Mobile Sources Air Toxics Protocol

Guidance Document

V1.3

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Sacramento Metropolitan Air Quality Management District

Contents

1 Purpose and Need

Freeways, high volume roadways, and railways are sources of toxic air contaminants, which the California Health and Safety Code describes as "air pollutants which may cause or contribute to an increase in mortality or serious illness, or which may pose a present or potential hazard to human health known to cause cancer or other human health impacts."[1]

Local governments have the authority to consider the impact of toxic air contaminants on public health through their police powers.[2,3] The Sacramento Metropolitan Air Quality Management District (Sac Metro Air District) recommends that lead agencies analyze toxic air contaminant health impacts and consider exposure reduction measures if proposed land use developments could expose people to sources of roadway or railway pollution. This is most commonly accomplished during project planning and review.

The Mobile Sources Air Toxics Protocol (MSAT Protocol) includes the following resources:

- An internet-based Mapping Tool that discloses localized cancer risk and $PM_{2.5}$ levels
- This Guidance document on how to use and understand the Mapping Tool
- A Sac Metro Air District Board-adopted Technical Appendix and Methodology explaining the calculations
- Suggested Exposure Reduction Measures that lead agencies, developers, business owners and residents can implement to reduce risk

The Mapping Tool includes the following pollutant sources in Sacramento County:

- Interstate 5
- Interstate 80
- Interstate 80 Business
- US Highway 50
- State Route 99
- Segments of State Route 160, Sunrise Boulevard, Watt Avenue and Hazel Avenue that exceed 100,000 Average Daily Traffic
- All railways in Sacramento County except for the SSRR and SVRR subdivisions.[4]

The Mapping Tool does not include existing background cancer risk levels. The cancer risk shown in the Mapping Tool is *in addition* to this existing background cancer risk value. See Section 4.3- *Limitations of Mapping Tool* for more information.

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1 California Health and Safety Code, *Article 2. Definitions*,
2 California Constitution, *Article XI, Section 7*, 1969.
3 Pleasant Hill Bayshore Disposal, Inc. v. Chip-It Recycling, Inc. (2001) 91 Cal.App.4th 678, 689.
4 Sacramento Southern Rail Road (SSSR) operates excursion train rides; SVRR (Sacramento Valley Rail Road) is a rail spur that serves McClellan Park.

2 Authority of Local Land Use Jurisdictions

The Sac Metro Air District has no authority to directly regulate land use.[5] However, the Sac Metro Air District is statutorily directed to represent the citizens of the District in influencing other agencies' decisions if those decisions could have an adverse impact on air quality.[6] *The Sac Metro Air District defers to the local land use jurisdiction to determine appropriate risk levels for intervention.*

The Sac Metro Air District does not recommend any particular risk-based or concentration-based thresholds for use with the MSAT Protocol and its Mapping Tool.

3 Pollutants Included In Analysis

The Mapping Tool quantifies cancer risk for Diesel Particulate Matter (DPM, represented as PM_{10}) and Total Organic Gases (TOG), and concentration levels of fine particulate matter ($PM_{2.5}$).

The Mapping Tool:

- Estimates the increased probability that an individual, or "receptor", will develop cancer over a lifetime as a direct result of exposure to PM_{10} and TOG
- Estimates the level (concentration) of $PM_{2.5}$ in the air for each receptor point
- Follows guidance and protocols issued by the California Office of Environmental Health Hazard Assessment (OEHHA Guidance) for estimating risk, which are designed to protect health by avoiding underestimation of risk to the public

Figure 1 below illustrates the pollutants and their sources.

Figure 1 Mapping Tool Pollutant Sources

Pollutant	Source
$PM_{2.5}$ Concentrations	On-road vehicle brake wear, road dust, and tire wear
Diesel Particulate Matter / PM_{10} Cancer Risk	Heavy-duty trucks Light-duty trucks Locomotives
Total Organic Gases Cancer Risk	All on-road vehicles with a gas or diesel engine (including hybrids)

[5] 42 USC § 7431; Health & Safety. Code, § 41015.
[6] Health & Safety Code, § 40961.

