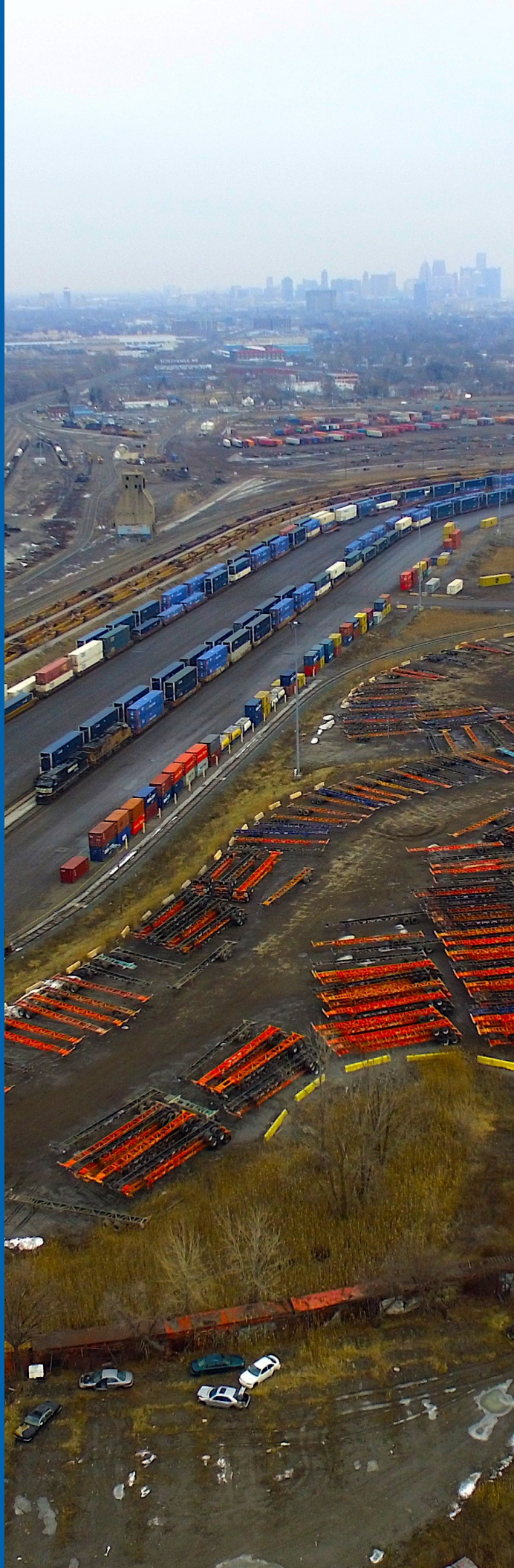
BASELINE HEALTH IMPACT ASSESSMENT FOR THE GORDIE HOWE INTERNATIONAL BRIDGE PROJECT

FULL REPORT

Health Impact Assessment

April 2019



Acknowledgements

Gordie Howe International Bridge Health Impact Assessment Team

Angela G. Reyes, Detroit Hispanic Development Corporation
Amy Schulz, University of Michigan School of Public Health
Natalie Sampson, University of Michigan Dearborn College of Education, Health & Human Services
Simone Sagovac, Southwest Detroit Community Benefits Coalition
Kristina Rice, University of Michigan School of Public Health
Graciela Mentz, University of Michigan Anesthesiology Department
Ricardo deMajo, University of Michigan School of Public Health
Bridget Vial, Detroit Hispanic Development Corporation, 2016-2017 and 2018 Interview Teams
Cindy Gamboa, Detroit Hispanic Development Corporation, and 2018 Interview Team

2016-2017 Survey Interviewing Team

Adriana Zuniga
Candida Leon-Torres
Janine Hussein
Lauren Thomas
Maria Avila
Marina Chavez
Marycruz Gutierrez
Nicole Bowman
Ramon Ramirez
Rita Ramirez
Rosalinda Sanchez
Sierra Ayers
Teia McGahey

2018 Survey Interviewing Team

Alejandra Enriquez
Brenda Quintero
Claudia Enriquez
Cathy Gamboa
Candida Leon-Torres
Dominique Leon
Holly Wood
Marina Chavez
Valeria Cossyleon

Translations

Kevin Casillas
Franco Gamero
Justin Hickley

In addition, we wish to thank the following groups: the Southwest Detroit Community Benefits Coalition Board, the Gordie Howe International Bridge Community Advisory Group, and the Resident Engagement Committee.

The 2016-2017 Bridge to a Healthy Community Survey was funded by the Fred A. and Barbara M. Erb Family Foundation, the Kellogg Foundation, the University of Michigan-Dearborn's Office of Metropolitan Impact, with additional support from the Ford Foundation and the Detroit Hispanic Development Corporation.

The 2018 Gordie Howe International Bridge HIA was funded by the Michigan Department of Health and Human Services and the Michigan Health Endowment Fund, with additional support from Community Action to Promote Healthy Environments (National Institute of Environmental Health Sciences #RO1ES022616).

Thank you especially to each family who gave their time to participate in the survey on behalf of better understanding the health of the community. All information from the surveys is anonymous.

October 30, 2019

Dear Southwest Detroit Partners,

At the Detroit Health Department, we know that healthy environments support healthy lives. This report reflects the incredibly hard work of the Southwest Detroit community and partners who have collaborated over the past decade to promote a healthy space for residents to call home.

True to the spirit of collaboration that led to the execution of a City-State Agreement, this assessment was completed through a community-driven process. This report is the first of three assessments that will span pre-construction, construction, and operation phases of the Gordie Howe International Bridge.

We look forward to your continued engagement as we carry out this important work together.

Sincerely,

Denise Fair, MPH, FACHE
Chief Public Health Officer

This page intentionally left blank

Contents

Figures

TABLES

1. Purpose

This Report on the Baseline Health Impact Assessment of the Gordie Howe International Bridge Project (henceforth Baseline HIA Report) describes findings from a baseline health assessment conducted with Detroit residents in the area in which the Gordie Howe International Bridge (GHIB) is to be built. The survey was developed by a partnership between the Detroit Hispanic Development Corporation (DHDC), the Southwest Detroit Community Benefits Coalition (SW Detroit CBC), and the University of Michigan's School of Public Health (UM SPH), the University of Michigan-Dearborn's College of Education, Health and Human Services (UM Dearborn). It is one component of a 10-year initiative funded by the State of Michigan and managed by the Detroit Health Department, designed to assess the environmental and health impacts of the new GHIB. The overarching goal of the broader initiative is to address community concerns related to the GHIB by documenting existing air quality and health conditions, tracking air quality and health over time, and identifying potential strategies for mitigating adverse health impacts experienced by local residents that might be associated with the GHIB.

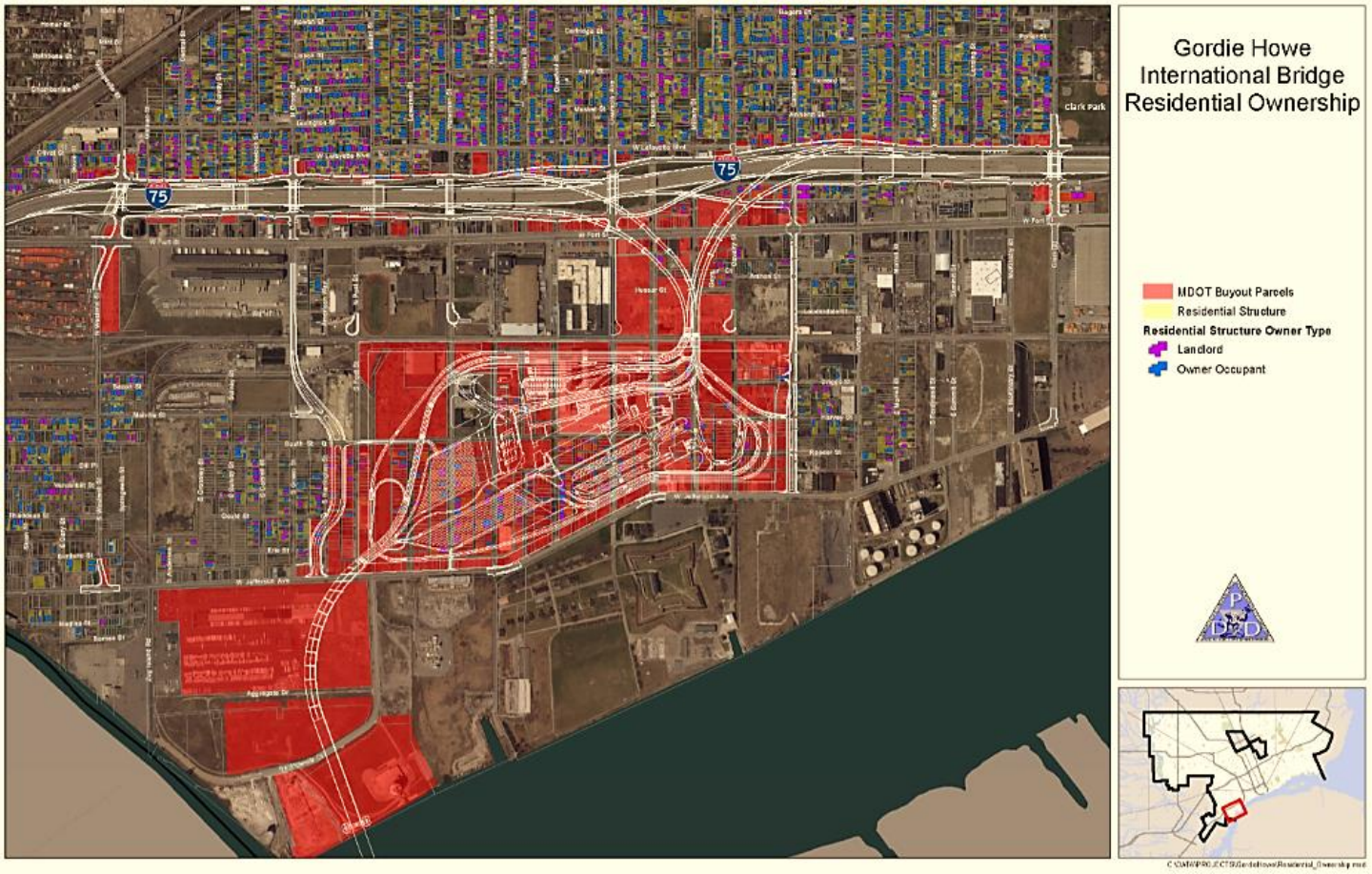
The Baseline HIA Report begins with a brief description of the community affected by the GHIB and the structure and process of community engagement relevant to the HIA. It includes a detailed description of methodology and results from two community surveys, one conducted 2016-2017, and a second complementary survey conducted in 2018 to collect information from residents about current (baseline) health status, identify resident concerns, and elicit resident input on potential strategies for mitigating adverse impacts that might associated with bridge construction and operations. Results from the community survey are supplemented with vital statistics and Behavioral Risk Factor Surveillance System (BRFSS) data for Detroit and the state of Michigan. The report closes with recommendations for actions that can be taken to reduce potential adverse health effects associated with the construction and operation of the GHIB, informed by this baseline analysis and discussions with community residents.

2. Southwest Detroit & the Gordie Howe International Bridge Community Benefits Agreement

2.1 Delray History and Population

The GHIB is currently under construction in the Delray community in Southwest Detroit, Michigan. Delray has historically been heavily industrialized,[1] with current area industries including the Detroit Wastewater Treatment Plant, which opened in 1939, US Steel and DTE, located on Zug Island immediately adjacent to Delray. Several rail lines, large highways and heavily trafficked roadways converge in the area, including I-75, which was built through the neighborhood in the 1950s and 1960s, and intermodal facilities are located in the area. Following the economic recession in the late 2000s many businesses moved out of the area.[2] Delray's population declined from an estimated 2,800 in 2000,[3] to 1,500 in 2016.[4] Based on data from the American Community Survey (2012-2016), Delray is 46.96% Hispanic, 28.62% non-Hispanic White, 23.79% non-Hispanic Black, and 0.63% non-Hispanic other.[5]

Figure 1: Gordie Howe International Bridge Footprint and Residential Ownership.[6]



In addition to the Delray community, in which the GHIB will be located, adjacent communities are likely to be affected by bridge construction and operations, and by new industrial uses in the immediate area drawn by the GHIB. Specifically, the Springwells community is a densely populated residential community located immediately north of I-75, the freeway that will be linked to Canada by the GHIB. This residential area is home to many families and has among the highest proportions of children under the age of 5 in the Detroit Metropolitan Area.[7] [8] Young children are particularly susceptible to adverse health effects of environmental exposures such as air pollution.[9] [10] [11] [12] Also located in the immediate area is the vibrant district known as Mexicantown, which houses many local businesses and Clark Park.

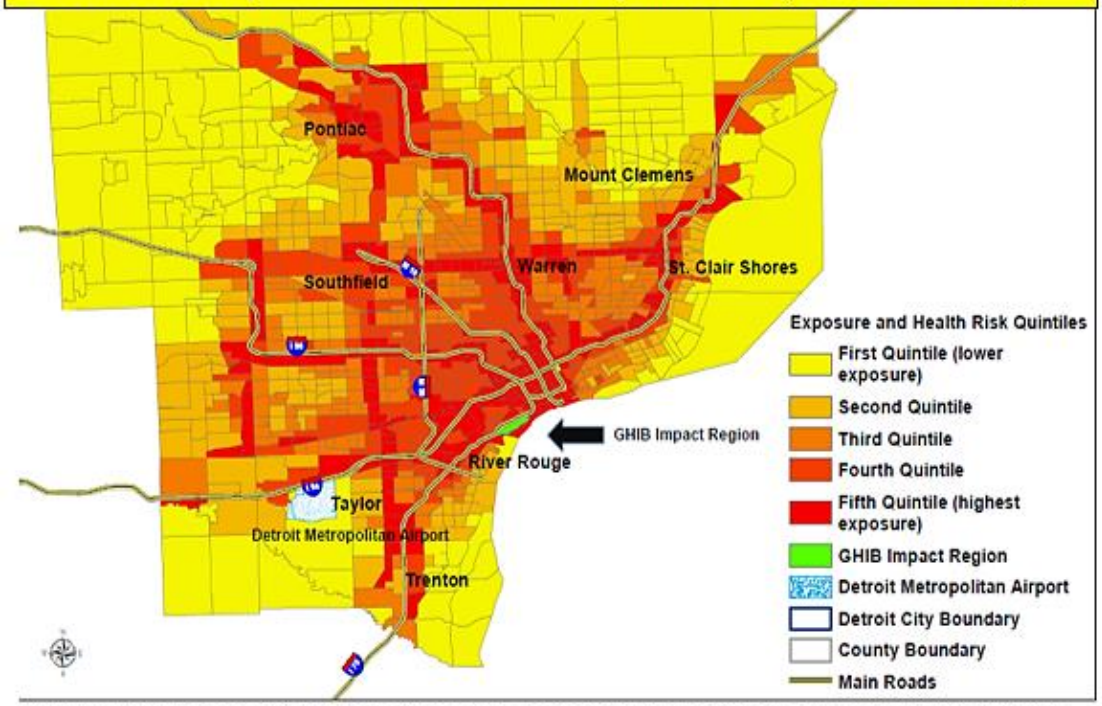
2.2 SW Detroit Community Benefits Coalition

In 2008, in response to proposals to build a bridge in southwest Detroit, residents formed the Southwest Detroit Community Benefits Coalition (henceforth SW Detroit CBC). A community-initiated organization with an elected community board that represents hundreds of residents and other community stakeholders, the SW Detroit CBC has worked for over a decade to identify and advocate for mutually beneficial development in the community hosting the new international border crossing. The Michigan Department of Transportation (MDOT) conducted the Final Environmental Impact Statement (FEIS) for what would become the GHIB (then called the DRIC), published in 2008. The FEIS estimated that border truck traffic would increase and that a majority would use the new bridge once completed, shifting from the Ambassador Bridge or the tunnel. Basing their conclusion on regional air quality, rather than changes in air quality in neighborhoods proximate to the new bridge, the FIES concluded that regional air quality would improve. This conclusion was based on the dual assumptions that there would be an overall traffic increase of 2% as more traffic was attracted to the region, and that this would be offset by the vehicle hours travelled, which was estimated to decline faster than the vehicle miles travel would increase, resulting in an overall reduction in regional congestion.[13]

In 2010, Southeast Michigan Council of Governments (SEMCOG) published the DRIC Comprehensive TR Study. This study of the new bridge predated its naming as the GHIB, and estimated that the bridge would become operational by 2016. This report assumed 2.7 million commercial vehicles would use the bridge in its inaugural year, increasing to 3.9 million in 2025, 4.9 million by 2035, and 7.0 million by 2060.[14]

Despite MDOT's expectation of improved regional air quality following construction of the GHIB, residents of SW Detroit, particularly in Delray, have had persistent concerns about the localized impacts on residents. These concerns are informed by multiple existing emission sources, including industrial and other transportation sources, and the concentration of increased international trade impacts associated with the bridge in local neighborhoods. Together, these multiple sources create an additive or cumulative threat to environmental quality and its impacts on human health. **Figure 2**, created by Community Action to Promote Healthy Environments (CAPHE),[15] illustrates that the GHIB Impact Area, highlighted in green and with a black arrow pointing to it, currently experiences cumulative air pollutants and associated health risks that are among the highest in the tri-county (Wayne, Oakland and Macomb Counties) area. In addition to health concerns, residents of the area selected for the GHIB expressed concern about implications for property values and relocation options. Property of residents living in the footprint of the GHIB has been purchased on the basis of eminent domain. In contrast, nearby

Figure 2: Diesel Particulate Matter (PM) exposure, cancer and respiratory risk attributable to air pollution in the Detroit Metropolitan Area (Schulz et al. 2016)



Cumulative impact polygons (CI) include: residential areas, child care facilities, health care facilities, schools and playgrounds. Exposure and Health risk include: 2011 NATA estimates of respiratory risk, cancer risk and diesel PM (non-cancer) concentration.

residents – some immediately adjacent to the bridge – whose homes did not fall under eminent domain expressed concern about rapidly declining home values and the inability to sell their devalued homes at a price that would enable them to afford to relocate to a comparable home away from the adverse impacts of the GHIB.

The SW Detroit CBC was formed to address resident concerns about the potential adverse impacts to quality of life and health due to the GHIB. Toward that end, the SW Detroit CBC conducted community-based research to document environmental health and safety concerns, meeting repeatedly since 2008 with community leaders, local and state decision makers and others to share their priorities for increased protections for residents. For example, the SW Detroit CBC collaborated with academic and community partners to: conduct community truck counts on residential streets that also serve as truck routes through the neighborhood; monitor air quality at homes near I-75 and the eventual customs crossing area; and conduct scientifically-grounded household health surveys. Findings from these efforts have been shared widely through community meetings, and in meetings with local and state decision makers, to ensure that decisions are informed by empirical data regarding current conditions and anticipated impacts.

2.3 City-State Agreement to Provide Community Benefits

In 2017, $45 million were approved in a City-State Agreement (henceforth CSA) to provide community benefits in the area of SW Detroit impacted by the bridge. Funds were designated to support: costs associated with job training and access programs for Detroit residents; monitoring health impacts of bridge construction and operations; monitoring of air quality over time (see **Section 6.3.2 Monitoring**); costs associated with an optional "home swap" initiative that allows residents of designated areas near the bridge to trade their home for a city-owned home elsewhere in Detroit; and home improvements to offset impacts associated with future operation of the GHIB. A key component of the CSA is the *Bridging Neighborhoods* program, initiated in 2018 and including the Home Swap Program and the I-75 Environmental Mitigation Program. The Home Swap Program is available for residents of selected areas whose homes are located proximate to the GHIB footprint but were not bought out by eminent domain, providing an option to relocate to another part of Detroit. The I-75 Mitigation Program provides renovation upgrades (e.g. HVAC, air filters, windows) to homes proximate to the I-75 highway expansion, only on the north side of the freeway.

The Bridging Neighborhood Program's funding allows for approximately 200 owner-occupants across Delray and Carbonworks neighborhoods and within 150-feet of I-75 on the north side of the freeway to "swap" their homes for recently renovated, city-owned properties in other neighborhoods. Residents between 150-300 feet on the north side of I-75 can qualify for the I-75 Environmental Mitigation Program, and residents between the freeway and 150-feet can choose either the I-75 Environmental Mitigation Program or the Home Swap Program. Presently, Delray and Carbonworks residents only qualify for the Home Swap Program option. If a Delray or Carbonworks resident chooses to stay, they are welcome to do so, but they are not eligible for retrofits or any other GHIB-related home repair program.

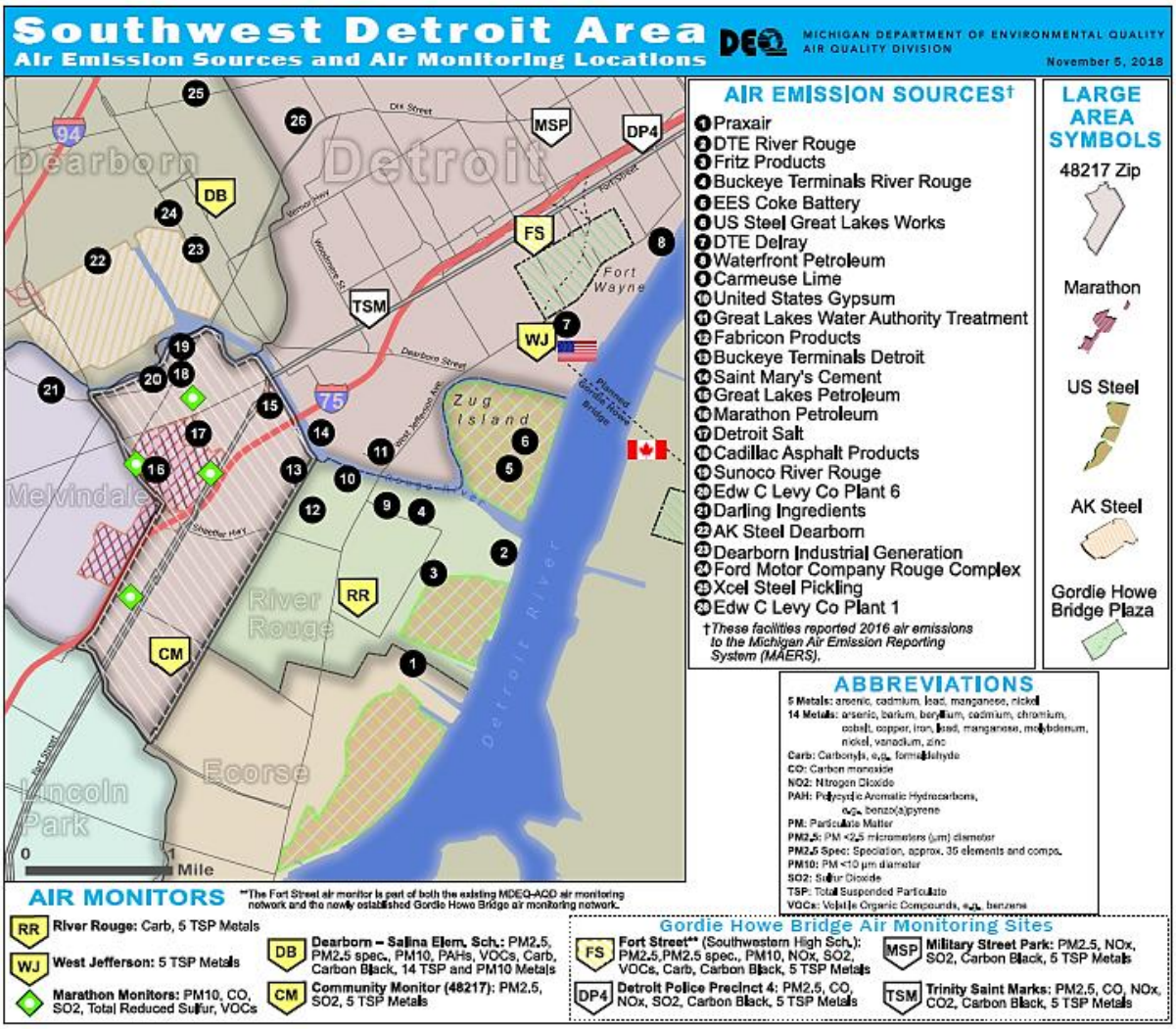
3. Cumulative Environmental Health Risks & Mitigation Strategies

While air quality in the U.S. has generally improved in the last several decades, these benefits have not been fully felt in many communities where exposure remains disproportionately high. For instance, under the Clean Air Act's National Ambient Air Quality Standards (NAAQS), parts of Wayne County have been in non-attainment for Sulfur Dioxide (SO_2) since 2013 and much of SE Michigan is in non-attainment for Oxone (O_3) as of 2018.[16] The GHIB is under construction within these non-attainment areas. The large body of existing evidence documenting adverse health impacts of air pollution[17] [18] [19] [20] and the disproportionate likelihood that communities of color and low-income communities will host major freight infrastructure like the GHIB[21] [22] [23] [24] [25] [26] [27] lends weight to concerns voiced by residents regarding potential health impacts related to the GHIB.

