February 2024

# Southeast Michigan Healthy Climate Plan

*Priority Climate Action Plan*

SEMCOG | SOUTHEAST MICHIGAN COUNCIL OF GOVERNMENTS

**SEMCOG** *. . . Developing Regional Solutions*

## Mission

SEMCOG, the Southeast Michigan Council of Governments, is the only organization in Southeast Michigan that brings together all governments to develop regional solutions for both now and in the future. SEMCOG:

- Promotes informed decision making to improve Southeast Michigan and its local governments by providing insightful data analysis and direct assistance to member governments;
- Promotes the efficient use of tax dollars for infrastructure investment and governmental effectiveness;
- Develops regional solutions that go beyond the boundaries of individual local governments; and
- Advocates on behalf of Southeast Michigan in Lansing and Washington

# Southeast Michigan Healthy Climate Plan: Priority Climate Action Plan (PCAP)

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## Abstract

The purpose of this Priority Climate Action Plan (PCAP) is to prioritize measures that will reduce greenhouse gas (GHG) emissions and enhance natural areas that capture climate pollution. Extensive stakeholder outreach, community engagement, and cross-sector coordination are integral to this goal and ensuring that these priority actions will benefit the region, with a focus on equity and environmental justice.

This plan was developed by SEMCOG in partnership with Sustainability Solutions Group (SSG). It is funded wholly by the U.S. Environmental Protection Agency (EPA) through the Climate Pollution Reduction Grant Program (CPRG) under the Inflation Reduction Act (IRA). It is covered under EPA assistance agreement 00E03475 to the Southeast Michigan Council of Governments. The contents of this document do not necessarily reflect the views and policies of the EPA, nor does the EPA endorse trade names or recommend the use of commercial products mentioned in this document.

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# Glossary

| | |
|---|---|
| **AAATA** | Ann Arbor Area Transit Authority |
| **Anerobic Digester** | Anerobic digestors use bacteria to break down organic matter—such as animal manure, wastewater biosolids, and food wastes—in the absence of oxygen. Anaerobic digestion takes place in a sealed vessel called a reactor, which is designed specific to the site and feedstock conditions. Bio gas is produced this chemical process and can be captured for re-use. |
| **CAP** | Criteria Air Pollutants: The Clean Air Act requires EPA to set National Ambient Air Quality Standards (NAAQS) for six commonly found air pollutants known as CAPs. |
| **Carbon Sequestration** | In this document, carbon sequestration refers to the biological processes that store atmospheric carbon in vegetation, soils, trees, and other vegetation. |
| **CCAP** | Comprehensive Climate Action Plan: A narrative report that provides an overview of the region's significant GHG sources/sinks and sectors, establishes near-term and long-term GHG emission reduction goals, and provides strategies and identifies measures that address the highest priority sectors to help the region meet those goals. |
| **CEDS** | Comprehensive Economic Development Strategy |
| **CEJST** | Climate and Economic Justice Screening Tool |
| **CO** | Carbon Monoxide, a Criteria Air Pollutant that primarily gets in the air when something is burned. CO can be found in both indoor and outdoor air but is more harmful at high concentrations indoors. |
| **CO2e** | Carbon Dioxide Equivalent: Although many gases contribute to climate change, some are more powerful creators of a greenhouse effect. To accurately reflect the relative strength of each gas and quantify the total emissions impact of many types of gases, we convert them all to a single unit of CO2e. This represents what their strength would be if they were all CO2. |
| **CPRG** | Climate Pollution Reduction Grants |
| **DDOT** | Detroit Department of Transportation |
| **EGLE** | Michigan Department of Environment, Great Lakes, and Energy |
| **EJScreen** | Environmental Justice Screening and Mapping Tool |

| | |
|---|---|
| **Equity and Environmental Justice Focus Areas** | Communities with residents that have low incomes, limited access to resources, and disproportionate exposure to environmental or climate burdens. For SEMCOG's PCAP, these have been identified using the Climate and Economic Justice Screening Tool and the Environmental Justice Screening and Mapping Tool which provides indicators of the following types of burdens: air quality, climate change, energy, environmental hazards, health, housing, legacy pollution, transportation, water and wastewater, and workforce development. This is based on the criteria described by EPA under CPRG for Low Income and Disadvantaged Communities (LIDAC). |
| **EPA** | United State Environmental Protection Agency |
| **EV** | Electric Vehicle |
| **GHG** | Greenhouse Gas |
| **GHG Inventory** | Greenhouse gas (GHG) Inventory: A calculation of the total amount of emissions generated over the course of one calendar year from a specified community or region. The emissions are grouped primarily by source (or sink in case of sequestration) and can also be sorted based on the type of greenhouse gas produced, whether they arise from energy use, and other qualities. Emissions in GHG inventories are calculated using standardized methods, so inventories can be compared across regions. SEMCOG's PCAP includes a summarized GHG inventory for 2019. |
| **GPC** | Global Protocol for Community (GPC) Emissions: An industry-standard methodology for calculating greenhouse gas emissions for a geographical area. |
| **GREEN** | Growing our Resilience, Equity, and Economy with Nature |
| **GSI** | Green Stormwater Infrastructure |
| **HAP** | Hazardous Air Pollutants |
| **HC** | Hydrocarbons: |
| **HSOW** | High Strength Organic Waste, which includes fats, oils, and greases |
| **IAP2** | International Association for Public Participation: An international organization advancing public participation and community engagement through initiatives that are guided by culturally adaptive standards of practice and core values. |
| **ICE** | Internal Combustion Engine |
| **IRA** | Inflation Reduction Act |
| **Justice40** | Justice40 refers to the Federal Government goal that 40 percent of the overall benefits of certain Federal investments flow to disadvantaged communities that are marginalized, underserved, and overburdened by pollution. |
| **MDOT** | Michigan Department of Transportation |

| | |
|---|---|
| **MHP** | Microbial Hydrolysis Process |
| **MPO** | Metropolitan Planning Organization |
| **MT** | Metric Ton (or Tonne) equivalent to 1,000 kilograms or 2,205 pounds |
| **MSA** | Metropolitan Statistical Area |
| **NAAQS** | National Ambient Air Quality Standards: The Clean Air Act requires EPA to set NAAQS for six commonly found air pollutants known as criteria air pollutants. |
| **NO2** | Nitrogen dioxide, a Criteria Air Pollutant that primarily gets in the air from the burning of fuel. NO2 forms from emissions from cars, trucks and buses, power plants, and off-road equipment. |
| **O3** | Ozone: a Criteria Air Pollutant when found at ground level. Oxides of nitrogen and volatile organic carbons can create O3 in the presence of sunlight. |
| **PCAP** | Priority Climate Action Plan: A narrative report that includes a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution, and an analysis of GHG emissions reductions. |
| **PM** | Particulate Matter: a Criteria Air Pollutant that primarily particles forming as a result of complex chemical reaction related to emissions from cars, trucks and buses, power plants, and industrial sources. |
| **RTA** | Regional Transit Authority |
| **RTP** | Regional Transportation Plan |
| **SEMAQs** | Southeast Michigan Air Quality Study |
| **SO2** | Sulfur Dioxide, a Criteria Air Pollutant from the burning of fuel. SO2 forms from emissions from power plants, and industrial processes. |
| **SSG** | Sustainability Solutions Group: The consultant group supporting the development of SEMCOG's Climate Action Plans. |
| **Stationary Energy** | Stationary energy includes the use of electricity, natural gas and non-utility fuels in residential, commercial, and industrial buildings, including lighting, heating/cooling, and other appliances or equipment. |
| **SMART** | Suburban Mobility Authority for Regional Transportation |
| **VOC** | Volatile Organic Compounds: a wide range of carbon containing harmful air pollutants from both indoor and outdoor sources. |

# Executive Summary

## Purpose

Southeast Michigan's changing climate presents many challenges for the health of our communities, environment, and economy. Working together as a region to reduce climate pollution will contribute to reducing future impacts of climate change and ensure that our communities can provide a more resilient, equitable, and thriving home for future generations.

**The goal of this Priority Climate Action Plan (PCAP) is to prioritize measures that will reduce greenhouse gas (GHG) emissions and enhance natural areas that capture climate pollution.** Extensive stakeholder outreach, community engagement, and cross-sector coordination are integral to this goal and ensuring that these priority actions will benefit the region, with a focus on equity and environmental justice.

The priorities established in the PCAP are intended to address the region's primary sources of GHG emissions, supported by implementation-ready measures to reduce climate pollution by 2030. These priorities will lay the foundation for a Comprehensive Climate Action Plan (CCAP), to be completed in 2025, with both near- and long-term solutions to reduce GHG emissions in all sectors by 2050.

With a regional PCAP approved by the U.S. Environmental Protection Agency (EPA), public entities in Southeast Michigan will be eligible to submit applications for implementation grant funding for any of the measures the plan describes, through the Climate Pollution Reduction Grant program (CPRG). CPRG Implementation Grants will award $4.6 billion nationwide in 2024.

## Approach

Throughout Southeast Michigan and across the country, local governments have become leaders in developing plans, adopting policies, and taking actions to improve the ability of their residents to adapt to the effects of climate change and to implement strategies to reduce GHG emissions. SEMCOG's coordinated approach to climate action planning connects and uplifts existing local, regional, and State plans. Representatives from all levels of government and partner organizations in various sectors have been engaged in developing this plan, which is designed to build on their experience and integrate with their ongoing work. Measures in the PCAP have been identified to achieve the following goals:

- These measures will rapidly and dramatically reduce greenhouse gas emissions from one or more of the following key sectors highlighted by the EPA: electricity generation, industry, transportation, buildings, agricultural and natural lands, or waste management in Southeast Michigan.

- The measures were all suggested or supported by Southeast Michigan's local governments and regional stakeholders, and align with their existing climate action plans, as well as strategies to improve housing, waste management, sustainability, economic development, and transportation.

- Where appropriate, proposed measures were refined to increase their emissions reduction impact, incorporate best practices, and optimize capital investments to provide long-term savings. Potential applicants are also being encouraged to submit joint project proposals that will achieve more in the region overall.

- All these measures will create good, local jobs[1], reduce long-term energy costs, and improve quality of life, resilience to climate change, and access to healthy housing and transportation, particularly in areas where addressing equity and environmental justice is a priority.

SEMCOG has convened a Healthy Climate Task Force to help lead this initiative, engaging regional stakeholders to provide input and guidance on developing priorities. Task Force members are noted in the Acknowledgements section of this plan. Smaller focus groups have also engaged subject matter experts to examine specific issues and report back to the larger Task Force. Other ongoing outreach and information sharing has been conducted with many existing partners, including local environmental and community-based organizations, utility providers, port authorities, academic institutions, industry representatives, the Southeast Michigan Air Quality Study (SEMAQS), along with State and Federal agencies, including the Michigan Department of Environment, Great Lakes, and Energy (EGLE), and Michigan Department of Transportation (MDOT).

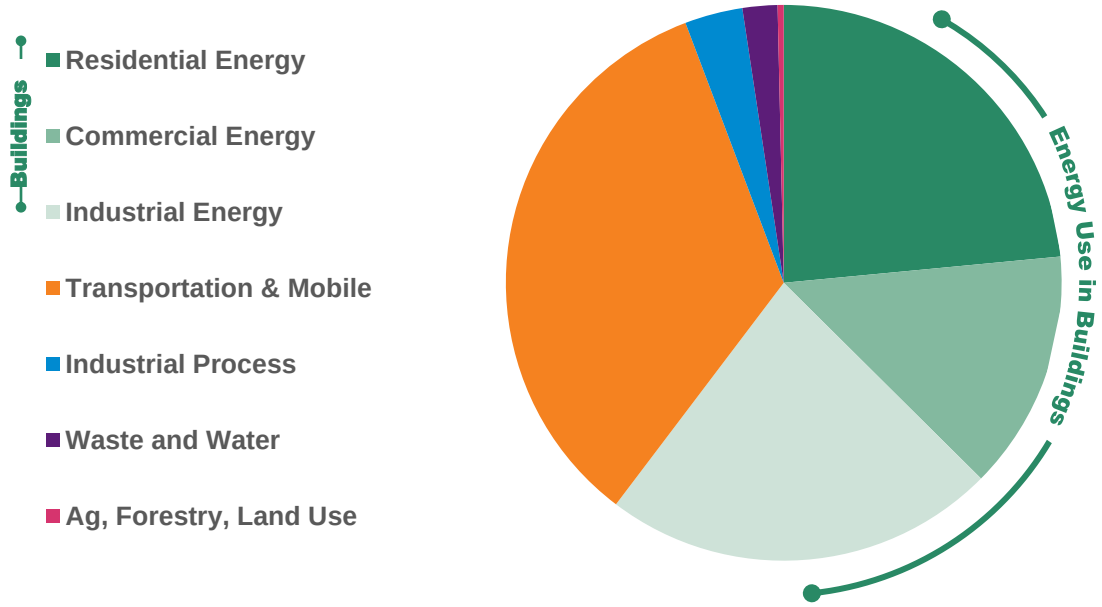
## Greenhouse Gas Emissions Inventory

SEMCOG has developed a GHG Emissions Inventory for the SEMCOG region (Wayne, Oakland, Macomb, St. Clair, Livingston, Washtenaw, and Monroe) to establish a framework for future regional climate action planning. Through the PCAP, SEMCOG also created an inventory for Lapeer County. Data from 2019 was used to establish the baseline for this inventory.

The GHG Emissions Inventory indicates that in 2019, the region emitted more than 81 million metric tons of CO2e. Figure 1 shows these emissions by sector.

Figure 1

**Greenhouse Gas Emissions in Southeast Michigan**




[1] 'Good jobs' are characterized by eight principles – recruitment and hiring; benefits; diversity, equity, inclusion, and accessibility (DEIA); empowerment and representation; job security and working conditions; organizational culture; pay; and skills and career enhancement – as defined by the United States Department of Labor: https://www.dol.gov/sites/dolgov/files/goodjobs/Good-Jobs-Summit-Principles-Factsheet.pdf.

## Equity and Environmental Justice

The Climate and Economic Justice Screening Tool (CEJST) was used in combination with EPA's Environmental Justice Screening and Mapping (EJScreen) tool to identify equity and environmental focus areas in the region. This tool is being used to ensure that the EPA and other government bodies have the information they need to fulfill the Justice40 Initiative, directing funding and programing to the communities most in need of support.

More than a quarter of Southeast Michigan's population has been identified as being within a Justice40 Census tract, and therefore in a focus area for equity and environmental justice. This represents approximately 1,387,880 people. To ensure that the priority measures identified in SEMCOG's PCAP improve the equity, resilience, and well-being of these communities, each measure has been analyzed to understand which areas in the region have the heaviest burdens. These burdens may be characterized as socioeconomic, demographic, and in terms of environmental and health indicators. Appendix B includes a list of communities where these tracts are located, and related maps for each of the eight CEJST indicators.

## Regional Priorities

Through this process, five broad measures have been identified as regional priorities for reducing climate pollution. As illustrated in Figure 2, these are:

- **Decarbonizing buildings and industry** to significantly increase energy efficiency and replace fossil fuel heating/ cooling systems with zero emissions alternatives in existing residential, commercial, municipal, and industrial buildings.

- **Modernizing mobility systems** by improving public transit services and infrastructure, increasing bicycle and pedestrian mobility options, and replacing Internal Combustion Engine (ICE) fleet vehicles with zero emissions equivalents and associated charging and fueling infrastructure.

- **Managing waste materials sustainably** by reducing excess production in food processing facilities while expanding existing food redistribution programs to hungry residents and increasing facilities and infrastructure to support composting and anaerobic digestion.

- **Expanding renewable electricity generation**, particularly in ways that will directly reduce energy costs for low income and disadvantaged communities. This will include integrating on-site renewable energy systems with building retrofits, helping to leverage other existing programs, and supporting communities in expediting larger-scale renewable energy projects.

- **Optimizing natural and working lands** to increase the coverage and management of trees, wetlands, green stormwater infrastructure (GSI), and green roofs in the region, improving their ability to sequester carbon emissions and provide cooling and air pollutant reduction, and preparing a workforce to sustain their long-term benefits.

SEMCOG will continue to engage with the Healthy Climate Task Force and coordinate with other state and regional stakeholders to support cooperation among applicants through the CPRG Implementation Grant funding process. This will also ensure that knowledge gained during the creation of the PCAP continues to inform the development of the Comprehensive Climate Action Plan (CCAP).

Figure 2

**Regional Priority Measures for the Southeast Michigan Healthy Climate Plan**

| Priority Measure | Goals |
|---|---|
| Decarbonizing Buildings and Industry | Decarbonize households with approximately 80% focus on households in equity and environmental justice areas. |
| | Decarbonize municipal buildings and facilities. |
| | Decarbonize small to medium commercial and industrial buildings. |
| Modernizing Mobility Systems | Shift rapidly to emissions-free fleet vehicles, in cooperation with local industry. |
| | Reduce emissions by increasing use of shared transportation and upgraded transit services. |
| | Avoid emissions by shifting to more active transportation modes. |
| Managing Waste Materials Sustainably | Divert food and food waste into meals and compost |
| | Eliminate emissions from wastewater processing through aerobic and anerobic digestion. |
| | Significantly increase or improve compost collection. |
| | Replace vehicles used for transportation of organic waste. |
| Expanding Renewable Electricity Generation | Increase installations of solar, wind, geothermal, combined heat and power, and other renewable energy generation and storage systems. |
| | Reduce costs by making bulk purchases or combining program administration. |
| Optimizing Natural and Working Lands | Increase the coverage and health of trees and other native vegetation. |
| | Build and maintain green stormwater infrastructure like bioswales, rain gardens, and green roofs. |
| | Conserve and expand wetlands |
| | Enhance climate-smart agricultural practices. |

# Introduction

## Background

Funded through the Climate Pollution Reduction Grant program (CPRG) by the U.S. Environmental Protection Agency (EPA), this plan is intended to guide investments in a cleaner economy that can spur innovation and economic growth while building more equitable, resilient communities. In implementing this and many other programs under the Inflation Reduction Act of 2022 (IRA), EPA seeks to achieve three broad objectives:

- Tackle damaging climate pollution while supporting the creation of good jobs and lowering energy costs for families.
- Accelerate work to address environmental injustice and empower community-driven solutions in overburdened neighborhoods.
- Deliver cleaner air by reducing harmful air pollution in places where people live, work, play, and go to school.

By developing a regional PCAP for Southeast Michigan through this program, SEMCOG's goal is to prioritize measures that will reduce greenhouse gas (GHG) emissions and enhance natural areas that capture climate pollution. Extensive stakeholder outreach, community engagement, and cross-sector coordination are integral to this goal and ensuring that these priority actions will benefit the region, with a focus on equity and environmental justice.

## Overview

### Goals

The goal of this PCAP is to prioritize measures that will reduce greenhouse gas (GHG) emissions and enhance natural areas that capture climate pollution. Extensive stakeholder outreach, community engagement, and cross-sector coordination are integral to this goal and ensuring that these priority actions will benefit the region, with a focus on equity and environmental justice.

The PCAP has been developed to identify a list of near-term, implementation-ready measures that will reduce GHG pollution quickly and dramatically across Southeast Michigan. In alignment with EPA requirements for CPRG, these measures have been identified to address electricity generation, industry, transportation, buildings, natural and working lands, and waste management. In addition, these measures have been optimized to:

- Increase the number of good jobs[2] in the region.
- Decrease localized and regional air and water pollution.

[2] "Good jobs' are characterized by eight principles – recruitment and hiring; benefits; diversity, equity, inclusion, and accessibility (DEIA); empowerment and representation; job security and working conditions; organizational culture; pay; and skills and career enhancement – as defined by the United States Department of Labor: https://www.dol.gov/sites/dolgov/files/goodjobs/Good-Jobs-Summit-Principles-Factsheet.pdf.

- Decrease long-term energy costs.
- Improve the health impacts, resilience, and comfort of housing and other buildings.
- Increase accessibility to and quality of healthy, safe, and affordable transportation for all ages.
- Increase and maintain healthy urban vegetation that will sequester GHG emissions and other air pollutants, absorb and divert rainfall during storm events, and provide cooling and habitats that will increase local biodiversity.

The measures described in this plan will directly reduce climate pollution in Southeast Michigan and advance the area's transition to a zero emissions future. They have also been selected because they will create good jobs in the region and reduce household energy costs. Where possible, the measures will be implemented in communities that are overburdened by pollution and environmental degradation. In so doing, the work will begin to address environmental injustices by providing cleaner air and water, healthier homes and workplaces, and safer and greener outdoor spaces.

## Contents

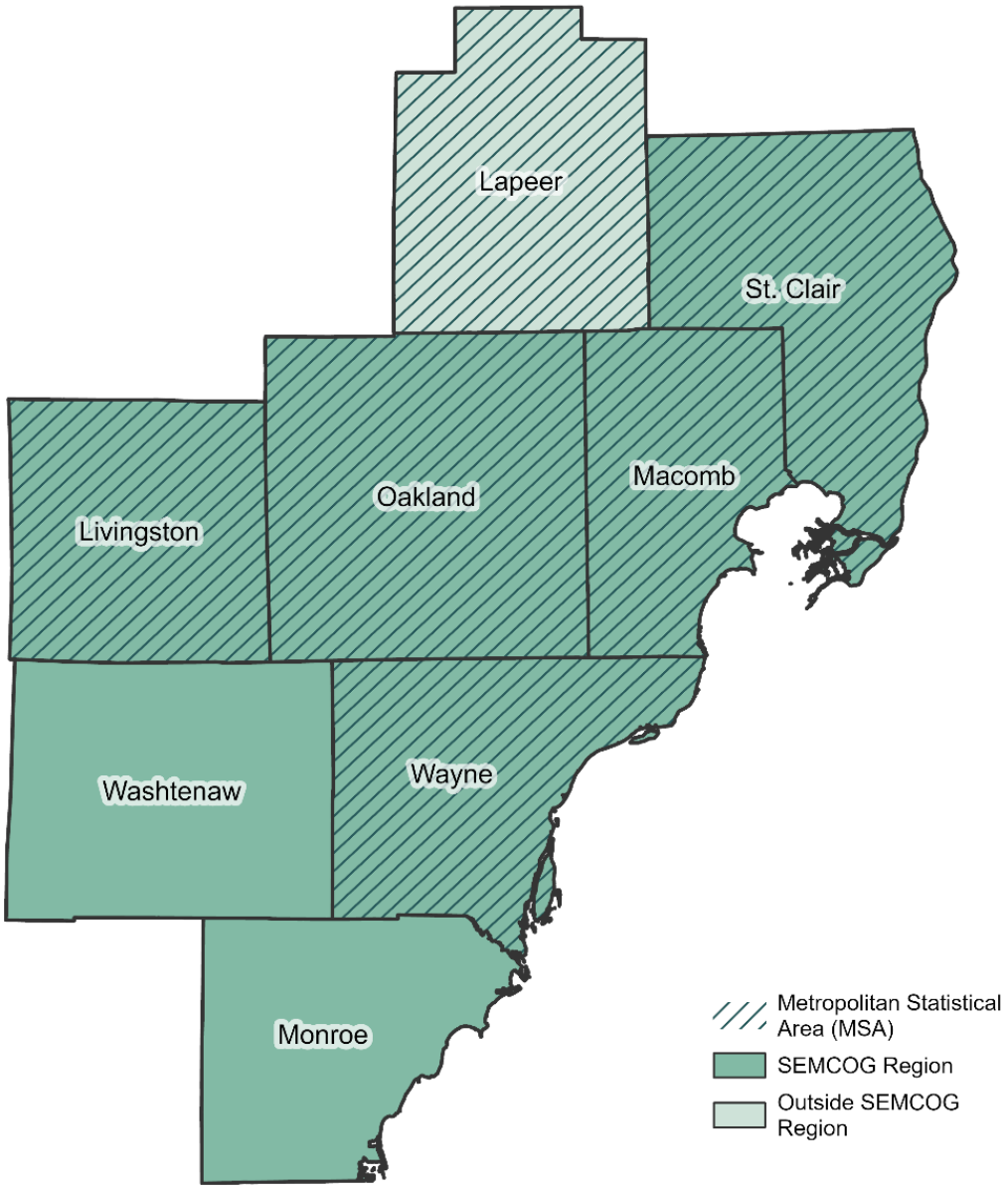
Based on the EPA's CPRG requirements and SEMCOG's intention to develop a regional plan that meets the specific needs of Southeast Michigan, this PCAP has been prepared with the following information:

- **GHG Inventory** – a calculation of the region's total greenhouse gas emissions, by source and sector for one calendar year. SEMCOG's GHG inventory is based on data from 2019 and was developed using the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) methodology.
- **Equity and Environmental Justice** – an overview of the metrics used to identify emphasis areas for equity and environmental justice, and a broad analysis of the impacts the proposed measures will have on these communities in the region.
- **Regional Priority Measures** – a list of policies, projects, programs, or other measures that will reduce GHG emissions, with a focus on the region's highest priority sectors. Measures included here are based on the PCAP's stakeholder-driven process and include an analysis of other benefits that may be achieved beyond the reduction in GHG emissions, such as reduction in other air pollutants, impacts to equity and environmental justice, a review of the entities with authority to implement the measure, and impacts to the region's workforce.
- **Next Steps** – including the CPRG Implementation Grants, and Comprehensive Climate Action Plan (CCAP).

## Geographic Scope

This plan covers eight counties in Southeast Michigan, including Lapeer, Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw, and Wayne, as shown in Figure 3. The CPRG planning grant was awarded to the Detroit-Warren-Dearborn Metropolitan Statistical Area (MSA), which includes Lapeer, Livingston, Macomb, Oakland, and Wayne Counties. SEMCOG, as a regional council of local governments, includes Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw, and Wayne Counties. EPA has encouraged inclusive regional planning beyond the CPRG's focus on the MSA, and SEMCOG has well-established collaborative relationships with all the counties and communities engaged in the planning process.

Figure 3
**PCAP Geographic Scope**



# Approach

## Connecting to Other Plans

SEMCOG's coordinated approach to climate action planning connects and uplifts existing local, regional, and State efforts. Representatives from all levels of government have been engaged with developing this plan, and its priorities are designed to build on their experience and integrate with their ongoing work. Working together with local governments and regional partners to reduce greenhouse gas emissions and enhance natural areas, Southeast Michigan can prevent future impacts of climate change and ensure the region is a more resilient, equitable, and thriving home for future generations.

SEMCOG's work covers a range of topics that work together to support a healthy climate, including the region's environment and infrastructure, transportation and mobility networks, and economic and community vitality. As the designated local air-quality planning agency under the federal Clean Air Act, SEMCOG leads a variety of efforts to help attain and maintain national air quality standards in the region. As the region's Metropolitan Planning Organization (MPO), SEMCOG is responsible for developing the Regional Transportation Plan (RTP), which serves as a policy document to guide long-term transportation investment. As the region's federally designated Economic Development District, SEMCOG is also responsible for developing, updating, and implementing the Comprehensive Economic Development Strategy (CEDS), addressing the region's priorities for workforce and education, quality of place, and the business climate. Climate action is embedded in other aspects of SEMCOG's work, including:

- The Southeast Michigan Community EV Toolkit sets the stage for emerging technology in the world of sustainability. It gives local communities and stakeholders quick access to key data and background information regarding electric vehicles and helps guide communities towards the implementation of EV policies and projects.

- SEMCOG's Water Infrastructure Planning Guide addresses how future rainfall projections and storm intensity will exceed existing stormwater infrastructure capacities and brought together regional partners and experts to address the resiliency of our water infrastructure systems and ensure protection of public health, property, and infrastructure.

- SEMCOG's GREEN Initiative aims to expand the quality, quantity, and connectivity of the green infrastructure network, and ensure that public benefits of green infrastructure are resilient, equitable, and improve the quality of life in Southeast Michigan communities.

A growing number of local plans for climate action and sustainability have been adopted in recent years, including the Cities of Ann Arbor, Detroit, Ferndale, Southfield, Sterling Heights, Royal Oak; Scio Township; and Washtenaw County. Several other municipalities have planning efforts in progress, along with dedicated staff to focus on sustainability and climate planning. Aligning with these initiatives and engaging with these professionals has been key to the development of this plan.

At the State level, the MI Healthy Climate Plan lays out a pathway for Michigan to reach carbon neutrality by 2050 to avert the worst impacts of the climate crisis, create good-paying jobs, and build a healthier and more prosperous, equitable, and sustainable Michigan for all. Published in 2022 by the Michigan Department of Environment, Great Lakes, and Energy (EGLE), its objectives have informed the regional planning process to develop strategies that are aligned with the State, while meeting the specific needs and goals of Southeast Michigan communities. Throughout the PCAP planning process, SEMCOG has coordinated with EGLE to share data, collect feedback from the public, and build upon the existing work laid out in the MI Healthy Climate Plan.

## Engaging Regional Stakeholders

SEMCOG has convened a Healthy Climate Task Force to lead this initiative, engaging regional stakeholders to provide input and guidance on the development of plans and policies. The Task Force is co-chaired by members of SEMCOG's local elected leadership, and includes representatives from government, transportation, utilities, business, health, development, workforce, and environmental sectors.

Smaller focus groups have also engaged subject matter experts to examine specific issues and report back to the larger Task Force. Five focus groups were convened for the PCAP, engaging more than 200 participants on topics including:

- Community Engagement;
- Transportation;
- Energy;
- Waste and Materials Management, and
- Nature-Based Solutions.

This input has been applied to help develop priority measures and coordinate project opportunities for future implementation.

Additional ongoing outreach and information sharing have been conducted with many existing partners, including local environmental and community-based organizations, utility providers, port authorities, academic institutions, industry representatives, the Southeast Michigan Air Quality Study (SEMAQS), along with State and Federal agencies, including the Michigan Department of Environment, Great Lakes, and Energy (EGLE), and Michigan Department of Transportation (MDOT). SEMCOG has also maintained open communication with interested and affected agencies and individuals to better understand their priorities and the existing climate planning initiatives throughout Southeast Michigan.

## Establishing Regional Priorities

Between September 2023 and January 2024, the PCAP was developed with two parallel activity streams. The first stream was research-based. This began with a review of the region's 2019 GHG Inventory and completion of a 2019 GHG inventory for Lapeer County. These inventories provided an understanding of the area's GHG emissions sources and sinks. This understanding ensured that all measures included in the PCAP will significantly reduce emissions from those sources. The team then reviewed the climate action plans and initiatives already underway throughout the region to begin to identify the best opportunities to accelerate and expedite durable emissions reductions.

The second stream of activity consisted of gathering input on priorities and potential measures to include in the plan from SEMCOG's member organizations and affiliates. Much of the information gathering and engagement activities are described in the sections above. Additionally, SEMCOG created and disseminated an online Call for Projects portal that allowed measures to be shared directly. In coordination with EGLE, projects submitted to both EGLE and SEMCOG were shared between the organizations. Through these activities projects were gathered and evaluated for potential emissions reductions, considered for their benefits to equity and environmental justice, evaluated for the number of good jobs they would create, and how much they would improve local air and water

quality. Appendix C contains more detailed descriptions of the technical evaluation and data analysis process.

Ultimately, the priority measures included in the PCAP have been identified to meet the following criteria. The measure will:

1. **Achieve quantifiable and significant reductions in GHG pollution** in Southeast Michigan between 2024 and 2030 and continue to do so after this date. Proposed measures include:
    - Reducing energy consumption and heat loss (or wasted heat) in buildings and industrial operations, or due to inefficient technologies.
    - Switching energy sources away from fossil fuels to renewable and alternative energy sources across all sectors - from transportation to buildings and industry.
    - Improving active transportation and transit infrastructure so that more trips are taken by walking, cycling or by bus, and fewer are taken in personal use, ICE vehicles.
    - Reducing and diverting food waste from landfills.
    - Reducing methane emissions by converting solid waste and wastewater into renewable natural gas; and
    - Increasing and protecting trees, GSI, and wetlands to allow them to sequester greenhouse gas emissions as they grow.
2. **Improve the long-term well-being of low-income and disadvantaged communities** in the SEMCOG region by improving their housing, access to transportation and food, and reducing their energy costs.
3. **Improve the health of all Southeast Michiganders** by reducing air pollution, water pollution, increasing green space and biodiversity, and supporting more active lifestyles.
4. **Create good, long-term jobs** in ‘green energy generation’, building construction and renovation, manufacturing of zero-emissions vehicles, charging and fueling infrastructure, and green infrastructure management.

# Greenhouse Gas Emissions Inventory

SEMCOG previously developed a 2019 baseline GHG inventory for the SEMCOG region (Wayne, Oakland, Macomb, St. Clair, Livingston, Washtenaw, and Monroe) to establish a framework for future regional climate action planning. Through the PCAP, SEMCOG also created an inventory for Lapeer County.

## Methodology

The GHG inventory created for the SEMCOG PCAP used the Global Protocol for Community (GPC) Emissions Basic framework. This framework calculates GHG emissions from the following sources across the SEMCOG Project Area over the course of a single calendar year.[3] The sectors and sources included are summarized in Figure 4.

The 'base year' refers to the calendar year of the data used to create the inventory. This inventory then becomes a reference point to which future emissions can be compared.

The process of creating a GHG inventory for SEMCOG's PCAP Project Area required taking SEMCOG's existing region-wide inventory and adding Lapeer County's emissions to it. SEMCOG's regional GHG emissions inventory used 2019 as its baseline year because it was the most recent year for which the necessary data was available. A recent SEMCOG study[4] of pre- and post-pandemic travel patterns has shown some shift in the types of trips in the region. Based on cell phone data, the overall number of trips has decreased across all travel modes (walking, biking, and mobile) while the length of trips has increased. There has also been a shift in weekday time of travel showing a decrease in typical commuting patterns.

As Lapeer County did not have a GHG inventory, the project team completed a GPC-compliant GHG inventory for this area using standard State and federal data sources for 2019. Lapeer County's GHG inventory was then combined with the SEMCOG inventory to create a complete 2019 GHG inventory for the whole Project Area.

It is important to understand that using the GPC means that inventories created for different communities will be comparable to each other, and that a regional inventory will be largely comparable with the individual inventories for communities within that region. Some variations may still exist; for example, some optional emissions sources that were included in the regional inventory may not be included in individual community inventories (or vice versa), and some estimation methods may be different. For the purposes of the PCAP, SEMCOG ensured that the Lapeer County inventory was calculated as similarly as possible to the region wide SEMCOG inventory. Details on the methodology and data sources are included in Appendix A.

[3] Some of these sources are optional according to the GPC framework.

[4] Data sources include LOCUS, the Bridge and Tunnel Operators Association (BTOA), and the National Transit Database (NTD).

