



CAPHE PHAP-RM
7.3 BUFFERS & BARRIERS
2016

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7.3 Buffers and Barriers

7.3.1 What are buffers?

Buffers are strips of land, vegetation or physical barriers located between sources of pollution (e.g., roadways) and homes, schools or other places where people spend time and may be exposed to those pollutants. Buffers can reduce people's exposure to harmful air pollutants by absorbing and trapping some of the pollutant. So, while buffers don't decrease air pollution emissions, they can reduce human exposures by lowering air pollution concentrations.

7.3.2 What types of buffers can be used and where can they be used?

There are three main types of buffers that can be useful for reducing exposure to air pollution:

- 1) vegetative buffers (i.e. green buffers)
- 2) sound walls and,
- 3) spatial buffers.

Selecting which buffer type is appropriate and where they can be implemented largely depends on the physical characteristics of the area and the specific goals, as described in more detail below.

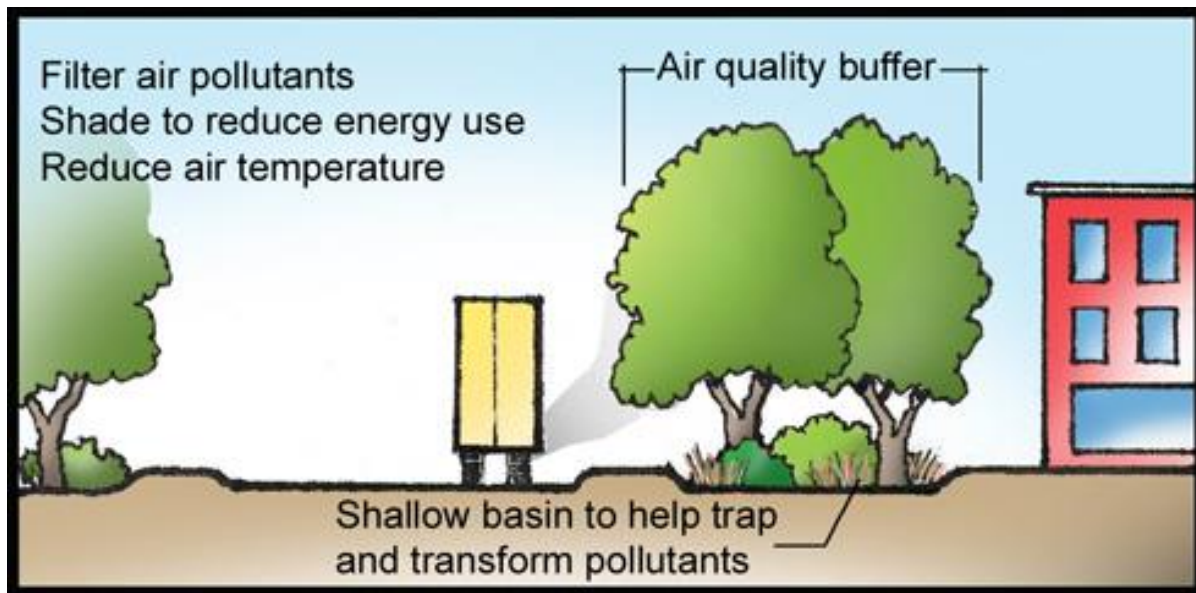


Figure 7.3 – 1. Vegetative buffers.

1) Vegetative buffers are 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 before they reach people through the air. 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.¹

¹ USDA (United States Department of Agriculture National Agroforestry Center). Conservation Buffers: Air Quality Buffers. Available: http://nac.unl.edu/buffers/guidelines/6_aesthetics/3.html [accessed 3 March 2016].

Tree species, soil types, and location all play an important role in the effectiveness of vegetative buffers. For example, the greatest pollutant removal is attained by planting vegetation in the areas with the highest pollution or ‘hot spots’, like traffic junctions and at traffic lights.² Additional considerations are choosing plants that can withstand exposure to roadway conditions, including exposure to pollutants, soil, de-icing salts that may be used, heat and other effects, for example, if planted near roadways. *Note: This information will be developed further in a separate document at a later point.*

2) Sounds Walls, a form of **non-vegetative buffers**, are physical structures that can reduce people’s exposure to noise as well as harmful air pollutants. Primarily built along major roadways to reduce traffic noise to the surrounding neighborhood, sound walls also influence the distribution of pollutants from traffic along those roadways.