3.1 Diesel Particulate Matter (DPM, expressed as PM_{10})

Diesel engine exhaust is a complex mixture of hundreds of harmful components, including diesel particulate matter (DPM). Diesel exhaust is considered carcinogenic by the State of California, the National Toxicology Program, the National Institute of Occupational Safety and Health, and the United States Environmental Protection Agency (US EPA).[7, 8]

Almost all DPM from diesel exhaust is in the fine particle range of 10 microns or less in diameter (PM_{10}).

For health risk modeling purpose, the Mapping Tool assumes that DPM from locomotives and diesel-fueled on-road vehicles is PM_{10} to provide a health-protective risk (i.e., conservative) estimate.

3.1.1 DPM (PM_{10}) Cancer Risk

The Mapping Tool quantifies PM_{10} levels in the air based on motor vehicle and locomotive traffic levels, wind speed and direction, and terrain features specific to Sacramento County.

The cancer risk calculation assumes a 30-year exposure period consistent with OEHHA protocols.

See the Technical Appendix for more information on the DPM (PM_{10}) cancer risk calculation method.

3.2 Total Organic Gases (TOG)

Total Organic Gases (TOG) emissions occur with vehicle tailpipe emissions and evaporation from the fuel system, and include various toxic components such as benzene, naphthalene and acetaldehyde.

3.2.1 TOG Cancer Risk Calculation

The Mapping Tool quantifies TOG levels in the air based on motor vehicle and locomotive traffic levels, wind speed and direction, and terrain features specific to Sacramento County.

TOG cancer risk must be calculated using a component-based method. The emissions are split into individual toxic components using the Bay Area Air Quality Management District's recommended methodology.[9] The risks from these individual components are then summed to estimate TOG cancer risk.

The Mapping Tool displays TOG cancer risk individually, as well as summed with the PM_{10} cancer risk.

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[7] California Air Resources Board (ARB). "Initial Statement of Reasons for Rulemaking. Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant". 1998.

[8] Cal/EPA. Office of Environmental Health Hazard Assessment. "Air Toxics Hot Spots Program Risk Assessment Guidelines: Part II Technical Support Document for Describing Available Cancer Potency Factors". 2009.

[9] Bay Area Air Quality Management District, *Recommended Methods for Screening and Modeling Local Risks and Hazards*, 2011, page 88.

See the Technical Appendix for more information on the TOG risk calculation method.

3.3 Fine Particulate Matter ($PM_{2.5}$)

Exhaust from locomotives, heavy-duty diesel vehicles and light-duty vehicles contains fine particulate matter. On-road vehicles, regardless of size and type, create $PM_{2.5}$ through roadway dust, brake wear and tire wear.

$PM_{2.5}$ is regulated at the state and federal levels, and has an annual average ambient air quality standard of 12 µg/m^3 in California.[10] The US EPA lists $PM_{2.5}$ as one of six "criteria" pollutants that are harmful to public health and the environment.

Exposure to $PM_{2.5}$ can cause many adverse health effects. Both short-term and long-term exposure to $PM_{2.5}$ harm the cardiovascular system and increase mortality, and may likely harm the respiratory system.[11] There is also a suggestive relationship between long-term exposure to $PM_{2.5}$ and cancer development. $PM_{2.5}$ damages cells and causes reproductive and developmental health problems. Research indicates that health effects exist even at low levels.[12]

3.3.1 $PM_{2.5}$ Concentration Calculation

Due to the complexity of $PM_{2.5}$, OEHHA has not approved toxicity values to aid in calculating a cancer risk value. Therefore, $PM_{2.5}$ impacts are typically reported as a concentration per unit of air. Typically, it is reported as micrograms per cubic meter (µg/m^3). This approach is consistent with CEQA guidelines in many California air districts.

