year
Socioeconomic Factors	Low Income	Percent of households where the household income is less than or equal to twice the federal "poverty level."	US Census Bureau ACS 5-year Estimate	2017-2021
	Low Income	Percent of households where the household income is less than or equal to twice the federal "poverty level."	US Census Bureau ACS 5-year Estimate	2017-2021
	People of Color	Percent of population who list their race as a race other than white and/or list their ethnicity as Hispanic or Latino (i.e., all people other than non-Hispanic white-alone individuals)	US Census Bureau ACS 5-year Estimate	2017-2021
	Unemployment	Percent of population 16 and older who are unemployed.	US Census Bureau ACS 5-year Estimate	2017-2021

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