Offsite Consequences Analysis and Hazards Buffer Report For Trical, Inc.

July 9, 2020

PREPARED FOR

County of San Benito

Prepared by

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Federal Agencies

ATF – Bureau of Alcohol, Tobacco, Firearms, and Explosives

ATSDR – Agency for Toxic Substances and Disease Registry

CSB – Chemical Safety and Hazard Investigation Board

DOT – Department of Transportation

EPA – Environmental Protection Agency

OSHA – Occupational Health and Safety Administration

NOAA – National Oceanic and Atmospheric Administration

NTSB – National Transportation Safety Board

Exposure Limits

AEGLs – Acute Exposure Guideline Levels

ERPGs – Emergency Response Planning Guidelines

IDLHs – Immediately Dangerous to Life or Health concentrations

PACs – Protective Action Criteria

PELs – Permissible Exposure Limits

TEELs – Temporary Emergency Exposure Limits

TLVs – Threshold Limit Values

State Agencies

CUPA – Certified Unified Program Agency

DPR – California's Department of Pesticide Regulation

SWRCB – State Water Resources Control Board

Programs

CalARP – California's Accidental Release Prevention Regulations

HMBP – California's Hazardous Materials Business Plan

NPIRS – National Pesticide Information Retrieval System

SMARTS – California's Storm Water Multiple Application and Report Tracking System

SWPPP – Storm Water Pollution Prevention Plan

TRI – EPA's Toxics Release Inventory

Federal Statutes

CAA – Clean Air Act

EPCRA – Emergency Planning and Community Right-to-Know Act of 1986

FIFRA – Federal Insecticide, Fungicide, and Rodenticide Act

Chemicals

1,3-DCP – 1,3-Dichloropropene

MITC – Methyl Isothiocyanate

Documents, Reports and Plans

CUP – Conditional Use Permit

RMP – Risk Management Plan

Modeling Programs

ALOHA – Areal Locations Of Hazardous Atmospheres

BIA – BREEZE Incident Analyst

CAMEO – Computer-Aided Management of Emergency Operations

DEGADIS – Dense Gas Dispersion model

Other

BLEVE – Boiling Liquid Expanding Vapor Explosion

VCE – Vapor Cloud Explosion

Executive Summary

Report Purpose. San Benito County's (County) 2035 General Plan includes health and safety policies designed to protect residents, workers, visitors and properties from unreasonable risks associated with potential hazards. The General Plan's Health and Safety Policy (Policy HS 6.9) applies to new sensitive land uses near industrial facilities that handle industrial or agricultural chemicals. That policy provides that a "buffer shall be maintained between new sensitive land uses" and certain facilities that can handle or receive "chemicals regulated as potentially hazardous." Policy HS 6.9 also provides that "the appropriate buffer zone shall be established on a case-by-case basis," depending on, among other factors, the degree of hazard associated with existing industrial facilities.

This report contains the findings and conclusions of an offsite consequences analysis, which was prompted by a new development (Strada Verde) next to Trical, Inc.'s (Trical) chemical storage and blending facility on Highway 25.[1] The Strada Verde project is proposed to be built by Bristol SB LLC on the Floriani Ranch immediately adjacent to the Trical facility. An offsite consequences analysis is used to evaluate potential harm to human life and property in areas adjacent to industrial facilities due to chemical releases, fires or explosions. This report evaluates the potential harm to human life and property associated with approval of the Strada Verde project.

The purpose of this report is to assist the County with making an informed determination regarding the establishment of a prudent and appropriate buffer zone between Trical and the Strada Verde project. In furtherance of that purpose, this report evaluates the hazards presented by the Trical facility to the surrounding area resulting from Trical's handling and storage of large quantities of toxic, flammable and explosive chemicals. While no analysis can address every conceivable hazard from a given facility, this report evaluates a set of reasonable worst-case chemical release scenarios and their consequences in recommending a prudent and appropriate buffer zone around Trical.

[1] *See* Strada Verde Project Application (May 19, 2019); Strada Verde Innovation Park Voter Initiative (May 26, 2020).

Chemical accidents and releases—often with serious negative consequences for surrounding communities—can and do occur for multiple reasons.[2] Many unexpected chemical releases result from unintentional acts like system failures, human errors (including inadequate employee training) or accidents. Intentional acts, such as vandalism or terrorism, also can cause releases by design. And acts of God (e.g., floods, earthquakes, lightning strikes, severe storms) also can cause the unexpected release of toxic, flammable and explosive chemicals. This report uses industry-standard methods to analyze the adverse consequences to people and property that would result from reasonable worst-case chemical release scenarios that might occur at Trical.

<u>The Strada Verde Project.</u> The Strada Verde project is a mixed-use development proposing more than 6.4 million square feet of commercial space comprised of an automotive research and testing facility, a 20-acre town center, retail shops, office space, hotels, a museum and other uses that are designed to draw a significant number of people to the area, including 5,500 employees. The proposed project would be developed on a 2,777-acre site on the County's northwestern boundary, southeast of the Pajaro River and southwest of Highway 25 and the Union Pacific rail line.

The Strada Verde Innovation Park Voter Initiative of May 2020 indicates that a variety of additional land uses would be permitted "by right" if the project is approved, including:

Farmer's market or a neighborhood center	Outpatient or urgent care medical clinics
College or other learning centers	Public event venues
Religious or charitable institutions	Wedding venues
Spas	Children's daycare facility

<u>Trical Site.</u> The proposed Strada Verde project location is immediately adjacent to and generally south of Trical's chemical facility. Trical is located at 8770 Bolsa Road (CA Highway 25) in the northwest corner of the County. The locations of Trical and the proposed Strada Verde project are shown in the map below:

[2] For example, in January 2020, an explosion and fire occurred at an industrial facility in Houston, Texas that killed three people and damaged 200 nearby homes and businesses. Appendix 8 summarizes numerous chemical incidents as reported by the U.S. Chemical Safety and Hazard Investigation Board and the National Transportation Safety Board.

Toxic Chemicals. The Trical facility is authorized to receive, handle and blend a range of regulated agricultural fumigants, including chloropicrin, 1,3-dichloropropene[3] (1,3-DCP) and methyl bromide. These fumigants are important tools for controlling pests but also pose inherent and serious human health and safety risks. For example, chloropicrin was used as a chemical-warfare agent in World War I, and exposure to high concentrations of chloropicrin can lead to death.

Trical receives or can receive substantial quantities of all three of these fumigants via railcars or tanker trucks (and sometimes trucks containing cylinders or other smaller containers) and stores them on its relatively compact site in either railcars (up to 175,000 pounds) themselves or in multiple large aboveground storage tanks (10,000 to 32,000 gallons in capacity), as well as in hundreds of smaller-sized containers.

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[3] Also commonly referred to as Telone or Telone II. National Center for Biotechnology Information, Compound Summary: 1,3-Dichloropropene, https://pubchem.ncbi.nlm.nih.gov/compound/1_3-Dichloropropene.

Hazard Zone Modeling. An offsite consequences analysis requires the characterization of specific release scenarios, including which chemical is released and how that chemical might be released. While many different types of chemicals can be handled at Trical, this report analyzes three chemicals: chloropicrin, 1,3-DCP and methyl bromide, as well as a by-product from the chemical degradation of chloropicrin which can form a highly toxic gas (phosgene) and an acid gas which is a combustion product of 1,3-DCP (hydrogen chloride). This report selects 15 release scenarios for analysis, each involving a large, unexpected direct release of these chemicals, as well as resulting fires and explosions. Release air dispersion models approved by federal and state agencies were then used to assess adverse impacts due to each release scenario. For example, the report uses ALOHA (Areal Locations Of Hazardous Atmospheres), which is a model developed by the U.S. Environmental Protection Agency (EPA) and the U.S. National Oceanic and Atmospheric Administration (NOAA). As described in Section 7 of the report, other models are also used.

The release dispersion models estimate downwind concentrations of airborne toxic chemicals after specified release scenarios. As a result, the models can identify the specific distances at which particular toxic concentrations can occur depending on the chemical and release conditions. For fires and explosions, the models predict the intensity of heat flux from fires (e.g., lethal heat) and over-pressure waves due to explosions, each of which can cause extensive damage to the surrounding area.

Airborne Toxics Endpoints. The release models use health-based endpoint concentrations to identify hazard zones that may result from chemical releases, as well as resulting fires and explosions. For exposures to airborne toxic chemicals, these health-based endpoints are often referred to as Protective Action Criteria (PACs).

PACs are levels or concentrations of airborne chemicals that threaten public safety and are intended to provide guidance to public agencies on the need to ensure that appropriate protective measures, such as avoidance through careful land use planning, are instituted. PACs are used for emergency planning scenarios by first responders and local, state and federal agencies to determine the protective actions needed to address unexpected release events. There are three levels of PAC values (one to three) that represent increasingly severe effects resulting from progressively higher concentrations of exposures:

Table ES-1. Airborne Toxics Endpoints

Level One		Mild, transient health effects
Level Two		Irreversible or other serious health effects that could impair the ability to take protective action
Level Three		Serious, life-threatening health effects or death

PACs are guidelines designed for public exposure as distinct from other guidelines designed solely for occupational exposures. For example, the EPA develops Acute Exposure Guideline Levels (AEGLs), a PAC, through a rigorous process which requires that all underlying toxicological data be peer-reviewed. This report uses AEGLs thresholds (as described further in Section 5), when available, as the PAC in order to identify the toxic hazard zones surrounding the Trical facility.

For a specific chemical, the Level Three (AEGL-3) and Level Two (AEGL-2) concentration levels are generally dependent on exposure duration. This report has selected a 60-minute exposure duration (see Section 5). Because AEGL-3 and AEGL-2 concentration levels may be lower than odor thresholds, it is possible that members of the public could be exposed to Level Three or Level Two concentrations for periods longer than 60 minutes. Such longer duration exposures could increase the severity of adverse consequences.

Fires and Explosions Endpoints. Some chemicals can burn or explode and cause serious adverse health impacts from the resulting intense heat or over-pressures. Over-pressures can be caused due to vapor cloud explosions (VCEs). Intense heat can be caused by pool fires and/or boiling liquid expanding vapor explosions (BLEVEs).

For scenarios involving fire, this report evaluates the fire's heat or thermal radiation flux (expressed in kilowatts per square meters, kW/m^2) based on two thresholds: Level One: five kW/m^2 (which can cause second-degree burns within 60 seconds), and Level Two: 10 kW/m^2 (which can cause lethal heat within 60 seconds).

For scenarios involving explosions, this report evaluates the distance to which a blast or over-pressure wave would propagate from the explosion and cause potential damage, depending on the strength of the over-pressure. There are two over-pressure thresholds considered in this report: Level One: 3.5 pounds per square inch (psi) (which can cause damage such as the rupture of storage tanks or serious injuries), and Level Two: 8 psi (which can destroy buildings, overturn loaded railcars and cause severe impairment or death).

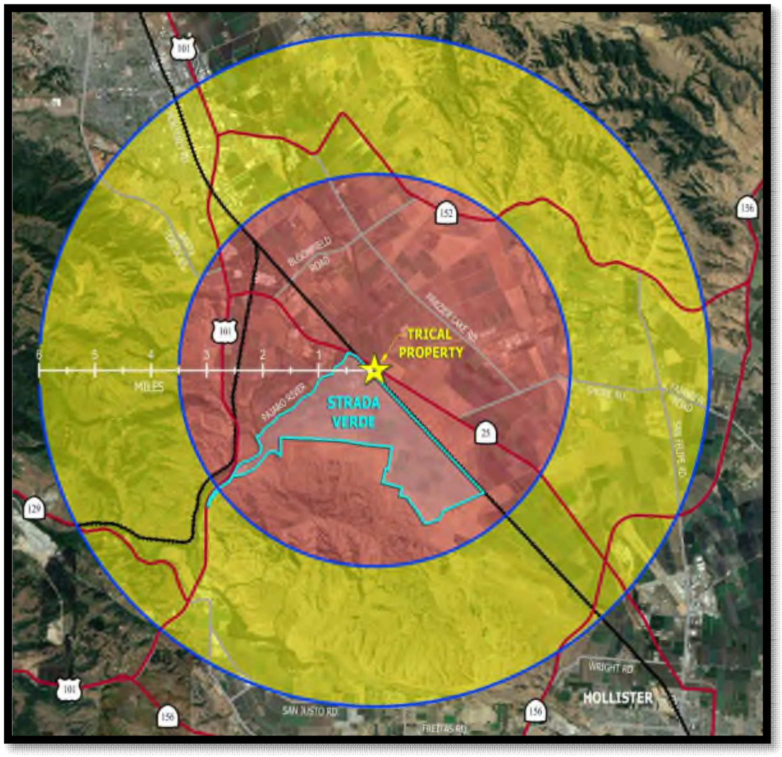
Table ES-2. Fires and Explosions Endpoints

Fires		
Level One	5 kW/ m^2	Second-degree burns within 60 seconds
Level Two	10 kW/m^2	Lethal heat within 60 seconds
Explosions		
Level One	3.5 psi	Rupture of storage tanks, serious injuries
Level Two	8 psi	Buildings destroyed, loaded railcars overturned, severe impairment or death

This report analyzes 15 selected toxic chemical releases, fires and explosions that might occur assuming reasonable worst-case scenarios. For each scenario, an associated map has been prepared to show the results depicted as the range of applicable hazard zones with Trical at the center. A few examples are discussed next.

Chloropicrin Aboveground Tank Release. One scenario that was modeled involved the unexpected release of 137,000 pounds of chloropicrin, the contents of a single, 10,000-gallon horizontal aboveground storage tank. For context, approximately 80,000 pounds of toxic chemicals were released in 1984 from the Union Carbide pesticide facility in Bhopal, India, which is widely considered to be among the world's worst industrial disasters, resulting in massive loss of human life.[4] Also for context, there are 10 such chloropicrin tanks onsite immediately adjacent to one another, each with the same 10,000-gallon (137,000-pound) capacity. In this scenario, the chemical release is assumed to result in the formation of a 500 square meter (m^2) area evaporating pool of chloropicrin. Within 60 minutes, the pool is assumed to evaporate into the atmosphere, dispersing high concentrations of chloropicrin gas around the surrounding area as shown below:

[4] That horrific accident gave rise to the industrial chemical safety statutory and regulatory programs that currently exists in the United States today, which aim to protect life and property from inherent and dangerous chemical risks associated with industrial facilities. Despite the implementation of regulations informed by the tragedy in India, accidents involving chemicals at industrial facilities still occur today in California, the United States, and elsewhere.

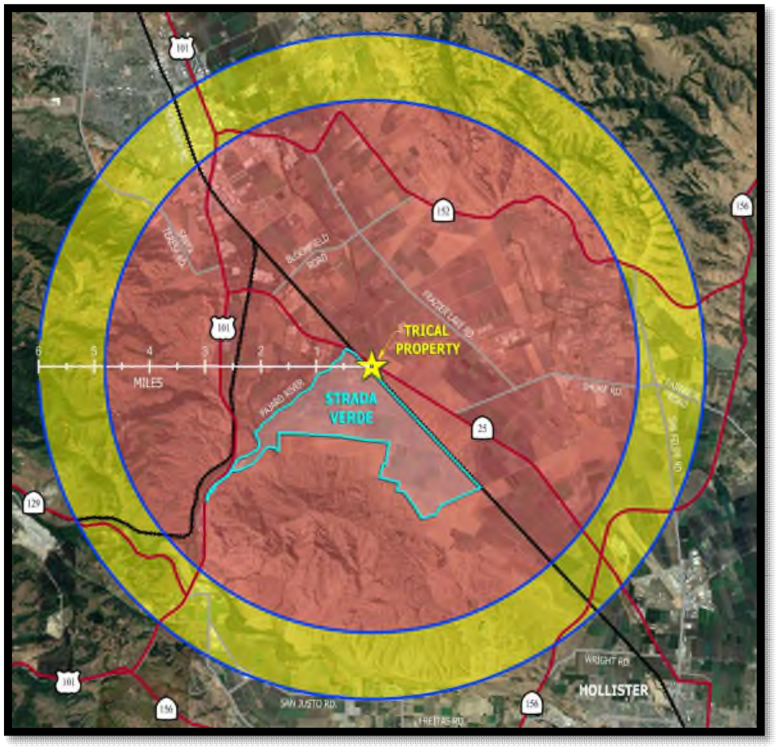


The red hazard zone in the map above covers areas subject to Level Three (AEGL-3) concentrations of chloropicrin—i.e., high danger areas with an immediate risk of life-threatening effects or death. The yellow hazard zone identifies Level Two (AEGL-2) danger areas presenting the risk of irreversible and serious negative health effects. This scenario shows that a Level Three hazard zone extends 3.5 miles in radius and that the Level Two hazard zone extends greater than 6 miles in radius from the Trical facility.[5]

Chloropicrin Railcar Release. The report also analyzes a scenario involving the rupture of a single railcar that releases 175,000 pounds of chloropicrin to form a liquid evaporating pool of 1,000 square meters.[6] Within 60 minutes, such a pool would evaporate into the atmosphere, dispersing high concentrations of chloropicrin gas around the surrounding area as shown below:

[5] Regardless of the models used, for making comparisons consistent, the hazard zones shown on the maps in this report are limited to a radius of six miles, which is approximately the maximum distance provided by the ALOHA model.

