Public Review Draft

California Air Resources Board

Gasoline Service Station Industrywide Risk Assessment Supplemental Policy Guidance Document

Draft - September 2021

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Introduction

California Air Resources Board (CARB) staff developed the 2021 Gasoline Service Station Industrywide Risk Assessment Supplemental Policy Guidance Document (Supplemental Policy Guidance) to provide recommendations regarding public policy for gasoline service stations[1] (gas stations) and discuss community-scale health impacts caused by gas station emissions. Community risk information gathered through industrywide risk assessments can be used to support the assessment of community impacts under Assembly Bill 617.[2] The Supplemental Policy Guidance is a companion document to the 2021 Gasoline Service Station Industrywide Risk Assessment Technical Guidance Manual[3] (Technical Guidance). The Technical Guidance, developed by staff from CARB[4], the California Air Pollution Control Officers Association[5] (CAPCOA), and the Office of Environmental Health and Hazard Assessment[6] (OEHHA), outlines the procedures for preparing gas station emission inventories and health risk assessments to meet the requirements of Assembly Bill 2588[7] (the Hot Spots Act or Hot Spots Program).

In addition to discussing community-scale health impacts, this document provides considerations and recommendations for the siting and permitting of new and modified gas stations. Local governments that make land use decisions[8] (local governments) evaluate proposals for new gas station projects and have primary authority over siting, zoning, and land use permitting decisions, while Districts conduct health risk assessments on new and modified gas stations and have primary authority over air quality permitting decisions.

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[1] Gasoline service stations are also referred to as gasoline dispensing facilities or gas stations.

[2] Assembly Bill 617, Garcia, C., Chapter 136, Statutes of 2017, modified the California Health and Safety Code, amending § 40920.6, § 42400, and § 42402, and adding § 39607.1, § 40920.8, § 42411, § 42705.5, and § 44391.2 dated July 26, 2017.

[3] The 2021 Gasoline Service Station Industrywide Risk Assessment Technical Guidance is available at: *Gasoline Service Station Industrywide Risk Assessment Guidance | California Air Resources Board*

[4] The California Air Resources Board (CARB) is a state agency that works to protect the public from the harmful effects of air pollution and develops programs and actions to fight climate change.

[5] The California Air Pollution Control Officers Association (CAPCOA) is an association of air pollution control officers representing the 35 Air Pollution Control and Quality Management Districts (Districts) in California.

[6] The Office of Environmental Health Hazard Assessment (OEHHA) is a state agency that evaluates health risks from chemical pollutants in the environment.

[7] Assembly Bill 2588, Air Toxics "Hot Spots" Information and Assessment Act (Hot Spots Act), Connelly, Statutes of 1987, Chapter 1252, in California Health and Safety Code § 44300-44394.

[8] Local governments that make land use decisions include, but are not limited to: land use agencies, planning departments, planning commissions, and the elected bodies with authority over land use projects.

The Supplemental Policy Guidance provides an overview of the following topics in a question and answer format:

- Existing public policy related to gas stations
- Exposure impacts from individual gas stations
- Exposure impacts from multiple gas stations
- Recommendations to reduce emissions from gas stations

I. What type of gas stations are addressed in the Supplemental Policy Guidance?

For the purposes of this document, a gas station is any new or existing retail motor vehicle fueling facility where gasoline is transferred from underground storage tanks to motor vehicles, fuel containers, and other gasoline-powered equipment. Retail motor vehicle fueling facilities (retail gas stations) may include additional fuel types such as natural gas, propane, diesel, or alternative fuels, however this Supplemental Policy Guidance only applies to the gasoline dispensed at those stations. Any retail gas station dispensing automotive gasoline is subject to this Guidance.

This Guidance does not apply to commercial gas stations[9],bulk-fueling stations[10], or mobile refueling operations[11] which were excluded from the Technical Guidance. Since the Supplemental Policy Guidance highlights the work done specifically for the Technical Guidance, these sources were not included. However, these fueling applications are also sources of gasoline emissions which may increase adverse health impacts to people nearby. To address potential health impacts, CARB recommends that all owners and/or operators of these applications work closely with their local Air Quality Management Districts or Air Pollution Control Districts (Districts) to comply with local rules and permitting requirements. Additional detail on applicability can be found in the Technical Guidance (Executive Summary, Section A).

[9] Commercial gas stations service industrial or privately-owned fleets.

[10] Bulk-fueling stations service fuel tanker trucks that deliver gasoline to gas stations.

[11] For the purposes of this document, a mobile refueling operation is any tanker truck or trailer that is used to transport and dispense gasoline from an on-board storage tank into any motor vehicle fuel tank. Mobile refueling operations are also referred to as mobile dispensing facilities or mobile refuelers.

II. What types of evaluations are gas stations subject to under Assembly Bill 2588?

The Hot Spots Act requires that each District determine which facilities will prepare a health risk assessment. Generally, facilities that are deemed high priority[12] are required to conduct a health risk assessment. A health risk assessment includes a comprehensive analysis of the dispersion of hazardous substances in the environment, their potential for human exposure, and a quantitative assessment of both individual and population-wide health risks associated with those levels of exposure. The level of detail required for analysis (e.g., screening or refined) requires case-by-case analysis and professional judgment.

As an industrywide source, gas stations are subject to all applicable requirements under the Hot Spots Act, including both individual and population-wide health risk analyses. The individual receptor[13] approach evaluates the exposures that may occur to an individual person in a given location over a period of time at a specific location. The population-wide approach (e.g., cancer burden or population exposure estimates) evaluates potential exposures to an entire population over a 70-year period using site-specific meteorology and population information. It provides an illustration of widespread impacts for facilities that may have individual cancer risks[14] below public notification thresholds, but expose a larger population to emissions. A cancer risk notification threshold is the health risk level at which a facility must notify exposed members of the public of potential health risks associated with facility emissions. Many Districts use a cancer risk public notification threshold of 10 chances per million. [15]

The Technical Guidance provides a generic presentation of potential impacts to individual receptors and does not include site-specific data necessary to perform population-wide health analyses (e.g., cancer burden and population exposure estimates); thus, no population exposure estimates are included. However, the Supplemental Policy Guidance includes an analysis of population-wide (community-wide) risk for multiple facilities in close proximity to one another in Appendix B. For gas stations requiring site-specific assessments, CARB recommends that Districts evaluate both individual and population-wide health impacts to provide a more complete illustration of a facility's health impacts. Methods for evaluating population-

[12] Under the Hot Spots Act, prioritization methods are used by Districts to determine which facilities will be required to submit a health risk assessment to the District. These methods consider factors such as the quantity of emissions, the cancer or noncancer health factor associated with each emitted substance, and the proximity of the nearest residence or business.

[13] Receptors may include nearby residences, workplaces, schools, hospitals, and care facilities.

[14] Cancer risk is the probability of developing cancer based on exposure to a substance over a specified period. Cancer risk is expressed in chances of developing cancer per million people exposed.

[15] Each Air District determines the appropriate risk notification threshold for their district. The AB 2588 District Prioritization Scores and Risk Threshold Levels are available at: *https://ww2.arb.ca.gov/ab-2588-district-prioritization-scores-and-risk-threshold-levels-0*

wide health impacts are outlined in the OEHHA's *Air Toxics Hot Spots Program Risk Assessment Guidelines: Guidance Manual for the Preparation of Health Risk Assessments*[16] (OEHHA Manual).

III. How does Assembly Bill 617 affect gas stations?

The goal of Assembly Bill (AB) 617 is to reduce cumulative exposure and improve public health in communities most impacted by air pollution. It requires new, community-focused actions that go beyond existing State and regional programs to reduce air pollution exposure in disproportionately burdened communities.[17] To support implementation of AB 617, CARB's Office of Community Air Protection released the *Community Air Protection Blueprint*[18] (Blueprint) in October 2018. The Blueprint defines statewide strategies and establishes requirements for: public engagement and community partnerships; selecting communities for focused action; conducting community air monitoring, and preparing community emissions reduction programs.

The Blueprint also identifies developing updated guidance on conducting health risk assessments for gas stations (i.e., the Technical and Supplemental Guidance documents) as an important tool to support community engagement on land use and transportation strategies for impacted communities. The Technical Guidance provides updated procedures for preparing health risk assessments for gas stations since the original Guidelines document was published in 1997. This Supplemental Guidance provides recommendations regarding public policy for gas stations and discusses community-scale health impacts of gas station emissions. Consistent with the goals of AB 617, CARB includes recommendations for reducing gas station emissions and community exposures in Sections 6 through 12.

IV. What are the sources of emissions at gas stations?

Both gas station infrastructure and vehicles visiting gas stations are sources of emissions at gas stations. However, potential emissions from vehicles driving to or idling at the station are not included in the Technical or Supplemental Guidance documents. For more information as to why these emissions are not included in this

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[16]Office of Environmental Health Hazard Assessment, The Air Toxics Hot Spots Program, Guidance Manual for Preparation of Health Risk Assessments, February 2015. Available at: *https://oehha.ca.gov/air/crnr/notice-adoption-air-toxics-hot-spots-program-Guidance-manual-preparation-health-risk-0*.

[17] Assembly Bill 617, Garcia, C., Chapter 136, Statutes of 2017, modified the California Health and Safety Code, amending § 40920.6, § 42400, and § 42402, and adding § 39607.1, § 40920.8, § 42411, § 42705.5, and § 44391.2 dated July 26, 2017.

[18] California Air Resources Board, Community Air Protection Blueprint, October 2018, available at: *https://ww2.arb.ca.gov/our-work/programs/community-air-protection-program/community-air-protection-blueprint*.

guidance documents, see Section K of the Technical Guidance. There are five routine (i.e., recurring, predictable sources) sources of emissions from gas station infrastructure: loading, breathing[19], fueling, spillage, and hose permeation.

Table 1 on the next page includes a detailed explanation of these sources. Additional detail on the sources of emissions at gas stations can be found in the Technical Guidance (Executive Summary, Section C).

Table 1. Emissions Sources at Gas Stations

Emission Source	Description
Loading	Loading emissions occur when a fuel tanker truck makes a delivery to a gas station. During each delivery, gas is transferred from the fuel tanker trunk into the underground storage tanks at a gas station. Gasoline vapors may be emitted as the liquid gasoline enters the underground storage tanks.
Breathing	Breathing emissions (or breathing losses) occur during periods of low activity or inactivity (e.g., after hours, station closed for repairs) at a gas station. During these periods, temperature changes inside the underground storage tank can cause gasoline vapor pressures to increase. If the vapor pressure rises above the pressure limit for the underground storage tank, excess pressure will be released from the gas station vent pipe in the form of gasoline vapor emissions. Breathing emissions are also called breathing losses or pressure-driven losses.
Fueling	Fueling emissions occur at the gas pump during vehicle fueling. During the fueling process, gasoline vapors are emitted from the space due to a poor seal between the nozzle and the vehicle.
Spillage	Spillage emissions occur from when gas leaks from the nozzle during vehicle fueling.
Hose Permeation	Hose Permeation emissions occur from the fueling hoses at the gas pump. Gasoline vapors can pass through (or permeate) the fuel delivery hoses.

V. What are the exposure impacts of individual gas stations, and what does CARB recommend when considering these exposures?

Gas stations are typically located in areas where people live and work. Health risk assessments show that estimated health risks from gas stations are typically higher in populated areas where large amounts of gasoline are dispensed. Thus, all new and modified gas stations should be evaluated during siting and permitting processes to mitigate the potential health impacts to nearby residents, workers, and sensitive populations.

CARB recommends that local governments work to ensure that areas around gas stations are zoned to avoid or minimize air quality impacts and that gas station projects include mitigation measures to avoid or reduce these impacts as conditions of approval. While CARB recommends that local governments not approve new gas

[19] Breathing emissions refers to emissions from an underground storage tank at a gas station.

stations immediately adjacent to housing and other locations with sensitive receptors, CARB recognizes that the critical need for affordable housing and infill development throughout the State will likely result in having gas stations near new or existing housing development. Therefore, CARB recommends that local governments implement land use policies to support additional housing while minimize air quality impacts on nearby communities.

Examples include, but are not limited to, the following:

- Including gas station emission reduction measures in agency general plans, zoning codes, and municipal codes that avoid or reduce air quality impacts from gas stations on nearby communities (see Section 12 for examples).
- Involving community members during the planning process of proposed gas station projects and working with them on solutions to address neighborhood air pollution concerns.
- Coordinating with Districts and Intergovernmental Review[20] (IGR) programs/entities during the planning processes for local plans and proposed gas station projects (e.g., during California Environmental Quality Act [CEQA] processes) to ensure health-protective public policy, exposure reduction strategies, and building/equipment configurations to reduce exposure near gas stations.
- Considering comments on air quality impacts, and corresponding mitigation measures, submitted through CEQA review processes before allowing prospective gas station projects to progress in the permit process.
- Evaluating gas station proposals, and adjacent housing or worksite proposals, to ensure inclusion of existing and emerging mitigation measures that avoid or lessen air quality impacts (e.g., installing air filters in new housing or worksites).

Furthermore, CARB recommends that Districts collaborate with gas station operators on ways to minimize air pollution from new and existing gas stations (e.g., relocating emission sources away from receptors or retrofitting equipment at gas stations currently without enhanced vapor recovery). Additional examples of options that can be used to reduce emissions from gas stations are listed in Section 12.

[20]Intergovernmental review is required under Presidential Executive Order 12372 and requires federal agencies to provide opportunities for state, area-wide, regional, and local agencies to review applications for federal grants and financial assistance programs, federally required state plans, federal development activities, and federal environmental documents. Presidential Executive Order 12372 is available at: *https://www.archives.gov/federal-register/codification/executive-order/12372.html*.

VI. What are the exposure impacts of multiple gas stations located near each other, and what does CARB recommend when considering these exposures?

Analyses by CARB staff indicate that gas stations located on multiple corners of an intersection may increase individual and population-wide health impacts to people nearby depending on the distance from the gas station and gasoline throughput.[21] If there are other existing sources of toxic emissions[22] in the area, the cumulative impacts can result in a larger number of people being exposed to higher levels of emissions. Therefore, CARB recommends that local governments and Districts consider the cumulative impacts from multiple gas stations, and other surrounding sources of toxic emissions, in siting and permitting decisions to reduce exposure to the already impacted public. By considering cumulative impacts in the evaluation of proposed projects, local governments may reduce higher potential exposures to people living and working near gas stations. Similarly, considering cumulative impacts will allow Districts to determine whether nearby receptors will potentially be exposed to emissions of toxic air contaminants from multiple emission sources.

VII. What are some considerations for addressing cumulative impacts in siting and permitting processes for gas stations?

Local governments and Districts do not currently consider cumulative impacts in siting and permitting processes for gas stations. Local governments have primary authority over siting, zoning, and land use permitting decisions, while Districts have primary authority over air quality permitting decisions. Districts do not have authority over land use decisions but they, along with CARB, may comment on air quality aspects of prospective gas station projects through the CEQA process. Lead agencies[23] should consider and implement District and CARB comments because they are an important step towards reducing public exposure to air pollutants. This will also help to ensure that local government decisions in siting, zoning, and land use permitting are made in a way that maximizes public health protection. Moving forward, an integral part of this process will be establishing mechanisms for early communication and collaboration with Districts, in addition to the existing CEQA process.