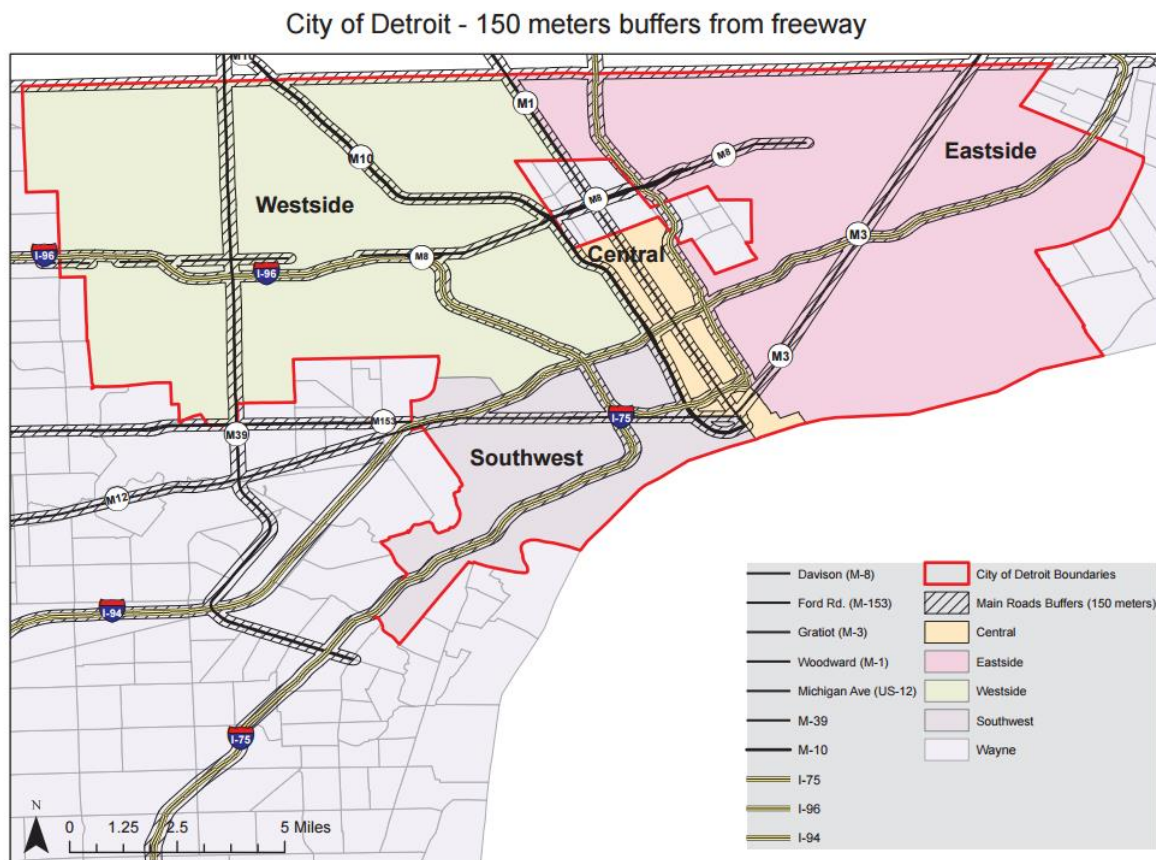


Figure 7.3 – 2. Spatial buffers along major highways in the City of Detroit.

3) Spatial buffers are another form of **non-vegetative buffer**. 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,

² Mitchell R, Maher BA. 2009. Evaluation and application of biomagnetic monitoring of traffic-derived particulate pollution. Atmospheric Environment 43:2095-2103.

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.

7.3.3 Why is this important?

Living next to highly travelled roadways is associated with negative health outcomes.³ In 2009, the EPA estimated more than 45 million people in the US lived within 300 feet of a highway with 4 or more lanes, a railroad, or an airport. Population trends suggest this number is increasing. Many schools and childcare centers are located within a few hundred feet of highways, particularly in urban areas. Furthermore, air pollution from cars and trucks may negatively impact those who drive to work. Every day, the average American spends more than an hour in travel, most of which takes place on major roadways.⁴

In the City of Detroit an estimated 69,000 (about 10%) residents live within 150 meters (about 500 feet) of a major freeway. Roughly 70,000 – 90,000 trucks travel on major corridors (I-75, I-94, I-96, M10 and M39) in Detroit daily,⁵ and as many as 6,900 trucks a day (2.5 million annually) cross the International Bridge.⁶ There are approximately 75 public schools within 200 meters of large highways, these trucks emit high proportions of heavy diesel vehicles.⁷ In 2014-2015, 58 of these schools were in operation with an estimated 24,490 students in attendance.

As noted above, trees can be important natural filters for air pollution. Most current estimates suggest that between 17-22% of Detroit's land has tree coverage,^{8, 9} although one recent analysis estimates coverage at 28%.¹⁰ The majority of estimates are substantially below the American Forests' recommendation of 30% for a temperate city.¹¹ Planting additional trees in strategic locations in Detroit has the potential to both improve air quality and health for city residents, and can also help to reduce adverse health effects associated with extreme heat events that can affect urban areas.

³ 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, in *Morbidity and Mortality Weekly Report*. Centers for Disease Control and Prevention, November 22, 2013/62(03);46-50.