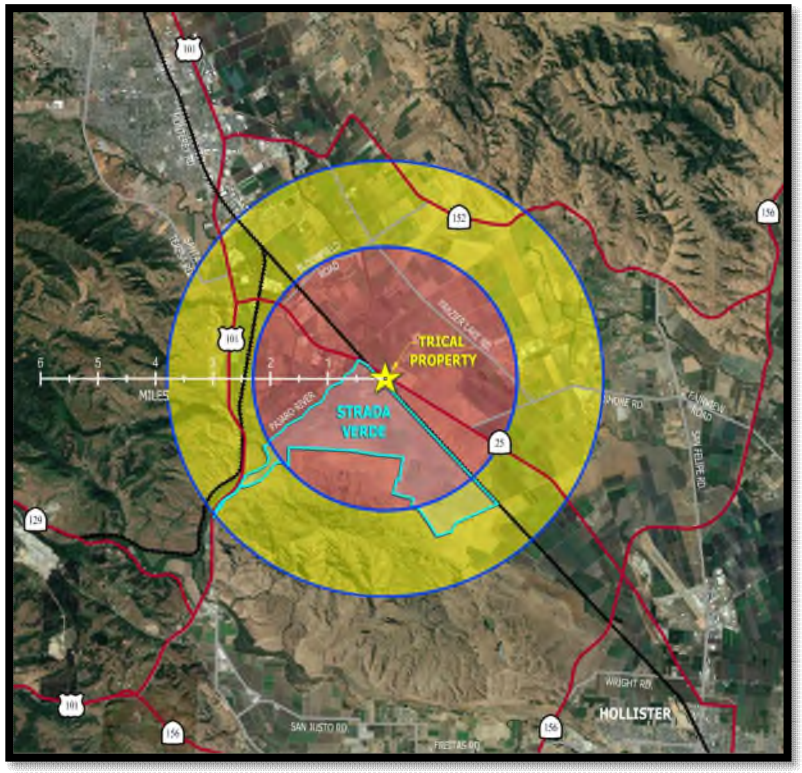
[6] During in-person site visits, multiple railcars containing chloropicrin were observed onsite, consistent with typical facility operations.



The scenario above shows that the Level Three hazard zone extends 4.8 miles in radius and that the Level Two hazard zone extends greater than 6 miles in radius from the Trical facility.

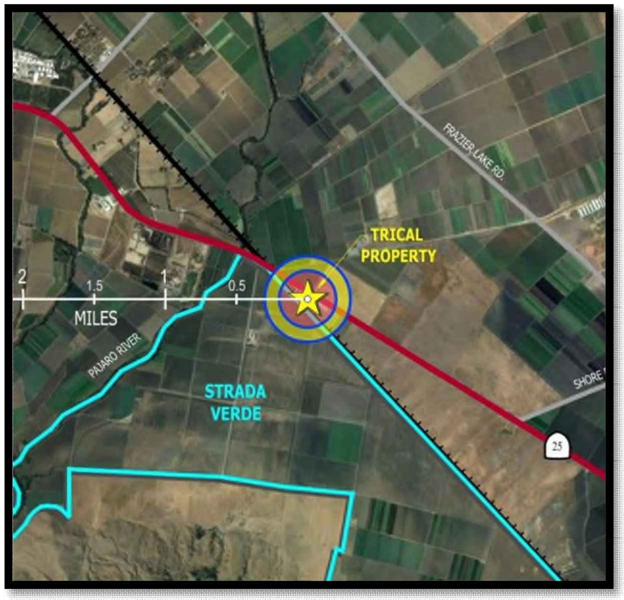
Methyl Bromide Railcar Release. Another scenario that was modeled involved the release of 175,000 pounds of methyl bromide from a single pressurized railcar.[7] The quantity of methyl bromide handled and stored by Trical has declined over time due to regulatory restrictions and concerns over the ozone-depleting effects associated with methyl bromide's use as a soil fumigant. For those reasons, Trical has transitioned to handling and storing greater quantities of chloropicrin and 1,3-DCP. However, Trical is still authorized to handle and store methyl bromide and continues to do so. Since methyl bromide is stored as a liquid under pressure in the railcar, and due to its relatively low boiling point, upon release it can quickly become a vapor which then disperses in the atmosphere under most ambient conditions. The following diagram depicts the spread or dispersion of methyl bromide after such a release:

[7] Trical itself has modeled this release scenario and submitted the results to San Benito County as part of its Risk Management Plan (RMP) obligations.

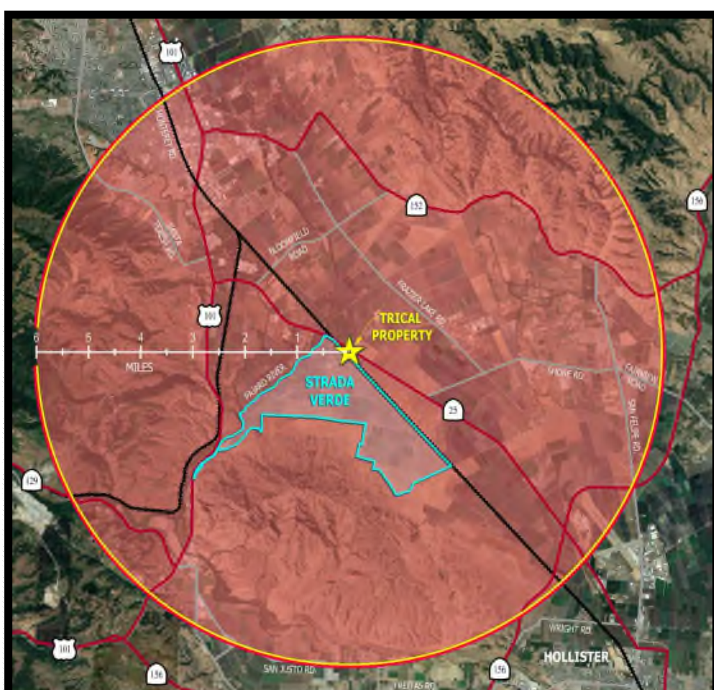


The scenario above shows that a Level Three hazard zone extends 2.3 miles in radius and that the Level Two hazard zone extends 3.8 miles in radius from Trical.

Fires and Explosions. As noted above, Trical stores 1,3-DCP in three vertical 32,000-gallon (326,400-pound) aboveground storage tanks and one horizontal 10,000-gallon (101,000-pound) aboveground tank. 1,3-DCP is a flammable liquid. A chemical spill or release could occur if any of the 1,3-DCP tanks is breached due to a number of potential causes, including a truck accident, terrorism, vandalism or material failure. Once discharged, 1,3-DCP could ignite and catch fire due to the presence of a number of potential ignition sources at Trical. Such a fire could then create a boiling liquid expanding vapor explosion (BLEVE), creating a zone with very high temperatures due to intense radiation from the fire and BLEVE. This radiation will then cause damage to additional tanks, resulting in cascading, compound failures. Alternatively, the discharge of 1,3-DCP could result in vapor concentrations that can exceed the Lower Explosive Limit for 1,3-DCP in air, causing a massive vapor cloud explosion (VCE) with resulting over-pressure waves. Both scenarios are evaluated in this report. Below is a diagram that shows the Level One and Level Two over-pressure endpoints associated with a VCE:



The Level Two hazard zone shown above in red would destroy most of the Trical facility. The high temperatures associated with the combustion of 1,3-DCP coupled with potential loss of containment of chloropicrin (which is stored immediately adjacent to 1,3-DCP), due to over-pressure or blast events, would also cause the degradation of chloropicrin to phosgene, a highly toxic chemical. This report has conservatively assumed that only 1% of the contents of one chloropicrin tank degrades to phosgene, resulting in a Level Three hazard zone extending beyond six miles, as depicted in the following diagram:



These examples and the other modeling results described in this report show that multiple and distinct reasonable worst-case scenarios would culminate in extremely dangerous and lethal levels of toxic chemicals and their by-products surrounding the Trical facility. Like most industrial facilities, Trical is required to have certain mitigation measures and the capability to address small spills of the chemicals it handles. However, a large unexpected chemical release would easily overwhelm Trical's mitigation and emergency response capabilities. This inability to handle large, unexpected release scenarios is not unique to Trical and there are numerous examples of even the most responsible industrial facilities easily becoming overwhelmed by large, unexpected chemical releases, fires and explosions.

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CONCLUSION

As noted above, Policy HS 6.9 of the County's General Plan requires that an appropriate buffer be established on a case-by-case basis for new sensitive land uses adjacent to industrial facilities that handle agricultural fumigants, such as the Trical facility. The purpose of the buffer is to protect human health and property from adverse consequences in the event of a large, unexpected chemical release.

The Trical facility is currently operating with a conditional use permit in an area zoned "Agricultural" in the County. If approved, the Strada Verde proposal would rezone approximately 2,777 acres of land immediately adjacent to Trical from Agricultural to a custom zoning district allowing a wide range of sensitive land uses including hotels, colleges, daycare facilities, event centers, medical facilities as well as automobile-related employment uses. If ultimately developed, the Strada Verde project would bring thousands of workers and hundreds of visitors on a daily basis in close proximity to Trical, which handles large quantities of many hazardous chemicals.

As set forth in Section 8 of this report (Table 8-1), multiple release scenarios could result in Level Three (serious, life-threatening health effects or death) hazard zones ranging from 2.3 miles to greater than 6 miles in radius from the Trical site. In addition, those same scenarios could result in Level Two (irreversible or other serious health effects) hazard zones ranging from 3.8 miles to more than 6 miles from the site. And prolonged exposures to Level Two chemical concentrations also could lead to even more serious adverse consequences consistent with Level Three impacts.

Thus, based on the findings of this report, the land uses that would be allowed if the Strada Verde proposal were approved should maintain a minimum buffer of 3.5 miles from the Trical facility. Any buffer zone less than 3.5 miles would place human life in jeopardy because multiple release scenarios result in unacceptably high concentrations of hazardous chemicals within 3.5 miles of the Trical site. Maps of a few scenarios illustrating this point are attached to this Executive Summary.

Below is a map showing that the Strada Verde project lies entirely within the 3.5-mile recommended minimum buffer zone. Given the findings of this report and degree of hazard at the Trical facility, the land uses that would be allowed under the Strada Verde proposal are not appropriate within this minimum buffer zone and should not be approved.

Below is a diagram showing the recommended 3.5-mile buffer zone and its relation to the Strada Verde project:

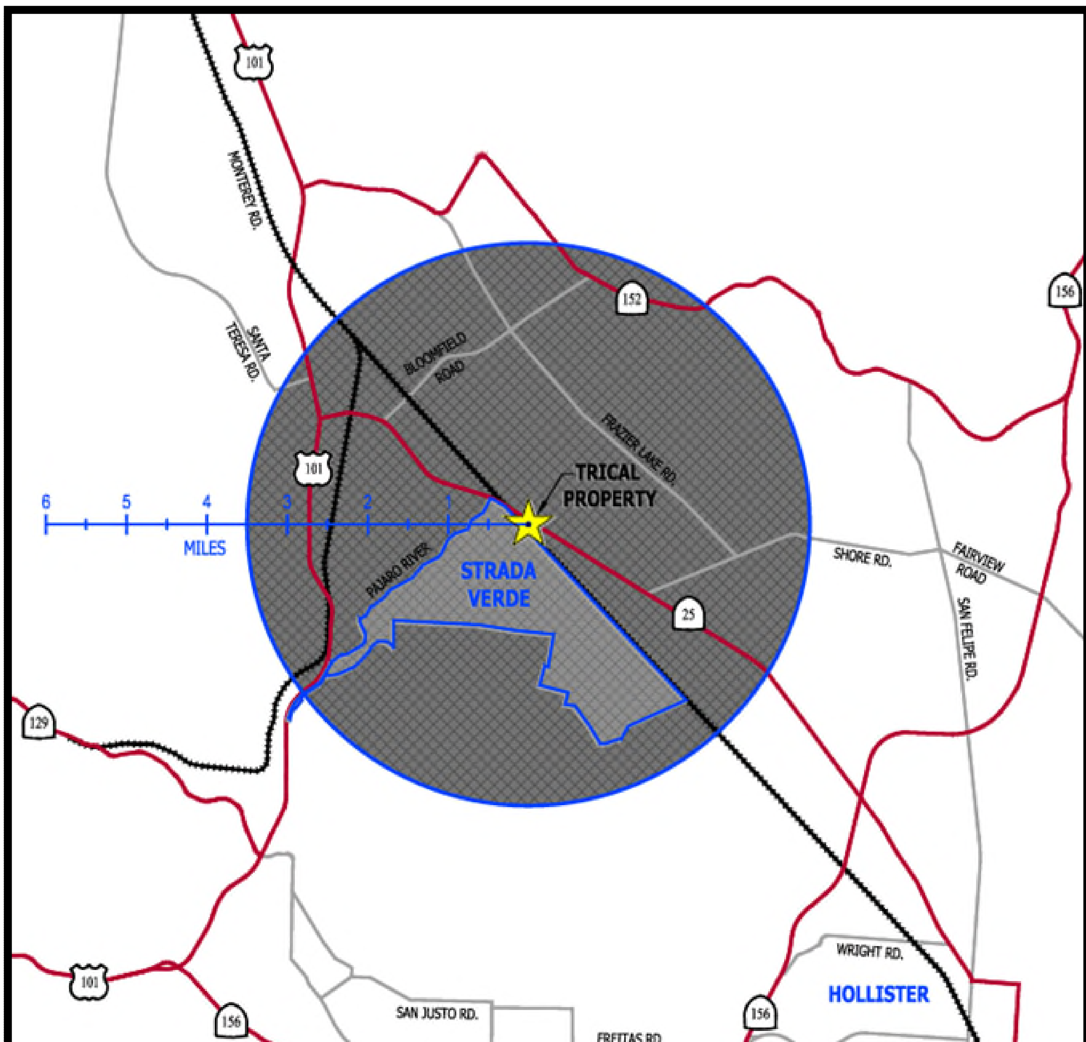

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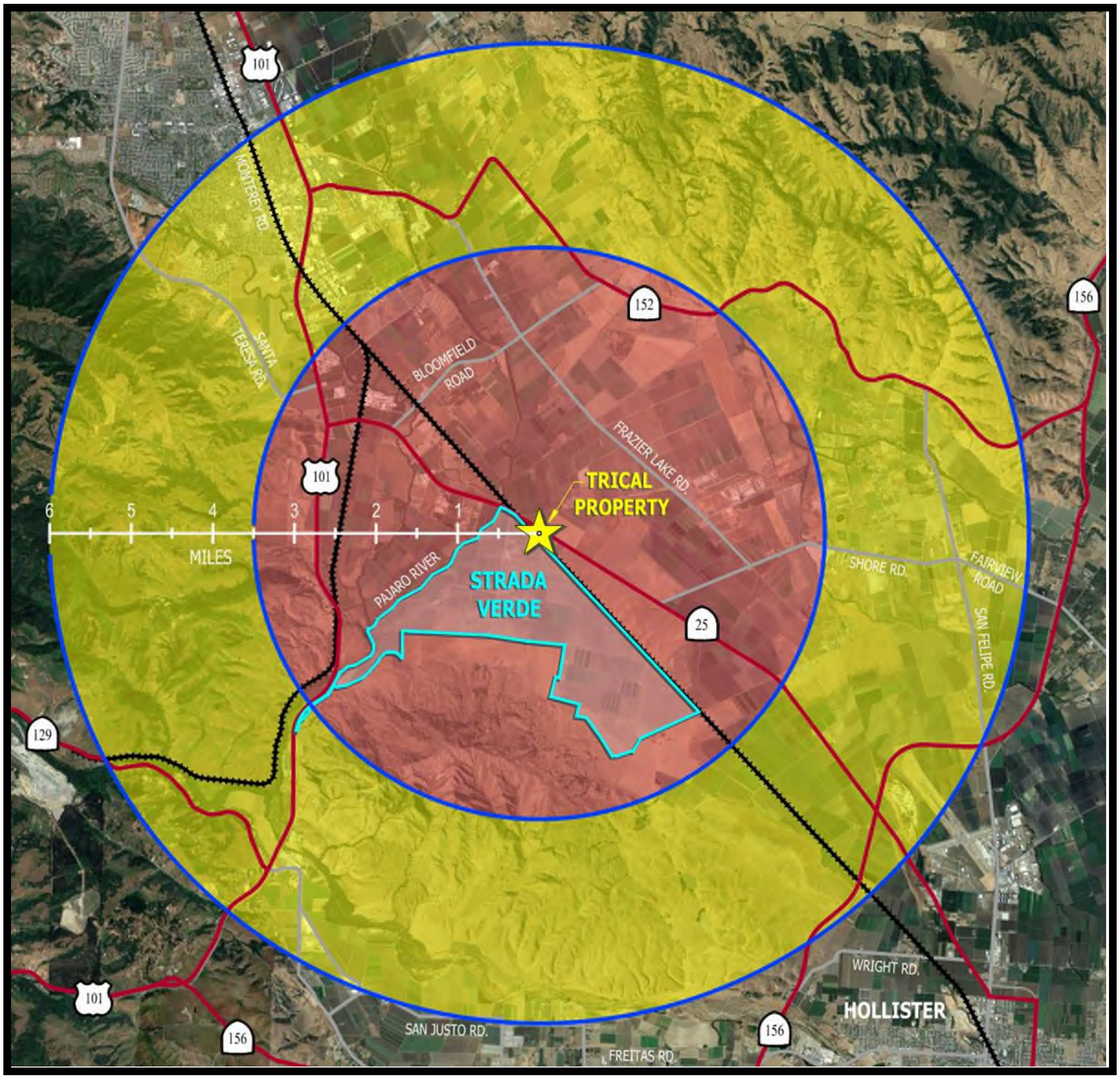
TABLE AND MAPS BELOW

The table below and the following maps show the results of six of the 15 release scenarios discussed in the report. The results and associated maps for all release scenarios analyzed are provided in Section 8 of this report. Appendix 5 is the Trinity Modeling Summary Report of Trinity Consultants, Inc., which was prepared by Dr. Qiguo Jing. That report describes in detail the parameters used and the modeling results (along with associated output files) for all scenarios.