See the Technical Appendix for more information on the $PM_{2.5}$ concentration calculation method.

4 Mapping Tool Overview

4.1 Scope of Mapping Tool

The Mapping Tool:

- Is designed to be used with the Guidance and Methodology documents
- Is based on information specific to Sacramento County, taking into account specific terrain features and meteorological conditions
- Extends two kilometers out from either side of roadways in which at least 100,000 vehicles travel daily on average, and rail lines, within Sacramento County
- Is based on roadway and railway traffic volumes and speeds

[10] California Environmental Protection Agency, *Particulate Matter – Overview,* 2005.

[11] United States Environmental Protection Agency, *Integrated Science Assessment for Particulate Matter*, EPA/600/R-08/139F. 2009.

[12] Bay Area Air Quality Management District, *Understanding Particulate Matter: Protecting Public Health in the San Francisco Bay Area*, page 88. 2012.

- Uses car and truck emission factors from the California Air Resources Board's EMission FACtor (EMFAC) database for vehicles within Sacramento County[13]
- Assumes future emission reductions due to technological advancements, as incorporated in the EMFAC model
- Uses locomotive emission factors from the CARB's Vision 2.0 Locomotive Inventory, representing the average locomotive in the Sacramento Valley Air Basin[14]
- Gives a health-protective estimate of cancer risk from PM_{10} and TOG
- Gives a health-protective estimate of $PM_{2.5}$ concentrations

4.2 Mapping Tool Visual Features

The Mapping Tool contains the following visual features:

- Areas that are shaded grey indicate the extent of risk modeling: 2 kilometers from either side of the modeled roadway and railway
- An area lights up when the user hovers the cursor over the area.
- Upon zooming in, blue receptor points will appear as a dotted grid.
- Blue receptor points turn yellow when selected.
- As a visual reference, the roadways whose emissions analyses form this model are colored **solid** lines. The colors are used to visually distinguish among the different roadways modeled. These include Interstates 5 and 80, Interstate 80 Business, State Routes 50 and 99, along with sections of State Route 160, Hazel Avenue, Sunrise Boulevard and Watt Avenue).
- Also as a visual reference, the railway sources are colored **dotted** lines. The colors correspond to the different railway "subdivisions" that were included in the analysis: Central California Traction (CTC), Fresno (FRES), Ione Industrial Lead (IONE), Martinez (MART), Placerville Industrial Lead (PLAC), Polk Industrial Lead (POLK), Sacramento (SAC), Sierra Northern Railroad (SSNR), Stockton (STOC), and the small sections joining the subdivisions links, where applicable.
- The Mapping Tool allows the user to override the default visual display and selectively display whether the map shows the analyzed roadways or railways by clicking on the respective green toggle buttons above the map. **Toggling between these views does not affect the risk values.**

[13] California Air Resources Board, *EMFAC2014 Web Database*, V1.0.7
[14] California Air Resources Board, *California Air Basin Map*, 2014.

4.3 Limitations of Mapping Tool

The Mapping Tool:

- Does not give an expected rate of disease, rather, gives an estimate of potential for disease based on current knowledge and assumptions that lean in the direction of overstating risk, so as to be as health-protective as possible
- Does not estimate health risks other than cancer from DPM and TOG, for example, risks of asthma and heart disease from emissions exposure are not estimated
- Does not take into account characteristics that make people more susceptible to pollution: for example, people with heart disease or other chronic conditions may be more susceptible to developing cancer
- Does not reflect the potential beneficial effects of sound walls, nearby vegetation, buildings or landscape features that may affect pollutant movement and reduce exposure, such as building filtration, the simple effect of being indoors, or living and working under a tree canopy
- Does not include existing background risk levels: regardless of where you live in California, diesel particulate matter exists in the air and contributes to a "background" health risk of 520 cancers per million people exposed over a lifetime[15]

  The risk shown in the Mapping Tool is in addition to this existing background risk value.

