

Near-Roadway Indoor Air Pollution: Assessing Health Effects and Mitigation Strategies

Appendix E2. Mitigation Summary of Included Systematic Reviews

This appendix provides table summaries of the systematic reviews included in the mitigation strategies chapter, organized by the following 3 categories:

- 1) Source control
- 2) Outdoor control
- 3) Indoor exposure pollution control

Mitigation Strategies for Source Control

Table 1 summarizes the literature that met CalSPEC’s inclusion criteria for source control; specifically, vehicle technology advances and adoption driven by policy and regulations; and travel and traffic management.

Table 1. Mitigation strategies for source control with corresponding literature

Categorization	Reviews Considered in Assessing Mitigation Effects		Reviews Considered in Assessing Costs
	References	# Primary studies applicable	
<i>Vehicle Technology Advances and Adoption Driven by Policy and Regulations</i>			
Emerging Clean vehicle technologies and adoption	Requia et al. 2018	65	Ayodele & Mustapa 2020; Machado et al. 2021
	Burns et al. 2020	1	
	Machado et al. 2021	20	
<ul style="list-style-type: none"> • Zero and low emitting vehicles • Alternative fuel vehicles • Sales mandate 			
Long-term policies Improving fuel and emission standards	Henneman et al. 2017	8	Rawat & Kumar 2023
	Burns et al. 2020	4	
	Rawat & Kumar 2023	*	
<ul style="list-style-type: none"> • Fuel standards • Emissions standards/regulations • Exhaust treatment technology 			
<i>Travel and traffic management</i>			
Operating restrictions and pricing	Bigazzi & Rouleau 2017	25	Bigazzi & Rouleau 2017
	Henneman et al. 2017	8	
	Burns et al. 2020	8	
<ul style="list-style-type: none"> • Traffic restrictions during major events (Olympic Games, World Expo) • Road, congestion, and cordon pricing (tolling, distance pricing, or pricing based on time-of-day or congestion levels; congestion charging schemes) • Low/zero emission zones and eco-zones (pricing or restrictions based on emissions status of vehicles) • Vehicle operating and access restrictions (by 			

Reviews Considered in Assessing Mitigation Effects			
Category	References	# Primary studies applicable	Reviews Considered in Assessing Costs
zone, time-of-day, or route; even-odd restrictions, anti-idling of buses outside schools) <ul style="list-style-type: none"> • Parking management (supply and pricing strategies) 			
Lane management	Bigazzi & Rouleau 2017	3	Bigazzi & Rouleau 2017
<ul style="list-style-type: none"> • High occupancy vehicle, High Occupancy Toll, and eco-lanes • Truck and/or bus lanes • Lane capacity changes (road diets, peak shoulder running) 			
Speed management	Bigazzi & Rouleau 2017	12	Bigazzi & Rouleau 2017
	CARB 2017	*	
	Burns et al. 2020	3	
<ul style="list-style-type: none"> • Lower speed limits • Variable speed limits • Speed control devices (traffic calming such as humps, chicanes, micro-roundabouts) • Speed enforcement devices & programs 			
Traffic flow control	Bigazzi & Rouleau 2017	10	Bigazzi & Rouleau 2017
	CARB 2017	*	
	Burns et al. 2020	3	
<ul style="list-style-type: none"> • Tunnels/bypass • Ramp meters • Electronic toll collection • Incident management systems • Intersection control device (roundabout, signal, stop signs, etc.) • Traffic signal timing (signal coordination, adaptive signal systems, transit signal priority, etc.) 			
Eco-driving/eco-routing	Bigazzi & Rouleau 2017	3	Bigazzi & Rouleau 2017; Tu et al. 2022
<ul style="list-style-type: none"> • Static guidance (training courses, videos, brochures, in-field practice with coaches) • Dynamic guidance (driving suggestions are generated based on real-time driving behavior analysis) 	Tu et al. 2022	34	
Vehicle miles traveled (VMT)/trip reduction strategies	Bigazzi & Rouleau 2017	3	Bigazzi & Rouleau 2017
<ul style="list-style-type: none"> • Shared-ride programs (carpool/vanpool/rideshare programs, incentives, and services) • Employer programs for trip reduction 	Burns et al. 2020	2	

Reviews Considered in Assessing Mitigation Effects			
Category	References	# Primary studies applicable	Reviews Considered in Assessing Costs
(flextime, telework)			
<ul style="list-style-type: none"> • Transit improvements (pricing, service quality, rerouting, rescheduling, improved transit vehicles, etc.) • Active travel and pedestrian and bicycle facilities (roadway & trip-end facilities) • Outreach & marketing (to reduce auto use) 			

Mitigation Strategies for Outdoor Control

Table 2 summarizes the literature that met CalSPEC’s inclusion criteria for outdoor NRAP control.