Table ES-3. Description of Maps Showing Release Scenarios

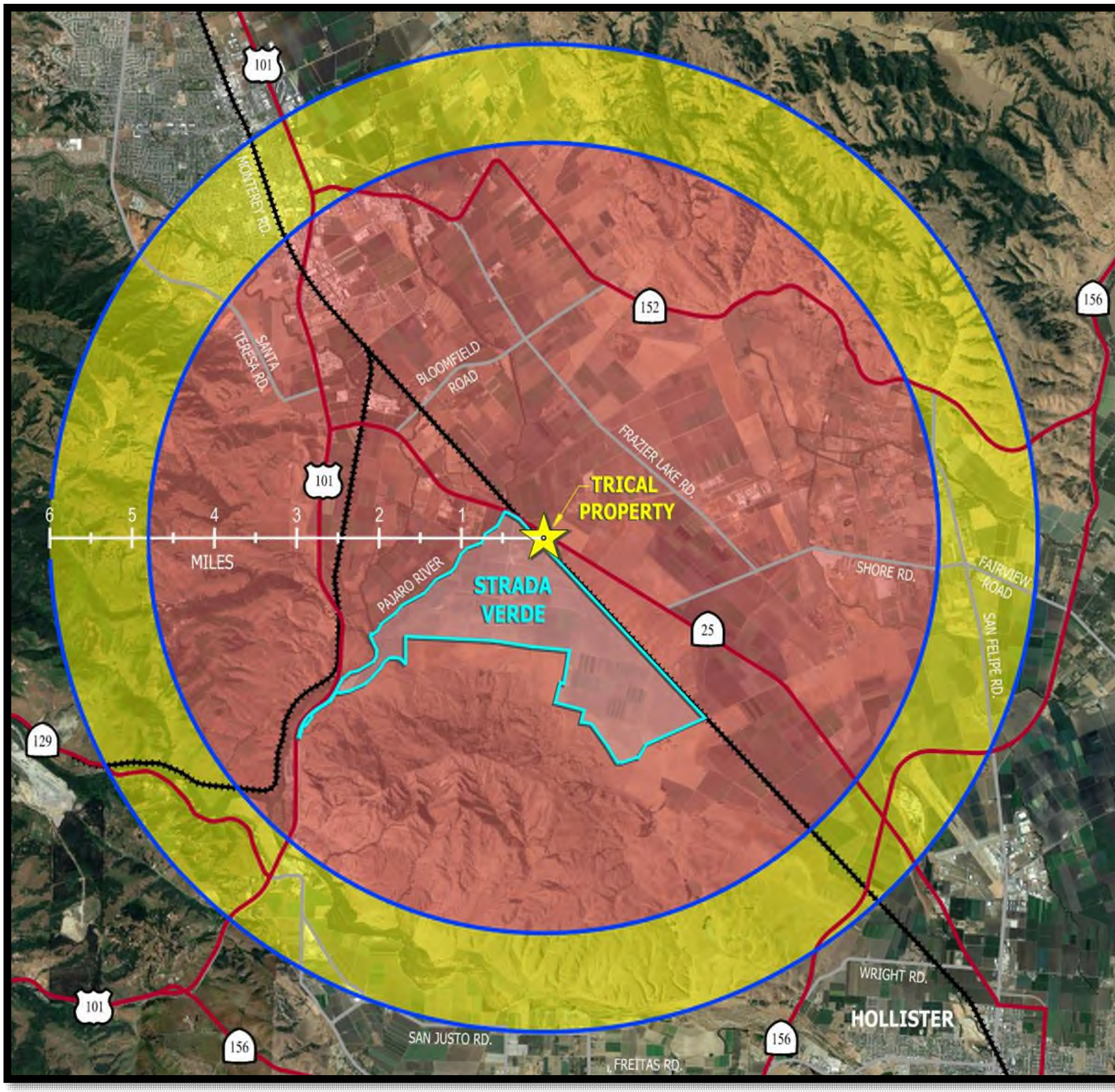
Scenarios	Maps	Descriptions	Models Used
Chloropicrin Tank Release	Map One	Sudden rupture of one horizontal storage tank (10,000 gallons) releasing chloropicrin to form a liquid evaporating pool (500 m^2.)	ALOHA, BREEZE INCIDENT ANALYST (BIA)
Chloropicrin Railcar Release	Map Two	Sudden rupture of one railcar (12,774 gallons) releasing chloropicrin to form a liquid evaporating pool (1,000 m^2)	ALOHA, BIA
Chloropicrin to Phosgene Degradation	Map Three	Phosgene, released by the degradation (1%) of chloropicrin due to adjacent fires	BREEZE AERSCREEN
1,3-DCP BLEVE	Map Four	Thermal radiation due to a 1,3-DCP BLEVE from one vertical storage tank (32,000 gallons)	ALOHA, BIA
1,3-DCP VCE	Map Five	Over-pressure wave due to a 1,3-DCP VCE from one vertical storage tank (32,000 gallons)	ALOHA, BIA
Methyl Bromide Railcar Release	Map Six	Sudden rupture of one railcar (175,000 pounds)	ALOHA, BIA

MAP ONE
Chloropicrin Tank Release: Evaporating Pool (500 m²)



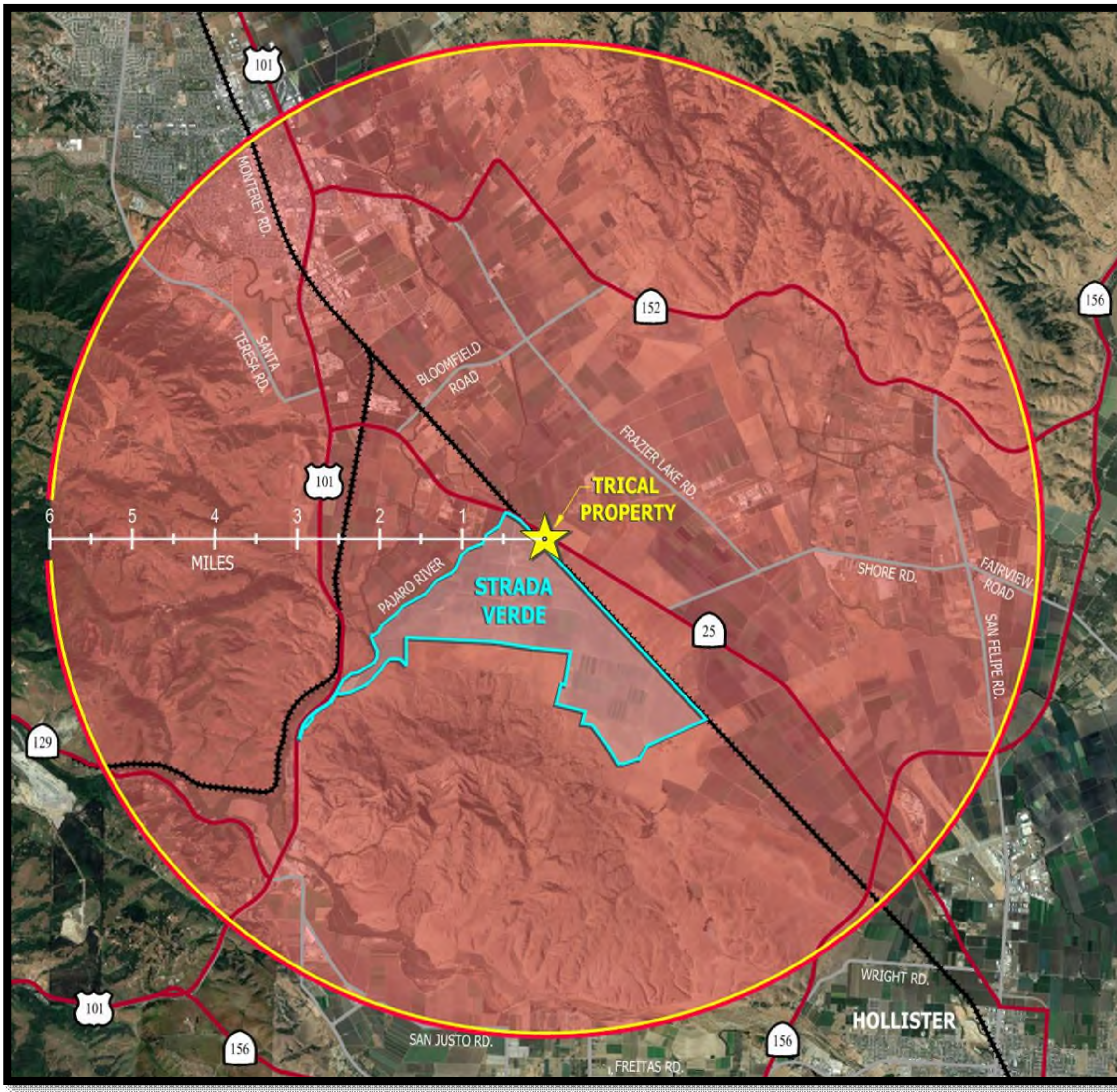
Level Two	(yellow)	Irreversible or other serious health effects that could impair the ability to take protective action	**Distance:** >6 miles
Level Three	(red)	Serious, life-threatening health effects or death	**Distance:** 3.5 miles

MAP TWO
Chloropicrin Railcar Release: Evaporating Pool (1,000 m^2)



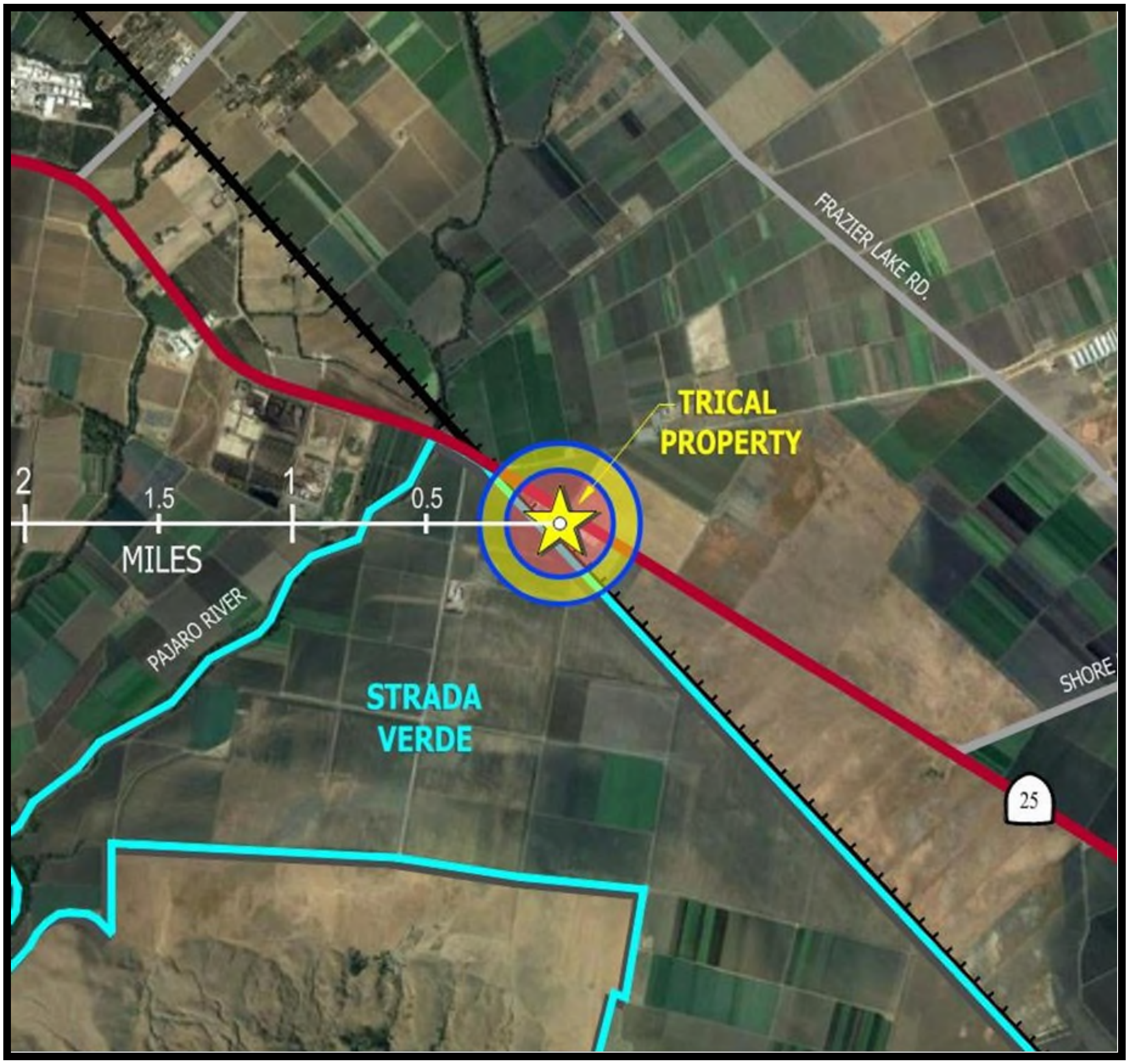
Level Two	(yellow)	Irreversible or other serious health effects that could impair the ability to take protective action	**Distance:** >6 miles
Level Three	(red)	Serious, life-threatening health effects or death	**Distance:** 4.8 miles

MAP THREE
Chloropicrin to Phosgene (1% Degradation)



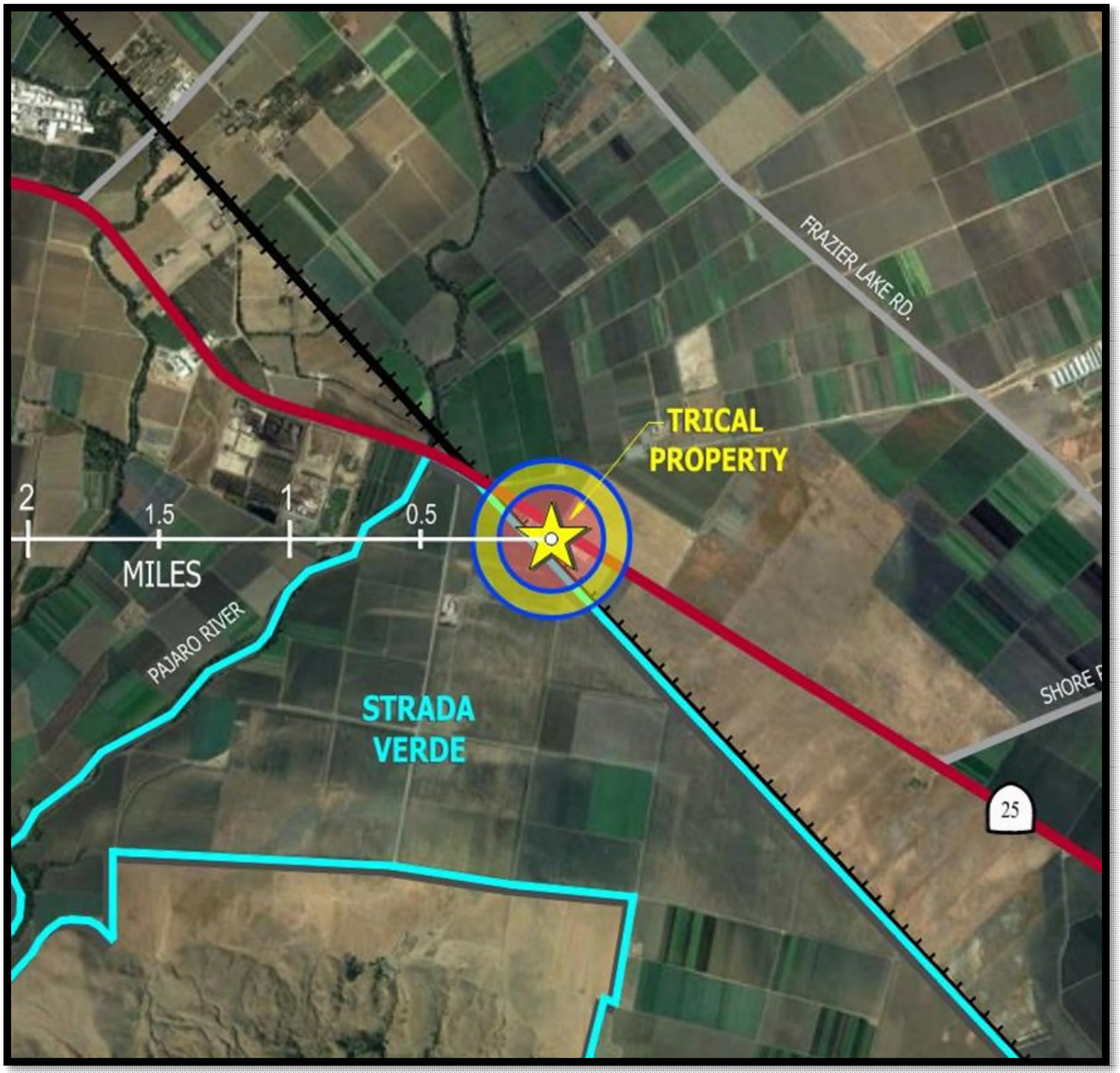
Level Two	(yellow)	Irreversible or other serious health effects that could impair the ability to take protective action	**Distance:** >6 miles
Level Three	(red)	Serious, life-threatening health effects or death	**Distance:** >6 miles