Figure 4

**GHG Emissions Sectors**

**Stationary energy** is the use of electricity, natural gas, and non-utility fuels in residential, commercial, and industrial buildings, including furnaces, generators, or other stationary combustion equipment.

**Transportation and mobile source emissions** include on-road passenger and freight motor vehicle travel, public transportation, freight and passenger rail, off-road vehicles and equipment, and waterborne shipping in and out of ports in the region.

**Solid Waste and Water Treatment** involves emissions from solid waste disposal through composting or landfills and water/ wastewater treatment processes.

**Industrial Processes** produce emissions related to physical and chemical transformations of raw materials and fugitive emissions that occur through natural gas leakage and oil production wells.

**Agriculture, Forestry, and Land Use** involve emissions as well as carbon sequestration from forests, crops, and other vegetation as well as livestock and manure management.

# GHG Inventory Results

The GHG Inventory completed for SEMCOG's PCAP indicates that in 2019, the region emitted a total of **81,101,000 metric tons of carbon dioxide equivalent (CO2e).** Although many gases contribute to climate change, some are more powerful creators of a greenhouse effect. To accurately reflect the relative strength of each gas and quantify the total emissions impact of many types of gases, we convert them all to a single unit of CO2e. This represents what their strength would be if they were all CO2.Figure 5 shows these emissions by sector and for each county within the Project Area. Figure 6 shows these same sector emissions at the regional level.

Figure 5a

**Southeast Michigan GHG Emissions by Sector**

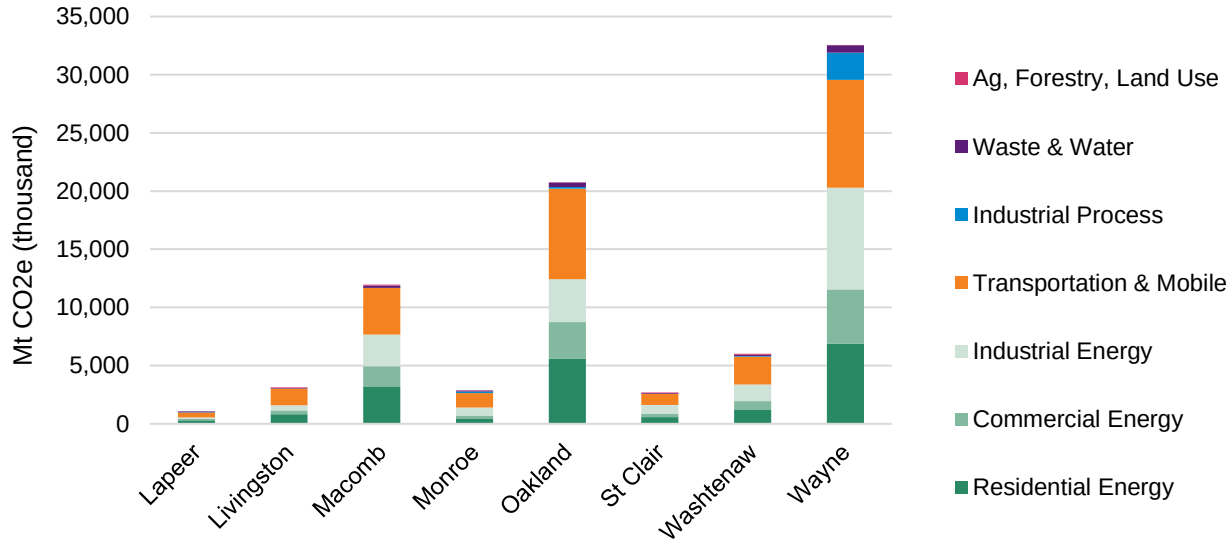



Figure 5b

**Southeast Michigan Emissions by Sector Details**

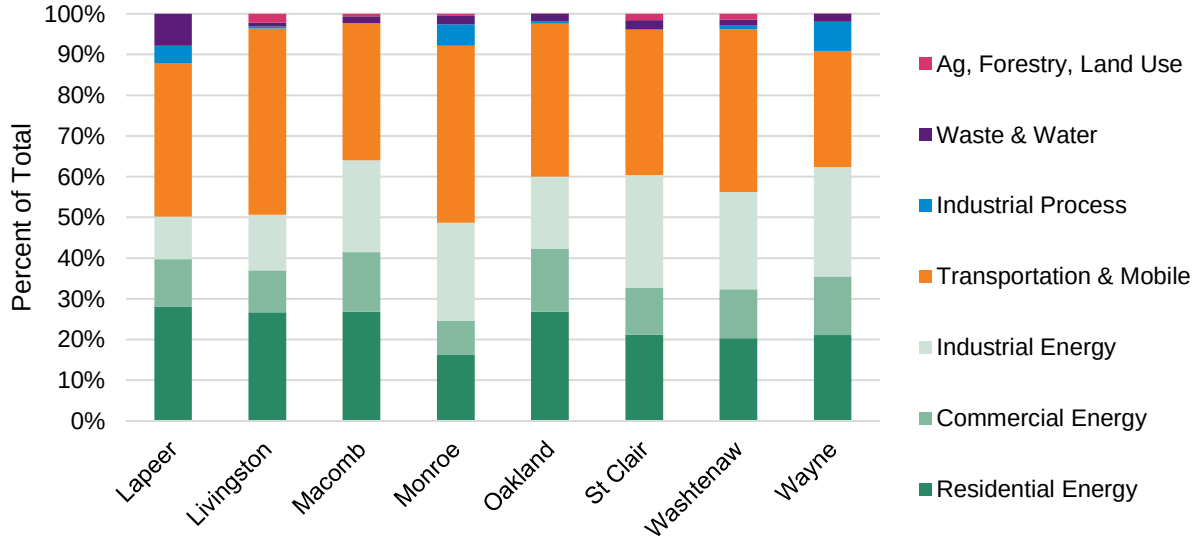
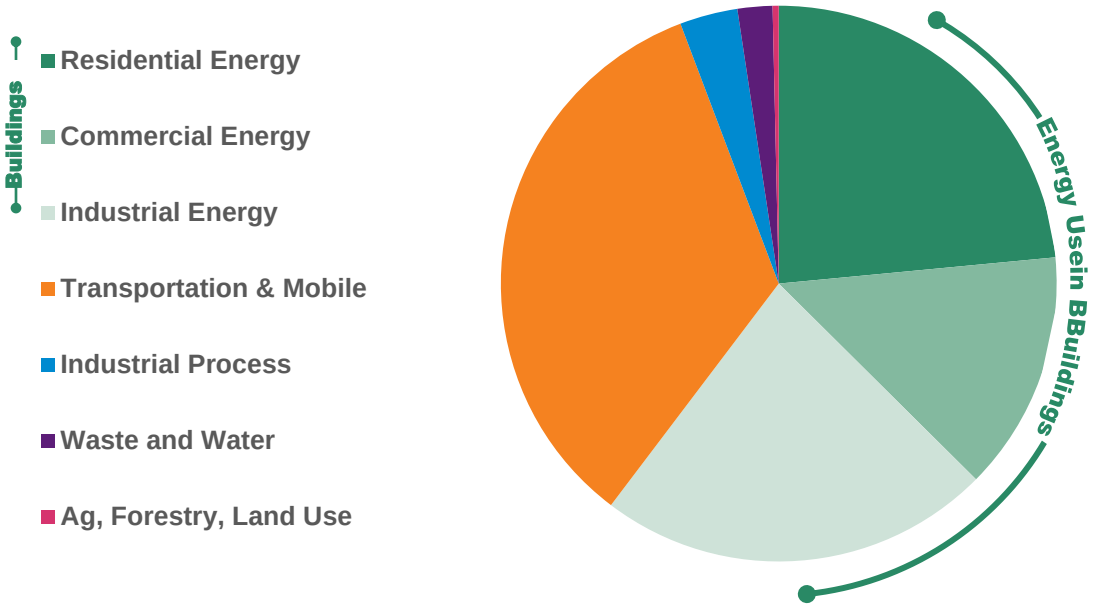


Figure 6

**Regional Total GHG Emissions by Sector**

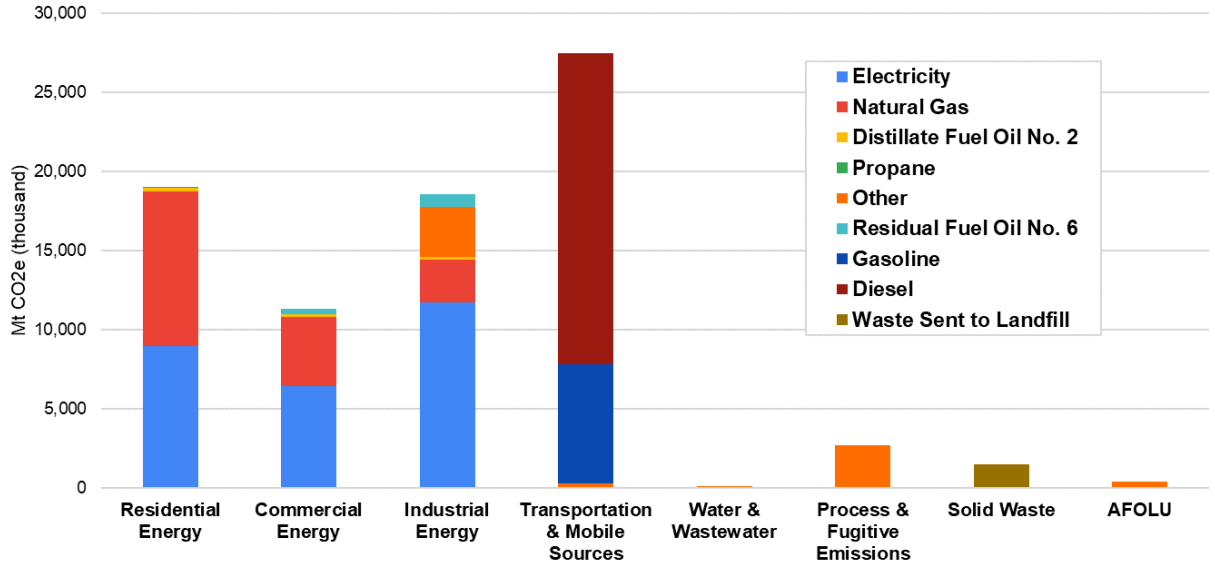



| Sector | Emissions *(Metric Ton CO2e)* | Percent of Total |
|---|---|---|
| Residential Energy | 19,052,112 | 23% |
| Commercial Energy | 11,310,905 | 14% |
| Industrial Energy | 18,554,603 | 23% |
| Industrial Processes | 2,732,800 | 3.4% |
| Transportation & Mobile | 27,515,718 | 34% |
| Waste and Water | 1,646,551 | 2.0% |
| Ag, Forestry, Land Use | 287,817 | 0.4% |
| Total | 81,100,506 | |

From these, we can see that **the primary sources of GHG emissions in Southeast Michigan are buildings, transportation, and industry.** Energy is used to heat and cool buildings, as well as to operate appliances and machinery within buildings. This energy is primarily electricity and natural gas, and the emissions come from the generation of grid electricity, and from the combustion of natural gas. Emissions from the transportation sector are primarily gasoline and diesel, and account for 35% of the total GHG emissions from the region. Figure 7 describes these sources by sector in greater detail.

Figure 7

**Sources of GHG Emissions by Sector**




With a population of 4.8 million people and total regional GHG emissions of 81,101,000 metric tons, this means **per capita emissions in 2019 were approximately 17 metric tons of CO2e/ person** within Southeast Michigan. For comparison, the national per capita emissions in 2019 were 15.7 tons of CO2e/ person[5], and Michigan's state-wide per capita emissions were 14.7 tons / person in 2021.

Working to reduce total and personal GHG emissions requires systemic changes to how energy is produced, and how it is used. One person cannot fix the climate crisis, but every person will be involved in the solutions.

[5] Global Carbon Budget (2023); Population based on various sources (2023) – with major processing by Our World in Data: https://ourworldindata.org/grapher/co-emissions-per-capita?tab=chart&country=USA~IND~CHN

# Equity and Environmental Justice

While the impacts of climate change are critical for all Southeast Michigan communities to address, it is now well-established that low-income and disadvantaged communities are and will continue to be disproportionately impacted by climate change. These communities are especially at risk from exposure to extreme heat and are less equipped to recover from flooding and extreme weather events that damage their homes and property.

Over a quarter of Southeast Michigan's population is identified as being within a Justice40 Census tract and thus part of an underserved community[6]. This represents approximately 1.2 million people. Underserved communities within the region need clean water, clean air, and access to green space, not only to be resilient, but to thrive.

## Metrics

To ensure that SEMCOG's PCAP measures improve equity and the resilience and well-being of these communities, information was consolidated from several sources to understand which areas in the region have the heaviest burdens socioeconomically, demographically, and in terms of environmental and health indicators.

- **The Climate and Economic Justice Screening Tool[7] (CEJST)** was used in combination with EPA's Environmental Justice Screening and Mapping[8] (EJScreen) tool to identify equity and environmental focus areas in the region. This tool is being used to ensure that the EPA and other government bodies have the information they need to fulfill the Justice40 Initiative, directing funding and programming to the communities most in need of support. In the CEJST tool, communities (at the census-tract level) are considered disadvantaged if they have disproportionately high numbers of low-income households and exceptionally high exposure to one or more environmental burdens. The EJ and Supplemental Indices from EJ Screen were also reviewed to learn more about the burdens in each census tract.

- **SEMCOG's Equity Emphasis Area Dashboard[9]** provides key demographic and socioeconomic variables at the same levels as the Green Dashboard. The Equity Emphasis Area Dashboard also describes relative concentrations of vulnerabilities across the region using a "0-4" composite score. This draws attention both to which areas have the most burdens and to the primary vulnerabilities in each area.

- **SEMCOG's GREEN Dashboard[10]** describes green infrastructure and natural resource allocation by county, community, and census tract across the region, highlighting areas that lack tree cover or natural spaces, and then highlighting the impacts of these gaps in terms of factors such as climate resilience, health equity, and attracting workforce.

[6] SEMCOG. SEMCOG Equity Emphasis Areas Dashboard. https://maps.semcog.org/EquityEmphasisAreas/?tiles=popage65andup_21,popage0_17_21,popminority_21,householdsinpoverty_21,hh_limitedenglish_21,hh_transitdependent_21,femalenospousehh_21,popdisability_21&project=Transportation%20Equity.

[7] Climate and Economic Justice Screening Tool. https://screeningtool.geoplatform.gov/en/#7.91/42.353/-83.616.

[8] EPA. Environmental Justice Screening and Mapping Tool. https://ejscreen.epa.gov/mapper/.

[9] SEMCOG. SEMCOG Equity Emphasis Areas Dashboard.

[10] SEMCOG. SEMCOG GREEN Dashboard. https://maps.semcog.org/green/.

# Impacts

The communities identified through this analysis were then used in several ways throughout the development of the PCAP. For example, equity and environmental justice focus areas were highlighted on maps used during workshops with the Healthy Climate Task Force. For example, in a group discussing transportation opportunities, communities where a disproportionate number of households have no car were highlighted on the map. Participants were encouraged to consider how transit and active transportation projects could be developed to benefit these communities.

SEMCOG'S Call for Projects portal asked for the proposed locations of the projects; any identified as equity and environmental justice focus areas were flagged as having greater potential. In follow-up discussions applicants were then asked to consider how the project could provide value to those communities, particularly in the context of the area's burdens and vulnerabilities.

The result is that each of the measures described in the PCAP has been associated with specific census tracts or communities in which it would make a positive difference for equity and environmental justice. The eight CEJST indicators of burden are described in Table 1 below, along with affected population and the number of census tracts in the SEMCOG project area that are disadvantaged according to that indicator.[11] A list of the communities where these census tracts are located and individual maps for each indicator are included in Appendix B.

Table 1

**CEJST Indicators and Regional Census Tracts**

| CEJST Indicators | Description | Population Affected | Number of Census Tracts |
|---|---|---|---|
| ***Climate Change*** | Census tracts are disadvantaged if they are:<br>• at or above the 90th percentile for expected agriculture loss rate OR expected building loss rate OR expected population loss rate OR projected flood risk OR projected wildfire risk;<br>• AND are at or above the 65th percentile for low income. | 82,666 | 29 |
| ***Energy*** | Census tracts are disadvantaged if they are:<br>• at or above the 90th percentile for energy cost OR PM2.5 in the air;<br>• AND are at or above the 65th percentile for low income. | 722,698 | 301 |
| ***Health*** | Census tracts are disadvantaged if they are:<br>• at or above the 90th percentile for asthma OR diabetes OR heart disease OR low life expectancy;<br>• AND are at or above the 65th percentile for low income. | 1,169,650 | 439 |
| ***Housing*** | Census tracts are disadvantaged if they are:<br>• Experienced historic underinvestment OR are at or above the 90th percentile for housing cost OR lack of green space OR lack of indoor plumbing OR lead paint;<br>• AND are at or above the 65th percentile for low income. | 939,030 | 372 |

[11] Climate and Economic Justice Screening Tool, 2023. Methodology.: https://screeningtool.geoplatform.gov/en/methodology.

| CEJST Indicators | Description | Population Affected | Number of Census Tracts |
|---|---|---|---|
| ***Legacy Pollution*** | Census tracts are disadvantaged if they are:<br>• Have at least one abandoned mine land OR Formerly Used Defense Sites OR are at or above the 90th percentile for proximity to hazardous waste facilities OR proximity to Superfund sites (National Priorities List (NPL)) OR proximity to Risk Management Plan (RMP) facilities;<br>• AND are at or above the 65th percentile for low income. | 239,073 | 89 |
| ***Transportation*** | Census tracts are disadvantaged if they are:<br>• at or above the 90th percentile for diesel particulate matter exposure OR transportation barriers OR traffic proximity and volume;<br>• AND are at or above the 65th percentile for low income. | 591,795 | 233 |
| ***Water and Wastewater*** | Census tracts are disadvantaged if they are:<br>• at or above the 90th percentile for underground storage tanks and releases OR wastewater discharge;<br>• AND are at or above the 65th percentile for low income. | 839,509 | 325 |
| ***Workforce Development*** | Census tracts are disadvantaged if they are:<br>• at or above the 90th percentile for linguistic isolation OR low median income OR poverty OR unemployment;<br>• AND more than 10% of people ages 25 years or older whose high school education is less than a high school diploma. | 919,620 | 353 |

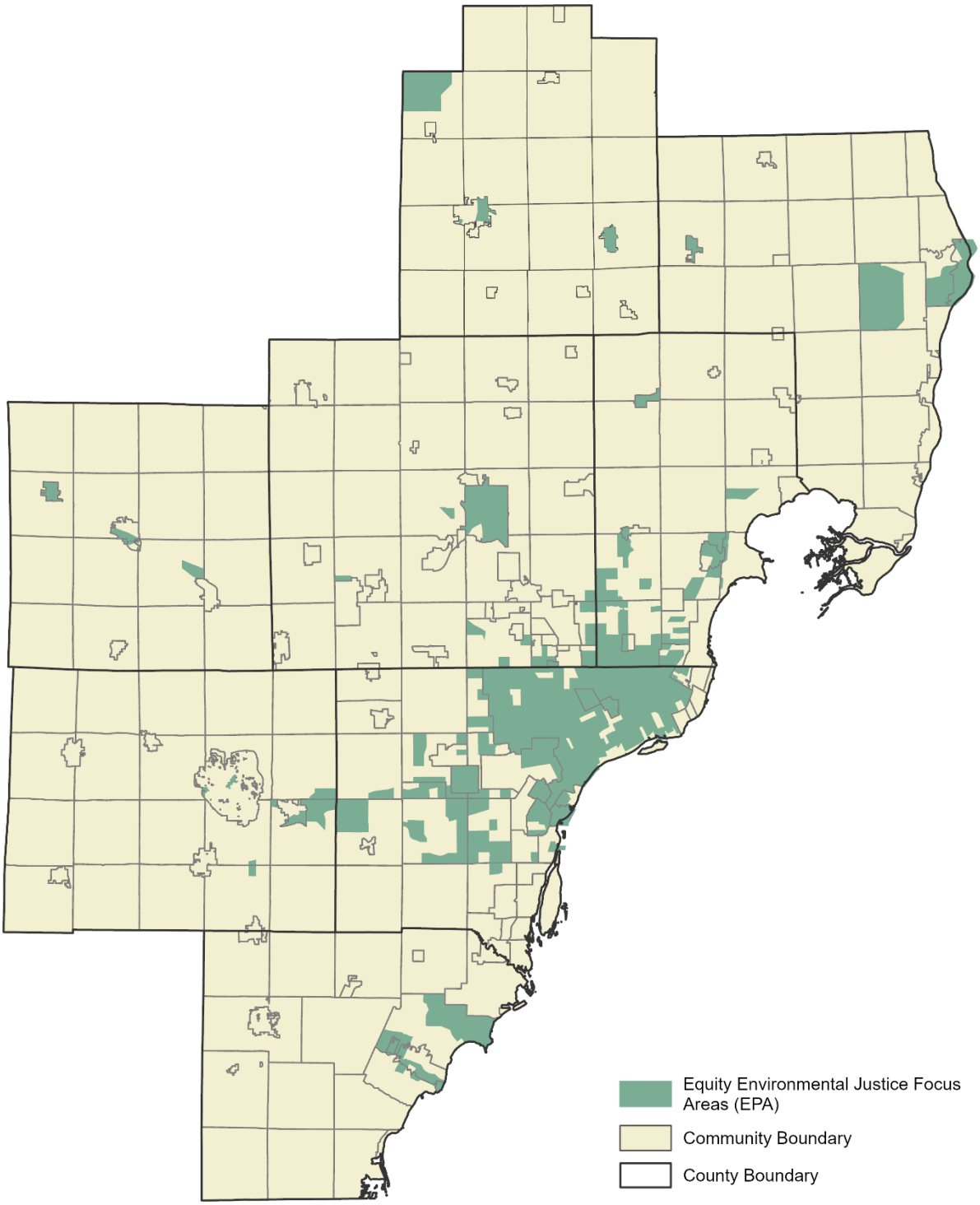
Of the 1,472 census tracts within the SEMCOG PCAP's Project Area, 498 individual tracts (34%) meet or exceed both the qualifications for one or more of the CEJST burden thresholds and meet the associated socioeconomic thresholds. These census tracts are mapped in Figure 8. This represents 1,387,880 residents of Southeast Michigan. These communities are disproportionately vulnerable to climate change impacts and other disruptions.

MI HEALTHY CLIMATE PLAN

This plan's focus on low-income and disadvantaged communities supports the *MI Healthy Climate Plan's* statewide ***Commitment to Environmental Justice and Pursuit of a Just Transition.*** Aligning these plans can ensure that at least 40 percent funding for climate-related initiatives benefit Michigan's disadvantaged communities and include a just transition for all workers through proactive engagement, job training, and workforce development.

Figure 8

**Equity and Environmental Justice Focus Areas in Southeast Michigan**



REGIONAL PRIORITY MEASURE:

# Decarbonizing Buildings and Industry

In 2019, almost 50 million metric tons (or 60% of the total) of GHG emissions generated in Southeast Michigan came from buildings and industrial processes. These emissions were produced from burning natural gas, distillate fuel, propane, and fuel oil to heat residential, commercial, and industrial buildings. They include electricity used to heat and cool buildings and to power lighting, appliances, and other plug load.

## Goals

This measure intends to significantly reduce total energy use and emissions from buildings across the region. It has three goals, one for each of three key building sectors:

- To **decarbonize households across the region**, providing annual energy savings of at least 50% to homeowners. Approximately 80% of these will be in equity and environmental justice areas.
- To **decarbonize municipal buildings and facilities**, reducing energy use by at least 50% and replacing internal heating and cooling systems with zero emissions alternatives; and
- To **decarbonize small to medium commercial or industrial buildings** in equity and environmental justice areas by 2030.

Following best practices, this measure will include coordination and funding for energy audits, materials, and labor for retrofits (e.g., replacement of windows and doors, sealing leaks, increased insulation and building envelopes) to reduce total energy use by at least 50%, and replacement of lighting and appliances with more efficient technologies[12]. After efficiency improvements, fossil fuel furnaces and water heaters (as well as air conditioning units) will be replaced with systems that use zero emissions energy sources, and solar systems installed on all retrofit buildings that are appropriate for solar.

Communities in the SEMCOG region have identified the following opportunities to further reduce emissions:

- Expanding policies and programs that are already operating in cities in the region into smaller, neighboring communities to expedite implementation of well-designed programs.

### ACTIONS TO SUPPORT THIS MEASURE CAN:

Reduce GHG emissions from sources contributing
**60%**
to the region's annual total

Reduce up to
**3,034,800 tons**
CO2e emissions by 2050 with identified projects

Impact up to
**1,300,708 people**
living in equity and environmental justice focus areas

Create up to
**16.4 jobs**
per $1 million invested

[12] The specific retrofits and upgrades required will be determined based on energy audits completed for each building or group of buildings.

- Targeting low-income and disadvantaged neighborhoods for these improvements to ensure that the poorest residents are the first to benefit from the resulting savings in energy costs.
- Coordinating this work with other programs and stack grants, rebates, and other incentives where possible to increase the benefits to building owners and take advantage of all options to achieve emissions reductions. Potential applicants suggested the following as some of the ways in which this would be done:
    - Adding on-site rooftop solar using the Solar for All grants,
    - Recycling old appliances for rebates from DTE which would then be used to replace them with zero emissions alternatives,
    - Making essential repairs to a residence with the support of programs like Michigan's State Emergency Relief, USDA Rural Development programs, and Michigan Department of Community Health's Lead Safe Program.
- Leveraging projects such as the community ground source heat exchange network developed in Ann Arbor through funding from the Department of Energy to ensure the local expertise and benefits gained are shared throughout the region.
- Ensuring that retrofit buildings also have resilient vegetation and landscaping to provide shade, insulation, reduce energy costs, and increase green space.

These additional opportunities will be considered and integrated where possible into the applications submitted for competitive funding.

MI HEALTHY CLIMATE PLAN

This regional priority measure supports the *MI Healthy Climate Plan's* statewide strategy to **Repair and Decarbonize Homes and Businesses**. This includes the goal to reduce emissions related to heating Michigan homes and businesses 17% by 2030, and increase investments in repairing and improving buildings to reduce costs for working families and small businesses.

## Projected Emissions Reductions

Emissions reductions were quantified for several sample scenarios, based on the types of building retrofits that local stakeholders have expressed interest in pursuing. The energy reductions and avoided emissions are summarized in Table 2. To achieve reductions in total energy consumption of at least 50% and ensure significant reductions in emissions, both thermal and water heating systems are assumed to be replaced with zero emissions systems. Moderately sized on-site solar installations on a portion of the buildings are included.[13]

Additionally, Table 3 highlights the corresponding air pollutant emission reductions from federal National Ambient Air Quality Standards (NAAQS). Criteria pollutants include carbon monoxide (CO), particulate matter (PM), nitrogen dioxide ($NO_2$ or NOx), and sulfur dioxide (SO2). While Ozone ($O_3$) is a criteria pollutant, it is not emitted directly, but its precursors of NOx and volatile organic compounds are emitted from vehicles and often quantified to estimate the ozone reduction benefit.

[13] Climate and Economic Justice Screening Tool, 2023. Methodology.

Table 2

**Projected Emissions Reductions for Decarbonizing Buildings and Industry**

| Sample Building Group[14] | Annual Reduction in Energy Costs | Annual Avoided Emissions 2025 *(MT CO2e)* | Cumulative Emissions Avoided 2025-2030 *(MT CO2e)* | Cumulative Emissions Avoided 2025-2050 *(MT CO2e)* | Lifetime Cost or Savings / Emissions Avoided |
|---|---|---|---|---|---|
| 1,000 Single Family Homes Retrofit, Air Source Heat Pumps Replacing Furnaces and Hot Water Heating, and 4,800 kW Rooftop Solar | $1,532 / Home | 6,215 | 36,014 | 110,100 | Cost: $111 / MTCO2e |
| 10,000 Single Family Homes (Across Counties) Retrofit, Air Source Heat Pumps Replacing Furnaces and Hot Water Heating, and 48,000 kW Rooftop Solar | $1,520 / Home | 58,372 | 332,297 | 1,237,121 | Cost: $101 / MTCO2e |
| 1,000 Single Family Homes Retrofit, Ground Source Heat Pumps Replacing Furnaces and Hot Water Heating, and 4,800 kW Rooftop Solar | $1,260 / Home | 6,897 | 39,336 | 149,298 | Cost: $222 / MTCO2e |
| 10,000 Single Family Homes (Across Counties) Retrofit, Ground Source Heat Pumps Replacing Furnaces and Hot Water Heating, and 48,000 kW Rooftop Solar | $1,710 / Home | 63,873 | 358,523 | 1,266,775 | Cost: $174 / MTCO2e |
| Municipal Portfolio Retrofit (6 medium office buildings, 2 citizen centers, 4 community halls, one garage and 4 fire halls), and 10,000 kW Rooftop Solar. | $1,206 Total | 4,532 | 22,846 | 54,103 | Savings: $298 / MTCO2e |
| Small to Medium Commercial and Industrial Retrofit (1.5 million sq. feet in retail, warehouses and industrial) and 20,000 kW Rooftop Solar | $2,968 Total | 12,231 | 64,375 | 185,823 | Savings: $42 / MTCO2e |

[14] These estimates were calculated using energy consumption data from SEMCOG counties in 2019, NREL's State Level Residential Building Stock and Energy Efficiency & Electrification Packages Analysis (https://public.tableau.com/app/profile/nrel.buildingstock/viz/StateLevelResidentialBuildingStockandEnergyEfficiencyElectrificationPackagesAnalysis/Introduction) and SSG's Energy Systems Simulator.

Table 3

**Projected Air Pollutants Avoided by Decarbonizing Buildings and Industry**

| Sample Building Type | Air Pollutant | Cumulative Air Pollutant Avoided 2025-2030 *(lbs)* | Cumulative Air Pollutant Avoided 2025-2050 *(lbs)* |
|---|---|---|---|
| 1,000 Single Family Homes Retrofit, Air Source Heat Pumps Replacing Furnaces and Hot Water Heating, and 4,800 kW Rooftop Solar | VOC | 3,056 | 13,243 |
| | CO | 22,226 | 96,311 |
| | NOx | 52,230 | 226,331 |
| | PM2.5 | 239 | 1,035 |
| | SO2 | 333 | 1,445 |
| 10,000 Single Family Homes (Across Counties) Retrofit, Air Source Heat Pumps Replacing Furnaces and Hot Water Heating, and 48,000 kW Rooftop Solar | VOC | 24,674 | 106,920 |
| | CO | 179,447 | 777,603 |
| | NOx | 421,700 | 1,827,367 |
| | PM2.5 | 1,929 | 8,359 |
| | SO2 | 2,692 | 11,664 |
| 1,000 Single Family Homes Retrofit, Ground Source Heat Pumps Replacing Furnaces and Hot Water Heating, and 4,800 kW Rooftop Solar | VOC | 3,056 | 13,243 |
| | CO | 22,226 | 96,311 |
| | NOx | 52,230 | 226,331 |
| | PM2.5 | 239 | 1,035 |
| | SO2 | 333 | 1,445 |
| 10,000 Single Family Homes (Across Counties) Retrofit, Ground Source Heat Pumps Replacing Furnaces and Hot Water Heating, and 48,000 kW Rooftop Solar | VOC | 24,674 | 106,920 |
| | CO | 179,447 | 777,603 |
| | NOx | 421,700 | 1,827,367 |
| | PM2.5 | 1,929 | 8,359 |
| | SO2 | 2,692 | 11,664 |

| Sample Building Type | Air Pollutant | Cumulative Air Pollutant Avoided 2025-2030 *(lbs)* | Cumulative Air Pollutant Avoided 2025-2050 *(lbs)* |
|---|---|---|---|
| Municipal Portfolio Retrofit (6 medium office buildings, 2 citizen centers, 4 community halls, one garage and 4 fire halls), and 10,000 kW Rooftop Solar. | VOC | 72 | 310 |
| | CO | 1,094 | 4,739 |
| | NOx | 1,302 | 5,642 |
| | PM2.5 | 6 | 24 |
| | SO2 | 8 | 34 |
| Small to Medium Commercial and Industrial Retrofit (1.5 million sq. feet in retail, warehouses and industrial) and 20,000 kW Rooftop Solar | VOC | 1,233 | 5,341 |
| | CO | 18,826 | 81,578 |
| | NOx | 22,412 | 97,117 |
| | PM2.5 | 96 | 418 |
| | SO2 | 134 | 583 |

## Other Benefits

Reducing energy consumption within buildings and then replacing space and domestic water heating systems with zero emissions systems, including air source heat pumps or ground source heat pumps, will provide building owners with the following co-benefits:

- Increased building resilience to extreme heat or cold, as buildings will be more thermally stable.
- Decreases in loss of heat or cooling due to leaks and ineffective insulation.
- Significantly lower energy bills because a) heat pumps are 2.5 to 4 times as efficient as furnaces, boilers or electric heaters and so use far less energy, even when coupled with backup electric heating, and b) after retrofits, the temperature of each building will vary less, requiring less energy to compensate with heating or cooling.
- Less air pollution than occurs with natural gas, fuel oil, propane, or wood heat.
- Elimination of carbon monoxide poisoning from heating systems in buildings.
- More comfortable internal building conditions with less temperature variation.
- Increased property values[15].

[15] Non-Energy Impacts, Approaches and Values: An Examination of the Northeast, Mid-Atlantic and Beyond." 2017. https://neep.org/sites/default/files/resources/NEI%20Final%20Report%20for%20NH%206.2.17.pdf

Completing retrofits and decarbonizing heating and cooling systems in municipal buildings benefits communities by providing public spaces with the qualities identified above. In addition, the long-term avoided energy costs for retrofit and decarbonized municipal facilities translates directly into funds that can be spent on other community services.

## Equity and Environmental Justice

Cities and counties that participate in these measures would experience the following specific benefits for people in equity and environmental focus areas from investments in building retrofits, changes to heating and cooling systems, and on-site solar energy generation. Benefits tied to the applicable CEJST indicators are included in Table 4, and the census tracts that are a priority for these indicators are mapped in Figure 9. Together, these areas represent approximately 1,300,708 residents that could potentially experience the benefits of this measure. Population by County and impacted communities are listed in Appendix B.