3.1 Cumulative Risks to Environmental Health in Metro Detroit

Several studies document the adverse health effects associated with air pollution in Metro Detroit specifically.[28] [29] The clustering of emission sources and their cumulative effects on air pollution and health impacts have recently been reported and quantified in a Public Health Resource Manual compiled by Community Action to Promote Healthy Environments (CAPHE). Southwest Detroit in particular is home to many stationary and mobile pollutant sources, each contributing to the cumulative mix of air pollutants and associated health risks experienced by residents (see **Figure 3**).

Figure 3: Air pollutant point sources in the city of Detroit - Southwest[30]



For more information, see: CAPHE Resource Manual, Chapter 5

3.2 Transportation & Health

These point sources of pollutants in SW Detroit combine with pollutants from mobile sources such as commercial trucks and trains to further contribute to cumulative levels of air pollutants. Over the last several decades, researchers, advocates, and policy-makers have considered freight transport an environmental justice issue,[31] with communities of color and low-income communities more likely to be located in areas with freight facilities and thus more likely to experience cumulative environmental exposures from those facilities.[32] The economic, social, environmental, and health implications of freight transport have been well documented globally in communities that host freight infrastructure.[33] [34] [35] [36] [37] [38] [39]

Detroit already houses the second largest international land border crossing in the U.S., the Ambassador Bridge, as measured by the $129.2 Billion in imports and exports transferred in 2017 between Detroit, MI, USA and Windsor, ON, Canada.[40] SEMCOG projections estimate that 8,109 commercial vehicles will use the GHIB Crossing in 2025, increasing to 10,766 commercial vehicles by 2040. A majority of this traffic will be offset from traffic that would have used either the Ambassador Bridge, or the Detroit-Windsor Tunnel.[41] Although SEMCOG does not initially project an increase in overall traffic for the Southwest region of Detroit with the GHIB, southbound trucks will travel further along I-75 to get to the GHIB, travelling through additional residential areas. This will expose more residents with homes along that route to a higher concentration of pollution from these sources.

Commercial trucks associated with freight transport use heavy-duty combustion engines, emitting diesel exhaust that diminishes air quality. These emissions include mixtures of compounds, entailing organic and black carbon, toxic metals, particulate matter (PM), nitrogen oxides (NO_x), sulfur oxides (SO_x), volatile organic compounds (VOCs), carbon monoxide (CO), formaldehyde, acrolein, and polycyclic aromatic hydrocarbons, among other air pollutants. Exposure to diesel exhaust can cause many acute and chronic health effects, including but not limited to: bronchitis, asthma, lung cancer, heart attacks, and premature mortality.[42] Children are particularly susceptible to these effects of air pollution because their lungs are still developing, they breathe faster, have a lower body weight, and spend more time outdoors than adults.[43] [44] [45] Adults older than 65 years of age, and people with heart or lung disease, asthma, or other respiratory problems are also more likely to experience adverse health effects from air pollution.[46] [47] [48]

A literature review by the Health Effects Institute synthesizes hundreds of epidemiological studies between 1980 and 2008, identifying an “exposure zone within a range of up to 300 to 500 meters from a highway or a major road as the area most highly affected by traffic emissions.”[49]

In addition to the adverse effects of air pollution, freight transport (i.e. diesel trucks, trains, shipping) can create other exposures that adversely impact quality of life for nearby residents. Freight transport is a direct source of noise pollution, which can have physical and mental health consequences.[50] [51] [52] [53] Defined as “unwanted or disturbing sound,” noise pollution is most commonly associated with noise-induced hearing loss.[54] Research links near-road noise pollution to high blood pressure, heart attacks, speech interference, diabetes, sleep disruption, and lost productivity.[55] Further, noise pollution may affect the stress process, which may manifest physically as diseases of the cardiovascular, respiratory, and metabolic systems.[56] In considering exposure assessment and potential interventions for this project, reductions of both air and noise pollution are goals. Interventions, such as buffers, may reduce air pollution, noise pollution, or both.

4. Baseline Survey

In response to concerns voiced by nearby residents, two surveys were conducted with residents of the GHIB area to gather baseline health and social indicators as a basis for understanding the health, economic, social and environmental impacts of the bridge as it is built and becomes operational. The first survey (2016-2017) was conducted by a team from the SW Detroit CBC and UM Dearborn, with funding from the Fred A. and Barbara M. Erb Family Foundation and UM Dearborn's Office of Metropolitan Impact. The second survey (2018), which extended the sample and geographic area covered by the first, was conducted by a team comprising Detroit Hispanic Development Corporation, SW Detroit CBC, UM Dearborn and UM SPH, with funding from the State of Michigan and the Michigan Health Endowment Fund through a contract managed by the Detroit Health Department. This section describes the survey process and methodology.

4.1 Role of Community

The need for a better understanding of health and other (e.g., economic, social) potential impacts of the bridge on the community was identified during initial discussions of community benefits and needs that began in 2008 and have continued to the present day. The community was integrally involved at all stages of the health surveys, including the initial identification of the need to document health concerns through a survey of residents, providing input into survey content, identifying local bi-lingual residents to conduct the survey interviews, and engaging in discussions of preliminary findings and potential mitigation options.

2016-2017: The SW Detroit CBC administered a Quality of Life Survey to participants in community meetings in 2015. As community discussions continued to point to health concerns, the CBC sought a partnership with public health researchers with expertise in survey research at the UM Dearborn. This partnership led to the initial survey of residents in the bridge impact area. The CBC, guided by its community-elected board, conducted the initial health survey in 2016 and 2017 (BHC survey, described below). Draft surveys were presented to community stakeholders for input, including CBC board members and local bilingual residents who were hired as interviewers. Through practice sessions to pretest the survey, the interviewer team finalized the initial survey tool. Survey participation was promoted through door-to-door information, phone-calls, and at community meetings. Preliminary findings from the survey were presented in April 2017 at a community meeting based at Community Health and Social Services (CHASS) center. The 2016-2017 CBC community survey tool and process provided the foundation for the 2018 HIA.

2018: During the 2017 negotiations for community benefits programs, community support for the need for further health protections continued, and long-term surveying was funded as part of the City-State Agreement. The Detroit Health Department specified community input at designated points in the request for proposals for the 2018 survey: these included community input into content, piloting, and discussion of preliminary results. The team contracted to conduct the HIA included: the Detroit Hispanic Development Corporation (DHDC) (fiduciary), the SW Detroit CBC, UM SPH, and UM Dearborn. DHDC and SW Detroit CBC are both members of the GHIB Community Advisory Group (CAG), are were responsible for organizing community input opportunities, and recruiting community interviewers. UM SPH and UM Dearborn were responsible for providing survey and analysis expertise. All team members partnered in the overall design, and met regularly with community groups to assure input. Specifically, the team met with the CAG in June 2018, to present and discuss initial findings from the 2016-2017 survey, followed by opportunities for community to suggest added or modified content for the 2018 survey. In July 2018, a draft of the revised survey was pilot tested with community residents, who provided feedback and additional input into the survey tool prior to finalization. The CAG was apprised of progress over the summer and early fall while the survey was in the field. Preliminary survey results were presented at a meeting of the CBC's Resident Engagement Committee in November, and at meetings of the SW CBC CAG in December, 2018 and February 2019. The December and February meetings specifically focused on survey results for the baseline health status of residents of the GHIB area and discussion of potential scientifically-informed recommendations for strategies to minimize potential adverse health impacts of bridge construction and operations on health.

4.2 Data collection

Data was collected in two periods. The first occurred during August 2016–September 2017, and the second occurred during July–September 2018.

4.2.1 Bridge to a Healthy Community (BHC) Survey, August 2016–September 2017

A team of community and academic researchers from the SW Detroit CBC and the UM Dearborn conducted the Bridge to a Healthy Community Survey in 2016 and 2017. The UM Dearborn Institutional Review Board (IRB) approved survey and data collection processes. All survey team members participated in a certification process during which they learned about research ethics, survey protocols, and practiced asking closed- and open-ended questions. The 100-item survey was administered face-to-face using Qualtrics software on handheld tablets. The survey took approximately 30-40 minutes to complete, and each respondent received $5 in cash as a token of appreciation for their time and contributions. All households in the study area, shown within the dotted line in **Figure 4**, were invited to participate. Respondents in 302 households, roughly one in three eligible households, completed the survey. Interviewers visited each household at least 3 times at varying times of day and week. The survey team met regularly to discuss survey management to ensure a representative response across the sampling frame. Two slightly different protocols were used during the field period: Version 1[57] was completed by n=13 respondents following which some minor changes were made and a revised Version 2 was administered to n=291 respondents. Survey interviewers requested to speak with the head of household and only interviewed respondents 18 years of age or older. Participants were asked questions related to demographics, insurance status, potential environmental exposures (e.g., occupational, tobacco), their own health conditions, perceptions of their neighborhood, and recommendations for decision-makers, as well as age, insurance status, tobacco use, and health conditions for others in their household. Interviewers were in the field August-November 2016, and June-September 2017 (henceforth 2016-2017).

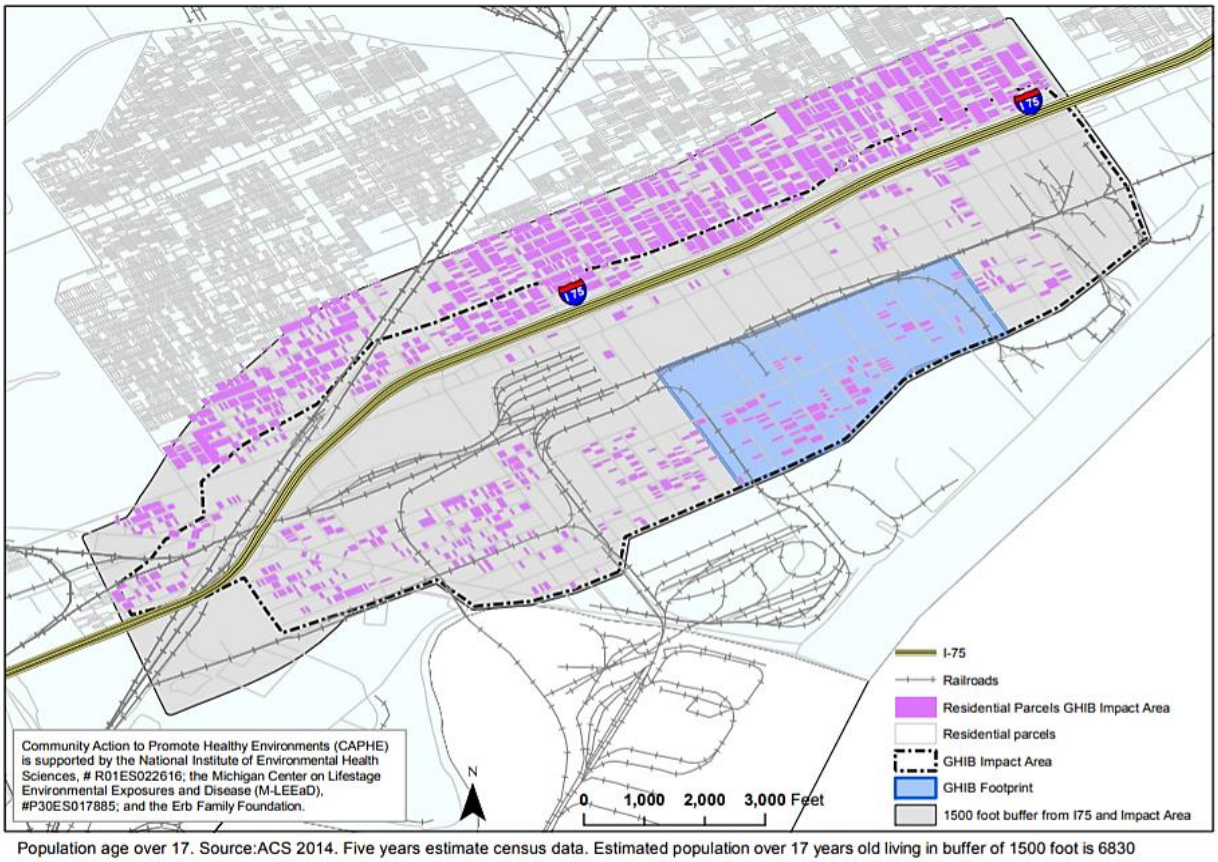


Figure 4: Gordie Howe International Bridge (GHIB) Survey area: Residential parcels in impact area and 1500 foot buffer.

4.2.2 Gordie Howe International Bridge (GHIB) Survey, July - September, 2018

The GHIB survey consisted of a two-stage, stratified random sample of residents living in the area surrounding the GHIB project footprint. As shown in **Figure 4,** the survey area included the area immediately surrounding the footprint of the bridge, east to Clark Park and west to Delray, and encompassed residents of the area up to 1500 feet north of the new I-75 service drive.

The survey area included approximately 2,586 parcels, excluding 96 parcels in the bridge footprint.[58] Based on data from the American Community Survey (ACS), an estimated 75% (n=1,943) of those households were occupied in 2014: Approximately 74% in the impact area and 76% in the area extending 1000 feet north of the impact area. In the first stage of sample selection, census blocks were selected with probabilities proportional to size, using the most recent data available regarding counts of households at the census block level. In the second stage, a sample of households was selected in each selected census block, with probabilities accounting for household type (e.g. single family, multi-family).

A probability sampling method ensures that all population members have a known, non-zero probability of selection. To address the issue of geospatial and temporal confounding (e.g., that the surveys conducted in 2016-2017 and in 2018 covered two different areas, making it difficult to disentangle differences related to geographic area from those due to temporal changes), the GHIB survey sample was drawn as a cross-sectional probability sample with an approximately 10% overlap with respondents from the BHC survey. The two surveys (BHC 2016-2017 and GHIB 2018) can be treated as two cross-sectional samples done in different spatial areas at two time points with 10% overlap.[59] [60]

The BHC survey team obtained completed interviews at roughly 1 in 3 housing units in the impact area during 2016-2017 field period. Based on that experience, the GHIB survey sample for the new or buffer area was created estimating a 33% response rate. In the impact area, where GHIB interviewers would be returning to housing units that had previously participated in the BHC survey, we estimated a 50% response rate. For the new or buffer area, extending 500-1500 feet north of I-75, we sought to complete at least 100 surveys in an area with 478 housing units. Thus, we drew random samples using a 1:3 sampling fraction for the new or buffer survey area (from 500-1500 feet north of I-75) and using a 1:2 sampling fraction in the impact area.

4.2.3 Survey questionnaire

To maximize comparability and integration of data across the BHC and GHIB surveys for the baseline GHIB Health Impact Assessment, survey questionnaires were kept as consistent as possible. Limited modifications made are described below (question numbers cited are from the 2018 GHIB questionnaire):

1) Response options were added to an item about race/ethnicity, to include “Middle eastern” (Q8);
2) Response options for doctoral degree and skilled trade were added to a question about highest level of education (Q9);
3) Additional employment items were included (e.g., number of jobs worked, number of hours worked/week, job related stress) (Q12-15);
4) Wording changes were made for an item about government aid (Q18);
5) Items were added about potential displacement and assistance received due to foreclosure, inability to pay taxes, or water bills/shut offs (Q19-31);
6) Several health conditions were added to the item asking about health problems experienced: (Q33) Coughing, anxiety, substance addiction (for example, alcohol, prescription drugs), severe dental problems, problems sleeping, chronic pain, skin problems (e.g. rashes), and frequent eye irritation or infection, or eye problems;
7) Item about use of supplemental oxygen and frequency was added (Q34);
8) A series of items were added asking about pregnancies and birth outcomes (Q38-43);
9) Additional items about visits to health care providers were included (Q44, Q45);

10) A question about gender of other household members was added (Q50 and repeated for all household members listed);

11) Item asking about smoking was modified to include “never” and “former” smokers (previous, just “no”) and to include cigars and other forms of tobacco (Q47, Q53);

12) A series of questions was added about social relationships/support with neighbors (Q57);

13) Items were added to a series of questions about concerns in the neighborhood, based on discussions with the Community Benefits Coalition or Community Advisory Group (Q58);

14) New questions added about home renovations in past 10 years (Q59), air conditioning use (Q60, Q61)

15) Questions were added about heating sources and filter maintenance schedules (Q62-66) and home characteristics (Q75, Obs 1-3) at the request of members of the GHIB Technical Advisory Committee;

16) Added response options to question about critical home repairs needed (Q70);

17) Several new observational items were included regarding home characteristics (QCKP 1-3).

4.2.4 Interview protocols

The GHIB survey was administered as Computer Assisted Personal Interviews (CAPI). The interview protocol was created using Qualtrics and administered by trained interviewers who were local residents. The survey protocol was approved by the University of Michigan’s Institutional Review Board in 2018 to assure ethical and effective data collection, management and storage. Protocols for contacting potential participants, maintaining confidentiality, anonymity and other ethical standards, interviewer training and supervision, and managing survey administration are described in **APPENDICES B, C and D**.

4.2.5 Survey data

The Bridge to a Healthy Community Survey (Sampson, PI) conducted during 2016-2017, completed 302 household interviews: 193 in the GHIB impact area; 96 in the buffer area (500-1500 feet north of I-75); 11 outside of either the impact or the buffer area; and 2 which did not include information on location. The Gordie Howe International Bridge (GHIB) survey completed 146 interviews: 31 in the impact area and115 in the buffer area between 500-1500 feet north of I-75.

4.2.5.1 Survey data analysis

Data from the 2016-2018 surveys were cleaned using standard procedures. Of the 146 surveys completed during the 2018 field period, 31 were intended to be replicate interviews, conducted at households, and with the respondents, who had completed the BHC interview in 2016-2017. Of those, 4 were subsequently determined not to have been replicas (e.g., not the same respondent at both points in time) and were thus omitted from tests of consistency over time. We used Pearson’s correlation coefficients to assess consistency of responses to 51 survey items (e.g., gender, smoking status, length of residence in Detroit, employments status) by the same respondent at the two points in time. The following standard characterization was used to evaluate these results: $r<0.4$ ‘Not consistent”; $0.4\leq r<0.6$ ‘Poor consistency’; $0.6\leq r<0.8$ ‘Good consistency’; $0.8\leq r$ ‘Excellent consistency.’[61] Using this rating system, 26 (96.3%) of the 27 replicate respondents had “good” or “excellent” consistency. Pearson’s correlation coefficients are sensitive to outliers and the interview with poor consistency (0.59) was determined to have had one outlier which likely affected the score.

An integrated database was created that included data from a total of 435 completed surveys: 289 from the 2016-2017 BHC survey (those from the impact and buffer areas) and 146 from the 2018 GHIB survey. New variables were created and included in the database to reflect: the year in which the survey was conducted (2016, 2017, 2018); whether the respondent lived in the impact area or the buffer area; the version of the questionnaire used (Version 1, n=13; Version 2, n=275; 2018 n=146); whether the survey respondent was part of the replicate sample (n=27); and whether the respondent lived within 300, 500 or 1000 feet of a heavily trafficked roadway (I-75) or one of the trucking routes through the neighborhoods. To facilitate comparisons across surveys, numeric designations for all survey items included in both surveys were converted to the 2018 questionnaire numbering system in an integrated codebook.

Where questions used in the 2016-2017 BHC were modified for the 2018 GHIB survey (see **Section 3.2.3**), implications for pooling data across survey waves are discussed below. Item numbers (e.g., Q33) referenced below are from the 2018 GHIB version of the survey unless otherwise noted.

1) *Middle eastern race/ethnicity (Q8):* This response option was included only in 2018;
2) *Doctoral degree and skilled trade education options (Q9):* No respondents indicated "doctoral degree" and just one indicated "skilled trade" in response to the new response options added to the education category in the 2018 GHIB survey. Based on these distributions, we recommend that analyses pooling data from 2016-2018 report the highest education category as college degree (e.g., associates, bachelor's, master's) and that the one respondent who indicated "skilled trade" in 2018 be included with relevant write-in responses*;*
3) *Additional employment questions (Q12-15):* Information about the number of jobs worked, number of hours worked/week, and job-related stress are available only for the 2018 survey respondents (n=146);
4) *Foreclosure, taxes and water bills/shut offs (Q19-31)*: These items were added in 2018 (Q19-31) and are only available for the 2018 survey respondents (n=146);
5) *Added health conditions (Q33)*: Questions asking about health conditions of the respondent and other household members were administered by reading the health condition and asking the respondent to respond, for each one, whether they (or household member) had that condition (yes/no). Thus the addition of new health conditions would not be expected to influence the distribution of responses, allowing data to be pooled for items included in both the 2016-2017 and 2018 versions of the survey (n=435 survey respondents, n=1,629 household members including respondents). For new items added in 2018, data is only available for 2018 and should be reported for only the n=146 respondents and n=565 household members interviewed as part of the GHIB survey;
6) *Supplement oxygen (Q34)*: Questions about use of supplemental oxygen and whether frequency of use has increased were added in 2018, with data available only for the 2018 survey respondents;
7) *Pregnancies and birth outcomes (Q38-43)*: Items asking about pregnancy and birth outcomes were modified in 2018 from the version used in 2016-2017. Specifically, the 2018 survey version included a more detailed protocol that prompted female respondents through a history of pregnancies and outcomes (Q38-43). Based on descriptive results for these variables, we recommend that data on miscarriages and other birth outcomes from the 2016-2017 protocol not be pooled with data from the 2018 protocol, due to substantial differences in distribution of responses that are likely influenced by changes in the survey items. For example, 25.5% of women responding to the 2016-2017 BHC survey protocol indicated that they had had one or more miscarriage compared to 34% of those responding to the 2018 GHIB survey protocol. Because these differences in the survey protocol are aligned with differences in the sampling areas, with the BHC survey conducted primarily in the impact area and the 2018 survey conducted primarily in the buffer area, these differences are likely to produce systematic bias when compared across the surveys. **Analyses using these survey items should be limited to *within* wave (e.g., 2016-2017 BHC or 2018 GHIB survey) comparisons and *should not be conducted using pooled 2016-2017 and 2018 data*;**
8) *Visits to health care providers (Q44,Q45)*: New items asking about visits to health care providers were added in 2018, with data only available for the 2018 GHIB survey respondents (n=146);
9) *Gender (Q50)*: In 2016-2017, only the gender of the respondent was recorded, and not the gender of other household members. Thus, data on gender of the survey respondent is available across all waves of the survey (n=435). Questions about gender of other household members was added for the 2018 GHIB survey, and is available for all members of the household only for the 2018 GHIB survey (n=565);
10) *Neighborhood characteristics (Q56):* A series of items was included asking about respondents' perceptions of their neighborhoods, including attachment to neighborhood and social relationships among residents. There were slight differences in response options to these items across survey

versions as follows: Version 1 BHC response options were strongly agree, agree, neutral, somewhat disagree, disagree (n=13); Version 2 BHC response options were strongly agree, agree, neutral, disagree, strongly disagree (n=282); and 2018 GHIB response options were strongly agree, agree, neutral, somewhat disagree and strongly disagree (n=146). We did not find statistically significant differences in distributions of responses tables when including and excluding the responses from the Version 1 (n=13) version of the survey. As a result, in reporting results, we have pooled data from all three versions of the survey, and used the following response options in describing the pooled data: strongly agree, agree, neutral, disagree, strongly disagree;

11) *Social relationships/neighbor support (Q57)*: Questions about social relationships and social support available from neighbors were added for the 2018 GHIB survey, with data available only for respondents to that wave of the survey (N=146);

12) *Neighborhood concerns (Q58)*: In the 2016-2017 survey, respondents were shown a list of seven potential neighborhood problems and asked to indicate which ones they would rate as being among their top three concerns. In 2018, several items were added to this list, based on resident concerns voiced as the bridge construction began, or discussions with the Community Benefits Coalition or Community Advisory Group. In addition, in 2018, respondents were asked to respond to each item in a list of potential neighborhood problems, indicating whether each item was "very much a concern" "not really a concern" or "not at all a concern" in their neighborhood. *Given these differences, data on neighborhood concerns should not be pooled across waves of the interview protocol. When reporting findings separately, data from the 2016-2017 survey should clearly indicate that respondents were reporting their top three concerns, while respondents to the 2018 survey were invited to rate each item in terms of the degree to which it was a concern;*

13) *Home heating (Q62-66, Q75):* A series of questions was asked in 2018 about heating sources in homes and filter maintenance schedules (Q62-66) and home characteristics (Q75, Obs 1-3) at the request of members of the GHIB Technical Advisory Committee. These results are available only for 2018 respondents (n=146);

14) *Smoking (Q47-48)*: In the 2016-2017 BHC survey, respondents were asked to indicate whether or not they smoked (yes, no). This item was modified in 2018 to invite respondents to indicate whether they currently smoked (yes), smoked formerly but not currently, or had never smoked. Examination of the distribution of responses to these items indicates differences across survey administrations with these different question formats: In the 2016-2017 BHC survey, 73% of respondents indicated that they did not smoke, while 82% of respondents to the 2018 GHIB survey indicated that they did not currently smoke (pooling responses to the former and never smoked response options). *These differences in distribution may be a result of the change in question format: analytic comparisons within waves of the survey are more strongly justified than those made across survey waves.*

Two systems of weights were created, one for household respondent (finalwt1) and one for the household members (finalwt2). For the household respondents, a probability of selection, p1, was created based on the probability distribution by age and gender of the 2012-2016 ACS population of non-overlapping block groups from the six census tracts in the GHIB study area; a second probability of selection, p2, was created using the distribution by age and gender of the actual drawn sample; a third weight, p3, accounted for the fact that some surveys were replicates. The final weight (finalwt1) for household respondents was the product of wt=p1*p2*p3. These weights were standardized to add to 435 completed surveys. Weights for household members followed a similar methodological approach in which we determined a probability of selection based on the age distribution of the population of the non-overlapping census block groups from the six census tracts of the GHIB study area, p4; and a probability of selection using the age distribution of the 1629 household members, p5. Similarly, we factored into the final weight the fact that some were replicate surveys, p6. Thus, the final weight for household members was Finalwt2=p4*p5*p6. Estimates of p1 and p4 used data from the American Community Survey for the GHIB study area (2012-2016). The post survey weights, p2 and p5, account for deviations in demographic characteristics of the sample from that of the population of the survey area (see **Table 4**), and allow the results reported from the survey to be interpreted as representative of the GHIB population as a whole.