⁴ EPA (Environmental Protection Agency). 2015. Near Roadway Air Pollution Health. Available: <http://www3.epa.gov/otag/nearroadway.htm> [accessed 3 March 2016].

⁵ CAPHE (Community Action to Promote Healthy Environments). 2016. Diesel Pollutant Fact Sheet. Available: <http://caphedetroit.sph.umich.edu/project/diesel/> [accessed 3 March 2016].

⁶ PBOA (Public Border Operations Association). 2016. Traffic Data. Available: <http://publicborderoperators.org/index.php/traffic> [accessed 10 February 2016].

⁷ Wu YC, Batterman SA. 2006. Proximity to Schools in Detroit, Michigan to automobile and truck traffic. J Expo

⁸ Urban Ecosystem Analysis SE Michigan and City of Detroit: Calculating the Value of Nature. 2006. American Forests Report. www.americanforests.com/analysis/php Accessed April 20, 2016

and 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].

⁹ 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/>

¹⁰ Nowak, D.J., Greenfield, E.J. 2012. Tree and impervious cover change in US cities, in *Urban Forestry and Urban Greening* 11, 21-30.

¹¹ 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].

Buffers can be a cost effective strategy that can be implemented at a variety of scales, from small to large. Buffers can also enhance visual interest, screen undesirable noise, filter unpleasant odors, and separate human industrial from residential or leisure activities, improving quality of life for residents, and the desirability of Detroit neighborhoods.

7.3.4 Implications for Health

7.3.4.1 Which pollutants are affected by buffers?

Buffers can reduce concentrations of several hazardous pollutants, including ozone (O₃), particulate matter (PM), nitrogen oxides (NO_x), sulfur dioxide (SO₂), and carbon monoxide (CO).¹² Estimates of the effectiveness of trees and tree canopies in removing pollutants depends on many factors, including the pollutant and density of the canopy, and estimates range from under 1% to about 13%.^{12, 13, 14} Even the smaller removals can be effective, however, consider the potentially very large extent of vegetated areas.

Properly installed windbreaks (i.e., continuous rows of trees or shrubs planted to provide a wind barrier) can lower concentrations of CO and PM_{2.5} generated by vehicles on the roadway by 12-40%. Similarly, sound walls can reduce concentrations of these traffic related pollutants near the roadway (within 15-20 m) by 15 to 50%. Depending on how sound walls are constructed, they may shift pollutants to other areas, so these need to be positioned so that pollutants are not directed into residential areas.¹⁵ When sufficient separation distance is provided between ground level sources of pollution (such as vehicles) and people, spatial buffers can reduce concentrations from these local sources as much as 80%.¹⁶

Buffers, walls and windbreaks work most effectively for those 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. Different strategies are needed for pollutants emitted by large industrial sources with elevated stacks (like power plants), and secondary pollutants (like ozone and PM_{2.5}), although tree canopies can provide smaller reductions in pollutant concentrations.

¹² Nowak, DJ, Crane, DE, Stevens, JC. Air pollution removal by urban trees and shrubs in the United States. *Urban Forestry and Urban Greening* 4:115-123.

¹³ Bealey WJ, McDonald AG, Nemitz E, Donovan R, Dragosits U, Duffy TR, et al. 2007. Estimating the reduction of urban PM10 concentrations by trees within an environmental information system for planners. *Journal of Environmental Management* 85:44–58.

¹⁴ Mitchell R, Maher BA. 2009. Evaluation and application of biomagnetic monitoring of traffic-derived particulate pollution. *Atmospheric Environment* 43:2095-2103.

¹⁵ Brechler, J. and Fuka, V. (2014) Impact of Noise Barriers on Air-Pollution Dispersion. *Natural Science*, 6, 377-386. <http://dx.doi.org/10.4236/ns.2014.66038>

¹⁶ NRCS (Natural Resources Conservation Services). 2004. Using Windbreaks to Reduce Odors Associated with Livestock Production Facilities. Available: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/mo/about/?cid=nrcs144p2_012665 [accessed 3 March 2016].