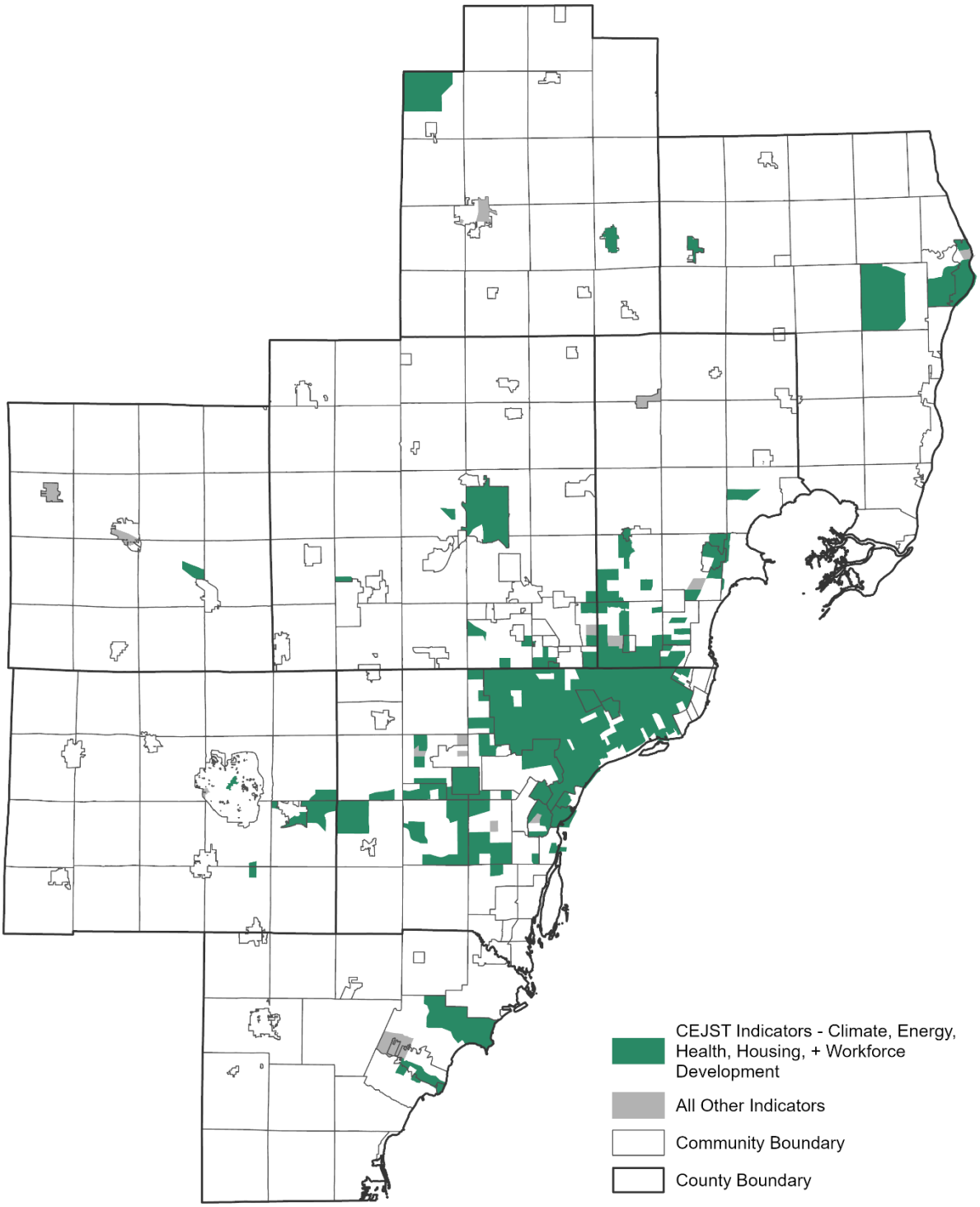
Table 4

**Equity and Environmental Justice Benefits for Decarbonizing Buildings and Industry**

| CEJST Indicators | Potential Benefits |
|---|---|
| ***Climate Change*** | • Efficient homes are less expensive to heat and cool.<br>• Efficient homes and buildings are more able to maintain livable temperatures during power outages |
| ***Energy*** | • Retrofits will reduce total energy demand for heating and cooling.<br>• Reduced energy costs of $1,200 - $1,700 annually per household. |
| ***Health*** | • Efficient, safe homes have better indoor air quality.<br>• Homes that have a safe temperature are less likely to have mold growth and allow residents to be more comfortable.<br>• Consuming less electricity and natural gas improves overall air quality |
| ***Housing*** | • Investment in existing housing allows for more safe, affordable, healthy homes.<br>• Efficiency and weatherization improvements increase home values. |
| ***Workforce Development*** | • Building retrofits require workforce development to train the skilled labor required.<br>• Workforce development can occur within communities, through mentorship and apprenticeship programs, as well as structured education opportunities to accommodate diverse learning needs |

Figure 9

**Equity and Environmental Justice Focus Areas for Building Decarbonization**



## Workforce Development

Decarbonizing buildings requires a significant workforce, particularly in construction. According to the Economic Policy Institute, for every million dollars in capital costs spent on construction (or retrofits) 16.4 jobs[16] are generated. These consist of 5.5 direct, local jobs and 10.9 supplier and induced jobs. This is a high ratio of investment to job creation. In addition, this measure will result in the creation of jobs in the energy efficiency and clean energy sectors, supporting the State of Michigan's goal to increase the number of working-age adults with a college degree or skill certificate to 60% of the population by 2030.

This creates challenges in Southeast Michigan, where there has been a persistent shortage in skilled construction workers, particularly since the COVID-19 pandemic. In addition, much of the working population in the region is approaching retirement age, raising the likelihood of increased labor shortages in coming years.

In this context, the success of this project will depend on the coordinating organization having the connections and skills to:

- Establish support from and coordination with programs such as the Department of Lifelong Education, Advancement and Potential's "Sixty by 30, Michigan Reconnect" initiative to increase the number of skilled workers available;
- Work closely with community colleges to provide estimates of the labor force and skillsets required, and to ensure the training is aligned with the energy efficiency standards and decarbonization goals of this project; and
- Providing support to connect new graduates with the employers who will participate in this work to Decarbonize Buildings and Industry.

The State of Michigan's Sixty by 30 initiative is focused on increasing its skilled workforce, especially by helping residents who have not been able to access post-secondary education to do so. The State recognizes that peoples' incomes, health, access to resources, and civic responsibility all improve with post-secondary education, and that the State's economic growth depends on having an educated labor force. This positions potential Southeast Michigan applicants for CPRG funding well to leverage the support of the State to achieve this important decarbonization work while also seizing the opportunity to improve the skills and lives of significant numbers of its residents.

## Implementation Authority

Many entities have the authority and have expressed an interest in applying for funding to implement a portion of this work within specific neighborhoods, cities, counties, or corporate settings.

Administration of this type of measure would include the following:

- Ensure energy audits are completed and that work is inspected, monitored, and verified as achieving the required energy use and emissions reductions.
- Coordinate the work across the region, prioritizing low-income neighborhoods, and incorporating repairs to ensure livability and durability of retrofits as necessary.

[16] In this context, the number of jobs refers to the number of 'job years', where one job year equals one year of full-time employment.

- Use a model, which may be similar to one developed and piloted by Ann Arbor, to decarbonize neighborhoods using a networked system of geothermal heat exchange.
- Manage funding distribution as payments to contractors, and
- Support the stacking of rebates for solar or other renewable or alternative energy systems to allow the CPRG funding to go further and ensure emissions reductions and energy savings are maximized.

Communities across various units of government are interested in participating in a collaborative or individual project aligned with these goals and have the authority to implement such a project.

REGIONAL PRIORITY MEASURE:

# Modernizing Mobility Systems

In 2019, combustion of fossil fuels for transportation produced 27 million metric tons of CO2e emissions, or 34% of the area's total emissions. Southeast Michigan is an area of concentrated freight transportation and contains much of North America's vehicle manufacturing industry. This makes decarbonizing transportation here both a challenge and an opportunity.

## Goals

The goal of this measure is to achieve significant emissions reductions from transportation through support for three types of work:

- **Shift rapidly to emissions-free fleet vehicles, in cooperation with local industry**: This work will be a coordinated effort to replace gas and diesel fleet vehicles with zero emissions equivalents and install sufficient charging or fueling infrastructure to keep these vehicles fully charged as required. This would extend to public and municipal fleets, ports and freight shipping activity, and other industrial vehicles.
- **Reduce emissions by increasing use of shared transportation and upgraded transit services**: This work is expected to include improving rapid transit service, increasing bus frequency and accessibility, updating transit routes, implementing rider incentives like fare reductions, and adjusting stop locations. This goal also includes replacing gas and diesel buses with zero emission equivalents with sufficient charging and fueling infrastructure. It is also expected to include installing mobility hubs in key locations to allow riders to easily switch from transit to bikes, scooters, and other sustainable modes of transport for different portions of their journeys.
- **Avoiding emissions by shifting to more active mode share**: This work will add walking and biking infrastructure, implement mobility hubs connecting to these networks, install secure bike parking and end-of-ride facilities, and deploy accompanying programs and education. This infrastructure can increase the number of walking and biking trips and is also critical for supporting the "first and last mile" of transit service.

### ACTIONS TO SUPPORT THIS MEASURE CAN:

Reduce GHG emissions from sources contributing
**34%**
to the region's annual total

Reduce at least
**350 tons**
CO2e emissions per new zero emission vehicle

Impact up to
**1,292,670 people**
living in equity and environmental justice focus areas

Create up to
**29.7 jobs**
per $1 million invested

This regional priority measure supports the *MI Healthy Climate Plan's* statewide strategy to **Electrify Vehicles and Increase Public Transit**: This includes goals to build the infrastructure necessary to support two million electric vehicles by 2030, and to increase access to clean transportation options – including public transit – by 15 percent each year.

## Projected Emissions Reductions

Anticipated emissions reductions are provided here for two of the goals: Shifting Rapidly to emissions-free fleet vehicles and avoiding emissions by shifting to more active mode share. Sufficient data was not available to calculate emissions reductions for increasing the use of shared transportation and upgraded transit services. See Appendix C for the assumptions associated with these calculations.

The total emissions reductions achieved from switching fleet vehicles in Southeast Michigan will depend on the final number, type, and schedule of vehicle replacements. Table 5 presents calculations of the emission reductions that will be achieved for six standard types of vehicles when they are switched from ICE to either hydrogen or electric models. The selection of these models was based on vehicles suggested by potential project participants, but other vehicle types may also be included.

Additionally, Table 6 highlights the corresponding air pollutant emission reductions from federal National Ambient Air Quality Standards (NAAQS). Criteria pollutants include carbon monoxide (CO), particulate matter (PM) and nitrogen dioxide ($NO_2$). While Ozone ($O_3$) is a criteria pollutant, it is not emitted directly from vehicles, but its precursors of NOx and volatile organic compounds are emitted from vehicles and often quantified to estimate the ozone reduction benefit.

Table 5

**Projected Emissions Avoided by Shifting to Emissions-Free Vehicles**

| Vehicle Type | Incremental Capital Costs[17] | Annual Operating Costs/ Savings[18] | Annual Avoided Emissions in 2025 *(MT CO2e)* | Cumulative Emissions Avoided 2025-2030 *(MT CO2e)* | Cumulative Emissions Avoided 2025-2050 *(MT CO2e)* | Lifetime Cost or Savings / Emissions Avoided |
|---|---|---|---|---|---|---|
| Diesel bus replaced with electric bus | $314,822 | -$18,895 | -1[19] | 21 | 352 | Savings of $501 / MT CO2e |
| Diesel bus replaced with electric bus with zero emissions electricity | $314,822 | -$18,895 | 25[20] | 148 | 639 | Savings of $276 / MT CO2e |
| Diesel bus replaced with hydrogen bus | $726,447 | -$23,242 | 18 | 109 | 472 | Cost of $259 / MT CO2e |
| Hydrogen Fueling Station for 10 H2 Fuel Cell Busses | $22,900,000 | - | - | - | - | - |
| Light duty gasoline fleet vehicle replaced with electric vehicle | $36,333 | -$2,838 | 14 | 87 | 436 | Savings of $363 / MT CO2e |
| Level 2 Public EV charger | $2,000 - $9,000 | - | - | - | - | - |
| Diesel heavy duty fire engine replaced with electric fire engine | $730,000 | -$24,488 | 55 | 253 | 1,360 | Cost of $69 / MT CO2e |

[17] Incremental costs are based on the cost of a new diesel bus (~$420,000).

[18] Negative values indicate savings and positive values indicate costs.

[19] Note that if electric buses were charged with grid electricity, this would increase total emissions by one metric ton annually as shown here, whereas if they were charged with zero emissions electricity, this would reduce total emissions by 25 metric tons annually, as shown in the second row.

[20] Alternative Fuels Data Center: Maps and Data - Average Annual Vehicle Miles Traveled by Major Vehicle Category (energy.gov).

Table 6

**Projected Air Pollutants Avoided by Shifting to Emissions-Free Vehicles**

| Vehicle Type | Air Pollutants[21] | Cumulative CAP Avoided 2025-2030 *(lbs)* | Cumulative CAP Avoided 2025-2050 *(lbs)* |
|---|---|---|---|
| Diesel bus replaced with electric bus | HC | 93 | 368 |
| | CO | 899 | 3,728 |
| | NOx | 1,478 | 5,867 |
| | PM2.5 | 28 | 100 |
| Diesel bus replaced with electric bus with zero emissions electricity | HC | 93 | 368 |
| | CO | 899 | 3,728 |
| | NOx | 3,728 | 5,867 |
| | PM2.5 | 28 | 100 |
| Diesel bus replaced with hydrogen bus | HC | 93 | 368 |
| | CO | 899 | 3,728 |
| | NOx | 1,478 | 5,867 |
| | PM2.5 | 28 | 100 |
| Light duty gasoline fleet vehicle replaced with electric vehicle | HC | 104 | 406 |
| | CO | 1,664 | 6,419 |
| | NOx | 44 | 146 |
| | PM2.5 | 5 | 20 |
| Diesel heavy duty fire engine replaced with electric fire engine | HC | 93 | 368 |
| | CO | 899 | 3,728 |
| | NOx | 1,478 | 5,867 |
| | PM2.5 | 28 | 100 |

[21] HC: hydrocarbons, sometimes referred to as volatile organic compounds
CO: carbon monoxide
NOx: nitrogen oxides
PM2.5: fine particulate matter which are 2.5 micrometers in diameter and smaller

The number of emissions eliminated when active transportation infrastructure is expanded depends on several other factors. These include the quality of the infrastructure provided, the perceived safety of the route, as well as whether the route is complete. There is considerable variability in capital and maintenance costs depending on the existing infrastructure and type of trail or bike lane needed. In addition, the number of emissions eliminated will also depend on how much of a disincentive there is to drive a personal vehicle, as well as how much vehicle traffic is known to travel on a route that would be replaced by the trail. The effectiveness of GHG reductions within this measure are highly variable but can be substantial. They should be calculated specifically for each situation or project.

Table 7 provides an estimate of the emissions reductions that may be achieved if 138 miles of paved bikeways are added to the existing network in Southeast Michigan. This is the total distance of active transportation infrastructure identified as ready for implementation through the PCAP's stakeholder engagement activities. Additional opportunities will be explored in future planning efforts. Table 8 provides the amount of air pollutants that will be eliminated because of trips taken by bike or walked on 40 miles of new paths, rather than being taken by vehicle.

Table 7

**Projected Emissions Avoided from Walking and Biking Trips with New Infrastructure**

| Infrastructure | Estimated Cost / Mile | Bikeway Lifespan | Annual Avoided Vehicle Miles Traveled | Annual Avoided Emissions in 2025 *(MT CO2e)* | Cumulative Emissions Avoided 2025-2030 *(MT CO2e)* | Cumulative Emissions Avoided 2025-2050 *(MT CO2e)* |
|---|---|---|---|---|---|---|
| 138 miles of Paved Shared-Use Path or Protected Bike Path | $1.05 Million | 15 years | 937,324 | 421 | 2,532 | 10,974 |

Table 8

**Projected Air Pollutants Avoided from Walking and Biking Trips with New Infrastructure**

| Infrastructure | Air Pollutants[22] | Cumulative CAP Avoided 2025-2030 *(lbs)* | Cumulative CAP Avoided 2025-2050 *(lbs)* |
|---|---|---|---|
| 138 miles of Paved Shared-Use Path or Protected Bike Path | HC | 2,781 | 10,909 |
| | CO | 41,162 | 158,666 |
| | NOx | 1,484 | 4,854 |
| | PM2.5 | 110 | 473 |

[22] HC: hydrocarbons, sometimes referred to as volatile organic compounds
CO: carbon monoxide
NOx: nitrogen oxides
PM2.5: fine particulate matter which are 2.5 micrometers in diameter and smaller

## Other Benefits

Shifting mode share from ICE vehicles to electric or hydrogen-fueled vehicles with adequate charging and fueling infrastructure will provide the following benefits in addition to significantly reducing GHG emissions:

- The incremental cost to purchase new zero emissions vehicles is generally paid back within 4-6 years from savings on fuel and vehicle maintenance. After this, operational cost savings continue for the life of the vehicles. Within government fleets, these savings can then be redirected into other beneficial community projects.
- Electric and hydrogen vehicles emit no tailpipe pollutants. This improves air quality particularly along roadways, along transit routes, and in parking areas reducing health risks associated with air pollution.
- Purchasing zero emissions vehicles directly supports the transition of Southeast Michigan's vehicle manufacturing industry and the workforce required to make this transition a reality.
- Electric vehicles convert over 77% of the electric energy they receive to power in the wheels whereas ICE vehicles only convert 12-30% of the gasoline or diesel they consume into power in the wheels. Overall, this is a significant reduction in the total energy consumption. It is also a switch to domestically produced energy, ending reliance on foreign energy sources and the associated variability in energy costs.
- Electric motors provide quiet, smooth operation and stronger acceleration, and require less maintenance than ICE vehicles, providing a more comfortable experience for riders.
- Increasing the availability of public and private hydrogen fueling infrastructure and public and private level 2 EV charging infrastructure is essential for fostering the widespread adoption of electric vehicles.

Increasing use of shared transportation and upgraded transit services will provide the following benefits:

- Shared transportation options and upgraded transit services can lead to cost savings for individuals and households, as they may require less spending on personal vehicles, fuel, maintenance, and parking.
- It can alleviate traffic congestion, leading to shorter commute times.
- Enhanced transit service can improve accessibility and provide reliable mobility options for individuals with no access to personal vehicles.
- Efficient transit services can stimulate economic development by facilitating access to jobs, education, healthcare, and recreational opportunities.
- Investing in shared transportation and transit services can promote compact, walkable, and transit-oriented development patterns, therefore helping preserve natural and green spaces.

- Commuting on transit rather than by personal vehicle can save a Michigander more than $10,000 each year.[23]

Increasing active transportation will provide the following benefits in addition to significantly reducing GHG emissions:

- Cyclists and walking commuters have significantly lower levels of exposure to carbon monoxide and benzene than car commuters, and significantly lower levels of NO2 than bus commuters.[24]
- Daily bike commuting is associated with the lowest risk of cardiovascular disease and cancer compared to non-active commuting and walking.[25]
- Bicycling has been calculated to reduce annual health costs state-wide in Michigan by $256 million annually, and to reduce annual costs associated with absenteeism by $187 million. It also provides an estimated $11 million in manufacturing revenue.[26]
- Expanding the accessibility of shared-use paths and protected bike lanes can serve as a catalyst for increased usage and significantly enhance the safety of pedestrians and cyclists.

[23] Michigan Public Transit Association. "Michigan Public Transportation: Moving Us Forward." https://www.house.mi.gov/hfa/PDF/Transportation/DOT_Subcmte_Testimony(MPTApamphlet_3-2-16).pdf

[24] Van Wihnene, V., et al, 1995 - The exposure of cyclists, car drivers and pedestrians to traffic-related air pollutants, International Archives of Occupational and Environmental Health, 67, 187-93.

[25] Celis-Morales, C. et al, 2017 - Association between active commuting and incident cardiovascular disease, cancer and mortality: prospective cohort study.

[26] BBC Research and Consulting. "Community and Economic Benefits of Bicycling in Michigan." 2014. https://headwaterseconomics.org/wp-content/uploads/Trail_Study_85-MI-Cycling-Impact.pdf.

## Equity and Environmental Justice

Cities and counties that participate in these measures would experience the following specific benefits for people in equity and environmental focus areas from investments to expand the active transportation network, expand and decarbonize transit, and electrify fleet vehicles. Benefits tied to the applicable CEJST indicators are included in Table 9, and the census tracts that are a priority for these indicators are mapped in Figure 10. Together, these areas represent approximately 1,292,670 residents that could potentially experience the benefits of this measure. Population by County and impacted communities are listed in Appendix B.

Table 9

**Equity and Environmental Justice Benefits for Transportation Priorities**

| CEJST Indicators | Potential Benefits |
|---|---|
| ***Climate Change*** | • Zero emissions vehicles can, in some cases, be used as back-up energy batteries during power outages. |
| ***Energy*** | • Zero emissions vehicles do not produce particulate matter pollution, which will improve air quality.<br>• Electric vehicles27 are cheaper to operate and maintain compared to gas- and diesel-powered vehicles. |
| ***Health*** | • Reducing or eliminating the combustion of gasoline and diesel improves outdoor air quality, particularly in locations adjacent to busy roads. |
| ***Transportation*** | • Conversion to zero emissions buses eliminates particulate matter pollution produced by diesel transit vehicles.<br>• Expanding transit and active transportation networks provides greater access to safe and affordable transportation for those without vehicles.<br>• Zero emissions vehicles are much quieter than ICE vehicles. Switching to EVs combined with increased walking, cycling and transit trips will mean there is less traffic noise. |
| ***Workforce Development*** | • Replacing diesel and gas vehicles with zero emissions vehicles will result in job creation in auto manufacturing, sales, and distribution as well as deployment and maintenance of charging and fueling infrastructure.<br>• Expanding transit and active transportation networks will create jobs in construction, maintenance, and operations.<br>• Jobs can also be produced in outreach programming to educate people such as new immigrants and those for whom English is a second language to be comfortable riding transit and bikes, and to teach bike maintenance skills.<br>• Increasing transit services can increase access to jobs, positively impacting employment and labor force participation. |

[27] Depending on the local price of hydrogen, this is not always true of hydrogen fuel cell vehicles, but it is true of electric vehicles.

Figure 10

**Equity and Environmental Justice Focus Areas for Modernizing Mobility Systems**

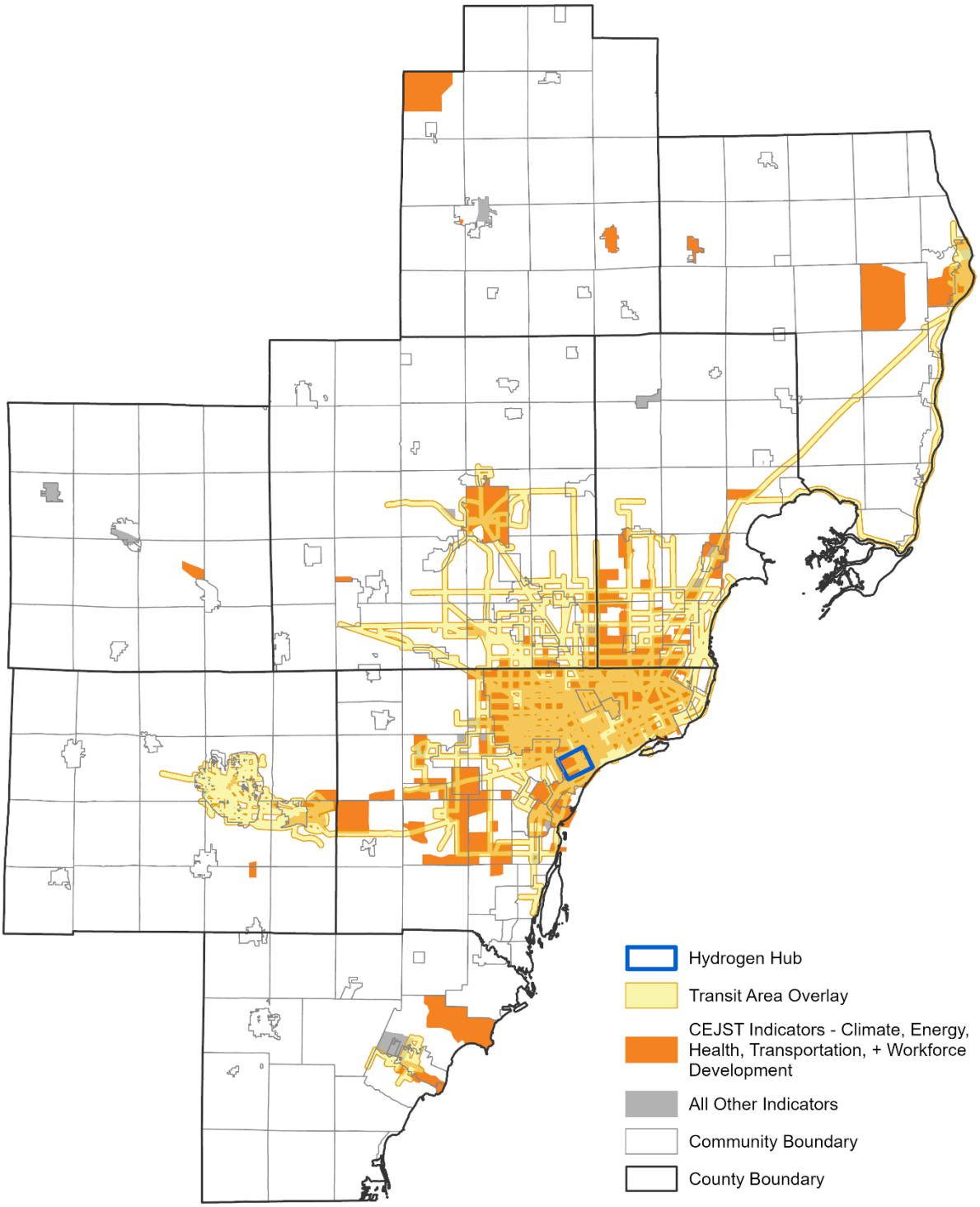


Figure 11 shows areas of the region served by fixed route transit and highlights the areas within ¼ of a mile of a bus stop. Improving transit services could impact 550,113 people living in equity and environmental justice focus area as designated by the CEJST Transportation Indicator. It would provide this population with greater access to safe and affordable transportation for those without vehicles. The map also shows an area of Southwest Detroit where a green hydrogen fueling facility (or 'Hydrogen Hub') has been proposed, through a regional coalition that includes the Detroit Department of Transportation (DDOT), Suburban Mobility Authority for Regional Transportation (SMART) and Ann Arbor Area Transit Authority (AAATA). The Hydrogen Hub would be accessible to hydrogen-powered trains, trucks and drayage, as well as hydrogen buses and other heavy-duty vehicles.

This area currently contains a major domestic and international freight rail yard, four major drayage yards, and other truck facilities, and handles more than 2000 trucks traveling through it daily. The proposed project may also include the replacement of diesel transit buses with hydrogen buses, and the replacement of diesel trucks with hydrogen fuel cell models. The benefits of this project extend beyond its significant ability to reducing greenhouse gas emissions by providing more direct benefits to three groups:

1. **Independent owners/ operators of trucks in the area.** This program would provide them with a significant grant to subsidize replacing their diesel vehicle with a hydrogen one. It would also provide them with access to a hydrogen fueling facility at a key location, which they may not otherwise have access to. This should expedite the decarbonization of freight vehicles while also providing some financial buffer to the independent operators who fill an important role in Southeast Michigan's economy.
2. **Transit riders and potential transit riders in the area.** The addition of new hydrogen buses to the transit fleet is expected to allow transit service and routes to be expanded, providing greater access to shared, zero-emissions transportation in the region, increasing people's mobility while also replacing the need for a portion of the existing personal vehicle traffic.
3. **Residents of the areas in the immediate vicinity of the proposed Hydrogen Hub.** This is a low-income community that has had diesel trucks passing through it for many years, taking freight to or from these storage areas and the rail terminal, and traveling among the different yards. As a result, they experience very high levels of particulate matter air pollution (represented by CEJST Energy Indicator), and have very high rates of asthma, diabetes or heart disease, and/ or have a low life expectancy (represented by CEJST Health Indicator). A map of this area is shown in Figure 10.

This project will also help ensure the success of related initiatives including Detroit's Truck Stop of the Future (which will also provide hydrogen fuel and is being built in part with federal funding), and the City's designation as a Thriving Community by the USDOT to help address the burden of freight in Southwest Detroit. These benefits and strategic alignment position this hydrogen project well to reduce emissions considerably while also solidifying the region as a key part of the hydrogen supply chain, improving residents' access to transportation, improving job security for people working in freight transportation, and improving air quality to reduce the health burden of some of the region's most disadvantaged residents. Other areas in the region served by the public transit systems that include equity and environmental justice focus areas would experience similar benefits for transit users.

Figure 12 shows opportunities to connect active transportation infrastructure in Southeast Michigan's existing trail network, in context with equity and environmental focus areas for transportation. Some of the new, proposed trails would complete networks that currently contain gaps or are only partially completed. Others will create connections among trail systems to create a more comprehensive network across the region, with safe biking and walking corridors between equity and environmental justice focus areas and core services or destinations.

Figure 11

**Equity and Environmental Justice Impacts of the Proposed Hydrogen Hub for Medium and Heavy-duty Transportation**

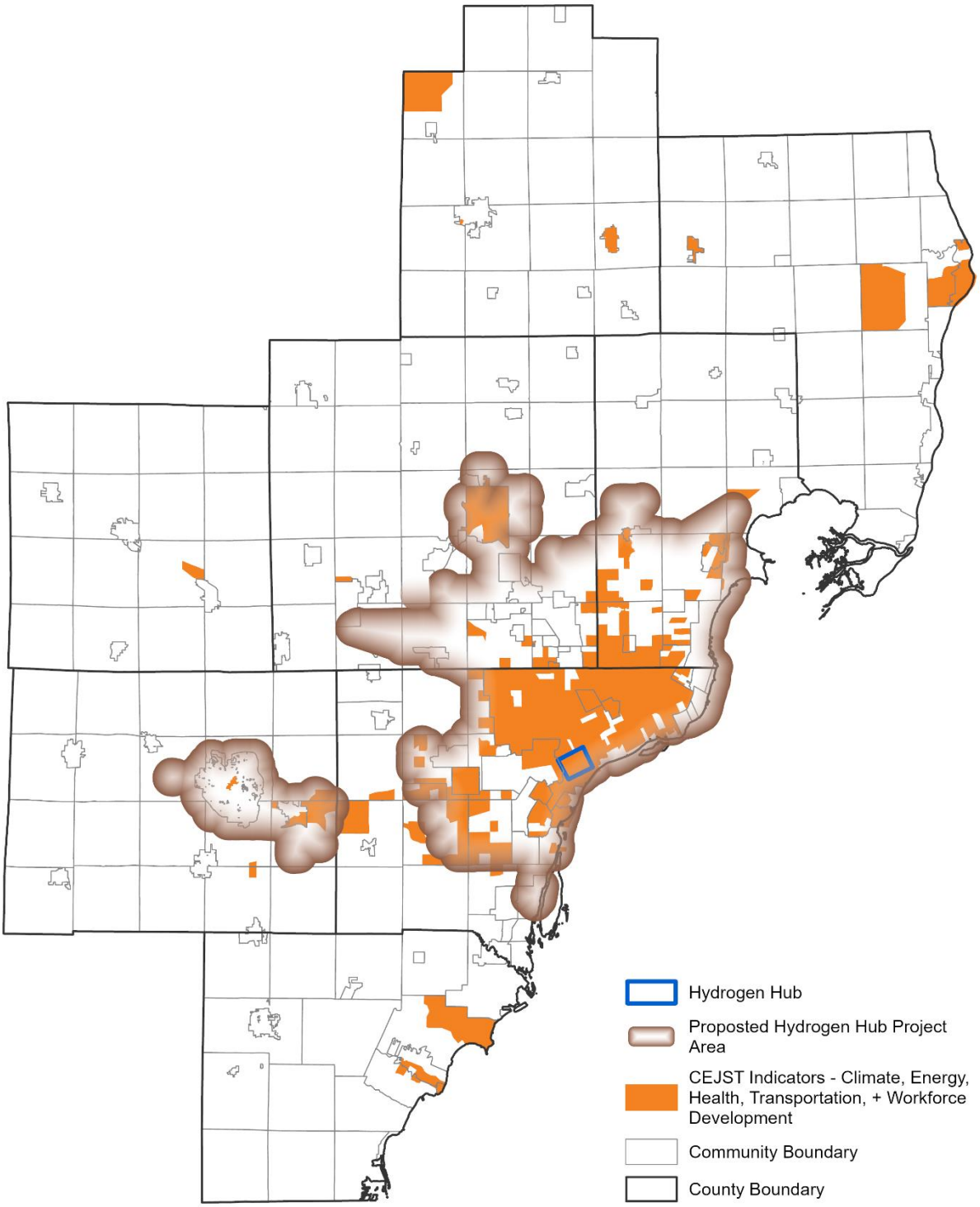
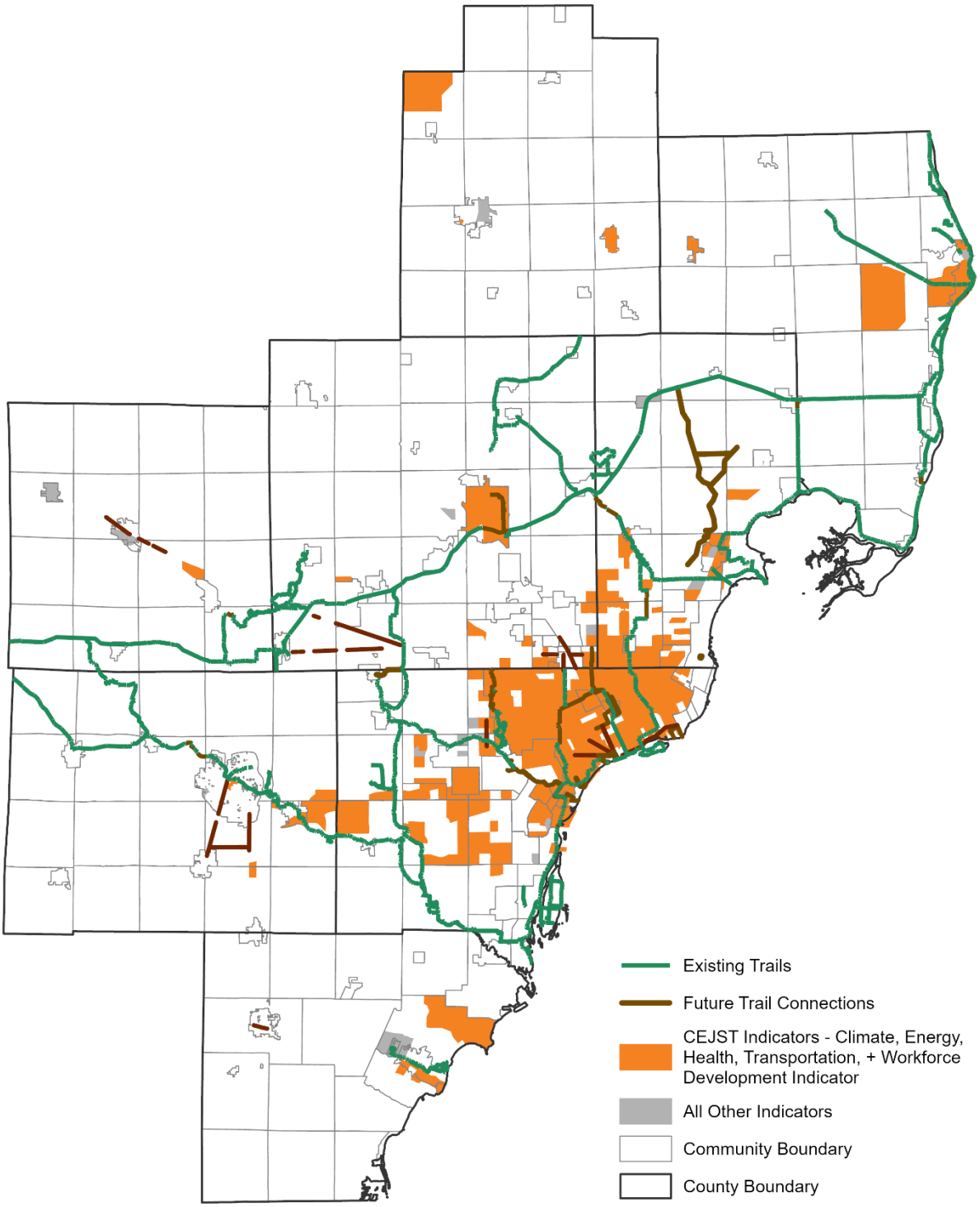


Figure 12

**Equity and Environmental Justice Impacts of Proposed Expansions in the Regional Trail Network**



## Workforce Development

In Southeast Michigan, the benefits of replacing fleet vehicles will include job creation in manufacturing, sales, and distribution. According to the Economic Policy Institute, for every million dollars in capital costs spent on new vehicles, 18.3 manufacturing jobs are generated, consisting of 1.8 direct, local jobs, 16.5 supplier and induced jobs; and 7.4 motor vehicle and parts dealer jobs. This is a high ratio of investment to job creation.