4.2.6 Vital statistics data

Birth certificate data for the 48209 zip code, which encompasses the whole study area and are available from the Michigan Department of Health and Human Services Vital Statistics Division, were used to complement self-reported health data obtained through the surveys described above. The Detroit Health Department obtained ZIP-code level birth certificate and infant death certificate data from MDHHS. Data for Detroit City and Michigan State were also examined. All reported data is aggregated over a three year period (2014−2016) for stability.

4.2.7 Michigan Behavioral Risk Factor Survey data

The Michigan Behavioral Risk Factor Survey (MiBRFS) is an annual, statewide telephone survey of Michigan adults aged 18 years and older. Michigan BRFS data contribute to the national Behavioral Risk Factor Surveillance System (BRFSS), and provide specific data on health outcomes and behavioral risk factors. Data from MiBRFS were used to supplement survey data, and in particular to examine asthma prevalence in Detroit and the state of Michigan. The asthma item from the MiBRFS specifically asks whether individuals have been told by a health care provider that they have asthma, which differs from the BHC and GHIB surveys which simply ask if each individual has asthma. MiBRFS data reported is aggregated 2014-2016.

5. Survey Results

5.1 Demographic characteristics

Demographic characteristics of survey respondents (2016-2018) are shown in **Table 1**, with census data from relevant census block groups drawn from the 2012-2016 American Community Survey (ACS). The full sample includes 435 adult survey respondents (age 18 and older): Those respondents reported on the health of a total of 1,629 household members of all ages.

Table 1: Demographic characteristics of survey respondents, household members and GHIB census block group population

		Survey respondents (2016-2018) (n=435) (A)	American Community Survey adults 18 and older (n=11,320) (B)	p-value (A) vs (B)	Survey household members (n=1629) (C)	American Community Survey all household residents (n=16,382) (D)	p-value (C) vs (D)	p-value (A) vs (D)
Age[1]	Age 4 and younger				9.1	9.9		
	Age 5-17				27.9	21		
	Age 18-64	85.9	87.2	0.4343	56	60.3	0.084	
	Age 65 and older	14.1	12.8		7.1	8.8		
Gender[2]	Female	68.1	50.5	<0.001	na	50.7		
	Male	32	49.5			49.3		
Education[3]	Less than High School Graduation	48.7	n.a.		na	46.2		
	High School Graduation	28.9				30.6		0.464
	More than High School Graduation	22.4				23.3		

1. All survey respondents were aged 18 and older (n=432): Household members were aged 0-65+ (n=16,382)

2. Gender is available for survey respondents only in 2018, thus not included in statistical comparisons for all household members

3. ACS data for education includes those aged 25 and older, thus this comparison includes only survey respondents aged 25 and older (n=415)

Results shown in **Table 1** indicate that survey respondents were significantly more likely to be female when compared with the population of adults in the survey area (68.1% compared with 50.5%, p<0.001). The age of survey respondents was not significantly different from that of the population of adults in the GHIB area (p=0.434). Age and education distributions of survey respondents were similar to ACS values for the GHIB area. The age distribution of household members reported on in the survey differed from that reported in the ACS data (p=0.084). Based on the results shown in **Table 1**, survey weights were constructed that allow survey results to be extended to the GHIB study area population.

5.2 Resident self-reports on neighborhood, social support, and concerns

Connection to neighborhood and social support.

Table 2: Percent of respondents who agree or strongly agree with statements about their neighborhood

	n*	% Agree or Strongly Agree	
		Unweighted	Weighted
I think this neighborhood is a good place for me to live.	431	70.3%	70.5%
People in this neighborhood share the same values.	417	69.5%	69.8%
I feel at home in this neighborhood.	431	85.2%	85.6%
It is very important to me to live in this particular neighborhood.	433	63.3%	64.0%
I expect to live in this neighborhood for a long time.	424	68.6%	69.6%
People in this neighborhood generally know each other.	429	81.1%	81.9%

* n's vary due to item missing data

Table 2 shows the percent of respondents who agreed or strongly agreed with a series of five items asking each respondent about their sense of connection to their neighborhood. Both unweighted and weighted results are presented. More than 4 out of 5 respondents agreed or strongly agreed that people in their neighborhood generally know each other and that they feel at home in their neighborhood. Seven in 10 respondents

indicated that they thought the neighborhood was a good place for them to live and that people in the neighborhood share the same values, with just under 7 in 10 expecting to live in the neighborhood for a long time. More than 6 in 10 indicated that it was important to them to live in this particular neighborhood.

The 2018 GHIB survey included a newly added series of questions asking about social support available to respondents within their neighborhoods. Unweighted and weighted results from this series of questions are shown in **Table 3**. Seven in ten survey respondents reported that in general there are people in their neighborhood they could turn to if they needed help around the house, and that they could get a ride from a neighbor to an appointment or for an urgent need. Eight out of ten indicated that there are people they can talk to in their neighborhood.

Table 3: Percent of respondents indicating types of social support available in their neighborhood (2018 only)

	n*	% Always or Most of the time	
		Unweighted	Weighted
In general there are people in my neighborhood who I can turn to, for example if I needed help with something around the house	144	72.2%	73.4%
In general, there are people I can talk to in my neighborhood	146	81.5%	83.0%
I could get a ride from a neighbor to an appointment or for an urgent need	140	72.9%	69.8%

* n's vary due to item missing data

Concerns in the neighborhood and plans to move.

Table 4: Neighborhood concerns reported by respondents in the 2016/2017 survey (respondents were asked to indicate their top three concerns) (n=286, weighted percents)

	Percent
Outdoor air (emissions/fumes, odors)	65.4%
Noise	45.8%
Safety with increasing trucks	37.8%
Road dust	37.4%
Indoor air quality (fumes & dust inside the home)	34.6%
Traffic congestion	33.9%
Loss of property value	31.8%
Other	7.3%
None/not concerned	2.5%

In both 2016-2017 and in 2018, respondents were asked to respond to sets of items asking about problems in their neighborhood. Questions were presented differently in the two surveys so results are reported separately. In the 2016-2017 version of the survey, survey participants were presented with a list of 7 concerns and asked to indicate their top three. As shown in **Table 4,** the most frequently noted concern was outdoor air (emissions/ fumes, odors) (65.4%, n=187), followed by noise (45.8%, n=131). Concerns about safety with increasing trucks (37.8%, n=108) and road dust (37.4%, n=107) were followed closely by concerns about indoor air quality (34.6%, n=99), traffic congestion (33.9%, n=97) and loss of property value (31.8%, n=91).

The set of items included in the survey in 2018 was substantially expanded from the above list, based on input from community residents. In addition, in 2018, rather than being asked to name their top three concerns, respondents were asked to indicate for each item whether it was very much a concern, somewhat a concern, or not a concern at all. As shown in **Table 5**, in 2018, 4 out of 5 household respondents reported that rats were very much a concern (81.6%), and 3 out of 4 (76.1%) indicated that clogged sewers or standing water in streets were very much a concern.

Table 5: Neighborhood concerns reported by survey respondents, 2018 (n=146, weighted percent)	Very much a concern	Somewhat of a concern	Not a concern at all
Rats	81.6%	9.2%	9.2%
Traffic congestion making it hard to get places	76.1%	8.8%	15.0%
Clogged sewers or standing water in streets.	75.3%	11.6%	13.1%
Outdoor air quality, such as emissions from trucks or industry, fumes or odors.	66.7%	18.8%	14.6%
Vibration from trucks or construction activity damaging property	60.9%	18.4%	20.7%
Vacant houses	60.4%	16.2%	23.3%
Road dust	60.2%	20.0%	19.9%
Loss of property value	56.7%	21.3%	22.0%
Crime	55.0%	23.9%	21.1%
Truck traffic on residential streets affecting safety.	54.8%	16.1%	29.1%
Noise during sleeping hours	47.1%	20.3%	32.6%
Indoor air quality, such as fumes and dust inside the house.	41.4%	25.1%	33.5%
Noise during the day	40.9%	29.8%	29.3%
Many residents moving away	23.8%	35.6%	40.6%

Three in 4 respondents (75.3%) reported that traffic congestion in the neighborhood was very much a concern, followed by a constellation of concerns linked to heavy truck traffic in the neighborhood: 2 out of 3 (66.7%) noted outdoor air quality such as emissions from trucks or industry, fumes or odors; 6 in 10 (60.2%) ranked vibration from trucks or construction activity damaging property (60.9%) and road dust, and over half (54.8%) indicated safety concerns linked to truck traffic on residential streets were very much a concern. Six in 10 (60.4%) respondents indicated that vacant houses, 56.7% indicated that loss of property value, and just under 1 in 4 (23.8%) indicated that many residents moving away were very much a concern. Just under half of residents indicated that noise during sleeping hours (47.1%), and 4 in 10 (41.4%) indicated that indoor air quality and noise during the day (40.9%) were very much a concern.

These concerns are also reflected in responses to an open ended survey item inviting respondents to indicate what they might say to policy or decision makers about how to reduce the impact of the bridge on residents of the neighborhood (see *Resident requests for how to address concerns*, below).

Table 6: Intention to move by residence in impact or buffer areas of GHIB (n=435, weighted percent)			
Plan to move	Living in impact area (n=224)	Living in buffer area (n=211)	Statistical test of difference[1]
Within one year	8.6%	5.3%	0.01
Between 1-5 years	17.7%	10.4%	
More than 5 years	5.9%	4.7%	
Not planning to move	57.8%	73.6%	

[1] p-value corresponds to test of of independent proportions - Chisquare test

Survey respondents were asked about any plans to move. Results shown in **Table 6** compare responses to this question for those living in the impact area and those living in the buffer area north of the bridge. Residents of the impact area were more likely to indicate that they planned to move within one year or within the next 1-5 years compared to those living in the buffer area north of I-75, with those living in the buffer area more likely to indicate that they were not planning to move. Differences were statistically significant (p=0.01). Those living in the impact area were more likely to have been interviewed in 2016-2017, while those living in the buffer area were more likely to have been interviewed in 2018, and those temporal differences may have influenced differences between the groups. In addition, those living in the impact area are closer to the footprint of the new bridge, and are more likely to be eligible for financial support for moving compared with those living

in the buffer area, potentially contributing to greater likelihood of indicating plans to move. It is also likely that response distributions to this item may change as bridge construction begins, and will likely affect different areas at different points in time.

Of the 31 survey respondents who were eligible to participate in the Bridging Neighborhoods Optional Relocation (home-swap) program in the 2018 survey, 7.8% were currently participating, 39.1% indicated that they were currently considering participation, and 20.6% indicated that they were not considering now but might consider in the future. 20.9% indicated that they were either unlikely to consider or were not planning to move.

5.3 Housing Characteristics

Characteristics of housing in the GHIB area influence opportunities to mitigate exposure to air pollutants (e.g., the extent to which outdoor air pollutants move indoors, and the extent to which they are concentrated indoors). They are also relevant for mitigation strategies that attempt to clean indoor air, such as indoor air filtration systems that may require, for example, forced air furnaces. In order to understand characteristics of housing stock in the area surrounding the GHIB, a series of items were included in the 2018 survey questionnaire (n=146).

Table 7: Proportion of respondents (2018) indicating that their home had undergone renovations in the last 10 years (n=146, weighted percent)

	Percent
New windows or doors	52.1%
New furnace	43.3%
New weather stripping	34.9%
Other	11.8%
None	31.3%
REFUSE	0.0%

Table 7 shows weighted percentages for responses to a question asking whether the respondents' home had undergone any of a series of renovations or improvements in the past 10 years. More than 2 out of three respondents (69.7%) indicated that their home had undergone some renovation or improvement in the previous 10 years. About half (52.1%) indicated their home had new windows or doors, 2 in 5 (43.3%) indicated a new furnace, and about 1 in 3 (34.9%) indicated new weather stripping in the past decade. About 3 in 10 indicated no home improvements during that period.

Table 8: Percent of responses indicating critical home repairs needed (n=435, weighted percent)

	Percent
Doors leak (cold or warm air from outside)	46.6%
Windows leak or broken	34.8%
Foundation cracks/leak	29.1%
Roof repair or replacement	24.4%
Porch or steps are dangerous	23.7%
Peeling paint inside home	22.4%
None	21.2%
Mold	17.4%
Electrical wiring problems or no electricity	17.1%
Flooding due to sewage or rainwater seepage or backup into basement	15.2%
Plumbing not working	11.6%
Furnace not working properly or no furnace	8.3%
Other	6.6%
Wheelchair ramp needed	4.2%
Don't know/refuse	2.0%

Respondents in all waves of the survey were asked to indicate whether their homes were in need of any of 12 critical repairs. Results shown in **Table 8** indicate weighted percentages, with doors (46.6%) and windows (34.8%) that leaked were among the top repairs noted. These were followed by foundation cracks or leaks (29.1%), needed roof repairs or replacements (24.4%), porch or steps are dangerous (23.7%) and peeling paint inside homes (22.4%). One in 5 (21.2%) indicated that no repairs were needed, with just fewer than 1 in 5 indicated that their homes were in need of repairs for mold (17.4%) or to electrical wiring (17.1%). About 1 in 7 indicated that their home was in need of repair related to flooding due to sewage or rainwater seepage or backup into the basement (15.2%) or that their plumbing was not working (11.6%). Others indicated that they furnace was

not working properly or they did not have a furnace (8.3%) or that they were in need of wheelchair ramps to assure access to their home (4.2%).

Table 9: Proportion indicating that their house has air conditioning for all or part 2018 survey (n=146, weighted percent).	
	Percent
No	32.7%
Yes, but is not working	4.9%
Yes, Central Air - for entire house	18.5%
Yes, Window units for some or all rooms	43.9%

Table 9 shows weighted percentages for responses to survey items asking respondents whether they had air conditioning and if so, whether it was for the entire home or a portion. One in 3 respondents (32.7%) indicated that their home did not have air conditioning. Two in five respondents (43.9%1) indicated that their home had window unit air conditioning in some or all rooms, and 18.5% indicated that their home had central air for the entire house. One in 20 (4.9%) indicated that their home had air conditioning but it was not working.

Respondents living in homes with air conditioning were also asked how often they used it. Of those with air conditioning, 40.5% indicated that they used it "most or all of the summer," 32.2% indicated that they used it "usually on the hottest days," and 27.3% indicated that they used it "only on the hottest days."

Table 10: Proportion of respondents reporting use of selected heating sources (2018: n=146, weighted percent)	
	Percent
Forced air vents (furnace)	78.6%
Radiators (steam or hot water)	10.7%
Electric baseboard heaters	2.6%
Wood burning stove/furnace	3.0%
Electric space heater	8.5%
Kerosene space heater	1.1%
Propane space heater	0.8%
Range or oven with door open	1.5%
Other	2.9%

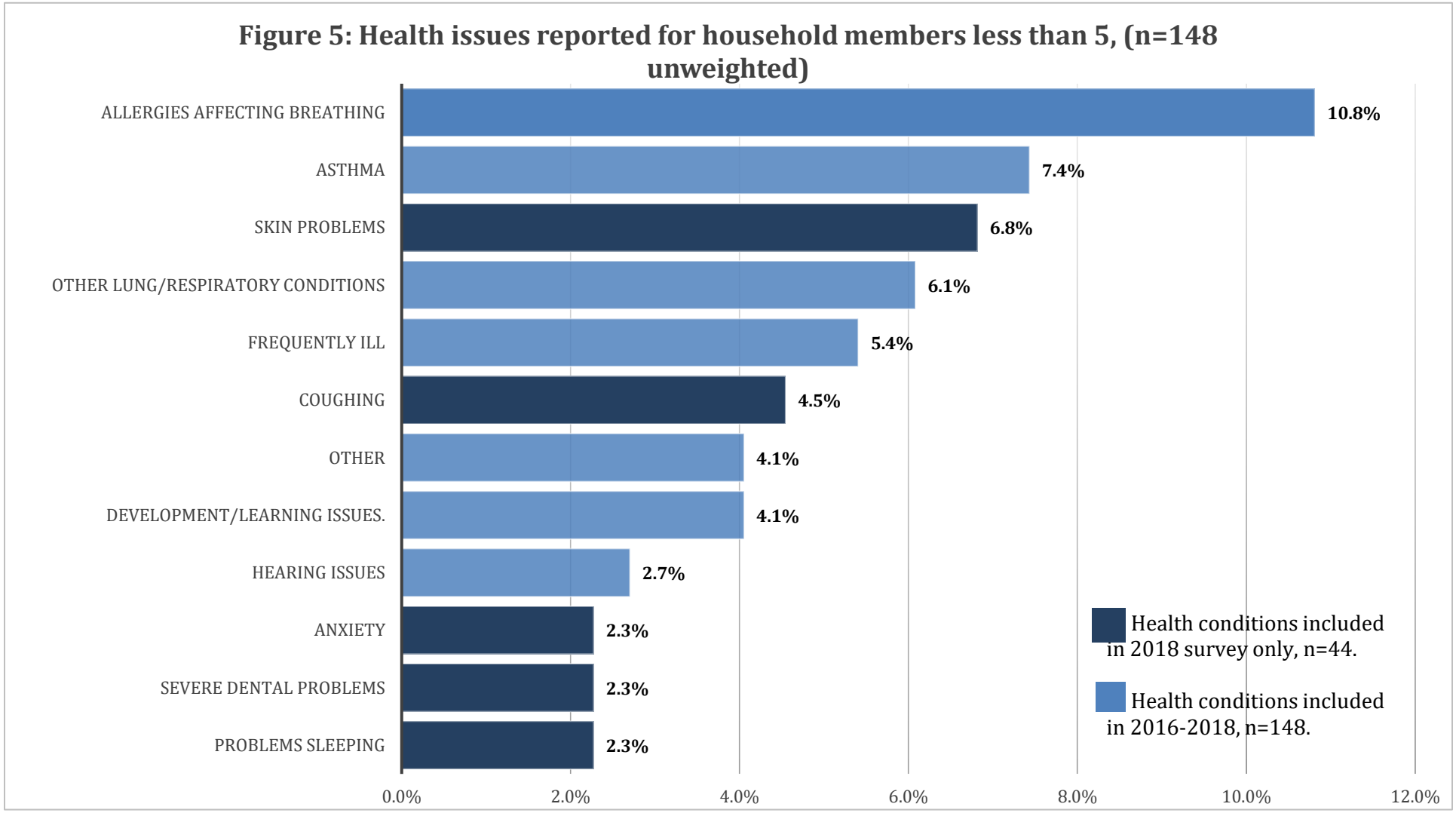
Table 10 shows responses to a question about heating sources in residents' homes. Over three in four (78.6%) respondents indicated that they used a forced air furnace, with 10.7% indicating steam or hot water radiators and 8.5% indicating electric space heaters. Smaller numbers reported using electric baseboard heaters, wood burning stoves or furnaces, kerosene or propane space heaters, or a range or oven with the door open.

Of those who reported having a furnace in their home, 84.2% reported using a filter in their furnace; 12.0% indicated they did not, and the remaining 3.8% reported that they did not know if there was a filter in their furnace (data not shown, weighted percentages). Of those who used a filter in their furnace, 55.1% indicated that they changed the filter 1-2 times per year; 38.9% reported changing furnace filters between 3 and 6 times per year; and 6.0% reported that they changed the filters in their furnace between 10-12 times per year (weighted percent). One in seven (16.0%) indicated that they regularly used other indoor air filters in their home, including non-HEPA paper or cloth filters (29.2%), deodorizer (e.g., carbon) (10.0%), HEPA (3.3%), ionizer (6.6%) or electrostatic (2.0%) filters. Furnace filters play a role in cleaning particulate matter from indoor air; their effectiveness in capturing indoor air particles is influenced by presence, type and frequency of replacement.

Of the participants in the 2018 survey, 31 were eligible for participation in the Bridging Neighborhoods I-75 Environmental Mitigation Program. Of those, 72.2% were currently considering participating in this opportunity to upgrade their homes to reduce adverse effects of air pollutants. 15.4% indicated that they might consider it in the future, and 12.3% indicated that they were unlikely to consider it at any point.

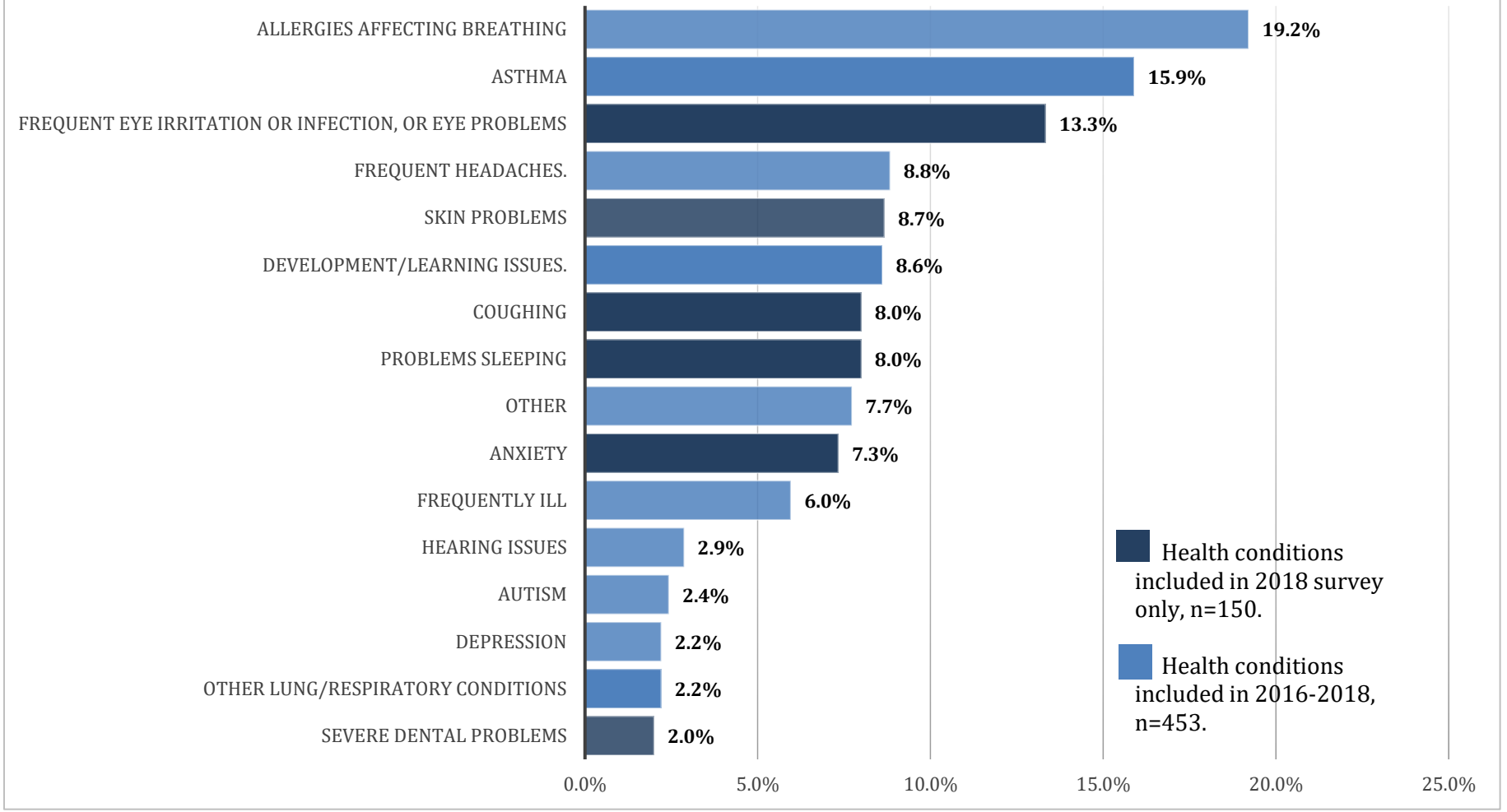
5.4 Health status of household members

Survey respondents were asked to report on the health of other members of their household. In this section, we report results on health status, inclusive of all household members (n=1,629), with exceptions described later in this paragraph. Data are reported by age group, with n's for the full sample as follows: children <5 (n=148); children aged 5 to 17 (n=453); adults aged 18 to 40 (n=493); adults aged 41 to 64 (n=417); and adults aged 65 and older (n=115). The denominator for percentages shown was the total number of household members in that age group, 2016-2018, with the following exceptions: response options that were available only in 2018 used the number of household members in each respective age group in the 2018 survey only as the denominator (shown in dark blue) (children <5, n=44; children 5-17, n=150; 18-40, n=184; 41-64, n=151; 65+ n=36); and in calculating the proportion of miscarriages, the denominator was the number of women in each age group. In the 2016-2017 survey, gender was recorded for the respondent only, and in the 2018 survey gender was recorded for all household participants. Thus the denominator for calculating the proportion of women who reported miscarriages in each age group was the sum of women respondents in 2016-2017 plus the number of women respondents plus household members in 2018: women aged 18-40, n=164; women aged 41-64, n=170; and women 65+, n=55. Health issues reported by fewer than 2% in any age group are not included in the figures. Because health status is reported stratified by age, percentages reported are unweighted.