To incorporate cumulative impacts into siting and permitting processes for gas stations, tools and metrics will need to be developed. This effort will require Districts and local governments to develop methods to assess and incorporate exposure and health impacts from both stationary sources (e.g., nearby gas stations) and mobile

[21] Gasoline throughput is the amount of gas dispensed at a gas station over a period of time.
[22] Sources of toxic emissions include, but are not limited to, existing or planned gas stations or other industrial or commercial sources of air toxics.
[23] A "lead agency" on a California Environmental Quality Act (CEQA) project is the public agency that has the principal responsibility for carrying out or approving the project.

sources (e.g., traffic from nearby roads and freeways) into siting and permitting processes. Due to the involvement of multiple jurisdictions, developing these methods will require coordination between various State and local agencies. Utilizing this type of information when making siting and permitting decisions will provide a more comprehensive, health-protective approach to reducing potential exposures.

One potential approach to consider cumulative risk in permitting of new or modified gas stations is to initially focus efforts in areas with designated AB 617 communities[24] and then expand to other areas. Local governments and Districts without designated AB 617 communities may choose to focus initial efforts on disadvantaged communities designated by CalEnviroScreen[25] and Senate Bill 535[26].

VIII. What were the results of CARB's analyses of multiple gas stations nearby each other?

CARB staff evaluated the potential cancer risk and potential population exposure caused by the presence of four three-million-gallon gas stations, one on each corner of an intersection, compared to a single three-million-gallon gas station, and a single 12-million-gallon gas station. A three-million-gallon gas station is more commonly seen throughout the state and can be located on a corner in a neighborhood, often located around areas where people live and work. Whereas, a 12-million-gallon gas station is usually found at larger retail establishments, typically located further away from where people live and work. When considering the four three-million-gallon gas stations, staff analyzed health impacts at varying distances between each gas station. The primary goal of this analysis was to compare the total area exposed to gas station emissions, or zone of impact[27], of the single three-million-gallon station to the zone of impact of four three-million-gallon stations. Staff included the single 12-million-gallon-station in this analysis to provide additional context for the four smaller stations. In this case, the single 12-million-gallon station has a throughput equal to the cumulative throughput of the four smaller stations. Additional detail on the multiple gas station analysis can be found in Appendix A of this document.

CARB staff evaluated urban and rural areas in our analyses. Urban and rural areas are designated based on population density and land cover, or topography. This

[24] Designated AB 617 communities are communities that have been selected by the CARB Board for community air monitoring and/or community emissions reduction programs.
[25] CalEnviroScreen is a screening tool that evaluates the burden of pollution from multiple sources in communities while accounting for potential vulnerability to the adverse effects of pollution. CalEnviroScreen is available at: *https://oehha.ca.gov/calenviroscreen*.
[26] Senate Bill SB (SB) 535 requires the California Environmental Protection Agency (CalEPA) to identify disadvantaged communities based on geographic, socioeconomic, public health and environmental hazard criteria. SB 535 also directs 25 percent of the proceeds from the Greenhouse Gas Reduction Fund go to projects that provide a benefit to disadvantaged communities.
[27] The zone of impact for a given level of risk is the total area exposed to gas station emissions.

evaluation considered impacts using meteorological data from San Jose (urban) and Redding (rural). CARB staff chose San Jose and Redding because they are the meteorological data sets that result in the highest potential cancer risk in the Technical Guidance. More information on the urban and rural scenarios can be found in Section II.G.1 in the Technical Guidance.

For this analysis, staff evaluated the risk results at the point of maximum impact (PMI). The PMI is the highest estimated pollutant concentration that might occur offsite of the gas station. The results of these analyses showed that cancer risk at the PMI of a single three-million-gallon gas station was 20 chances per million[28] for the urban scenario and 26 chances per million for the rural scenario, while the cancer risk at the PMI of four three-million-gallon gas stations in close proximity could be as high as 23 chances per million for the urban scenario and 30 chances per million for the rural scenario. Many Districts have cancer risk permitting and public notification thresholds[29] below these levels for individual facilities, with the typical public notification threshold being 10 chances per million.

Per the OEHHA Manual, an exposure duration (ED) of 70 years is used to evaluate population-wide risk impacts, while an ED of 30 years is used to evaluate individual residential risk impacts. The multiple gas station assessment assumes a population is exposed to gas station emissions for 70 years. Thus, multiple gas stations in close proximity may warrant further evaluation to determine cumulative health impacts (see Section 7 above for recommendations for multiple gas stations). Most Districts do not currently have permitting or public notification thresholds for multiple facilities; therefore, some Districts may find it challenging to use the results of cumulative risk analyses in air quality permitting decisions until relevant thresholds are developed.

Additional results are summarized below. Due to the site-specific nature of this assessment, similar analyses elsewhere may yield different results depending on the modeling inputs. The full analyses and results for the individual cancer risk approach can be found in Appendix A and the results of the population-wide approach can be found in Appendix B.

The potential impacts from four gas stations increase the size of the cumulative area of exposure to emissions, and potentially the corresponding risk, to people living and working nearby. In some cases, the zone of impact for four three-million-gallon gas stations could be over four times larger than the zone of impact of a single three-million-gallon station.

The potential cumulative cancer risk from the four three-million-gallon gas stations varies depending on their proximity to each other. In our analysis, we evaluated offsite cancer risks for gas stations separated by distances ranging from 100 meters to 300

[28] A cancer risk of 20 chances per million means that in a population of one million people exposed to a substance, 20 people may potentially develop cancer.

[29] A cancer risk notification threshold is the health risk level at which a facility must notify exposed members of the public of potential health risks associated with facility emissions.

meters for both urban and rural scenarios. For these separation distances, our results showed the largest zones of impact for a potential cancer risk of 5 to 10 chances per million at a separation distance of 100 meters for the urban analyses and 10 to 20 chances per million for the rural analyses. However, impacts may vary for larger gas station throughputs, control configurations, and separation distances.

The cancer risk from gas stations significantly decreases as the receptor moves further from the source. For a single gas station, cancer risk drops by about half the value from 10 to 20 meters away from the source, and quickly drops to below 1 chance per million at about 60 to 70 meters. In the multiple gas station analysis, at the 100 meter separation distance for the urban scenario, the zones of impact for each station interact with each other at cancer risks of 5 to 10 chances per million but no longer impact each other as the separation distance increases. For the rural scenario, the zones of impact for each station at cancer risks of 5 to 10 chances per million completely separate at a separation distance of 200 meters.

In the urban scenario, the cancer risks at the PMIs of the multiple gas station scenarios ranged from 21 to 23 chances per million in which the highest cancer risk at the PMI occurred at a separation distance of 100 meters.

In the rural scenario, the cancer risks at the PMIs of the multiple gas station scenarios ranged from 27 to 29 chances per million in which the highest cancer risk at the PMI occurred at a separation distance of 100 meters.

The potential health impacts from multiple gas stations in close proximity to each other can be highly site-specific. Potential impacts do not increase linearly or in proportion to gas station throughput and can be affected by meteorological conditions, gas station configurations, distance to potential receptors, emission source release parameters, and grid spacing used in the modeling analysis.

The figures below show the zones of impact for gas stations using San Jose meteorological data (urban). Figure 1 shows the zone of impact of a single three-million-gallon gas station. Figure 2 shows the zone of impact of four three-million-gallon gas stations with a separation distance of 100 meters. The map used in the figures below is a generic representation of a geographic area with a four-corner intersection with one gas station located on each corner and may not be representative of all urban areas.

Figure 1. Zone of Impact of Gas Station Emissions: Single Three-Million-Gallon Gas Station (Urban)

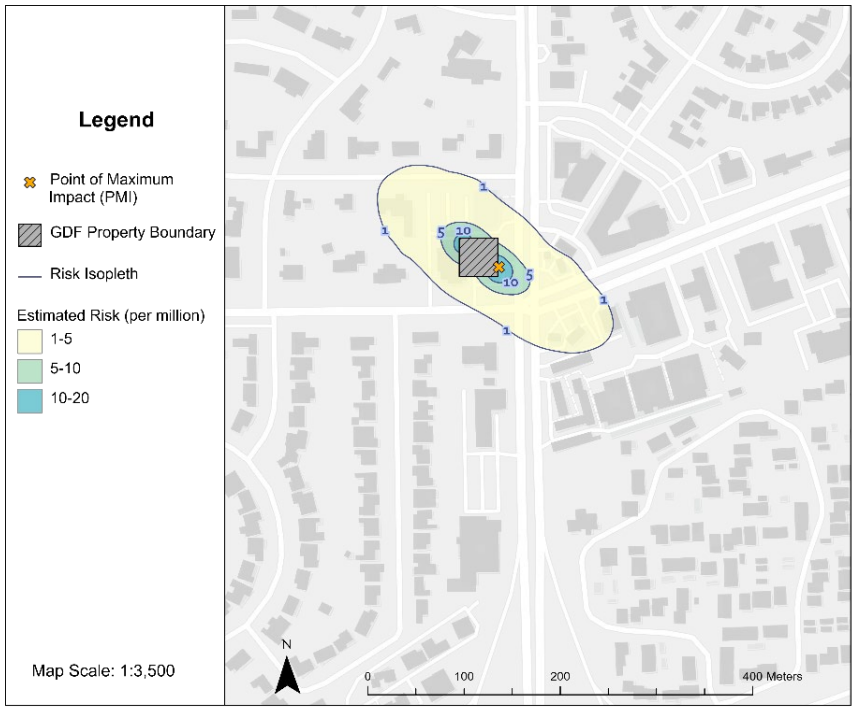
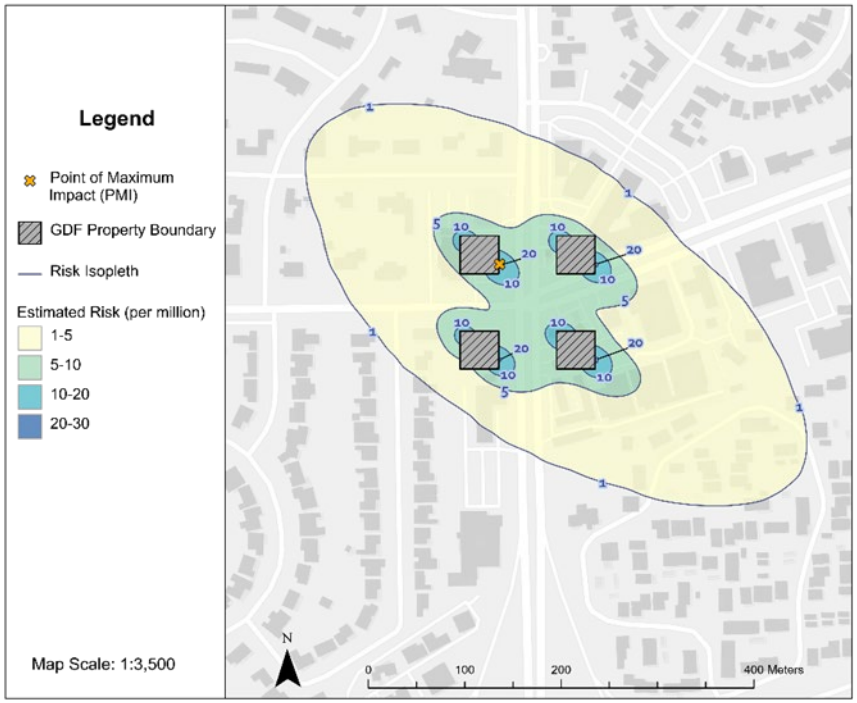


Figure 2. Zone of Impact of Gas Station Emissions: Four Three-Million-Gallon Gas Stations with 100 m Separation (Urban)



The figures below show the zones of impact for gas stations using Redding meteorological data (rural). Figure 3 shows the zone of impact of a single three-million-gallon gas station. Figure 4 shows the zone of impact of four three-million-gallon gas stations with a separation distance of 100 meters. The map used in the figures below is a generic representation of a geographic area with a four-corner intersection with one gas station located on each corner and may not be representative of all rural areas.

Figure 3. Zone of Impact of Gas of Station Emissions: Single Three-Million-Gallon Gas Station (Rural)

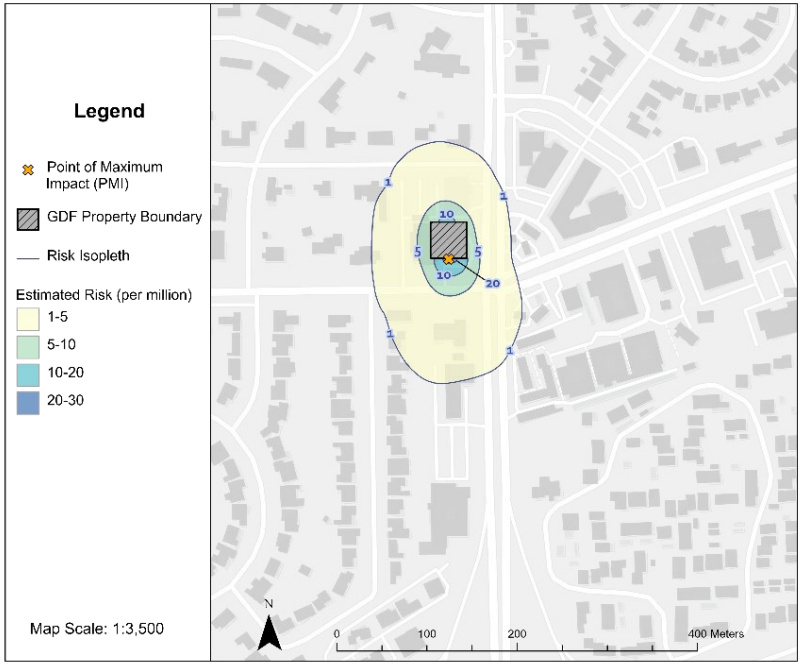


Figure 4. Zone of Impact of Gas Station Emissions: Four Three-Million-Gallon Gas Stations with 100 m Separation (Rural)