The press release that accompanied the U.S. Department of Energy's October 2023 award of $1 billion to develop a Clean Hydrogen Hub in SW Detroit described similar job potential. That project is expected to create 13,600 direct jobs - 12,100 construction jobs and 1,500 permanent positions.[28]

A study of 58 projects across the U.S. showed that for every $1 million in investment in bicycling infrastructure jobs, 11.4 jobs were created in the state where the project was located.[29] The same study found that in 2014, cycling provided the state of Michigan with approximately $668 million of benefits in sectors as diverse as retail spending and manufacturing, to avoided health costs, reduced absenteeism and event and tourism spending.

The opportunities for job creation in the active transportation industry are also diverse, but bike manufacturing stands out. Beginning in the late 19th century, America has long been one of the largest manufacturers of bicycles and bicycle components. By 1973, U.S. manufacturers were producing 15 million bikes annually from plants in Ohio, Illinois, and New York.[30] However, in the years leading up to the COVID-19 pandemic, most bicycle manufacturing and assembly moved overseas. During the pandemic, demand for bikes, and particularly e-bikes, surged; but in 2020 over 97% of all bikes sold in the U.S. were imported.[31] Organizations such as the Coalition for a Prosperous America have called for support to bring these good jobs back to America by moving production of 5 million bikes (30% of total US annual sales) back to the US within five years, creating 5,000 direct jobs and another 5,000-8,000 indirect jobs.[32]

IBIS World Industry Reports forecasts that bicycle manufacturing in the US will continue to grow, supported by demand particularly from increasing numbers of retirees as well as young, urban professionals who prefer to commute by bike.[33] This report also notes specifically that manufacturers south of the Great Lakes are well-positioned to benefit from this growth due to their proximity to the Canadian-US border and to other manufacturing industries.

In this context, this project facilitates and supports a significant increase in active transportation that would both stimulate and benefit from increased bicycle manufacturing in Southeast Michigan.

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[28] Governor Gretchen Whitmer. 2023. "Gov Whitmer Announces Michigan Wins Funding for Clean Hydrogen Hub, Creating Thousands of Good-Paying Jobs and Building a Brighter, Cleaner Future". https://www.michigan.gov/whitmer/news/press-releases/2023/10/13/whitmer-announces-michigan-wins-funding-for-clean-hydrogen-hub

[29] BBC Research & Consulting. 2014 "Community and Economic Benefits of Bicycling in Michigan." https://headwaterseconomics.org/wp-content/uploads/Trail_Study_85-MI-Cycling-Impact.pdf. Accessed January 5, 2024.

[30] American Business History. 2021. "The American Bicycle Industry: A Short History". https://americanbusinesshistory.org/the-american-bicycle-industry-a-short-history/. Accessed Feb. 2, 2024.

[31] Industry Week. 2021. "The US Can Rebuild its Iconic Bicycle Manufacturing Industry." https://www.industryweek.com/the-economy/competitiveness/article/21183399/the-us-can-rebuild-its-iconic-bicycle-manufacturing-industry. Accessed, January 27, 2024.

[32] The Coalition for a Prosperous America (CPA). "CPA Releases New Economic Report on Re-Shoring the U.S. Bike and E-Bike Industry." November 17, 2021. https://prosperousamerica.org/wp-content/uploads/2021/11/The-Global-Bicycle-Market-A-Comprehensive-Plan-to-Re-Shore-the-U.S.-Bike-E-Bike-Industry-1.pdf. Accessed Jan. 31, 2024.

[33] IBIS World Industry Reports. Bicycle Manufacturing in the US - Market Size, Industry Analysis, Trends and Forecasts (2024-2029). https://www.ibisworld.com/united-states/market-research-reports/bicycle-manufacturing-industry/.

## Implementation Authority

Many cities, counties, transit providers and port authorities have identified specific projects they wish to deploy to modernize local transportation either through fleet decarbonization or through shifting to greater use of transit and active transportation. These entities have the authority to implement these projects within their boundaries. SEMCOG is encouraging all regional applicants for these types of projects to collaborate in these efforts to ensure the following:

- Communities in Southeast Michigan working together are uniquely positioned to strategize with local vehicle manufacturers in developing a regional, fleet replacement strategy. This cooperative approach could provide communities with lower costs and expedited delivery of the less-common vehicle types required for municipal and county operations, while giving manufacturers local testing partners and a secure schedule of demand.

- Many cities, counties and transit providers have identified specific projects they wish to deploy to increase the region-wide active transportation infrastructure and incentives. All these entities are eligible to lead this collaborative effort. SEMCOG is encouraging potential applicants to coordinate their planning because region-wide, interconnected bike and pedestrian networks that are developed cooperatively will be most effective in shifting people's transportation habits.

REGIONAL PRIORITY MEASURE:

# Managing Waste Materials Sustainably

Emissions from wastewater and solid waste include methane released during decomposition. Methane is approximately 25 times more powerful as a greenhouse gas than carbon dioxide, particularly in the first 20 years after it is released. For this reason, controllable sources of methane emissions are a high priority to eliminate as quickly as possible.

In 2019, Southeast Michigan produced over 2.8 million metric tons of emissions (or 3.5% of all emissions) from solid waste in landfills, and water and wastewater treatment. Solid waste was responsible for 2.7 million metric tons of this total.

## Goals

This measure intends to significantly reduce emissions from organic waste and the transportation of it. It has four goals:

- **Divert food and food waste into meals and compost**.
- **Eliminate emissions from the wastewater process** by **establishing or expanding aerobic and anaerobic digesters** in both rural and urban contexts.
- **Significantly increase and improve composting collection** and compost facility effectiveness, such that less methane escapes from organic decomposition into the atmosphere.
- **Reduce volume of waste transported in the region and replace vehicles used for transportation of organic waste** with zero emissions models.

MI HEALTHY CLIMATE PLAN

This regional priority measure supports the *MI Healthy Climate Plan*'s statewide strategy to **Drive Clean Innovation in Industry**. A program to divert food and food waste in the 15 largest cities in Southeast Michigan would reach the State's goal of reducing 50% of food waste by 2030. It also supports decarbonization in the wastewater treatment industry.

### ACTIONS TO SUPPORT THIS MEASURE CAN:

Reduce GHG emissions from sources contributing
**3.5%**
to the region's annual total

Reduce up to
**1,685,745 tons**
$CO_2e$ emissions by 2050 with identified projects

Impact up to
**1,287,991 people**
living in equity and environmental justice focus areas

Create up to
**29.9 jobs**
per $1 million invested

## Projected Emissions Reductions

The following potential projects in support of the goals listed above have been identified in the region. The projected emissions reductions will depend on the specifics of each project and are included below where details are available.

Implementing a city-wide food rescue program is proposed through partnerships with municipalities, nonprofits, and waste management organizations. When fully implemented, this type of initiative could divert 30 million pounds of food waste from landfills annually, reducing waste emissions by 21,000 metric tons between 2026 and 2030. Additional reductions will be achieved from the reductions in waste transportation, retrofitting kitchen facilities and equipment, and decarbonizing waste hauling vehicles.

Implementing a large-scale anaerobic digester at the Great Lakes Water Authority Water Resource Recovery Facility (WWRF) is proposed to eliminate an estimated 63,000 metric tons CO2e annually, beginning in 2030. This comprehensive project will eliminate emissions from the natural gas currently used at the facility by replacing it with biogas produced from the digester, and from the transportation of biosolids and ash currently produced. It will also help allow the facility to fully retire its incinerator.

Table 10

**Projected Emissions Avoided from a Large-Scale Anaerobic Digester**

| Infrastructure | Incremental Capital Costs | Annual Avoided Transport Emissions *(MT CO2e)* | Annual Avoided Emissions from Natural Gas *(MT CO2e)* | Cumulative Emissions Avoided 2025-2030 *(MT CO2e)* | Cumulative Emissions Avoided 2025-2050 *(MT CO2e)* | Lifetime Cost or Savings / MT of Emissions Avoided |
|---|---|---|---|---|---|---|
| Large-scale anaerobic digester | $846,491,000 | 232 | 62,898 | 63,131 | 1,325,745 | Cost of $639 / MT CO2e avoided. |

Table 11

**Projected Air Pollutants Avoided from a of Large-Scale Anaerobic Digester**

| Infrastructure | Air Pollutants[34] | Cumulative CAC Avoided 2025-2030 *(lbs)* | Cumulative CAC Avoided 2025-2050 *(lbs)* |
|---|---|---|---|
| Large-scale anaerobic digester – Reduced Transportation | HC | 50.42 | 1,059 |
| | CO | 519 | 10,895 |
| | NOx | 805 | 16,905 |
| | PM2.5 | 13 | 277 |

[34] HC: hydrocarbons, sometimes referred to as volatile organic compounds
CO: carbon monoxide
NOx: nitrogen oxides
PM2.5: fine particulate matter, which are 2.5 micrometers in diameter and smaller

| Infrastructure | Air Pollutants[34] | Cumulative CAC Avoided 2025-2030 *(lbs)* | Cumulative CAC Avoided 2025-2050 *(lbs)* |
|---|---|---|---|
| Large-scale anaerobic digester – Reduced Incineration | HC | 7[35] | 15[31] |
| | CO | 519,470 | 1,038,940 |
| | NOx | 118,900 | 237,800 |
| | PM2.5 | 5,200 | 10,400 |

Implementing enhancements in an existing anaerobic digester facility (specifically a new high strength organic waste (HSOW) receiving station, and a microbial hydrolysis process (MHP)) would allow the digesters to begin processing an estimated 3,700 wet metric tons of diverted food waste annually. This would eliminate the emissions associated with the decay of this material in a landfill. The HSOW and MHP would also increase the amount of biogas produced and used in the combined heat and power (CHP) units (to be operational in 2026) to provide heat and electricity to the facility, reducing the facility's consumption of natural gas and grid electricity. The annual reductions in emissions have been estimated to be 5,900 MT annually beginning when the enhancements have been completed in 2028.

Table 12 provides the total estimated annual emissions savings from avoided landfill, as well as emissions savings per ton of natural gas and electricity avoided. Estimated reductions in natural gas and electricity consumption that would occur because of this project were not available. As a result, the Cumulative Emissions Avoided from 2025-2030, and from 2025-2050 were calculated including only the emissions savings from removing HSOW from landfills.

Table 12

**Projected Avoided Emissions from Anaerobic Digester Enhancements to Process High Strength Organic Wastes (HSOWs)**

| Infrastructure | Annual Avoided Transport Emissions *(MT CO2e)* | Annual Avoided Emissions from HSOW and MHP in Landfills *(MT CO2e)* | Annual Avoided Emissions from Natural Gas *(MT CO2e)* | Annual Avoided Emissions from Grid Electricity *(MT CO2e)* | Cumulative Emissions Avoided 2025-2030 *(MT CO2e)* | Cumulative Emissions Avoided 2025-2050 *(MT CO2e)* |
|---|---|---|---|---|---|---|
| Enhance anaerobic digester to process HSOWs and add MHP | TBD | 3,300 | 850 | 1,700 | 12,000 | 71,000 |

[35] Units in Parts Per Million (PPM)

## Other Benefits

The initiatives to reduce waste will provide the following benefits in addition to significantly reducing GHG emissions:

- Redistributing edible food to residents provides meals to people who would otherwise be hungry. This aligns with recommendations from Governor Whitmer's Food Security Council and helps address ongoing food insecurity in the State.[36]
- Reducing organic waste:
    - Reduces the need to transport that waste to the landfills, resulting in further emissions reductions by decreasing fuel required for transportation. This in turn reduces costs for waste producers and municipalities.
    - Extends the life of the landfills.
    - Decreases odors from landfills caused by decomposing organic matter.
    - Aligns with the State's goal to reduce food waste by 50% by 2030.
- Establishing or upgrading anaerobic digesters:
    - Can allow wastewater utilities to establish more stable rate structures;
    - In rural communities:
        - Reduce air and water pollution from livestock manure;
        - Increase production of renewable natural gas, which is required particularly for industrial purposes, and;
        - Can provide a steady source of income to farmers who are otherwise dependent on the more variable income streams of farming.

## Equity and Environmental Justice

Cities and counties that participate in these measures would experience the following specific benefits for people in equity and environmental focus areas from investments in diverting organic waste, redistributing food, and installing or upgrading anaerobic digesters. Benefits tied to the applicable CEJST indicators are included in Table 13, and the census tracts that are a priority for these indicators are mapped in Figure 13. Together, these areas represent approximately 1,287,991 residents that could potentially experience the benefits of this measure. Population by County and impacted communities are listed in Appendix B.

[36] Governor Gretchen Whitmer. "Gov Whitmer's Food Security Council Issues Recommendations to Ensure Michigan Families Have Access to Affordable Nutritious, Food." 2022. https://www.michigan.gov/whitmer/news/press-releases/2022/03/03/gov--whitmers-food-security-council-issues-recommendations-to-ensure-michigan-families-have-access-.

Table 13

**Equity and Environmental Justice Benefits for Materials Management Priorities**

| CEJST Indicators | Potential Benefits |
|---|---|
| ***Health*** | • Diverting organic waste from landfills improves air quality by removing decomposing organic matter that causes odors.<br>• Food diversion and community kitchens provide healthy food for people who are otherwise hungry.<br>• Food diversion increases the amount of food available in food pantries.<br>• Reducing food waste reduces household food costs. |
| ***Transportation*** | • Conversion to electric vehicles to transport both diverted food and waste reduces air pollution from waste transportation vehicles. |
| ***Workforce Development*** | • New jobs will be created particularly in composting facilities and food diversion.<br>• Education and communication campaigns will require on-the-ground support drawn from the local community.<br>• Anaerobic digesters will require skilled labor to maintain and operate. |

## Workforce Development

Investment in anaerobic or aerobic digesters creates jobs in waste management, sewage, and transportation. According to the Economic Policy Institute, for every million dollars in capital costs spent on waste management, 23.7 jobs are created, consisting of 10.6 direct, local waste and sewage operations jobs, and 13.1 supplier and indirect jobs. This is a high ratio of investment to job creation.

Community composting programs are much more effective at creating jobs than other forms of waste management.[37] For each 10,000 tons of materials managed, community composting crates 6.2 jobs per year, compared to 1 for waste incinerators and 2 for landfills. The composting initiatives supported in this PCAP would be deployed in a community composting model that would align with this level of job creation.

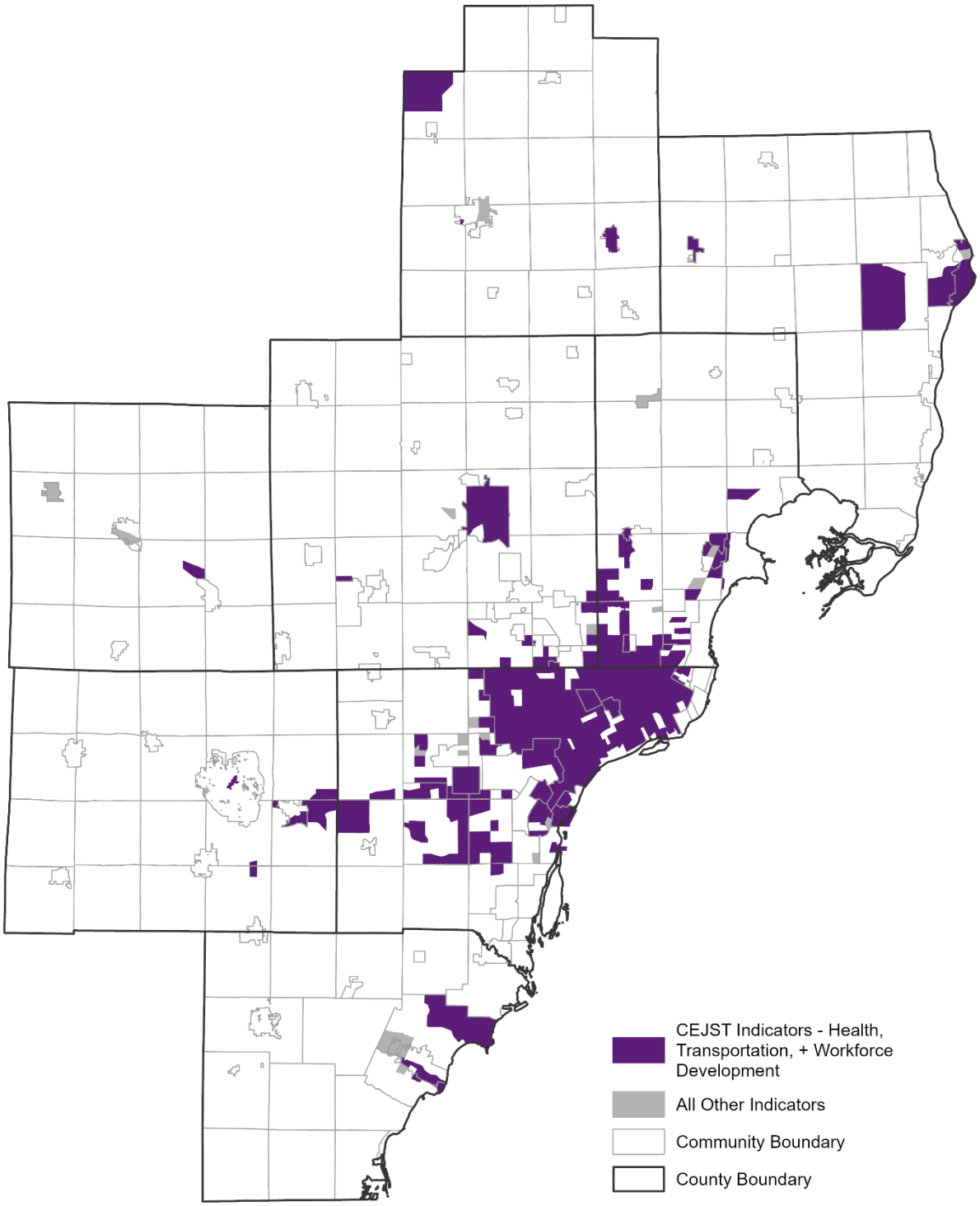
## Implementation Authority

Specific entities including water authorities, counties, and cities in the region have expressed interest in developing projects aligned with these goals and have the authority to implement such a project.

[37] C. Libertelli, B. Platt, M. Matthews, "A Growing Movement: 2022 Community Composter Census". Institute for Local Self-Reliance, 2023 (ilsr.org/composting-2022-census/). Reprinted with permission.

Figure 13

**Equity and Environmental Justice Focus Areas for Managing Waste Materials**



REGIONAL PRIORITY MEASURE:

# Expanding Renewable Electricity Generation

in 2019, the generation of electricity represented over 27 million metric tons of CO2e or roughly 33% of the total emissions for the region. In 2022, renewable energy accounted for approximately 12% of the total electricity generated in Michigan, primarily from wind.

According to the Citizens Research Council of Michigan, the State has ample resource and land availability to reach this goal and there are feasible solutions to addressing the intermittency and public resistance challenges, all while keeping the lights on for Michigan residents and businesses. Potential difficulties in achieving this goal include the lack of adequate transmission and storage infrastructure to ensure the sustainability of widespread and uninterrupted service.

## Goals

This measure will take advantage of the region's capacity to produce zero emissions electricity to speed up the greening of Michigan's grid and provide more affordable electricity to residents, particularly in low income and disadvantaged communities. It will support:

- Installations of solar, wind, geothermal, combined heat and power, and other renewable energy generation and storage systems; and,
- Reducing costs by making bulk purchases or combining program administration.

MI HEALTHY CLIMATE PLAN

This regional priority measure supports the *MI Healthy Climate Plan's* statewide strategy to **Clean the Electric Grid**. This includes the goal of generating 60% of the state's electricity from renewable resources, as well as limiting the consumer cost of powering and heating homes to not more than 6% of annual income for low-income households.

### ACTIONS TO SUPPORT THIS MEASURE CAN:

Reduce GHG emissions from sources contributing **33%** to the region's annual total

Increase the existing **12%** of energy in Michigan being generated from clean, renewable sources

Impact up to **1,287,991 people** living in equity and environmental justice focus areas

## Projected Emissions Reductions

Table 8 outlines projected emissions reductions related to this measure, which have been analyzed for solar installations of different types and sizes in different years over time, relative to the forecast grid emissions.

Table 14

**Projected Emissions Reductions for Expanding Renewable Electricity Generation**

| System Type and Capacity | Year of Install | Capital and Installation Cost | Annual Savings in Energy Costs | Avoided Emissions in Install Year *(MT CO2e)* | Cumulative Emissions Avoided 2025-2030 *(MT CO2e)* | Cumulative Emissions Avoided 2025-2050 *(MT CO2e)* | Lifetime Cost or Savings / MT of Emissions Avoided |
|---|---|---|---|---|---|---|---|
| Single Residential Rooftop Solar PV, 10 kW | 2025 | $18,570 | $1,508 | 4 | 22 | 44 | Savings of $290 / MT avoided |
| Single Residential Rooftop Solar PV, 10 kW | 2030 | $10,040 | $1,447 | 3 | 3 | 25 | |
| Single Residential Rooftop Solar PV, 10 kW | 2035 | $9,480 | $1,501 | 1.5 | 0 | 7 | |
| Ground Mount Solar PV, 1 MW | 2025 | $1,857,000 | n/a | 436 | 2,178 | 4,355 | Costs of $284 / MT avoided |
| Ground Mount Solar PV, 1 MW | 2030 | $1,004,000 | n/a | 290 | 290 | 2,468 | |
| Ground Mount Solar PV, 1 MW | 2035 | $948,000 | n/a | 145 | 0 | 726 | |
| Land-based Wind Turbine, 100 kW | 2025 | $437,760 | n/a | 94 | 469 | 937 | Costs of $55 / MT avoided |
| Land-based Wind Turbine, 100 kW | 2030 | $347,144 | n/a | 62 | 62 | 531 | |

| System Type and Capacity | Year of Install | Capital and Installation Cost | Annual Savings in Energy Costs | Avoided Emissions in Install Year *(MT CO2e)* | Cumulative Emissions Avoided 2025-2030 *(MT CO2e)* | Cumulative Emissions Avoided 2025-2050 *(MT CO2e)* | Lifetime Cost or Savings / MT of Emissions Avoided |
|---|---|---|---|---|---|---|---|
| Land-based Wind Turbine, 100 kW | 2035 | $329,752 | n/a | 31 | 0 | 156 | |
| Land-based Wind Turbine, 3 MW | 2025 | $3,618,000 | n/a | 2,812 | 14,059 | 28,118 | Costs of $105 / MT avoided |
| Land-based Wind Turbine, 3 MW | 2030 | $2,868,000 | n/a | 1,875 | 1,875 | 15,934 | |
| Land-based Wind Turbine, 3 MW | 2035 | $2,724,000 | n/a | 937 | 0 | 4,686 | |

Table 15 provides the reduction in air pollutants that would be achieved throughout the region if total energy drawn from the grid was reduced by 0.24% in 2025. This is the amount of reduction that would be achieved with the installation of approximately 100,000 kW of renewable energy such as wind or solar power.

Table 15

**Projected Air Pollutant Reductions for Expanding Renewable Electricity Generation**

| System Type and Capacity | Cumulative PM 2.5 Avoided 2025-2030 *(micrograms/ cubic meter)* | Cumulative PM 2.5 Avoided 2025-2050 *(micrograms/ cubic meter)* |
|---|---|---|
| Reduction of 0.24% of grid electricity use due to the addition of 100,000 kW of renewable energy | 0.00836 | 0.0501 |

## Other Benefits

Increasing on-site renewable and alternative energy generation and energy storage systems provides benefits such as the following, in addition to significantly reducing greenhouse gas emissions:

- By installing solar on a home or business, residents can decrease or even eliminate their monthly power bills.
- Building owners with on-site renewable energy and energy storage systems on-site rely less on grid electricity. Even during power outages, they can continue to use their own power; this will make them more resilient as climate change increases the frequency of power outages.

## Equity and Environmental Justice

Cities and counties that participate in these measures would experience the following specific benefits for people in equity and environmental focus areas from investments in expanding renewable electricity generation. Benefits tied to the applicable CEJST indicators are included in Table 16, and the census tracts that are a priority for these indicators are mapped in Figure 15. Together, these areas represent approximately 1,287,991 residents that could potentially experience the benefits of this measure. Population by County and impacted communities are listed in Appendix B.

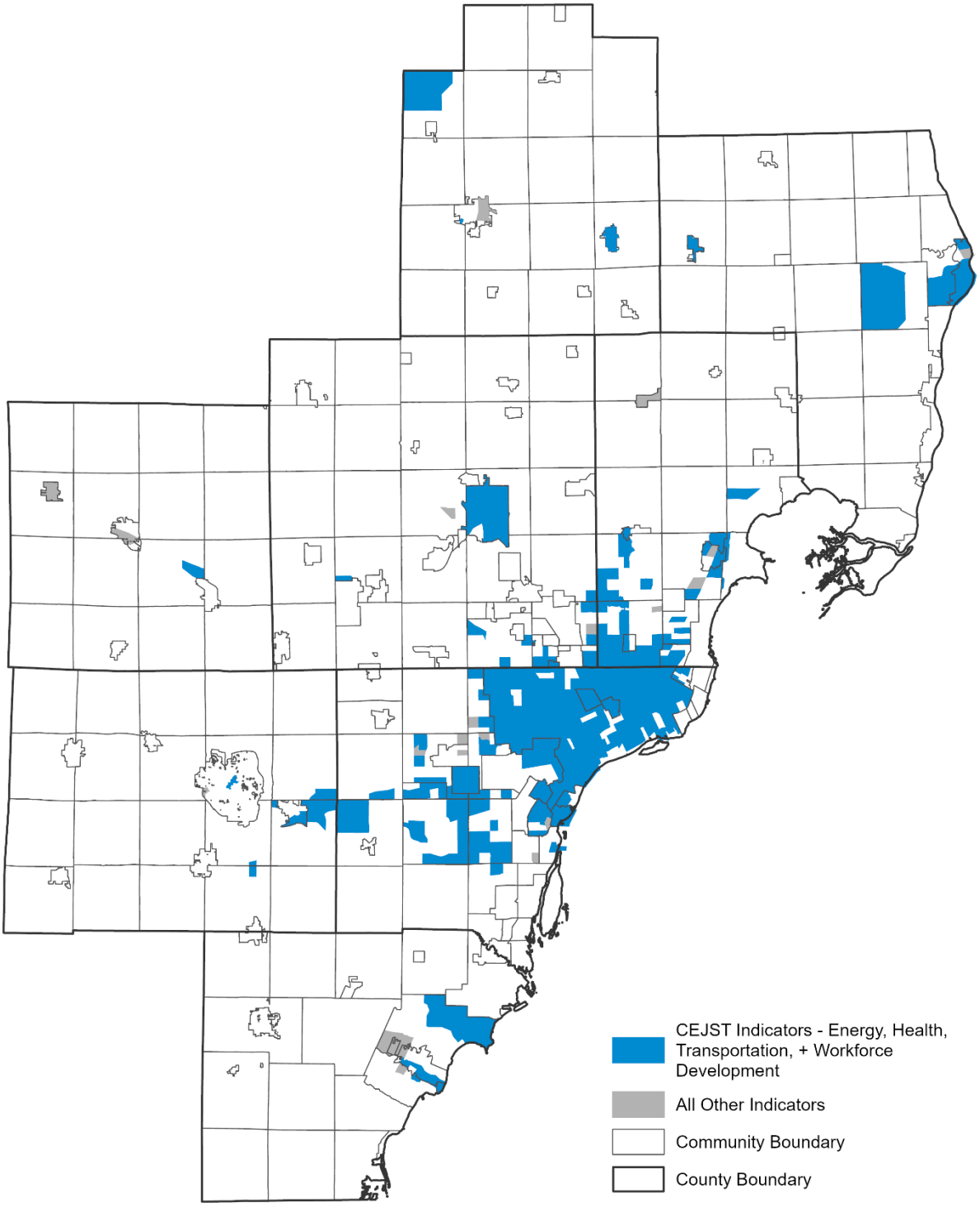
Table 16

**Equity and Environmental Justice Benefits for Renewable Energy Priorities**

| CEJST Indicators | Potential Benefits |
|---|---|
| ***Energy*** | • Energy costs can be significantly reduced by installing renewable energy systems in a home or business. This can effectively move low-income residents out of energy poverty. |
| ***Health*** | • Reducing energy costs helps homes, workplaces, and public cooling centers be kept at healthy temperatures. This reduces health risks (such as heat stroke) for vulnerable people particularly as heat waves increase due to climate change.<br>• Reducing coal-fired electricity generation in St. Clair, Wayne, and Monroe Counties will reduce the particulate matter emissions near these plants. |
| ***Transportation*** | • Local generation of clean electricity will allow more people to charge/ fuel their vehicles with emissions-free electricity, reducing air pollution. |
| ***Workforce Development*** | • New jobs will be created in manufacturing, installing, and maintaining renewable energy generation and storage systems. |

Figure 14

**Equity and Environmental Justice Focus Areas for Expanding Renewable Energy**



## Workforce Development

Investing in renewable power generation systems will produce jobs in manufacturing generation and energy storage systems as well as in installation, maintenance, transportation, and supply. The National Renewable Energy Laboratory has indicated that relative to 2020, Michigan will have an additional 1,300 - 3400 solar PV jobs by 2025, and an additional 3,100 - 6,700 by 2030.[38] It will also have an additional 1,900 - 3,500 jobs in battery storage by 2025, and an additional 4,000 - 9,500 by 2030.

IREC's Solar Jobs Census[39] reported that at the end of 2022, a total of 4,073 people were working in the solar industry in Michigan, and projected that this number will grow by 8.5% in 2023 and continue to grow into the future. It also reported that in 2022, 44% of solar industry employers said it was 'very difficult' to find qualified employees, and that this number continues to increase.

Communities including the City of Detroit are heeding this advice and have developed toolkits[40] and programs like The Youth Energy Squad, and connections with community, technical colleges and unions to proactively help young adults access the training they require to support Southeast Michigan's energy transition. This measure anticipates leveraging these partnerships to ensure that the required workforce is ready, and that low-income residents are able to benefit from these new employment opportunities.

## Implementation Authority

Many entities have the authority and have expressed an interest in applying for funding to implement a portion of this work within specific neighborhoods, cities, counties, or corporate settings. Many communities across various units of government are interested in participating in a collaborative or individual project aligned with these goals and have the authority to implement such a project.

[38] National Renewable Energy Laboratory. State-Level Employment Projections for Four Clean Energy Technologies in 2025 and 2030. https://www.nrel.gov/docs/fy22osti/81486.pdf.

[39] IREC. "National Solar Jobs Census 2022". https://irecusa.org/census-executive-summary/.

[40] City of Detroit. 2021. "Detroit Solar Project Toolkit: Jobs and Training." https://detroitmi.gov/sites/detroitmi.localhost/files/2021-03/ELE-3-Detroit%20Solar%20Project%20toolkit-jobs-training-v8.pdf.

REGIONAL PRIORITY MEASURE:

# Optimizing Natural and Working Lands

In 2019, Southeast Michigan produced over 1.5 million metric tons of emissions (or 1.9% of all emissions) from agriculture, forestry, and land use. At the same time, natural systems were responsible for sequestering over 2.5 million metric tons of emissions from the atmosphere. While these figures represent a small portion of the region's overall emissions, natural and working lands provide many other benefits that are important to resilience, community health, and environmental quality, and enhancing these opportunities are a priority for many Southeast Michigan communities.