MAP FOUR
1,3-DCP: Fire and Thermal Radiation



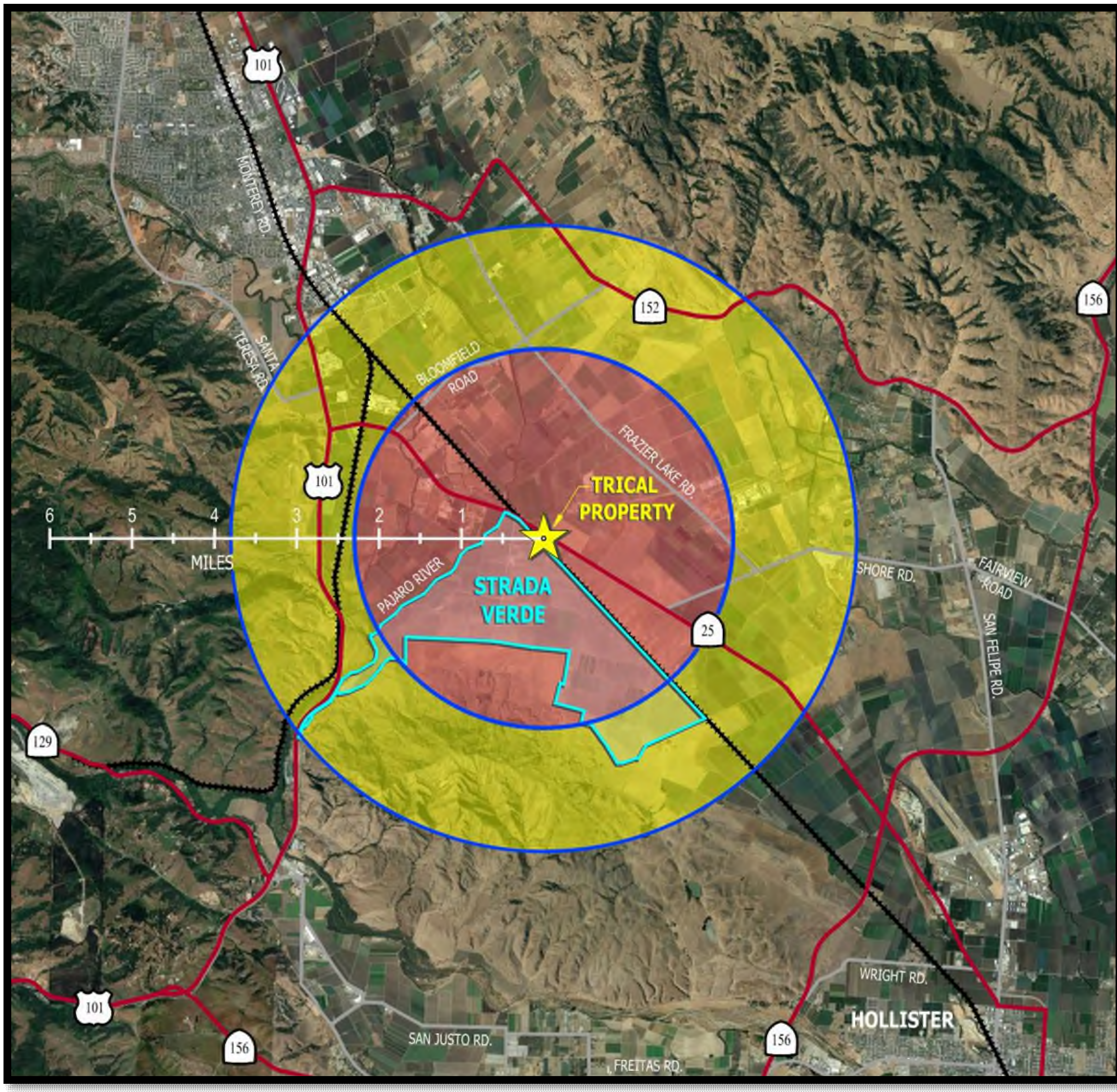
Level One	(yellow)	Second-degree burns within 60 seconds	**Distance:** 0.3 miles
Level Two	(red)	Lethal heat within 60 seconds	**Distance:** 0.2 miles

MAP FIVE
1,3-DCP: Explosion



Level One		Rupture of storage tanks, serious injuries	**Distance:** 0.3 miles
Level Two		Buildings destroyed, loaded railcars overturned, severe impairment or death	**Distance:** 0.2 miles

MAP SIX
Methyl Bromide: Single Railcar Release



Level Two		Irreversible or other serious health effects that could impair the ability to take protective action	**Distance:** 3.8 miles
Level Three		Serious, life-threatening health effects or death	**Distance:** 2.3 miles

1. Introduction

This report evaluates the potential offsite consequences associated with reasonable worst-case sudden and unexpected releases of certain agricultural soil fumigant chemicals located at the facility operated by Trical at 8770 Bolsa Road in San Benito County, California (hereafter Trical, facility or site). The facility's Conditional Use Permit (CUP) issued by San Benito County broadly allows Trical to package and formulate agricultural fumigants and to then distribute them.[8] This report only focuses on the three major soil fumigants handled at Trical, even though it is allowed by its CUP to handle any other federally or state-approved soil fumigants, which are all toxic and dangerous chemicals, now or in the future.

Fumigation is a pest-control method in which a pesticide gas or vapor is released into the air or injected, as liquid or gas, into the soil to kill or eliminate pests. Agricultural soil fumigants are injected into soil as liquids, becoming vapors which then move through the soil matrix, killing pests present in the soil.[9] Consistent with its CUP, the Trical facility is operated for the storage, formulation, packaging and distribution of agricultural soil fumigants, as well as for storage, cleaning, maintenance and fueling of equipment used to apply the fumigants to local and regional agricultural fields.

The primary fumigants handled at and distributed from the facility are individual chemicals and mixtures of chloropicrin, 1,3-DCP and methyl bromide. These raw material chemicals are received at the site in large quantities via railcars and tanker trucks and are then either stored in the railcars themselves or in aboveground storage tanks at the site prior to packaging and distribution.

1.1 Facility Description and Surrounding Area

The site on which Trical is located was constructed in the 1980s, with subsequent expansion of the facility since that time, leading to its present configuration. The facility is located in a generally rural area surrounded by agricultural lands. It is situated between Highway 25 immediately to its north and railroad tracks immediately to its south/southwest. The facility is located approximately four miles southeast of Gilroy, approximately 7.5 miles northwest of

[8] The CUP was originally issued in the 1970s to the Soils Chemical Corporation, a subsidiary of Trical.
[9] Centers for Disease Control and Prevention, Pesticide Exposures: Fumigants, https://ephtracking.cdc.gov/showpesticideFumigants.

Hollister, and 6.8 miles north-northeast of San Juan Bautista. Figure 1-1 below is an aerial photograph that shows the facility and the surrounding area.

Figure 1-1. Aerial Photograph of the Trical Site and Surrounding Area

The Trical site is approximately 17 acres, the majority of which is used for its industrial activities, with a smaller portion (to the northwest and southeast of the industrial areas) containing a stormwater detention pond and fire-water storage ponds, respectively. In addition to smaller structures, there are three buildings on the industrial site: an 8,000-square-foot office building, a 2,500-square-foot laboratory, and a 15,000-square-foot maintenance and storage shop. A diesel fueling station is located to the northwest of the maintenance building, and an exterior wash pad—and pond for wash pad overflow and rainwater collection—is located to the southeast of the maintenance shop. The northwestern portion of the site includes a 6,000-square-foot semi-open structure that houses fumigant-blending equipment and two operating filling stations. A large number of aboveground storage tanks are located on the site, and the facility also contains a large enclosed paint booth west of the diesel fueling station.

Trical uses the remaining portions of the site for material and equipment storage and parking. Adhesives are stored in drums mostly along the western edge of the facility. A caged area within the facility is used to store research or experimental chemicals used in field trials. Large rolls of plastic sheeting are stored east of the chemical aboveground storage tanks. Formulated fumigants are stored overnight (in containers ranging in size from tanker trucks to cylinders) prior to transport to customer locations each morning. A rail spur equipped with three unloading stations is located along the southern site boundary. The western-most of the three unloading stations is used exclusively for 1,3-DCP. The other two are used for chloropicrin. The eastern-most unloading station is used for methyl bromide, as needed. All unloading of railcars is conducted from the top using relatively small-diameter (one- or two-inch) hoses. Historical photographs show as many as 20 tanker cars on the spur at any one time.[10] More than 10 were observed during in-person site visits conducted in December 2019 and May 2020.[11] Chemicals are transferred from the railcars to aboveground storage tanks at the site from the top of the railcar via hoses. The general layout was confirmed during the site visits. A detailed site map provided by Trical with labeled site locations is below:

[10] In addition to conducting onsite inspections, the site size and layout were confirmed using Google Earth imagery; the facility's Risk Management Plan prepared by Trical and submitted to the County; and documents obtained electronically from the State Water Resources Control Board (SWRCB) Storm Water Multiple Application and Report Tracking System (SMARTS) database, including a site map (dated January 12, 2015) and the facility's Storm Water Pollution Prevention Plan (SWPPP, last revised May 2017). Historical photographs were obtained from Google Earth.

[11] *See* Appendix 3 (facility photographs).

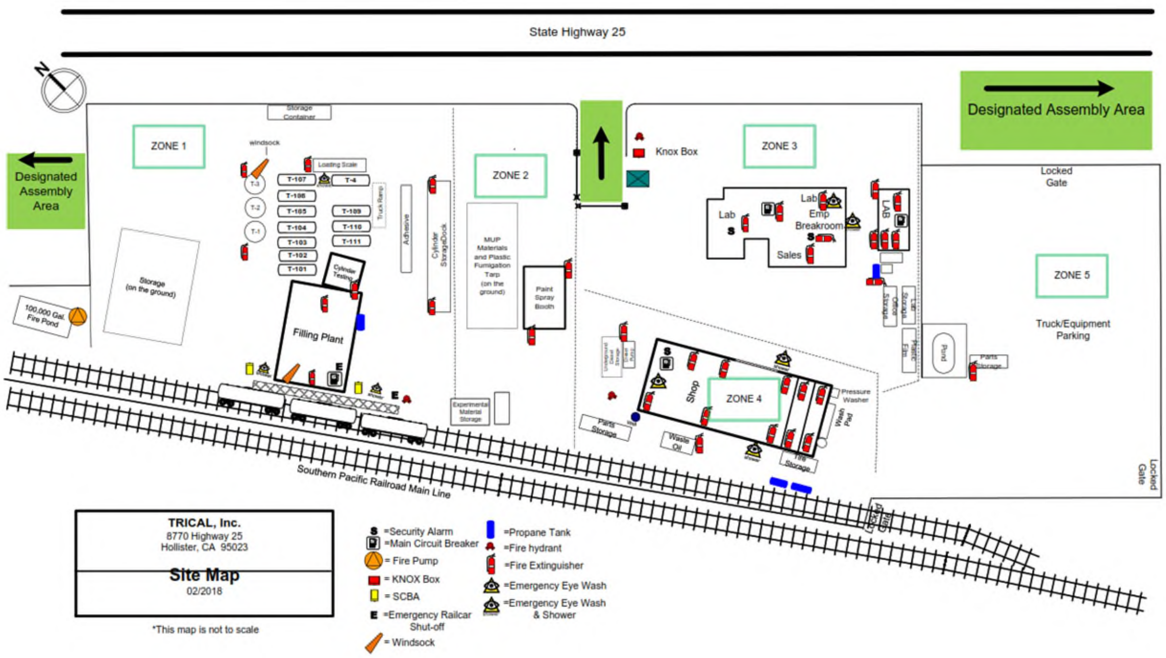


Figure 1-2. Trical Site Map

The primary site operations include: (i) the receipt of bulk chemicals via railcar (and tank trucks or cylinders, as needed); (ii) unloading and storage of bulk chemicals in aboveground storage tanks; (iii) fumigant formulation (i.e., blending); and (iv) packaging (i.e., filling of blended fumigants into smaller-sized containers including tank trucks and cylinders of various sizes). The three primary chemicals handled at the facility are chloropicrin, 1,3-DCP and methyl bromide. Delivered by railcars, chloropicrin and 1,3-DCP are stored in large bulk aboveground storage tanks (either 10,000 or 32,000 gallons in capacity) and smaller containers and cylinders. Methyl bromide is stored under pressure in railcars (up to 175,000 pounds) prior to unloading and blending. In addition, a large quantity of diesel fuel is stored onsite in a 10,000-gallon underground storage tank, along with adhesives and emulsifiers (in 55-gallon drums) and other chemicals including several propane tanks.[12]

Tank containment areas for the 1,3-DCP and chloropicrin aboveground storage tanks are located in Zone 1 of the site map (Figure 1-2) and depicted in Figure 1-3 below:

[12] Information related to site operations and chemical handling/storage was obtained from the facility's 2019 Hazardous Materials Business Plan; its SWPPP; and the facility's RMP.

Figure 1-3. Layout of Agricultural Fumigant Aboveground Storage Tank Containment Areas

Appendix 4 includes a detailed table showing the specifics of each aboveground storage tank and associated containment areas, including each containment area's identification number (created solely for the purposes of this report because there are no official designations of the containment areas), the number of tanks in each containment area (including their capacities in gallons), the total tank volume in each containment area, the approximate area of each containment area (rounded to the nearest square meter), and the approximate capacity/volume of each containment area (rounded to the nearest hundred gallons). There is no containment area per se at the unloading stations for the railcars or elsewhere on the site, including the parking areas, cylinder storage areas, etc.[13]

1.2 Agricultural Fumigants

The EPA identifies soil or agricultural fumigants as a subcategory of pesticides that, "when applied to soil, form a gas to control pests that live in the soil and can disrupt plant growth and crop production."[14] In recognition of the inherently dangerous characteristics of agricultural fumigants (i.e., that they are poisons, by design), the EPA approval and registration process includes, among other aspects, an evaluation of the effects of fumigants spreading in the air when used in the field.

Pursuant to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the EPA currently recognizes several registered soil fumigants nationally, including those used at the

[13] On May 15, 2020, Dr. Ron Sahu conducted a site inspection to confirm the site layout and facility operations.

[14] Information regarding EPA's regulation of soil fumigants was primarily obtained from https://www.epa.gov/soil-fumigants and related links.

Trical site: chloropicrin, 1,3-DCP and methyl bromide.[15] The others include dazomet, metam sodium/potassium, methyl isothiocyanate (MITC) and dimethyl sulfide. In addition, still other potential soil fumigants have been evaluated or considered for registration or regulatory approval by the EPA or other regulatory bodies.[16] Key FIFRA provisions include registration of pesticides, registration of pesticide-producing establishments, and labeling requirements.

In addition to the EPA, the California Department of Pesticide Regulation (DPR) regulates the use of soil fumigants in California, including the three major chemicals at Trical.[17] The DPR, like the EPA, evaluates and considers other potential soil fumigants that are not currently registered with the EPA (e.g., sulfuryl fluoride and sodium tetrathiocarbonate).[18]

In an effort to ensure chemical safety, FIFRA requires that the EPA reevaluate, and re-register pesticides initially registered prior to 1984. Re-registrations have been completed for 1,3-DCP in 2007, and in May 2009 for chloropicrin, dazomet, metam sodium/potassium, MITC and methyl bromide. The remaining soil fumigant, dimethyl disulfide, was not subject to re-registration because it was first registered in 2010. The EPA is currently conducting registration review for uses of fumigants other than for soil fumigation (e.g., structural fumigants), including aluminum phosphide, magnesium phosphide, phosphine, ethylene oxide, inorganic sulfites (sulfur dioxide and sodium metabisulfite) and propylene oxide.[19] Research has been conducted to evaluate whether some of these chemicals could be effective soil fumigants.

Based on information from the National Pesticide Information Retrieval System (NPIRS) database, Trical maintains active registrations for 19 pesticidal products, all of which have some combination of chloropicrin, 1,3-DCP and methyl bromide as the active ingredients. The database does not identify any current Trical products containing dazomet, metam sodium/potassium, MITC or dimethyl disulfide. The EPA's Pesticide Product and Label System database identifies 47 active and inactive pesticide product labels that have been registered with the EPA by Trical.

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[15] Methyl bromide was the most widely used soil fumigant worldwide until its use was restricted, not due to its toxicity but because of its adverse impacts on the earth's stratospheric ozone layer. For that reason, researchers have been evaluating potential replacements for methyl bromide, including chemicals more toxic than methyl bromide itself, but with the advantage that they do not adversely impact the earth's stratospheric ozone layer.

[16] EPA, Regulatory Status of Fumigants, https://www.epa.gov/soil-fumigants/regulatory-status-fumigants.

[17] California Department of Pesticide Regulation (DPR), *A Guide to Pesticide Regulation in California, 2017 Update*, https://www.cdpr.ca.gov/docs/pressrls/dprguide.htm.

[18] DPR, Human Health Risk Assessment and Mitigation by Active Ingredient, https://www.cdpr.ca.gov/docs/whs/active_ingredient/index.htm.

[19] EPA, Registration Review Schedule, https://www.epa.gov/pesticide-reevaluation/registration-review-schedules.

FIFRA allows for states to develop their own pesticide rules or regulations, and some states therefore regulate pesticides more stringently than FIFRA. For example, pesticides (including fumigants) used in California are overseen by the DPR as noted above. The DPR has implemented several rules related to soil fumigants that are more restrictive than federal laws and regulations.[20] Five of the six EPA-registered soil fumigants (chloropicrin, 1,3-DCP, dazomet, metam sodium/potassium, MITC and methyl bromide) are also identified as soil fumigants by the DPR,[21] and the DPR recognizes additional fumigants that are not currently registered or undergoing registration review with the EPA (e.g., sulfuryl fluoride and sodium tetrathiocarbonate).[22]

Although new or different agricultural fumigants may be handled at the facility and Trical itself keeps small quantities of experimental or research chemicals at the site, this report limits its analysis to chloropicrin, 1,3-DCP and methyl bromide as well as two related compounds: (i) phosgene, which is formed from the degradation of chloropicrin as a result of high temperatures such as those due to a fire; and (ii) hydrogen chloride (HCl), which is formed from the combustion of 1,3-DCP in the event of a fire.