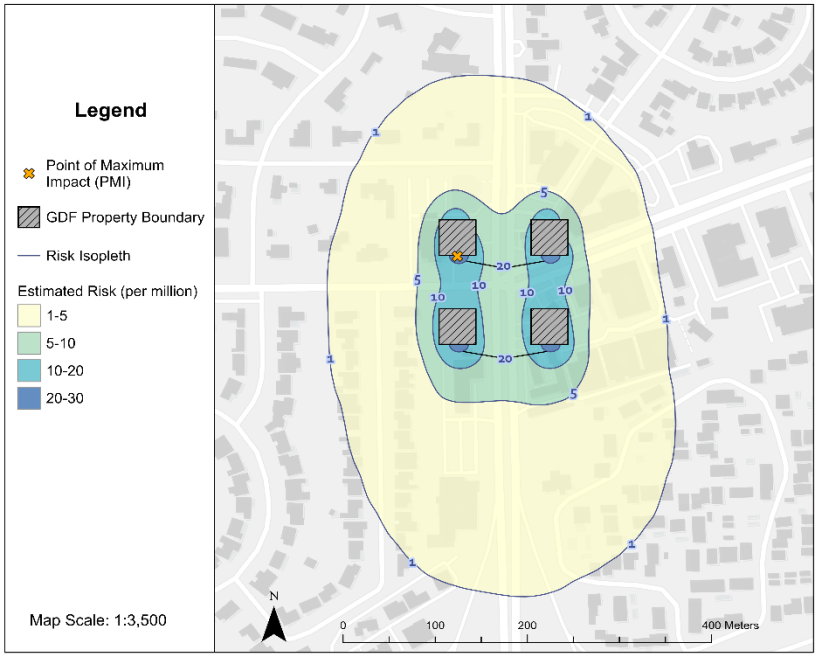
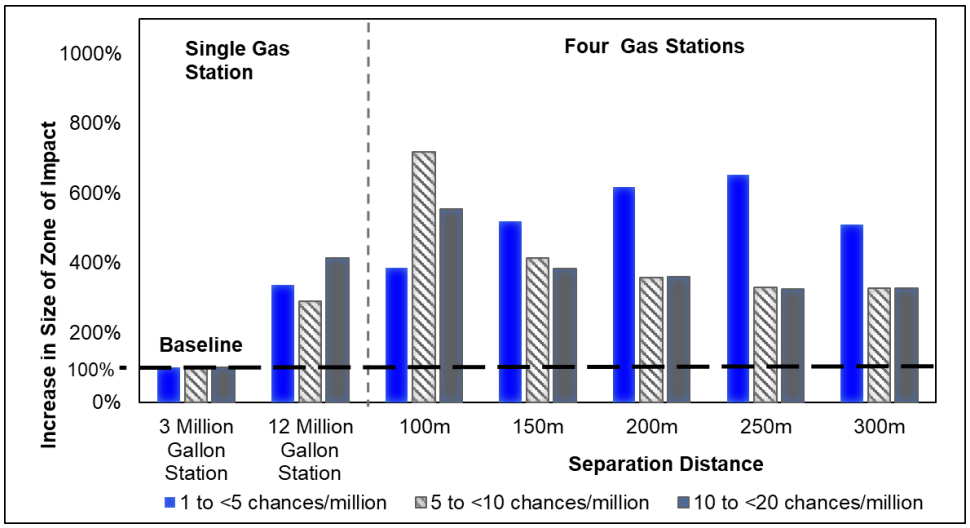


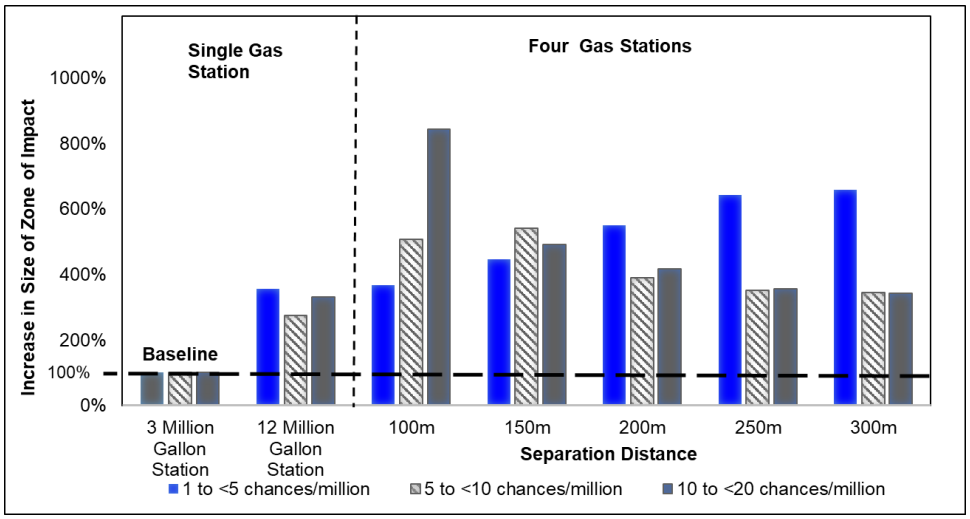
Figure 5 and Figure 6 below show the percent increase in the zone of impact from a baseline of a single three-million-gallon gas station to a single 12-million-gallon station, and four three-million-gallon gas stations for urban and rural scenarios, respectively. Both figures show the zone of impact for potential cancer risks up to 10 chances in a million.

Figure 5. Percent Increase in Size of Zone of Impact of Gas Station Emissions: San Jose Meteorological Data (Urban)[1,2,3]



1. Results will vary for different locations, throughputs, and separation distances.
2. "Separation Distance" is the distance between each of the four gas stations.
3. The zone of impact for a given level of risk is the total area exposed to gas station emissions.

Figure 6. Percent Increase in Size of Zone of Impact: Redding Meteorological Data (Rural)[1,2,3]

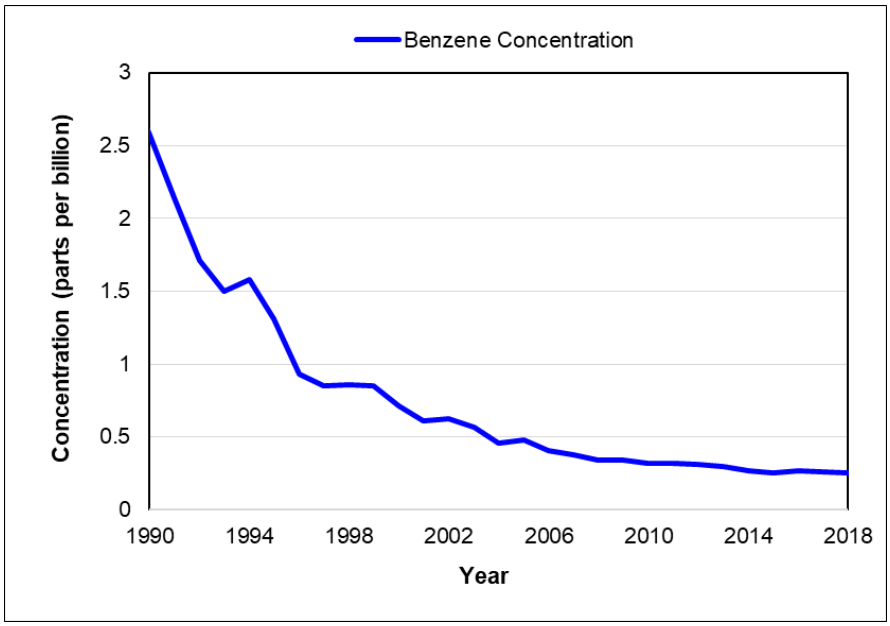


1. Results will vary for different locations, throughputs, and separation distances.
2. "Separation Distance" is the distance between each of the four gas stations.
3. The zone of impact for a given level of risk is the total area exposed to gas station emissions

IX. What regulations are currently in place to reduce emissions and community exposure from gas stations in California?

Beginning in 1988, emissions from gas stations were significantly reduced due to air quality regulations requiring reformulated gasoline and emission control technology. Data from CARB's statewide ambient air monitoring network shows that concentrations of benzene, the most toxic of the gas station emissions, have decreased by approximately 90 percent since 1989. This trend is shown in Figure 7 below. Benzene is also emitted through many industrial sources such as oil refineries, landfills, gas stations, and the production of lubricants and synthetic fibers.

Figure 7. Statewide Average Ambient Benzene Concentrations from 1990 to 2018 (parts per billion)



1. The data presented in this table comes from the CARB, iADAM Annual Toxics Statewide Summary for Benzene, available at: *https://www.arb.ca.gov/adam/toxics/toxics.html*.

The State and national gas and vapor recovery regulations that address gasoline and gas stations are listed below:

- In 1988, the Benzene Airborne Toxic Control Measure[30] required all existing and new gas stations with annual throughput[31] greater than 480,000 gallons to install vapor recovery systems[32] by 1991.
- From 1995 to 2005, national standards required On-Board Refueling Vapor Recovery[33] (ORVR) to be phased in on all passenger cars and trucks.
- In 2001, the Certification Procedure for Vapor Recovery Systems at Gasoline Dispensing Facilities (CP-201)[34] required enhanced vapor recovery (EVR) systems to be phased in for existing gas stations in State ozone nonattainment areas[35] and new stations statewide. CARB certification procedures have been used to specify performance standards for gas station vapor recovery systems since 1975.
- In 2003, California's Phase 3 Reformulated Gasoline (CaRFG Phase 3) Regulations[36] lowered Reid Vapor Pressure requirements on gas used in motor vehicles below the national standard.
- In 2015, specifications for Enhanced Conventional (ECO) Nozzles[37] were approved for non-retail gas stations.
- In 2018, CARB approved specifications for Enhanced ORVR-Vehicle Recognition (EOR) nozzles[38] for gas stations with vapor assist control systems.
- In 2018, CARB approved amendments to specifications for fill pipes[39] and openings of motor vehicle fuel tanks.

[30] California Code of Regulations, Title 17 § 93101.
[31] Annual throughput is the amount of gas dispensed at a gas station in one year.
[32] A vapor recovery system reduces the amount of gas station emissions escaping into the atmosphere by capturing gasoline vapors emitted during fuel tanker truck deliveries or vehicle refueling.
[33] On Board Refueling Vapor Recovery is a vehicle system that captures gasoline vapor emissions during vehicle fueling.
[34] California Air Resources Board, Certification procedure for Vapor Recovery Systems at Gasoline Dispensing Facilities (CP-201), April 23, 2015, available at: *https://www.arb.ca.gov/testmeth/vol2/CP201_april2016.pdf*, accessed January 2019.
[35] A State ozone nonattainment area is an area with ozone levels above the State air quality standard.
[36] California Code of Regulations, Title 13 § 2260.
[37] Enhanced Conventional (ECO) Nozzles reduce liquid gasoline emissions due to gas spilling on the ground after vehicle fueling, or spillage. ECO nozzles allow only three drops of liquid gasoline to spill from the nozzle.
[38] Enhanced ORVR Vehicle Recognition (EOR) nozzles reduce gasoline vapor emissions during vehicle fueling by forming a tight seal at the vehicle/nozzle interface.
[39] A fill pipe is part of a vehicle fueling system that connects the gas cap to the fuel tank.

X. What are the options to reduce emissions from existing gas stations?

Emissions from gas stations have been significantly reduced through California's air quality programs and regulations (see Section IX above for the list of regulations). However, additional reductions in gas station emissions can be achieved by improved emissions control technologies at gas stations, and encouraging modes of transportation that either do not use gas or use gas more efficiently.

Examples include, but are not limited to, the following:

- Retrofitting high-throughput stations with high-capacity vapor processors[40].
- Driving zero-emission vehicles including all-electric and fuel cell vehicles.
- Driving hybrids and other fuel-efficient vehicles that reduce the amount of gas required per vehicle mile.
- Riding non-gas public transit methods (e.g., electric light rail trains and buses).
- Riding electric and non-motorized bicycles or scooters.
- Creating safe walking and bicycling corridors to maximize safety while using alternative transit modes.

XI. What does CARB recommend to reduce exposure and minimize potential health impacts from gas station emissions?

In addition to the recommendations in Sections 6 through 11, CARB encourages local governments and Districts to consider the following recommendations to reduce potential exposures to people living and working near gas stations.

A. Local Governments

During the land use permitting and siting processes for new gas stations, CARB recommends that local governments include gas station emission reduction measures in agency general plans, zoning codes, and municipal codes that avoid or reduce air quality impacts from gas stations on nearby communities. Examples include, but are not limited to, the following:

Adopting or updating zoning codes and ordinances requiring gas station site design and operational standards that reduce community exposure to the gas stations emissions (e.g., locating gas station equipment away from people both within the

[40] A vapor processor is a control device that manages the pressure of the vapor in a gasoline storage tank to prevent overpressure issues and reduce breathing emissions from the pressure/vent valve. The high capacity vapor processors currently certified by CARB are capable of processing 350 gallons of gasoline vapor per hour at a concentration of 61 percent hydrocarbon, as propane.

property boundary and adjacent to the station, considering wind patterns and the location of buildings inside the property boundary when locating equipment).

Adopting or updating conditions of approval for the permitting and siting of new gas station projects to require use of the cleanest possible equipment during construction (e.g. all construction equipment must meet or exceed CARB-certification standards).

Requiring gas stations to conduct periodic reviews of operations to identify opportunities to upgrade or phase out older equipment, as part of local government Development Agreements[41].

Including language in construction contracts, tenant lease agreements, and development agreements requiring gas station developers/operators to include existing and emerging mitigation measures in the construction and operation of gas stations (e.g., vegetative walls[42] or other effective barriers that separate gas station operations and people living or working nearby).

Requiring gas stations to add fueling/charging stations for advanced technology vehicles (i.e., electric charging stations, hydrogen fueling stations).

B. Districts

During the air quality permitting process for new or modified gas stations, CARB recommends Districts consider all control strategies available to reduce community exposures to gas station emissions. Examples include, but are not limited to, the following:

- Retrofitting equipment at gas stations currently without enhanced vapor recovery.
- Adding high capacity vapor processors to high throughput gas stations.
- Limiting the amount of throughput at gas stations.
- Reconfiguring gas stations or relocating gas station equipment away from receptors (e.g., raising the release height of a P/V valve).

[41] A Development Agreement is a contract between a local jurisdiction and a person who owns or controls property within the jurisdiction. It details the obligations of both parties, specifying the standards and conditions that will govern development of the property.

[42] Effectiveness of Sound Wall-Vegetation Combination Barriers as Near-Roadway Pollutant Mitigation Strategies (2017) is available at: *https://ww2.arb.ca.gov/sites/default/files/classic//research/apr/past/13-306.pdf*

XII. List of Appendices

Appendix A: Analysis of Multiple Gas Stations

Appendix B: Population-Wide Cancer Risk

Appendix A: Analysis of Multiple Gas Stations

CARB staff evaluated the potential cancer risk caused by the presence of four gas stations, one on each corner of an intersection. Gas stations are typically located in areas where people live, shop, and work. Health risk assessments show that estimated health risks from gas stations are typically higher in areas where large amounts of gasoline are dispensed. The purpose of this analysis was to determine how multiple gas stations in close proximity to each other, compared to a single station, affect the size of the area where people could be exposed to emissions (zone of impact).

A. Approach

This evaluation considered impacts in urban and rural scenarios using meteorological data from San Jose and Redding, respectively. Staff modeled the following scenarios in the Hotspots Analysis and Reporting Program (HARP)[43] for each meteorological data set:

- A single, three-million-gallon gas station
- A single, 12 million-gallon gas station
- Four three-million-gallon gas stations, modeled at five separation distances (100 m, 150 m, 200 m, 250 m, 300 m) for each meteorological data set. One modeling run was created for each separation distance.

The primary goal of this analysis was to compare the size of the zone of impact of a single three-million-gallon station to the zone of impact of four three-million-gallon stations, as smaller throughput stations are more likely to be located in and around areas where people live and work. Although larger throughput stations are typically located further away from these areas, staff included the 12-million-gallon gas station to provide additional context as a comparison to the four smaller stations.