Results for reported health problems for children under the age of 5 living in survey households are shown in **Figure 5.** Of the 148 children under the age of 5 on whom data was obtained, 10.8% were reported to have allergies affecting breathing, followed by asthma (7.4%), skin problems (6.8%), and other lung/respiratory conditions (6.1%). Between 4-5% of children under 5 were reported to have frequent illnesses, coughing, other health issues not included in the pre-identified list, and developmental/learning issues.

Figure 6: Health issues reported for children aged 5 to 17 (n=453, unweighted)



Health problems reported for those in the next age group, 5-17 (n=453), are shown in **Figure 6.** In this age group, nearly 1 in 5 children were reported to have allergies affecting breathing (19.2%). The second most commonly reported health issue was asthma (15.9%). Frequent eye irritation or infections or other eye problems were reported for 13.3% in this age group and 8.8% reported frequent headaches. Between 8 and 9% reported skin problems, developmental or learning issues, anxiety, coughing or problems sleeping. Six percent reported frequent illnesses, and between 2-3% in this age group reported hearing issues, autism, depression, other lung/respiratory conditions and severe dental problems.

Figure 7: Health issues reported for adults aged 18 to 40 (n=493, unweighted)

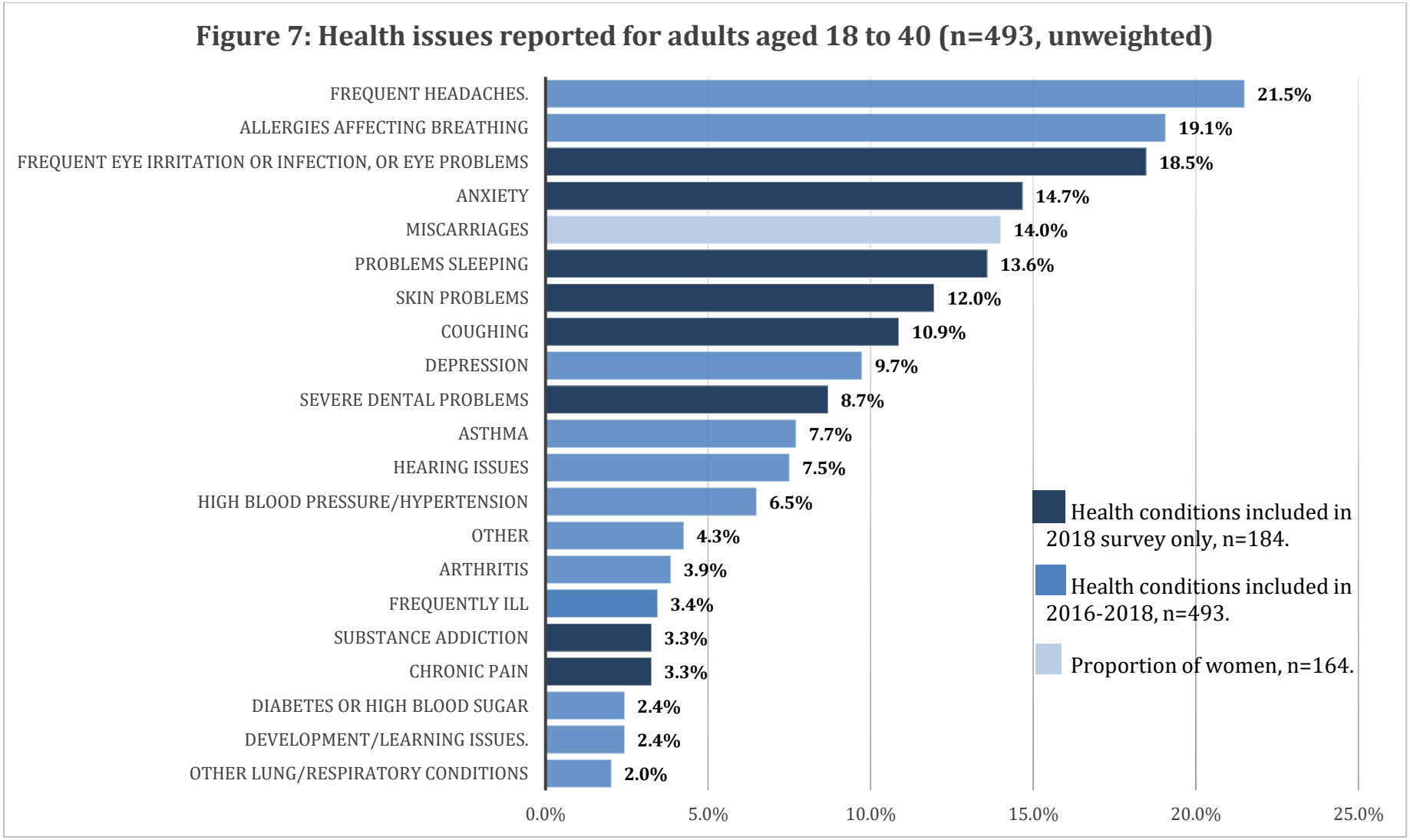
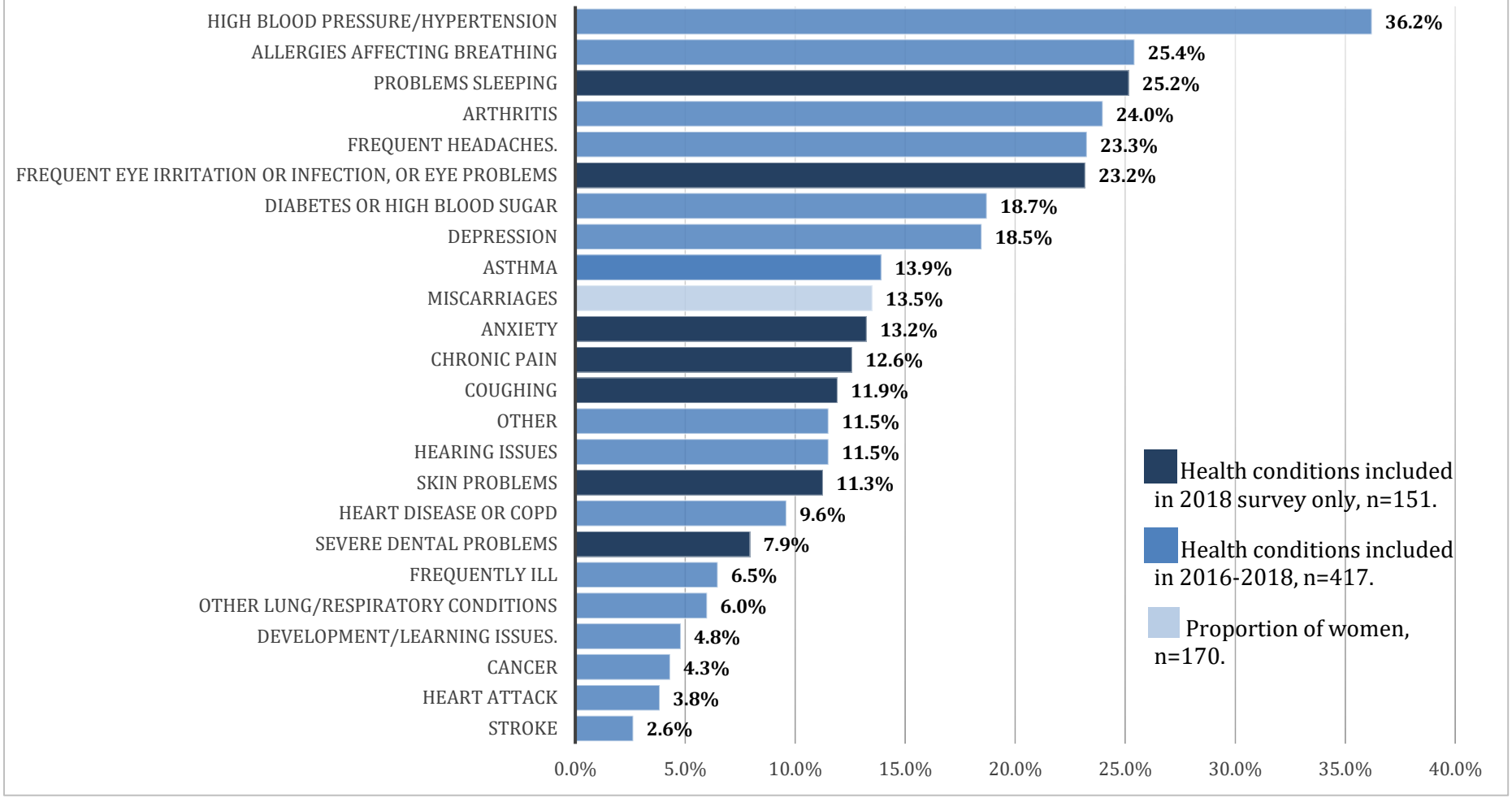


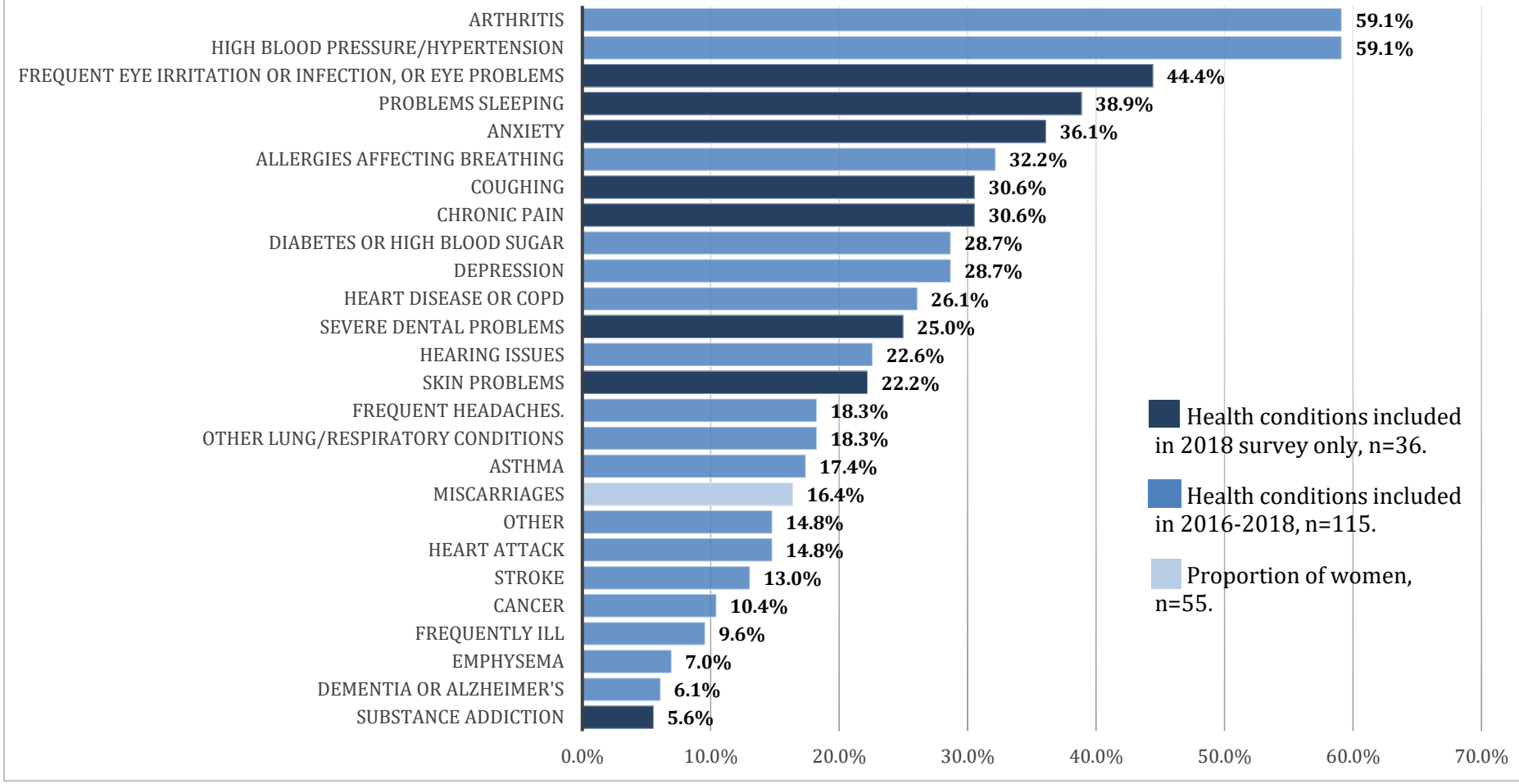
Figure 7 shows the distribution of health issues reported for those aged 18-40 (n=493). About 1 in 5 in this age group report frequent headaches (21.5%) and allergies affecting breathing (19.1%). Frequent eye irritations or infections or other eye problems were reported by 18.5%, 14.7% reported anxiety, 13.6% problems sleeping, and 12.0% reported skin problems. These were followed by coughing (10.9%), depression (9.7%), severe dental problems (8.7%), asthma (7.7%), hearing issues (7.5%) and high blood pressure (6.5%). Fourteen percent of women in this age group were reported to have experienced a miscarriage.

Figure 8: Health issues reported for adults aged 41 to 64 (n=417, unweighted)



Among adults aged 41 to 64 (n=417), shown in **Figure 8**, the most commonly reported health problem was high blood pressure or hypertension (36.2%). Roughly 1 in 4 reported allergies affecting breathing (25.4%), problems sleeping (25.2%) arthritis (24%), frequent headaches (23.3%) and frequent eye irritation or infections or eye problems (23.2%). About 1 in 5 reported diabetes (18.7%) or depression (18.5%), with 13.9% reporting asthma and 13.2% reporting anxiety. Additional health problems were reported by 12% or fewer in this age group. Among women in this age group, 13.5% were reported to have experienced a miscarriage.

Figure 9: Health issues reported for adults aged 65 and older (n=115, unweighted)



Health issues reported for those aged 65 and older are shown in **Figure 9** (n=115). Among those in this age group, the most frequently reported health issues were arthritis (59.1%) and high blood pressure or hypertension (59.1%). Two in five reported frequent eye irritation or infection (44.4%), followed by problems sleeping (38.9%) and anxiety (36.1%). About a third reported allergies affecting breathing (32.2%), 30.6% reported coughing, 18.3% reported other lung or respiratory conditions and 17.4% reported asthma. Roughly one in three reported chronic pain (30.6%), followed by diabetes (28.7%), depression (28.7%), heart disease or COPD (26.1%) or severe dental problems (25.0%). About one in five reported hearing issues (22.6%), skin problems (22.2%), or frequent headaches (18.3%). About 16% of women in this age group reported having experienced a miscarriage. Other health problems were reported by 15% or fewer in this age group.

Given substantial evidence of adverse health effects of residing near to heavily trafficked roadways, particularly those with high levels of diesel truck traffic, we examined whether there were differences in frequency of reported allergies or asthma between residents living within 500 feet and those living further than 500 feet from heavily trafficked roadways. Results are shown in **Table 11.** In all age strata the proportion of reported asthma reported was greater for those residing near heavily trafficked roadways. The same was true for allergies and asthma combined.

Table 11: Percent reported asthma by age group among those living 500 feet or less and more than 500 feet from heavily trafficked roadways (unweighted data, 2016-2018, n=1690)

		GHIB Area		GHIB Area
	Age Group	<=500 feet	>500 feet	All
Asthma	Under 18 years*	16.3%	11.6%	13.8%
	Under 5 years	9.8%	4.6%	7.4%
	Age 5 to 17	19.0%	13.4%	15.9%
	Age 18 to 40 years	9.1%	6.6%	7.7%
	Age 41 to 64 years	14.4%	13.6%	13.9%
	65 years and over	24.4%	12.9%	17.4%
Allergies affecting breathing or asthma	Under 18 years**	28.7%	20.4%	24.3%
	Under 5 years	18.3%	10.6%	14.9%
	Age 5- 17**	33.0%	22.9%	27.4%
	Age 18 to 40 years	25.5%	20.9%	22.9%
	Age 41 to 64 years	34.8%	29.7%	31.9%
	65 years and over	42.2%	32.9%	36.5%

*p<0.10 **p<0.05

Table 12 presents comparisons of asthma rates for the city of Detroit and the state of Michigan, based on the Michigan Behavioral Risk Factor Surveillance Survey (MiBRFS), 2014-2016. In Detroit, the prevalence of asthma was 14.3% among children under 18. The prevalence of asthma was also higher among adults in Detroit than in Michigan.[62]

Table 12. Prevalence of asthma among children under 18 and adults for Detroit and Michigan, 2014-2016.[1]

	Detroit		Michigan	
	Current asthma	95% CI	Current asthma	95% CI
Children under 18[2]	14.3%	10.5%, 19.1%	8.9%	7.7%, 10.3%
Adults[3]	14.7%	12.4%, 17.3%	10.7%	10.2%, 11.5%

[1]Source: Michigan Behavioral Risk Factor Survey, 2014-2016, Michigan Department of Health and Human Services
[2]Respondents were asked, "Has a doctor, nurse or other health professional EVER said that the child has asthma?". If they answered "Yes" they were asked "Does the child still have asthma?" (reported as “current asthma” in table).
[3]Respondents were asked, "Has a doctor, nurse or other health professional EVER said that you have asthma?". If they answered "Yes" they were asked "Do you still have asthma?"

Birth outcomes.

A body of scientific literature suggests an association between traffic-related air pollution and adverse birth outcomes.[63] [64] [65] **Table 13** shows results from vital statistics data showing infant mortality (deaths to infants <12 months), Low Birth Weight (LBW, <2500 grams at birth) and preterm delivery (infants born prior to 37 completed weeks of gestation) for the 48209 zip code (which encompasses the entire survey area and also includes other neighborhoods of Southwest Detroit), Detroit City, and for the state of Michigan. All data are reported as three-year averages for the years 2014-2016. Infant death rates per 1000 live births are higher in the 48209 zip code compared to Detroit and the state of Michigan. The proportion of LBW infants and the proportion of infants born prematurely are both higher in 48209 compared to the state of Michigan, but lower than for the city of Detroit. Contributors to potentially heightened rate of mortality among infants in their first year of life should be considered in future work.

Table 13: Three Year Average (2014-2016) Birth Outcomes and Infant Deaths - Zip Code 48209, Detroit, and Michigan

	48209	Detroit	Michigan
Infant Death Rate (per 1000)	11.8	8.8 ± 3.6	5.1 ± 0.3
% Low Birth Weight (<2500 g)	9.6%	14.2%	8.5%
% Premature (<37 weeks)	10.5%	14.0%	9.9%

5.5 Resident requests for how to address concerns

In this section, we present themed responses to the open-ended question: "With regards to the new bridge, if decision-makers could do one thing to address your, your families' or your neighbors' health concerns, what would you request?" We have grouped responses into three major categories: 1) actions that reduce pollution emissions and other potential adverse effects of the bridge; 2) actions that reduce residents' exposure to pollutants and other potential adverse effects of the bridge; and 3) actions that recognize potential adverse effects of the bridge on residents' health, and increase access to health care or other resources to address them. Within each of these categories, we present results organized thematically, with examples of responses in the language of the respondents themselves.

5.5.1 Reduce emissions and other adverse environmental conditions (e.g., noise, vibrations) in the GHIB area

Survey respondents offered multiple suggestions for strategies to reduce air pollution in the neighborhood, including requests to reduce truck emissions, reduce the amount of truck traffic and congestion, reduce noise and vibrations from trucks and heavy equipment, reduce other pollutant sources impacting the neighborhood, and a request to simply not build the bridge in their neighborhood.

Reduce truck emissions. Multiple respondents requested (n=17) that emissions from trucks be reduced during the operations phase and from heavy construction equipment during the construction phase of the bridge. Examples included:

> *Pongan cosas en los camiones para reducir la contaminación (Retrofit the trucks to reduce contamination)*
>
> *Reduce diesel emissions from trucks*
>
> *Mandatory emission standards on semi-trucks to keep it [emissions] to a minimum, but affordable for truck owners to improve emissions*
>
> *Que hagan mandato reducir la contaminación e inspeccionar el humo de los camiones como lo que hicieron en California (Mandate a decrease in contamination by inspecting truck emissions, as they did in California)*

Limit truck traffic. Requests also include limiting the number of trucks to reduce congestion and other challenges associated with traffic in the neighborhood (n=20). Many focused specifically on truck traffic: For example, one resident recommended "Make a truck maximum limit during the day so that the bridge traffic

doesn't affect residents trying to leave the area." Another noted the need to reduce congestion but went beyond to comment on the need to protect residents from the contents of the trucks moving through the neighborhood: "Reduce truck traffic congestion, prevent leaking and escape of toxic loads." Additional requests included: "eliminate traffic congestion and pollution emissions," and "do something with the traffic, it is horrible."

Address noise, vibrations and safety hazards associated with heavy trucks and equipment. Multiple requests focused on reductions in noise, vibrations and safety hazards associated with large trucks and construction equipment in residential areas (n=23). These included requests to "reduce pollution and noise," "reduce vibrations from traffic," and to "address safety related to traffic" including the need for lights in the neighborhood. Specific requests were made to "limit night construction," "take into account the noise and the excavation tremors can affect the housing," and requests to address "the noise and smells."

Address stationary pollution sources contributing to cumulative risk. Several respondents (n=9) also made requests that recognized the multiple stationary as well as mobile pollution sources that contributed to poor air quality in the GHIB area, as well as the role played by proximity of industry to the GHIB residential neighborhoods in shaping truck traffic. These included, for example "get rid of some of these polluting factors" and "close the factory in front of my home."

Don't build the bridge. Finally, a group of requests (n=12) simply asked that the bridge not be built, or be relocated to another neighborhood, in order to reduce the amount of air pollution within their neighborhoods. Examples of such requests included "don't build the bridge" and "try to look for another alternative to do their project and not impact us or the community."

5.5.2 Reduce exposure to pollutants and adverse effects

A second broad category of requests made in response to this question were those focused on reducing the exposure of neighborhood residents to pollutants and noise associated with construction and operation of the bridge.