1.3 The Strada Verde Project

The proposed Strada Verde project is a mixed-use development project proposing more than 6.4 million square feet of commercial space comprised of an automotive research and testing facility, a 20-acre town center, retail shops, office space, hotels, a museum and other uses that are designed to draw a significant number of people to the area, including 5,500 employees. The proposed project would be developed on a 2,777-acre site on the County's northwestern boundary, southeast of the Pajaro River and southwest of Highway 25 and the Union Pacific rail line.

The Strada Verde Innovation Park Voter Initiative of May 2020 indicates that a variety of additional land uses would be permitted "by right" if the project is approved, including:

Farmer's market or a neighborhood center
College or other learning centers
Religious or charitable institutions
Spas
Outpatient or urgent care medical clinics
Public event venues
Wedding venues
Children's daycare facility

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[20] Information regarding California DPR's regulation of soil fumigants was primarily from *A Guide to Pesticide Regulation in California, 2017 Update*, https://www.cdpr.ca.gov/docs/pressrls/dprguide.htm.
[21] Dimethyl disulfide is not a registered fumigant in California.
[22] DPR, Human Health Risk Assessment and Mitigation by Active Ingredient, https://www.cdpr.ca.gov/docs/whs/active_ingredient/index.htm.

2. Regulatory Background on Releases of Hazardous Chemicals

2.1 Overview

Thirty-five years ago, an incident involving the release of approximately 40 tons (80,000 pounds) of toxic gases, primarily methyl isocyanate, from a Union Carbide pesticide plant located in Bhopal, India resulted in the immediate and subsequent deaths of thousands of people living near the facility. That horrific accident gave rise to the industrial chemical safety statutory and regulatory programs that currently exist in the United States, which aim to protect life and property from inherent and dangerous chemical risks associated with industrial facilities. Despite the implementation of regulations informed by the tragedy in India, accidents involving chemicals at industrial facilities still occur today in California, the United States and elsewhere.

The current regulatory framework and industry practices designed to reduce the risk of industrial accidents include facility design mitigation principles, inventory management, chemical handling requirements, employee training, first responder interactions and community involvement via right-to-know requirements.

Federal law gives the EPA, the U.S. Department of Transportation (DOT), and the U.S. Occupational Health and Safety Administration (OSHA) authority to implement regulations to reduce the likelihood and severity of the consequences of chemical releases. For example, those laws or regulations include the public right-to-know aspects of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA), and the Accidental Release Prevention requirements under Section 112(r) of the Clean Air Act (CAA), as amended in 1990. Many states also have adopted health and safety programs consistent with federal law.[23] This regulatory scheme generally reflects the current health and safety rules used in the United States for addressing the entire safety continuum of chemical accident prevention preparedness and response. This section briefly describes how some of these regulations apply to and are implemented at Trical.

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[23] *See, e.g.*, Health & Safety Code §§ 25500-25547.8 [Hazardous Materials Release Response Plans and Inventory]; California Code of Regulations [CCR] Title 19, §§ 2735.1-2785.1.

2.2 Emergency Planning and Community Right-to-Know Act

EPCRA was passed by Congress in 1986. It has two major goals: (i) improve emergency planning at the local level, where emergency responses first occur; and (ii) improve information to the public about hazardous chemicals in the community. EPCRA focuses on understanding hazards and planning for emergencies to ensure that when an accidental release occurs, the local responders will be able to take quick, effective actions to protect public health and the environment. In addition, facilities subject to EPCRA must report annually the amounts of each chemical released to the environment. The information submitted by facilities is compiled in the Toxics Release Inventory (TRI).

2.2.1 Trical Toxics Release Inventory Reporting

Trical reports to the TRI as a result of its processing of the following listed toxic chemicals: chloropicrin, 1,3-DCP and methyl bromide. The most recent TRI Form R filing information available through the EPA's EnviroFacts database was from the 2018 reporting year, during which the facility reported releases to air of 2,533 pounds of chloropicrin, 542 pounds of 1,3-DCP and 11 to 499 pounds of methyl bromide.

2.2.2 Hazardous Materials Business Plan Program

The Hazardous Materials Business Plan (HMBP) program was established in California in 1986 as a result of the Bhopal, India accident. Its purpose is to prevent or minimize the damage to public health and safety and the environment from a release or threatened release of hazardous materials.[24] It also satisfies federal community right-to-know laws, such as EPCRA. This is accomplished by requiring businesses that handle hazardous materials to:

- Inventory their hazardous materials;
- Develop a site map;
- Establish an emergency plan; and
- Implement a training program for employees.[25]

Businesses must submit this information electronically to the statewide information management system (California Environmental Reporting System) and to the local Certified Unified Program Agency (CUPA).[26]

[24] Health & Safety Code § 25500.
[25] Health & Safety Code § 25505.
[26] Health & Safety Code § 25508.

Trical stores hazardous materials in excess of the applicable HMBP thresholds and thus is required to submit an HMBP to the local CUPA each year, which is the San Benito County Health Department.[27] Trical's most recent HMBP chemical inventory submittal included many different hazardous materials including the three major chemicals that are the subject of this report.

2.2.3 Risk Management Programs (RMPs)

In 1986, again driven by the Bhopal incident, the EPA began a program to work with industry and others to identify ways to improve chemical handling safety practices. Congress, in 1990, included requirements in its amendments to the Clean Air Act (CAA) to address the dangers of hazardous chemical releases to the air. The regulations implementing CAA section 112(r) (40 C.F.R. part 68) require covered facilities to develop and implement a Risk Management Program (RMP) that includes analyses of offsite consequences resulting from standardized chemical releases to the air, a five-year accident history review, a prevention program and an emergency response program, among other requirements. Similar to the federal RMP program, facilities in California can be subject to California's Accidental Release Prevention (CalARP) program, which may require preparation of an RMP.[28] Trical has submitted to the County an RMP for the facility, which includes an offsite consequences analysis for methyl bromide only.

The offsite consequences analysis in Trical's RMP evaluates two release scenarios based on a single system failure. One scenario assumes the release of methyl bromide from a railcar. Under that scenario, the RMP concluded that the toxic endpoint concentration (i.e., 25 parts per million [ppm] methyl bromide in the air) extended beyond six miles from the facility, and noted that within that radius there were a number of sensitive receptors including "commercial and industrial facilities, schools, daycares, and the Hollister and Frazier lake airports." Trical's RMP did not specify the more dangerous toxicity thresholds (e.g., corresponding to AEGL 3 [740 ppm] or AEGL 2 [210 ppm]) or their endpoint distances which occur closer to the Trical facility.

The purpose of this analysis, as distinct from a CalARP or RMP analysis, is to aid land use decisions within the County. Therefore, the analysis presented in this report is broader than what would be required by an RMP. For example, the Trical RMP that was reviewed in preparation of this report only analyzed releases of methyl bromide; it apparently was not required to analyze (as a result of how the RMP is triggered) and did not analyze chloropicrin or 1,3-DCP or any other chemical.

[27] California Environmental Reporting System, Unified Program Regulator Directory: San Benito County Health Department, http://cersapps.calepa.ca.gov/Public/Directory/RegulatorDetails/1052.

[28] California Code of Regulations [CCR] Title 19, §§ 2735.1 to 2785.1.

3. Chemical Incidents Overview

Chemical incidents involve releases and subsequent fires or explosions, and can occur as a result of natural, intentional or unintentional events. Chemical incidents caused by natural events (e.g., due to extreme weather)[29] are becoming increasingly common and are exacerbated by climate change.[30] Chemical incidents caused by intentional events, such as terrorism and other criminal acts, are less common,[31] but the probability of acts of ecoterrorism has been increasing due to environmental concerns. Unintentional events, such as human error or equipment or process failures, are by far the most common causes of chemical incidents. Some examples of chemical incidents caused by unintentional events are described below. Appendix 8 provides additional examples. Information on chemical incidents presented in this report is based primarily on official reports published by the U.S. Chemical Safety and Hazard Investigation Board (CSB) and the National Transportation Safety Board (NTSB), which are independent agencies charged with investigating non-transportation and transportation-related incidents, respectively.

As described earlier, a 1984 incident at a large pesticide manufacturing facility in Bhopal, India resulted in around 40 tons of highly toxic gases, including methyl isocyanate, being released into surrounding communities.[32] The release was caused by human error and multiple

[29] U.S. Chemical Safety and Hazard Investigation Board (CSB), *Arkema Inc. Chemical Plant Final Investigation Report* (May 2018), https://www.csb.gov/file.aspx?DocumentId=6068 (federal investigators explaining that hurricane flooding disabled refrigeration systems designed to keep organic peroxide products from decomposing resulting in the generation of toxic vapors that injured several individuals and caused hundreds of others to evacuate their homes).

[30] *See* World Health Organization, *Chemical Releases Caused by Natural Hazard Events and Disasters*, 1, 2, 11 (2018), https://apps.who.int/iris/rest/bitstreams/1135962/retrieve.

[31] Bureau of Alcohol, Tobacco, Firearms, and Explosives, *ATF Announces $50,000 Reward in West, Texas Fatality Fire* (May 11, 2016), https://www.atf.gov/news/pr/atf-announces-50000-reward-west-texas-fatality-fire (explaining that the fire that caused an explosion killing 15 and injuring hundreds at a fertilizer blending and distribution facility was deliberately set); CSB, *West Fertilizer Final Investigation Report* (Jan. 2016), https://www.csb.gov/file.aspx?DocumentId=5983.

[32] *See* Edward Broughton, U.S. National Library of Medicine National Institutes of Health, *The Bhopal Disaster and Its Aftermath: A Review* (May 10, 2005), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1142333/.

equipment and process failures that allowed water to mix with a highly reactive pesticide intermediate compound. The resulting reaction over-pressurized a holding tank, causing it to release large amounts of the toxic gases in a short amount of time. More than half a million people were exposed to the gases, which caused burning, nausea and death. At least 3,000 people were killed immediately, and an estimated 15,000 to 20,000 were killed over the next 20 years as a result of their exposure.[33] Many others who were exposed to the gas gave birth to physically and mentally disabled children.[34]

While the Bhopal incident devastated the local community, it served as a catalyst for the chemical industry, government and other stakeholders worldwide to develop and adopt stronger and improved chemical process safety standards and practices. Despite these improvements, chemical incidents continue to occur throughout the United States, given the inherently dangerous properties of many chemicals. Several incidents have occurred in California in recent years, in spite of its strict regulatory oversight requirements. A few examples follow.

In 2012, a petroleum refinery in Richmond, California experienced a catastrophic pipe failure that resulted in the release of flammable chemicals.[35] The chemicals ignited, causing a large vapor plume and associated toxic particulate matter to disperse through surrounding communities. Six employees were injured, and approximately 15,000 people sought medical treatment as a result of their exposure.[36]

In 2015, hydrocarbon processing equipment at a Torrance, California refinery failed, causing an explosion that resulted in two fires and multiple chemical releases.[37] A large amount of shrapnel and debris from the explosion impacted a building frequently used by operators and landed within feet of two tanks containing highly toxic chemicals. Federal investigators indicated that the incident could have been even more devastating if the debris had struck the tanks—characterizing the incident as a "near miss event" that could have resulted in the release of highly corrosive hydrofluoric acid.[38]

In addition to chemical incidents occurring at industrial facilities, chemical incidents involving railroad tank cars and highway cargo tanks also pose significant threats to employees and communities. Such incidents often occur as a result of unintentional events occurring during transfer operations at industrial facilities, such as when operators inadvertently mix

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[33] *See* Broughton, *The Bhopal Disaster and Its Aftermath: A Review*.
[34] *See* Broughton, *The Bhopal Disaster and Its Aftermath: A Review*.
[35] CSB, *Chevron Richmond Final Investigation Report*, at 1 (Jan. 2015), https://www.csb.gov/file.aspx?DocumentId=5917.
[36] CSB, *Chevron Richmond Final Investigation Report*, at 1-2.
[37] CSB, *ExxonMobil Torrance Final Investigation Report*, at 6 (May 2017), https://www.csb.gov/file.aspx?DocumentId=6023.
[38] *See* CSB, *ExxonMobil Torrance Final Investigation Report*, at 6-7.

incompatible chemicals or when poorly maintained transfer equipment fails. For example, in 2016, in Atchison, Kansas, a chemical release occurred at a processing facility when an operator inadvertently connected a highway cargo tank carrying various chemicals to a fixed storage tank containing incompatible chemicals.[39] The chemicals mixed, resulting in a toxic gas plume that escaped into the neighboring community. A shelter-in-place was ordered for thousands of residents and over 140 people sought medical attention.[40]

Similarly, in 2016, in Natrium, West Virginia, a railroad tank car cracked after being loaded with nearly 180,000 pounds of a liquified compressed toxic gas (chlorine).[41] The gas released, causing a large vapor cloud to migrate over adjacent communities. Eight employees were treated for chlorine exposure injuries.[42]

In 2005, in Graniteville, South Carolina, a freight train was improperly diverted from the main line onto an industrial facility's track.[43] The train struck a stationary train with tank cars containing toxic gases. One of the tank cars failed, releasing chlorine gas. Nine people died due to chlorine gas inhalation, and approximately 554 others were taken to area hospitals due to respiratory difficulties. Additionally, more than 5,000 people living near the derailment site were evacuated for several days.[44]

In addition to the past incidents investigated by the CSB, there have been a number of recent chemical incidents in Texas, home to many chemical facilities, for which CSB investigations are ongoing and reports are not yet available. For example, in January 2020, an explosion and fire at the Watson Grinding and Manufacturing Facility in Houston, Texas, killed two people and damaged approximately 200 nearby homes and businesses.[45] In November 2019, an explosion and fire occurred at the TPC Group facility in Port Neches, Texas, which caused

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[39] CSB, *MGPI Processing, Inc. Case Study*, at 5 (Dec. 2017), https://www.csb.gov/file.aspx?DocumentId=6047.

[40] CSB, *MGPI Processing, Inc. Case Study*, at 5.

[41] NTSB, *Rupture of a DOT-105 Rail Tank Car and Subsequent Chlorine Release at Axiall Corporation New Martinsville, West Virginia*, at v (Feb. 2019), https://www.ntsb.gov/investigations/AccidentReports/Reports/HZM1901.pdf.

[42] NTSB, *Rupture of a DOT-105 Rail Tank Car and Subsequent Chlorine Release at Axiall Corporation New Martinsville, West Virginia*, at 4.

[43] NTSB, *Collision of Norfolk Southern Freight Train 192 With Standing Norfolk Southern Local Train P22 With Subsequent Hazardous Materials Release at Graniteville, South Carolina*, at 1 (Nov. 2005), https://www.ntsb.gov/investigations/AccidentReports/Reports/RAR0504.pdf.

[44] NTSB, *Collision of Norfolk Southern Freight Train 192 With Standing Norfolk Southern Local Train P22 With Subsequent Hazardous Materials Release at Graniteville, South Carolina*, at v.

[45] CSB, *Watson Grinding Fatal Explosion and Fire*, https://www.csb.gov/watson-grinding-fatal-explosion-and-fire-/; *see* City of Houston, Public Safety and Homeland Security Committee, Watson Grinding & Manufacturing Incident (Feb. 5, 2020), https://www.houstontx.gov/council/committees/pshs/20200205/Emergency-Response-Watson.pdf#search=watson%20grinding.

several injuries and required more than 60,000 nearby residents to evacuate.[46] In October 2019, a chemical release at an Aghorn Energy pump house in Odessa, Texas killed two people.[47]

Appendix 8 contains additional details of numerous chemical incidents.

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[46] CSB, *TPC Group Explosion and Fire*, https://www.csb.gov/tpc-group-explosion-and-fire/; *see* Jefferson County, Texas, Mandatory Evacuation Order (Nov. 27, 2019), https://co.jefferson.tx.us/documents/TPC%20Incident%20Docs/evac%20order%20pdf.pdf.

[47] CSB, *Aghorn Energy Fatal Chemical Release*, https://www.csb.gov/aghorn-energy-fatal-chemical-release-/.

4.
Overview of Subject Chemicals

This section describes the primary chemicals of concern that are the focus of this report. They include the three chemicals that are stored in significant quantities at Trical: chloropicrin, 1,3-DCP and methyl bromide. Additional chemicals can be created as a result of fires and combustion. Phosgene is a highly toxic chemical that is created by the degradation of chloropicrin, and hydrogen chloride (HCl), a corrosive acid, is created as a result of the combustion of 1,3-DCP. Accordingly, all five of these chemicals (the three stored at Trical and the two that can be created from these chemicals) are discussed below. Although these chemicals may have adverse toxicological effects from multiple exposure pathways (e.g., inhalation, ingestion and dermal exposure), this report focuses on the health effects caused by inhalation exposures.

4.1 Chloropicrin

Chloropicrin is a fumigant with a wide variety of uses, particularly as an antimicrobial, fungicide, herbicide, insecticide and nemacide.[48] It also has been used as a chemical-warfare agent (e.g., in World War I) and as a riot-control agent (i.e., tear gas). Chloropicrin is a colorless to faintly yellow oily liquid. Because it causes eye irritation at concentrations as low as 1 ppm, it may be used as a warning agent to be mixed with other soil fumigants to alert individuals to potential fumigant exposure. Chloropicrin reacts explosively when heated above 112 °C.

Inhalation exposure to chloropicrin can result in severe irritation to the respiratory tract and gastrointestinal tract, including coughing, choking, shortness of breath, chest tightness, pulmonary edema, nausea, vomiting, headache, dizziness, orthostatic hypotension, anxiety, lethargy, fatigue and cyanosis. Severe exposure can result in profound inflammation of the lower respiratory tract with potentially fatal pulmonary edema. Chloropicrin degrades to phosgene and nitrosyl chloride upon heating at its boiling temperature of approximately 112 °C.[49]

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48 CDC, NIOSH, *Chloropicrin*, https://www.cdc.gov/niosh/idlh/76062.html; CDC, The National Institute for Occupational Safety and Health (NIOSH), Chloropicrin (PS): Lung Damaging Agent, https://www.cdc.gov/niosh/ershdb/emergencyresponsecard_29750034.html.