## Goals

This measure includes a range of goals to increase natural sequestration through more resilient stormwater management and agricultural practices. It will support:

- **Increase the coverage and health of trees**, in line with SEMCOG's GREEN target of 40% tree canopy across the region.
- **Build and maintain Green Stormwater Infrastructure,** such as bioswales, rain gardens, and green roofs to increase natural sequestration of greenhouse gases, and reduce energy required to pump and treat stormwater.
- **Conserve and expand wetlands.** Wetlands are very effective at sequestering carbon dioxide, even more effective in some cases than terrestrial forests. In addition to the carbon stored in the plants themselves, wetlands transfer carbon into rich organic soils where it can be stored for hundreds or even thousands of years. When these systems are degraded or destroyed, this carbon can be released back to the atmosphere within a matter of years[41].
- **Enhance climate smart agricultural practices.** The key sources of emissions from agricultural practices are cropland soil, enteric fermentation, and manure management. A project to reduce these emissions would support the use of precision agriculture practices and technologies and the practices recommended from the Michigan Climate Smart Farm Verification Project when it is completed in 2028.

### ACTIONS TO SUPPORT THIS MEASURE CAN:

Reduce GHG emissions from sources contributing
**1.9%**
to the region's annual total

Increase the existing
**2,500,000 tons**
CO2e emissions that are sequestered by natural systems annually

Impact up to
**1,354,958 people**
living in equity and environmental justice focus areas

Create up to
**16 jobs**
per $1 million invested

[41] IPCC "Statement on IPCC Wetlands Supplement - technical considerations

This regional priority measure supports the *MI Healthy Climate Plan's* statewide strategy to **Protect Michigan's Land and Water**: This includes the goals to protect 30 percent of Michigan's land and water by 2030 to naturally capture GHG emissions, maintain and improve access to recreational opportunities for all Michiganders, and protect biodiversity. Additionally, both plans include strategies to support climate-smart agriculture.

## Projected Emissions Reductions

This action will reduce emissions in two ways. The first will be by increasing trees and other natural or engineered green infrastructure systems that sequester carbon as they grow. Estimates for the sequestration capacity of common tree species in Michigan, and for green roofs are provided in Tables 17 and 18.

Table 17

**Emissions Sequestration by Trees**

| Tree Species | Avg Annual Sequestration / Tree[42] *(lbs)* | Avg Lifespan *(years)* | Avg Lifetime Sequestration *(lbs)* | Cumulative Emissions Avoided 2025-2030 *(MT CO2e/ tree)* | Cumulative Emissions Avoided 2025-2050 *(MT CO2e/ tree)* |
|---|---|---|---|---|---|
| Birch - *Betula papyrifera* | 62.4 | 75 | 4681 | 0.1698 | 0.7359 |
| Bur Oak - *Quercus macrocarpa* | 12.5 | 200 | 2504 | 0.0340 | 0.1474 |
| Sugar Maple - *Acer saccharum* | 17.9 | 180 | 3227 | 0.0487 | 0.2111 |
| Blue Spruce - *Picea pungens* | 12.8 | 60 | 767 | 0.0348 | 0.1510 |

[42] i-Tree. i-Tree Tools. https://www.itreetools.org/tools.

Table 18

**Emissions Sequestration and Energy Savings from Green Roofs**

| Implementation Measure | Average Annual Direct Sequestration *(lbs /ft²)* | Average Annual Energy Savings *(kWh / ft²)* | Total Average Annual Avoided Emissions *(MT / ft²)* | Cumulative Emissions Sequestered 2025-2030 *(MT CO2e/ft²)* | Cumulative Emissions Sequestered 2025-2050 *(MT CO2e/ft²)* |
|---|---|---|---|---|---|
| Green Roof[43] | 0.367 | 1.071 | 0.00036 | 0.0022 | 0.0094 |

The second way in which this action will reduce climate pollution will be by reducing the amount of stormwater that is processed in wastewater treatment facilities, reducing the energy required for pumping and treatment, and so reducing the emissions produced to generate the energy.

The effectiveness of GHG reductions within this measure are highly variable but can be substantial. They are based on a variety of factors including location, soil type, vegetation type or current vegetation health and should be calculated specifically for each situation or facility.

## Other Benefits

Increasing the number of trees and other vegetation, and maintaining their health provides benefits such as the following, in addition to significantly reducing greenhouse gas emissions:

- Improving air quality by removing pollutants.
- Providing cooler areas in cities.
- Diverting and absorbing rain during storm events, reducing the impact of those storms on drainage infrastructure.
- Projects to develop a ‘green collar workforce’ will create good jobs for local residents and will also allow more trees to be planted.

## Equity and Environmental Justice

Cities and counties that participate in these measures would experience the following specific benefits for people in equity and environmental focus areas from investments to expand and enhance natural areas and resilient infrastructure. Benefits tied to the applicable CEJST indicators are included in Table 19, and the census tracts that are a priority for these indicators are mapped in Figure 16. Together, these areas represent approximately 1,354,958 residents that could potentially experience the benefits of this measure. Population by County and impacted communities are listed in Appendix B.

[43] Cai, L. “Reduction in Carbon Dioxide Emission and Energy Savings Obtained by Using a Green Roof.” 2019. https://aaqr.org/articles/aaqr-19-09-oa-0455.

Table 19

**Equity and Environmental Justice Benefits for Natural Sequestration Priorities**

| CEJST Indicators | Potential Benefits |
|---|---|
| ***Climate Change*** | • Reduced risk of flooding because of increased infiltration through trees, vegetation, and wetlands.<br>• Urban heat islands reduced by increased vegetation cover, resulting in cooler and safer urban areas, and more access to cool shady spaces. |
| ***Health*** | • Vegetation absorbs air pollution, improving air quality, and reducing health conditions associated with pollution.<br>• Exposure to green spaces improves mental health and increases opportunities for exercise, improving strength and cardiovascular health.[44] |
| ***Housing*** | • Tree planting increases access to green space in neighborhoods currently considered nature deprived. |
| ***Transportation*** | • Tree planting along active transportation networks increases the likelihood of their use for transportation. |
| ***Water and Wastewater*** | • Increasing stormwater infiltration through vegetation can reduce flows in combined stormwater and sewage systems particularly during storm events, reducing the frequency and volumes of sewage overflow into homes, basements, and public spaces.<br>• Vegetation can naturally remove some pollutants, improving water quality in natural systems. |
| ***Workforce Development*** | • Job opportunities will be created to develop green spaces and urban forests, and to maintain and manage them. |

[44] Yeager et al, 2018. Association between residential greenness and cardiovascular disease risk. Journal of the American Heart Association. Vol 7, No 24.

Figure 15

**Equity and Environmental Justice Focus Areas for Optimizing Natural and Working Lands**

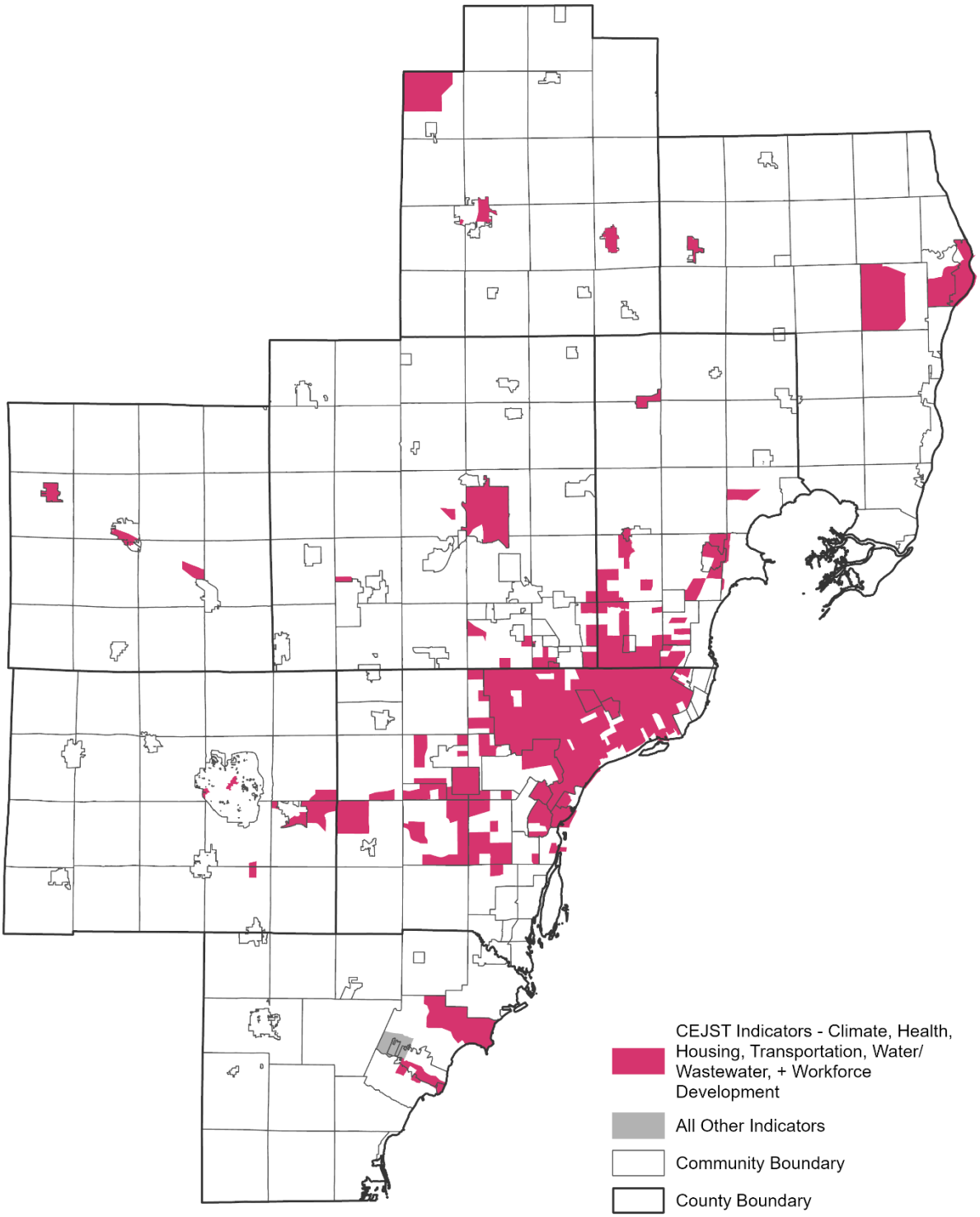


Figure 13 shows the areas in which tree planting will provide benefits to low-income residents with very little green space and/ or less than 20% tree canopy. These census tracts represent 336,901 Southeast Michigan residents. Projects to increase and protect vegetation in these areas will not only decrease greenhouse gas emissions but will also improve the well-being of residents in these communities.

In addition, Southeast Michigan frequently experiences flooding and backups of the combined sewer system. Green Stormwater Infrastructure can provide benefits related to resilience, carbon sequestration of native vegetation, and decreased emissions related pumping and wastewater treatment of excess rainwater in the sewer system. Figure 14 shows where the combined sewer system areas intersect with CJEST Water and Climate Indicators. Focusing GSI implementation in these equity and environmental justice focus areas could impact 572,405 Southeast Michigan residents.

## Workforce Development

Investing in tree planting and maintenance, as well as renewing natural vegetation and wetlands, will produce jobs in silviculture and forest management. According to the Economic Policy Institute, for every million dollars in capital costs spent on forestry, 16 jobs are created, consisting of 5.9 direct forestry jobs, and 10.1 supplier and indirect jobs. Within climate action economic development, this is a moderate ratio of investment to job creation.

Participants in the engagement sessions that informed this plan indicated that they regularly encounter shortages in labor both to plant and maintain urban forests. However, this need is also being communicated to the region's educational institutions, and in January 2024, the Michigan State University Forest Carbon and Climate Program announced a new one-year course on Urban Forests and Climate Change, developed collaboratively with the USDA Forest Service.[45]

## Implementation Authority

Cities, townships, and counties across the region have expressed an interest in collaborating to plant trees, increase green roofs and install other natural sequestration and stormwater infrastructure. They all have the authority to implement this work within their jurisdiction.

[45] Wisconsin DNR Forestry News. 2024. "Michigan State University Launches Course on Urban Forests and Climate Change." https://forestrynews.blogs.govdelivery.com/2024/01/19/michigan-state-university-launches-course-on-urban-forests-and-climate-change/

Figure 16

**Equity and Environmental Justice Focus Areas for Increasing Urban Tree Canopy**

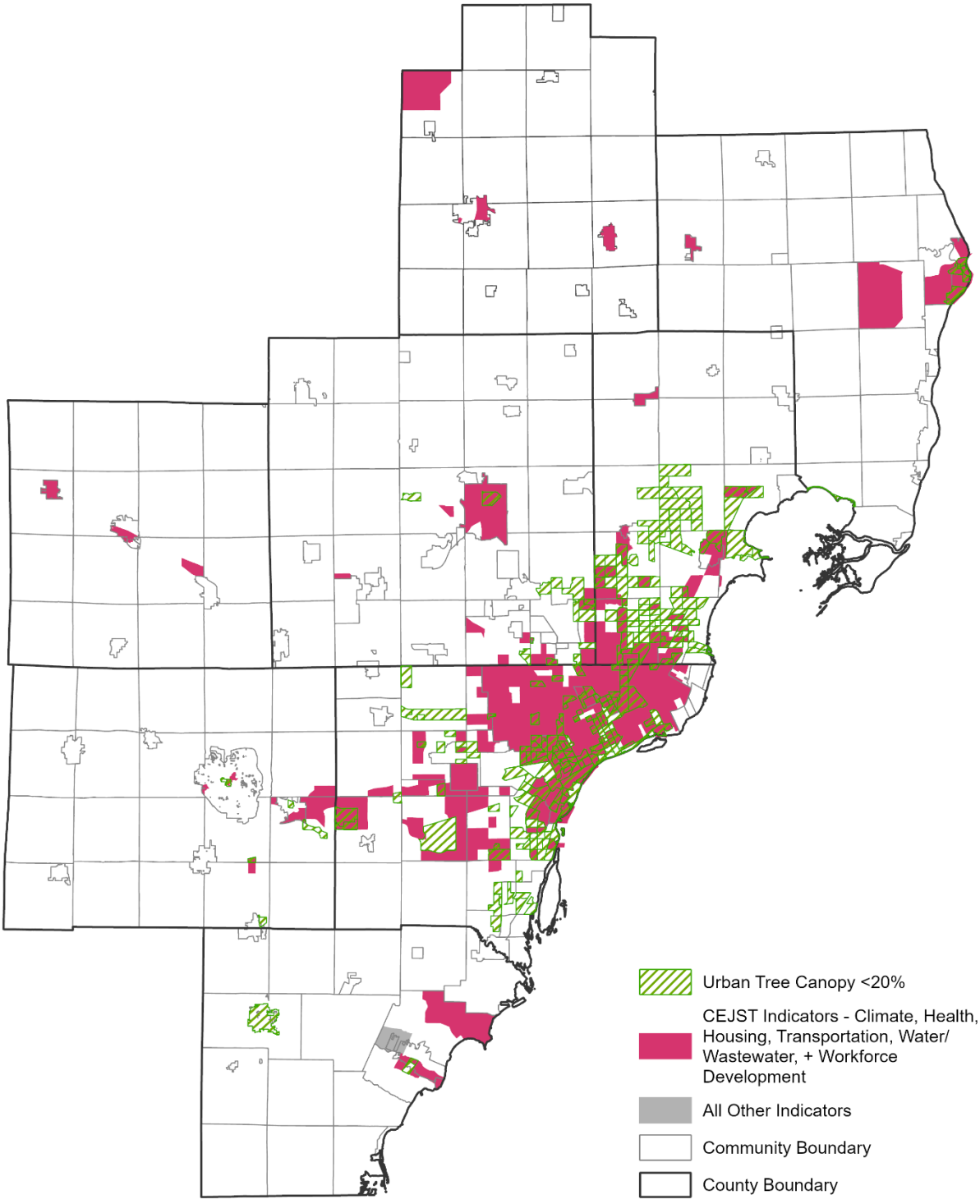
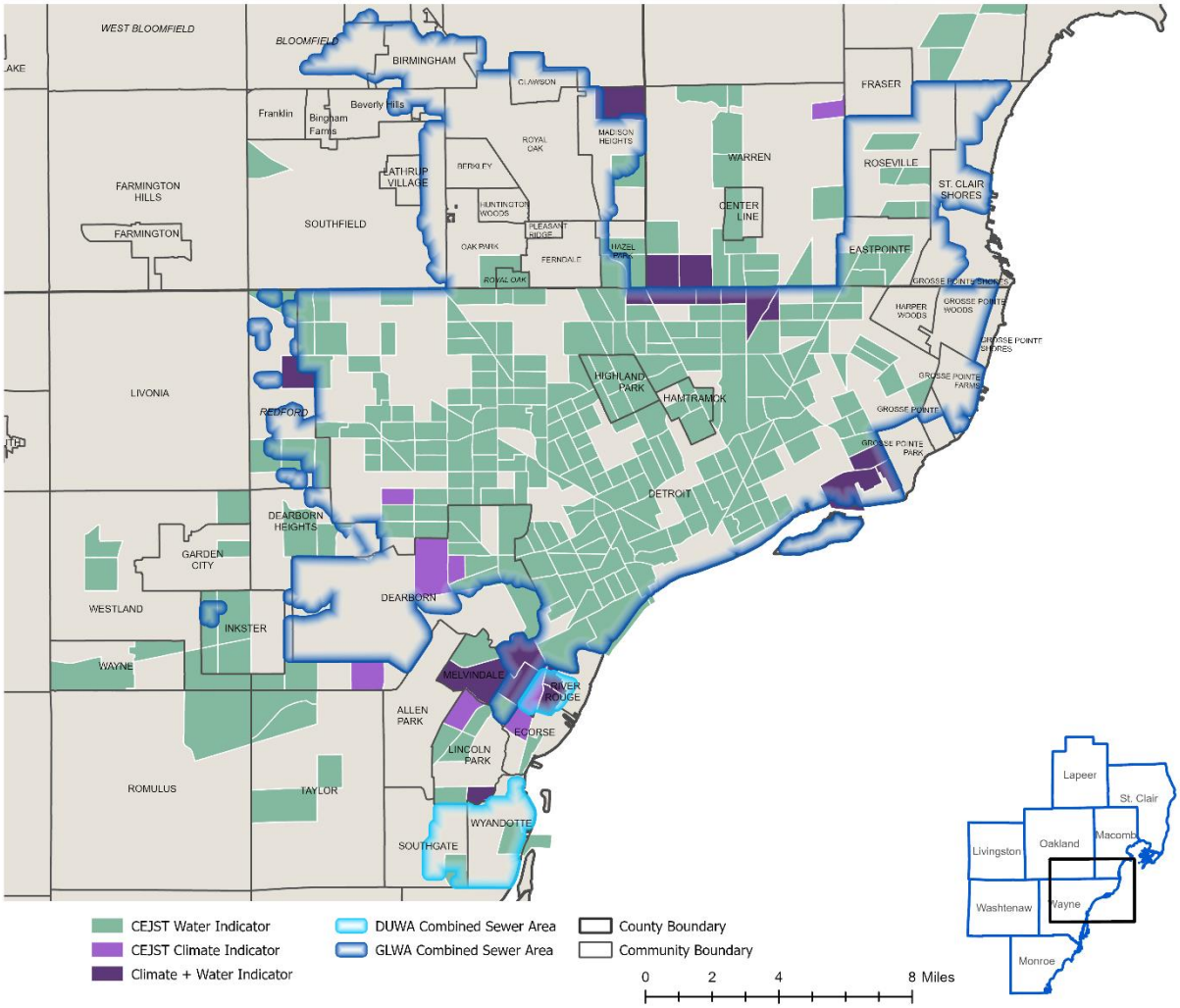


Figure 17

**Equity and Environmental Justice Focus Areas for Increasing Green Stormwater Infrastructure**



# Next Steps

## CPRG Implementation Grants

Following the PCAP, the Climate Pollution Reduction Grant program (CPRG) will award $4.6 billion in competitive grants to eligible applicants to implement GHG reduction measures identified in the PCAP. Applications are due to EPA on April 1, 2024. The CPRG general competition for implementation grants is designed to enable government entities to achieve the following goals:

1. Implement ambitious measures that will achieve significant cumulative GHG reductions by 2030 and beyond.
2. Pursue measures that will achieve substantial community benefits (such as reduction of criteria air pollutants (CAPs) and hazardous air pollutants (HAPs)), particularly in equity and environmental justice focus areas.
3. Complement other funding sources to maximize these GHG reductions and community benefits.
4. Pursue innovative policies and programs that are replicable and can be “scaled up” across multiple jurisdictions.

The CPRG general competition is also designed to incentivize eligible applicants to apply for funding together as a coalition to implement GHG reduction measures regionally, across municipal or state boundaries. Through this process, SEMCOG has actively engaged and coordinated among potential grant applicants to build coalitions and develop competitive concepts for grant applications.

## Comprehensive Climate Action Plan

Building on the PCAP, the CCAP will touch on all sectors of GHG sources and sequestration opportunities in the region, establish near-term and long-term GHG emission reduction goals, and provide strategies and identify measures to achieve those goals. The Healthy Climate Task Force will continue to meet and guide the development of the CCAP with support from topic-specific focus groups and input collected through community engagement. It is scheduled to be complete in June 2025, when it will come before SEMCOG’s General Assembly for adoption before final deliverables are provided to EPA.

To support the CCAP, an Engagement and Equity Plan is also being developed. This Plan will be based on the principles of the International Association for Public Participation (IAP2) and will provide a framework for the engagement undertaken for SEMCOG’s Comprehensive Climate Action Plan. It will use input from a group of pre-engagement interviewees to identify the important groups to engage with, and it will identify the objectives to be achieved with each group. The activities will be selected specifically to meet those objectives. In the context of Southeast Michigan’s Healthy Climate Plan, engagement activities will not be designed merely to disseminate information. Instead, they will be designed to ensure that the Southeast Michigan Climate Action Plan reflects the collective insight, aspirations, and concerns of the community, also positioning all community members to benefit.

APPENDIX A:

# Greenhouse Gas Emissions Inventory Methodology

This appendix describes the data sources, methodologies and assumptions used to create the greenhouse gas emissions inventory for the SEMCOG region.

## Stationary Energy: Residential, Commercial and Industrial Energy Use

### Utility-provided Energy Use Data

Data on electricity use and/or natural gas use, as applicable, was categorized as residential, commercial, or industrial and provided by the following utilities:

- DTE Energy
- Consumers Energy

Electricity usage for Wyandotte Municipal Service Commission and the Village of Chelsea was obtained from U.S. Energy Information Administration (EIA) Sales to Ultimate Customers data. Because the service of each utility is completely within the county where they are located, no further estimation was needed.

Consumers Energy and DTE provided CO2/MWh emissions factors for electricity, which were used to calculate emissions associated with energy use from those providers, in combination with CH4 and N2O emissions factors from eGRID. For the City of Wyandotte and Village of Chelsea, eGRID emissions factors were used for CO2, CH4 and N2O.

### Estimated Natural Gas Usage

Michigan Gas Utilities and SEMCO Energy Gas Company did not provide data, so an estimation approach was applied.

Total gas sales for each utility were obtained from the EIA form 176 Natural Gas Annual Respondent Query System. Because each utility provides service to areas both inside and outside the SEMCOG region, it was necessary to estimate the percentage of each utility's total sales within the region. To do this, the number of townships served by each utility was counted visually from the Michigan Public Service Commission (MPSC) natural gas service area map.

In some cases, a township is served by multiple utilities; in this case, the township was assigned to whichever utility appeared to have the largest area of the township. The total gas sales for each utility were then allocated to SEMCOG counties based on the percentage of total townships served by the utility that are in that county.

## Residential Non-Utility Fuel Use

The number of households in each county using propane and fuel oil as their primary heating fuel were obtained from data.census.gov, American Community Survey Table S2504, Physical Housing Characteristics. Reported natural gas usage and number of residential customers in each county from Consumers Energy was used to calculate the average heating MMBtu per household needed in each county. This was used to estimate residential propane and fuel oil use for each county.

## Commercial and Industrial Non-Utility Fuel Use

Statewide commercial usage of fuel oil, propane, and wood was allocated based on job counts for each county, totaling the job categories listed under commercial in Table C1 below. Job counts were provided by SEMCOG. Statewide commercial usage of each fuel was obtained from the EIA State Energy Data System (SEDS), and usage per job was calculated by dividing the statewide usage by the number of statewide jobs in the commercial categories. The number of statewide job counts was obtained from the U.S. Census OnTheMap tool. Industrial residual and distillate fuel oil, propane, wood, still gas, petroleum coke, and coal were allocated using the same method with the industrial job categories.

Job categories used to estimate commercial, non-utility fuel usage:

- Information
- Finance and Insurance
- Real Estate and Rental and Leasing
- Professional, Scientific, and Technical Services
- Management of Companies and Enterprises
- Administration & Support, Waste Management and Remediation
- Educational Services
- Health Care and Social Assistance
- Arts, Entertainment, and Recreation
- Accommodation and Food Services
- Other Services (excluding Public Administration)
- Public Administration

Job categories used to estimate industrial, non-utility fuel usage:

- Agriculture, Forestry, Fishing and Hunting
- Mining, Quarrying, and Oil and Gas Extraction
- Utilities
- Construction
- Manufacturing
- Wholesale Trade
- Retail Trade
- Transportation and Warehousing

# Transportation and Mobile Sources

## On-road Vehicles

On-road daily VMT was produced from SEMCOG's travel demand model. The regional annual total VMT from the Federal Highway Performance Monitoring Program (HPMS) was divided by the regional daily total from the travel demand model to produce a conversion from daily to annual VMT. This conversion was applied to the daily VMT for each county; this approach ensures that the regional annual total matches the annual total from HPMS.

VMT was broken into gasoline and diesel based on ICLEI's defaults of 9.4% diesel, 90.6% gasoline, which come from the EPA state inventory tool. VMT by county and fuel is listed in Table 2. Defaults were used, rather than local vehicle registration data, because commercial vehicles are typically driven much higher mileage per vehicle than passenger vehicles, so the count of vehicles is not a good indicator of VMT breakdown. In addition, freight vehicles, particularly long haul trucks, making trips into and out of the region are frequently registered outside the region, often in a different state.

Table A-1

**On-Road Vehicle Miles Traveled by Fuel Type**

| Location | Annual VMT (Origin-Destination) | Gasoline VMT (90.6%) | Diesel VMT (9.4%) |
|---|---|---|---|
| Detroit | 5,036,116,933 | 4,562,721,941 | 473,394,992 |
| Wayne | 15,829,408,000 | 14,341,443,648 | 1,487,964,352 |
| Oakland | 13,083,863,000 | 11,853,979,878 | 1,229,883,122 |
| Macomb | 6,784,653,000 | 6,146,895,618 | 637,757,382 |
| Washtenaw | 4,179,755,724 | 3,786,858,686 | 392,897,038 |
| Monroe | 2,036,500,000 | 1,845,069,000 | 191,431,000 |
| St. Clair | 1,518,162,000 | 1,375,454,772 | 142,707,228 |
| Livingston | 2,430,280,000 | 2,201,833,680 | 228,446,320 |
| **Regional** | **45,636,216,000** | **41,346,411,696** | **4,289,804,304** |

VMT was assigned by percentage to different vehicle types:

- Diesel VMT assigned to vehicle types based on the following defaults: 88.2% heavy truck, 8.3% light truck, 3.5% passenger car. As with gasoline VMT, these are ICLEI defaults taken from the EPA state inventory tool.
- Gasoline VMT assigned to vehicle types based on vehicle registration data by county, which was provided by SEMCOG. Vehicle body types in the registration data were assigned to categories matching those used in ClearPath. Since this assignment is within passenger vehicles, the count of vehicles is a good proxy for VMT breakdown.

Table A-2

**Percent of Gasoline VMT by vehicle type for each county**

| Vehicle Type | Detroit | Livingston | Macomb | Monroe | Oakland | St. Clair | Washtenaw | Wayne |
|---|---|---|---|---|---|---|---|---|
| passenger car | 50.4% | 34.0% | 36.6% | 34.4% | 37.8% | 33.3% | 41.8% | 43.5% |
| light truck | 47.9% | 61.5% | 60.4% | 60.6% | 61.6% | 61.9% | 55.0% | 56.1% |
| motorcycle | 1.3% | 3.7% | 2.6% | 4.3% | 2.4% | 3.9% | 2.7% | 2.4% |
| heavy truck | 0.3% | 0.7% | 0.4% | 0.7% | 0.5% | 0.8% | 0.5% | 0.4% |

## Public Transportation

For the following transit agencies, fuel usage data was obtained from Federal Transit Administration

- Enterprise Rideshare
- Blue Water Area Transit
- Lake Erie Transit
- Detroit Transportation Corporation (rail)
- QLINE Detroit

In addition, data on vehicle revenue miles from the National Transit Database were collected for the following transit agencies:

- City of Detroit
- Ann Arbor Area Transportation Authority
- University of Michigan Parking and Transportation Services
- Detroit Transportation Corporation (bus)
- Livingston County Board of Commissioners

Revenue miles were converted to gallons of fuel based on a default of 17.9 miles per gallon from FHWA Annual Vehicle Distance Traveled in Miles and Related Data.(value for 'Light Duty Vehicles Long WB.')

Equation used: Gallons fuel = Revenue miles / 17.9

## Rail

For freight rail, MDOT's Office of Rail provided ton miles by county. This was used with an average efficiency of 500 ton miles/gallon. This was used to calculate gallons of diesel fuel used.

For passenger rail, gallons of diesel fuel for each route were obtained from MDOT. Fuel use was allocated to each county based on the percent of the total route track miles in each county (see Table A-3).

Table A-3

**Allocated passenger rail fuel use by county**

| County, route | Route track miles | County track miles | % of route | 2019 fuel for route | County fuel use (gallons) |
|---|---|---|---|---|---|
| Washtenaw, Wolverine | 304 | 35 | 11.5% | 805,555 | 92,745 |
| Wayne, Wolverine | 304 | 30 | 9.9% | 805,555 | 79,496 |
| Oakland, Wolverine | 304 | 15 | 4.9% | 805,555 | 39,748 |
| St. Clair, Blue Water | 319 | 25 | 7.8% | 416,972 | 32,678 |

## Waterborne Transportation

Data on vessel movements (ships entering and leaving port) and total tonnage of freight for the ports of Detroit, Monroe, Marine City, Marysville, and Port Huron were obtained from the Army Corps of Engineers Waterborne Commerce Statistics Center, Ports and Waterways page (see Table A-4). Marine emissions are accounted for based on the port's area of authority, incoming and outgoing. Factors for fuel use of vessels during cruise, reduced speed and maneuvering (see Tables A-5 and A-6) were applied to the tonnage and number of trips to calculate emissions, which were directly entered into ClearPath.

Table A-4

**Number of vessels and freight tonnage for ports in region in 2019**

| Port | Detroit | Marine City | Monroe | Marysville | Port Huron |
|---|---|---|---|---|---|
| Total vessels (inbound + outbound) | 841 | 158 | 239 | 81 | 55 |
| Liquid tanker vessels | 22 | 0 | 43 | 0 | 0 |
| Tonnage of freight | 5,694,217 | 1,037,063 | 1,656,927 | 720,561 | 76,197 |

Table A-5

**Full power fuel usage and emissions factors for marine vessels[46]**

| Ship type | Fuel consumption (metric tons/day) at full power |
|---|---|
| Solid bulk | 20.186 + 0.00049 * gross tonnage |
| Liquid bulk | 14.685 + 0.00079 * gross tonnage |
| Tonnage of freight | 5,694,217 |

| GHG | Emissions (g/kg fuel) |
|---|---|
| CO2 | 3,188 |
| CH4 | 0.23 |
| N2O | 0.08 |

Table A-6

**Factors used for adjusting from full power fuel use factor for marine vessels[47]**

| Mode | Time in mode (minutes) per inbound or outbound trip | Load factor (% of full power) |
|---|---|---|
| Cruise | 30 | 80% |
| Reduced speed | 31 | 33% |
| Maneuvering | 30 | 12% |

Data was not available on ferry operations.

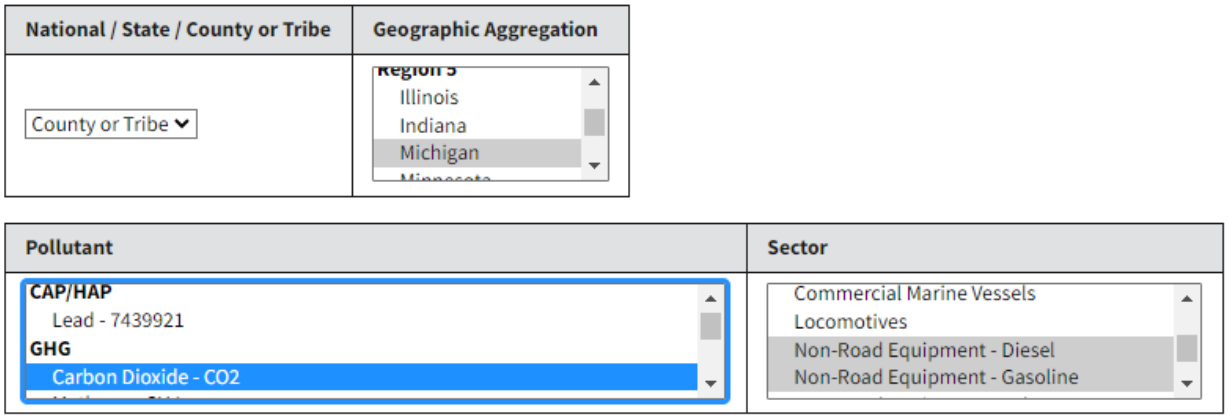
[46] Source: Tables 13 and 7 of IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, CO2 , CH4 , AND N2O EMISSIONS FROM TRANSPORTATION - WATER-BORNE NAVIGATION.

[47] Source: Spreadsheet "Cuyahoga County Marine Vessel Data 2010-2018.xlsx", unpublished, developed by Brendle Group for Cuyahoga County GHG inventory, received from the Northeast Ohio Areawide Coordinating Agency on August 5, 2022. The spreadsheet cites the Great Lakes Marine Air Emissions Study of 2006 as the original source of the data, however, we were not able to locate this original source.

## Off-road/Mobile Equipment

Data was entered by county from the 2017 National Emissions Inventory (NEI). CO2 emissions from the NEI are pulled for 'Non-Road Equipment - Diesel' and 'Non-Road Equipment - Gasoline' (see figure A-1). NEI data is updated on a three year cycle, with approximately a three year delay (data for 2023 is expected to be available in 2026). As of June 2023, data for 2020 had been released, but not in a queryable format.

Figure A-1: NEI Query settings.




Air travel was not included.