Home improvements to reduce the amount of outdoor air that gets indoors. Perhaps reflecting the strong ties to neighborhoods and neighbors described in **Tables 3 and 4**, the largest number of requests focused on reducing pollution exposures among those who remained living in the neighborhood. Thirty-five requests made by survey respondents were requests for air filters or indoor filtration systems for homes proximate to the GHIB footprint, and an additional 6 requested other home improvements designed to reduce the amount of outdoor air pollution that makes its way indoors, reduces noise or address the impact of vibrations on houses. Examples include:

> *New windows and stopping pollution going inside the homes*
>
> *Air filters, central air*
>
> *Provide air filters for the interior of the home because my daughter has asthma*
>
> *Sound reduction*

Compensation for damage or reductions in home value. Residents also requested recognition of, and compensation for, adverse impacts of bridge construction on home condition and value. Requests included, for example:

> *Compensate the families near the bridge*
>
> *Keep (maintain) the value of my home*
>
> *After the construction is over, pay for the damage to my home like when tremors and vibrations occur to my house*

Home buyouts and assistance with relocation. The second most common request within the broad area of reducing residents' exposure to air pollutants from the bridge were for home buy-outs or other support for residents to move away from the area of the bridge (n=30). These included multiple requests to "buy our house", and others such as:

Help us find a place or an apartment before the construction of the bridge

To buy our houses for the children's health and adult health

Buy my home and help my family relocate

Buy homes within 500 yards [of the bridge]

Get us out of here

Requests in this category included requests by renters for assistance with relocation, in addition to homeowners.

Build walls or create buffers to protect residents from pollution and noise. Respondents requested that walls (n=15) or spatial or vegetative buffers (n=11) be constructed to create barriers between the bridge and associated truck traffic and residential areas. Examples included, for example:

[Build a] buffer wall along the service drive to reduce noise and pollution

A wall along the service drive to keep some of the noise away and pollution down, because I am currently pregnant

Build a wall along the service drive like along the Southfield Freeway

Get that barrier wall up

Residents also requested the creation of more green space in general and in particular planting of trees and vegetation between the heavily trafficked roadways and residential areas in order to reduce the amount of pollution traveling from the freeway to residential areas. Examples included:

[My request is] that they create more green spaces and upkeep them, not just abandon what they throw at the community and expect people to do the [maintenance] work for them

More trees, buffers, parks for the environment

Plant more trees

Create new truck routes that avoid residential neighborhoods. In keeping with quantitative findings reported in **Table 8** indicating that over 50% of survey respondents ranked concerns about trucks on residential streets as a "very great concern" in their neighborhoods, several of the qualitative responses to the question regarding requests to address concerns specifically described the need to create truck routes that avoid residential neighborhoods (n=15). Examples include:

Keep trucks on the freeway and off residential streets

Truck re-routing and crossing fee for trucks in the neighborhood

Different routes for trucks, time limits for when trucks go down side streets

In addition, several residents made specific suggestions for ways to structure the built environment to reduce residential exposure to truck traffic (n=4). These included:

No ramp by my house

Cul-de-sac at the freeway

Make the street a dead end street

5.5.3 Reduce the adverse effects of pollution on residents

Finally, there were many requests by neighborhood residents for recognition of, and resources to help address, the adverse effects of pollution on the health of residents. These included requests that decision makers take health impacts on local residents into consideration, particular attention to the impacts on vulnerable residents such as children and the elderly, specific requests for information and monitoring of health impacts over time, and requests for improved access to health care resources needed to address the adverse impacts of the bridge on the health of residents.

Consider the impacts of the bridge on the health and safety of residents. Over 40 responses fell into this category. Of those, a subset (n=14) were requests for consideration by decision makers of the impact of the bridge on the health of residents broadly, including for example:

Look into safety and health, think about the people that have been here for years

Protect the residents' health

Safety and health - please be aware of what is happening with our health

Take into account the residents' health and the impact it will cause

Others focused more specifically on vulnerable subgroups of the population, including families and children, those with existing health conditions, and the elderly. Examples of comments that were explicitly concerned about protections for vulnerable subgroups include:

Take our children health in consideration and their safety

Help those who will be affected protect their health

Protect the children's health and be cautious

Take in consideration the health of the community the children and moms to be and adults

Take into account children's health

La salud de la familia (Family health)

Think about our children's health and themselves in our shoes

[Protect] my children's health, especially my daughter's - she has many conditions already

Emissions are hard on old people

Consider the people especially the seniors

These requests are consistent with substantial evidence that children, those with existing health conditions such as asthma, and the elderly are more susceptible to the adverse health impacts associated with exposure to air pollutants compared with healthy adults under age 65.[66] [67] [68]

Requests for resources to help address health impacts of the bridge. Survey respondents made a number of specific requests for resources to enable them to better understand and address potential adverse health effects of the bridge. These included requests for additional information about local air pollutant levels and health impacts, as well as increased access to health care resources for residents to address health impacts of the bridge among local residents.

5.5.4 Information and Monitoring

Requests for additional information about the impacts of air pollution on health, included, for example:

Mas informacion de como afectan la salud (More information about effects [of pollution] on health)

Mantener comunicación acerca del desarrolló que haya pasado o que pueda pasar (Maintain communication about all the development that has happened or might happen)

In addition, respondents requested ongoing monitoring of truck traffic, air quality and health, and access to that information regarding the results, for example:

Constant monitoring right now of air quality, noise pollution

Monitor truck traffic to make sure it doesn't get out of control

Frequent testing of air and of health of children

Yearly report of air quality so we know that we are safe

Reading levels of pollution and compared to other areas (suburbs)-- public data

Residents also requested additional information about the construction plans, for example:

> *Make us more aware of what's going on - give more information*
>
> *Construction planning maps to share with residents*
>
> *Let everybody know about the plan because people don't know*

Additional resources to address adverse health impacts of bridge. Many survey respondents anticipated that there would be adverse health impacts for residents resulting from the construction and operation of the GHIB, and in keeping with that concern, requested access to resources that could help in reducing or addressing those health impacts. Among these were requests for improved access to health care facilities for neighborhood residents:

> *Un hospital en el barrio que apoye a los residentes con problemas respiratorios (A hospital in the neighborhood to support residents who have respiratory problems)*
>
> *More health facilities and professionals in neighborhood*
>
> *Pagar exámenes para los residentes que están en el área [para monitorear su salud] (Pay for exams for residents of the area [to monitor their health])*

In addition, a substantial number (n=20) of respondents commented on the importance of expanded access to health insurance for those living in the area, anticipating additional need for services as the GHIB was built and became operational:

> *Health insurance in case our health gets bad or worse*
>
> *Help people that don't have insurance*
>
> *Health insurance for me and my family*
>
> *Health insurance if not going to help us move out of here*

The themes summarized in this section, combined with information about the priority concerns of neighborhood residents (**Tables 4 and 5**), literature on effective mitigation strategies, informed the recommendations presented in the following section.

6. Recommendations to Reduce Health Impacts of the GHIB: Public Health Response Strategy

There are many approaches that have demonstrated effectiveness in reducing air pollution by controlling emissions of air pollutants at their source (either stationary or mobile), or once air pollutants have been emitted, to reduce the number of people exposed or the concentrations of air pollutants to which they are exposed,[69] [70] [71] [72] thus mitigating adverse effects on health. Similarly, there are effective strategies to reduce health impacts associated with noise[73] [74] [75] [76] [77] [78] emitted from heavily trafficked roadways.[79] The recommendations below include:

1) strategies that can be used to reduce emissions of air pollutants and/or noise associated with the new GHIB,
2) recommendations for actions that can reduce the exposure of residents to air pollutants and/or noise emitted as a result of GHIB activity, and
3) recommendations that can reduce adverse health effects among residents whose health is impacted by air pollutants and/or noise in the GHIB area.

Recommendations below are informed by baseline health data described above, literature on health impacts associated with air pollutants described earlier in this report[80] [81] [82] [83] [84] [85] [86] [87] [88] [89] [90] and recommendations included in the Community Action to Promote Healthy Environments (CAPHE)'s Resource Manual and Public Health Action Plan to reduce emissions, exposures and health impacts. Many are consistent with recommendations or requests made by survey participants (see **Section 5**), and voiced in community forums as residents described their biggest concerns with regards to health and safety related to the GHIB's construction and operation. For a more comprehensive discussion of scientifically-informed strategies to reduce emissions and exposures and reduce their adverse health impacts, supporting documentation, and examples of implementation in other cities, see the CAPHE Resource Manual and Public Health Action Plan.

6.1 Recommendations to Reduce Emissions

Reducing the amount of pollutants emitted (reducing emissions) is the most effective strategy for reducing adverse health effects, as it eliminates or reduces the amount of air pollution that is released. Recommendations here focus on reducing emissions from mobile sources, given the projected volume of truck traffic over the GHIB, along I-75 and trucking routes through residential neighborhoods. Core recommendations listed below are followed by more detailed discussions.

1) Reduce Idling

   Recommendation 1: Increase enforcement of anti-idling ordinance by enabling multi-agency enforcement

   Recommendation 2: Develop app or add capacity to Improve Detroit app for reporting idling issues

2) Reduce Emissions and Increase Compliance with Air Quality Standards

   Recommendation 3: Enact stronger emission standards for diesel engines

   Recommendation 4: Enact more stringent air quality standards near highways

3) Utilize Clean Fuels

   Recommendation 5: Require and monitor the use of clean fuels throughout the GHIB area during construction

   Recommendation 6: Develop incentive programming to encourage the use of zero-emission vehicles, including cars, trucks, and construction equipment

4) Expand Retrofitting

   Recommendation 7: Expand diesel retrofits and fleet engine replacements

6.1.1 Reduce Idling

Idling and the GHIB

Idling is the running of a car or truck's engine when the vehicle is not in motion. Idling burns fuel unnecessarily, increases fuel costs, and produces emissions that are harmful to human health and the environment.[91] Diesel truck engines burn roughly a gallon of fuel per hour when idling and the EPA estimates that over one billion gallons of fuel are wasted each year due to this practice.[92]

Idling has historically been a significant issue in Southwest Detroit. A 2013 survey indicated that truck pollution was one of the top concerns of residents living in City Council District 6 (which includes Southwest Detroit).[93] In 2018, about 2.4 million trucks crossed the Ambassador Bridge, equivalent to about 6900 trucks each day. The Ambassador Bridge, tunnel, and terminal areas are already locations where a large number of large trucks idle while waiting to enter or leave the USA; idling emissions at these areas can be substantial.[94]

Among respondents to the GHIB HIA survey July−Sept 2018, 66.7% indicated that they were 'very much concerned' by the outdoor air quality, including emissions from trucks or industry, fumes and odor.

Existing Measures to Reduce Idling. Based on community input, the Windsor-Detroit Bridge Authority[95] has taken precautionary measures to mitigate the idling of trucks once the GHIB is operational. First, they have created a 'no-idling' rule for vehicles on the US side of the GHIB crossing, and vehicles being processed through secondary inspection will not be allowed to idle. They also state:

> *In terms of processing, all US-originating, Canada-bound vehicles will be processed at the Canadian Port of Entry. Similar to tolling, any back-ups into the US and onto the I-75 ramps related to inspections, both primary and secondary, would be the result of over 300 vehicles waiting to be processed. For Canada-origination, US-bound vehicles, primary and secondary inspections will take place at the UD port of Entry with any back-ups being along the bridge, through the Canadian Port of Entry and onto Highway 401. Again, in excess of 300 vehicles would be lined up to result in such a back-up*.[96]

The precautionary measures described above should help mitigate backups along the highway, which currently contributes to idling related to the Ambassador Bridge. They do not take into account anticipated increases in truck traffic in SW Detroit more generally as businesses such as warehouses are attracted to the area due to the new crossing. It is likely that idling will remain an issue for residents in SW more broadly, even taking into account the precautionary measures the WDBA has made. Thus we provide two additional recommendations below that would substantially reduce emissions of air pollutants associated with diesel truck idling in the area of the GHIB.

Recommendation 1: Increase enforcement of anti-idling ordinance by enabling multi-agency enforcement

The City of Detroit passed an anti-idling ordinance in 2010, currently enforced by the Detroit Police Department (Traffic Enforcement Division).[97] The anti-idling regulations include: a five minute consecutive idling limit in any 60-minute period, a written warning for a first offense, and a fine of $150 for the operator and $500 to the owner for a second offense. There are several exemptions to this rule, which include: when traffic conditions do not allow for idling, when a truck is motionless for more than 2 hours and temperatures are below 25 degrees F, when trucks are undergoing state inspections, and during hybrid vehicle recharging. Also, idling restrictions do not apply to power auxiliary equipment, emergency vehicles, and electric, hydrogen or natural gas powered vehicles.[98] Enforcement of the existing ordinance by the Traffic Enforcement Department of the Detroit Police Department has been limited.

Enabling multi-agency enforcement is a strategy other cities have used to reduce idling violations. For example, Chicago's 2009 anti-idling ordinance is enforceable by Department of Public Health (CDPH)

inspectors, traffic control aides, parking enforcement aides, and police officers. Enabling multiple agencies to enforce anti-idling ordinances can help to alleviate enforcement issues faced by cities like Detroit.[99]

Recommendation 2: Develop app or add capacity to Improve Detroit app for reporting idling issues

Enforcement of Detroit's existing anti-idling ordinance could be coupled with the use of Detroit's existing Improve Detroit app or a new app specific to idling, which would enable residents to easily report idling issues in their neighborhoods. Improve Detroit is a City of Detroit app that allows residents to report running water, potholes, damaged street signs, and other issues.[100] The app has an option for reporting traffic complaints but no explicit option for reporting idling. Other cities have used apps to promote enforcement of anti-idling regulations. Philadelphia, Pennsylvania implemented anti-idling laws in 2008. The city's air pollution control agency, Air Management Services, is responsible for monitoring air pollutants and enforcing air quality standards. Residents can report idling violations in their neighborhood using a telephone hotline or a web-based mapping tool called IdleFreePhilly.org and clicking on the map where the idling issue is occurring. This information is reported to Air Management Services, and the city's Clean Air Agency can issue a ticket if enough information is provided. In addition, the collected data allows the city to identify and address idling hot spots (see **Figure 10**).[101]

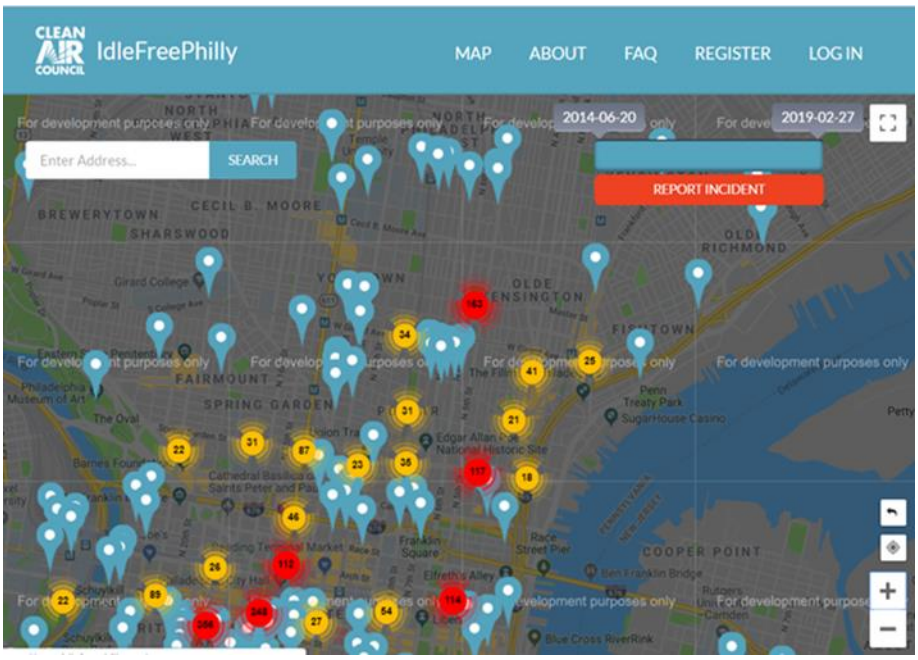


Figure 10: Idle Free Philly

For more information on Idling, see the CAPHE Public Health Action Plan, Chapter 4.

6.1.2 Reduce Emissions and Increase Compliance with Air Quality Standards

Emissions and Air Quality Standards in Southwest Detroit

National Ambient Air Quality Standards (NAAQS) for criteria pollutants are established by the United States Environmental Protection Agency (US EPA), using a systematic process that weighs new scientific evidence on an established schedule. Southwest Detroit is currently out of compliance with established NAAQS for both Sulfur Dioxide (SO_2),[102] and Ozone (O_3).[103] In addition to point sources of pollutants (e.g., industrial emissions), truck emissions are important contributors to air pollutants in Southwest Detroit, due to the amount of industry-related truck traffic and because of the Ambassador Bridge, one of the most heavily travelled international crossings in the United States.

There are several actions that can be taken at a local level to regulate emissions, increase compliance with existing standards, and limit airborne concentrations of pollutants. These include:

(1) Establishing local requirements or standards that limit emissions from point sources or trucks, or that promote dispersion and reduce concentrations of pollutants emitted can substantially reduce local air pollutants from facilities and trucks;

(2) Strengthening equipment and process rules to address the feedstocks, fuels, technological controls and other materials or activities at facilities that emit pollutants can substantially reduce emissions at their source; and

(3) Establishing reporting, disclosure and emergency planning procedures that require local authorities to be informed about routine and emergency emissions can increase monitoring, provide information about non-compliance or violations, and provide information that can be used to increase compliance with existing emissions standards.

For more information, see the CAPHE Public Health Action Plan, Chapter 9.

Recommendation 3: Enact stronger emission standards for diesel engines

> *Mandatory emission standards on semi-trucks to keep it [emissions] to a minimum, but affordable for truck owners to improve emissions.*
>
> *-Survey participant*

In Southeast Michigan, based on MDOT 2015 vehicle registration records, the average age for short-haul trucks is 14.2 and 10.3 years for long-haul trucks for the SEMCOG region.[104] The age of the vehicles serving the industries within the study area (GHIB area) will have truck fleet ages that are likely higher than the regional average.[105] Other jurisdictions have successfully enacted stronger emissions standards to help substantially reduce air pollution burden associated with diesel trucks.[106] California has been successful in phasing out older trucks by creating regulations that require upgraded engines.[107] Regulations that require operators in the GHIB area or SE Michigan to meet 'health-based requirements' prior to registering their vehicles, and that require older vehicles to be replaced with a 2011 or newer vehicle, or repowered with a 2010 or newer engine,[108] could realize substantial reductions in emissions from diesel engines in the GHIB area. Promoting investment in engine upgrades and retirement of older vehicles should be a high priority. Several opportunities exist to upgrade the trucking fleet. These include: continuing to support funding for the federal Diesel Emissions Reduction Act to support transportation hub areas, investment of federal funds from settlements with auto companies for diesel emissions violations (e.g. Volkswagen) [109], which could be invested in engine upgrades or replacements in Southwest Detroit and Wayne County where the diesel emission burden is highest in the state due to the border crossings and heavy industry.

> *Keep trucks on the freeway and off residential streets*
>
> *Truck re-routing and crossing fee for trucks in the neighborhood*
>
> *Different routes for trucks, time limits for when trucks go down side streets*
>
> *-Survey participants*

Recommendation 4: Enact more stringent air quality standards near highways

An important way to combat air quality issues in Southwest Detroit would be to enact more stringent air quality standards that recognize the cumulative impacts of air pollutants from multiple sources and recognize that the adverse impacts of air pollutants disproportionately affect low income communities and communities of color.

While federal air quality standards are established by the Environmental Protection Agency (EPA), there are opportunities for states and municipalities to enact air quality standards at the state and local level to promote cleaner air and equity. Examples include the California Air Resource Board's (CARB) program to protect the

areas most impacted by pollution. Through this program, the State works with local pollution control agencies and community-based organizations to focus monitoring, enforcement and regulatory activities on the sources of greatest concern to residents. This approach was established by Assembly Bill 617, and signed into law in July 2017. To date they have selected 10 communities to participate in the program. These communities have the highest cumulative impacts from multiple air pollution sources.[110] In 2008 the Minnesota legislature passed a law that affects how the Minnesota Pollution Control Agency (MPCA) evaluates air permit applications. The new law requires an analysis of the "cumulative levels and effects of past and current pollution" before a permit can be issued.[111]

Either of these programs can serve as models for a similar cumulative risk assessment in the City of Detroit, and in Southeast Michigan more broadly. Focusing monitoring, regulatory and enforcement efforts in areas near highways or other heavily trafficked roadways, and in areas with high levels of cumulative risk due to multiple emissions sources, can help to document levels, including exceedances, and reduce pollutants in areas experiencing the cumulative impacts of air pollutants from diesel engines and other sources.

In addition, federal air quality standards are established by the Environmental Protection Agency (EPA) according to an established process that relies on scientific evidence. Active participation of scientists, public health professionals and community members in this process can help inform the regulatory standards set, which must take into consideration scientific evidence of health impacts and population vulnerabilities and susceptibilities. EPA has efforts underway to improve engage scientists and affected communities in this process.[112]

6.1.3 Utilize Clean Fuels

Clean Fuels and Southwest Detroit

"Clean fuels" that have low emissions of air pollutants can be used to power cars, trucks, buses and other on-road vehicles, as well as non-road vehicles and equipment such as construction vehicles, cranes and pumps. Examples of clean fuels include most types of ethanol, biodiesel, natural gas, biogas, electricity, propane and hydrogen.[113] Some of these fuels can be substituted directly for conventional fuels, while others require special equipment or retrofits.[114]

Recommendation 5: Require and monitor use of clean fuels throughout the GHIB area during the construction process[115]

The WDBA has multiple guidelines relating to clean fuels for the construction phase of the GHIB. They are:

- ensure that all non-road engines (i.e. generators) meet EPA Tier 4 emission standards
- use the best available diesel retrofit control technology
- develop and follow anti-idling protocols to aid in reducing diesel emissions
- use ultra-low sulfur fuels for all equipment
- limit the age of on-road vehicles used in construction or requiring diesel particulate traps and oxidation catalysts
- minimize engine operations
- restrict construction activities around certain more sensitive receptors
- institute fugitive dust control plans
- use existing power sources or clean fuel generators, rather than temporary power generators.

Adherence to these guidelines would result in substantial reductions in emissions in the GHIB area as compared to emissions anticipated without adherence to the guidelines. To assure their implementation, the WDBA should create a transparent strategic plan and monitoring process to ensure accountability in the application of these guidelines and use of clean fuels throughout the construction process. These guidelines are transferrable to other uses and could subsequently be applied to reduction in emissions more broadly.

Recommendation 6: Develop incentive programming to encourage the use of zero-emission vehicles, including cars, trucks, and construction equipment

The use of zero-emission vehicles in Detroit and/or Michigan could be facilitated by development and implementation of incentive programs that encourage their use. Delaware's Clean Transportation Incentive Program, for example, promotes wider use and acceptance of electric and clean fuel vehicles, and seeks to boost investment in clean fuel infrastructure using a clean vehicle rebate program, heavy-duty vehicle rebate program, electric vehicle charging infrastructure rebate program, alternative fueling infrastructure grants, and innovative transportation greenhouse gas reduction grants.[116]

For more information on Clean Fuels, see CAPHE Public Health Action Plan, Chapter 5.

6.1.4 Expand Diesel Engine Retrofits

Diesel Engine Retrofits and Southwest Detroit

Diesel engine retrofitting involves installing more modern and effective emission controls on older diesel engines, or replacing older diesel engines with new cleaner ones. Diesel retrofits can be used on trucks, buses, off-road construction vehicles (e.g., dump trucks, cranes), diesel-powered equipment (e.g., generators, pumps), ships and trains. Retrofits can significantly reduce emissions and can be more cost-effective than vehicle replacement.[117] [118]

Recommendation 7: Expand diesel retrofits and fleet engine replacements

Retrofitting old diesel engines with effective emission controls and replacing old diesel engines can significantly reduce pollution.[119] Emissions of pollutants including diesel exhaust PM2.5, a cancer-causing pollutant, are greatly lowered by new technologies like oxidative catalysts and diesel particulate traps – technologies entirely lacking on diesel engines in buses and trucks built before 2007.[120] [121] Retrofits can be used on trucks, school buses, construction vehicles (e.g. dump trucks, cranes), diesel-powered equipment (e.g. generators, pumps), ships and trains. Retrofits would particularly benefit the residents living near busy roads, children riding school buses (70% of DPS's bus fleet is diesel),[122] and truck drivers who are exposed to air pollutants from their trucks while driving.

> *Pongan cosas en los camiones para reducir la contaminación*
>
> *(Retrofit the trucks to reduce contamination)*
> *-Survey participant*

For more information on Diesel Engine Retrofits, see the CAPHE Public Health Action Plan, Chapter 3.

6.2 Reducing Exposures

Once pollutants have been emitted from trucks or construction equipment associated with the new bridge, health benefits can be attained by minimizing the exposure of workers and residents to those air pollutants. Strategies that can be used to minimize population exposure to air pollutants include modification of truck routes to avoid populated areas, buffers that put distance between sources of emissions and people, barriers that block pollutants from going into residential areas, or indoor air filters that clean air pollutants from the indoor air.