49 J.C. Lizardo-Huerta, et al. Combustion and Pyrolysis Kinetics of Chloropicrin. J. Phys. Chem. A 2018, 122 5735-5741.

4.2 1,3-DCP

1,3-DCP is used as a component in formulations for soil fumigants in food and non-food crops, particularly for pre-planting control of parasitic nematodes. It is a colorless to straw-colored liquid that dissolves in water and evaporates readily. It has a sweet, chloroform-like odor, with an odor threshold of 1 ppm. 1,3-DCP is corrosive, combustible and flammable (with a flash point of approximately 95 °F). Acute inhalation exposure to 1,3-DCP can result in respiratory irritation, coughing, chest pain and breathing difficulties. More severe effects on the lungs include emphysema and edema, which have been observed in rats acutely exposed to 1,3-DCP by inhalation. In humans exposed to 1,3-DCP vapors from accidents or spills, the most common symptoms observed included headaches, irritation of mucous membranes, dizziness, chest discomfort, breathing difficulties and unconsciousness. When burned, 1,3-DCP produces the acid gas HCl as one of its by-products. HCl is discussed further below.

4.3 Methyl Bromide

Methyl bromide is a toxic gas used to control a wide variety of pests in agriculture and shipping.[50] It is usually shipped and applied as a pressurized liquid. Generally speaking, it is colorless and odorless (although it has a sweet, chloroform-like odor at high concentrations, typically greater than 1,000 ppm). Because methyl bromide lacks adequate warning properties to alert individuals to the presence of a toxic compound in the air, it is often combined with up to 2% chloropicrin (a lacrimatory, i.e., tear-inducing, agent) when used as a fumigant.[51] Hazardous decomposition products of methyl bromide produced during a fire include oxides of carbon, acid halides and halides.[52] Inhalation exposure to methyl bromide can result in negative respiratory, neurotoxic and developmental effects demonstrated through several sub-chronic and chronic toxicity studies.[53] Methyl bromide gas can cause cellular disruption, primarily in the central nervous system, which can result in nausea, vomiting and dizziness. At higher concentrations it can also cause more severe effects such as trembling of extremities, brain damage, convulsions, coma and long-term neuromuscular effects. These neurologic symptoms may not develop for several days or weeks after exposure. The most common non-neurologic effects of acute methyl bromide inhalation are respiratory irritation due to

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[50] Methyl bromide depletes the earth's stratospheric ozone layer when it is released into the atmosphere and allows increased ultraviolet radiation to reach the earth's surface. It is classified as a Class I ozone-depleting substance. Therefore, the use of methyl bromide has been restricted in the United States, but those restrictions do not apply to critical uses, quarantine and pre-shipment uses and in other situations. Despite the restrictions and phaseout efforts, methyl bromide continues to be used in the United States, including at Trical.

[51] Agency for Toxic Substances & Disease Registry (ATSDR), Medical Management Guidelines for Methyl Bromide, https://www.atsdr.cdc.gov/MMG/MMG.asp?id=818&tid=160.

[52] Med-Tech, *Methyl Bromide MSDS Sheet*, http://www.medtechgases.com/images/MSDS/SPECIALTY/methyl-bromide-msds.pdf.

[53] Med-Tech, *Methyl Bromide MSDS Sheet*.

inflammation of the bronchi or lungs. Inflammation can be severe enough to result in respiratory or cardiovascular failure.[54]

4.4 Phosgene

Phosgene is a degradation product of chloropicrin. It is also a major industrial chemical intermediate used to make plastics and pesticides. At 70 °F, phosgene is a gas. Due to its acute toxicity, phosgene was used as a chemical weapon during World War I. Phosgene is formed from the thermal degradation of chlorinated hydrocarbons, including chloropicrin. Phosgene gas is colorless and, at low concentrations, has an odor resembling freshly cut grass or hay. The odor threshold for phosgene is 0.4 ppm, which is greater than the AEGL-2 threshold of 0.3 ppm (see Table 5-1). As a result, individuals can be exposed to phosgene at toxic levels before it can be detected. Inhalation is the primary route of exposure for phosgene, and exposure to it can cause respiratory and cardiovascular failure, due to low plasma volume, increased hemoglobin concentration, low blood pressure and an accumulation of fluid in the lungs, leading to death.[55]

4.5 Hydrogen Chloride

At room temperature, HCl is a nonflammable, colorless to slightly yellow gas with a pungent odor in moist air.[56,57] On exposure to air, the gas forms dense white vapors due to condensation with atmospheric moisture. When HCl gas comes in contact with moisture, it forms hydrochloric acid, which is corrosive and can cause irritation. Acute inhalation of HCl can lead to eye, nose and respiratory tract irritation, as well as pulmonary edema, respiratory distress and chest pain. Exposure to high concentrations can lead to elevated respiratory irritation including swelling and spasm of the throat and suffocation.[58]

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[54] ATSDR, Medical Management Guidelines for Methyl Bromide, https://www.atsdr.cdc.gov/MMG/MMG.asp?id=818&tid=160.

[55] ATSDR, Medical Management Guidelines for Phosgene, https://www.atsdr.cdc.gov/mmg/mmg.asp?id=1201&tid=182.

[56] ATSDR, Hydrogen Chloride, https://www.atsdr.cdc.gov/MHMI/mmg173.pdf.

[57] PubChem, National Center for Biotechnology Information, Hydrochloric Acid, https://pubchem.ncbi.nlm.nih.gov/compound/Hydrochloric-acid#section=Solubility.

[58] ATSDR, Hydrogen Chloride, https://www.atsdr.cdc.gov/MHMI/mmg173.pdf.

5. Toxic Air and Public Exposure Guidelines and Hazard Thresholds

This section summarizes public exposure guidelines and hazard thresholds that were used in connection with the modeling of various release scenarios in this report. For toxic air release, the report discusses: Protective Action Criteria (PACs) including Acute Exposure Guideline Levels (AEGLs), Emergency Response Planning Guidelines (ERPGs) and Temporary Emergency Exposure Limits (TEELs).

For fire scenarios, the report evaluates hazard zones where a fire's thermal radiation flux (i.e., measured in kilowatts per square meters, kW/m^2) would be sufficient to result in lethal heat or second-degree burns. For scenarios involving explosions, the report evaluates distances where a blast over-pressure from the explosion could result in near-total destruction or significant damage, depending on the strength of the over-pressure.

5.1 Public Exposure Guidelines for Toxic Chemicals

Emergencies involving the actual or potential release of toxic chemicals are defined in terms of health impacts or risks to the general public. If the impact or risk approaches or exceeds health and safety thresholds or levels, then steps to protect the public should be taken. These health and safety levels are expressed in terms of doses, exposures or concentrations and are termed PACs or Protective Action Criteria. The PAC dataset is a hierarchical list of three types of public exposure guidelines: AEGLs,[59] ERPGs[60] and TEELs.[61]

The main difference between AEGLs, ERPGs and TEELs is the method by which they are developed. AEGL and ERPG development is a thorough and rigorous process involving a review of all primary source data and peer-reviewed literature. Because of this time-consuming process, AEGLs and ERPGs have been developed only for approximately 270 and

[59] Developed by the EPA.
[60] Developed by the American Industrial Hygiene Association.
[61] Developed by the U.S. Department of Energy.

145 substances, respectively, at this time. TEEL values, on the other hand, are based on secondary sources of data (existing exposure limits) and are not subject to a peer-reviewed procedure—though the methodology used to derive them is peer reviewed. Because they take less time to develop, TEELs are available for a larger number of substances, more than 3,000, and are somewhat less reliable but still widely used for planning purposes. TEEL values are always subject to change, being replaced by AEGLs or ERPGs when new values are published, and many are updated annually when different exposure limits such as occupational limits (e.g., Permissible Exposure Limits [PELs] or Threshold Limit Values [TLVs]) or new toxicity data are published. New chemicals for which TEEL values are derived are added at the same time. AEGL and ERPG values, while generally consistent, can vary due to their development by different groups and due to differences in time when they are updated.

Table 5-1 below displays the PAC datasets applicable to the chemicals that Trical handles. Further summaries of each public exposure guideline follow the table.

Table 5-1. One-Hour Public Exposure Guidelines (ppm)[62,]

	Methyl Bromide	Chloropicrin	1, 3-DCP	Phosgene	Hydrogen Chloride
PAC-1	19	0.05	3.0	0.027	1.8
PAC-2	210	0.15	19	0.3	22
PAC-3	740	1.4	120	0.75	100
AEGL-1	N/A	0.05	N/A	N/A	1.8
AEGL-2	210	0.15	N/A	0.30	22
AEGL-3	740	1.4	N/A	0.75	100
ERPG-1	N/A	0.075	N/A	N/A	3
ERPG-2	50	0.15	N/A	0.5	20
ERPG-3	200	1.5	N/A	1.5	150
TEEL-1	20	0.1	3.0	0.1	1.8

[62] TEEL data may not be precise due to data availability.
Specific PACs, AEGLs, and ERPGs can be found here: https://cameochemicals.noaa.gov/search/simple.

TEEL-2	210	0.3	19	0.3	22
TEEL-3	4200	1.5	120	0.75	100

5.1.1 Protective Action Criteria (PACs)

PACs are emergency exposure guidelines that can be used before or during an unexpected release of toxic chemicals into the atmosphere. PACs are developed by the U.S. Department of Energy and are defined as the "threshold concentration of a chemical in air at which protective action is required."[63] The guidelines are intended to protect the general public from health effects resulting from a rare one-time exposure to a chemical. PACs are used before emergencies to estimate the toxic severity of potential accident scenarios (i.e., a consequences analysis such as in this report), or during actual chemical emergencies to identify at-risk populations, which in turn influence the need for stay-at-home, shelter-in-place or evacuation orders and other emergency responses. As mentioned above, the PAC dataset is a consolidated list of three types of emergency exposure guidelines: AEGLs, ERPGs and TEELs.

AEGLs and ERPGs are the preferred emergency guidelines, in that order, but are only available for a limited number of chemicals at this time. For chemicals without AEGLs or ERPGs, TEELs are temporary guidelines and are used until AEGLs or ERPGs are developed. PACs are applicable to a 60-minute exposure duration (representing the total time of exposure).

PACs have three health-effect levels based on symptom severity. Briefly and in general, PAC-1 (which is typically based on the corresponding AEGL-1, ERPG-1 or TEEL-1 value) is the threshold level for mild, transient health effects; PAC-2 (based on AEGL-2, ERPG-2 or TEEL-2) is the threshold level for irreversible or other serious health effects that could impair the ability to take protective action; and PAC-3 (based on AEGL-3, ERPG-3 or TEEL-3) is the threshold level for life-threatening health effects. Additionally, for TEELs, there is a TEEL-0 value that represents the threshold level for no adverse effects; however, this is not discussed in this report.

5.1.2 Acute Exposure Guideline Levels (AEGLs)

AEGLs represent threshold exposure limits for the general public, including susceptible individuals, and are applicable to emergency exposures ranging from 10 minutes to eight hours. The methodology for AEGL development is the most comprehensive of the three

[63] U.S. Department of Energy, *Temporary Emergency Exposure Limits for Chemicals: Methods and Practice* xi (2008), https://www.standards.doe.gov/standards-documents/1000/1046-BHdbk-2008/@@images/file.

emergency guidelines.[64] The three AEGL levels are developed for each of five exposure periods (10 minutes, 30 minutes, one hour, four hours and eight hours) and are distinguished by varying degrees of severity of toxic effects.[65] The three health-effect tiers for AEGLs are defined as follows:

> **AEGL-1:** The airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation or certain asymptomatic, non-sensory effects. However, these effects are not disabling and are transient and reversible upon cessation of exposure.
>
> **AEGL-2:** The airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting, adverse health effects or an impaired ability to escape.
>
> **AEGL-3:** The airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening adverse health effects or death.

5.1.3 Emergency Response Planning Guidelines (ERPGs)

ERPGs are air concentration guidelines for single exposures to chemicals and are intended for use as tools to assess the adequacy of accident prevention and emergency response plans. ERPGs are developed in a similar manner to AEGLs; the process includes a comprehensive literature search and related toxicity studies, preparation of a technical support document, and committee and public reviews. ERPGs are derived for 60-minute exposure durations. The three health severity levels are defined as follows:

> **ERPG-1:** The maximum concentration in air below which nearly all individuals could be exposed for up to one hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor.
>
> **ERPG-2:** The maximum concentration in air below which nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other

[64] The development process includes an in-depth scientific literature search and preparation of a technical support document, followed by a rigorous public and peer review.

[65] The 60-minute exposure thresholds were selected from the available choices because the reasonable worst-case scenarios analyzed in this report could lead to exposures around or in excess of 60 minutes before emergency responses are effective.

serious health effects or symptoms that could impair their abilities to take protective action.

ERPG-3: The maximum concentration in air below which nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects.

5.1.4 Temporary Emergency Exposure Limits (TEELs)

TEELs are emergency exposure guidelines intended for use when AEGL or ERPG values are unavailable. TEELs undergo a less rigorous review process than AEGLs and ERPGs, and are only to be used until AEGLs or ERPGs are developed. In developing TEELs, the U.S. Department of Energy utilizes secondary data sources as the basis for TEELs.[66] TEELs are often derived for 15-minute and one-hour exposure durations. The three health severity levels corresponding to the three PAC levels are defined as follows:

TEEL-1: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation or certain asymptomatic, non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

TEEL-2: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

TEEL-3: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

5.2 Fire and Explosions Thresholds

Some chemicals can burn or explode and cause health impacts from either intense heat or pressure waves, or over-pressures. The thresholds for intense heat and pressure waves are consistent with the standards used in offsite consequences analyses and in ALOHA. For scenarios involving fire, this report evaluates the fire's heat or thermal radiation flux (expressed in kilowatts per square meters, kW/m^2) based on two thresholds: (i) five kW/m^2,

[66] Secondary data sources include existing exposure limits from other agencies (e.g., Permissible Exposure Limits (PELs), Threshold Limit Values (TLVs), and Immediately Dangerous to Life or Health concentrations (IDLHs)).

which is consistent with second-degree burns within 60 seconds (Level One); and (ii) 10 kW/m^2, which is consistent with lethal heat within 60 seconds (Level Two).[67]

For scenarios involving explosions, this report evaluates the distance within which a blast over-pressure wave would propagate from the explosion and cause potential damage, depending on the strength of the over-pressures. The report considers distances based on two over-pressure thresholds: (i) an over-pressure of 3.5 pounds per square inch (psi), consistent with serious damage and injuries (Level One); and (ii) an over-pressure of 8 psi, consistent with building and facility destruction (Level Two).[68]

Each of the Level One and Level Two values above are commonly used in offsite consequence evaluations. The EPA has historically used the thermal radiation levels of 5 and 10 kW/m^2.[69] For blast over-pressure, the degree of damage increases with the amount of over-pressure. For example, at three to four psi, an over-pressure wave could rupture aboveground storage tanks and collapse steel panel buildings. At seven to eight psi, an over-pressure wave is strong enough to overturn loaded railcars, destroy buildings and cause death.[70]

5.3 HAZARD ZONE THRESHOLDS

As noted, AEGL thresholds are developed through a rigorous and comprehensive process and therefore are the recommended guidelines for evaluating hazard zones associated with the release of toxic chemicals into the air. Except for 1,3-DCP, there is an AEGL threshold for each of the subject chemicals. For 1,3-DCP, this report relies on the TEEL thresholds. Because this report has been prepared to evaluate serious negative effects to the area surrounding the facility, the release scenarios only consider AEGL-2 and AEGL-3 thresholds.

As noted above, AEGL-2 defines the threshold concentrations at which irreversible or other serious, long-lasting adverse health effects could occur. Importantly, AEGL-2 exposures could impair a person's ability to escape the exposure source or area. The inability to escape may result in a person being exposed to AEGL-2 concentrations for longer periods, thus presenting serious life-threatening conditions or even causing death. For example, the 60-minute AEGL-2 concentration for phosgene is 0.3 ppm. A person who is unable to escape a location with AEGL-2 level concentrations may therefore be exposed to life-threatening conditions. AEGL-3 defines the most serious health and safety risks, including death. Accordingly, this report analyzed scenarios for AEGL-2 and AEGL-3 risks and identified the corresponding hazard zones around the facility.

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[67] EPA & NOAA, *ALOHA User's Guide* 20 (2007).

[68] EPA & NOAA, *ALOHA User's Guide* at 22.

[69] *See, e.g.*, Flammable Liquids and Gases and Their Hazards, EPA744-R-94-002, p. B-18 (Feb. 1994).

[70] Flammable Liquids and Gases and Their Hazards, EPA744-R-94-002, Exhibit C-2.

Similarly, for the fire and explosion scenarios, the hazard zones depict the distance from the chemical release point to an endpoint that would experience the Level One and Level Two values discussed in Section 5.2 for each of these scenarios.

6. Trical Release Scenarios

This section identifies the chemical release scenarios that were modeled by Trinity Consultants for this report. The consequences of the different chemical release scenarios are summarized in Section 8. As noted above, many different types of chemicals are or can be handled at Trical, now or in the future, but this report focuses on release scenarios involving chloropicrin, 1,3-DCP and methyl bromide and the by-products from the first two: hydrogen chloride and phosgene.