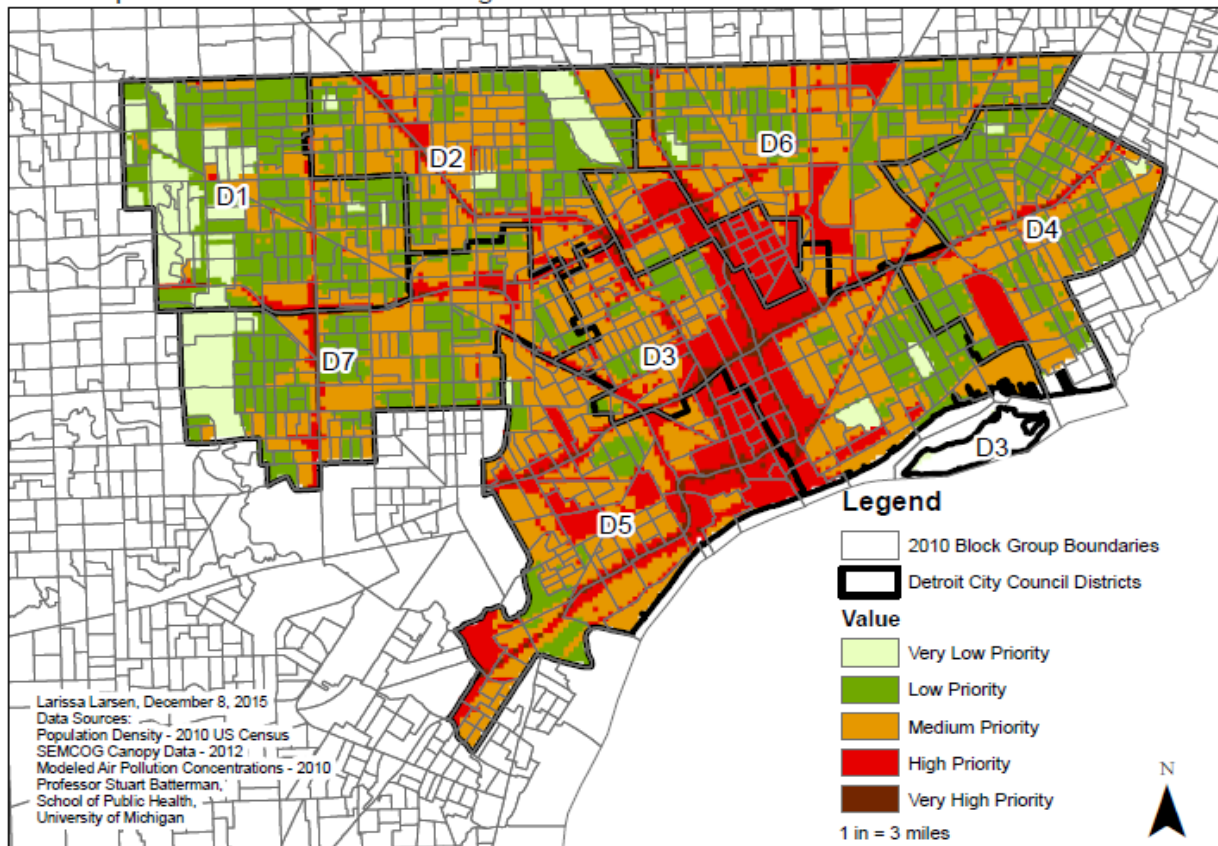
7.3.4.2 What health effects can be mitigated?

Using buffers could lead to improvements over time in respiratory diseases such as asthma and reduced lung irritation, coughing, and difficulty breathing; reduced lung diseases; fewer heart attacks, irregular heartbeat, and cases of cardiovascular disease; fewer low birth weight infants; and cancer.^{17, 18 19}

7.3.5 What is happening in Detroit?

Prioritizing Tree Planting Locations to Enhance Air Pollution Removal along Detroit's Roadways Project. Based on an approach conducted in New York City in 2011,²⁰ CAPHE combined three spatial layers of information including pollution concentration (for PM_{2.5} and NO₂), population density, and lack of tree canopy, to create an index of priority planting areas. **Figure 7.3 – 3** provides results from this analysis, ranging from very low priority tree planting areas, to very high priority tree planting areas. These findings will be expanded to identify specific recommendations for tree planting, including tree species information and information on impervious surfaces where planting may not be feasible.²¹

Map 4: Prioritized Tree Planting Areas to Enhance Vehicular Air Pollution Removal



¹⁷ EPA (Environmental Protection Agency). 2015. Near Roadway Air Pollution Health. Available: <http://www3.epa.gov/otag/nearroadway.htm> [accessed 3 March 2016].

^{18 13} ARB (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> [accessed 3 March 2016].

¹⁹ EPA (Environmental Protection Agency). 2016. Near-Source Air Pollution Research. Available: <http://www.epa.gov/air-research/near-source-air-pollution-research> [accessed 3 March 2016].