Recommendations to Reduce Exposures:

1) Move Truck Routes

   Recommendation 8: Establish and enforce trucking routes that have the least impact on residential neighborhoods and areas with sensitive populations

2) Require Spatial Buffers

   Recommendation 9: Require spatial buffers of at least 500 feet between heavily trafficked roadways and land uses with sensitive populations (e.g. schools, hospitals, clinics, and nursing homes)

Recommendation 10: Expand relocation opportunities to a minimum of 500 feet and increase uptake of Home Swap Program among eligible families

3) Install Vegetative Buffers

Recommendation 11: Plant vegetative buffers in strategic places near the GHIB, prioritizing residential areas and land uses with sensitive populations (i.e. schools, hospitals, clinics and nursing homes), freeways, heavily trafficked roadways, areas with high cumulative risk, and areas where setback criteria are not met

Recommendation 12: Plant trees throughout Southwest to replace those cut down during the during the initial construction phase of the GHIB

4) Extend Filter Programming

Recommendation 13: Extend programming for high-efficiency filters and other retrofits in homes near construction yards and site for the Gordie Howe International Bridge, up to 500 feet from roadway

6.2.1 Move Truck Routes

Due to the crossings and industrialized nature of Southwest, trucks often route through secondary roads in SW Detroit neighborhoods. SEMCOG recently completed a truck count, which tracked the number of light, medium and heavy class trucks on secondary roads in and around the current bridge footprint. **Figure 11** shows the SEMCOG Study Area, and **Figure 12** shows the average percent of medium and heavy trucks on weekdays along key points within the study area.

Figure 11: Southeast Michigan Council of Governments (SEMCOG) Study Area

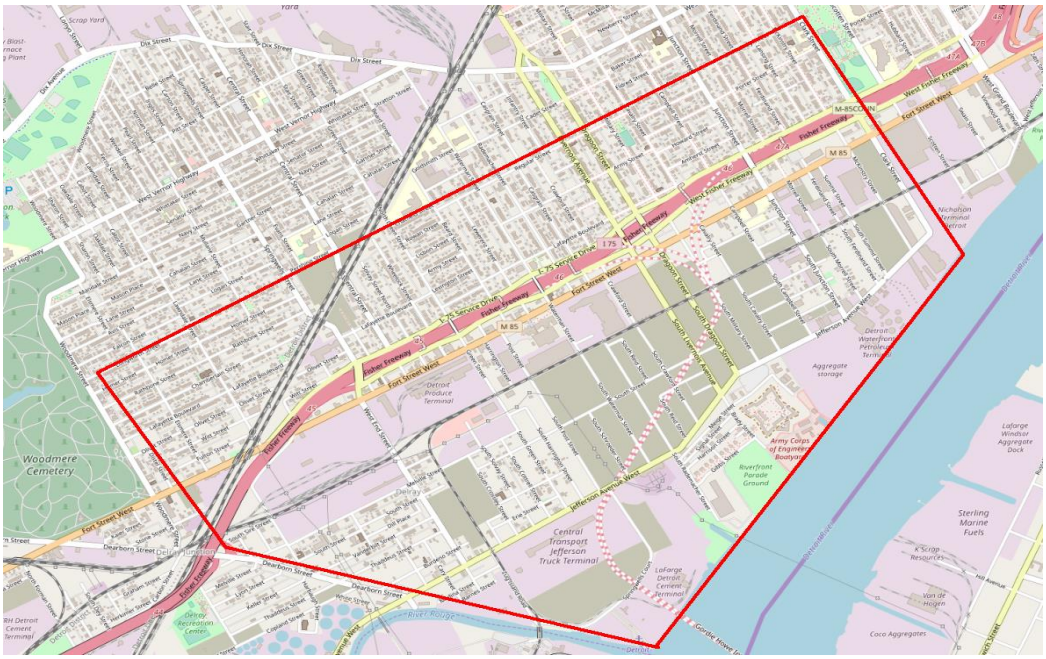


Figure 12: Average Weekday Percent Medium and Heavy Trucks

Recommendation 8: Establish and enforce trucking routes that have the least impact on residential neighborhoods and areas with sensitive populations (i.e. that do not route through or near neighborhoods, child serving or senior serving institutions, health care organizations)

Among GHIB survey respondents (2018), 54.8% indicated that safety related to truck traffic on residential streets was “very much a concern” and multiple open-ended survey responses emphasized this importance of addressing this issue. Residents participating in community meetings regularly report truck traffic through neighborhoods. Establishing strict trucking routes that avoid residential areas and enforcing them could substantially lessen emissions of air pollutants in residential areas in SW Detroit near the GHIB. Enforcement of these routes will be critical to the effectiveness of this recommendation and can serve as a potential revenue source for the City.

6.2.2 Require Spatial Buffers

Spatial buffers and Southwest Detroit

Spatial buffers are strips of land located between sources of pollution (e.g., roadways), homes, schools or other places where people spend time where they may be exposed to air pollutants. Often, concentrations of air pollutants from vehicle emissions are highest close to their source, and are lowered as distance from the source increases. Spatial buffers work by creating greater physical separation between the pollution source and places where people are, such as schools, playgrounds, childcare centers, health care facilities, rehabilitation centers, convalescent centers, hospitals, retirement homes, or residences. Spatial buffers around roadways can be supplemented with vegetation and sound barriers, particularly if the buffer is close to the roadway, enhancing the protection of people nearby (see vegetative buffers recommendations).[123]

Buffers, walls and windbreaks work most effectively for sources that release pollutants at or near ground level (like exhaust emissions from vehicles, and entrained dust from storage piles) and that are located just upwind of the buffer or barrier. Vehicle emissions of $PM_{2.5}$ and diesel exhaust are particularly important examples of such sources and pollutants.

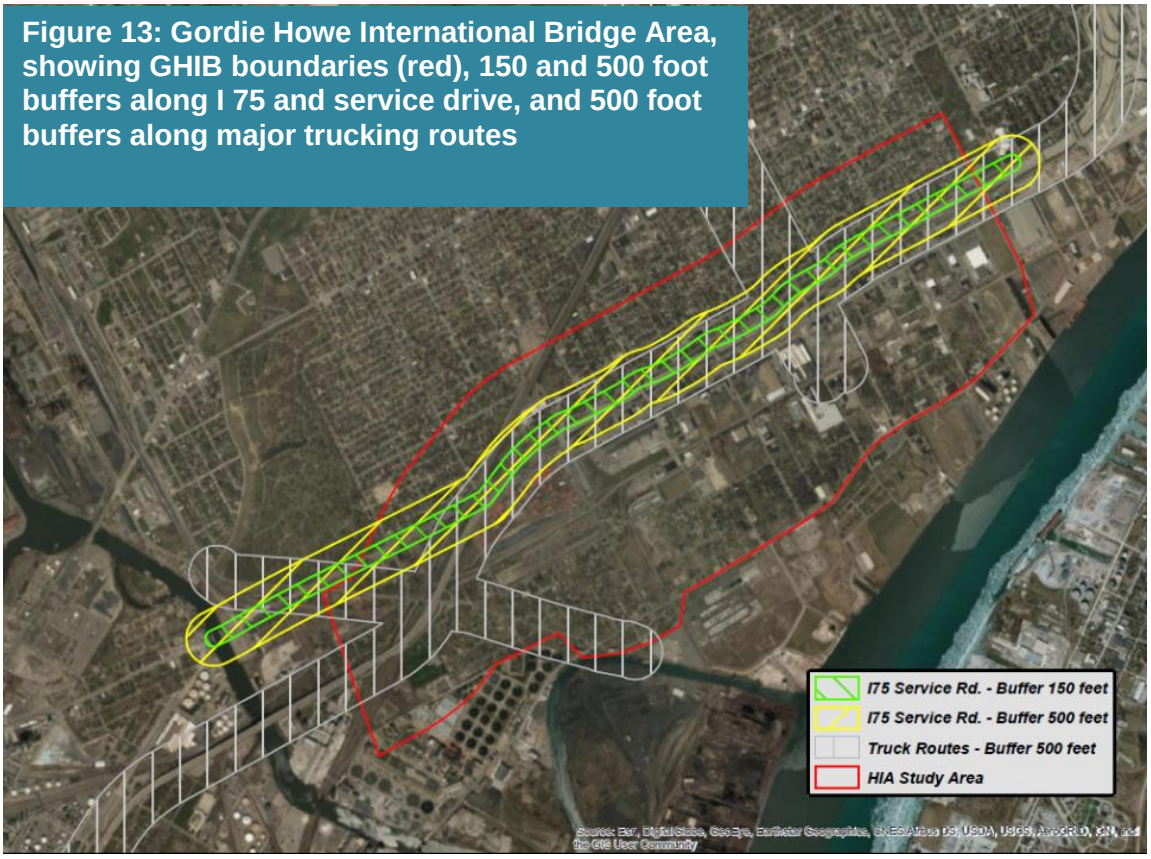
Living next to highly travelled roadways is associated with negative health outcomes.[124] In the City of Detroit an estimated 69,000 (about 10%) residents live within 150 meters (about 500 feet) of a major freeway.[125] In the GHIB area, an estimated 2,513 residents live less than 500 feet from a heavily trafficked roadway. This represents about 16% of all residents of the GHIB survey area, and about 32% of residents of the impact area for the bridge, both substantially higher than the citywide proportions. Given this, spatial buffers, walls, and windbreaks may have particularly important population health impacts in the GHIB Bridge area. The protections offered by buffers will increase as truck traffic in the area increases during construction and operational phases of the GHIB.

Recommendation 9: Require spatial buffers of at least 500 feet between heavily trafficked roadways and land uses with sensitive populations (e.g. schools, hospitals, clinics, and nursing homes)

Results from the GHIB survey (see **Table 11**) found that one in five (19.0%) children aged 5-18 living within 500 feet of I-75 or trucking routes were reported to have asthma. This is higher than the rate reported for children in the same age group living more than 500 feet from these truck routes (13.4%). These results are consistent with a substantial body of evidence suggesting that living near to heavily trafficked roadways is associated with increases in multiple adverse health impacts, including but not limited to asthma.[126] Other health effects observed for those living near to heavily trafficked roadways include increased cardiovascular risk,[127] COPD,[128] mortality,[129] compromised lung function,[130]neurological diseases,[131] and effects on cognitive functioning.[132]

Requiring spatial buffers of at least 500 feet between I-75 and other heavily trafficked roadways and residential areas as well as other sensitive land uses (e.g., schools, hospitals, senior centers, day care centers) could reduce asthma, cardiovascular and other adverse health outcomes associated with diesel particulate matter and other air pollutants emitted through fuel combustion. Spatial buffers of up to 1500 feet would be even more health protective, especially for sensitive populations.[133] These spatial buffers can be as part of updated zoning codes, for example.

Figure 13: Gordie Howe International Bridge Area, showing GHIB boundaries (red), 150 and 500 foot buffers along I 75 and service drive, and 500 foot buffers along major trucking routes



Recommendation 10: Expand relocation opportunities to a minimum of 500 feet and increase uptake of Home Swap Program among eligible families

A significant portion of the $45 million community benefits agreement (described in **Section 2.3**) went into the Home Swap Program and I-75 Environmental Mitigation Programs coordinated by the City of Detroit's Bridging Neighborhoods Program. Money from this program offers residents in Delray, who have not been bought out by eminent domain, the option to relocate to another part of Detroit. The program also provides for renovation upgrades to some resident homes due to their proximity to the I-75 expansion.[134] Some families are eligible for both programs and can choose between them. The impact of the Home Swap Program could be maximized by promoting uptake of the program among eligible families with a particular focus on those with severe health conditions for whom the I-75 Environmental Mitigation Program may not provide sufficient protection. Impact can also be maximized by supporting Home Swap-eligible families who are facing barriers to enrollment. Support could include grants, comprehensive case management services, and increased opportunities for eligible but undecided families to connect with families who have already participated in the program.

Figure 13 shows the Gordie Howe Bridge Impact Area, with 150 and 500 foot buffers along I-75 and the service drive, and 500 foot buffers along major trucking routes. Creating programs that extend opportunities for home renovation or relocation for homes up to 500 feet from I-75 could reduce risks associated with near-roadway pollutants, including asthma, cardiovascular risk,[135] COPD,[136] mortality,[137] lung function,[138] and cognitive functioning.[139] Funding for such opportunities could come from, for example, public-private partnerships.

6.2.3 Install Vegetative Buffers

Vegetative buffers and Southwest Detroit

Vegetative buffers are made up of different species of trees, shrubs and other vegetation that are planted around pollution sources, or between pollution sources and people. Vegetative buffers separate people from sources of pollution and can trap pollutants. Small amounts of air pollution can be absorbed through the plant's stomata (small openings largely on the underside of the leaf). The majority of pollutants are deposited on tree surfaces (to either be recirculated later or dropped by leaf-fall and twigs). Vegetative buffers also can reduce temperatures by shading structures, thus reducing energy use.[140] [141]

Vegetative buffers can be particularly useful along roadways, as they can be used to separate neighborhoods, schools, businesses, health care facilities, and senior care centers from roadway air pollution Buffers can improve ambient air quality, which in turn can help to reduce irritation to airways, coughing, breathing difficulties and lung disease; reduce cardiovascular risk and prevent some heart attacks; and reduce risk of low birth weight infants.[142] [143] Buffers have many co-benefits, including: reducing noise, providing shade that can help cool buildings, reducing CO_2 (carbon), improving storm water management, and providing spaces for greenways and non-motorized paths and corridors. Some evidence suggests vegetation during childhood is associated with better mental health later in life,[144] and improved academic performance.[145]

Trees can be important natural filters for air pollution. Most current estimates suggest that between 17-22% of Detroit's land has tree coverage[146] [147], although one recent analysis estimates coverage at 28%.[148] These estimates are substantially below the American Forests' recommendation of 40% for a temperate city. Planting additional trees in strategic locations in Detroit, and particularly in Southwest, has the potential to both improve air quality and health for city residents, and could also help to reduce adverse health effects associated with extreme heat events that can affect urban areas.

Recommendation 11: Plant vegetative buffers in strategic places near the GHIB, prioritizing residential areas and areas with sensitive populations (i.e., schools, hospitals, clinics, nursing homes), freeways, heavily trafficked roadways, areas with high cumulative risk, and areas where minimum setback criteria are not met

[My request is] that they create more green spaces and upkeep them, not just abandon what they throw at the community and expect people to do the [maintenance] work for them

More trees, buffers, parks for the environment
-Survey participants

The current plan for tree planting around the Gordie Howe International Bridge includes deciduous shade trees planted along the parkway between the sidewalk and road every 25 feet between Springwells and Clark Streets. Trees will also be planted from the United States Port of Entry to I-75's crossings at Green, Campbell and Junction Streets, along Jefferson Avenue and along Fort Street between Green and Junction Streets.[149]

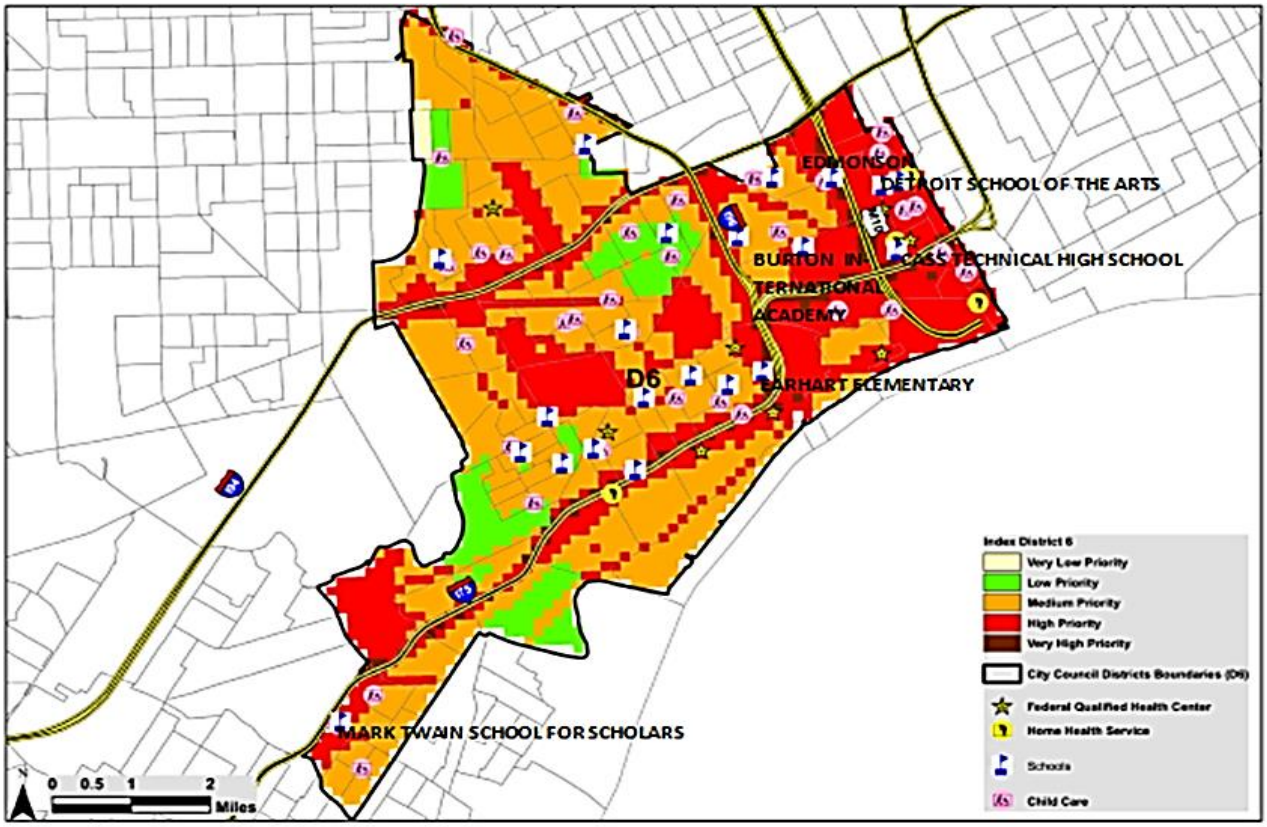
This current plan will not create a barrier that will be dense enough to be considered a vegetative buffer. A vegetative buffer should be much denser, including 3 rows of vegetation, and should also include shrubbery for maximum effect. Specific design guidelines are outlined in the CAPHE Buffer Toolkit.

Figure 14: Conceptual Model for Vegetative Buffers, Southwest Detroit Green Buffers Planning Project.[150]

Figure 14 shows a conceptual model for Vegetative Buffers in and around the GHIB site, highlighting areas where full vegetative buffers of three rows of tree and/or shrub plantings could be planted. **Figure 15** shows prioritized tree planting areas in Southwest Detroit, along with sites where vulnerable and/or more susceptible populations are located. These sites include home health service sites, nursing homes, school and child care centers, which tend to have a high concentration of infants, children, adults over 60, and adults with health conditions that increase their susceptibility to adverse effects of air pollutants. This is based on an approach conducted in New York City in 2011,[151] and applied to the City of Detroit by Community Action to Promote Healthy Environments.[152] The approach combines three spatial layers of information including pollution

concentration (for PM2.5 and NO2), population density, and lack of tree canopy, to create an index of priority tree planting areas. Figure 15 provides results from this analysis, ranging from very low priority tree planting areas (yellow), to very high priority tree planting areas (dark red).

Figure 15: City of Detroit District 6 Prioritized Tree Planting Areas



Additional buffers should be considered around the health service sites, nursing homes, school and child care centers, which tend to have a high concentration of infants, children, and adults over 60**.** As shown in **Figure 15**, these include sites like Mark Twain School for Scholars, Earhart Elementary, Western High School, Maybury Elementary, and Clippert Academy.

Recommendation 12: Plant trees throughout Southwest to replace those cut down during the initial construction phase of the GHIB

Initial construction plans for the GHIB Bridge construction required the removal of 1700 trees. To date, more than 4000 trees across 17 acres in and around the construction site for the GHIB have been removed.[153] The WDBA will replace some trees with planned tree plantings, but more extensive replacement of trees that were cut down could improve the air quality, as each tree can absorb ten pounds of air pollutants a year.[154]

6.2.4 Extend Filter Programming

Indoor air filters and Southwest Detroit

Indoor air filters are devices that remove certain air pollutants from air that is passed through them. Most filters remove particles, including: dust, small particles (including much $PM_{2.5}$), pollen, allergens, animal dander and fibers. Some filters can remove gases, such as sulfur dioxide (SO_2), odors, and volatile organic compounds (VOCs), although these are infrequently used. When designed and used appropriately, filters reduce indoor exposure to $PM_{2.5}$ and PM_{10}, and potentially other harmful air pollutants. Removal of these air pollutants can reduce the incidence of asthma, decrease respiratory inflammation and irritation, and lessen nose, throat, and

lung irritation. In addition, lower $PM_{2.5}$ levels are associated with fewer premature deaths, lower rates of heart attacks and hypertension, and lower risks of adverse birth outcomes and cancer.[155]

Most people spend over 90% of their time indoors.[156] Air pollution found indoors arises from indoor sources, such as cooking, smoking and vacuuming, as well as outdoor sources, such as traffic and power plants. Outdoor pollutants can enter a building through the ventilation system, windows, doors, cracks, and other openings. Using indoor filters is advantageous in that they reduce levels of pollutants that arise from both indoor and outdoor sources.[157]

Substantial improvements in indoor air quality can be realized by upgrading existing filters with more efficient filters, for example, by replacing low efficiency furnace filters with extended area filters (often rated as MERV 11 to 13 or higher). In buildings without forced air systems, stand-alone or portable air filters can be installed to improve indoor air quality.[158] Filters require regular replacement and use to be effective.

Recommendation 13: Extend programming for high-efficiency filters and other retrofits in homes near construction yards and site for the Gordie Howe International Bridge, up to 500 feet from roadways.

Provide air filters for the interior of the home because my daughter has asthma
-Survey participant

The current I-75 Environmental Mitigation Program (EMP) supports homes that are most proximate to the potential health impacts of increased traffic, but health improvements and associated cost reductions could be maximized by extending programming further. We estimated reductions in asthma exacerbations, hospitalizations, emergency department visits, lost school and work time associated with asthma among children <18 under two scenarios: Expansion of the EMP to homes within 500 feet of the I-75 Service Drive, and expansion to homes within 500 feet of both the I-75 Service Drive and trucking routes within the GHIB area. To account for uncertainties in the proportions of homes that would choose to participate in the EMP, scenarios were modeled assuming filtration systems were upgraded from MERV 5 to MERV 12 in 25%, 50%, 75% and 100% of eligible homes, following work by Martenies and Batterman (2018)[159] for the city of Detroit. For this analysis, we used age-specific asthma prevalence rates derived from GHIB survey results (see **Section 4** of this report) and age specific population data from the ACS (ACS 2014-2016). Again, following work by Martenies and Batterman (2018),[160] estimated reductions in monetized costs of 11-16% were estimated for each level of participating homes. **Table 14** shows results from these estimates. Under scenarios in which 50-75% of eligible households with children with asthma living within 500 feet of I-75 participate in the filter upgrade program, estimated annual reductions in monetized costs range from $3,750.00 (50% uptake, 11% reduction) to $5,454.55 (75% uptake, 16% reduction).

Table 14: Estimated current annual monetized costs and reductions in monetized costs of childhood asthma with with upgrades of home filtration systems from MERV 5 to MERV 12 in homes with children with asthma within 500 feet of heavily trafficked roadways in GHIB area

			Estimated annual reductions in monetized costs with varying proportions of homes with filters[2] (range, 11-16% reduction in monetized cost)							
			25%		50%		75%		100%	
	Estimated number of children with asthma	Estimated current annual monetized costs[1]	11%	16%	11%	16%	11%	16%	11%	16%
500 feet										
I-75 only	125	68,181.81	1,875.00	2,727.27	3,750.00	5,454.55	5,625.00	8,181.81	7,500.00	10,909.09
I-75 + Trucking Routes	186	101,454.55	2,790.00	4,058.18	5,580.00	8,116.36	8,370.00	12,174.55	11,160.00	16,232.73

1. Monetized costs estimated at $545.45 per child with asthma (Martenies and Batterman, 2018)
2. Estimated reductions in monetized costs associated with asthma of 11-16% with MERVE 12 filters (Martenies and Batterman, 2018)

If the homes eligible for the filtration systems were expanded to include those within 500 feet of current trucking routes through residential areas of the GHIB area in addition to the I-75 Service Drive, reductions in

asthma burden would increase accordingly. Estimated annual reductions in asthma burden for those <18 years are also shown in **Table 14**. Under mid-range assumptions (50-75% of households adopt indoor air filters), estimated annual reductions in monetized costs associated with childhood asthma range from $5,580 (50% uptake, 11% reduction) to $12,174.55 (75% uptake, 16% reduction).