The Sac Metro Air District does not recommend any particular health risk or concentration-based thresholds for use with the MSAT Protocol and its Mapping Tool, and defers to the local jurisdiction to determine appropriate risk levels for intervention. However, for reference, the Bay Area Air Quality Management District suggests a cumulative cancer risk threshold of 100 cancers in a million from all local sources, and a cumulative $PM_{2.5}$ threshold of 0.8 µg/m^3.[16] San Joaquin Valley Air Pollution Control District has a CEQA threshold of 20 cancers in a million for both cumulative and project-specific impacts due to carcinogens. Additionally, the San Joaquin Valley Air Pollution Control District considers any $PM_{2.5}$ concentration above the California Ambient Air Quality Standard of 12 µg/m^3 to be a significant impact.[17]

The Technical Appendix and Methodology document provides more detail on the assumptions underlying the Mapping Tool results.

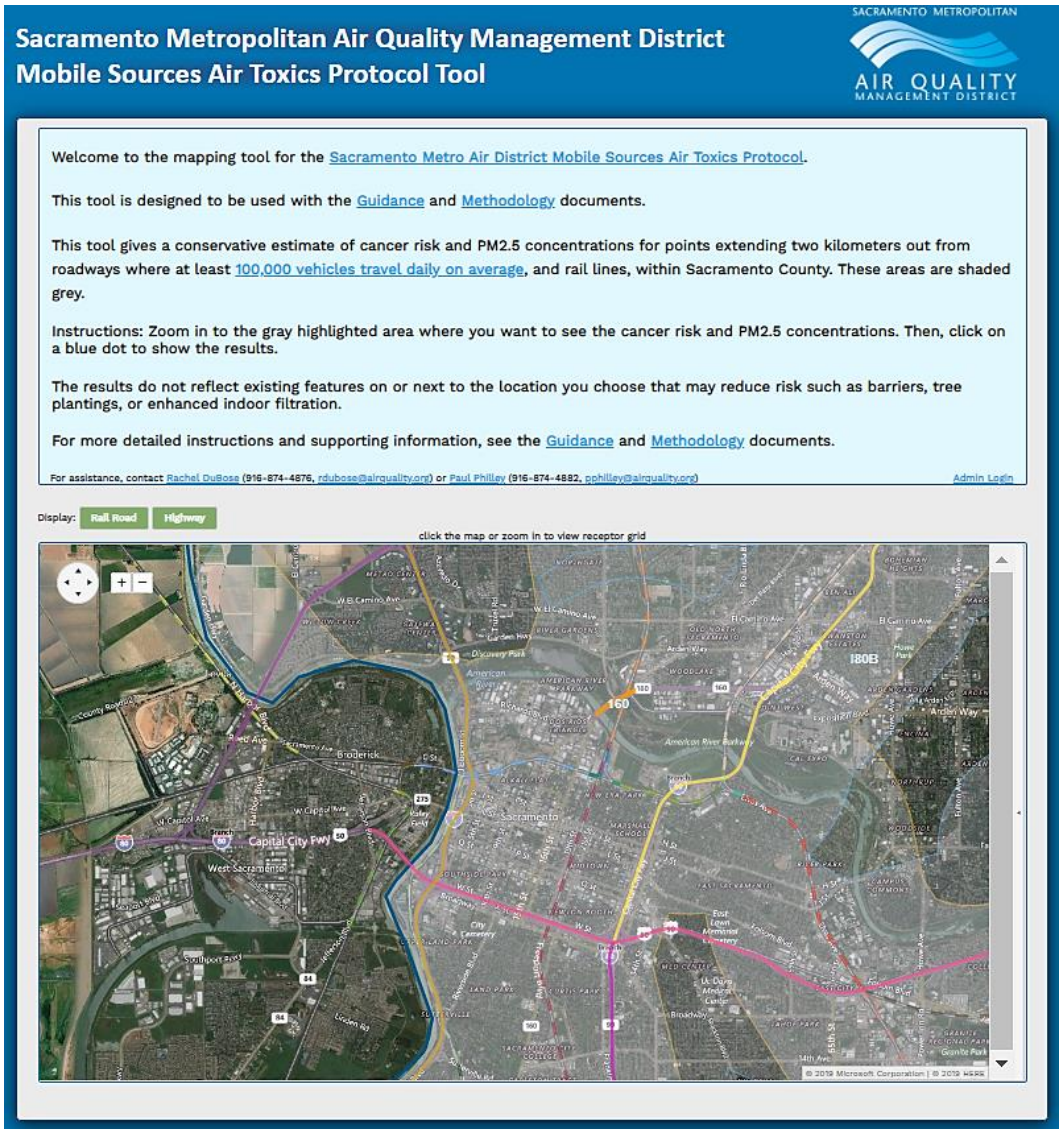
[15] California Air Resources Board, *Overview: Diesel Exhaust and Health*, viewed February 2019.
[16] Bay Area Air Quality Management District, *California Environmental Quality Act Air Quality Guidelines*, May 2017.
[17] San Joaquin Air Pollution Control District, *CEQA Thresholds of Significance*, viewed February 2019.