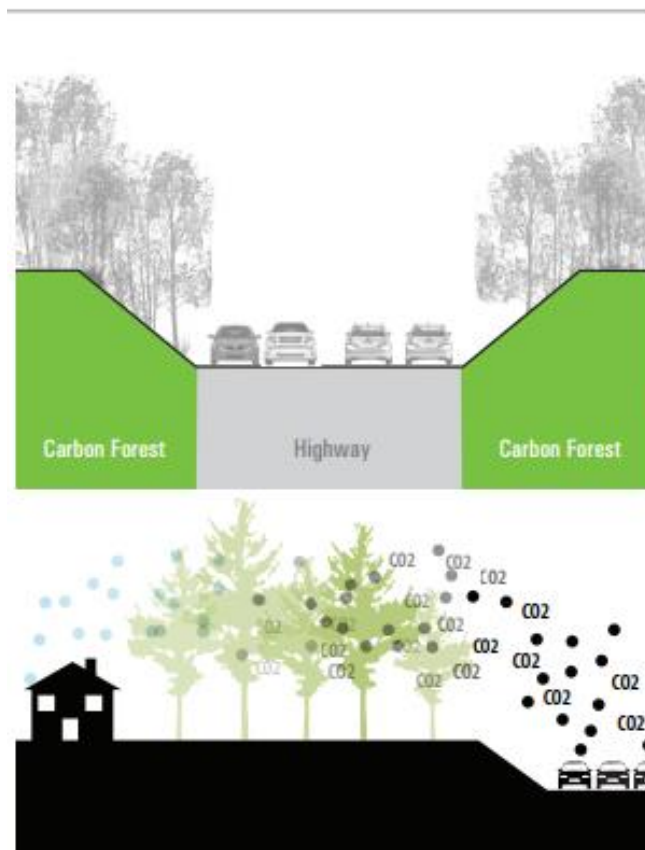
²⁰ Morani, A., Nowak, D.J., Hirabayashi, S., and Calfapietra, C. 2011. How to select the best tree planting locations to enhance air pollution removal in the MillionTreesNYC initiative, *Environmental Pollution* 159, 1040-1047.

²¹ Larsen, L. (Unpublished). Prioritizing tree planting locations to enhance air pollution removal along Detroit's roadways.

Figure 7.3 – 3. Prioritized Tree Planting Areas to Enhance Vehicular Air Pollution Removal

Carbon Buffering Pilot Program. Detroit Future City is working with The Greening of Detroit to prioritize sites and implement carbon buffers based on air quality measures, public land availability, and the future adjacent land uses. The primary goal of this program is to improve air quality in neighborhoods near expressways with green infrastructure that absorbs carbon dioxide, particulate matter, and other pollution from traffic.²²

Green Buffers Plan in Southwest Detroit. The Southwest Detroit Community Benefits Coalition, in partnership with Detroiters Working for Environmental Justice (DWEJ) was awarded a Kresge Foundation Innovation Planning Grant to develop a green buffers plan to protect the Delray neighborhood and surrounding areas in Southwest Detroit from air pollution from industrial facilities and the future Gordie Howe International Bridge connecting Detroit to Windsor, which will be located in this community.²³



A Healthier and Greener Detroit: Policy Recommendations for How Trees can be used to Improve Public Health in Detroit. In 2015 the Greening of Detroit partnered with the Institute for Population Health (IPH) to establish the “Healthier and Greener Detroit” (HGD) workgroup, with representatives from many Detroit based organizations.¹⁸ Funded through a grant from Trees Forever, they developed policy recommendations for the targeted use of trees to mitigate some of Detroit’s most serious public health problems, including: respiratory illness, heat stress, and mental health. One of their main goals is to increase Detroit’s tree canopy from 16.6% to 30% by 2025.²⁴

Noise Abatement Program. Michigan Department of Transportation (MDOT) has a Noise Abatement Program that includes the use of sound walls. While the primary goal of this program is to reduce noise pollution, sound walls can lower concentrations due to vehicle-related emissions in nearby neighborhoods. MDOT implements barriers when an area meets its ‘feasibility’ and ‘reasonableness’ criteria. These criteria consider whether a barrier can be implemented, the amount it would lower

Figure 7.3 – 4. Carbon Buffering Pilot Program. Detroit Future City.

²² Detroit Future City. 2014. Carbon Buffering Pilot Program. Available: <http://detroitfuturecity.com/wp-content/uploads/2014/12/Carbon-Buffering.pdf> [accessed 3 March 2016].

²³ Southwest Detroit Community Benefits Coalition. 2015. Green Buffers Planning Project in Southwest Detroit. Available: <http://www.swdetroitcbc.org/archives/51> [accessed 3 March 2016].

¹⁸ These included the Asthma and Allergy Foundation of America Michigan Chapter, Data Driven Detroit, Detroit Future City, Detroiters Working for Environmental Justice, Henry Ford Health System, Office of City Councilman Scott Benson, State of Michigan Department of Community Health, U.S. Forest Service, University of Michigan, and Wayne State University.

²⁴ The 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].

noise pollution, and the number of people affected.²⁵

7.3.6 What are the best practices elsewhere?

Policy support for spatial buffers. The California Environmental Quality Act (CEQA) created an air quality land use handbook that helps decision-makers determine whether a proposed development will result in environmental and health impacts and how to identify appropriate measures to reduce adverse impacts. The handbook includes spatial buffering recommendations for the siting of sensitive land uses including: residences, schools, daycare centers, playgrounds, or medical facilities. See *Recommendations for Siting Sensitive Land Uses Table*.²⁶

²⁵ MDOT (Michigan Department of Transportation). 2016. Noise Abatement. Available: <http://www.michigan.gov/mdot/0,1607,7-151-58298---F,00.html> [accessed 3 March 2016].