# Solid Waste

## Landfilled Waste

Waste generation for each county was obtained from the Fiscal Year 2019 Annual Report of Solid Waste Landfilled in Michigan. This data includes the amount of waste by origin county and location of the landfill. This data was summed into the amount for each county that was both generated and landfilled within that county; the amount generated in that county and exported to another SEMCOG county; the amount generated in that county and exported outside the region; and the amount imported and landfilled in that county. For the regional inventory, there would be double counting between waste exported to another county in the region, and imported waste (waste exported from one county would also show up as imported to another county). To avoid this double county, all 'waste imported' entries are marked as information only in the regional inventory. The double counting issue does not arise with individual county inventories, so imported waste entries are not marked as information only in those (this means if waste emissions from each county inventory were added together, the total is more than the regional total waste emissions).

Waste was converted from volume to mass units using an EPA conversion factor of 550 lbs/cubic yard. For municipal solid waste, waste composition was used from *Economic Impact Potential and Characterization of Municipal Solid Waste in Michigan 2016* report. For Detroit, Wayne county waste generation was downscaled based on population.

Equation used: Tons waste = cubic yards * 550/2000

## Compost

Cubic yards of material brought to composting sites in each county was obtained from the EGLE Waste Data System. The assumption was used that the material originated in that county. Cubic yards converted to tons using 0.175 tons/cubic yard, from New Hampshire Department of Environmental Services . For Detroit, Wayne county compost tonnage was downscaled based on population.

Equation used: Tons composted = cubic yards composted * 0.175

# Water and Wastewater

## Wastewater Treatment Process Emissions

Data on wastewater treatment processes was provided by the following wastewater utilities:

- Ypsilanti Community Utilities Authority (YCUA)
- South Huron Valley Utility Authority (SHVUA)
- Monroe Metro Sewer Authority
- Downriver Utility Wastewater Authority
- City of Ann Arbor
- Great Lakes Water Authority (GLWA)

Process N2O emissions and effluent discharge N2O emissions were calculated for each facility based on the data provided (depending on the data provided, either daily N load in effluent discharge or population was used). In addition, YCUA and GLWA reported combustion of wastewater solids, and emissions were calculated from the data provided. Since GLWA serves multiple counties, tons of biosolids are allocated to each county based on the portion of the total population served by GLWA reside in that county.

Emissions were not calculated for the remaining utilities that did not provide data.

# Process and Fugitive Emissions

## Process Emissions from Industrial Facilities

Process emissions from large emitters were obtained from the EPA Facility Level Information on Greenhouse Gases Tool (FLIGHT). Industrial fuel use at electricity generation facilities is entered as information only in ClearPath. These emissions are not included in totals to avoid duplicating this portion of the sector wide electricity use already accounted for in the Stationary Energy sector. Fuel oil use at two commercial facilities that report to EPA is also entered as information only. These emissions are not included in totals to avoid duplicating this portion of the estimate of sector wide fuel oil use already accounted for in the Stationary Energy sector.

## Fugitive Emissions from Oil and Gas production

- Gas production emissions estimated using emissions factor of 4.1 MT CH4/year. The emissions factor comes from the EPA state inventory tool. A total of four producing gas wells were identified in the region in 2019.
- Oil production emissions estimated using emissions factor of 0.3477 MT CH4 per 1000 barrels of oil produced. The emissions factor comes from the EPA state inventory tool.

Data on gas production wells and oil production was supplied by EGLE's Oil, Gas, and Minerals Division.

## Fugitive Emissions from Natural Gas Distribution

Fugitive emissions from natural gas distribution were calculated using the total gas usage in each county (including usage provided by utilities, and estimated usage as described above). The default leakage rate of 0.3 percent was applied to this total usage.

# Agriculture, land use and forestry (AFOLU)

## Livestock Enteric Fermentation and Manure Management

CH4 emissions from enteric fermentation were calculated using factors from the EPA's State Inventory Tool. The number of livestock of different types by county were obtained from the USDA Census of Agriculture for 2017 (USDA 2019). [48] Enteric fermentation emissions were calculated for dairy cows, beef cows, heifer stockers, sheep, and swine. Manure management emissions were calculated for dairy cows, beef cows, heifer stockers, sheep, swine, and chickens. [49]

## Agricultural Production

N2O emissions from crop residues and legumes were calculated using factors from the EPA State Inventory Tool. Production of crops by county was obtained from the USDA Census of Agriculture for 2017. Emissions were calculated from the following crops based on availability of data and emissions factors: corn (grain), oats, soybeans, wheat, and beans (dry edible).

## Forests and Trees

Emissions and carbon removed from the atmosphere were calculated using ICLEI's Land Emissions and Removals Navigator (LEARN) tool. Calculation of forest and tree emissions and removals requires land cover and canopy data from two years. For forests, the time period of 2013 to 2019 was used, and for trees outside of forests, the time period of 2011 to 2016 (the only two years of data available in the LEARN tool) was used.

[48] The agricultural census is conducted every five years.

[49] Enteric fermentation does not occur in chickens.

APPENDIX B:

# Equity and Environmental Justice Indices and Maps

This appendix further describes the data used to identify equity and environmental focus areas in the region. The Climate and Economic Justice Screening Tool[50] (CEJST) is being used to ensure that the EPA and other government bodies have the information they need to fulfill the Justice40 Initiative, directing funding and programming to the communities most in need of support. In the CEJST tool, communities (at the census-tract level) are considered disadvantaged if they have disproportionately high numbers of low-income households and exceptionally high exposure to one or more environmental burdens. The EJ and Supplemental Indices were reviewed and mapped to learn more about the burdens in each census tract.

The eight CEJST indicators of burden are described in Table B-1 below, along with affected population and the number of census tracts in the SEMCOG region that are identified by each indicator.[51] Table B-2 summarizes the Equity and Environmental Justice Focus Areas by County, and a list of the communities where these tracts are located. Additionally, regional maps for each of the indices are included as Figures B-1 through B-8. Table B-3 lists Equity and Environmental Justice Focus Areas by census tract number, with their associated population by community and county.

[50] Climate and Economic Justice Screening Tool. https://screeningtool.geoplatform.gov/en/#7.91/42.353/-83.616.
[51] Climate and Economic Justice Screening Tool, 2023. Methodology.: https://screeningtool.geoplatform.gov/en/methodology.

Table B-1

**Equity and Environmental Justice Focus Area Indicators**

| CEJST Indicators | Description | Population Affected | Number of Census Tracts |
|---|---|---|---|
| ***Climate Change*** | Census tracts are disadvantaged if they are:<br>• at or above the 90th percentile for expected agriculture loss rate OR expected building loss rate OR expected population loss rate OR projected flood risk OR projected wildfire risk;<br>• AND are at or above the 65th percentile for low income. | 82,666 | 29 |
| ***Energy*** | Census tracts are disadvantaged if they are:<br>• at or above the 90th percentile for energy cost OR PM2.5 in the air;<br>• AND are at or above the 65th percentile for low income. | 722,698 | 301 |
| ***Health*** | Census tracts are disadvantaged if they are:<br>• at or above the 90th percentile for asthma OR diabetes OR heart disease OR low life expectancy;<br>• AND are at or above the 65th percentile for low income. | 1,169,650 | 439 |
| ***Housing*** | Census tracts are disadvantaged if they are:<br>• Experienced historic underinvestment OR are at or above the 90th percentile for housing cost OR lack of green space OR lack of indoor plumbing OR lead paint;<br>• AND are at or above the 65th percentile for low income. | 939,030 | 372 |
| ***Legacy Pollution*** | Census tracts are disadvantaged if they are:<br>• Have at least one abandoned mine land OR Formerly Used Defense Sites OR are at or above the 90th percentile for proximity to hazardous waste facilities OR proximity to Superfund sites (National Priorities List (NPL)) OR proximity to Risk Management Plan (RMP) facilities;<br>• AND are at or above the 65th percentile for low income. | 239,073 | 89 |
| ***Transportation*** | Census tracts are disadvantaged if they are:<br>• at or above the 90th percentile for diesel particulate matter exposure OR transportation barriers OR traffic proximity and volume;<br>• AND are at or above the 65th percentile for low income. | 591,795 | 233 |
| ***Water and Wastewater*** | Census tracts are disadvantaged if they are:<br>• at or above the 90th percentile for underground storage tanks and releases OR wastewater discharge;<br>• AND are at or above the 65th percentile for low income. | 839,509 | 325 |
| ***Workforce Development*** | Census tracts are disadvantaged if they are:<br>• at or above the 90th percentile for linguistic isolation OR low median income OR poverty OR unemployment;<br>• AND more than 10% of people ages 25 years or older whose high school education is less than a high school diploma. | 919,620 | 353 |

Table B-2

**Equity and Environmental Justice Focus Areas by County**

| Communities | Population Affected | Number of Census Tracts |
|---|---|---|
| **Lapeer County** | **10,764** | **4** |
| Including areas of Imlay City, Lapeer, and Marathon Township. | | |
| **Livingston County** | **10,222** | **3** |
| Including areas of Fowlerville, Genoa Township, and Howell. | | |
| **Macomb County** | **194,222** | **58** |
| Including areas of Center Line, Chesterfield Township, Clinton Township, Eastpointe, Harrison Township, Mount Clemens, Romeo, Roseville, Sterling Heights, Utica, and Warren. | | |
| **Monroe County** | **21,268** | **6** |
| Including areas of Frenchtown Township, Monroe, and Monroe Township. | | |
| **Oakland County** | **123,692** | **34** |
| Including areas of Commerce Township, Hazel Park, Madison Heights, Oak Park, Pontiac, Royal Oak Township, Southfield, Troy, and Waterford Township. | | |
| **St. Clair County** | **36,574** | **12** |
| Including areas of Capac, Kimball Township, Port Huron, and Port Huron Township. | | |
| **Washtenaw County** | **38,328** | **12** |
| Including areas of Ann Arbor, Superior Township, York Township, Ypsilanti, and Ypsilanti Township. | | |
| **Wayne County** | **926,788** | **362** |
| Including areas of Brownstown Township, Canton Township, Dearborn, Dearborn Heights, Detroit, Ecorse, Garden City, Hamtramck, Harper Woods, Highland Park, Inkster, Lincoln Park, Melvindale, Redford Township, River Rouge, Romulus, Southgate, Taylor, Van Buren Township, Wayne, Westland, and Wyandotte. | | |
| **Southeast Michigan** | **1,361,858** | **491** |