Because there are so many ways an unexpected release or other emergency scenario may occur at Trical, this report, due to practical reasons, did not exhaustively consider all possible scenarios. For example, no propane explosion scenario is considered even though substantial quantities of propane are stored at the facility at several locations and propane leaks have caused fatal explosions.[71] As another example, spills often occur during filling and blending operations, which can lead to fires that might spread to other areas, causing cascading incidents, as shown by the examples discussed in Appendix 8. Also, because a large number of pressurized cylinders of various products are stored at the facility throughout the year, another reasonable and plausible release scenario might involve the rupture of one or more cylinders followed by a fire, which could result in cascading effects involving yet other cylinders or the aboveground storage tanks. Finally, there are numerous tanker trucks containing products at the facility at any given time, including trucks parked very close to the aboveground storage tanks containing 1,3-DCP and chloropicrin. This report did not specifically model all reasonable and plausible releases associated with tanker trucks or accidents related to a tanker truck collision or explosion.

In short, the goal of the analysis was not to analyze every possible release scenario or every possible combination of releases followed by cascading, serial impacts and subsequent releases—although such release scenarios are not uncommon. Rather, the goal was to identify a comprehensive set of reasonable worst-case significant releases and their impacts, all to guide the determination of a prudent and appropriate development buffer within the context of land use planning. In this regard, this report goes beyond what the EPA or California RMP would require because the goal of the analysis is to provide a more robust and complete

[71] In March 2019, a propane leak caused a fatal explosion in Farmington, Maine. *See* Maine Department of Public Safety, Farmington Investigation (Sep. 27, 2019), https://www.maine.gov/dps/msp/taxonomy/term/190.

picture of potential impacts and consequences as a result of reasonable worst-case chemical release scenarios so the County can make an informed land use decision.

Following is a description of various release scenarios that were modeled by Trinity Consultants.

6.1 Chloropicrin Aboveground Storage Tank and Railcar Releases (Evaporating Pool)

Trical stores and uses large quantities of chloropicrin. In addition to being stored at times in one or more railcars, chloropicrin is typically stored onsite in ten 10,000-gallon aboveground storage tanks at Trical. Chloropicrin is a liquid at typical storage temperatures.

This report analyzed the offsite consequences of the release of 175,000 pounds of chloropicrin from a single railcar, which forms a 1,000 square meter evaporating pool. There are a number of accidents and intentional acts that could result in the release of chloropicrin from a railcar, which include: damage to the railcar that results in a rupture, terrorism, vandalism, and derailment due to trains on the adjoining main line.

This report also evaluated the consequences of chloropicrin being released from just one of the 10,000-gallon aboveground storage tanks located at Trical. A chloropicrin release could occur if a tank is breached due to any number of causes, including a truck accident, vandalism, terrorism or material failure. In those scenarios, the report assumes that the chloropicrin, upon release, will form liquid pools of 163, 250, 500 and 1,000 square meters. There is a containment area surrounding the 10,000-gallon tanks, and the 163 square meter pool area scenario assumes the liquid will remain within the containment area. However, because the walls of the containment area can be easily breached under a variety of reasonably foreseeable scenarios (e.g., explosion, vandalism, onsite vehicle accidents, highspeed accident on immediately adjacent Highway 25, etc.), the 250, 500 and 1,000 square meter pool sizes assume that the liquid can spread beyond the containment area.

After an evaporating pool is formed either from a release from the railcar or the aboveground tanks, chloropicrin will then evaporate and disperse in the atmosphere spreading across the surrounding land.

6.2 1,3-DCP Aboveground Storage Tank Release (Evaporating Pool)

Trical stores and uses large quantities of 1,3-DCP. 1,3-DCP is stored in three vertical 32,000-gallon aboveground storage tanks and one 10,000-gallon horizontal aboveground storage tank at the site. 1,3-DCP is a liquid at typical storage temperatures. This report analyzed the impact of 1,3-DCP releases that could occur if a tank is breached due to any number of causes, including a truck accident, explosion, vandalism or material failure. These scenarios assume that the 1,3-DCP, upon release, will form a liquid evaporating pool of 140, 250, 500 and 1,000 square meters. There is a containment area surrounding the 32,000-gallon tanks, and the 140 square meter pool area scenario assumes that the liquid will remain within the containment area. However, because the walls of the containment area can be easily breached under a variety of reasonably foreseeable scenarios (e.g., explosion, vandalism, onsite vehicle accidents, highspeed accident on immediately adjacent Highway 25, etc.), the 250, 500 and 1,000 square meter pools sizes assume that the liquid can spread beyond the containment area. Once a liquid pool is formed, 1,3-DCP liquid will evaporate and disperse in the atmosphere spreading across the surrounding land.

6.3 Phosgene from Chloropicrin Degradation

Chloropicrin can degrade to form phosgene, a highly toxic compound.[72] This reaction, which can occur at low rates even under ambient conditions, is accelerated when chloropicrin is heated. This scenario assumes that the 1,3-DCP liquid pool discussed above catches on fire (or that a fire results from any other cause near the chloropicrin tanks) which then heats up one of the chloropicrin tanks, causing degradation of the chloropicrin to phosgene, which is then released from the chloropicrin tank as vapor. Conservatively, the report assumes that only 1% of the chloropicrin stored in a single tank degrades to phosgene.

6.4 Combustion of 1,3-DCP, Creating Hydrogen chloride (HCl)

In this scenario, this report assumes that the 1,3-DCP liquid, once discharged (like the scenario in Section 6.3 above) ignites and then catches fire. This could occur due to any number of potential ignition sources present in the area. HCl is a combustion by-product of 1,3-DCP. The 1,3-DCP fire assumed here causes a high temperature plume, which then disperses in the atmosphere. The rate of HCl generation and the dispersion of HCl from the fire into the atmosphere depend on a variety of factors, including combustion conditions, turbulence, wind speed and plume rise. To conduct a conservative evaluation and simplify the analysis for purposes of the report, the model inputs for this scenario have two sub-cases with differing HCl generation rates based on plausible plume temperatures and wind velocities.

6.5 Radiation from 1,3-DCP Fire

In this scenario, the 1,3-DCP fire scenario described in Section 6.4 was analyzed to determine the zone within which the radiation flux from the fire itself could exceed the Level One and Level Two thermal radiation endpoints described previously in Section 5.2.

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[72] CDC, The National Institute for Occupational Safety and Health (NIOSH), Chloropicrin (PS): Lung Damaging Agent, https://www.cdc.gov/niosh/ershdb/emergencyresponsecard_29750034.html.

6.6 Explosion from 1,3-DCP

The report also analyzes whether vapors from the 1,3-DCP release scenario described above could ignite and then result in explosive conditions—such as when the vapor concentrations exceed the Lower Explosive Limit for 1,3-DCP in air. This scenario utilizes the Level One and Level Two over-pressure thresholds described in Section 5.2 to identify the endpoint distances of the hazard zones.[73]

6.7 Methyl Bromide Railcar Releases (Vapor Release)

Trical uses significant quantities of methyl bromide. Methyl bromide could be delivered to the facility by pressurized railcar or tanker truck; the historical and current practice is for delivery by pressurized railcar. Multiple railcars could be parked at any given time on the rail spur.

This report analyzed the offsite consequences of a methyl bromide railcar release. There are a number of accidents and intentional acts that could result in the release of methyl bromide from more than one railcar, which include: damage to the railcar that results in a rupture, terrorism, vandalism and derailment due to trains on the adjoining main line. Although it is possible for releases to involve multiple railcars and Appendix 5 presents the results of releases from one, two and three railcars, the analysis presented in this report is limited to releases from a single railcar.[74]

Methyl bromide is stored as a liquid under pressure in the railcars. When the gas is released from a railcar at typical ambient temperatures, the pressurized methyl bromide liquid will rapidly depressurize and vaporize because methyl bromide has a boiling point of 38.4 °F at atmospheric pressure. For the methyl bromide railcar release scenario, each railcar is assumed to empty its contents in 10 minutes. This is a reasonable release scenario for a catastrophic failure of a tank car releasing pressurized gas. Trical analyzed this scenario in its RMP and its results are consistent with the findings of this report. However, that RMP did not analyze AEGL-2 (210 ppm) and AEGL-3 (740 ppm) thresholds and instead considered an endpoint concentration of 25 ppm which it found posed a hazard to the public at a distance of 6.8 miles from the Trical facility. In other words, the more serious consequences associated with a methyl bromide railcar release were not identified in the Trical RMP.

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[73] CDC, The National Institute for Occupational Safety and Health (NIOSH), Chloropicrin (PS): Lung Damaging Agent, https://www.cdc.gov/niosh/ershdb/emergencyresponsecard_29750034.html.

[74] Trinity Consultants modeled the offsite consequences involving releases from multiple railcars and those results are included in Appendix 5. Because many other scenarios demonstrate hazard zones at the same or greater distances, this report does not separately discuss multiple-railcar scenarios, even though such scenarios are plausible.

7. Modeling Methodology

Mathematical simulations, or models, use physical and chemical information, along with meteorological (i.e., atmospheric and wind) data to estimate the concentrations of chemicals or pollutants in space and time after a chemical release. Downwind chemical concentrations can be combined with health-based ambient air concentration thresholds as discussed in Section 5 to provide decision makers information on how to set prudent and appropriate buffer zones for facilities that handle hazardous chemicals.

As discussed in Section 5.3, the endpoint chemical concentrations for the release scenarios are the AEGL-2 and AEGL-3 thresholds, except for 1,3-DCP, which does not have AEGL values and instead is based on available TEEL thresholds. For fires and explosions, the endpoint thresholds are discussed in Section 5.2.

7.1 Overview of Models

Chemical release models require a set of input information to estimate downwind concentrations resulting from a release of a hazardous chemical. Some of the information includes details about the release, for example, whether the released chemical results in the formation of a liquid pool (like chloropicrin and 1,3-DCP) or whether it is released as a gas (like methyl bromide). Models also use information about the chemical being released, such as vapor pressure, vapor and liquid densities and other chemical properties. Meteorological parameters such as ambient temperature and local terrain are also input into the models.

Chemical release models have been developed by governmental and academic organizations to estimate the impacts of chemical releases for regulatory programs, such as the RMP discussed earlier. In addition to predicting downwind concentrations for airborne toxics, models can predict heat flux from fires, as well as over-pressure from explosions.

Downwind concentrations, heat flux and over-pressure estimates from release models are combined with health-based endpoint concentrations to delineate hazard zones that may result from chemical releases, fires and explosions.

To protect the public, models and associated public exposure guidelines approved by regulatory agencies generally account for various uncertainties by relying on the precautionary principle. That conservative methodology helps to protect the general public and minimizes the risk of erroneously setting an exposure threshold that might result in serious and long-term adverse impacts to any member of the public.

As noted, this report relies on release models approved by state and federal agencies, and they are briefly described below. More detail is available in user-manuals and technical support documents.[75]

7.1.1 ALOHA

ALOHA (Areal Locations of Hazardous Atmospheres) is a model developed by the EPA and NOAA, and is part of the broader, CAMEO (Computer-Aided Management of Emergency Operations) software suite. CAMEO houses chemical data and dispersion and mapping tools designed to assist emergency responders and emergency planners (e.g., firefighters), and federal, state and local agencies, private industry, and environmental organizations.[76]

ALOHA can simulate a variety of airborne chemical releases, including toxic gas clouds, flammable gas clouds, boiling liquid expanding vapor explosions (BLEVEs), jet fires, pool fires and vapor cloud explosions (VCEs). ALOHA includes a library of chemical property data, which it can use to calculate release rates and dispersion to estimate the spatial extent of airborne toxics and hazard zones. Inputs to ALOHA include:

- chemical data, which can be taken directly from ALOHA's chemical database;
- selection of a source model (e.g., direct release from a single point, liquid puddle, tank with hole or leaking valve, gas pipeline); and
- atmospheric data (e.g., wind speed, stability class, surface roughness)

ALOHA uses two separate dispersion models for dense (i.e., heavier than air) and neutrally buoyant gases and incorporates a decision algorithm to choose between these two models. For neutrally buoyant releases, ALOHA uses a steady-state Gaussian plume model. ALOHA's dense gas dispersion model is designed to account for gravitational effects on pollutant clouds and is based on the EPA's well-accepted Dense Gas Dispersion (DEGADIS) model, adapted to handle time-varied releases. However, both of ALOHA's dispersion models are limited in

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[75] *See* NOAA, *ALOHA (Areal Locations Of Hazardous Atmospheres) ® 5.4.4 Technical Documentation* (2013), https://response.restoration.noaa.gov/sites/default/files/ALOHA_Tech_Doc.pdf; BREEZE, BREEZE Incident Analyst Tech Sheet, https://www.breeze-software.com/software/incident-analyst; EPA, SCRAM, Air Quality Dispersion Modeling – Screening Models, https://www.epa.gov/scram/air-quality-dispersion-modeling-screening-models; EPA, SCRAM, Air Quality Dispersion Modeling – Preferred and Recommended Models, https://www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models.

[76] EPA, What is the CAMEO Software Suite?, https://www.epa.gov/cameo/what-cameo-software-suite.

their ability to account for the effects of terrain and buildings and use a wind field that does not vary with time or location.[77]

ALOHA can predict the distance to specific levels of concern from the point of release.

7.1.2 BREEZE Incident Analyst

BREEZE Incident Analyst (BIA) is a proprietary software package developed by Trinity Consultants that can model the results from a variety of emergency scenarios including chemical releases. It incorporates several industry-standard and regulatory-approved toxic dispersion, fire and explosion models that have been developed by the U.S. government, military and industry groups.[78] The BIA tool provides a graphical user interface to enter input data and model options. BIA also includes a database of physical/chemical property data and exposure hazard levels for more than 150 common chemicals.

BIA includes four dispersion models, DEGADIS, SLAB, INPUFF, and AFTOX, to calculate the dispersion of airborne chemicals and evaluate offsite chemical concentrations. Of these, the two relevant models for this report's analysis are DEGADIS and SLAB. Both are "dense gas models" that calculate the gravity-driven flow and atmospheric dispersion of gases that are denser than air. DEGADIS is capable of handling ground-level area sources released with zero momentum over flat terrain, whereas SLAB is capable of handling ground-level and elevated jets, liquid pool evaporation and instantaneous volume sources.[79]

Like other emergency response models, the results provide information on airborne chemical concentrations and potential hazard zones (i.e., distances to specified PACs).

7.1.3 AERSCREEN

AERSCREEN is the EPA's recommended screening dispersion for regulatory applications, such as air permitting, and is based on the EPA's recommended air dispersion model, AERMOD.[80] Like AERMOD, AERSCREEN is a steady-state, Gaussian plume model, which calculates pollutant dispersion in the atmosphere using planetary boundary layer turbulence

[77] NOAA, *ALOHA (Areal Locations Of Hazardous Atmospheres) ® 5.4.4 Technical Documentation* 3-4 (2013), https://response.restoration.noaa.gov/sites/default/files/ALOHA_Tech_Doc.pdf.

[78] BREEZE, BREEZE Incident Analyst Tech Sheet, https://www.breeze-software.com/software/incident-analyst.

[79] EPA, Support Center for Regulatory Atmospheric Dispersion Modeling (SCRAM), Air Quality Modeling – Alternative Models (2020), https://www.epa.gov/scram/air-quality-dispersion-modeling-alternative-models.

[80] Tyler Fox, *EPA Memorandum: AERSCREEN Released as the EPA Recommended Screening Model* (Apr. 11, 2011), https://www3.epa.gov/ttn/scram/guidance/clarification/20110411_AERSCREEN_Release_Memo.pdf.

structure and scaling concepts.[81] While AERSCREEN was designed for use in permitting, it can also be used to model neutrally buoyant emergency releases, with an emphasis on situations where there is an exhaust momentum or high-temperature release.

AERSCREEN is designed to estimate worst-case air concentrations (for one-hour, three-hour, eight-hour, 24-hour and annual averaging periods) for a single source, and AERSCREEN results have been shown to be somewhat greater than or equal to the estimates produced by AERMOD for a variety of modeling scenarios.[82] Similar to AERMOD, AERSCREEN requires input information including:

- emission source type (e.g., point/stack, area);
- emission source parameters (e.g., stack location, stack height, stack diameter, stack gas exit velocity and temperature);
- emission or release rate;
- building dimensions, if building downwash is to be evaluated; and
- distance to the nearest offsite receptor.

AERSCREEN is designed to calculate downwind air concentrations under specified worst-case meteorological conditions.[83] Additionally, as a screening model, AERSCREEN calculates the maximum downwind concentrations along the plume centerline.[84] As a result, AERSCREEN identifies the maximum offsite air concentration, as well as air concentrations at user-specified distances from the emission source.

7.2 RECEPTOR GRID USED TO ESTABLISH THE HAZARD ZONE

All of the models described above estimate concentrations at specific points downwind from the source to estimate worst-case ambient air concentrations. Most models can specify the spacing of where concentrations are to be estimated (i.e., locations of "receptors"). The spacing of the receptor points should be small enough to accurately estimate the distance to the desired endpoint. For purposes of this report, the modeling results are used to specify the endpoint distances from the release point to the hazards thresholds both in miles and meters.

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[81] EPA, SCRAM, Air Quality Dispersion Modeling – Screening Models, https://www.epa.gov/scram/air-quality-dispersion-modeling-screening-models; EPA, SCRAM, Air Quality Dispersion Modeling – Preferred and Recommended Models, https://www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models.

[82] James Thurman, *AERSCREEN: Status and Update. 9th Modeling Conference*, https://www3.epa.gov/scram001/9thmodconf/aerscreen_9thmc_1009.pdf.

[83] Worst-case meteorological conditions can be either generic or site-specific, as the optional MAKEMET program can interface with AERSCREEN to generate a site-specific matrix of screening meteorological conditions.

[84] EPA, *AERSCREEN Users Guide, EPA-454/B-16-004* (Dec. 2016), https://www3.epa.gov/ttn/scram/models/screen/aerscreen_userguide.pdf.