²⁶ 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> [accessed 3 March 2016].

Source Category	Advisory Recommendations
Freeways and High-Traffic Roads	<ul style="list-style-type: none"> • Avoid Siting new sensitive land uses within 500 feet (152 meters) of a freeway, urban roads with 100,000 vehicles/day, or rural roads with 50,000 vehicles/day.
Distribution Centers	<ul style="list-style-type: none"> • Avoid siting new sensitive land uses within 1,000 feet (305 meters) of a distribution center that accommodates more than 100 trucks per day, more than 40 trucks with operating transport refrigeration units (TRUs) per day, or where TRU unit operations exceed 300 hours per week. • Take into account the configuration of existing distribution centers and avoid locating residences and other new sensitive land uses near entry and exit ports.
Rail Yards	<ul style="list-style-type: none"> • Avoid siting new sensitive land uses within 1,000 feet (305 meters) of a major service and maintenance rail yard. • Within one mile (1,609 meters) of a rail yard, consider possible siting limitations and mitigation approaches.
Ports	<ul style="list-style-type: none"> • Avoid siting new sensitive land uses immediately downwind of ports in the most heavily impacted zones. Consult local air districts.
Refineries	<ul style="list-style-type: none"> • Avoid siting new sensitive land uses immediately downwind of petroleum refineries. Consult with local air districts and other local agencies to determine an appropriate separation.
Chrome Platers	<ul style="list-style-type: none"> • Avoid siting new sensitive land uses within 1,000 feet (305 meters) of a chrome plater.
Dry Cleaners Using Perchloroethylene	<ul style="list-style-type: none"> • Avoid siting new sensitive land uses within 300 feet (92 meters) of any dry cleaning operation. For operations with two or more machines, provide 500 feet (152 meters). For operations with three or more machines, consult with the local air district. • Do not site new sensitive land uses in the same building with perc dry cleaning operations.
Gasoline Dispensing Facilities	<ul style="list-style-type: none"> • Avoid siting new sensitive land uses within 300 feet (92 meters) of large gas stations (defined as a facility with a throughput of 3.6 million gallons (13.6 million liters) per year or greater). A 50 foot (15 meter) separation is recommended for typical gas dispensing facilities.

Table 7.3 – 1. Recommendations for citing sensitive land uses.⁷

Mapping city trees. The City of Lancaster, Pennsylvania used surveying technology (LiDAR) and aerial imagery to determine where tree canopy currently existed and where there was potential for tree canopy. They found that 28% of the City’s land area was covered in tree canopy. More importantly, they identified large areas (45% of total land area) where trees could be planted to increase the City’s tree canopy. This information will

⁷ California Environmental Protection Agency. 2005. Air Quality and Land Use Handbook: A Community Health Perspective. Available: <http://www.arb.ca.gov/ch/handbook.pdf>[accessed 9-13-16]

be utilized to set feasible planting goals and prioritize locations.²⁷ See above for estimates using a similar process in Detroit.

Master Plan – Air Pollution Emission Reduction Policies. San Jose, California included air pollution emission reduction policies in their Envision San Jose 2040 Master Plan. Policy Air 2.5 encourages the use of pollution absorbing trees and vegetation in buffer areas between substantial air pollution sources and sensitive land uses, where appropriate and feasible.²⁸

Community workshop and partner meetings. In Buffalo, New York, the Clean Air Coalition of Western New York hosted a local organization that designs and implements green buffers to protect vulnerable neighborhoods. They held a community workshop and facilitated meetings with stakeholders. The members also met with nine Common Council members. As a result, the Peace Bridge Authority (i.e., an international compact entity between the State of New York and Canada) announced that it will spend \$3 million on green infrastructure to improve air quality and buffer vulnerable neighborhoods from diesel exhaust.²⁹

Trees and sound walls combined near schools/vulnerable sites. The US Environmental Protection Agency (EPA) recently recommended that sound walls and/or vegetation should be planted around roadways adjacent to schools to reduce air pollution. EPA suggests that a well-designed sound wall can reduce pollutant concentrations from vehicle sources on the order of 15 to 50%, and that the combined use of trees and sound walls may reduce downwind vehicle pollution by up to 60%. To select appropriate tree and shrub species specific for vegetative buffers, the EPA recommends consulting the U.S. Department of Agriculture's (USDA's) i-Tree Species tool, as well as experts from plant nurseries, city government, or the U.S. Forest Service.³⁰

Carefully consider both type and placement of vegetation for greatest impact. A review of literature showed that it is important to consider plant species type, leaf characteristics, plant density, and placement of plants as these characteristics influence the reduction of air pollution. It is recommended to consult guidelines, such as the USDA National Agroforestry Center plant selection criteria for air pollutant removal.³¹

7.3.7 What are the benefits of using buffers in Detroit?

Buffer strategies evaluated

The remainder of this section estimates the health benefits of buffers located along freeways in Detroit. We consider two strategies:

- Assuring that all residents live more than 150 meters (500 feet) from freeways and roads with more than 10,000 vehicles per day.