After completing the modeling runs, staff generated contours or risk isopleths that could be mapped for each modeled scenario. Maps showing the risk isopleths in relation to gas station locations are located in the results section of this appendix, Section A.14.3.a (urban meteorology) and Section A.14.3.b (rural meteorology). Collectively, all risk isopleths within a map scenario represent the total area exposed to gas station emissions or the "zone of impact". Zones of impact were calculated for each risk isopleth, gas station separation distance, and meteorological data set. Tables and charts showing zone of impact comparisons are located in the results section of this appendix, Section A.14.3.

[43] The Hotspots Analysis and Reporting Program (HARP) is a collection of computer programs that addresses the requirements of Assembly Bill 2588 (Hot Spots Act). More information on HARP and access to the computer programs can be found at: *https://www.arb.ca.gov/toxics/harp/harp.htm*.

B. Summary of Modeling Parameters and Assumptions

The assumptions used in the risk assessment for gas stations located on multiple corners of an intersection (multiple gas station assessment) are the same as those used in the individual gas station assessment. However, there are some differences in the modeling parameters. A detailed list of the modeling parameters and assumptions used in the individual gas station assessment can be found in the Technical Guidance (Appendix D, Section IV.D.4). The sections below outline the modeling parameters used in both assessments and highlight the differences between them.

1. Operational Schedule

The multiple gas station assessment uses the operational schedule provided in the Technical Guidance (Appendix D, Section IV.D.1).

2. Gas Station Scenarios

The multiple gas station assessment uses the same gas station scenarios provided in the Technical Guidance (Appendix D, Section IV.D.2). Staff modeled risk values for Scenario 1 as 97 percent of California gas stations fall into this scenario.

3. Exposure Parameters

Per the OEHHA Manual[44], an exposure duration (ED) of 70 years is used to evaluate population-wide risk impacts, while an ED of 30 years is used to evaluate individual residential risk impacts. Thus, the ED was changed from 30 years to 70 years for the multiple gas station assessment assuming a population is exposed to gas station emissions for 70 years.

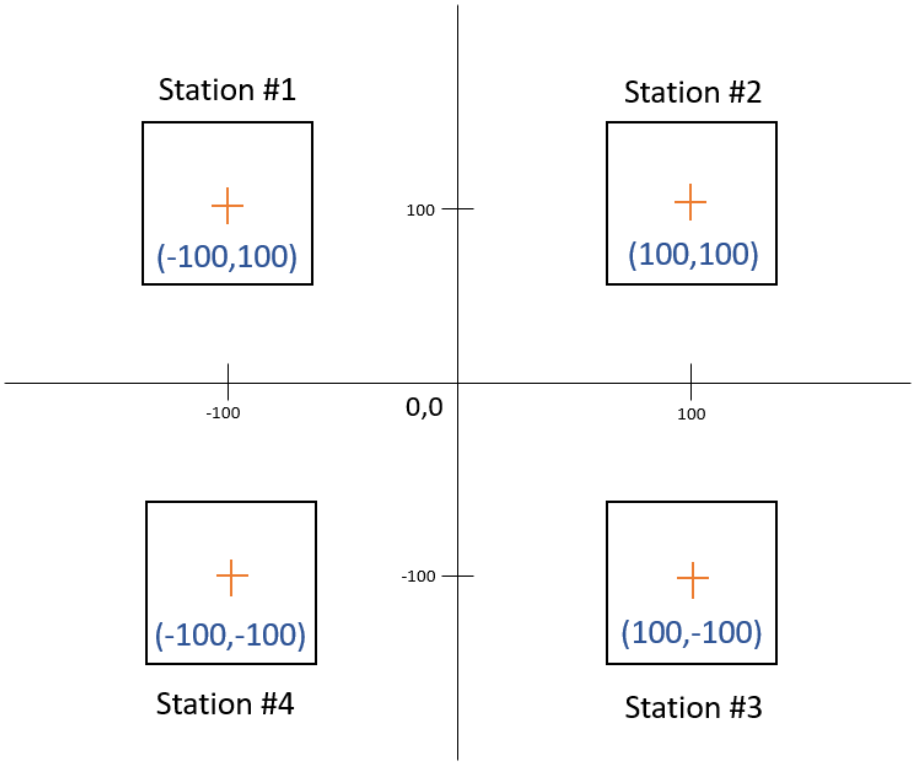
4. Modeling Parameters

The multiple gas station assessment modeled four gas stations with the same dispersion parameters as the individual gas station in the Technical Guidance (Section IV.D.4). All gas stations were centered around (0,0) on a Cartesian grid according to the following separation distances: 100 m, 150 m, 200 m, 250 m, 300 m.

Figure A1 shows the modeling schematic for the gas station locations.

[44]Office of Environmental Health Hazard Assessment, The Air Toxics Hot Spots Program, Guidance Manual for Preparation of Health Risk Assessments, February 2015. Available at: *https://oehha.ca.gov/air/crnr/notice-adoption-air-toxics-hot-spots-program-Guidance-manual-preparation-health-risk-0.*

Figure A1. Modeling Schematic for Multiple Gas Station Assessment: 100m Gas Station Separation Distance



5. Meteorological Data

The multiple gas station assessment uses the same meteorological data provided in the Technical Guidance. Staff used San Jose (urban) and Redding (rural) meteorological data sets in the multiple gas station assessment because they are the most health protective meteorological data sets in the Technical Guidance. The meteorological data sets can be found in the Technical Guidance (Appendix D, Section IV.D.5).

In this analysis, each of the meteorological data sets were modeled over a four-corner intersection with one gas station located on each corner (see modeling schematic in Figure A1 above).

6. Site-Specific Data Considerations: Variations and Uncertainties

There are many site-specific considerations that can impact health risk assessments. The estimated concentrations and potential health risks produced by a risk assessment are based on assumptions, many of which are designed to be health protective so that potential risks to individuals are not underestimated. Variations in site-specific modeling parameters can yield different modeling results and introduce uncertainty to the risk assessment process.

The results of the multiple gas station risk assessment showed that health impacts from multiple sources in close proximity to each other can be highly site-specific. One example of a site-specific modeling parameter is the separation distance between gas stations. When multiple gas stations are in close proximity to each other, there is a range of separation distances in which the size of the zone of impact for each individual station increases due to emissions from the surrounding stations. Depending on site-specific considerations, an increased zone of impact may not occur for all risk levels. Outside this range of separation distances, the stations will no longer influence each other and the zone of impact for each station will mimic that of a single isolated station.

Additional examples of site-specific modeling parameters can be found in the Technical Guidance (Appendix D, Section IV.D.6).

C. Results

Table A1 below summarizes the potential cancer risk levels, or isopleths, observed for each separation distance and meteorological data set modeled in this analysis. The urban meteorological data is represented by "U" and the rural meteorological data is represented by "R". See the results section of this appendix (Section A.14.3.14.3.1. and Section A.14.3.14.3.2 for maps of the zone of impact results for each meteorological data set and separation distance.

Table A1. Potential Cancer Risk Isopleths for Gas Station Separation Distances - Urban and Rural Meteorological Data[1,2,3,4]

Potential Cancer Risk	Separation Distances					
	Single Station	100m	150m	200m	250m	300m
1 chance per million	U, R	U, R	U, R	U, R	U, R	U, R
5 chances per million	U, R	U, R	U, R	U, R	U, R	U, R
10 chances per million	U, R	U, R	U, R	U, R	U, R	U, R
20 chances per million	U, R	U, R	U, R	U, R	U, R	U, R
30 chances per million[3]		U, R	R only	R only	R only	U only

1. U = Urban (San Jose meteorological data), R = Rural (Redding meteorological data)]
2. Includes data for 12 scenarios, six urban and six rural.
3. "Separation Distance" is the distance between each of the four gas stations.
4. Twenty meter spacing was used for the receptor grid. The presence of the 30 chances per million isopleth is dependent on the spacing of the receptor grid. More refined spacing reveals additional receptors within the isopleth.

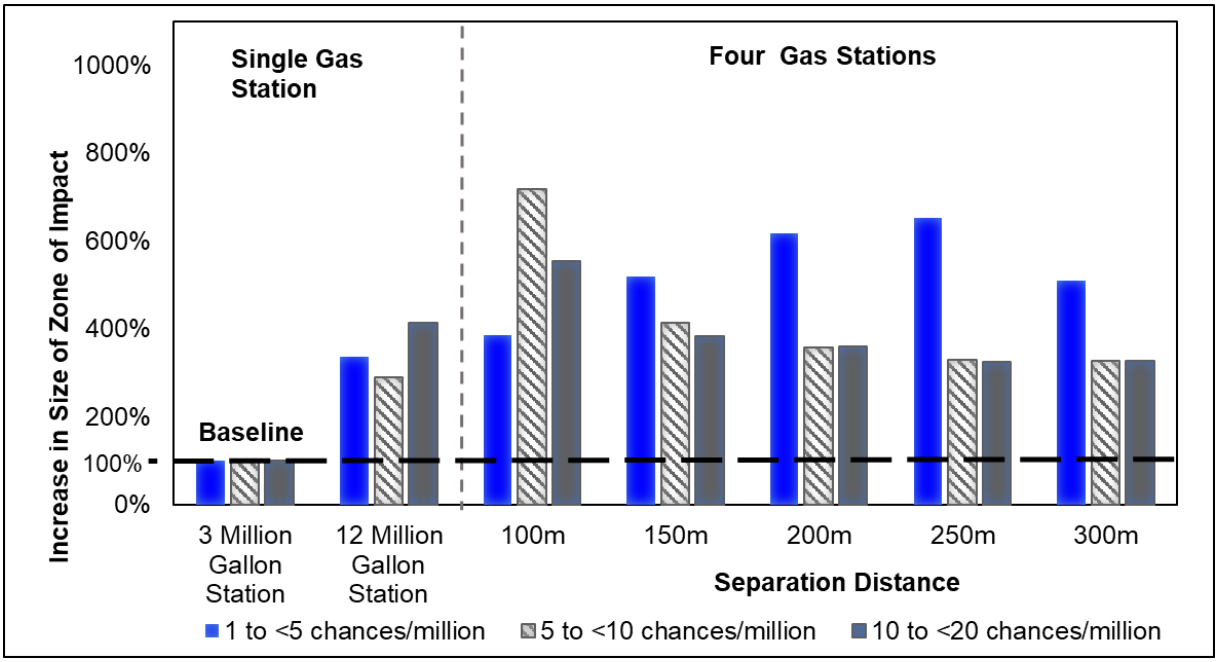
On the next page, Table A2 and Figure A2 show the percent increases in the size of zones of impact for a 12-million-gallion station and a group of four three-million-gallon gas stations (separated by 100 m, 150 m, 200 m, 250 m and 300 m) versus a single three-million-gallon gas station for an urban meteorological data set. See the results section of this appendix (Section A.14.3.14.3.3 for detailed figures of the one to less than five chances per million, five to less than 10 chances per million, and 10 to less than 20 chances per million risk isopleths.

Table A2. Percent Increase in Size of Zone of Impact of Gas Station Emissions: San Jose Meteorological Data (Urban)[1,2]

Separation Distance (m)	Percent Increase in Size of Zone of Impact (%)		
	1 to <5 Chances per Million	5 to <10 Chances per Million	10 to <20 Chances per Million
Single Three-Million-Gallon Station	Baseline	Baseline	Baseline
Single 12-Million-Gallon Station	337%	290%	414%
100m	386%	717%	553%
150m	519%	414%	384%
200m	616%	357%	360%
250m	652%	330%	325%
300m	510%	327%	328%

1. Percent increase results are not provided for the 20 and 30 chances per million isopleths because the single three-million-gallon gas station only included isopleths for one, five, and 10 chances per million.
2. "Separation Distance" is the distance between each of the four gas stations.

Figure A2. Percent Increase in Size of Zone of Impact of Gas Station Emissions: San Jose Meteorological Data (Urban)[1,2,3,4]



1. Results will vary for different locations, throughputs, and separation distances.
2. "Separation Distance" is the distance between each of the four gas stations.
3. The zone of impact for a given level of risk is the total area exposed to emissions.
4. Percent increase results are not shown for the 20 and 30 chances per million isopleths because the single three-million-gallon gas station only included isopleths for one, five, and 10 chances per million.

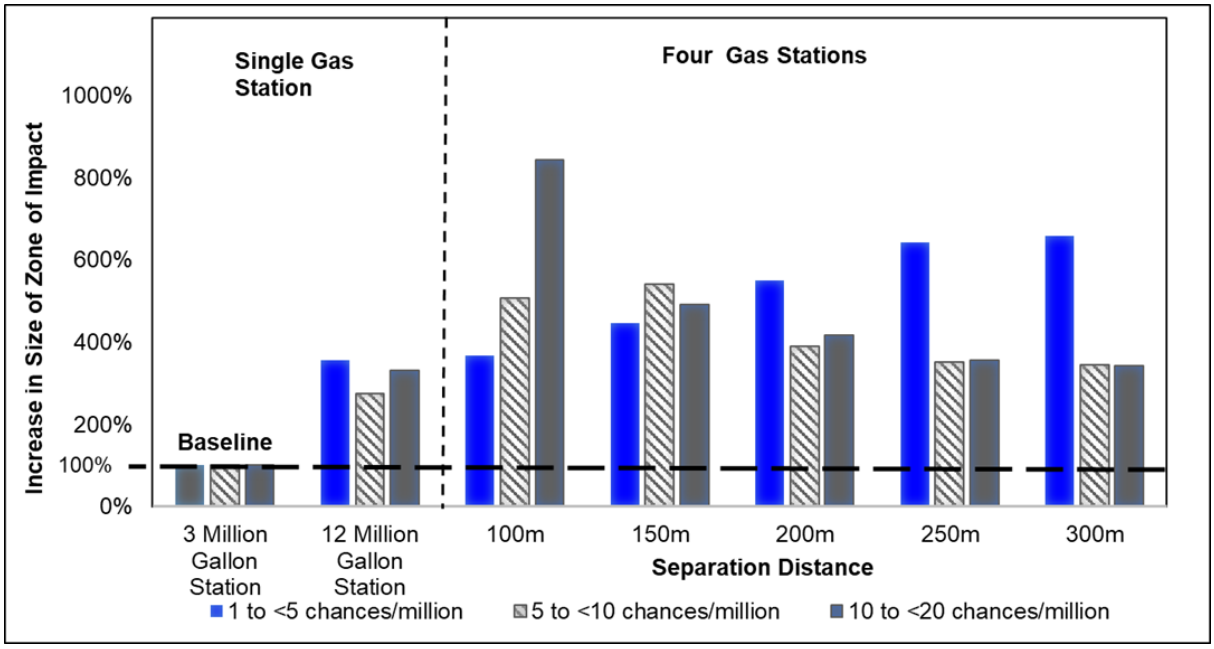
Table A3 and Figure A3 summarize the percent increases in the size of zones of impact for a 12-million gallon station and a group of four three-million-gallon gas stations (separated by 100 m, 150 m, 200 m, 250 m and 300 m) versus a single three-million-gallon gas station for a rural meteorological data set. See the results section of this appendix (Section A.14.3.14.3.3 for detailed figures of the one to less than five chances per million, five to less than 10 chances per million, and 10 to less than 20 chances per million risk isopleths.