5 Step by Step Instructions with Example

The Mapping Tool can be used by anyone with internet access.

1. Access the map at http://sacramentorisk.azurewebsites.net. Basic instructions are provided above the map. Figure 2 below shows what the Mapping Tool looks like.

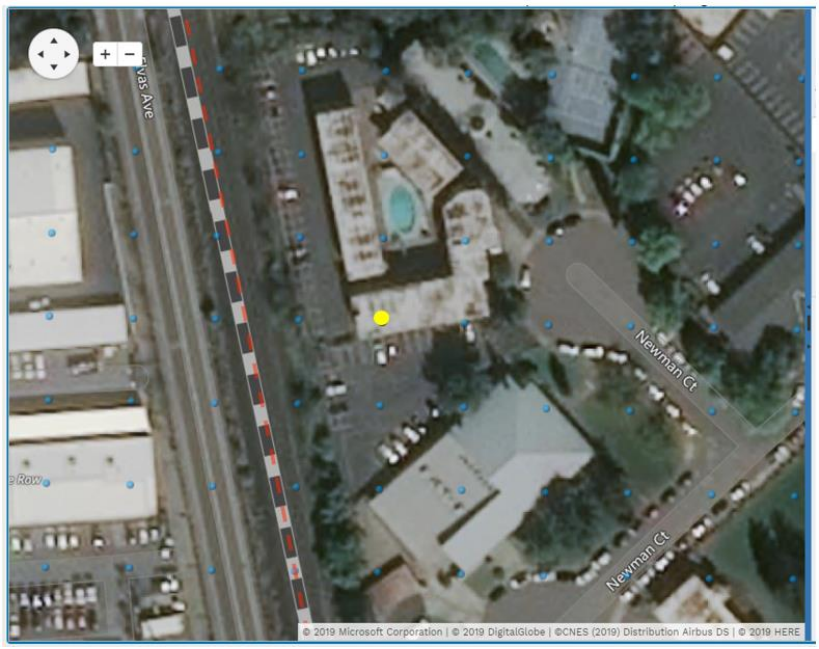
Figure 2 View of Mapping Tool Homepage (this image best viewed in color)



2. Navigate to your general location of interest using either your mouse to drag and zoom in, or the navigation tools located in the top left hand corner of the map.

3. Click anywhere within the shaded light grey areas to show cancer risk data and $P_{M2.5}$ concentrations.
4. Tip: To more accurately identify your location of interest, zoom in until a blue grid of receptor dots appears, and then click on the nearest blue dot. The dot will then turn yellow.