²⁷ The City of Lancaster place. Can we apply any of ster. 2011. Green Infrastructure Plan. Lancaster, PA: CH2M Hill, Inc. Available: http://cityoflancasterpa.com/sites/default/files/documents/cityoflancaster_giplan_fullreport_april2011_final_0.pdf [accessed 3 March 2016].

²⁸ The City of San Jose. 2007. Envision San Jose 2040: General Plan. Available: <http://www.sanjoseca.gov/DocumentCenter/View/19425> [accessed 3 March 2016].

²⁹ Clean Air Organizing for Health and Justice. 2014. 2014 Annual Report. Buffalo, NY: The Clean Air Coalition of W.N.Y. Available: <http://www.cacwny.org/wp-content/uploads/2012/03/CA-Annual-Report-2014.pdf> [accessed 3 March 2016].

³⁰ EPA (Environmental Protection Agency). 2015. Best Practices for Reducing Near-Road Pollution Exposure at Schools. Available: http://www.epa.gov/sites/production/files/2015-10/documents/ochp_2015_near_road_pollution_booklet_v16_508.pdf [accessed 3 March 2016].

³¹ USDA (United States Department of Agriculture National Agroforestry Center). Air Quality Buffers. Available: <http://nac.unl.edu/buffers/docs/6/6.3ref.pdf> [accessed 3 March 2016].

- Increasing vegetation along freeways and roads with more than 10,000 vehicles per day, to create vegetative buffers between mobile air pollutants and residences located within 150 meters (500 feet) of those roadways.

Analysis methods

This analysis considered Detroit and the surrounding Tri-County area. The Tri-county area had a population of 3,962,783 in 2009, and the population of Detroit was 706,663 in that same year (see Figure 6-1). We estimated the number of residents living within 150 meters (500 feet) of freeways and roads with more than 10,000 vehicles per day, using census data and GIS techniques and following methods described by Beelen and colleagues (2007).³² The measure for proximity to highways was defined as an indicator variable of ‘living within 150 m from a highway (I-75, I-94, I-96, I-275, M-10 and M-39) and/or within 150 m of a local road with traffic volumes over 10,000 vehicles/day (M-8 (Davison), M-12 (Michigan Av), M-153 (Ford Road), M-1 (Woodward), M-3 (Gratiot)).³³ Mortality was assessed using mortality data from the Michigan Department of Health and Human Services (MDHHS), between January 1, 2008 and December 2012. Cause of death was coded according to the International Classification of Diseases 10th revision (ICD-10). Causes of death were grouped into all-cause mortality, cardiopulmonary mortality, cardiovascular mortality, respiratory mortality and lung cancer mortality.

Diesel PM was obtained from the 2011 NATA concentration estimates, and modeled at the census tract levels using exposure in quintiles (1=low, 5=high). Percent tree canopy coverage at the census tract level was derived from the 2011 National Land Cover Database (NLCD), and entered in models using quintiles (1=low, 5=high). A cumulative risk index made up of exposure and health risks, cumulative vulnerabilities and hazardous land uses and facilities was also created at the census tract level. Methods used to create this measure are detailed in Schulz et al. (2016).³⁴

We used multivariate multilevel longitudinal models to assess the independent and joint effects of diesel PM concentrations, tree canopy and proximity to freeways on different measure of mortality, with a focus on cardiopulmonary mortality due to its strong association with air pollutants. Models adjusted for individual level: age; gender; race/ethnicity categorized in Hispanic, Non-Hispanic black, Non-Hispanic white(ref); educational attainment categorized in less than high school education, high school education and more than high school education(ref); smoking status categorized in smoker at the time of death, former smoker and non-smoker (ref); and marital status.

³² 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 Perspective* 116:202

³³ 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 Perspective* 116:202

³⁴ Schulz, A.J., Mentz, G.B., Sampson, N, Ward, M., Anderson, R., deMajo, R., Israel, B.A., Lewis, T.C., Wilkins, D. 2016. RACE AND THE DISTRIBUTION OF SOCIAL AND PHYSICAL ENVIRONMENTAL RISK: A Case Example from the Detroit Metropolitan Area. *DuBois Review*. In Press.