Table A3. Percent Increase in Size of Zone of Impact of Gas Station Emissions: Redding Meteorological Data (Rural)[1,2]

Separation Distance (m)	Percent Increase in Size of Zone of Impact (%)		
	1 to <5 Chances per Million	5 to <10 Chances per Million	10 to <20 Chances per Million
Single Three-Million-Gallon Station	Baseline	Baseline	Baseline
Single 12-Million-Gallon Station	357%	276%	332%
100m	369%	508%	843%
150m	448%	541%	492%
200m	551%	390%	418%
250m	644%	351%	357%
300m	660%	344%	342%

1. Percent increase results are not provided for the 20 and 30 chances per million isopleths because the single three-million-gallon gas station only included isopleths for one, five, and 10 chances per million.
2. Separation distance is the distance between each of the four gas stations.

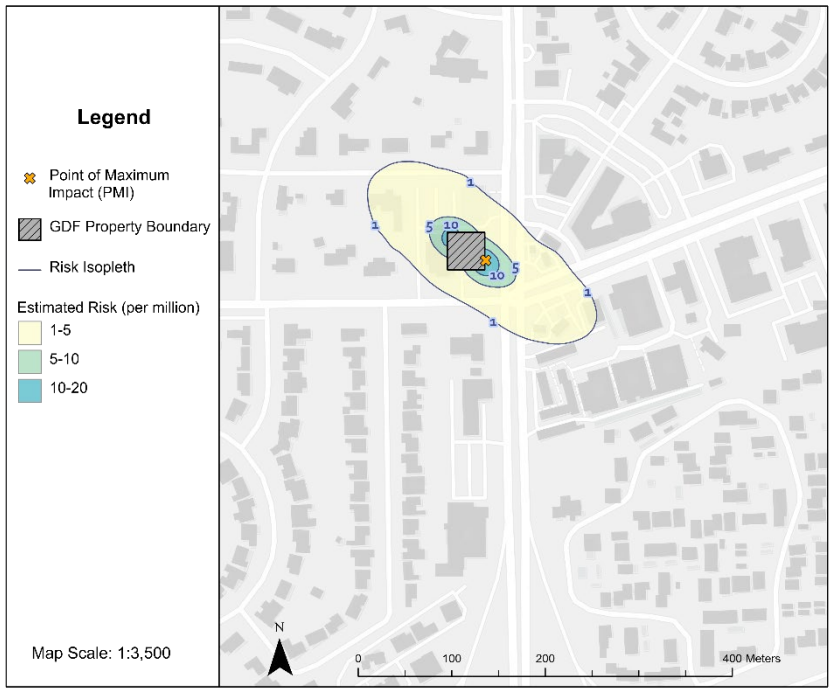
Figure A3. Percent Increase in Size of Zone of Impact of Gas Station Emissions: Redding Meteorological Data (Rural)[1,2,3,4]



1. Results will vary for different locations, throughputs, and separation distances.
2. "Separation Distance" is the distance between each of the four gas stations.
3. The zone of impact for a given level of risk is the total area exposed to emissions.
4. Percent increase results are not shown for the 20 and 30 chances per million isopleths because the single three-million-gallon gas station only included isopleths for one, five, and 10 chances per million.

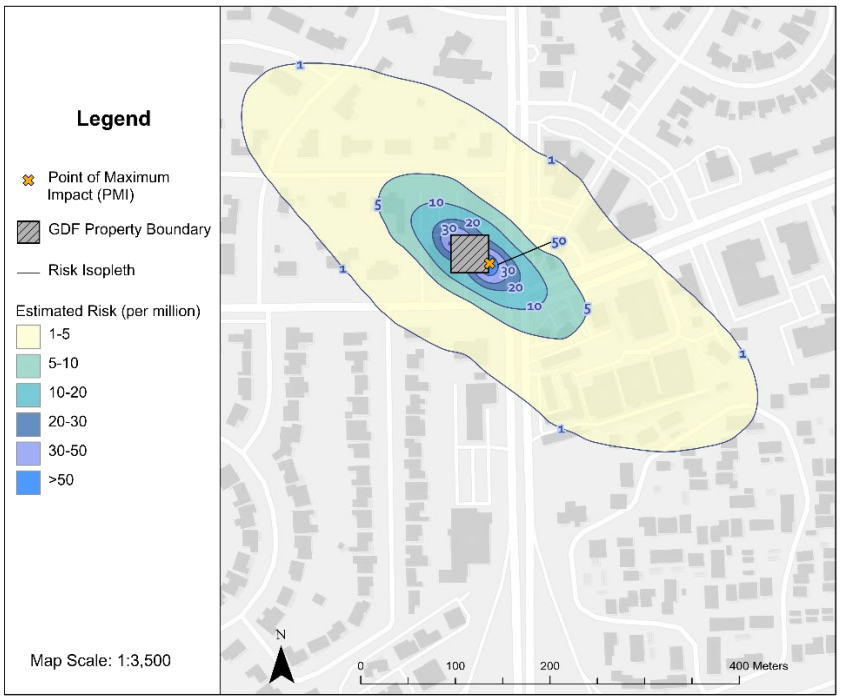
1. Zone of Impact Maps - Urban Meteorology (San Jose Meteorological Data)

Figure A4. Zone of Impact of Gas Station Emissions: Single Three-Million-Gallon Gas Station (Urban)[1,2]



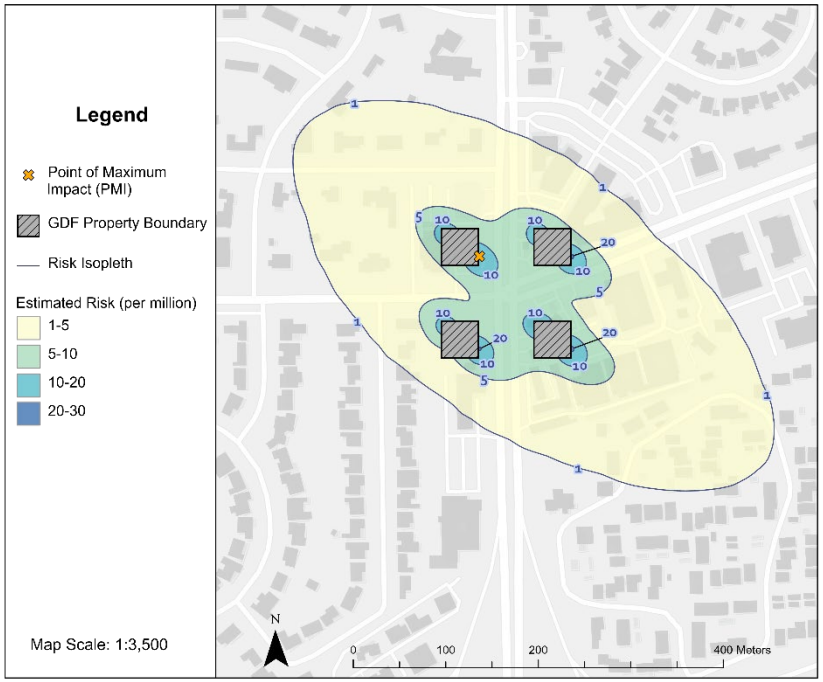
1. Urban = San Jose meteorological data.
2. This map is a generic represention of an area with a four-corner intersection. This layout may not be representative of all urban areas.
3. The Point of Maximum Impact (PMI) is 20 chances per million.

Figure A5. Zone of Impact of Gas Station Emissions: Single 12-Million-Gallon Gas Station (Urban)[1,2]



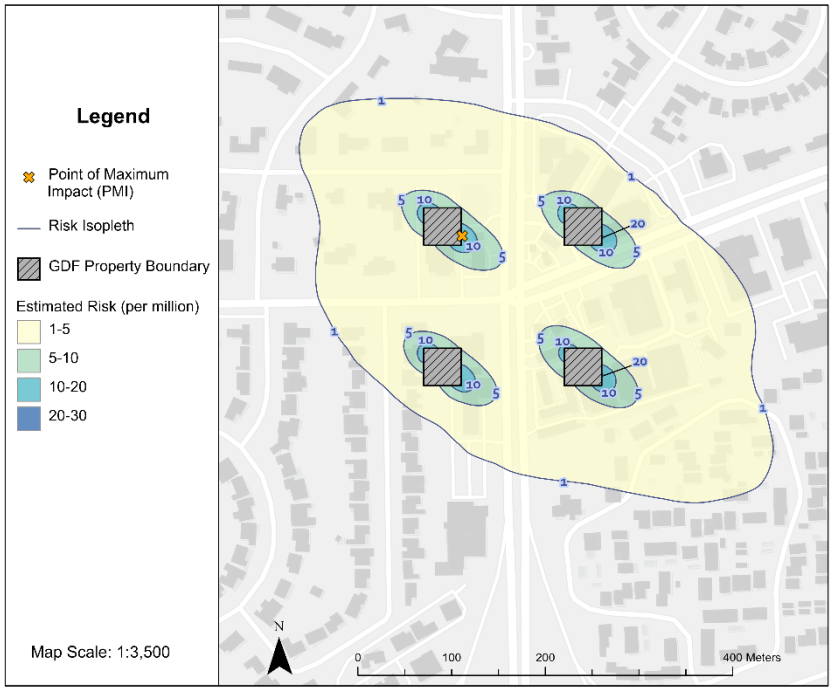
1. Urban = San Jose meteorological data.
2. This map is a generic represention of an area with a four-corner intersection. This layout may not be representative of all urban areas.
3. The Point of Maximum Impact (PMI) is 80 chances per million.

Figure A6. Zone of Impact of Gas Station Emissions: Four Three-Million-Gallon Gas Stations with 100m Separation (Urban)[1,2]



1. Urban = San Jose meteorological data.
2. This map is a generic represention of an area with a four-corner intersection with one gas station on each corner. This layout may not be representative of all urban areas.
3. The Point of Maximum Impact (PMI) is 23 chances per million.

Figure A7. Zone of Impact of Gas Station Emissions: Four Three-Million-Gallon Gas Stations with 150m Separation (Urban)[1,2]



1. Urban = San Jose meteorological data.
2. This map is a generic represention of an area with a four-corner intersection with one gas station on each corner. This layout may not be representative of all urban areas.
3. The Point of Maximum Impact (PMI) is 22 chances per million.

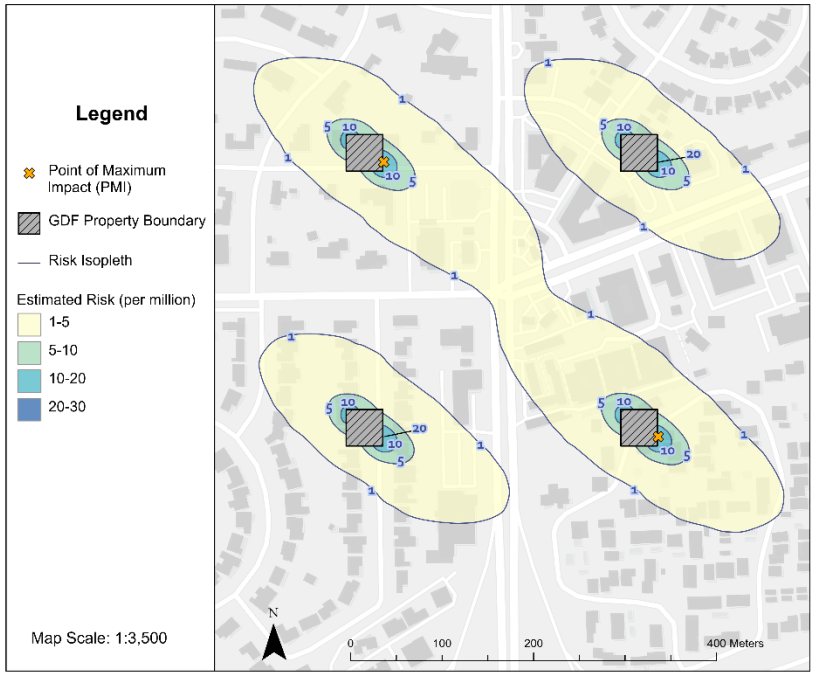
Figure A8. Zone of Impact of Gas Station Emissions: Four Three-Million-Gallon Gas Stations with 200m Separation (Urban)[1,2]

1. Urban = San Jose meteorological data.
2. This map is a generic represention of an area with a four-corner intersection with one gas station on each corner. This layout may not be representative of all urban areas.
3. The Point of Maximum Impact (PMI) is 21 chances per million.

Figure A9. Zone of Impact of Gas Station Emissions: Four Three-Million-Gallon Gas Stations with 250m Separation (Urban)[1,2]

1. Urban = San Jose meteorological data.
2. This map is a generic represention of an area with a four-corner intersection with one gas station on each corner. This layout may not be representative of all urban areas.
3. The Point of Maximum Impact (PMI) is 21 chances per million.

Figure A10. Zone of Impact of Gas Station Emissions: Four Three-Million-Gallon Gas Stations with 300m Separation (Urban)[1,2]



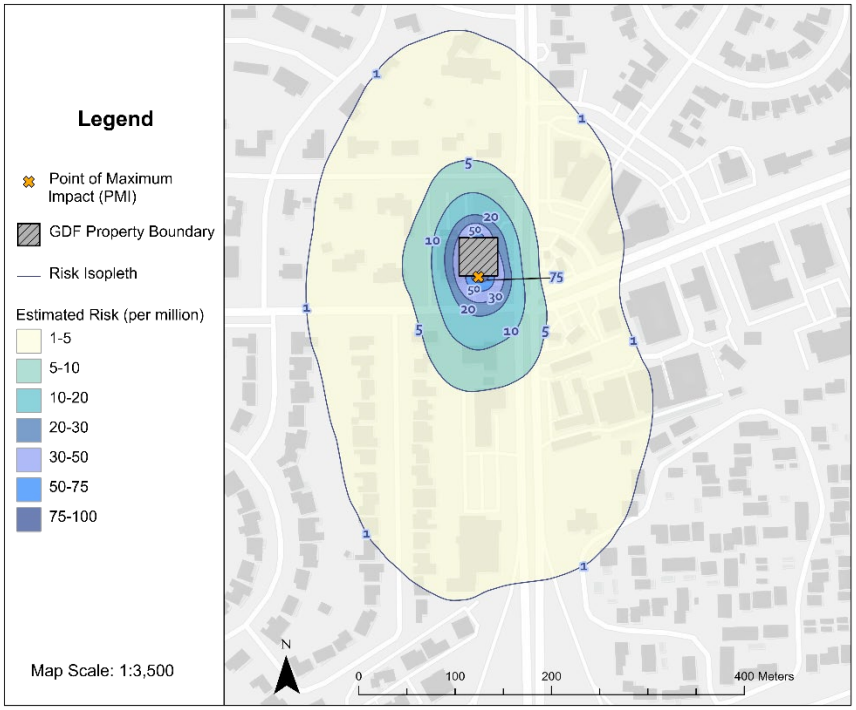
1. Urban = San Jose meteorological data.
2. This map is a generic represention of an area with a four-corner intersection with one gas station on each corner. This layout may not be representative of all urban areas.
3. The Point of Maximum Impact (PMI) is 21 chances per million.