Figure 3: Close-up Example of Selected Receptor Point (this image best viewed in color)



Once the dot turns yellow, and a table will pop up with the results. This may take a few seconds.

The table shows the results as a Health Risk Variable in the left column and the corresponding Estimate Value in the right column. DPM and TOG are shown in per million cancer risk individually, as well as summed. The $PM_{2.5}$ results are shown as a concentration (per unit of air).

Figure 4: Example of Mapping Tool Results

Health Risk Variable	Estimated Value
DPM (in one million)	66
TOG (in one million)	3
Total DPM + TOG (in one million)	*69*
PM2.5 (µg/m3)	0.86

In this example, the cancer risk for DPM is 66 cancers per million people above and beyond the background DPM cancer risk of 520 cancers per million. The cancer risk from TOG is 3 cancers

per million people. Summed, the result is 69 cancers per million people. The concentration of $PM_{2.5}$ is 0.86 micrograms per cubic meter of air ($\mu g/m^3$).

6 Exposure Reduction Measures

The Sac Metro Air District recommends that exposure reduction measures be considered for any proposed land use project where individuals will be exposed to pollution from a freeway, major roadway, or active railway with locomotives.

In 2017, CARB released a guidance document called *Strategies to Reduce Air Pollution Exposure Near High-volume Roadways* that contains three recommended exposure reduction measures.[18]

The three exposure reduction strategies are:

- Indoor air treatment: Heating, Ventilation and Air Conditioning (HVAC) filters and portable air cleaners
- Land use design
- Solid and vegetation barriers

These strategies are discussed below.

Wildfire Smoke and Climate Change Resilience

HVAC filters and portable air cleaners can be effective in reducing wildfire smoke concentrations within homes. Because climate change is increasing the occurrence of wildfires, **the Sac Metro Air District recommends higher-efficiency HVAC filters in all new homes**, and in existing homes where the unit is capable of handling the increased pressure.

Portable air cleaners can also help reduce pollutants during episodes of high PM concentrations.

6.1 Indoor Air Treatments

HVAC filters and portable air cleaners can reduce indoor air particulate concentration levels by 50 to 99 percent with high efficiency HVAC filters, and 30 to 90 percent with portable air cleaners.

6.1.1 HVAC Filters

HVAC filters are rated by the size of particles they can capture. Some manufacturers report the effectiveness based on the Minimum Efficiency Reporting Value (MERV) rating system. Others use a Micro-Particle Performance Rating (MPR), or a Filter Performance Rating (FPR). The Sac Metro Air District recommends a MERV of at least 13, an MPR of at least 1500, or an FPR of at least 10. An FPR of 10 and an MPR of 1500 are equivalent to a MERV 13.

For HVAC filters, check with the HVAC unit manufacturer to ensure that a higher-efficiency filter will not overexert the system; as MERV rating increases, in general, the power required to pump air through the filtration system also increases.

[18] California Air Resources Board, *Technical Advisory: Strategies to Reduce Air Pollution Exposure Near High-Volume Roadways,* April 2017.

6.1.2 Portable Air Cleaners

For maximum health benefit, portable air cleaners should recirculate the air in the room at least two times every hour of operation. The Sac Metro Air District's Air Exchange Rate Tool,19 found on www.AirQuality.org, can help determine if an air cleaner meets this recommendation.

Note: To be sold in California, portable air cleaners must be certified by CARB.

For more information on HVAC filters and how to choose an effective and safe portable air cleaner:

- Air Exchange Rate Tool: http://www.airquality.org/LandUseTransportation/Documents/final%20Portable%20Air%20Cleaner%20Air%20Exchange%20Rate%20Tool_July%202018.zip

- CARB's Air Cleaner FAQ: https://ww2.arb.ca.gov/sites/default/files/2020-07/acdsumm.pdf

- MERV, MPR, and FPR Rating Systems: https://www.airfiltersdelivered.com/merv-mpr-fpr-ratings
  No endorsement implied.