Note that the cost reductions estimated in **Table 14** are conservative in that they only include asthma related costs for children under 18: They do not include asthma related reductions for adults, nor do they include monetized reductions in costs associated with other health outcomes linked with air pollution, including birth outcomes, cardiovascular and other pulmonary conditions. Finally, the estimated costs shown above are annual costs: Filter upgrades would result in annual reductions in monetized costs over multiple years with minimal costs (annual cost of replacement filters).

Expanded filter programming could be funded through grants, federal agencies, philanthropic organizations, and local industries through mechanisms such as community benefits agreements and Supplemental Environmental Projects.

6.3 Other Relevant Strategies

Other relevant strategies include strategies that do not directly impact air quality emissions or exposures, but instead impact resident's quality of life and our ability to understand the impacts air quality has on resident's quality of life.

Recommendations – Other Relevant Strategies

1) Expand Health Care Access

   Recommendation 14: Expand access to health care by assuring access to health insurance, neighborhood-based mental and physical health care services, and addressing transportation issues.

2) Expand Monitoring

   Recommendation 15: Support expanded monitoring of air quality

6.3.1 Expand Health Care Access

Recommendation 14: Expand access to health care by assuring access to health insurance, neighborhood-based mental & physical health care services, and addressing transportation issues

Health was a common worry cited in residents' responses, as illustrated in **Section 5** of this Report. In particular, many respondents voiced concerns about increased health risks due to transit and GHIB-related exposures, and frequently noted insufficient or limited access to health care to address those health issues when they arose. Many requested improvements in access to health care for themselves or family members, including screenings for health conditions that commonly remain undiagnosed.

> *Look into safety and health, think about the people that have been here for years*
>
> *Take in consideration the health of the community the children and moms to be and adults*
>
> *Health insurance in case our health gets bad or worse*
>
> *-Survey participants*

Residents suggested additional health screenings are needed to assess for childhood asthma, as asthma is often undiagnosed especially among children under 5. There is substantial evidence that children, those with existing health conditions such as asthma, and the elderly are more susceptible to the adverse health impacts associated with exposure to air pollutants compared with healthy adults under age 65,[161] [162][163] so screening is particularly important for these groups. However, the findings presented in **Figures 7-9** suggest additional screenings for adults related to mental health or hearing, for example, may also be beneficial in identifying underlying health issues. About one-third of survey participants in the GHIB survey reported that they did not have health insurance. Efforts to

expand screening and access to health care are particularly important given the heightened exposures to environmental conditions associated with adverse health outcomes among residents in this area.

Efforts to improve health care access should also focus improving access to transportation, and providing accessible neighborhood-based health screenings and services.

6.3.2 Expand Monitoring

Recommendation 15: Support expanded monitoring of air quality

In addition to this Health Impact Assessment, DHD is managing ongoing Air Quality Monitoring projects in the GHIB area. DHD collaborates with partners including Michigan Department of Health and Human Services (MDHHS), Michigan Department of Environmental Quality (MDEQ), and the University Of Michigan School Of Public Health on the development and implementation of three air quality monitoring systems:

1) Expanded stationary air quality monitoring across the Gordie Howe International Bridge area. Stationary monitors in the area are established and maintained by MDEQ and analyzed in partnership with DHD. The new monitoring efforts include upgraded capabilities at the existing Southwestern High School monitoring site to include continuous $PM_{2.5}$, nitrogen oxides, and Black Carbon. New monitors have been established at three sites: Trinity St. Marks Church, Detroit Police 4th Precinct, and Military Park. These new monitors gather data on $PM_{2.5}$, carbon monoxide, sulfur dioxide, nitrogen oxides, lead, and Black Carbon. See **Figure 3** for more information about where the monitors are located.
2) Mobile monitoring for a suite of pollutants including particulate matter of a variety of sizes, carbon dioxide, Black Carbon, and metals in various locations around Southwest Detroit. A mobile monitoring vehicle will follow set routes, and will also be able to visit locations as recommended or requested by community members. Mobile monitoring results will show patterns of pollution in the neighborhood, “hot spots” of high pollution, and daily and seasonal patterns of air quality. This work is being led by partners at UM SPH.
3) Indoor air quality monitoring in residential homes. Several households around the GHIB area will be eligible to host indoor air quality monitors for a period of time. These monitors will measure a variety of pollutants including carbon dioxide, particulate matter, and Black Carbon.

The data from these monitoring systems will complement data from this baseline assessment as well as future assessments of the health of the population in the GHIB area. It will help to document any changes in air quality that may occur as bridge construction and operation ensue, and can be used to estimate potential health impacts.

Appendices

APPENDIX A: Survey 1 & 2 in English & Spanish

Survey 1: Bridge to a Healthy Community (BHC) Survey, August 2016- September 2017
English – Version 1
English – Version 2
Spanish – Version 1
Spanish – Version 2

Survey 2: Gordie Howe International Bridge (GHIB) Survey, July - September, 2018

English
Spanish

APPENDIX B: Tips and Protocols for use prior to entering the field

Interviewer training

- Interviewer Training and Training Manual: The research team created a training manual for each survey interviewer (henceforth "interviewer"). This manual contained all the protocols listed in this Appendix and was carried by interviewers for use in the field as needed. The research team held two interviewer trainings to orient interviewers to the procedures and processes (explained in the manual), and to ensure accurate completion of the survey questionnaire. Interviewer training included a focus on specific survey items and training on the background methodology for data collection. Surveyors were also trained in the following: how to ask questions that may contain sensitive information, how to ask interview questions in an unbiased manner, how to use neutral probes, how to pace and time questions to promote accurate retrieval of information, how to negotiate item-specific refusals, and how to address interrupted interviews.
- Interviewer certification: The research team established certification criteria and developed protocols to certify all interviewers prior to entering the field. To obtain certification, interviewers were required to demonstrate their ability to: complete a household unit (HU) log-in under different scenarios, determine respondent eligibility, and introduce themselves to potential respondents. They also participated in mock interviews to demonstrate their ability to navigate the survey protocol and clearly administer the survey itself.
- Safety: Protocols for assuring interviewer safety included: training on how to handle different scenarios, safety tip information, and emergency call numbers. Interviewers always worked in teams of two, and interviewing shifts ended no later than dusk. Interviewers wore bright green shirts and name tags. The local Police Commander was also given a letter with information about the survey, which included the names of all interviewers. Interviewers carried copies of this letter while in the field.
- Pledge of Confidentiality: Since the survey contains potentially sensitive information, each interviewer was required to complete a Pledge of Confidentiality prior to beginning any work in the field.
- Reminders to Surveyors: This sheet/document contains reminders to surveyors about what to do before, during and after they are in the field/complete a shift.
- Tips for Interviewers: This document contains tips to use during the interviewing process, relating specifically to the different types of questions contained in the survey: close ended and open-ended questions.

APPENDIX C: Tips and Protocols for use during field work/survey period

Computer Assisted Personal Interviewing (CAPI): Interviews were administered using a computer assisted personal interviewing process, and programmed using Qualtrics. Programing helped to assure accuracy in complex skip patterns within the survey design, and also helped in defining parameters of response options to help assure accuracy in reporting.

- Using Qualtrics: Interviewers were trained how to use Qualtrics, and provided with a troubleshooting document, should they encounter issues in the field.

Ethics - Informed consent: Completion of informed consent, including procedures for assuring competency of respondents to provide informed consent and procedures for assuring comprehension among those with lower literacy levels, were specified as part of the IRB review at the University of Michigan. These protocols were reviewed as part of interviewer training.

English

Spanish

Contacting selected households: Households selected to participate in the survey received a letter describing the study, indicating that they have been randomly selected to participate, that an interviewer would be coming by in the next few days, and providing a phone number to call to schedule an appointment.

- Letters to Households

Scheduling Interviews: Most interviews were not scheduled in advance, but were completed when interviewers knocked at a respondent's door, and the respondent agreed to participate. However, if a respondent was willing to participate but not immediately available, interviewers would ask for a date and time at which the respondent would be available, and for respondent's name and a phone number at which the appointment could be confirmed. Confirmation calls were made one day ahead of the appointment. During the first four weeks of the field season, interviewers were free to schedule appointments at any time because shifts covered 10am - 8pm every day. In the last two weeks, the field coordinator provided interviewers with a list of times when shifts were taking place and appointments could be scheduled.

- Recruitment script: Recruitment scripts were used by interviewers as a doorstep introduction to the purpose, length and content of the survey.
- Phone Script
- Leave-behind postcards

Number of attempts: In the 2018 GHIB Survey, 8 attempts were made to contact residents of each selected household. These attempts occurred, on varying days of the week, at different times of day, on at least one weekend day and one week day, over at least a two week period. Interviewers used household unit logs to record relevant information for each attempt. Interviewers left flyers about the survey, which contained a call-back number so the respondent could contact the office to schedule an appointment. If no contact was made after 8 attempts, the housing unit contact log was retired. Several HU logs were not retired according to this protocol, based on feedback received by the field office manager (e.g., in one case a neighbor indicated the resident was out of town and would be back the following week).

- Housing Unit Logs
- Conversion letter
- Frequently Asked Questions

Data transfer: Data was collected using tablet computers and the electronic data collection program Qualtrics. At the end of each field period, the Field Project Manager uploaded all completed surveys to a password protected google folder where they were integrated into the central database by the GHIB Data Manager.

APPENDIX D: Tips and Protocols for use after the survey is complete

Validation: Standard protocols were used for ascertaining the validity of completed surveys. These included call-backs households at which a completed survey was conducted by each interviewer team to verify survey completion and accuracy (e.g. birth date of the respondent). A listing of interviews completed by each interviewer was maintained: Call backs were conducted with the 1st, 3rd, 7th OR 2nd, 4th, 8th interview completed by each interviewer, than with every 10th respondent following.

Data cleaning and checks: As data was uploaded to the central database, the data manager reviewed for abnormalities for example, sections with missing data, invalid patterns of responses, or responses outside of the parameters of allowed response options, in order to identify data problems at the earliest possible point. When anomalies were identified, the research team worked to resolve the issue and the resolution was recorded in the master database as a post-survey change.

APPENDIX E: Notes from the Field

Notes from post-field surveyor debrief

APPENDIX F: Health Effects for the six criteria pollutants (ozone, lead, nitrogen oxide, particulate matter, carbon monoxide, sulfur dioxide), and diesel. Drawn from the EPA's Integrated Science Assessments.[164]

	Ozone	Lead	NO_x	$PM_{2.5}$	CO	SO_2	Diesel
Respiratory Effects							
Lung diseases (COPD, chronic bronchitis, emphysema, and/or cancer)	X		X			X	X
Asthma incidences, attacks, hospitalizations, and aggravations	X			X			X
Aggravation of bronchitis	X						X
Impaired lung growth				X			X
Decreased lung function			X	X			
Difficulty breathing	X			X	X	X	
Lung irritation (airway hyper responsiveness and inflammation)			X	X		X	X
Lung related emergency visits	X		X				
Irritation of the nose and throat; coughing	X			X		X	X
Cardiovascular Effects							
Coronary heart disease		X					
Heart attacks				X			X
Hypertension or increases in blood pressure		X		X			X
Reduce oxygen carrying capacity of the blood		X			X		
Aggravation of existing heart disease					X	X	
Reproductive Effects							
Decreased fertility (men and women)		X				X	
Birth Outcomes & Childhood Development							
Adverse birth outcomes (premature birth, low birth weight, or miscarriage)	X	X	X	X	X		
Brain damage and other birth defects	X	X					
Behavioral and emotional problems		X					
Cognitive impairments		X			X		
Other							
Cancer		X		X			
Increased risk of premature death	X	X	X	X	X	X	X
Fever, convulsions, dizziness						X	
Headaches, nausea, vomiting		X			X	X	
Inhibition of thyroid functions						X	
Kidney damage		X					X
Loss of Smell						X	
Visual impairment					X		
Cognitive decrements in adults		X			X		
Immune system impairments		X					

References

[1] Lougheed, Tim. 2014. Arising from the Ashes? Environmental Health in Detroit. Environmental Health Perspectives. Available: https://ehp.niehs.nih.gov/doi/full/10.1289/ehp.122-A324 [accessed 4-4-19]

[2] Detroit Free Press. 2017. Is this the end of Delray? Available: https://www.freep.com/story/news/columnists/john-carlisle/2017/12/07/delray-neighborhood-detroit-michigan/676597001/ [accessed 4-4-19].

[3] Decennial Census. 2000. Available: https://www.census.gov/data/developers/data-sets/decennial-census.html [accessed 4-4-19].

[4] ACS (American Community Survey). 2012-2016. Data Survey at Block Group Level.

[5] ACS (American Community Survey). 2012-2016. Data Survey at Block Group Level.

[6] City of Detroit Planning and Development. 2017.

[7] ACS (American Community Survey). 2012-2016. Data Survey at Block Group Level.

[8] Schulz, A.J.; Mentz, G.B.; Sampson, N.; *Ward, M.; Anderson, R.; DeMajo, R.; Israel, B.A., Lewis, T.; Wilkins, D; 2016. Race and the distribution of social and physical environmental risk: A case example from the Detroit Metropolitan Area. Du Bois Review. 13(2): 285-304. NIHMSID: NIHMS904517. PMID: 28951763. PMCID: PMC5610908

[9] Kim JJ; American Academy of Pediatrics Committee on Environmental Health. 2004. Ambient air pollution: health hazards to children. Pediatrics. 114(6):1699-707.

[10] CAPHE Resource Manual. 2016. Available: http://caphedetroit.sph.umich.edu/cumulative-risk-air-pollution-population-vulnerability/ [accessed 3-7-19].

[11] Mercedes Medina-Ramona and Joel Schwartz. 2008. Who is more vulnerable to die from air pollution? Epidemiology. 19(4).

[12] Schweitzer, Lisa and Zhou, Jianping. 2010. Neighborhood Air Quality, Respiratory Health, and Vulnerable Populations in Compact and Sprawled Regions. Journal of American Planning Association. 76(3): 363-371

[13] FEIS (Federal Environmental Impact Statement). 2008. The Environment: What's There Now and What are the Impacts? Available: pg. 3-67 http://www.partnershipborderstudy.com/reports_us.asp#feis [accessed 3-14-19].

[14] Preliminary Results of the Comprehensive Traffic and Toll Revenue Study for the Detroit River International Crossing Project Forcast Refresh and Update. Available: http://www.partnershipborderstudy.com/pdf/6-16-10/DRIC%20Comprehensive%20TR%20Study%20Draft%20Final%20Report%20May%202010%20on.pdf [accessed 3-15-19].

[15] Schulz, A.J.; Mentz, G.B.; Sampson, N.; *Ward, M.; Anderson, R.; DeMajo, R.; Israel, B.A., Lewis, T.; Wilkins, D; 2016. Race and the distribution of social and physical environmental risk: A case example from the Detroit Metropolitan Area. Du Bois Review. 13(2): 285-304. NIHMSID: NIHMS904517. PMID: 28951763. PMCID: PMC5610908

[16] EPA (Environmental Protection Agency). 2019. Nonattainment Areas for Criteria Pollutants (Green Book). Available: https://www.epa.gov/green-book [accessed 3-21-19).

[17] Anderson, J.O. 2012. Clearing the air: A review of the effects of particulate matter air pollution on human health. Journal of Medical Toxicology. 8(2): 166-175.

[18] Landrigan, PK, Fuller R, Acosta, NJR et al. 2017. The Lancet Commission on pollution and health. Lancet. 391:462-512.

[19] Cohen, AJ, Brauer, M, Burnett R, et al. 2017. Estimates and 25 year trends of the global burden of disease attributable to ambient air pollution: An analysis of data from the Global Burden of Diseases Study 2015. Lancet. 389:1907-1918.

[20] Burnett, RT, Pope 3rd, CA, Ezzati, M et al. 2014. An integrated risk function for estimating the global burden of disease attributable to ambient fine particulate matter exposure. Environmental Health Perspectives. 122: 397-403

[21] Schulz, A., Mentz, G., Sampson, N., Ward, M., Anderson, R., deMajo, R., Israel, B., Lewis, T., Wilkins, D. 2016. Social and physical environments and the distribution of risk: A case example from Detroit. DuBois Review. 13(2);285-304. doi:10.1017/S1742058X1600016

[22] Yuan, Q. 2018. Mega freight generators in my backyard: A longitudinal study of environmental justice in warehousing location. Land Use Policy. 76: 130-143.

[23] Hricko, A, Rowland, G, Eckel, S, Logan, A., Taher, M., Wilson, J. 2014. Global trade, local impacts: Lessons from California on health impacts and environmental justice concerns for residents living near freight rail yards. International Journal of Environmental Research and Public Health. 1:1914-1941.

[24] Hricko, A.M. 2006. Guest Editorial: Ships, Trucks, and Trains: Effects of Goods Movement on Environmental Health. Available: https://ehp.niehs.nih.gov/doi/10.1289/ehp.114-a204 [accessed 3-14-19].

[25] Matsuoka, M., Hricko, A., Gottlieb, R., and DeLara, J. March 2011. Global Trade Impacts: Addressing the Health, Social and Environmental Consequences of Moving International Freight through Our Communities. Retrieved from http://scholar.oxy.edu/uep_faculty/411 [accessed 3-14-19].

[26] EPA (Environmental Protection Agency). 2009. Reducing Air Emissions Associated with Goods Movement: Working Towards Environmental Justice. Available: https://www.epa.gov/sites/production/files/2015-02/documents/2009-goods-movement.pdf [accessed 3-14-19].
[27] EPA (Environmental Protection Agency). EJ 2020 Action Agenda: EPA's Environmental Justice Strategy. Available: https://www.epa.gov/environmentaljustice/ej-2020-action-agenda-epas-environmental-justice-strategy [accessed 3-14-19].
[28] Dvonch JT, Kannan S, Schulz AJ, et al. 2009. Acute effects of ambient particulate matter on blood pressure: differential effects across urban communities. Hypertension. 53(5):853-9.
[29]Martenies SE, Milando CW, Batterman SA. Air pollutant strategies to reduce adverse health impacts and health inequalities: a quantitative assessment for Detroit, Michigan. Air Quality, Atmosphere and Health. 2018 May;11(4):409-422. doi:10.1007/s11869-017-0543-3.
[30] MDEQ (Michigan Department of Environmental Quality). 2019. Gordie Howe International Bridge: Air Monitoring. Available: https://www.michigan.gov/mienvironment/0,9349,7-385-90164-485834--,00.html [accessed 4-4-19].
[31] The term 'environmental justice' is defined in many ways, and the EPA (n.d.) defines it as: "*the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation and enforcement of environmental laws, regulations and policies.*"
[32] Hricko A, Rowland G, Eckel S, Logan A, Taher M, Wilson J. Feb 10 2014. Global trade, local impacts: lessons from California on health impacts and environmental justice concerns for residents living near freight rail yards. International Journal of Environmental Research and Public Health.11(2):1914-41. doi: 10.3390/ijerph110201914.
[33] Hricko, A.M. 2006. Guest Editorial: Ships, Trucks, and Trains: Effects of Goods Movement on Environmental Health. Available: https://ehp.niehs.nih.gov/doi/10.1289/ehp.114-a204 [accessed 3-14-19].
[34] Hricko, A.M. 2008. Global Trade Comes home: Community Impacts of Goods Movement. Available: https://ehp.niehs.nih.gov/doi/full/10.1289/ehp.116-a78 [accessed 3-14-19].
[35] Hricko, A. 2012. Progress and Pollution: Port Cities Prepare for the Panama Canal Expansion. Available: https://ehp.niehs.nih.gov/doi/full/10.1289/ehp.120-a470[accessed 3-14-19].
[36] Matsuoka, M., Hricko, A., Gottlieb, R., and DeLara, J. March 2011. Global Trade Impacts: Addressing the Health, Social and Environmental Consequences of Moving International Freight through Our Communities. Retrieved from http://scholar.oxy.edu/uep_faculty/411 [accessed 3-14-19].
[37] EPA (Environmental Protection Agency). 2009. Reducing Air Emissions Associated with Goods Movement: Working Towards Environmental Justice. Available: https://www.epa.gov/sites/production/files/2015-02/documents/2009-goods-movement.pdf [accessed 3-14-19].
[38] EPA (Environmental Protection Agency). 2016. National Port Strategy Assessment: Reducing Air Pollution and Greenhouse Gases at U.S. Ports. Available: https://www.epa.gov/ports-initiative/national-port-strategy-assessment-reducing-air-pollution-and-greenhouse-gases-us [accessed 3-14-19].
[39] EPA (Environmental Protection Agency). EJ 2020 Action Agenda: EPA's Environmental Justice Strategy. Available: https://www.epa.gov/environmentaljustice/ej-2020-action-agenda-epas-environmental-justice-strategy [accessed 3-14-19].
[40] Bureau of Transportation Statistics. 2017. Available: https://www.bts.gov/top-25-us-international-trade-freight-gateways-value-shipments [accessed 3-7-19].
[41] SEMCOG Presentation. 2018.
[42] State of Oregon Department of Environmental Quality. 2015. The Concerns about Diesel Engine Exhaust. Available: https://www.oregon.gov/deq/FilterDocs/DieselEffectsReport.pdf
[43] CAPHE Resource Manual. 2016. Available: http://caphedetroit.sph.umich.edu/cumulative-risk-air-pollution-population-vulnerability/ [accessed 3-7-19].
[44] Mercedes Medina-Ramona and Joel Schwartz. 2008. Who is more vulnerable to die from air pollution? Epidemiology. 19(4).
[45] Schweitzer, Lisa and Zhou, Jianping. 2010. Neighborhood Air Quality, Respiratory Health, and Vulnerable Populations in Compact and Sprawled Regions. Journal of American Planning Association. 76(3): 363-371
[46] CAPHE Resource Manual. 2016. Available: http://caphedetroit.sph.umich.edu/cumulative-risk-air-pollution-population-vulnerability/ [accessed 3-7-19].
[47] Mercedes Medina-Ramona and Joel Schwartz. 2008. Who is more vulnerable to die from air pollution? Epidemiology. 19(4).
[48] Schweitzer, Lisa and Zhou, Jianping. 2010. Neighborhood Air Quality, Respiratory Health, and Vulnerable Populations in Compact and Sprawled Regions. Journal of American Planning Association. 76(3): 363-371
[49] Health Effects Institute. 2010. Available: https://www.healtheffects.org/publication/traffic-related-air-pollution-critical-review-literature-emissions-exposure-and-health [accessed 3-7-19].
[50] Beutel, M.E.; Junger, C.; Klien, E.M. et al. 2016. Noise Annoyance Is Associated with Depression and Anxiety in the General Population- The Contribution of Aircraft Noise. PLoS One. 11(5): e0155357. doi: 10.1371/journal.pone.0155357

[51] Basner, M.; Babisch, W.; Davis, A. et al. 2014. Auditory and non-auditory effects of noise on health. Lancet. 383(9925): 1325–1332. Published online 2013 Oct 30. doi: 10.1016/S0140-6736(13)61613-X

[52] Davies H, Kamp IV. Nov-Dec 2012. Noise and cardiovascular disease: a review of the literature 2008-2011. Noise Health. 14(61):287-91. doi:10.4103/1463-1741.104895. Review.

[53] Belojevic G.; Jakovljevic B.; Stojanov V.; et al. 2008. Urban road-traffic noise and blood pressure and heart rate in preschool children. Environment International. 34(2): 226–31.

[54] Berglund, B., Lindvall, T. and Schwela, D.H. 1999. Guidelines for Community Noise Geneva: World Health Organization. Available: http://whqlibdoc.who.int/hq/1999/a68672.pdf [accessed 3-7-19].

[55] Basner, M.; Babisch, W.; Davis, A.; et al. 2014. Auditory and non-auditory effects of noise on health. Lancet. 383(9925): 1325–1332. Published online 2013 Oct 30. doi: 10.1016/S0140-6736(13)61613-X PMCID: PMC3988259 NIHMSID: NIHMS562938 PMID: 24183105

[56] Recio A, Linares C, Banegas JR, Díaz J. April 2016. Road traffic noise effects on cardiovascular, respiratory, and metabolic health: An integrative model of biological mechanisms. Environmental Research. 146:359-70. doi:10.1016/j.envres.2015.12.036.

[57] In survey documentation materials, Version 1 is referred to as 2016.1 and Version 2 is referred to as 2016.0

[58] Certified Final Motor City Mapping 2013-2014. Data Driven Detroit. Available: http://data.ferndalemi.gov/datasets/6d51c9a94e2944d1bffc24f95c9b08e8_0 [accessed 4-2-19].