2. Zone of Impact Maps - Rural Meteorology (Redding Meteorological Data)

Figure A11. Zone of Impact of Gas Station Emissions: Single Three-Million-Gallon Gas Station (Rural)[1,2]

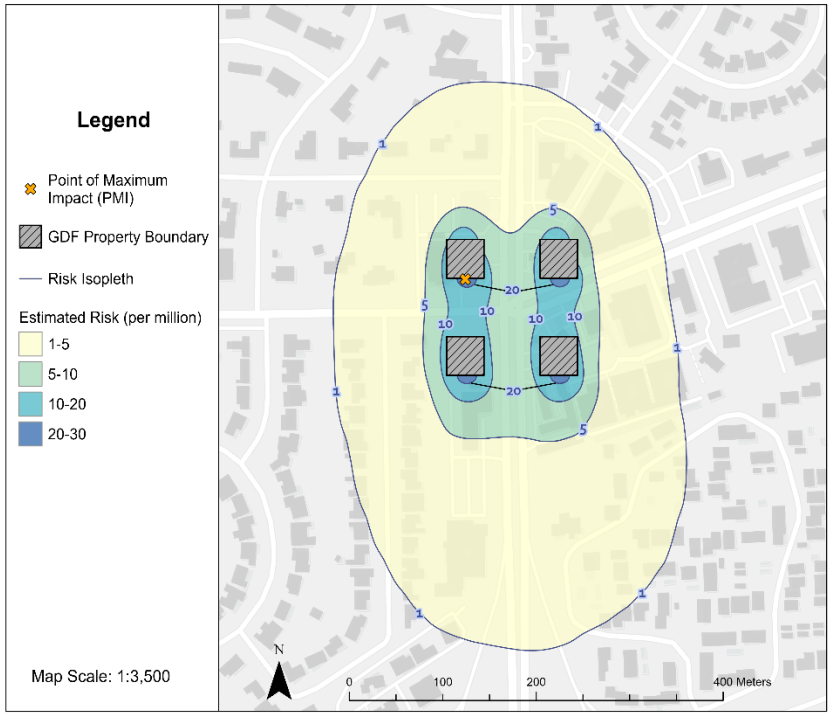
1. Rural = Redding meteorological data.
2. This map was used for illustration purposes and may not be representative of all rural areas.
3. The Point of Maximum Impact (PMI) is 26 chances per million.

Figure A12. Zone of Impact of Gas Station Emissions: Single 12-Million-Gallon Gas Station (Rural)[1,2]



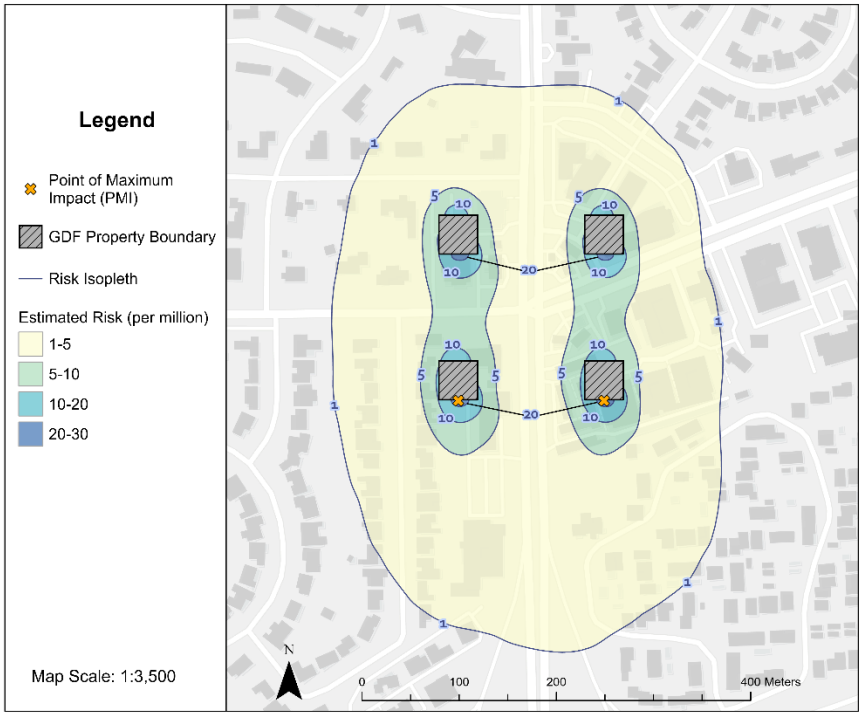
1. Rural = Redding meteorological data.
2. This map was used for illustration purposes and may not be representative of all rural areas.
3. The Point of Maximum Impact (PMI) is 104 chances per million.

Figure A13. Zone of Impact of Gas Station Emissions: Four Three-Million-Gallon Gas Stations with 100m Separation (Rural)[1,2]



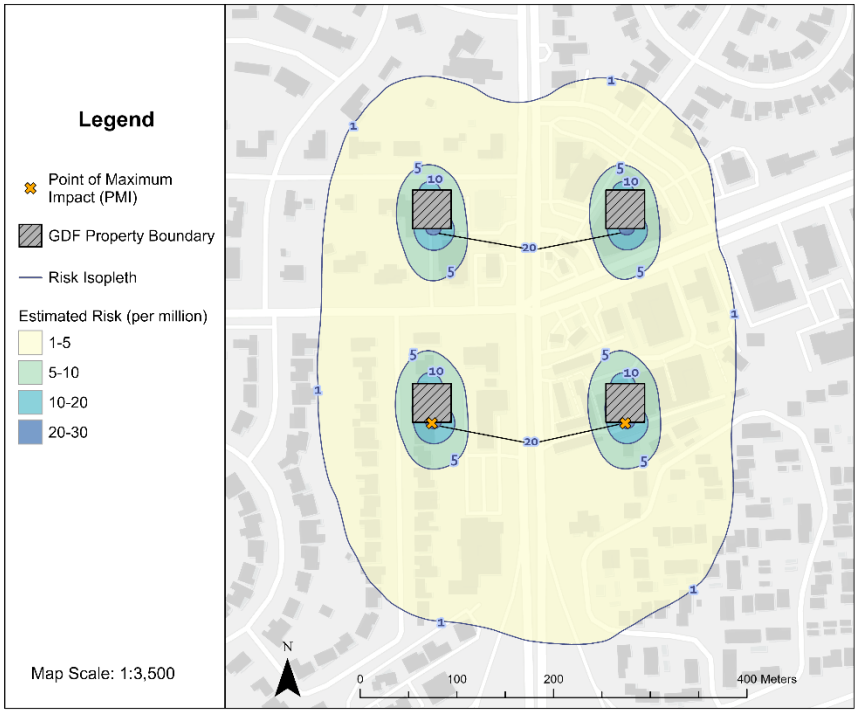
1. Rural = Redding meteorological data.
2. This map is a generic represention of an area with a four-corner intersection with one gas station on each corner. This layout may not be representative of all rural areas.
3. The Point of Maximum Impact (PMI) is 29 chances per million.

Figure A14. Zone of Impact of Gas Station Emissions: Four Three-Million-Gallon Gas Stations with 150m Separation (Rural)[1,2]



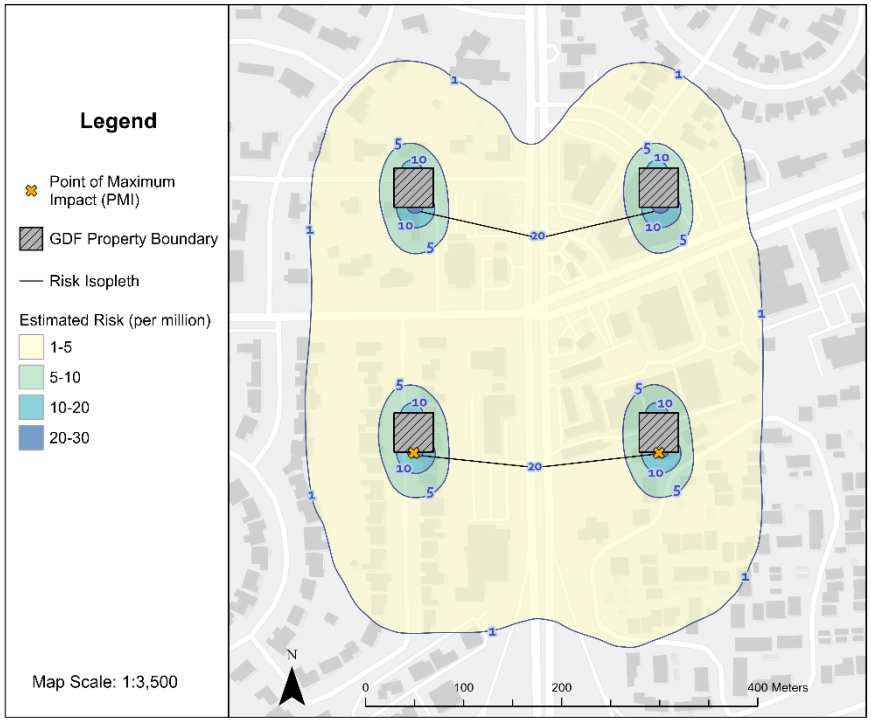
1. Rural = Redding meteorological data.
2. This map is a generic represention of an area with a four-corner intersection with one gas station on each corner. This layout may not be representative of all rural areas.
3. The Point of Maximum Impact (PMI) is 28 chances per million.

Figure A15. Zone of Impact of Gas Station Emissions: Four Three-Million-Gallon Gas Stations with 200m Separation (Rural)[1,2]



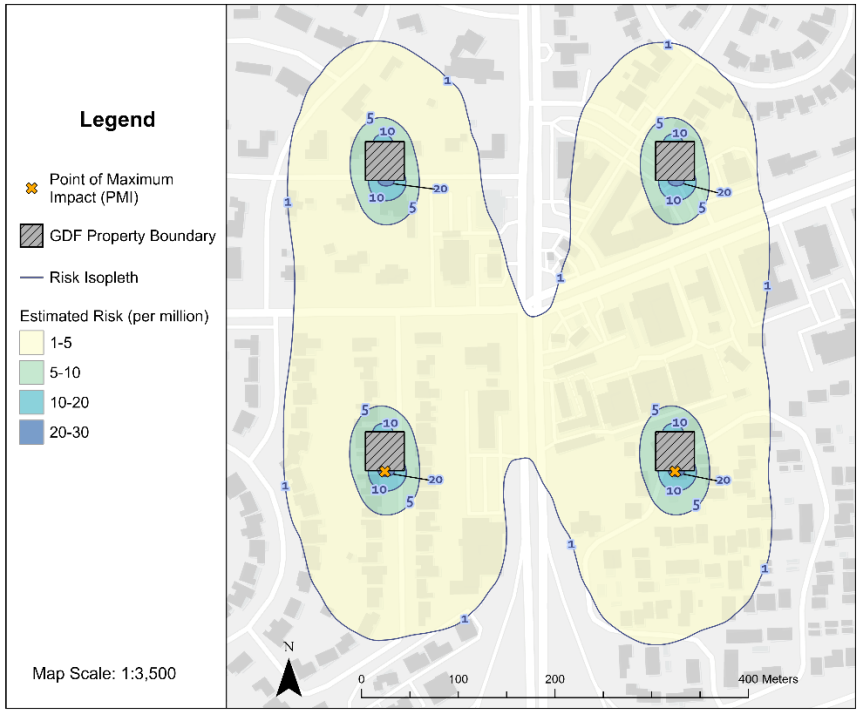
1. Rural = Redding meteorological data.
2. This map is a generic represention of an area with a four-corner intersection with one gas station on each corner. This layout may not be representative of all rural areas.
3. The Point of Maximum Impact (PMI) is 27 chances per million.

Figure A16. Zone of Impact of Gas Station Emissions: Four Three-Million-Gallon Gas Stations with 250m Separation (Rural)[1,2]



1. Rural = Redding meteorological data.
2. This map is a generic represention of an area with a four-corner intersection with one gas station on each corner. This layout may not be representative of all rural areas.
3. The Point of Maximum Impact (PMI) is 27 chances per million.

Figure A17. Zone of Impact of Gas Station Emissions: Four Three-Million-Gallon Gas Stations with 300m Separation (Rural)[1,2]

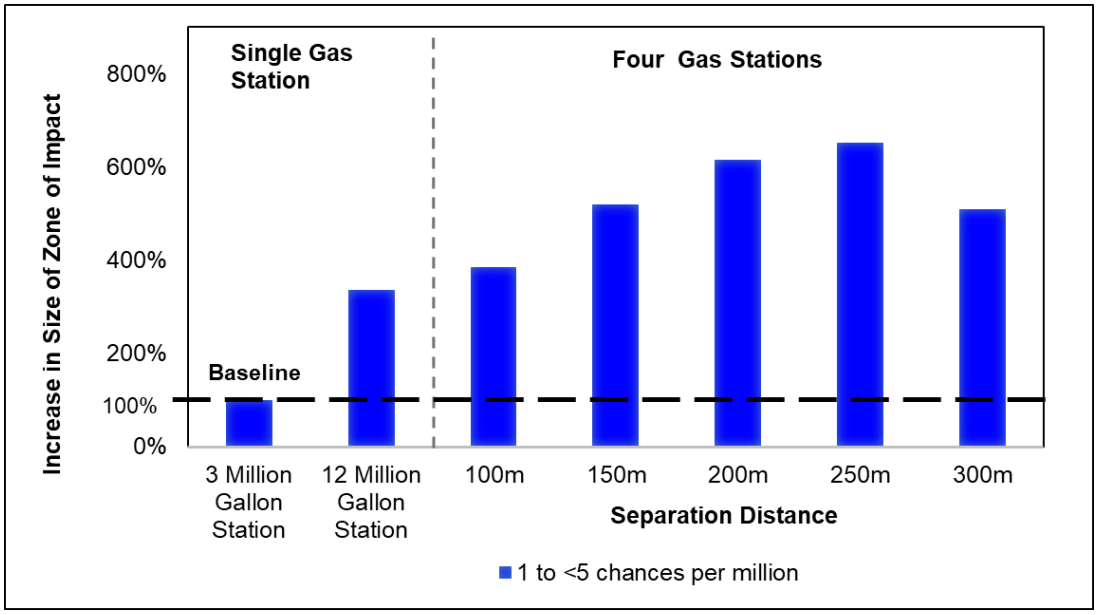


1. Rural = Redding meteorological data.
2. This map is a generic represention of an area with a four-corner intersection with one gas station on each corner. This layout may not be representative of all rural areas.
3. The Point of Maximum Impact (PMI) is 27 chances per million.