Table 2. Mitigation strategies for outdoor NRAP control with corresponding literature

Category	References for effects data extraction	# Primary studies applicable	Cost references
<i>Obstacles and sinks</i>			
Green infrastructure	CARB 2017	*	Fonesca et al. 2023; Rawat & Kumar 2023; Song et al. 2018; Teotonio et al. 2021
<ul style="list-style-type: none"> • Vegetation barriers (tall trees, canopy cover/leaves vs. low hedges) 	Li et al. 2021	11	
<ul style="list-style-type: none"> • Green infrastructure envelops (green walls (biofilters/vertical gardens/living walls; green roofs) 	Rawat & Kumar 2023	11	
<ul style="list-style-type: none"> • Green space (parks/forests) 	Abhijith et al. 2017	49	
Non-vegetation obstacles	Li et al. 2021	15	Buccolieri et al. 2022
<ul style="list-style-type: none"> • Roadside barriers (solid barriers/sound walls, others, such as decking over highways or viaduct) 	CARB 2017	*	
<ul style="list-style-type: none"> • Parked cars • Wind catchers • Solar chimneys • Others (e.g., decking over highways or viaduct) 			
<i>Built environment design</i>			
Street canyon configuration	CARB 2017	*	N/A
<ul style="list-style-type: none"> • Street canyon orientation • Aspect ratio • Street canyon length/depth 	Voordeckers et al. 2021	75	

Category	References for effects data extraction	# Primary studies applicable	Cost references
Building architecture	CARB 2017	*	N/A
<ul style="list-style-type: none"> • Building height variation (non-uniform heights) • Building setback in street canyons • Roof shape • Building permeability 	Li et al. 2021	17	
Land use buffers	CARB 2017	*	N/A
<ul style="list-style-type: none"> • Separation distance from high volume roadways • Land use restriction around high pollution roadways 	Karner et al. 2010	*	

Mitigation Strategies for Indoor Pollution Exposure Control

Table 3. summarizes the literature that met CalSPEC’s inclusion criteria for indoor NRAP exposure control.

Table 3. Mitigation strategies for indoor exposure control with corresponding literature

Category	References for effects data extraction	# Primary studies applicable	Cost references
Building envelope control			
Retrofits	Fisk et al. 2020	*	Fisk et al. 2020
<ul style="list-style-type: none"> • Sealing of windows, doors, roofs, walls, etc. • Sealing of forced air, heating, and cooling system ducts 	Rawat & Kumar 2023	14	Rawat & Kumar 2023
Ventilation schedule and rates	Fernandes et al. 2023	*	N/A
<ul style="list-style-type: none"> • Decreasing ventilation rates during high traffic times • Mechanical HVAC systems 			
Indoor removal			
Filtration	CARB 2017	*	CARB 2017; Kelly & Fussell 2019;
<ul style="list-style-type: none"> • Portable air cleaners (PAC) / portable air purifiers (PAP) 	Kelly & Fussell 2019	3	Rajagopalan et al. 2020; Walzer et al. 2020; Rawat & Kumar
	Cheek et al. 2021	2	
	Rajagopalan et al. 2020	3	

Categorization	References for effects data extraction	# Primary studies applicable	Cost references
<ul style="list-style-type: none"> Mechanical filtration (HEPA filter) HVAC systems with high efficiency filters 	Walzer et al. 2020 Xia et al. 2021 Fernandes et al. 2023 Rawat & Kumar 2023	2 4 * *	2023
Phytoremediation <ul style="list-style-type: none"> Indoor green walls/vertical greenery systems (VGS) Indoor plants 	Fonesca et al. 2023	12	Fonesca et al. 2023
3.3 Personal-level interventions			
Diet <ul style="list-style-type: none"> Fruit and vegetables diet Mediterranean diet Olive oil supplementation Fish oil supplementation Vitamins C and E 	Barthelemy et al. 2020	11	Barthelemy et al. 2020
3.4 Public health educational interventions			
Citizen science campaigns/ educational programs <ul style="list-style-type: none"> Guidelines for schools to mitigate air pollution Anti-idling education campaigns Use of classroom air quality monitors Teaching parents, children, and teachers about air pollution and how they can help 	Rawat & Kumar 2023	16	Rawat & Kumar 2023