6.2 Land Use Design

The design of land uses can impact pollutant dispersion in such a way to reduce concentrations and subsequent exposure.[20] Airflow and pollutant movements are influenced by the physical layout of urban streetscapes. These include building geometry, street and adjacent building dimensions (street canyons), architectural design, and building location. Generally, pollutant movement and air quality can be improved when urban streetscapes have buildings with varying shapes and heights, building articulation (design elements such as edges and corners), and open spaces such as parks.

Placing parking lots between the pollutant source and building, adding wider sidewalks, bike lanes, and dedicated transit lanes create additional space allowing for more dispersion and therefore fewer concentrated emissions.

Resource:

- The California Air Resources Board's *Strategies to Reduce Air Pollution Exposure near High-Volume Roadways*: https://www.arb.ca.gov/ch/rd_technical_analysis_fact_sheet.pdf.

[19] Link: Portable Air Cleaner Air Exchange Rate Tool (July 2018). This is a .zip file. Please save it and then open it to extract the .xlsm file.

[20] California Air Resources Board, *Technical Advisory: Strategies to Reduce Air Pollution Exposure Near High-Volume Roadways,* 2017.

6.3 Solid and Vegetation Barriers

Studies have found that solid barriers such as sound walls can increase the vertical dispersion of emissions and consequently reduce concentrations. Reductions range from 10% to 50%. These reductions have been confirmed in field measurements, wind tunnel studies, and modeling exercises.[21]

Plants and trees when densely arranged can also act as a barrier because they can alter pollutant transport and dispersion. In 2016, the US EPA summarized current research results and best practices for using vegetation barriers near roadways to improve air quality.[22] The Sac Metro Air District developed guidance specific to the Sacramento area. The *Landscaping Guidance for Improving Air Quality near Roadways* offers direction on evaluating a potential vegetation barrier site; gives vegetation planting recommendations appropriate to the Sacramento region to meet height, thickness and porosity goals; provides a recommended plant species list; addresses planting best practices; and offers suggestions for effective long term maintenance.

Vegetation barriers also may reduce urban heat islands, which reduces the formation of ozone, another air pollutant with serious health consequences.

Resources:

- Sac Metro Air District's *Landscaping Guidance for Improving Air Quality near Roadways* (May 2020)

  http://www.airquality.org/LandUseTransportation/Documents/LandscapingGuidanceforImprovingAirQualityNearRoadwaysMay2020V2.pdf

- The US EPA's *Recommendations for Constructing Roadside Vegetation Barriers to Improve Near-Road Air Quality*
  https://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=528612&Lab=NRMRL

- The California Air Resources Board's *Strategies to Reduce Air Pollution Exposure near High-Volume Roadways*
  https://www.arb.ca.gov/ch/rd_technical_analysis_fact_sheet.pdf

[21] United States Environmental Protection Agency, *Recommendations for Constructing Roadside Vegetation Barriers to Improve Near-Road Air Quality*, 2016.
[22] ibid

7 Document Revision History

V1.3, September 2020

Updated the link to the California Air Resources Board's Air Cleaning Devices for the Home- Frequently Asked Questions document.

Updated the link to the Landscaping Guidance for Improving Air Quality Near Roadways - Plant Species and Best Practices for the Sacramento Region to the newest version (2.0, May 2020).

V1.2, April 2019:

Clarified the Exposure Reduction Measures section to specify MERV 13 as the recommended filtration level.

Revised the rail discussion to be consistent with the current Mapping Tool and methodology.

Added a step-by-step example with images.

Reorganized and reformatted to enhance overall readability.

V1.1, July 20, 2018:

Corrected the Exposure Reduction Measure discussion to include railways.

8 Staff Contact

Contact Rachel DuBose or Paul Philley of the Sac Metro Air District if you have questions about the Mobile Sources Air Toxics Protocol, including this document.

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Staff will update the Mapping Tool as new data becomes available.