3. Percent Increase in Zone of Impact Analysis: 1 to <5, 5 to <10, and 10 to <20 Chances per Million Risk Isopleths

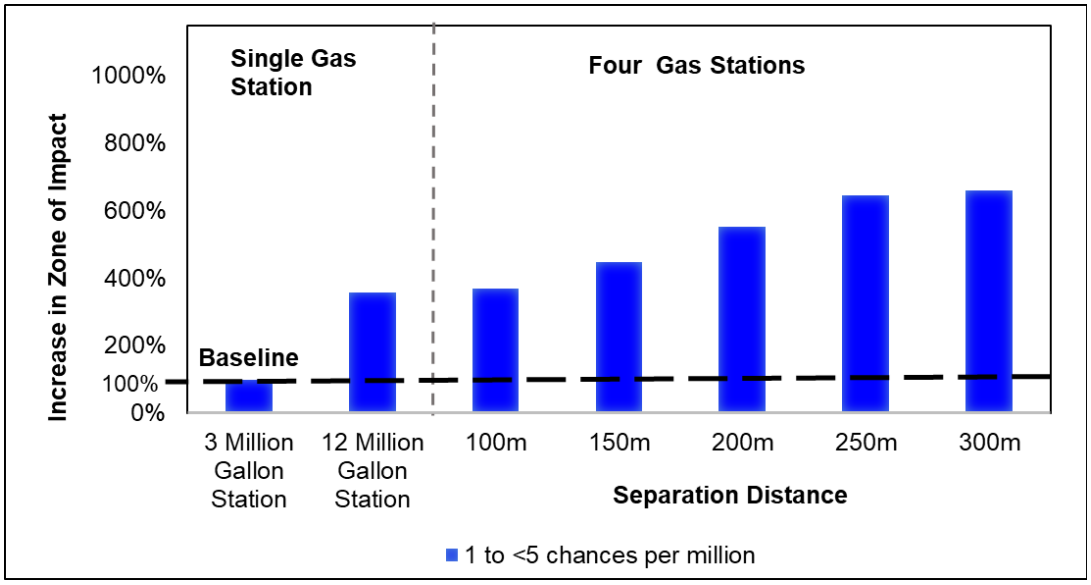
On the next page, Figure A18 through Figure A23 show the percent increase in the size of zones of impact for a 12-million gallon station and a group of four three-million-gallon gas stations versus a single three-million-gallon gas station for urban and rural meteorological data sets. In all cases, four three-million-gallon stations has a larger zone of impact than a single three-million-gallon gas station. For both the urban and rural scenarios, the zone of impact of four three-million-gallon stations is generally larger than the zone of impact of the12-million-gallon station, regardless of separation distance.

Figure A18. Size of Zone of Impact of Gas Station Emissions: One Chance per Million Isopleth (Urban)[1,2,3]



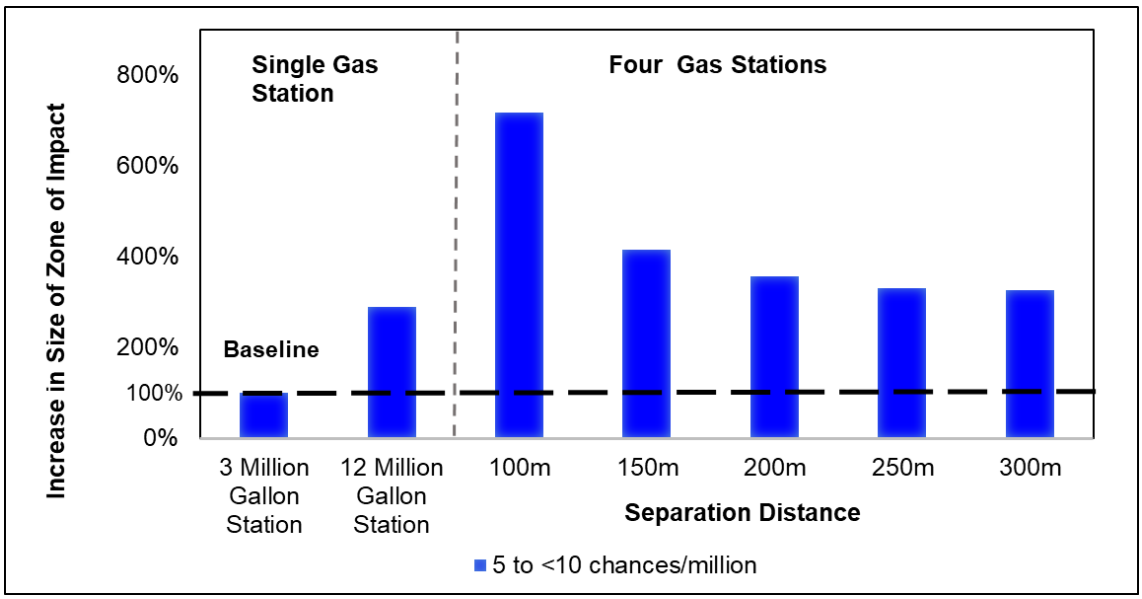
1. Percent increase results are not shown for the 20 and 30 chances per million isopleths because the single three-million-gallon gas station only included isopleths for one, five, and 10 chances per million.
2. Urban = San Jose meteorological data.
3. "Separation Distance" is the distance between each of the four gas stations.

Figure A19. Size of Zone of Impact of Gas Station Emissions: One Chance per Million Isopleth (Rural)[1,2,3]



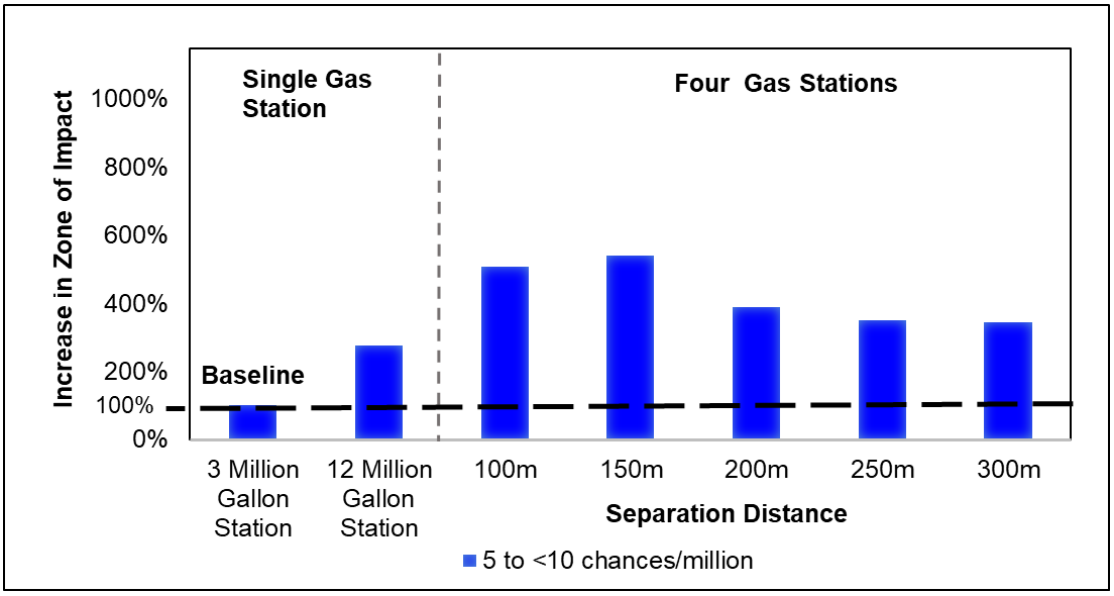
1. Percent increase results are not shown for the 20 and 30 chances per million isopleths because the single gas station only included isopleths for one, five, and 10 chances per million.
2. Rural = Redding meteorological data.
3. "Separation Distance" is the distance between each of the four gas stations.

Figure A20. Size of Zone of Impact of Gas Station Emissions: Five Chances per Million Isopleth (Urban)[1,2,3]



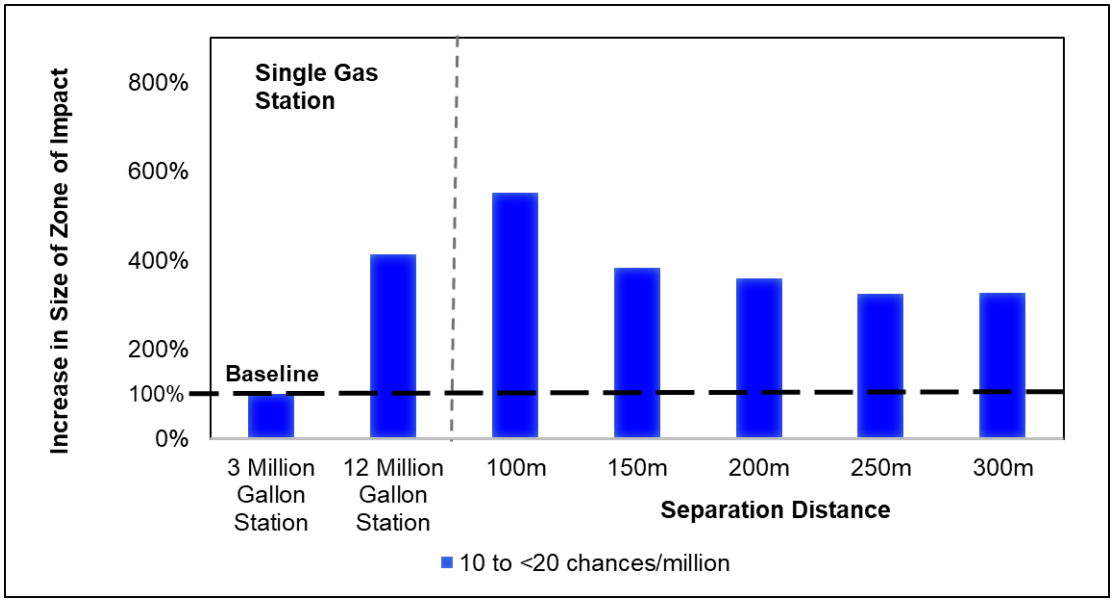
1. Percent increase results are not shown for the 20 and 30 chances per million isopleths because the single gas station only included isopleths for one, five, and 10 chances per million.
2. Urban = San Jose meteorological data.
3. "Separation Distance" is the distance between each of the four gas stations.

Figure A21. Size of Zone of Impact of Gas Station Emissions: Five Chances per Million Isopleth (Rural)[1,2,3]



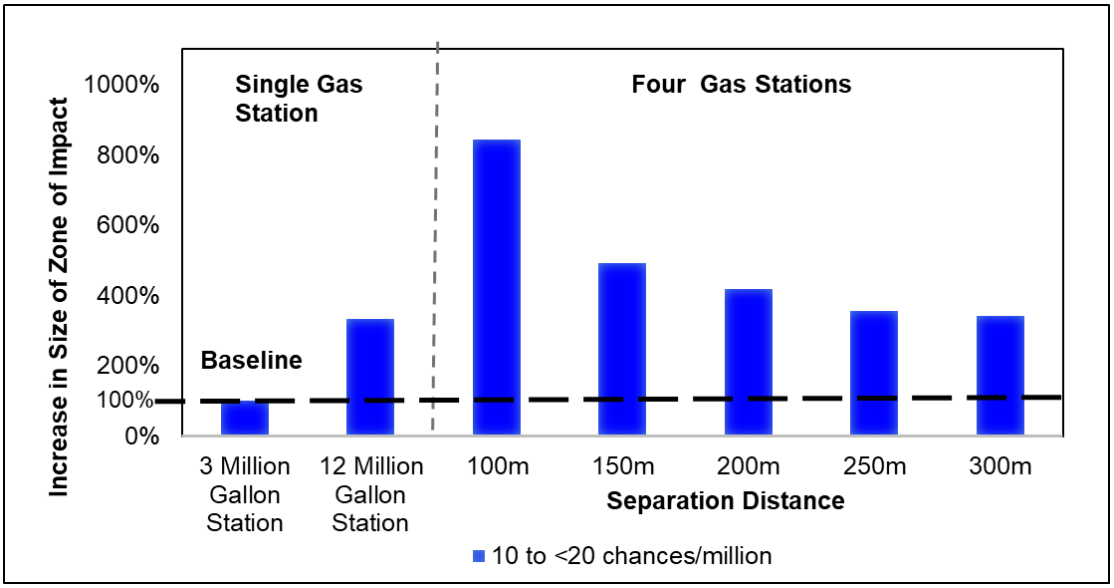
1. Percent increase results are not shown for the 20 and 30 chances per million isopleths because the single gas station only included isopleths for one, five, and 10 chances per million.
2. Rural = Redding meteorological data.
3. "Separation Distance" is the distance between each of the four gas stations.

Figure A22. Size of Zone of Impact of Gas Station Emissions: Ten Chances per Million Isopleth (Urban)[1,2,3]



1. Percent increase results are not shown for the 20 and 30 chances per million isopleths because the single gas station only included isopleths for one, five, and 10 chances per million.
2. Urban = San Jose meteorological data.
3. "Separation Distance" is the distance between each of the four gas stations.

Figure A23. Size of Zone of Impact of Gas Station Emissions: Ten Chances per Million Isopleth (Rural)[1,2,3]



1. Percent increase results are not shown for the 20 and 30 chances per million isopleths because the single gas station only included isopleths for one, five, and 10 chances per million.
2. Rural = Redding meteorological data.
3. "Separation Distance" is the distance between each of the four gas stations.

D. Summary of Findings

The results of the multiple gas station assessment show that the presence of multiple gas stations in close proximity to each other increase the zone of impact, and potentially the corresponding risk, to people living and working nearby when compared to an individual station. In most cases, the zone of impact for multiple gas stations was over four times larger than the zone of impact of a single station. The largest zones of impact occurred at a separation distance of 100 m for both the urban (San Jose meteorological data) and rural scenarios (Redding meteorological data). The modeling results showed potential population-wide (70 year) cancer risks as high as 30 chances per million.

The results also showed that the zone of impact of four three-million-gallon stations in an urban area can range from three to seven times larger than the zone of impact for a single three-million-gallon-station. The largest increase in the zone of impact occurred for the 5 to less than 10 chances per million risk isopleth at a separation distance of 100 m. Many districts use a cancer risk public notification threshold[45] of 10 chances per million. The zone of impact of four three-million gallon stations is larger than the zone of impact of the single 12-million-gallon station, except when risk reaches 10 to less than 20 chances per million.

[45] A cancer risk notification threshold is the health risk level at which a facility must notify exposed members of the public of potential health risks associated with facility emissions.

Based on the results, the zone of impact of four three-million-gallon stations in a rural area can range from about three and half times to eight and a half times larger than the zone of impact for a single three-million-gallon-station. The largest increase in the zone of impact occurred in the 10 to less than 20 chances per million isopleth. Additionally, the largest 10 to less than 20 chances per million isopleth for the group of four three-million-gallon stations was eight and a half times larger than the same isopleth in the single three-million-gallon station. Similar to the urban scenario, the group of four three-million-gallon stations in a rural area generally have a larger zone of impact than a single 12-million-gallon station.

The cancer risk from gas stations significantly decreases as the receptor moves further from the source. Cancer risk drops by about half the value from 10 to 20 meters, and quickly drops to below 1 chance per million at about 60 to 70 meters. At the 100m separation distance for the urban scenario, the zones of impact for each station interact with each other at cancer risks of 5 to 10 chances per million but no longer impact each other as the separation distance increases. For the rural scenario, the zones of impact for each station at cancer risks of 5 to 10 chances per million completely separate at a separation distance of 200 meters.