We calculated the relative risk of cardiopulmonary mortality for those residing <150 meters from heavily trafficked roadways compared to those living \geq 150 meters. We then divided the cardiopulmonary mortality rate (number of cardiopulmonary deaths/total population) by the relative risk of cardiopulmonary mortality based on proximity to heavily trafficked roadways, to estimate the number of cardiopulmonary deaths averted per year if all Detroit residents were to live \geq 150 meters from a major roadway. Similarly, we calculated the relative risk of cardiopulmonary mortality for each 15% increase in tree canopy coverage, and applied that relative risk to estimate the number of cardiopulmonary deaths averted if tree canopy coverage were increased by 15%, 30% and 45% along major roadways.

7.3.8 Estimated health benefits of buffers in Detroit

The number of people affected by buffers depends on how many are implemented, what type, where they are implemented, the scale (small to large), and how long it takes for them to grow and/or be installed. Using the metrics described above, we estimate that 69,000 Detroit residents live within 150 meters (500 feet) of a major freeway or a road with >10,000 vehicles per day. Similarly, reducing the number of schools located close to a major freeway would result in substantial health benefits to children from reduced exposure.³⁵

Approximately 16 - 20% of cardiopulmonary mortality is attributable to exposure to PM.³⁶ For Detroit, this suggests that between 544-625 of the 3,400 cardiopulmonary deaths each year are attributable to PM. Of those, approximately 10% (54-63) live <150 meters from a freeway. Applying the relative risk of 1.16 (the relative risk of cardiopulmonary mortality due to living <150 meters from a freeway derived from our models) to those cardiopulmonary deaths <150 meters from freeway, we estimate that if all Detroit residents lived at least 150 meters from a major freeway, there would be 9-10 fewer cardiopulmonary deaths per year attributable to diesel PM_{2.5}.

Using a similar method, we estimate that increasing vegetation by 45% within the 150 meter buffer areas along those same freeways, would contribute to a reduction of 2 to 6 cardiopulmonary deaths per year attributable to diesel PM_{2.5}. These estimates do not include reductions in asthma events, hospitalizations, and other adverse health outcomes, detailed in Section 5.4.4. Furthermore, they are conservative as they do not consider improvements in mental well-being, property values, or reductions in severe heat events associated with climate change, co-benefits of increased vegetation.

Those who live, work, and spend time near major freeways could benefit from the implementation of buffers. Additional sites in Detroit that could use buffers:

- Ambassador Bridge and the future site of the Gordie Howe Bridge
- The new Industrial Park and Logistic Center in Eastside
- Truck and rail transfer stations, for example the Container Port on West Fort Street
- Schools near major roadways
- Along major freeways such as I94 and I75
- Along major traffic routes, such as Fort Street and Michigan Avenue

³⁵ WHO (World Health Organization). Available: http://www.who.int./gho/phe/outdoor_air_pollution/en/ [Accessed 20 April 2016].

³⁶ WHO (World Health Organization). Available: http://www.who.int./gho/phe/outdoor_air_pollution/en/ [Accessed 20 April 2016].

7.3.9 Applicable strategies for Detroit

Require minimum setbacks of 150 meters (500 feet) or more between sensitive land uses and freeways and heavily trafficked roadways, railyards, distribution centers and other sources of air pollutants. Such setbacks would reduce exposures to children attending schools, and to residents in their homes and neighborhoods, resulting in reduced cardiopulmonary mortality, as well as reduced asthma hospitalizations and exacerbations.

Expand vegetative buffer projects throughout the City of Detroit. Given the existing momentum for greening projects in Detroit, it is feasible to implement vegetative buffers that complement or expand on current efforts to use vegetation as an air pollution mitigation measure. Areas can be prioritized by analyzing different spatial layers, similar to the approach mentioned above in [Figure 7.3 – 3](#).

Implement vegetative buffers along major roadways. Increasing tree canopy or other vegetation along freeways would reduce exposure to near-roadway pollutants, particularly for residents who live, work or go to school near high traffic roadways.

Increase City of Detroit tree canopy. Increasing tree canopy in Detroit to the 30% recommended by the American Forest Service could reduce mortality among Detroit residents. Increases in tree canopy have been associated with reduced asthma prevalence, reduced mental distress, increased life satisfaction and decreased mortality,³⁷ particularly for those who live nearby.

Create policies requiring buffers. A consideration for land use that is environmentally friendly (e.g. spatial buffers, use of greenery) in future construction and design plans can be legally mandated and enforced.

Request buffers in Community Benefits Agreements and/or to be incorporated in future development projects. Similarly to enacting policy that encourages the use of buffers, incorporating buffers into Community Benefits Agreements will provide a contract legally mandating the inclusion of buffers. Additionally, it makes sense to consider the use of buffers in the design phase of a project, rather than following its completion.

Create partnerships with relevant organizations like The Greening of Detroit and state/local authorities. Working with relevant and interested organizations can provide valuable insight, skills and knowledge. It is important to work with state and local authorities to ensure buffer plans are complementary to city plans.

³⁷ The 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].