Figure B-1

**Equity and Environmental Justice Focus Area for Climate Change Indicators**

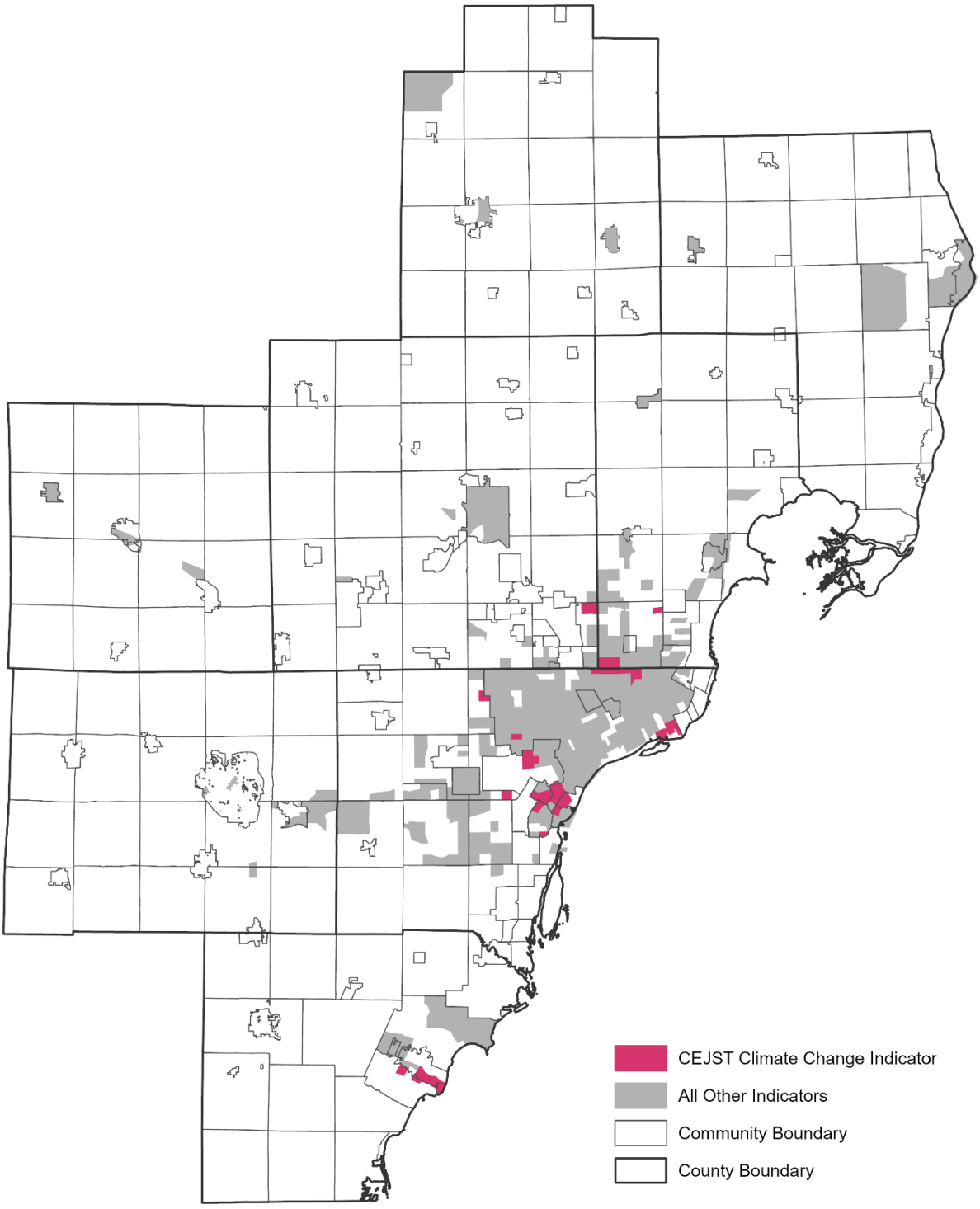


Figure B-2

**Equity and Environmental Justice Focus Area for Energy Indicators**

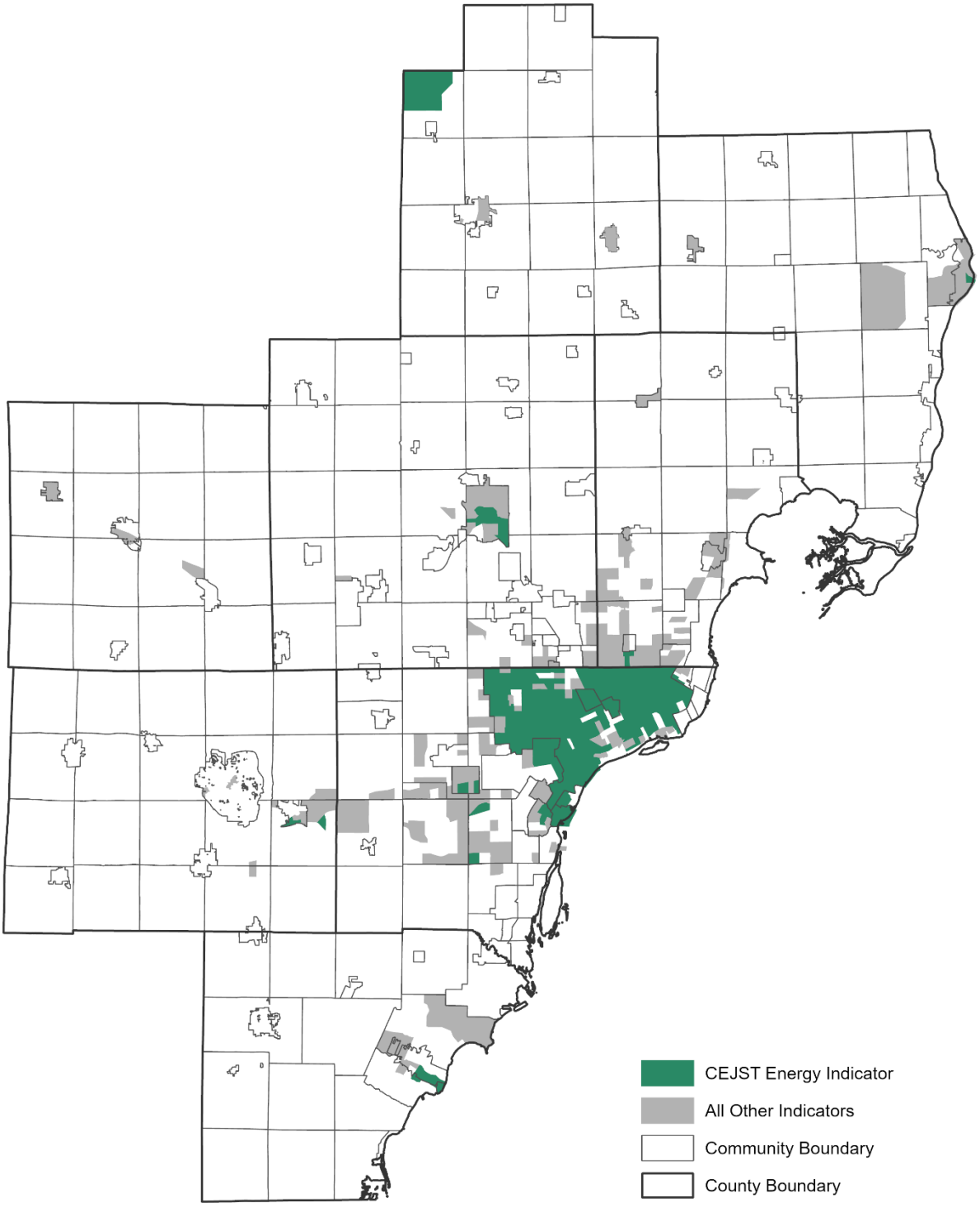


Figure B-3

**Equity and Environmental Justice Focus Area for Health Indicators**

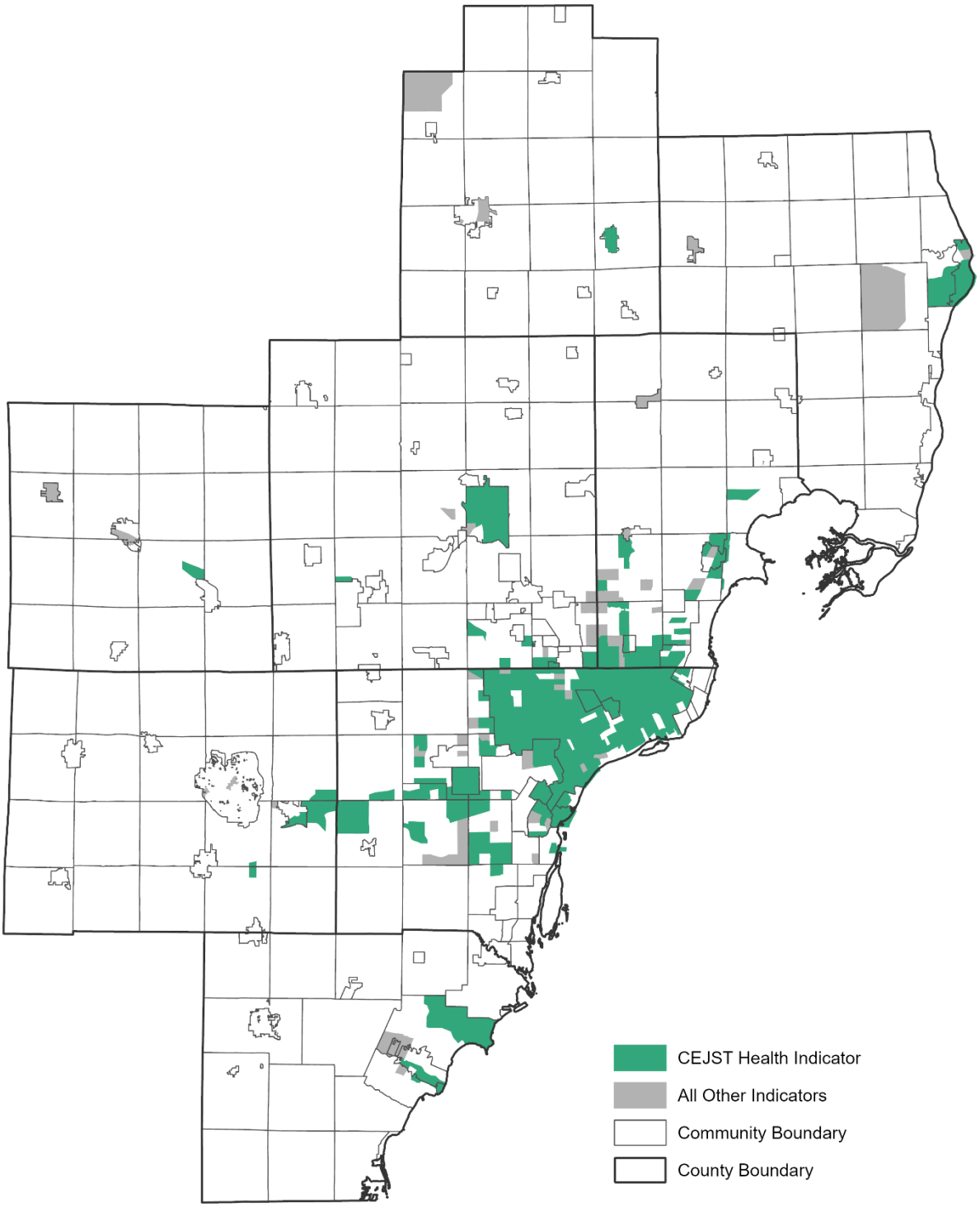


Figure B-4

**Equity and Environmental Justice Focus Area for Housing Indicators**

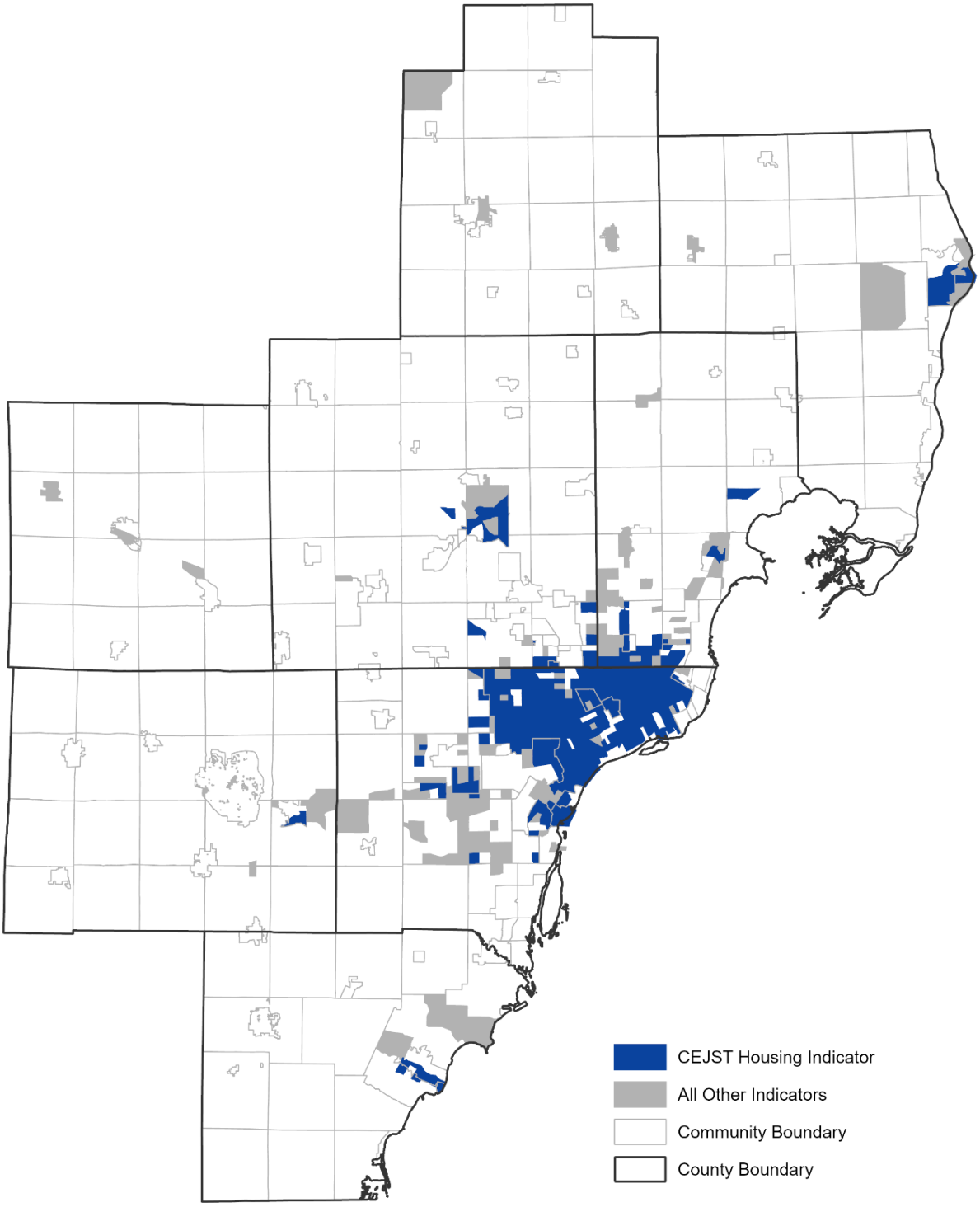


Figure B-5

**Equity and Environmental Justice Focus Area for Pollution Indicators**

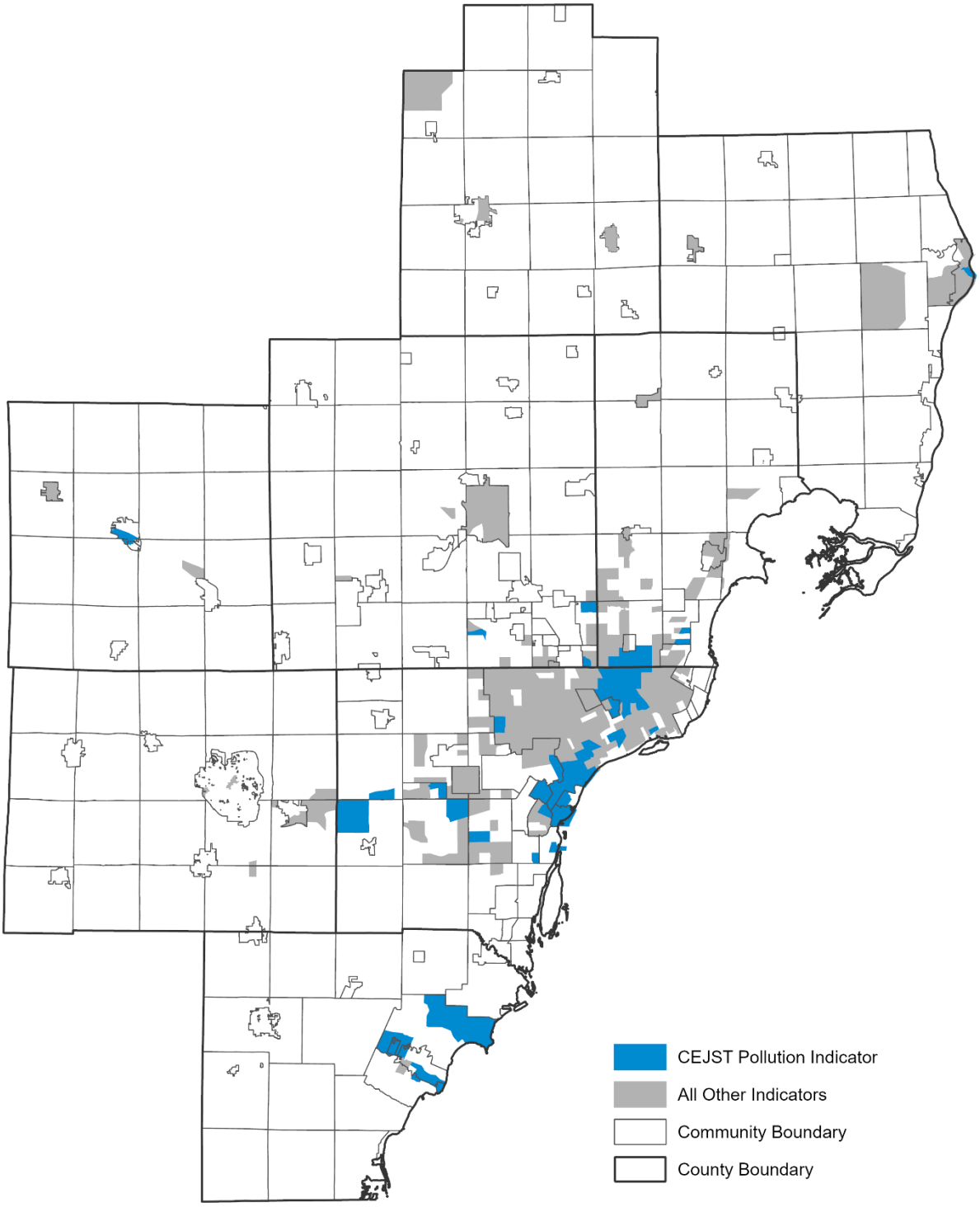


Figure B-6

**Equity and Environmental Justice Focus Area for Transportation Indicators**

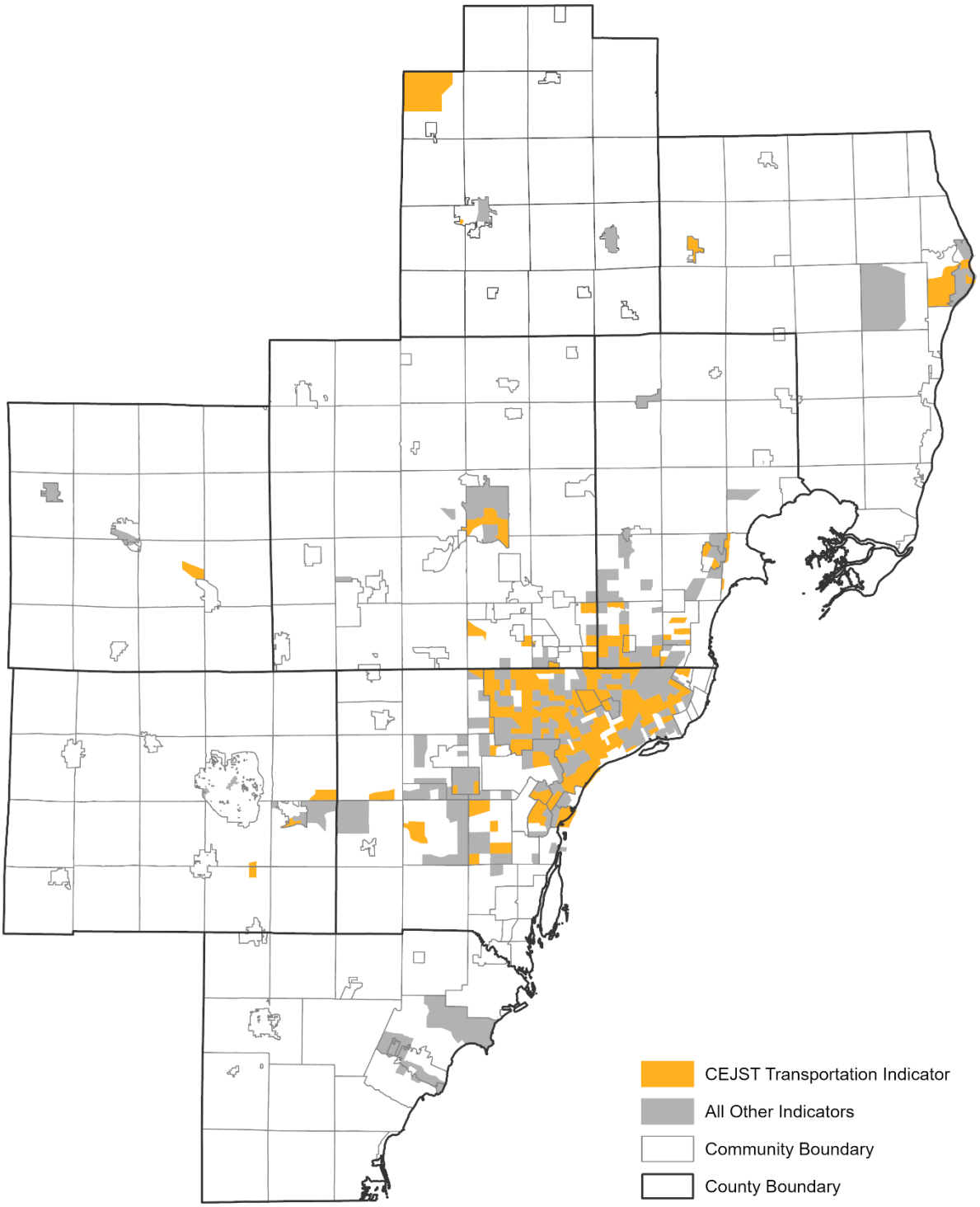


Figure B-7

**Equity and Environmental Justice Focus Area for Water and Wastewater Indicators**

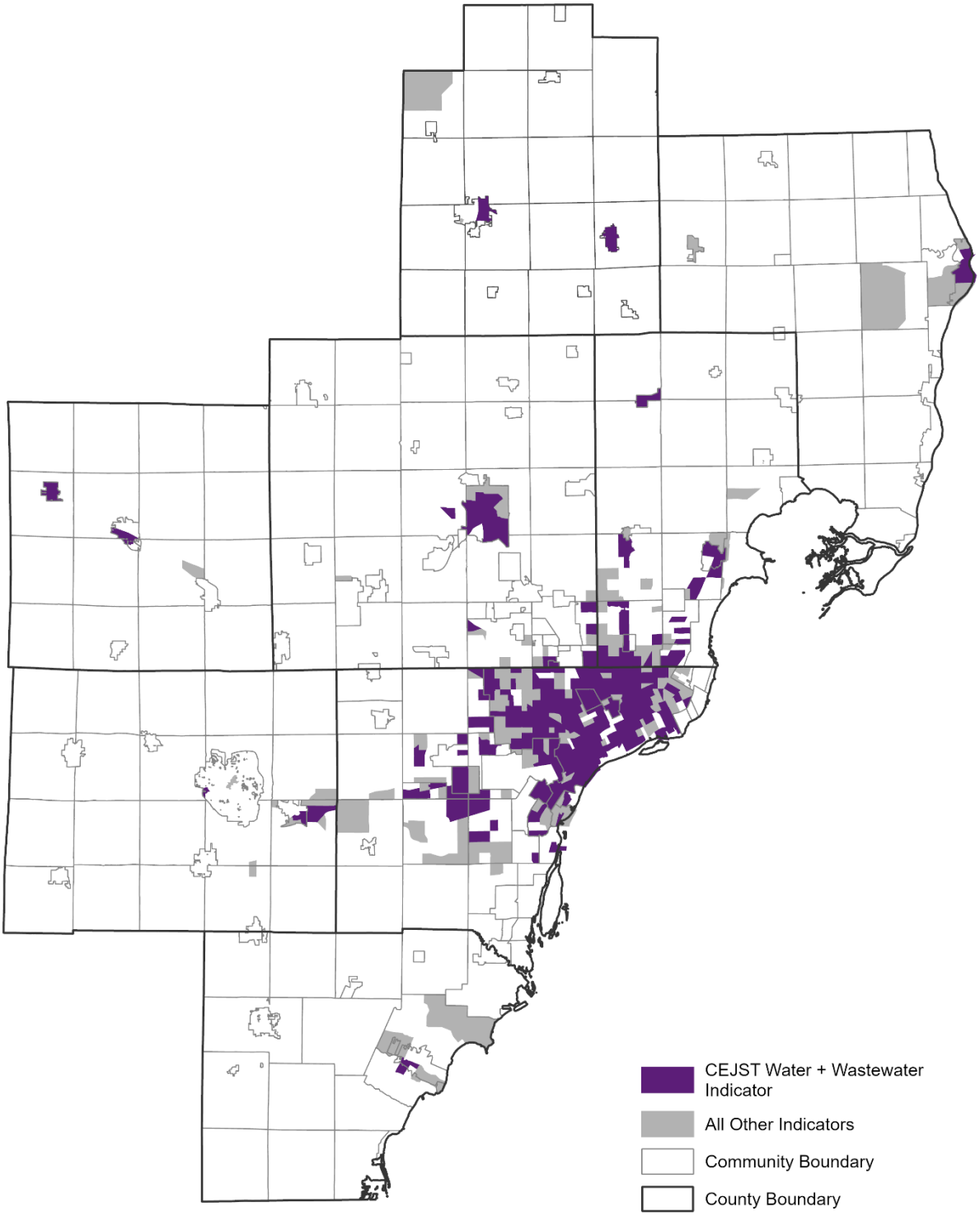


Figure B-8

**Equity and Environmental Justice Focus Area for Workforce Development Indicators**

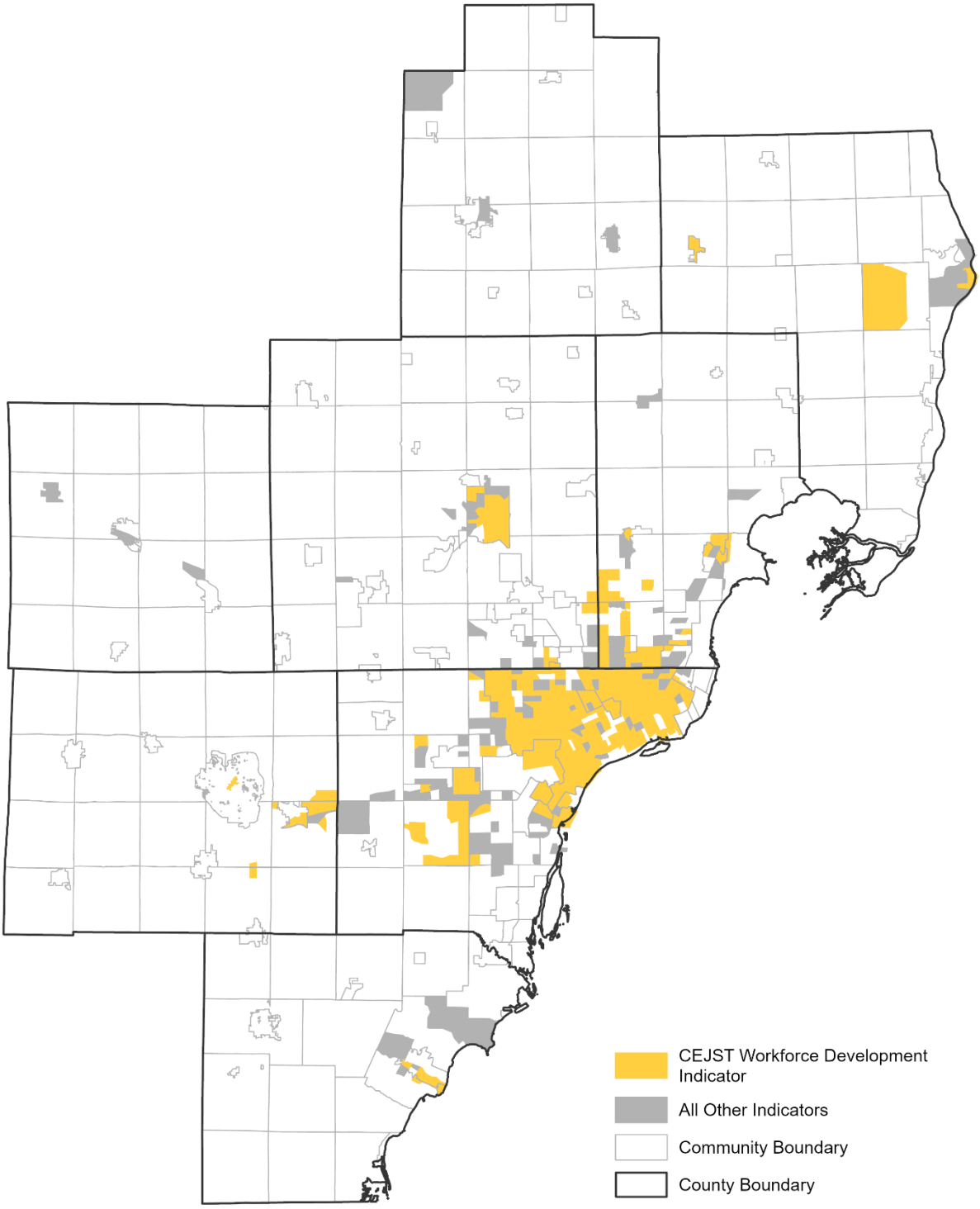


Table B-3

**Equity and Environmental Justice Focus Areas by Census Tract Number**

| Census Tract Number | County | Community | Tract Population | Total Community Population |
|---|---|---|---|---|
| 26087339500 | Lapeer County | Imlay City | 3,568 | 3,568 |
| 26087337500 | Lapeer County | Lapeer | 4,190 | |
| 26087336500 | Lapeer County | Lapeer | 1,268 | 5,458 |
| 26087331000 | Lapeer County | Marathon Twp | 1,738 | 1,738 |
| | **Lapeer County** | | | **10,764** |
| 26093722300 | Livingston County | Fowlerville | 2,881 | 2,881 |
| 26093742202 | Livingston County | Genoa Twp | 2,457 | 2,457 |
| 26093725100 | Livingston County | Howell | 4,884 | 4,884 |
| | **Livingston County** | | | **10,222** |
| 26099268100 | Macomb County | Center Line | 2,839 | 2,839 |
| 26099222101 | Macomb County | Chesterfield Twp | 5,665 | 5,665 |
| 26099241200 | Macomb County | Clinton Twp | 4,878 | |
| 26099241000 | Macomb County | Clinton Twp | 4,821 | |
| 26099241700 | Macomb County | Clinton Twp | 4,796 | |
| 26099240000 | Macomb County | Clinton Twp | 3,958 | |
| 26099241600 | Macomb County | Clinton Twp | 2,714 | 21,167 |
| 26099258600 | Macomb County | Eastpointe | 4,707 | |
| 26099258200 | Macomb County | Eastpointe | 2,617 | |
| 26099258700 | Macomb County | Eastpointe | 2,803 | |
| 26099258800 | Macomb County | Eastpointe | 3,583 | |
| 26099258400 | Macomb County | Eastpointe | 5,268 | |
| 26099258900 | Macomb County | Eastpointe | 2,799 | 21,777 |
| 26099247100 | Macomb County | Harrison Twp | 857 | |
| 26099247601 | Macomb County | Harrison Twp | 2,089 | 2946 |
| 26099245000 | Macomb County | Mount Clemens | 3,655 | |
| 26099245200 | Macomb County | Mount Clemens | 3,003 | |
| 26099245100 | Macomb County | Mount Clemens | 3,832 | |
| 26099245400 | Macomb County | Mount Clemens | 1,421 | 11,911 |
| 26099206700 | Macomb County | Romeo | 3,836 | 3,836 |
| 26099255300 | Macomb County | Roseville | 3,988 | |
| 26099256800 | Macomb County | Roseville | 1,631 | |
| 26099256100 | Macomb County | Roseville | 2,499 | |
| 26099255800 | Macomb County | Roseville | 2,630 | |
| 26099256700 | Macomb County | Roseville | 1,994 | |
| 26099256500 | Macomb County | Roseville | 1,490 | |
| 26099255900 | Macomb County | Roseville | 1,796 | |
| 26099256600 | Macomb County | Roseville | 3,025 | 19,053 |

| Census Tract Number | County | Community | Tract Population | Total Community Population |
|---|---|---|---|---|
| 26099231500 | Macomb County | Sterling Heights | 5,080 | |
| 26099232300 | Macomb County | Sterling Heights | 4,481 | |
| 26099231400 | Macomb County | Sterling Heights | 5,781 | |
| 26099230500 | Macomb County | Sterling Heights | 3,724 | |
| 26099231600 | Macomb County | Sterling Heights | 5,322 | |
| 26099231900 | Macomb County | Sterling Heights | 6,143 | |
| 26099232400 | Macomb County | Sterling Heights | 5,769 | 36,300 |
| 26099228100 | Macomb County | Utica | 1,641 | 1,641 |
| 26099262300 | Macomb County | Warren | 4,079 | |
| 26099263400 | Macomb County | Warren | 3,802 | |
| 26099262800 | Macomb County | Warren | 2,052 | |
| 26099260100 | Macomb County | Warren | 2,910 | |
| 26099260600 | Macomb County | Warren | 2,859 | |
| 26099262400 | Macomb County | Warren | 3,484 | |
| 26099262500 | Macomb County | Warren | 4,961 | |
| 26099263200 | Macomb County | Warren | 2,509 | |
| 26099264000 | Macomb County | Warren | 2,159 | |
| 26099263600 | Macomb County | Warren | 5,134 | |
| 26099263700 | Macomb County | Warren | 4,602 | |
| 26099263800 | Macomb County | Warren | 2,618 | |
| 26099263900 | Macomb County | Warren | 3,625 | |
| 26099264200 | Macomb County | Warren | 4,463 | |
| 26099263500 | Macomb County | Warren | 4,110 | |
| 26099262100 | Macomb County | Warren | 961 | |
| 26099262900 | Macomb County | Warren | 4,057 | |
| 26099260800 | Macomb County | Warren | 2,708 | |
| 26099268300 | Macomb County | Warren | 2,626 | |
| 26099268400 | Macomb County | Warren | 3,232 | |
| 26099982200 | Macomb County | Warren | 32 | |
| 26099982300 | Macomb County | Warren | 104 | 67,087 |
| | **Macomb County** | | | **194,222** |
| 26115831200 | Monroe County | Frenchtown Twp | 6,800 | 6,800 |
| 26115831800 | Monroe County | Monroe | 1,275 | |
| 26115831900 | Monroe County | Monroe | 1,338 | |
| 26115832100 | Monroe County | Monroe | 3,186 | |
| 26115831400 | Monroe County | Monroe | 6,900 | 12,699 |
| 26115832200 | Monroe County | Monroe Twp | 1,769 | 1,769 |
| | **Monroe County** | | | **21,268** |
| 26125135000 | Oakland County | Commerce Twp | 3,842 | 3,842 |

| Census Tract Number | County | Community | Tract Population | Total Community Population |
|---|---|---|---|---|
| 26125175100 | Oakland County | Hazel Park | 5,169 | |
| 26125175200 | Oakland County | Hazel Park | 3,910 | |
| 26125175300 | Oakland County | Hazel Park | 4,314 | 13,393 |
| 26125181600 | Oakland County | Madison Heights | 5,236 | |
| 26125181000 | Oakland County | Madison Heights | 3,875 | |
| 26125181300 | Oakland County | Madison Heights | 6,002 | 15,113 |
| 26125172400 | Oakland County | Oak Park | 1,651 | |
| 26125171300 | Oakland County | Oak Park | 3,356 | |
| 26125171500 | Oakland County | Oak Park | 5,194 | 10,201 |
| 26125142400 | Oakland County | Pontiac | 3,428 | |
| 26125141600 | Oakland County | Pontiac | 4,485 | |
| 26125142300 | Oakland County | Pontiac | 2,307 | |
| 26125142700 | Oakland County | Pontiac | 3,797 | |
| 26125140900 | Oakland County | Pontiac | 5,419 | |
| 26125142000 | Oakland County | Pontiac | 2,348 | |
| 26125141500 | Oakland County | Pontiac | 6,378 | |
| 26125141200 | Oakland County | Pontiac | 3,136 | |
| 26125141400 | Oakland County | Pontiac | 4,626 | |
| 26125141700 | Oakland County | Pontiac | 2,268 | |
| 26125141000 | Oakland County | Pontiac | 5,225 | |
| 26125141100 | Oakland County | Pontiac | 2,984 | |
| 26125141300 | Oakland County | Pontiac | 3,719 | |
| 26125142100 | Oakland County | Pontiac | 1,584 | |
| 26125142200 | Oakland County | Pontiac | 2,764 | |
| 26125142600 | Oakland County | Pontiac | 3,539 | 58,007 |
| 26125171600 | Oakland County | Royal Oak Twp | 2,061 | |
| 26125172500 | Oakland County | Royal Oak Twp | 2,411 | 4,472 |
| 26125162400 | Oakland County | Southfield | 2,289 | |
| 26125160400 | Oakland County | Southfield | 2,816 | |
| 26125161400 | Oakland County | Southfield | 4,032 | |
| 26125160300 | Oakland County | Southfield | 3,001 | 12,138 |
| 26125198100 | Oakland County | Troy | 2,696 | 2,696 |
| 26125144701 | Oakland County | Waterford Twp | 3,830 | 3,830 |
| | **Oakland County** | | | **123,692** |
| 26147657100 | St. Clair County | Capac | 1,821 | 1,821 |
| 26147634100 | St. Clair County | Kimball Twp | 3,669 | 3,669 |
| 26147620000 | St. Clair County | Port Huron | 4,607 | |
| 26147621000 | St. Clair County | Port Huron | 4,146 | |
| 26147626000 | St. Clair County | Port Huron | 2,042 | |

| Census Tract Number | County | Community | Tract Population | Total Community Population |
|---|---|---|---|---|
| 26147629000 | St. Clair County | Port Huron | 2,331 | |
| 26147622000 | St. Clair County | Port Huron | 4,338 | |
| 26147624000 | St. Clair County | Port Huron | 1,662 | |
| 26147623000 | St. Clair County | Port Huron | 2,611 | |
| 26147625000 | St. Clair County | Port Huron | 1,484 | |
| 26147628000 | St. Clair County | Port Huron | 3,250 | 26,471 |
| 26147636000 | St. Clair County | Port Huron Twp | 4,613 | 4,613 |
| | **St. Clair County** | | | **36,574** |
| 26161404200 | Washtenaw County | Ann Arbor | 1,802 | |
| 26161400200 | Washtenaw County | Ann Arbor | 6,143 | 7,945 |
| 26161407400 | Washtenaw County | Superior Twp | 5,824 | 5,824 |
| 26161422900 | Washtenaw County | York Twp | 2,100 | 2,100 |
| 26161410600 | Washtenaw County | Ypsilanti | 2,598 | |
| 26161410700 | Washtenaw County | Ypsilanti | 1,220 | |
| 26161410800 | Washtenaw County | Ypsilanti | 1,725 | 5,543 |
| 26161412300 | Washtenaw County | Ypsilanti Twp | 3,039 | |
| 26161412100 | Washtenaw County | Ypsilanti Twp | 3,205 | |
| 26161410100 | Washtenaw County | Ypsilanti Twp | 3,060 | |
| 26161411900 | Washtenaw County | Ypsilanti Twp | 3,380 | |
| 26161412000 | Washtenaw County | Ypsilanti Twp | 4,232 | 16,916 |
| | **Washtenaw County** | | | **38,328** |
| 26163591501 | Wayne County | Brownstown Twp | 3,359 | 3,359 |
| 26163564900 | Wayne County | Canton Twp | 1,904 | 1,904 |
| 26163573701 | Wayne County | Dearborn | 1,890 | |
| 26163573702 | Wayne County | Dearborn | 6,642 | |
| 26163574000 | Wayne County | Dearborn | 5,879 | |
| 26163573500 | Wayne County | Dearborn | 4,455 | |
| 26163574100 | Wayne County | Dearborn | 4,399 | |
| 26163573300 | Wayne County | Dearborn | 4,229 | |
| 26163573600 | Wayne County | Dearborn | 6,173 | |
| 26163573800 | Wayne County | Dearborn | 5,230 | |
| 26163573900 | Wayne County | Dearborn | 5,252 | |
| 26163574300 | Wayne County | Dearborn | 3,401 | |
| 26163573400 | Wayne County | Dearborn | 3,616 | 51,166 |
| 26163572800 | Wayne County | Dearborn Heights | 5,034 | |
| 26163572100 | Wayne County | Dearborn Heights | 5,842 | |
| 26163572600 | Wayne County | Dearborn Heights | 4,984 | |
| 26163571800 | Wayne County | Dearborn Heights | 2,883 | |
| 26163572500 | Wayne County | Dearborn Heights | 1,857 | |

| Census Tract Number | County | Community | Tract Population | Total Community Population |
|---|---|---|---|---|
| 26163571600 | Wayne County | Dearborn Heights | 1,842 | |
| 26163572000 | Wayne County | Dearborn Heights | 2,039 | 24,481 |
| 26163504400 | Wayne County | Detroit | 1,567 | |
| 26163507300 | Wayne County | Detroit | 1,942 | |
| 26163507400 | Wayne County | Detroit | 2,160 | |
| 26163512900 | Wayne County | Detroit | 1,228 | |
| 26163516700 | Wayne County | Detroit | 3,194 | |
| 26163518400 | Wayne County | Detroit | 269 | |
| 26163538900 | Wayne County | Detroit | 3,419 | |
| 26163542200 | Wayne County | Detroit | 3,244 | |
| 26163542500 | Wayne County | Detroit | 2,663 | |
| 26163543500 | Wayne County | Detroit | 944 | |
| 26163543800 | Wayne County | Detroit | 777 | |
| 26163544100 | Wayne County | Detroit | 2,479 | |
| 26163545200 | Wayne County | Detroit | 2,515 | |
| 26163545800 | Wayne County | Detroit | 5,325 | |
| 26163545900 | Wayne County | Detroit | 4,000 | |
| 26163546200 | Wayne County | Detroit | 3,945 | |
| 26163546600 | Wayne County | Detroit | 2,027 | |
| 26163534500 | Wayne County | Detroit | 683 | |
| 26163534700 | Wayne County | Detroit | 3,423 | |
| 26163535600 | Wayne County | Detroit | 4,363 | |
| 26163536700 | Wayne County | Detroit | 956 | |
| 26163536800 | Wayne County | Detroit | 1,803 | |
| 26163537800 | Wayne County | Detroit | 1,446 | |
| 26163523800 | Wayne County | Detroit | 4,683 | |
| 26163524000 | Wayne County | Detroit | 3,312 | |
| 26163524100 | Wayne County | Detroit | 3,695 | |
| 26163525400 | Wayne County | Detroit | 2,369 | |
| 26163525700 | Wayne County | Detroit | 5,372 | |
| 26163526500 | Wayne County | Detroit | 1,821 | |
| 26163530300 | Wayne County | Detroit | 1,312 | |
| 26163531700 | Wayne County | Detroit | 1,553 | |
| 26163532600 | Wayne County | Detroit | 1,969 | |
| 26163532700 | Wayne County | Detroit | 614 | |
| 26163533200 | Wayne County | Detroit | 827 | |
| 26163533700 | Wayne County | Detroit | 899 | |
| 26163521900 | Wayne County | Detroit | 3,105 | |
| 26163516900 | Wayne County | Detroit | 2,052 | |

| Census Tract Number | County | Community | Tract Population | Total Community Population |
|---|---|---|---|---|
| 26163521400 | Wayne County | Detroit | 1,147 | |
| 26163522400 | Wayne County | Detroit | 972 | |
| 26163536900 | Wayne County | Detroit | 3,235 | |
| 26163537200 | Wayne County | Detroit | 592 | |
| 26163539600 | Wayne County | Detroit | 3,529 | |
| 26163542100 | Wayne County | Detroit | 4,104 | |
| 26163542300 | Wayne County | Detroit | 1,989 | |
| 26163544000 | Wayne County | Detroit | 2,634 | |
| 26163544300 | Wayne County | Detroit | 2,388 | |
| 26163545500 | Wayne County | Detroit | 4,002 | |
| 26163536500 | Wayne County | Detroit | 2,338 | |
| 26163537000 | Wayne County | Detroit | 3,399 | |
| 26163537300 | Wayne County | Detroit | 1,727 | |
| 26163537500 | Wayne County | Detroit | 3,064 | |
| 26163524800 | Wayne County | Detroit | 2,632 | |
| 26163526100 | Wayne County | Detroit | 3,196 | |
| 26163526300 | Wayne County | Detroit | 3,685 | |
| 26163534300 | Wayne County | Detroit | 1,477 | |
| 26163535100 | Wayne County | Detroit | 1,737 | |
| 26163535700 | Wayne County | Detroit | 1,122 | |
| 26163536100 | Wayne County | Detroit | 3,400 | |
| 26163540100 | Wayne County | Detroit | 2,938 | |
| 26163536200 | Wayne County | Detroit | 2,315 | |
| 26163533500 | Wayne County | Detroit | 1,195 | |
| 26163535500 | Wayne County | Detroit | 3,400 | |
| 26163539500 | Wayne County | Detroit | 3,283 | |
| 26163540300 | Wayne County | Detroit | 3,524 | |
| 26163540700 | Wayne County | Detroit | 3,536 | |
| 26163540900 | Wayne County | Detroit | 3,477 | |
| 26163542600 | Wayne County | Detroit | 3,731 | |
| 26163510600 | Wayne County | Detroit | 6,074 | |
| 26163510700 | Wayne County | Detroit | 2,006 | |
| 26163512200 | Wayne County | Detroit | 1,061 | |
| 26163512400 | Wayne County | Detroit | 1,097 | |
| 26163524700 | Wayne County | Detroit | 3,933 | |
| 26163525800 | Wayne County | Detroit | 2,046 | |
| 26163526200 | Wayne County | Detroit | 3,285 | |
| 26163530500 | Wayne County | Detroit | 1,815 | |
| 26163531100 | Wayne County | Detroit | 951 | |

| Census Tract Number | County | Community | Tract Population | Total Community Population |
|---|---|---|---|---|
| 26163531600 | Wayne County | Detroit | 1,855 | |
| 26163533300 | Wayne County | Detroit | 1,023 | |
| 26163534200 | Wayne County | Detroit | 3,398 | |
| 26163535200 | Wayne County | Detroit | 2,048 | |
| 26163536600 | Wayne County | Detroit | 2,483 | |
| 26163523200 | Wayne County | Detroit | 3,956 | |
| 26163513900 | Wayne County | Detroit | 1,879 | |
| 26163506200 | Wayne County | Detroit | 1,974 | |
| 26163506900 | Wayne County | Detroit | 3,571 | |
| 26163510400 | Wayne County | Detroit | 514 | |
| 26163514100 | Wayne County | Detroit | 2,585 | |
| 26163515600 | Wayne County | Detroit | 1,456 | |
| 26163516300 | Wayne County | Detroit | 720 | |
| 26163521100 | Wayne County | Detroit | 1,949 | |
| 26163521300 | Wayne County | Detroit | 889 | |
| 26163522200 | Wayne County | Detroit | 390 | |
| 26163530200 | Wayne County | Detroit | 4,298 | |
| 26163531300 | Wayne County | Detroit | 1,044 | |
| 26163531800 | Wayne County | Detroit | 1,281 | |
| 26163533000 | Wayne County | Detroit | 1,634 | |
| 26163542400 | Wayne County | Detroit | 2,763 | |
| 26163543400 | Wayne County | Detroit | 3,577 | |
| 26163543600 | Wayne County | Detroit | 1,084 | |
| 26163545100 | Wayne County | Detroit | 773 | |
| 26163500100 | Wayne County | Detroit | 3,369 | |
| 26163500900 | Wayne County | Detroit | 3,550 | |
| 26163501000 | Wayne County | Detroit | 3,094 | |
| 26163503500 | Wayne County | Detroit | 2,784 | |
| 26163504700 | Wayne County | Detroit | 1,714 | |
| 26163506500 | Wayne County | Detroit | 2,141 | |
| 26163507800 | Wayne County | Detroit | 456 | |
| 26163510500 | Wayne County | Detroit | 4,257 | |
| 26163511200 | Wayne County | Detroit | 1,204 | |
| 26163543200 | Wayne County | Detroit | 2,848 | |
| 26163545300 | Wayne County | Detroit | 2,078 | |
| 26163545400 | Wayne County | Detroit | 1,863 | |
| 26163545600 | Wayne County | Detroit | 5,503 | |
| 26163546700 | Wayne County | Detroit | 2,705 | |
| 26163512600 | Wayne County | Detroit | 1,179 | |

| Census Tract Number | County | Community | Tract Population | Total Community Population |
|---|---|---|---|---|
| 26163514300 | Wayne County | Detroit | 2,550 | |
| 26163541500 | Wayne County | Detroit | 4,185 | |
| 26163541700 | Wayne County | Detroit | 2,501 | |
| 26163512100 | Wayne County | Detroit | 2,707 | |
| 26163512300 | Wayne County | Detroit | 1,405 | |
| 26163535000 | Wayne County | Detroit | 2,741 | |
| 26163546800 | Wayne County | Detroit | 3,925 | |
| 26163525600 | Wayne County | Detroit | 1,551 | |
| 26163526000 | Wayne County | Detroit | 3,122 | |
| 26163533100 | Wayne County | Detroit | 1,427 | |
| 26163533400 | Wayne County | Detroit | 2,171 | |
| 26163535400 | Wayne County | Detroit | 1,435 | |
| 26163534600 | Wayne County | Detroit | 1,834 | |
| 26163537600 | Wayne County | Detroit | 3,655 | |
| 26163536400 | Wayne County | Detroit | 2,274 | |
| 26163540500 | Wayne County | Detroit | 3,356 | |
| 26163500700 | Wayne County | Detroit | 4,608 | |
| 26163540800 | Wayne County | Detroit | 2,440 | |
| 26163503900 | Wayne County | Detroit | 2,071 | |
| 26163540400 | Wayne County | Detroit | 2,883 | |
| 26163524300 | Wayne County | Detroit | 2,904 | |
| 26163503600 | Wayne County | Detroit | 1,431 | |
| 26163506100 | Wayne County | Detroit | 2,014 | |
| 26163531400 | Wayne County | Detroit | 1,206 | |
| 26163536300 | Wayne County | Detroit | 2,745 | |
| 26163538600 | Wayne County | Detroit | 5,558 | |
| 26163538700 | Wayne County | Detroit | 4,522 | |
| 26163538500 | Wayne County | Detroit | 4,658 | |
| 26163539000 | Wayne County | Detroit | 2,778 | |
| 26163513200 | Wayne County | Detroit | 1,668 | |
| 26163507500 | Wayne County | Detroit | 1,869 | |
| 26163508000 | Wayne County | Detroit | 1,273 | |
| 26163514500 | Wayne County | Detroit | 943 | |
| 26163515200 | Wayne County | Detroit | 1,951 | |
| 26163516100 | Wayne County | Detroit | 576 | |
| 26163516800 | Wayne County | Detroit | 948 | |
| 26163522000 | Wayne County | Detroit | 1,936 | |
| 26163522300 | Wayne County | Detroit | 1,266 | |
| 26163523300 | Wayne County | Detroit | 3,350 | |

| Census Tract Number | County | Community | Tract Population | Total Community Population |
|---|---|---|---|---|
| 26163543900 | Wayne County | Detroit | 782 | |
| 26163546500 | Wayne County | Detroit | 2,414 | |
| 26163541400 | Wayne County | Detroit | 2,893 | |
| 26163542700 | Wayne County | Detroit | 939 | |
| 26163542800 | Wayne County | Detroit | 2,800 | |
| 26163544200 | Wayne County | Detroit | 1,781 | |
| 26163545700 | Wayne County | Detroit | 3,399 | |
| 26163546900 | Wayne County | Detroit | 1,061 | |
| 26163513600 | Wayne County | Detroit | 1,379 | |
| 26163515300 | Wayne County | Detroit | 3,172 | |
| 26163516200 | Wayne County | Detroit | 645 | |
| 26163501500 | Wayne County | Detroit | 4,516 | |
| 26163501700 | Wayne County | Detroit | 1,888 | |
| 26163504000 | Wayne County | Detroit | 1,241 | |
| 26163504800 | Wayne County | Detroit | 591 | |
| 26163505100 | Wayne County | Detroit | 3,736 | |
| 26163506600 | Wayne County | Detroit | 3,423 | |
| 26163507100 | Wayne County | Detroit | 2,082 | |
| 26163531900 | Wayne County | Detroit | 904 | |
| 26163532200 | Wayne County | Detroit | 1,199 | |
| 26163533600 | Wayne County | Detroit | 1,674 | |
| 26163535300 | Wayne County | Detroit | 4,195 | |
| 26163500200 | Wayne County | Detroit | 2,834 | |
| 26163500300 | Wayne County | Detroit | 1,900 | |
| 26163500500 | Wayne County | Detroit | 1,289 | |
| 26163501100 | Wayne County | Detroit | 2,886 | |
| 26163501300 | Wayne County | Detroit | 3,011 | |
| 26163539700 | Wayne County | Detroit | 1,994 | |
| 26163530400 | Wayne County | Detroit | 1,045 | |
| 26163531500 | Wayne County | Detroit | 2,715 | |
| 26163532400 | Wayne County | Detroit | 1,412 | |
| 26163534100 | Wayne County | Detroit | 1,590 | |
| 26163534400 | Wayne County | Detroit | 1,718 | |
| 26163537100 | Wayne County | Detroit | 2,275 | |
| 26163507000 | Wayne County | Detroit | 2,956 | |
| 26163501600 | Wayne County | Detroit | 2,149 | |
| 26163506300 | Wayne County | Detroit | 1,792 | |
| 26163517500 | Wayne County | Detroit | 2,691 | |
| 26163518500 | Wayne County | Detroit | 833 | |

| Census Tract Number | County | Community | Tract Population | Total Community Population |
|---|---|---|---|---|
| 26163523100 | Wayne County | Detroit | 1,480 | |
| 26163524200 | Wayne County | Detroit | 5,379 | |
| 26163526400 | Wayne County | Detroit | 1,356 | |
| 26163530100 | Wayne County | Detroit | 2,171 | |
| 26163530800 | Wayne County | Detroit | 1,531 | |
| 26163500400 | Wayne County | Detroit | 1,052 | |
| 26163504100 | Wayne County | Detroit | 1,357 | |
| 26163500800 | Wayne County | Detroit | 3,179 | |
| 26163501900 | Wayne County | Detroit | 2,872 | |
| 26163502000 | Wayne County | Detroit | 2,076 | |
| 26163504300 | Wayne County | Detroit | 2,067 | |
| 26163516400 | Wayne County | Detroit | 855 | |
| 26163505000 | Wayne County | Detroit | 795 | |
| 26163506400 | Wayne County | Detroit | 2,015 | |
| 26163506700 | Wayne County | Detroit | 1,066 | |
| 26163507200 | Wayne County | Detroit | 1,091 | |
| 26163541000 | Wayne County | Detroit | 4,176 | |
| 26163541300 | Wayne County | Detroit | 2,872 | |
| 26163518600 | Wayne County | Detroit | 373 | |
| 26163537700 | Wayne County | Detroit | 3,083 | |
| 26163538300 | Wayne County | Detroit | 2,129 | |
| 26163539200 | Wayne County | Detroit | 5,542 | |
| 26163540600 | Wayne County | Detroit | 3,370 | |
| 26163539100 | Wayne County | Detroit | 1,764 | |
| 26163541800 | Wayne County | Detroit | 2,373 | |
| 26163503300 | Wayne County | Detroit | 3,508 | |
| 26163500600 | Wayne County | Detroit | 2,891 | |
| 26163504900 | Wayne County | Detroit | 3,486 | |
| 26163507900 | Wayne County | Detroit | 1,102 | |
| 26163516600 | Wayne County | Detroit | 2,534 | |
| 26163518800 | Wayne County | Detroit | 565 | |
| 26163520400 | Wayne County | Detroit | 1,941 | |
| 26163521500 | Wayne County | Detroit | 1,514 | |
| 26163522100 | Wayne County | Detroit | 662 | |
| 26163525500 | Wayne County | Detroit | 1,177 | |
| 26163505400 | Wayne County | Detroit | 2,412 | |
| 26163505500 | Wayne County | Detroit | 1,162 | |
| 26163508100 | Wayne County | Detroit | 1,252 | |
| 26163511000 | Wayne County | Detroit | 1,562 | |