In the urban scenario, the cancer risk at the Point of Maximum Impact (PMI) for the single three-million gallon station is 20 chances per million. The cancer risk at the PMIs for the multiple gas station scenarios ranged from 21 to 23 chances per million in which the highest cancer risk at the PMI occurred at a separation distance of 100 meters.

In the rural scenario, the cancer risk at the PMI of the single three-million gallon station is 26 chances per million. The cancer risk at the PMIs for the multiple gas station scenarios ranged from 27 to 29 chances per million in which the highest cancer risk at the PMI occurred at a separation distance of 100 meters.

At the PMI of each scenario, the cancer risk is substantially driven by emissions from the nearest gas station. The impact from the other stations are minor in comparison and vary due to the meteorological data used. The PMI is located at the property boundary because risk is typically driven by spillage and is modeled as a volume source. Therefore, we can expect to observe the PMI close to the source. For some scenarios, we may see two PMIs. This is likely attributed to the meteorological data used. In these cases, the predominant wind direction and calm meteorological conditions only allowed the emissions from two stations to interact.

Appendix B: Population-Wide Cancer Risk

The purpose of Appendix B is to illustrate how population-wide risk estimates can be evaluated for individual gas stations and multiple gas stations in close proximity to one another. Under the Hot Spots Act, health risk assessments should quantify both individual and population-wide health impacts[46]. The Office of Health Hazard Assessment's (OEHHA) *Air Toxics Hot Spots Program Risk Assessment Guidelines: Guidance Manual for the Preparation of Health Risk Assessments*[47] (OEHHA Manual) presents procedures for evaluating both individual and population-wide health impacts. Both approaches are necessary to provide a complete illustration of a facility's health impacts.

For example, the individual health impact approach may show that gas stations impact a small number of people with high individual cancer risks and a larger number of people with low individual cancer risks. However, because gas stations are ubiquitous in nature and are often found in groups of two or more throughout the State, many more people are exposed to the lower levels of individual cancer risk from gas station emissions. This potential for higher population impacts is not captured by the individual cancer risk methodology. Population-wide risk provides an illustration of widespread impacts for facilities that may have individual cancer risks below public notification thresholds, but expose a larger population to emissions.

Population-wide risk is independent of individual risk, and is calculated on the basis of a 70-year lifetime, regardless of how many people move in or out of the vicinity of the source of emissions during that time period. The level of detail and procedures required for analyzing population-wide risk require case-by-case analysis. Thus, Districts should be consulted before beginning analysis on population-wide health impacts. The OEHHA Manual includes two methods of evaluating population-wide cancer risk, cancer burden and population-wide risk estimates. CARB's Hotspots Analysis and Reporting Program[48] (HARP) software can provide population-wide cancer risk as a cancer burden number or as a population-wide risk estimate. Both of these methods are detailed in Sections B.1 and B.2.

A. Cancer Burden

Cancer burden is an estimate of the increase in potential cancer risk within a population as a result of exposures to toxic emissions. This calculation results in a single number that

[46] Assembly Bill 2588, Air Toxics "Hot Spots" Information and Assessment Act (Hot Spots Act), Connelly, Statutes of 1987, Chapter 1252, in California Health and Safety Code § 44306.
[47] Office of Environmental Health Hazard Assessment, The Air Toxics Hot Spots Program, Guidance Manual for Preparation of Health Risk Assessments, February 2015. Available at: *https://oehha.ca.gov/air/crnr/notice-adoption-air-toxics-hot-spots-program-Guidance-manual-preparation-health-risk-0.*
[48] Additional information on the HARP software can be found here: *https://www.arb.ca.gov/our-work/programs/hot-spots-analysis-reporting-program.*

represents the potential cancer risk within the population that was exposed to the emissions for over a 70-year lifetime.

Cancer burden is calculated in two parts: (1) multiplying the potential cancer risk at a census block centroid[49,50] by the number of people who live in the census block[51], and (2) summing the cancer burden values for each census block centroid across the zone of impact. The units for potential cancer risk and the population of a census block are chances per million and number of people, respectively. However, cancer burden itself is a unitless number. Cancer burden values can be compared to District permitting and/or public notification thresholds to determine whether additional evaluation is warranted for a facility. Most Districts do not currently have permitting or public notification thresholds for cancer burden; therefore, some Districts will most likely not be able to use the results of a cancer burden analyses in air quality permitting decisions until relevant thresholds are developed.

An example cancer burden calculation is shown in Section A.1.

1. Example Cancer Burden Calculation

Table B2 lists population-wide risk information for three census blocks within the 0.1 chance per million (1×10^{-7}) zone of impact of a gas station.

Table B1. Example Population-Wide Risk Information

Census Block	Cancer Risk at Census Block Centroid[1]	Census Block Population
1	7.51×10^{-7}	278
2	2.20×10^{-7}	160
3	1.27×10^{-7}	152

1. Per the OEHHA Manual, the zone of impact for estimating the number of people exposed to a given cancer risk from facility emissions can be set at a minimum of 0.1 chance per million (1×10^{-7}).

To determine cancer burden, first determine a cancer burden value for each of the five census blocks using Equation B1:

Equation B1. Cancer Burden at a Census Block Centroid

$$Cancer\ Burden_{\ Census\ Block\ Centroid} = Cancer\ Risk_{\ Census\ Block\ Centroid}\ x\ Population_{Census\ Block}$$

Applying Equation B1 to the population-wide risk information from Table B2:

$$Cancer\ Burden_{\ Census\ Block\ Centroid\ 1} = 7.51\text{x}10^{-7}\ x\ 278 = \ 2.09x10^{-4}$$

$$Cancer\ Burden_{\ Census\ Block\ Centroid\ 2} = 2.20\text{x}10^{-7}\ x\ 160 = \ 3.52x10^{-5}$$

[49] The centroid is defined as the central location within a specified geographic area.
[50] U.S. Department of Commerce, (1994), Geographic Areas Reference Manual, U. S. Department of Commerce, November, 1994.
[51] A census block is defined as the smallest entity for which the Census Bureau collects and tabulates decennial census information. It is bounded on all sides by visible and nonvisible features shown on Census Bureau maps.

$$Cancer\ Burden_{\ Census\ Block\ Centroid\ 3} = 1.27\text{x}10^{-7}\ x\ 152 = \ 1.27x10^{-5}$$

Once values are calculated for each census block centroid, sum the values to determine the cumulative cancer burden across the zone of impact using Equation B2:

Equation B2. Cumulative Cancer Burden

$$Cancer\ Burden_{Zone\ of\ Impact} = Sum\ of\ Individual\ Cancer\ Burden\ values\ from\ each\ Census\ Block\ Centroid$$

Applying Equation B2, the final cancer burden across the zone of impact is:

$$Cancer\ Burden_{\ Zone\ of\ Impact=10^{-7}} = \ 2.09x10^{-4} + \ 3.52x10^{-5} + \ 1.27x10^{-5} = \ \mathbf{2.63x10^{-4}}$$

Although cancer burden is a widely accepted method for calculating population-wide risk, it does not characterize the difference between a facility with a high risk in a sparsely populated area and the same facility with a low risk in a densely populated area. For example, if 100,000 people are exposed to a cancer risk of 10 chances per million ($1x10^{-5}$), and 1,000,000 people are exposed to a cancer risk of 1 chance per million (1×10^{-6}), the cancer burden in both cases would be one. However, the overall public health impact is unclear because the impact by the same facility can differ depending on the surrounding population. As a result, population-wide risk estimates may provide a more complete illustration of population-wide health impacts in certain situations.

B. Population-Wide Risk Estimates

Population-wide risk estimates characterize the number of people exposed to certain cancer risk levels at census block centroids. This approach can be used in lieu of the cancer burden calculation or it can be used to provide additional population-wide risk information. An estimate of the number of people exposed at various cancer risk levels can provide perspective on the magnitude of the potential public health impact of an individual facility or multiple facilities. Per the OEHHA Manual, the zone of impact for estimating the number of people exposed to a given cancer risk from facility emissions should be set at a minimum of one chance per million (1×10^{-6}), and can extend out to 0.1 chances per million (1×10^{-7}) to better illustrate the zone of impact for cancer risk.

An example of presenting population-wide risk estimates for individual gas stations and multiple stations in close proximity are shown in Section B.1.

1. Example Estimate of Population-Wide Risk

Staff modeled the following scenarios in HARP, using many of the same assumptions found in Appendix A (Section B.4):

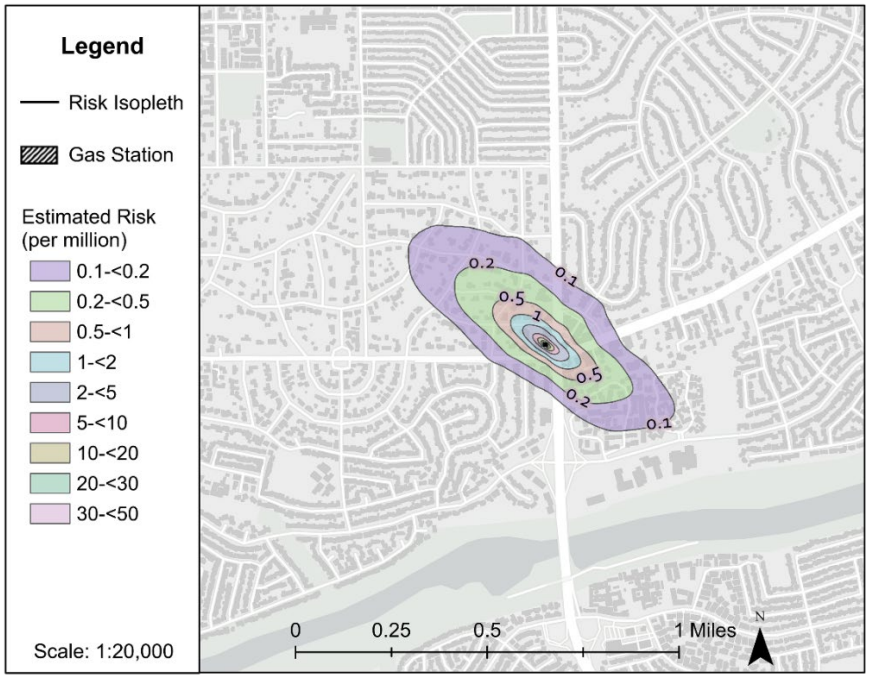
- A single, three-million-gallon gas station.
- Four three-million-gallon stations, modeled at a separation distance of 100 meters between each station (see modeling schematic in Appendix A, Section B.4)

For the site-specific data necessary to evaluate population-wide risk, staff used the San Jose (urban) meteorological data set and fictitious census data created using census data from

various urban locations. Staff used HARP to calculate risk results and generate a population exposure estimate report which presents information about the number of people exposed to a given cancer risk. After all the modeling runs were complete, staff used GIS to generate contours or risk isopleths that could be mapped for each modeled scenario. Collectively, all risk isopleths within a map scenario represent the total area exposed to gas station emissions or the "zone of impact".

Figure B1 shows the zone of impact map for a single three-million-gallon station. Table B2 shows the potential cancer risk and the estimated number of people exposed each level of risk. The risk levels in the table correspond to the risk isopleths shown in Figure B1.

Figure B1. Zone of Impact Map for Population-Wide Cancer Risk: Single Three-Million-Gallon Gas Station



1. The zone of impact for a given level of risk is the total area exposed to emissions from the single three-million-gallon gas station.

Table B2. Population-Wide Cancer Risk Estimates: Single Three-Million-Gallon Gas Station[1,2]

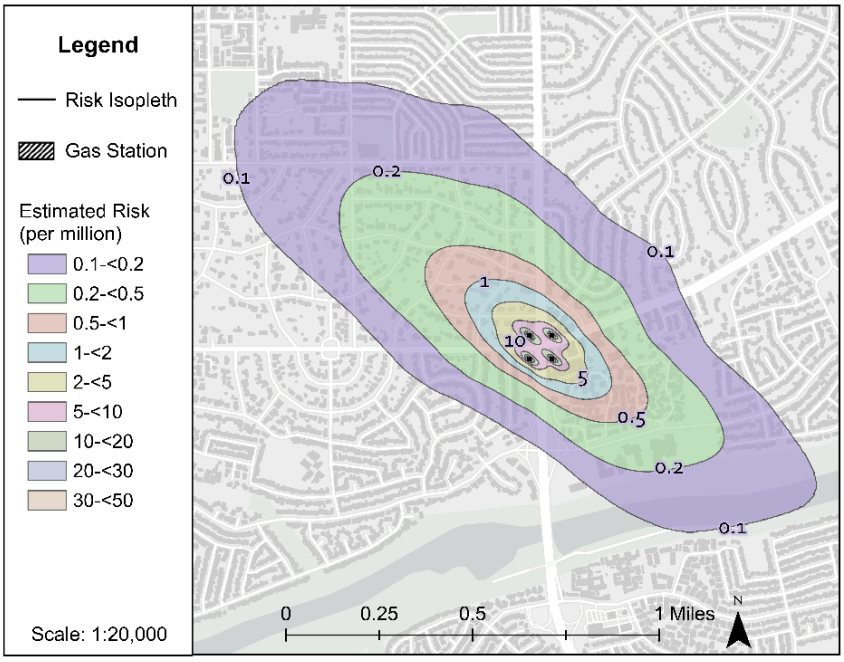
Cancer Risk[2] (chances per million)	Number of People
0.1 to <0.2	3200
0.2 to <0.5	1238
0.5 to <1	438
1 to <2	744
2 to <5	186
5 to <10	0
10 to <20	0
20 to <30	0
30 to <50	0

1. Results will vary for different locations, throughputs, and separation distances.

2. Per the OEHHA Manual, the zone of impact for estimating the number of people exposed to a given cancer risk from facility emissions can be set at a minimum of 0.1 chances per million (1×10^{-7}).

Figure B2 shows an example of a risk isopleth map for four three-million gallon stations, separated by 100 meters. Table B3 is an example table showing the potential population-wide cancer risk and the estimated number of people exposed corresponding to the risk isopleths in Figure B2.

Figure B2. Zone of Impact Map for Population-Wide Cancer Risk: Four Three-Million-Gallon Gas Stations



1. The zone of impact for a given level of risk is the total area exposed to emissions from all four gas stations.

Table B3. Population-Wide Cancer Risk Estimates: Four Three-Million-Gallon Gas Stations[1,2]

Cancer Risk[2] (chances per million)	Number of People
0.1 to <0.2	15111
0.2 to <0.5	8154
0.5 to <1	1724
1 to <2	1271
2 to <5	681
5 to <10	593
10 to <20	0
20 to <30	0
30 to <50	0

1. Results will vary for different locations, throughputs, and separation distances.
2. Per the OEHHA Manual, the zone of impact for estimating the number of people exposed to a given cancer risk from facility missions can be set at a minimum of 0.1 chances per million (1×10^{-7}).