[59] Sample overlap results in reductions in sampling variances on estimates of change as variations due to inclusion of different units is reduced. The reduction in variances depends on the correlation of the variable at the unit level over time and the degree of sample overlap. Overlapping sample designs can be implemented using a rotation pattern or design, with 5%, 10% or 15% rotation pattern designed to manage the sample over time. Future surveys conducted as part of the GHIB HIA may develop rotation patterns that have the same proportion of the sample in common between any two time periods the same time apart and the same proportion of sample rotated out and into the sample at each period. The rotation design should ensure that the cross-sectional estimates are unbiased, while reducing costs and sampling variances on important estimates of change. A rotation pattern should ensure that at each wave the sample is balanced on the number of times a unit has been included in the survey.

[60] Steel, D.; McLaren, C. 2008. Design and Analysis of Repeated Surveys Centre for Statistical & Survey Methodology. Working Paper Series.

[61] Cicchetti, D.V. 1994. Guidelines, criteria, and rules of thumb for evaluating normed and standardized assessment instruments in psychology. Psychological Assessment. 6 (4): 284-290. doi: 10.1037/1040-3590.6.4.284.

[62] Iterative proportional fitting or raking was the weighting methodology used to make the 2014-2016 Michigan BRFS data representative of the current Michigan adult population. Estimates based on this methodology were weighted to adjust for the probabilities of selection and a raking adjustment factor that adjusted for the distribution of Michigan adults by telephone source (land line vs. cell phone), details race/ethnicity, education level, marital status, age by gender, gender by race/ethnicity, age by race/ethnicity, and renter/owner status. No additional weighting factors were computed at the regional or local health department (LHD) level, thus the weights used might not always provide accurate regional and/or LHD estimates, particularly when regional and/or LHD demographic distributions vary greatly from that of the state. Michigan Behavioral Risk Factor Surveillance System (Michigan BRFSS). 2014-2016. Health Indicators and Risk Estimates by Community Health Assessment Regions & Local Health Departments, State of Michigan. Pg 3 and Table 21. Available: https://www.michigan.gov/documents/mdhhs/2014-2016_MiBRFSS_Reg__LHD_Tables_608878_7.pdf, [accessed 9-26-19].

[63] Stieb DM, Chen L, Hystad P, et al. 2016. A national study of the association between traffic-related air pollution and adverse pregnancy outcomes in Canada, 1999-2008. Environ Research. 148:513-526. doi:10.1016/j.envres.2016.04.025.

[64] Brauer M, Lencar C, Tamburic L, Koehoorn M, Demers P, Karr C. 2008. A cohort study of traffic-related air pollution impacts on birth outcomes. Environmental Health Perspectives. 116(5):680-686. doi:10.1289/ehp.10952.

[65] Klepac P, Locatelli I, Korošec S, Künzli N, Kukec A. 2018. Ambient air pollution and pregnancy outcomes: A comprehensive review and identification of environmental public health challenges. Environ Research. 167(July):144-159. doi:10.1016/j.envres.2018.07.008.

[66] CAPHE Resource Manual. 2016. Available: http://caphedetroit.sph.umich.edu/cumulative-risk-air-pollution-population-vulnerability/ [accessed 3-7-19].

[67] Mercedes Medina-Ramona and Joel Schwartz. 2008. Who is more vulnerable to die from air pollution? Epidemiology. 19(4).

[68] Schweitzer, Lisa and Zhou, Jianping. 2010. Neighborhood Air Quality, Respiratory Health, and Vulnerable Populations in Compact and Sprawled Regions. Journal of American Planning Association. 76(3): 363-371

[69] Martenies SE, Milando CW, Batterman SA. May 2018. Air pollutant strategies to reduce adverse health impacts and health inequalities: a quantitative assessment for Detroit, Michigan. Air Quality, Atmosphere and Health. 11(4):409-422. doi:10.1007/s11869-017-0543-3.

[70] CAPHE Resource Manual. 2016. Available: http://caphedetroit.sph.umich.edu/cumulative-risk-air-pollution-population-vulnerability/ [accessed 3-7-19].
[71] EPA (Environmental Protection Agency). 2009. Reducing Air Emissions Associated with Goods Movement: Working Towards Environmental Justice. Available: https://www.epa.gov/sites/production/files/2015-02/documents/2009-goods-movement.pdf [accessed 3-14-19].
[72] EPA (Environmental Protection Agency). 2016. National Port Strategy Assessment: Reducing Air Pollution and Greenhouse Gases at U.S. Ports. Available: https://www.epa.gov/ports-initiative/national-port-strategy-assessment-reducing-air-pollution-and-greenhouse-gases-us [accessed 3-14-19].
[73] Beutel, M.E.; Junger, C.; Klien, E.M. et al. 2016. Noise Annoyance Is Associated with Depression and Anxiety in the General Population- The Contribution of Aircraft Noise. PLoS One. 11(5): e0155357. doi: 10.1371/journal.pone.0155357
[74] Basner, M.; Babisch, W.; Davis, A. et al. 2014. Auditory and non-auditory effects of noise on health. Lancet. 383(9925): 1325–1332. Published online 2013 Oct 30. doi: 10.1016/S0140-6736(13)61613-X
[75] Davies H, Kamp IV. 2012. Noise and cardiovascular disease: a review of the literature 2008-2011. Noise Health. 14(61):287-91. doi:10.4103/1463-1741.104895. Review.
[76] Belojevic G.; Jakovljevic B.; Stojanov V.; et al. 2008. Urban road-traffic noise and blood pressure and heart rate in preschool children. Environment International. 34 (2): 226–31.
[77] Basner, M.; Babisch, W.; Davis, A.; et al. 2014. Auditory and non-auditory effects of noise on health. Lancet. 383(9925): 1325–1332. Published online 2013 Oct 30. doi: 10.1016/S0140-6736(13)61613-X PMCID: PMC3988259 NIHMSID: NIHMS562938 PMID: 24183105
[78] Recio A, Linares C, Banegas JR, Díaz J. April 2016. Road traffic noise effects on cardiovascular, respiratory, and metabolic health: An integrative model of biological mechanisms. Environ Research. 146:359-70. doi:10.1016/j.envres.2015.12.036.
[79] Berglund, B., Lindvall, T. and Schwela, D.H. 1999. Guidelines for Community Noise Geneva: World Health Organization. Available: http://whqlibdoc.who.int/hq/1999/a68672.pdf [accessed 3-7-19].
[80] Anderson, J.O. 2012. Clearing the air: A review of the effects of particulate matter air pollution on human health. Journal of Medical Toxicology. 8(2): 166-175.
[81] Landrigan, PK, Fuller R, Acosta, NJR et al. 2017. The Lancet Commission on pollution and health. Lancet. 391:462-512.
[82] Cohen, AJ, Brauer, M, Burnett R, et al. 2017. Estimates and 25 year trends of the global burden of disease attributable to ambient air pollution: An analysis of data from the Global Burden of Diseases Study 2015. Lancet. 389:1907-1918.
[83] Burnett, RT, Pope 3rd, CA, Ezzati, M et al. 2014. An integrated risk function for estimating the global burden of disease attributable to ambient fine particulate matter exposure. Environmental Health Perspectives. 122: 397-403
[84] Hricko, A.M. 2006. Guest Editorial: Ships, Trucks, and Trains: Effects of Goods Movement on Environmental Health. Available: https://ehp.niehs.nih.gov/doi/10.1289/ehp.114-a204 [accessed 3-14-19].
[85] Matsuoka, M., Hricko, A., Gottlieb, R., and DeLara, J. March 2011. Global Trade Impacts: Addressing the Health, Social and Environmental Consequences of Moving International Freight through Our Communities. Retrieved from http://scholar.oxy.edu/uep_faculty/411 [accessed 3-14-19].
[86] EPA (Environmental Protection Agency). 2009. Reducing Air Emissions Associated with Goods Movement: Working Towards Environmental Justice. Available: https://www.epa.gov/sites/production/files/2015-02/documents/2009-goods-movement.pdf [accessed 3-14-19].
[87] EPA (Environmental Protection Agency). EJ 2020 Action Agenda: EPA's Environmental Justice Strategy. Available: https://www.epa.gov/environmentaljustice/ej-2020-action-agenda-epas-environmental-justice-strategy [accessed 3-14-19].
[88] Dvonch JT, Kannan S, Schulz AJ, et al. 2009. Acute effects of ambient particulate matter on blood pressure: differential effects across urban communities. Hypertension. 53(5):853-9.
[89] Hricko A, Rowland G, Eckel S, Logan A, Taher M, Wilson J. Feb 10 2014. Global trade, local impacts: lessons from California on health impacts and environmental justice concerns for residents living near freight rail yards. International Journal of Environmental Research and Public Health. 11(2):1914-41. doi: 10.3390/ijerph110201914.
[90] Health Effects Institute. 2010. Available: https://www.healtheffects.org/publication/traffic-related-air-pollution-critical-review-literature-emissions-exposure-and-health [accessed 3-7-19].
[91] EPA (U.S. Environmental Protection Agency). 2010. Idle Reduction: A Glance at Clean Freight Strategies. Available: http://www3.epa.gov/smartway/forpartners/documents/trucks/techsheets-truck/420f09038.pdf . [accessed 9 February 2016].
[92] CAPHE Resource Manual. 2016. Available: http://caphedetroit.sph.umich.edu/wp-content/uploads/2016/10/Resource-Manual-7.5-Mobile-Source-Controls-Idling-Controls-Website-Version-10-4-16.pdf [accessed 3-7-19].
[93] The Detroit Environmental Agenda. 2013. Available: http://detroitenv.org/wp-content/uploads/2016/07/DEA-Report.pdf [accessed 4-3-18]
[94] PBOA (Public Border Operations Association). 2016. Available: http://publicborderoperators.org/index.php/traffic [accessed 2-10-16].

[95] The Windsor-Detroit Bridge Authority was created in 2012, and is responsible for the construction and operation of the new GHIB. Once completed, they will operate the bridge and set and collect bridge tolls. For more information see: WDBA (Windsor Bridge Authority). 2018. Available: https://www.gordiehoweinternationalbridge.com/en/who-we-are [accessed 3-15-19].
[96] Windsor-Detroit Bridge Authority. 2018. Available: https://www.gordiehoweinternationalbridge.com/en/mitigating-emissions-and-keeping-traffic-moving-on-the-gordie-howe-international-bridge-project-us-project-components [accessed 1-20-190.
[97] City of Detroit Zoning Code. 2019. Available: https://library.municode.com/mi/detroit/codes/code_of_ordinances?nodeId=DECO_CH55TRVE_ARTIVLORE_DIV6IDPRCOVEEXGRVEWERA8500PO [accessed 4-3-19].
[98] ATRI (American Transportation Research Institute). 2015. Compendium of Idling Regulations. Available: http://www.atri-online.org/research/idling/ATRI_Idling_Compendium.pdf [accessed 12-17-15].
[99] City of Chicago. Available: http://www.cityofchicago.org/city/en/depts/cdot/supp_info/doing_our_share_forcleanerairidlingreduction.html/ [accessed 2-11-16].
[100] City of Detroit. Improve Detroit. Available: https://detroitmi.gov/ImproveDetroit
[101] IdleFreePhilly. Available: http://www.idlefreephilly.org/ [accessed 3-7-19].
[102] MDEQ (Michigan Department of Environmental Quality). Available: https://www.michigan.gov/deq/0,4561,7-135-3310_70940-193455--,00.html [accessed 4-3-19].
[103] Environmental Protection Agency. 2019. Nonattainment Areas for Criteria Pollutants (Green Book). Accessed 3/21/2019. Available: https://www.epa.gov/green-book
[104] SEMCOG (Southeast Michigan Council of Governments). 2018.
[105] SEMCOG (Southeast Michigan Council of Governments). 2018.
[106] California Air Resources Board. 2019. Truck and Bus Regulation. Available: https://www.arb.ca.gov/msprog/onrdiesel/onrdiesel.htm [accessed 3-7-19].
[107] Millstein D.E.; Harley R.A. 2010. Effects of retrofitting emission control systems on in-use heavy diesel vehicles. Environmental Science & Technology. 2010 Jul 1;44(13):5042-8. doi: 10.1021/es1006669.
[108] CARB (California Air Resources Board). 2019. Current Regulation and Advisories. Available: https://www.arb.ca.gov/msprog/onrdiesel/regulation.htm?bay [accessed 4-3-19]. And Overdrive. 2018. CARB to block DMV registration of pre-2011 trucks starting 2020. Available: https://www.overdriveonline.com/carb-to-block-dmv-registration-of-older-trucks-starting-in-2020/ [accessed 3-7-19].
[109] Environmental Mitigation Trust Agreement for State Beneficiaries, Attachment A. Volkswagen "Clean Diesel" Marketing, Sales Practices, and Products Liability Litigation, MDL No. 2672 CRB (JSC) (Dkt. No. 2103-1) https://www.vwclearinghouse.org/public/Dkt%2051-1%20%20State%20Beneficiary%20Trust%20Agreement.pdf. [accessed 04-16-19].
[110] CARB (California Air Resources Board). 2018. CARB Adopts Blueprint for Statewide Community Air Protection in Areas Most Impacted by Pollution. Available: https://ww2.arb.ca.gov/news/carb-adopts-blueprint-statewide-community-air-protection-areas-most-impacted-pollution [accessed 3-8-19].
[111] MPCA (Minnesota Pollutionhttps://www.pca.state.mn.us/air/air-permitting-south-minneapolis
[112] For more information about the process of establishing air quality standards and opportunities to inform that process, see https://www.epa.gov/clean-air-act-overview and https://www.epa.gov/clean-air-act-overview/developing-clean-air-programs-through-dialogue
[113] ODEQ (Oregon Department of Environmental Quality). Oregon Clean Fuels Program: Clean Fuels 101. Available: http://caphedetroit.sph.umich.edu/wp-content/uploads/2017/05/CAPHE-PHAP-Full-Report-and-Executive-Summary-5-10-17.pdf [accessed 3-7-19].
[115] DRIC (Detroit River International Crossing/New International Trade Crossing). Final Environmental Impact Statement: The Environment: What's There Now and What are the Impacts? Available: http://www.partnershipborderstudy.com/pdf/us-reports/Section%204.pdf [accessed 4-17-19].
[116] 9 Delaware DNREC (Department of Natural Resources and Environmental Control). Overview of the Delaware Clean Transportation Incentive Program. Available: http://www.dnrec. delaware.gov/energy/Documents/Transportation%20Program/FINAL_Overview%20of%20the% 20Delaware%20Clean%20 Transportation%20Rebate%20Programs.pdf. [accessed 8 December 2016]
[117] CAPHE Public Health Action Plan. 2017. Executive Summary. Available: http://caphedetroit.sph.umich.edu/wp-content/uploads/2017/05/CAPHE-PHAP-Full-Report-and-Executive-Summary-5-10-17.pdf [accessed 3-7-19].
[118] Millstein D.E.; Harley R.A. 2010. Effects of retrofitting emission control systems on in-use heavy diesel vehicles. Environmental Science & Technology. 44(13):5042-8. doi: 10.1021/es1006669.
[119] Millstein D.E.; Harley R.A. 2010. Effects of retrofitting emission control systems on in-use heavy diesel vehicles.

Environ Science & Technology. 44(13):5042-8. doi: 10.1021/es1006669.

[120] Silverman, D. T. 2017. Diesel Exhaust Causes Lung Cancer – Now What? Occupational and Environmental Medicine. Author manuscript; available in PMC 2017 Mar 15. Published in final edited form as: Occup Environ Med. 2017 Mar; 74(4): 233–234. Published online 2017 Jan 9. doi: 10.1136/oemed-2016-104197

[121] Silverman, D.T. 2018. Diesel Exhaust and Lung Cancer—Aftermath of Becoming an IARC Group 1 Carcinogen. *American Journal of Epidemiology*, Volume 187, Issue 6, June, Pages 1149–1152, https://doi.org/10.1093/aje/kwy036

[122] Crain's Detroit Business. 2015. Detroit students to ride to school on propane-fueled buses. Available: http://www.crainsdetroit.com/ article/20150902/NEWS/150909990/detroit-students-to-ride-toschool-on-propane-fueled-buses [accessed 3 February 2016].

[123] CAPHE Resource Manual. 2016. Vegetative Buffers. Available: http://caphedetroit.sph.umich.edu/buffers-and-barriers/ [accessed 3-7-19].

[124] Beelen, R., Hoeke, G., van der Brandt, P., Goldbohm, R., Schouten, L., Jerret, M., Hughes, E., Armstrong, B. and Brunekreef, B. 2008. Long term effects of traffic related air pollution on mortality in a Dutch cohort. Environmental Health Perspectives. 116:202

[125] Boehmer, T.K, Foster, S.L., Henry, J.R., Woghiren-Akinnifesia, E.L., Fuyuen, F.Y. 2013. Residential Proximity to Major Highways–United States, 2010. Morbidity and Mortality Weekly Report. Centers for Disease Control and Prevention, November 22, 2013/62(03);46-50.

[126] Health Effects Institute Panel on the Health Effects of Traffic-Related Air Pollution. 2010. Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects. Health Effects Institute: Available at https://www.healtheffects.org/publication/traffic-related-air-pollution-critical-review-literature-emissions-exposure-and-health

[127] Peters A, von Klot S, Heier M, Trentinaglia I, Cyrys J, Hormann A, Hauptmann M, Wichmann HE, Lowel H. 2004. Exposure to Traffic and the Onset of Myocardial Infarction. New England Journal of Medicine. 351: 1721-1730

[128] Anderson, J.O. 2012. Clearing the air: A review of the effects of particulate matter air pollution on human health. Journal of Medical Toxicology. 8(2): 166-175.

[129] Finklestein MM, Jerrett M., Sears M.R. 2004. Traffic Air Pollution and Mortality Rate Advancement Periods. American Journal of Epidemiology. 160: 173-177;

[130] Suglia SF, Gryparis A, Schwartz J, and Wright RJ. Association between Traffic-Related Black Carbon Exposure and Lung Function among Urban Women. Environmental Health Perspectives. 116 (10): 1333-1337.

[131] Chen H, KJC, Capes R, et al. 2017. Living near major roads and the incidence of dementia, Parkinson's disease and multiple sclerosis: a population-based cohort study. Lancet. 389(10070):718-726. Published online https://doi.org/10.1016/S0140-6736(16)32399-6 1.

[132] Power MC, Weisskopf MG, Alexeeff SE, et al,. 2011. Traffic-related air pollution and cognitive function in a cohort of older men. Environmental Health Perspectives 119:682–687. doi:10.1289/ehp.1002767

[133] Health Effects Institute. 2010. Available: https://www.healtheffects.org/publication/traffic-related-air-pollution-critical-review-literature-emissions-exposure-and-health [accessed 3-7-19].

[134] City of Detroit. Bridging Neighborhoods Program. 2018. Available: https://detroitmi.gov/government/mayors-office/bridging-neighborhoods-program/about-us [accessed 3-7-19].

[135] Peters A, von Klot S, Heier M, Trentinaglia I, Cyrys J, Hormann A, Hauptmann M, Wichmann HE, Lowel H. 2004. Exposure to Traffic and the Onset of Myocardial Infarction. New England Journal of Medicine. 351: 1721-1730

[136] Anderson, J.O. 2012. Clearing the air: A review of the effects of particulate matter air pollution on human health. Journal of Medical Toxicology. 8(2): 166-175.

[137] Finklestein MM, Jerrett M., Sears M.R. 2004. Traffic Air Pollution and Mortality Rate Advancement Periods. American Journal of Epidemiology. 160: 173-177;

[138] Suglia SF, Gryparis A, Schwartz J, and Wright RJ. 2008. Association between Traffic-Related Black Carbon Exposure and Lung Function among Urban Women. Environmental Health Perspectives. 116 (10): 1333-1337.

[139] Power MC, Weisskopf MG, Alexeeff SE, et al. 2011. Traffic-related air pollution and cognitive function in a cohort of older men. Environmental Health Perspectives. 119:682–687. doi:10.1289/ehp.1002767

[140] Edmondson JL, Stott I, Davies ZG, Gaston KJ, Leake JR. 2016. Soil surface temperatures reveal moderation of the urban heat island effect by trees and shrubs. Science Reports. 6:1-8. doi:10.1038/srep33708.

[141] Gunawardena KR, Wells MJ, Kershaw T. 2017. Utilising green and bluespace to mitigate urban heat island intensity. Science of the Total Environment. 584-585:1040-1055. doi:10.1016/j.scitotenv.2017.01.158

[142] EPA (Environmental Protection Agency). 2015. Near Roadway Air Pollution Health. Available: http://www3.epa.gov/otaq/nearroadway.htm

[143] CARB (California Environmental Protection Agency Air Resources Board). 2005. Air Quality and Land Use Handbook: A Community Health Perspective. Available: http://www.arb.ca.gov/ch/handbook.pdf

[144] Engemann K, Pedersen CB, Arge L, Tsirogiannis C, Mortensen PB, Svenning J-C. 2019. Residential green space in childhood is associated with lower risk of psychiatric disorders from adolescence into adulthood. Proceedings of the National Academy of Sciences. February 2019:201807504. doi:10.1073/pnas.1807504116.
[145] Sivarajah, S., Smith, SM, Thomas, SC. 2018. Tree cover and species composition effects on academic performance of primary school students. PLOS One. 13(2): e0193254. https://doi.org/10.1371/journal.pone.0193254
[146] Greening of Detroit. 2016. A Healthier and Greener Detroit: Policy Recommendations for How Trees can be used to improve public health in Detroit. Available: http://www.greeningofdetroit.com/ [accessed 3 March 2016].
[147]Urban Ecosystem Analysis SE Michigan and City of Detroit: Calculating the Value of Nature. 2006. American Forests Report. www.americanforests/analysis/php Accessed April 20, 2016 and 9
[148] Nowak, D.J., Greenfield, E.J. 2012. Tree and impervious cover change in US cities, in Urban Forestry and Urban Greening 11, 21-30)
[149] Gordie Howe International Bridge. 2019. Design and Technology. Available: https://www.gordiehoweinternationalbridge.com/en/design-and-technology [accessed 3-7-19].
[150] Kresge Buffer Project. 2016. Southwest Detroit Community Benefits Coalition and Detroiters Working for Environmental Justice.
[151] Morani, A., Nowak, D.J., Hirabayashi, S., and Calfapietra, C. 2011. How to select the best tree planting locations to enhance air pollution removal in the MillionTreesNYC initiative, Environmental Pollution. 159, 1040-1047.
[152] CAPHE (Community Action to Promote Healthy Environments). 2016. CAPHE Resource Manual Buffers and Barriers. Available: http://caphedetroit.sph.umich.edu/wp-content/uploads/2016/10/Resource-Manual-7.3-Buffers-and-Barriers-10-4-16-Website-Version.pdf [accessed 4-4-19].
[153] WDBA (Windsor Detroit Bridge Authority). 2019. Personal communication.
[154] American Forests. Available: https://www.americanforests.org/wp-content/uploads/2012/10/Meeting-ReLeaf-Flyer-Final.pdf [accessed 4-4-19].
[155] EPA (Environmental Protection Agency). Integrated Science Assessments (ISAs). Available: https://www.epa.gov/isa [accessed 29 February 2016].
[156] EPA (Environmental Protection Agency). 2019. Indoor Air Quality. Available: https://www.epa.gov/report-environment/indoor-air-quality [accessed 4-4-19}.
[157] CAPHE Public Health Action Plan. 2017. Available: http://caphedetroit.sph.umich.edu/public-health-action-plan/ [accessed 3-17-19].
[158] CAPHE Public Health Action Plan. 2017. Available: http://caphedetroit.sph.umich.edu/public-health-action-plan/ [accessed 3-17-19].
[159] Martenies S.E.; Batterman S.A.; 2018. Effectiveness and health benefits of enhanced filters in schools and homes for children with asthma. Environmental Science & Technology. 52(18):10767-10776. PMID: 30141330.
[160] Martenies S.E.; Batterman S.A.; 2018. Effectiveness and health benefits of enhanced filters in schools and homes for children with asthma. Environmental Science & Technology. 52(18):10767-10776. PMID: 30141330.
[161] CAPHE Resource Manual. 2016. Available: http://caphedetroit.sph.umich.edu/cumulative-risk-air-pollution-population-vulnerability/ [accessed 3-7-19].
[162] Mercedes Medina-Ramona and Joel Schwartz. 2008. Who is more vulnerable to die from air pollution? Epidemiology, vol 19, no. 4.
[163] Schweitzer, Lisa and Zhou, Jianping. 2010. Neighborhood Air Quality, Respiratory Health, and Vulnerable Populations in Compact and Sprawled Regions. Journal of American Planning Association. 76(3): 363-371
[164] EPA (Environmental Protection Agency). Integrated Science Assessments. Available: https://www.epa.gov/isa [accessed 4-4-19].