| Census Tract Number | County | Community | Tract Population | Total Community Population |
|---|---|---|---|---|
| 26163511300 | Wayne County | Detroit | 2,514 | |
| 26163511400 | Wayne County | Detroit | 2,364 | |
| 26163513700 | Wayne County | Detroit | 3,616 | |
| 26163514200 | Wayne County | Detroit | 2,267 | |
| 26163515900 | Wayne County | Detroit | 1,340 | |
| 26163516000 | Wayne County | Detroit | 2,230 | |
| 26163539400 | Wayne County | Detroit | 4,070 | |
| 26163540200 | Wayne County | Detroit | 3,345 | |
| 26163541100 | Wayne County | Detroit | 2,359 | |
| 26163541200 | Wayne County | Detroit | 2,274 | |
| 26163543700 | Wayne County | Detroit | 2,620 | |
| 26163546100 | Wayne County | Detroit | 3,579 | |
| 26163521800 | Wayne County | Detroit | 1,625 | |
| 26163523400 | Wayne County | Detroit | 2,112 | |
| 26163524500 | Wayne County | Detroit | 113 | |
| 26163504200 | Wayne County | Detroit | 1,926 | |
| 26163501400 | Wayne County | Detroit | 3,258 | |
| 26163517300 | Wayne County | Detroit | 2,436 | |
| 26163518900 | Wayne County | Detroit | 1,855 | |
| 26163522500 | Wayne County | Detroit | 1,772 | |
| 26163511900 | Wayne County | Detroit | 1,369 | |
| 26163524900 | Wayne County | Detroit | 1,179 | |
| 26163525000 | Wayne County | Detroit | 632 | |
| 26163530900 | Wayne County | Detroit | 1,626 | |
| 26163527200 | Wayne County | Detroit | 649 | |
| 26163527300 | Wayne County | Detroit | 1,014 | |
| 26163533900 | Wayne County | Detroit | 2,799 | |
| 26163546300 | Wayne County | Detroit | 1,998 | |
| 26163546000 | Wayne County | Detroit | 3,086 | |
| 26163546400 | Wayne County | Detroit | 935 | |
| 26163501200 | Wayne County | Detroit | 1,648 | |
| 26163503100 | Wayne County | Detroit | 3,096 | |
| 26163503200 | Wayne County | Detroit | 2,453 | |
| 26163503400 | Wayne County | Detroit | 955 | |
| 26163505200 | Wayne County | Detroit | 2,961 | |
| 26163506800 | Wayne County | Detroit | 3,890 | 613,878 |
| 26163579600 | Wayne County | Ecorse | 2,739 | |
| 26163579500 | Wayne County | Ecorse | 1,751 | |
| 26163579700 | Wayne County | Ecorse | 3,062 | |

| Census Tract Number | County | Community | Tract Population | Total Community Population |
|---|---|---|---|---|
| 26163579800 | Wayne County | Ecorse | 1,880 | 9,432 |
| 26163569200 | Wayne County | Garden City | 2,458 | 2,458 |
| 26163552000 | Wayne County | Hamtramck | 3,298 | |
| 26163552300 | Wayne County | Hamtramck | 3,204 | |
| 26163552400 | Wayne County | Hamtramck | 2,842 | |
| 26163552100 | Wayne County | Hamtramck | 3,814 | |
| 26163552200 | Wayne County | Hamtramck | 3,709 | |
| 26163552800 | Wayne County | Hamtramck | 4,955 | 21,822 |
| 26163551400 | Wayne County | Harper Woods | 4,206 | |
| 26163551600 | Wayne County | Harper Woods | 3,592 | 7,798 |
| 26163553100 | Wayne County | Highland Park | 1,665 | |
| 26163553300 | Wayne County | Highland Park | 1,108 | |
| 26163553200 | Wayne County | Highland Park | 661 | |
| 26163553400 | Wayne County | Highland Park | 2,598 | |
| 26163553800 | Wayne County | Highland Park | 1,557 | |
| 26163553000 | Wayne County | Highland Park | 1,006 | |
| 26163553600 | Wayne County | Highland Park | 2,272 | 10,867 |
| 26163570400 | Wayne County | Inkster | 5,253 | |
| 26163570600 | Wayne County | Inkster | 2,273 | |
| 26163571000 | Wayne County | Inkster | 1,915 | |
| 26163570100 | Wayne County | Inkster | 4,311 | |
| 26163570800 | Wayne County | Inkster | 2,971 | |
| 26163570900 | Wayne County | Inkster | 1,902 | |
| 26163570500 | Wayne County | Inkster | 3,282 | |
| 26163570200 | Wayne County | Inkster | 2,613 | 24,520 |
| 26163577100 | Wayne County | Lincoln Park | 2,428 | |
| 26163577400 | Wayne County | Lincoln Park | 3,548 | |
| 26163577600 | Wayne County | Lincoln Park | 3,447 | |
| 26163578000 | Wayne County | Lincoln Park | 2,527 | |
| 26163577200 | Wayne County | Lincoln Park | 3,297 | |
| 26163577000 | Wayne County | Lincoln Park | 3,761 | |
| 26163577900 | Wayne County | Lincoln Park | 4,325 | |
| 26163577500 | Wayne County | Lincoln Park | 3,057 | |
| 26163577300 | Wayne County | Lincoln Park | 3,159 | 29,549 |
| 26163578600 | Wayne County | Melvindale | 5,246 | |
| 26163578500 | Wayne County | Melvindale | 5,102 | 10,348 |
| 26163555300 | Wayne County | Redford Twp | 3,107 | |
| 26163555100 | Wayne County | Redford Twp | 4,542 | |
| 26163554200 | Wayne County | Redford Twp | 3,245 | |

| Census Tract Number | County | Community | Tract Population | Total Community Population |
|---|---|---|---|---|
| 26163555400 | Wayne County | Redford Twp | 2,384 | |
| 26163554500 | Wayne County | Redford Twp | 2,725 | |
| 26163554100 | Wayne County | Redford Twp | 3,952 | 19,955 |
| 26163579300 | Wayne County | River Rouge | 2,396 | |
| 26163579100 | Wayne County | River Rouge | 1,570 | |
| 26163579200 | Wayne County | River Rouge | 3,536 | 7,502 |
| 26163586200 | Wayne County | Romulus | 7,123 | |
| 26163585500 | Wayne County | Romulus | 1,730 | |
| 26163585900 | Wayne County | Romulus | 2,920 | 11,773 |
| 26163582000 | Wayne County | Southgate | 3,235 | 3,235 |
| 26163584400 | Wayne County | Taylor | 3,111 | |
| 26163584600 | Wayne County | Taylor | 1,916 | |
| 26163584300 | Wayne County | Taylor | 1,871 | |
| 26163583900 | Wayne County | Taylor | 3,954 | |
| 26163583100 | Wayne County | Taylor | 3,515 | |
| 26163584800 | Wayne County | Taylor | 6,098 | |
| 26163584500 | Wayne County | Taylor | 2,662 | |
| 26163583200 | Wayne County | Taylor | 2,245 | 25,372 |
| 26163588100 | Wayne County | Van Buren Twp | 2,365 | 2,365 |
| 26163566500 | Wayne County | Wayne | 2,335 | |
| 26163566700 | Wayne County | Wayne | 4,147 | |
| 26163566400 | Wayne County | Wayne | 915 | |
| 26163566900 | Wayne County | Wayne | 4,925 | 12,322 |
| 26163568800 | Wayne County | Westland | 3,138 | |
| 26163568900 | Wayne County | Westland | 2,776 | |
| 26163568000 | Wayne County | Westland | 2,212 | |
| 26163565300 | Wayne County | Westland | 6,069 | |
| 26163567000 | Wayne County | Westland | 3,578 | |
| 26163568300 | Wayne County | Westland | 3,845 | |
| 26163568500 | Wayne County | Westland | 3,734 | |
| 26163567100 | Wayne County | Westland | 3,562 | 28,914 |
| 26163580700 | Wayne County | Wyandotte | 3,768 | 3,768 |
| | **Wayne County** | | | **926,788** |
| | **Southeast Michigan** | | | **1,361,858** |

APPENDIX C:

# Data Methods and Assumptions

This appendix describes the data, methodologies and assumptions used to calculate emissions reductions for all measures/ projects, as well as the uncertainty factor based on the methodology used.

## Buildings

To quantify emissions reductions from residential and non-residential building retrofits, the methodology compares a building's total energy use and resulting emissions before retrofits with its total energy use and emissions after retrofits.

Note that these retrofits include both energy efficiency improvements and switching from systems using fossil fuel energy to heat pumps that can use zero-emissions electricity. Because Southeast Michigan's energy use in buildings currently comes primarily from natural gas and electricity (as indicated by the 2019 data used for the SEMCOG GHG inventory), the formulas provided here estimate changes in energy consumption and emissions from these two energy sources to either air or ground source heat pumps.

### 1. Changes in Total Energy Use

In the formulas below, for the purposes of SEMCOG's Decarbonizing Buildings and Industry projects:

- The 'Energy Reduction %' was set to 50% to reflect a desired reduction in non-space conditioning energy consumption in these buildings by 50%.
- The 'Thermal Energy Reduction %' was set to 50% to reflect a reduction in space conditioning energy consumption by 50%; and,
- The COP (coefficient of performance) reflects the increase in efficiency of heat pumps relative to natural gas or electric systems.

#### For Electricity

To determine the impact of retrofits on buildings' **non-space conditioning electricity consumption** (i.e. energy used for appliances, lighting, plug load, etc.) we use the following formula:

$$Retrofit\ NonSpace\ Conditioning\ Electricity\ Use\ (MMBTU) = (1 - Energy\ Reduction\ \%)\ \times$$

$$Baseline\ NonSpace\ Conditioning\ Electricity\ Use\ (MMBTU)$$

To determine the impact of retrofits on buildings' **space-conditioning electricity consumption** (i.e. space heating and cooling and water heating) we use the following formula:

$$Retrofit\ Space\ Conditioning\ Electricity\ Use\ (MMBTU) = (1 - Thermal\ Energy\ Reduction\ \%) \times$$

$$Baseline\ Space\ Conditioning\ Natural\ Gas\ Use\ (MMBTU)/COP\ +$$

$$(1 - Energy\ Reduction\ \%) \times\ Electricity\ of\ Baseline\ Buildings\ (MMBTU)$$

The final, total electricity consumption after retrofits are complete is calculated as:

$$Retrofit\ Electricity\ Use\ (MMBTU) =\ Retrofit\ Space\ Conditioning\ Electricity\ Use\ (MMBTU)\ +$$

$$Retrofit\ NonSpace\ Conditioning\ Electricity\ Use\ (MMBTU)$$

**For Natural Gas**

To determine the impact of retrofits on buildings' **non-space conditioning natural gas consumption** (e.g. natural gas use for stoves) we use the following formula:

$$Retrofit\ NonSpace\ Conditioning\ Natural\ Gas\ Use\ (MMBTU) =$$

$$(1 - Energy\ Reduction\ \%) \times\ Baseline\ NonSpace\ Conditioning\ Natural\ Gas\ Use\ (MMBTU)$$

To determine the impact of retrofits on buildings' **space conditioning natural gas consumption** (e.g. space heating and hot water heating) we can generally use the following formula to show for example a *reduction* in natural gas use due to increased insulation:

$$Retrofit\ Space\ Conditioning\ Natural\ Gas\ Use\ (MMBTU) = (1 - Thermal\ Energy\ Reduction\ \%) \times$$

$$Baseline\ Space\ Conditioning\ Natural\ Gas\ Use\ (MMBTU)$$

However, in order to achieve significant emissions reductions, the projects for this PCAP will include completely removing natural gas systems for space conditioning, and replacing them with heat pumps. In this case the following formula is used:

$$Retrofit\ Space\ Conditioning\ Natural\ Gas\ Use\ (MMBTU) = 0$$

The final, total natural gas consumption after retrofits are complete is calculated as:

$$Retrofit\ Natural\ Gas\ Use\ (MMBTU) =\ Retrofit\ Space\ Conditioning\ Natural\ Gas\ Use\ (MMBTU)\ +$$

$$Retrofit\ NonSpace\ Conditioning\ Natural\ Gas\ Use\ (MMBTU)$$

## 2. Changes in Total Emissions

The resulting changes in emissions are calculated by applying the appropriate emissions factors to the change in energy consumption (both electricity and natural gas) calculated above:

$$Net\ Electricity\ Emissions\ (MT\ CO2e) = Baseline\ Electricity\ Use\ (MMBTU)\ - Retrofit\ Electricity\ Use\ (MMBTU)\ \times Emission\ Factor\ of\ the\ Grid\ (MT\ CO2e/MMBTU)$$

$$Net\ Natural\ Gas\ Emissions\ (MT\ CO2e) = Baseline\ Natural\ Gas\ Use\ (MMBTU)\ - Retrofit\ Natural\ Gas\ Use\ (MMBTU)\ \times Natural\ Gas\ Emission\ Factor\ (MT\ CO2e/MMBTU)$$

The final, total emissions reductions (MT CO2e) then are the sum of electricity and natural gas emissions.

$$Net\ Emission\ Reduction\ (MT\ CO2e) = Net\ Electricity\ Emissions\ (MT\ CO2e) + Net\ Natural\ Gas\ Emissions\ (MT\ CO2e)$$

## 3. Calculating Capital Costs

The capital costs of retrofitting buildings for the projects in this PCAP were assumed to consist of two elements. The first addresses the thermal envelope of the building, affecting the heating/cooling required to keep the building comfortable. The extent or 'depth' of the thermal retrofit dictates the cost of this action, such that the more the thermal envelope is improved, the greater the cost. The formulas for calculating retrofit capital costs for residential and non-residential buildings is as follows:

$$Residential\ Thermal\ Envelope\ Capital\ Cost\ (USD) = number\ of\ dwelling\ units\ \times\ Costs\ for\ Percent\ Energy\ Reduction\ (USD/unit)$$

$$NonResidential\ \ Thermal\ Envelope\ \ Capital\ Cost\ (USD) = floorspace\ retrofit\ \ \times\ Costs\ for\ Percent\ Energy\ Reduction\ (USD/sqft)$$

The second element addresses the equipment used to heat/cool the building. For these projects, it was assumed that natural gas furnaces or electric radiator heating would be replaced by either electric air source heat pumps or ground source heat pumps. Capital costs to make these replacements are calculated by multiplying the number of units being replaced by the cost per unit, as follows:

$$Space\ Conditioning\ Capital\ Cost\ (USD) = number\ of\ installed\ units\ \times\ unit\ cost\ (USD/unit)$$

### 4. Calculating Energy Costs/ Savings

Changing the fuel used to heat and cool buildings also results in a difference in ongoing energy costs when operating the buildings. Actions such as retrofitting the thermal envelope of the building will reduce energy consumption, reducing energy costs. The formula for calculating annual energy costs or savings that was used is shown here:

$$Annual\ Energy\ Cost\ (USD) =$$

$$Change\ in\ energy\ consumption\ by\ fuel\ (MMBTU)\ *\ Cost\ by\ fuel\ (USD/MMBTU)$$

### 5. Calculating Costs/ Savings per Ton of Emissions Avoided

The final cost / savings per metric ton of emissions avoided was calculated using the following formula:

*Cost/ Savings per MT of Emissions Avoided =*

*Capital Costs + (Annual Energy Cost/ Savings X Total Time) / Net Emission Reduction*

Calculating a cost/ savings per MT of emissions avoided allows SEMCOG to compare the cost-effectiveness of different actions to reduce emissions over a period of time (or the Total Time). For the purposes of this PCAP, the Total Time for each measure began when emissions reductions would first be realized and continue until 2050.

## Co-pollutants Reduction Calculations for Natural Gas

Eliminating natural gas combustion in buildings also reduces the presence of pollutants including carbon monoxide (CO), nitrogen oxides (NOx), sulfur dioxide (SO2), particulate matter (PM2.5), and volatile organic compounds (VOCs). Quantifying the reductions of these pollutants was done using emissions data from the EPA National Emissions Inventory (NEI). For each pollutant, its emission rate per MMBtu of natural gas consumed is calculated by dividing the total emissions of each co-pollutant by the total natural gas consumption, as shown in the formula:

$$Pollutant's\ Emission\ Rate\ by\ Type\ (metric\ tons/MMBtu) = \frac{Total\ Emissions\ of\ Pollutant\ (metric\ tons)}{Total\ Natural\ Gas\ Consumption\ (MMBtu)}$$

Subsequently, the reduction of the pollutant can be calculated by applying the reduction in natural gas consumption to the pollutants emission rate by type using this formula:

$$Reduction\ of\ Pollutant\ (metric\ tons) = Natural\ Gas\ Consumption\ Reduction\ (MMBtu) \times$$

$$Pollutant's\ Emission\ Rate\ by\ Type\ (metric\ tons/MMBtu)$$

In this formula Natural Gas Consumption Reduction represents the amount of the reduction in natural gas use due to the retrofit (in million British thermal units, or MMBtu).

Each Pollutant's Emission Rate by Type (metric tons/MMBtu) specifies the amount of pollutant emitted per unit of natural gas consumed. This rate varies by pollutant type and reflects the average emissions associated with the combustion of natural gas.

# Transportation

## Electric Vehicle Adoption Emissions Reduction

The calculation for Electric Vehicle (EV) adoption and its impact on emissions reduction involves several steps, each leveraging specific data points to quantify the net emissions reduction achieved by transitioning from conventional vehicles to EVs. Here's a detailed explanation of the process, and relevant equations:

### 1. Calculating Total Distance (VMT) that will Shift to EVs

This step calculates the total miles that will be transitioned by type of vehicle from gasoline or diesel to electric vehicles:

$$VMT\ to\ shift\ (miles) = Number\ of\ Vehicles\ to\ shift \times Annual\ VMT\ per\ vehicle\ (miles)$$

This equation multiplies the number of vehicles by type being transitioned to EVs by the annual vehicle miles traveled (VMT) per vehicle, giving the total miles that will now be covered by EVs instead of conventional vehicles.

### 2. Calculating Gross Emissions Reductions

This step calculates the gross emissions reduction, which is the total potential reduction in emissions *if* the shifted VMT were no longer contributing to greenhouse gas (GHG) emissions from conventional vehicle tailpipes.

$$Gross\ Emissions\ Reduction\ (MT\ CO2e) =$$

$$VMT\ to\ shift\ (miles) \times Emission\ Factor\ (MT\ CO2e/miles)$$

The emission factor (MT CO2e/mile) represents the amount of CO2e emissions produced per mile by conventional vehicles. Multiplying this factor by the VMT to shift gives the total emissions that could be avoided by switching to EVs.

### 3. Calculating Emissions from EVs

This step calculates the emissions from the electricity consumed by EVs for the shifted VMT. It considers the average electricity consumption by type of EV and the emission factor for electricity generation.

$$Emissions\ EVs\ (MT\ CO2e) = VMT\ to\ shift\ by\ type\ of\ EV\ (miles) \times$$

$$Average\ Electricity\ consumption\ by\ Type\ of\ EV\ (GWh/miles) \times$$

$$Emission\ Factor\ Electricity\ (MT\ CO2e/GWh)$$

This equation takes into account the average electricity consumption (GWh/mile) by the type of EV for the shifted VMT and multiplies it by the emission factor for electricity (MT CO2e/GWh). If the vehicles are being charged using grid electricity, the emission factor used is that of the grid. If the vehicles are charged using renewable power, then the emissions factor used will reflect that no emissions are generated from charging these vehicles.

### 4. Calculating Net Emissions Reduction

The net emissions reduction is the difference between the gross emissions reduction (potential emissions savings from not using conventional vehicles) and the emissions attributable to the electricity used by EVs.

$$Net\ Emission\ Reduction\ (MT\ CO2e) =$$

$$Gross\ Emissions\ Reduction\ (MT\ CO2e) - Emissions\ EVs\ (MT\ CO2e)$$

This final step provides the overall emissions reduction benefit of transitioning to EVs, taking into account the emissions from electricity generation for EV charging.

## Electric Vehicle Adoption Costs and Savings

The net costs/ savings associated with switching to an electric vehicle is calculated by adding the purchase cost to the operations (or fuel) costs/ savings and maintenance costs/ savings for the lifetime of the vehicle. This is shown in the two steps below.

### 1. Calculating Capital Costs

The capital cost reflects the investment needed to purchase a zero-emissions vehicle(s). It is calculated using the following formula:

$$Capital\ Cost\ (USD) = \ Number\ of\ Vehicles\ *\ Cost\ \ (USD/vehicle)$$

In most cases in this PCAP, the capital costs presented are 'incremental capital costs'. This means that they represent the difference between what would be paid for the traditional option (e.g. an ICE vehicle) and what will be paid for the new option (an EV). The column labels in the PCAP indicate when the costs provided are incremental versus total.

### 2. Calculating Operation and Maintenance Costs

Vehicle operation costs include the costs of fuel or charging. Maintenance costs include the costs of vehicle upkeep and servicing. These two values are calculated using the formulas below. If the calculation is being made for more than one vehicle, the Vehicle Miles Traveled and the Energy Consumed must be the total values for all the vehicles being considered:

$$Maintenance\ Cost\ (USD) = \ Vehicle\ Miles\ Traveled\ (miles)\ *\ Cost\ \ (USD/mile)$$

$$Operation\ Cost\ (USD) = Energy\ Consumed\ (MMBTU)\ *\ Cost\ \ (USD/MMBTU)$$

## Mode shift Emissions Reduction

The calculation for mode shift begins with estimating the reduction in vehicle miles traveled (VMT) as a result of shifting transportation modes from personal gasoline-powered vehicles to alternative modes such as public transit, biking, walking, or electric vehicles.

### 1. Calculating VMT Reductions

The formula provided here calculates the total reduction in distance driven that is attributable to the mode shift, and is expressed in millions of VMT:

$$VMT\ reduction\ (million\ VMT) = Total\ VMT\ with\ Gasoline\ (million\ VMT) -$$

$$(Total\ VMT\ with\ Gasoline\ (million\ VMT) \times \frac{Share\ of\ VMT\ by\ auto\ Baseline\ (\%)}{Share\ of\ VMT\ by\ auto\ After\ action\ (\%)})$$

**Total VMT with Gasoline (Million VMT):** This represents the total miles traveled by gasoline-powered vehicles before any interventions to encourage a mode shift. It serves as the baseline against which the reduction in VMT is measured.

**Share of VMT by auto Baseline (%):** This is the baseline share of total VMT traveled by gasoline-powered vehicles before any interventions to encourage a mode shift.

**Share of VMT by auto After action (%):** This percentage reflects the projected share of total VMT that is traveled by gasoline-powered vehicles after interventions have been implemented to promote a mode shift.

The equation subtracts the adjusted VMT (considering the action-induced change in the share of VMT by auto) from the baseline total VMT with gasoline to calculate the reduction in VMT due to the mode shift, quantifying how much vehicle travel has been avoided by shifting away from gasoline-powered vehicles toward more sustainable modes of transportation.

### 2. Calculating Emission Reductions

The emission reductions from a transportation mode shift are calculated by multiplying the reduction in vehicle miles traveled (VMT) by the emission factor of the vehicle fuel being used (e.g. gasoline), yielding the total emissions avoided in metric tons of CO2 equivalent (MT CO2e). The formula is as follows:

$$Emission\ Reduction\ (MT\ CO2e) =$$

$$VMT\ reduction\ (Million\ VMT) \times Emission\ factor\ (MT\ CO2e\ /\ Million\ VMT)$$

This equation translates VMT reduction into greenhouse gas emissions savings, providing a clear measure of the environmental benefits of shifting away from internal combustion engine (ICE) vehicles towards more sustainable transportation modes.

### 3. Calculating Capital Costs

For this analysis, the capital costs to support the desired transportation mode shift are calculated by multiplying the miles of infrastructure required by the cost per mile. The formula is as follows:

$$Capital\ Cost\ (USD) =$$

$$Miles\ of\ infrastructure\ (mile)\ \times\ Costs\ per\ mile\ (USD/mile)$$

Note that other other costs such as education and safety programs, as well as savings such as avoided health care costs (e.g. from conditions arising from inactivity) could also be incorporated into a 'total' assessment of financial costs and benefits; however these values were not included in the calculations made for this PCAP.

## Co-pollutants Reduction Calculations

For the transportation sector, the calculation of emissions reductions for co-pollutants entails analyzing the decrease in vehicle miles traveled (VMT) and applying designated emissions rates for various vehicle types. The co-pollutants in focus—Total Hydrocarbons (HC), Carbon Monoxide (CO), Nitrogen Oxides (NOx), and Particulate Matter (PM2.5)—are evaluated for their emissions impact. The formula to calculate the emissions reductions for each co-pollutant is given by:

$$Emissions\ Reductions\ per\ co-pollutant\ (metric\ ton) =$$

$$VMT\ reduction\ (miles)\ \times\ Emissions\ Rates\ per\ Vehicle\ Type\ (metric\ ton/mile)$$

In this context:

VMT reduction (miles) denotes the decrease in vehicle miles traveled, achieved through increased adoption of electric vehicles (EVs), greater use of public transit, and encouragement of biking or walking.

Emissions Rates per Vehicle Type (metric ton/mile) specifies the rate at which each vehicle type emits HC, CO, NOx, and PM2.5 per mile. These rates vary by vehicle type and fuel used, reflecting the different contributions to air pollution.

# Energy Systems

To accurately assess the emissions reduction attributable to renewable installations, the methodology uses two key 'factors':

1. A 'capacity factor' for each type of technology, and for each State, as provided by NREL. These factors estimate the energy generation potential of solar and wind installations based on geographical and climatic variations that will affect wind patterns and solar irradiance and consequently also, energy production.
2. The 'grid emissions factor' from the EPA eGRID database. This factor represents the average emissions intensity of electricity generation and distribution on the region's electricity grid. This provides a baseline against which the impact of renewable-generated electricity can be measured. Additionally, projections of emission factors based on Michigan's Clean Energy targets are used to anticipate the grid's future carbon intensity.

## 1. Calculating Annual Generation

The annual electricity generation from installed renewable systems is calculated using the formula:

$$Annual\ Generation\ (GWh) = Installed\ Capacity\ (GWh) \times 8760 \times Capacity\ Factor$$

This equation multiplies the installed capacity (in gigawatt-hours, GWh) by the total number of hours in a year (8760) and the capacity factor, providing an estimate of the total energy produced by solar installations annually.

## 2. Calculating Emissions Reductions

The reduction in emissions resulting from the generated renewable electricity is quantified as follows:

$$Emissions\ Reduction\ (MT\ CO2e) = Emission\ Factor\ (MT\ CO2e/GWh) \times Annual\ Generation\ (GWh)$$

This calculation applies the emission factor (in metric tons of CO2 equivalent per gigawatt-hour, or MT CO2e/GWh) to the annual generation from renewable energy installations, estimating the total emissions avoided by displacing grid electricity with renewable energy.

## 3. Calculating Capital Costs

The capital costs of renewable energy depend on the installed capacity and the technology. The formulas for calculating renewable energy capital costs are as follows:

$$Renewable\ Energy\ Capital\ Cost\ (USD) = Generation\ Capacity\ (kW)\ \times\ Costs\ (USD/kw)$$

## 4. Calculating Energy Costs

In cases such as rooftop solar, the amount of electricity a customer requires from the grid will be reduced by the amount they generate from their solar system. This translates into lower utility bills for the customer. The formula for calculating these energy savings is a follows:

$$Energy\ Cost\ (USD) =$$

$$Change\ in\ energy\ consumption\ by\ fuel\ (MMBTU)\ *\ Cost\ by\ fuel\ (USD/MMBTU)$$

# Restore Landscapes and Sequester Carbon

The methodology for calculating carbon sequestration from green roofs and tree planting initiatives incorporates emission sequestration intensities from Aerosol and Air Quality Research and i-Tree respectively. These sources allow us to align with the physical characteristics of the trees and vegetation being planted.

## Emissions Reduction

The emissions reduction is quantified by calculating the carbon sequestration potential of the vegetation at maturity. This calculation takes into account the area covered by the vegetation once the trees and plants have reached their full growth potential, as well as the carbon sequestration factor, which represents the amount of carbon dioxide (CO2) that can be absorbed per unit roof area or per tree. The formulas to estimate the emissions reduction in metric tons of CO2 equivalent (MT CO2e) are as follows:

## 1. Calculating Sequestration from Tree Planting

$$Carbon\ Sequestered\ (MT\ CO2e) = number\ of\ trees \times Carbon\ Sequestration\ Factor\ (MT\ CO2e/tree)$$

In this formula:

Carbon Sequestration Factor (MT CO2e/tree) indicates the amount of CO2 that can be sequestered per tree per year, reflecting the capacity of the trees to absorb CO2 from the atmosphere.

## 2. Calculating Sequestration from Green Roofs

$$Emissions\ Reduction\ (MT\ CO2e) =$$

$$area\ for\ roof\ (sqft) \times Carbon\ Sequestration\ Factor\ (MT\ CO2e/sqft)$$

In this formula, the Carbon Sequestration Factor (MT CO2e/sqft) indicates the amount of CO2 that can be sequestered per square foot of roof area per year, reflecting the capacity of the roofs to absorb CO2 from the atmosphere.

# Data Sources

This table describes the data and assumptions used for the calculations outlined above, and their sources.

Table C-1:
**Data Sources**

| Source | Data Set |
|---|---|
| Federal Highway Administration | Vehicle Miles Traveled (VMT) data by vehicle type[52] |
| NREL's BC Transit Fuel Cell Bus Project | Alternative fuel vehicle consumption metrics[53] |
| Replica | Detailed mode-specific transportation data, including trip numbers, lengths, and occupancy rates by county[54] |
| U.S. Department of Energy's resources, Alternatives Fuel Data Center and 2023 Fuel Economy Guide | Vehicle mileage and fuel consumption rates[55] |
| American Council for an Energy-Efficient Economy and average vehicle emissions rates from the U.S. Department of Transportation | Heavy-duty vehicle fuel consumption[56] |
| United States Department of Transportation, National Transportation Statistics | Estimated National Average Vehicle Emissions Rates per Vehicle by Vehicle Type using Gasoline and Diesel[57] |
| U.S. Energy Information Administration Annual Energy Outlook 2023 | Residential, Commercial and Transportation Energy prices[58] |

[52] Federal Highway Administration. "Vehicle Miles Traveled (VMT) data by vehicle type." Policy Information, Statistics 2020. https://www.fhwa.dot.gov/policyinformation/statistics/2020/.

[53] National Renewable Energy Laboratory. "BC Transit Fuel Cell Bus Project: Evaluation Results." https://www.nrel.gov/docs/fy14osti/60603.pdf.

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[55] U.S. Department of Energy. "2023 Fuel Economy Guide." Published January 2024. https://fueleconomy.gov/feg/pdfs/guides/FEG2023.pdf.

[56] Nadel, Steven, and Eric Junga. "Electrifying Trucks: From Delivery Vans to Buses to 18-Wheelers." An ACEEE White Paper, January 2020. https://www.aceee.org/sites/default/files/pdfs/electric_trucks_1.pdf.

[57] United States Department of Transportation. "Estimated National Average Vehicle Emissions Rates per Vehicle by Vehicle Type using Gasoline and Diesel." National Transportation Statistics. https://www.bts.gov/product/national-transportation-statistics.

[58] U.S. Energy Information Administration. “Annual Energy Outlook 2023 - Table 3 Energy Prices by Sector and Source”. https://www.eia.gov/outlooks/aeo/data/browser/#/?id=3-AEO2023&sourcekey=0

| Source | Data Set |
|---|---|
| California HVIP | Bus and Heavy Duty Vehicle capital and O&M costs[59] |
| International Council on Clean Transportation, Argonne National Laboratory and American Automobile Association | Light Duty Vehicle capital and O&M costs[606162] |
| Portland State University Cost Analysis of Bicycle Facilities | Capital Cost of active transportation infrastructure[63] |
| Energy Information Administration (EIA) forms 861 and 176 | Electricity and natural gas consumption data for both residential and non-residential buildings[6465] |
| US Census Bureau | Dwelling units by building type[66] |
| Replica | Non-residential building floorspace |
| National Renewable Energy Laboratory's (NREL) ResStock and ComStock databases | Residential and commercial buildings' energy use by type and end-use |
| EPA National Emissions Inventory (NEI) | Co-pollutants emissions by Natural gas combustion in residential and commercial/ institutional buildings[67] |

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[66] U.S. Census Bureau. "Population and Housing Unit Estimates Datasets." https://www.census.gov/programs-surveys/popest/data/data-sets.html.

[67] Environmental Protection Agency. "2020 National Emissions Inventory (NEI) Data." https://www.epa.gov/air-emissions-inventories/2020-national-emissions-inventory-nei-data.

| Source | Data Set |
|---|---|
| U.S. Energy Information Administration 2023 Building Sector Appliance and Equipment Costs and Efficiencies | Residential and commercial heat pump capital costs[68] |
| Environmental Protection Agency's (EPA) inventory tool | eGRID electricity and fossil fuel emission factors[69] |
| NREL Rooftop Solar Photovoltaic Technical Potential | Energy production potential of solar rooftop installations[70] |
| State of Michigan, Clean Energy Future Plan, Senate Bills 271, 273, 277, 502 and 519 | Electricity Grid Emission Factor projections |
| Pembina Institute | Residential and Non-residential Building Envelope Retrofit Incremental Costs[71] |
| NREL System Advisory Model (SAM) | Capacity Factor for Photovoltaic Plants and Wind Farms[72] |
| NREL 2021 Electricity Annual Technology Baseline | Solar and Wind Renewable Electricity Production Capacity Capital Costs[73] |
| i-Tree Tools | Tree carbon sequestration potential[74] |
| Aerosol and Air Quality Research | Green roof carbon sequestration potential[75] |

[68] U.S. Energy Information Administration. “Building Sector Appliance and Equipment Costs and Efficiencies, 2023”. https://www.eia.gov/analysis/studies/buildings/equipcosts/

[69] Environmental Protection Agency. "Emissions & Generation Resource Integrated Database (eGRID)." https://www.epa.gov/egrid.

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## Uncertainty

The quantification of GHG emissions is largely the result of applying emissions factors, as measured in metric tons per unit of activity, to an estimated amount of activity, as measured in MMBTU, kWhs, vehicle miles traveled, etc. Different methodologies and assumptions used in determining these emissions factors can introduce uncertainty into the process. To mitigate this, when possible we have used emission factors derived from EPA tools and calculations, ensuring that our calculations align with EPA data and methodologies.

The projected transformation of the modeled activity also introduces uncertainties to the calculations. An assumption that crosses all action is the rate of adoption of various technologies or behaviors. We assume uniform adoption rates for zero emission vehicles (ZEVs), building retrofits, renewable energy, etc, which may not align with real-world market dynamics, consumer behavior, or policy shifts. The projected actions also simplifies the logistical and technical challenges involved in its deployment, such as spatial planning, required workforce, materials and electrical grid impacts. Furthermore, the methodology might not accurately capture the dynamic effects on emissions one action has on another action, for example, overlooking how increased use of one mode (e.g., biking) affects others (e.g., public transit). These technical limitations underscore the need for cautious interpretation of projected emissions reductions, highlighting the complexity of decarbonization.

Additionally, aggregating or averaging, such as the application of uniform capacity factors across counties, can create uncertainty. In reality local variations in rooftop orientations would allow for different levels of energy generation.

Finally when dealing with natural working lands and green infrastructure, the methodologies may not fully account for the variability in tree species' survival rates and carbon sequestration capacities or the long-term maintenance and potential risks to planted trees. Additionally, assumptions of linear growth and sequestration rates do not accurately reflect the dynamic growth patterns of trees. The potential indirect effects on local ecosystems and the lack of a robust framework for verification and ongoing monitoring of sequestration outcomes also pose challenges.

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