7.3 MODELING INPUTS

This analysis uses reasonable worst-case modeling parameters, which are designed to represent release and dispersion conditions for the purpose of protecting human health and property near the site. The parameters used in the modeling are based on or consistent with relevant regulatory guidance. Importantly, and consistent with EPA guidance, site-specific data were used in lieu of generic EPA recommendations because they are more representative of the site and site conditions.

For purposes of this report, relevant parameters include: source release height, wind speed, atmospheric stability, temperature and humidity, topography, and gas or vapor density.[85]

7.3.1 Wind Speed and Atmospheric Stability

Some models, such as AERSCREEN, test a range of atmospheric conditions to ensure that the worst-case meteorological conditions are represented. Other models require user-specified worst-case conditions as inputs. Calm winds and stable atmospheric conditions limit atmospheric dispersion and are typically associated with higher air concentrations in the event of ground-level chemical releases, such as the types relevant to this analysis. Local and onsite meteorological data from multiple years were available (i.e., multi-year data from the Hollister Municipal Airport, as well as data from the Trical meteorological station) and that data indicate local wind speeds can be as low as 0.5 m/s representing calm conditions, and that winds blow from all directions. A wind speed of 1.0 m/s was selected for this analysis, which is lower than the default 1.5 m/s wind speed often used in some contexts (such as RMP analysis) if no site-specific data is available. The selected windspeed of 1.0 m/s is higher, however, than even lower wind speeds recorded at Trical. Thus, the modeling used a wind speed which is consistent with evaluating reasonable worst-case release scenarios.

Consistent with standard modeling practice, the models used ambient temperature data collected and maintained by the Hollister Municipal Airport, which also was consistent with onsite data maintained by Trical.

Atmospheric stability is often represented using the Pasquill Stability Classes A-G, where A is extremely unstable (denoting a well-mixed atmosphere) and G is extremely stable (denoting a very stratified atmosphere).[86] Consistent with accepted modeling practices and with EPA guidance, this report assumed a stable atmosphere, represented by F Class stability for ground-level releases, where the models required stability class as an input.

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[85] EPA, *Risk Management Program Guidance for Offsite Consequence Analysis* (2009), https://www.epa.gov/sites/production/files/2013-11/documents/chap-04-final.pdf.

[86] NOAA, *Pasquill Stability Classes* (2019), https://www.ready.noaa.gov/READYpgclass.php.

7.3.2 Temperature

For volatile chemicals, high ambient temperatures will be associated with a greater rate of vaporization and higher chemical emissions. The EPA's guidance recommends using the highest temperature reached in the last three years. Although the highest recorded temperature at the site was 120 °F, the report used an ambient temperature of 104 °F, which corresponds to the highest measured temperature in the last three years at the Hollister Municipal Airport. Even though the higher temperature would have likely yielded more severe offsite consequences, the ambient temperature of 104 °F was more in line with historical temperature data. It therefore represents reasonable worst-case conditions.

7.3.3 Topography

For emergency release modeling, local topography may be described as either urban or rural, or by providing a surface roughness as an input, depending on the model. EPA guidance recommends selecting the most appropriate option for a given site.

If the model requires a choice between rural and urban topography, the site's surroundings are evaluated. If a site is located in an area with few building or other obstructions, rural conditions are assumed. Rural dispersion parameters tend to yield more health-protective results.

Surface roughness is a parameter that is frequently used in dispersion modeling to describe the height of obstacles to wind flow. EPA guidance states that land use within a one-kilometer (approximately 0.62-mile) radius of the release site should be examined to determine surface roughness. Surface roughness values range from less than 0.001 meters over calm water to one meter or more over forest or urban areas. Land use within a one-kilometer radius around Trical is primarily classified as low-height cultivated crops, with few-to-no buildings. As a result, rural dispersion and a surface roughness of 0.02 meters were used as input modeling parameters.

7.4 Furthermost Endpoint

In the diagrams provided in this report and to facilitate review, downwind distances are presented to a maximum distance of 6.0 miles, consistent with the maximum distance (6.2 miles) provided by the ALOHA model.[87] However, the actual maximum endpoint distances for the various scenarios are provided in Appendix 5.

[87] EPA & NOAA, *ALOHA User's Manual*.

8. Modeling Results

The modeling of the scenarios described in this report was done by Trinity Consultants. The report describing the parameters used by Trinity and the modeling results (i.e., endpoint distances) for each of these scenarios is provided in Appendix 5.

8.1 OVERVIEW OF RESULTS

This section summarizes the results of modeling the selected reasonable worst-case scenarios of unexpected chemical releases and resulting fires and explosions. The endpoint distance for each release scenario is shown in Table 8-1, and Maps 8-1 through 8-15 show the hazard zones around the Trical facility.

Multiple chloropicrin release scenarios involving evaporating pools were considered as described previously. The smallest pool size of 163 square meters assumes that the chloropicrin remains within the containment area for the tank. Even in that scenario, the Level Three (AEGL-3) red zone extends 2.3 miles in radius around the Trical facility. Because the containment area could be breached in a number of ways (e.g., explosion), the report also considered evaporating pool sizes of 250, 500 and 1,000 square meters resulting from the rupture of a single aboveground chloropicrin tank.

In addition, Trical also receives large quantities of chloropicrin by railcar, and there is no containment area to capture a large, unexpected release from a railcar. Accordingly, a 1,000 square meter evaporating pool of chloropicrin resulting from a single railcar release was also modeled. Level Three (AEGL-3) red zones range between 2.3 and 4.8 miles in radius around the Trical facility. Importantly, the modeling results show that at 2.5 miles the toxic air concentration levels for chloropicrin can be as much as three times the AEGL-3 value.

The phosgene scenario shows the Level Three (AEGL-3) red zone extends beyond six miles in radius around the Trical facility. Additionally, the modeling results show that at 2.5 miles the toxic air concentration levels for phosgene can be approximately twice the AEGL-3 value.

Multiple 1,3-DCP release scenarios were considered involving evaporating pools: 140, 250, 500 and 1,000 square meters. No scenario resulted in a Level Three (AEGL-3) red zone beyond 0.3 miles in radius around the Trical facility. And, the Level Two (AEGL-2) yellow zone did not extend beyond 0.7 miles in radius around the facility. Similarly, the offsite consequences of the HCl emissions scenarios resulting from the combustion of 1,3-DCP did not extend beyond 0.4 miles in radius around the Trical facility.

For the fire and explosion scenarios, the offsite consequences do not extend beyond 0.3 miles, but the onsite consequences of such fires and explosions would be devastating given the concentrated chemical inventory at the Trical facility. Secondary damage due to fires and explosions could result in more releases of chloropicrin, 1,3-DCP and phosgene than have been considered and modeled in this report.

Only one scenario involving methyl bromide is discussed below and it involves a vapor release resulting from the rupture of a single pressured railcar. The results show that the Level Three (AEGL-3) danger red zone extends 2.3 miles in radius around the Trical facility.

Table 8-1. Description of Maps Showing Release Scenarios

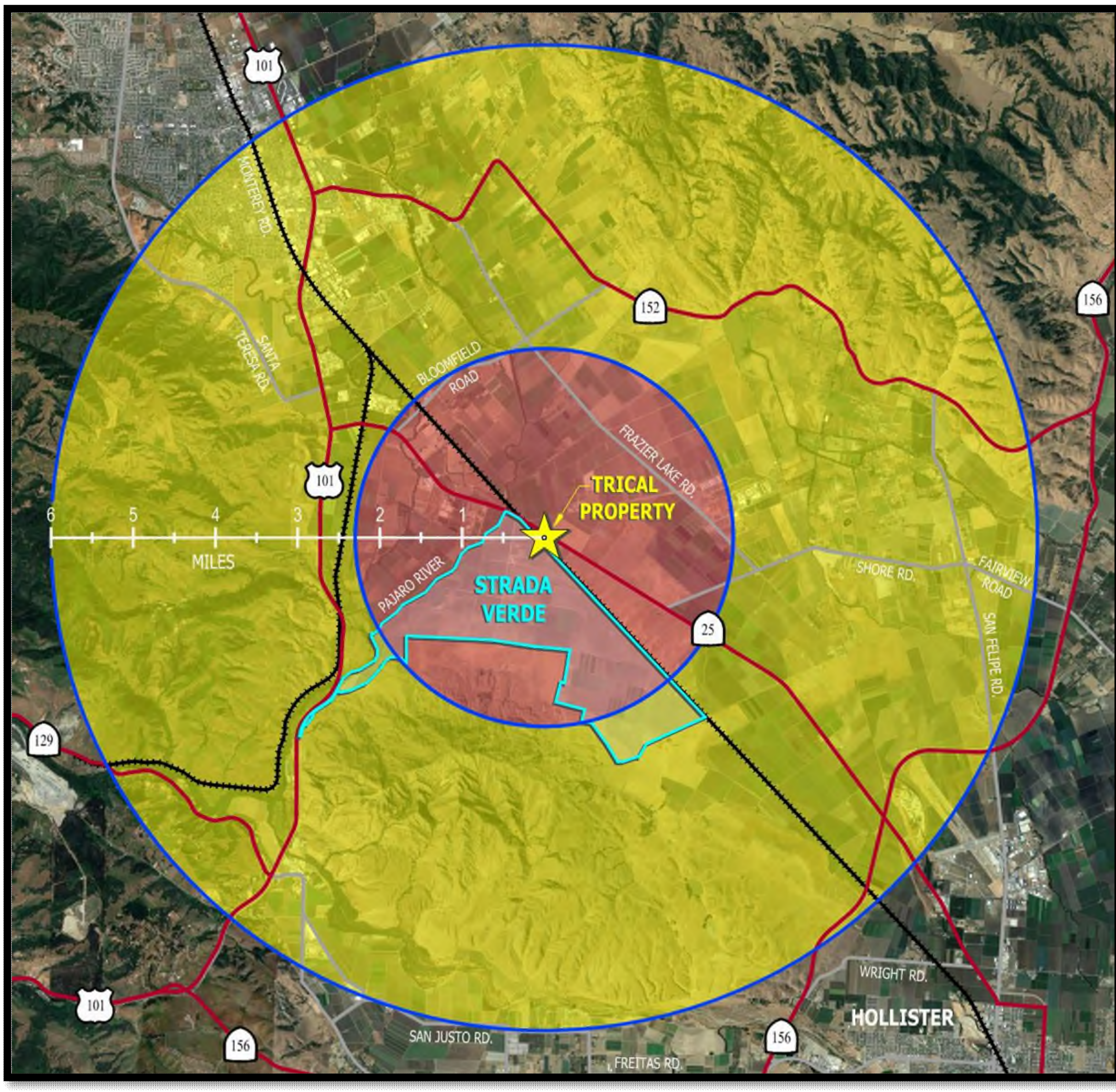
Scenarios	Descriptions	End-Point Distances (miles)
Map 8-1: Chloropicrin Tank Release – 163 m^2	Sudden rupture of one horizontal storage tank (10,000 gallons) releasing chloropicrin to form a liquid evaporating pool of 163 m^2	Level Two: >6.0[88]
		Level Three: 2.3
Map 8-2: Chloropicrin Tank Release – 250 m^2	Sudden rupture of one horizontal storage tank (10,000 gallons) releasing chloropicrin to form a liquid evaporating pools of 250 m^2	Level Two: >6.0
		Level Three: 2.7
Map 8-3: Chloropicrin Tank Release – 500 m^2	Sudden rupture of one horizontal storage tank (10,000 gallons) releasing chloropicrin to form a liquid evaporating pools of 500 m^2	Level Two: >6.0
		Level Three: 3.5
Map 8-4: Chloropicrin Tank Release – 1,000 m^2	Sudden rupture of one horizontal storage tank (10,000 gallons) releasing chloropicrin to form a liquid evaporating pools of 1,000 m^2	Level Two: >6.0
		Level Three: 4.6
Map 8-5: Chloropicrin Railcar Release – 1,000 m^2	Sudden rupture of one railcar (12,774 gallons) releasing chloropicrin to form a liquid evaporating pool of 1,000 m^2	Level Two: > 6.0
		Level Three: 4.8

[88] Regardless of the model used and for comparison purposes, the hazard zones shown on the maps are limited to a distance of six miles in radius, which is consistent with the standard ALOHA output.

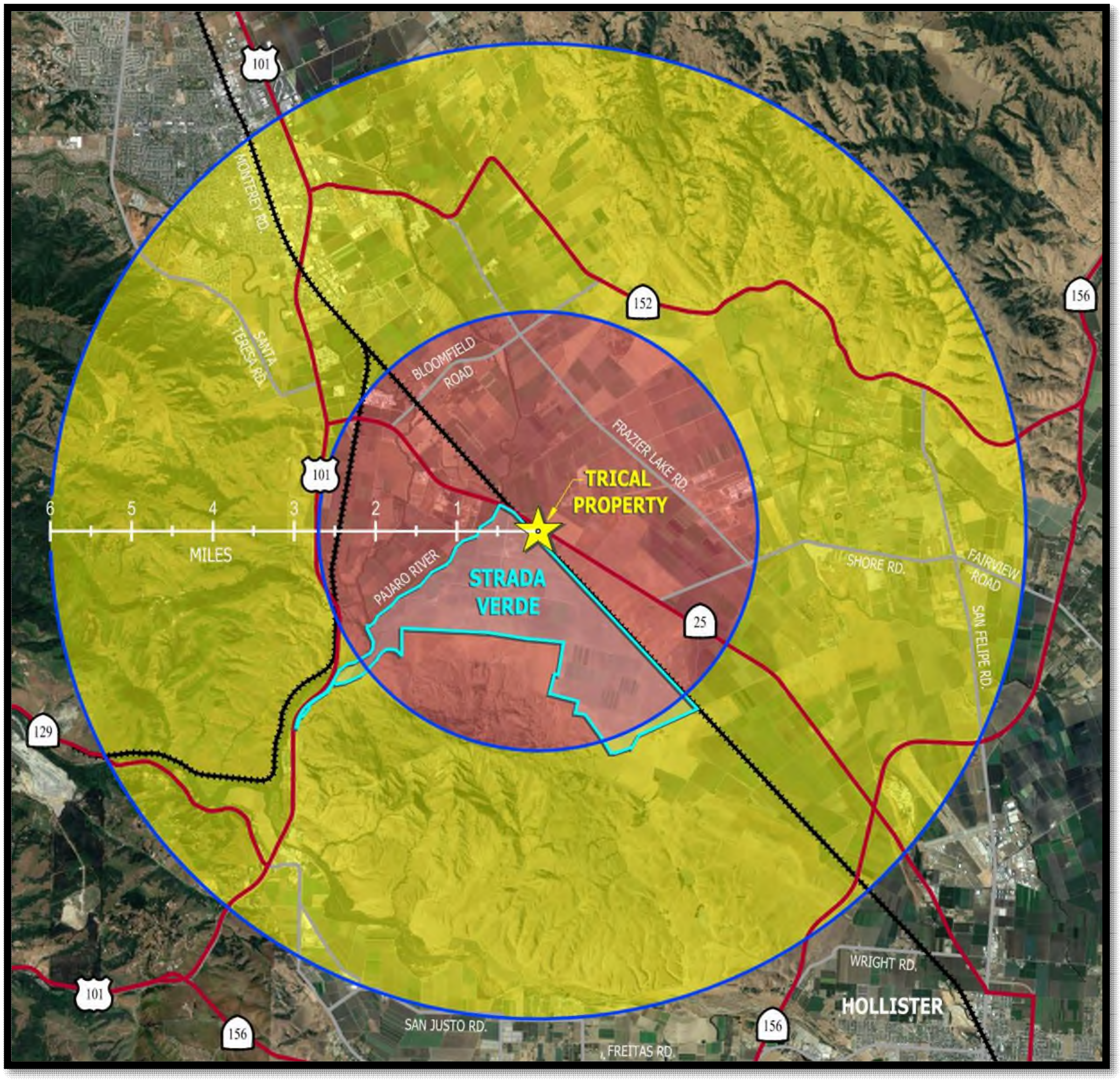
Map 8-6: Chloropicrin to Phosgene Degradation	Phosgene, released by the degradation (1%) of chloropicrin due to adjacent fires	Level Two: >6.0 Level Three: >6.0
Map 8-7: 1,3-DCP Tank Release – 140 m^2	Sudden rupture of one vertical storage tank (32,000 gallons) releasing 1,3-DCP to form a liquid evaporating pool of 140 m^2	Level Two: 0.3 Level Three: 0.1
Map 8-8: 1,3-DCP Tank Release – 250 m^2	Sudden rupture of one vertical storage tank (32,000 gallons) releasing 1,3-DCP to form a liquid evaporating pool of 250 m^2	Level Two: 0.4 Level Three: 0.1
Map 8-9: 1,3-DCP Tank Release – 500 m^2	Sudden rupture of one vertical storage tank (32,000 gallons) releasing 1,3-DCP to form a liquid evaporating pool of 500 m^2	Level Two: 0.5 Level Three: 0.2
Map 8-10: 1,3-DCP Tank Release – 1,000 m^2	Sudden rupture of one vertical storage tank (32,000 gallons) releasing 1,3-DCP to form a liquid evaporating pool of 1,000 m^2	Level Two: 0.7 Level Three: 0.3
Map 8-11: 1,3-DCP BLEVE	Thermal radiation due to a 1,3-DCP BLEVE from one vertical storage tank (32,000 gallons)	Level One: 0.3 Level Two: 0.2
Map 8-12: 1,3-DCP VCE	Over-pressure wave due to a 1,3-DCP VCE from one vertical storage tank (32,000 gallons)	Level One: 0.3 Level Two: 0.2
Map 8-13: HCl Formation from 1,3-DCP Combustion – Run1	HCl is created as one of the by-products from the combustion of 1,3-DCP released from one vertical storage tank	Level Two: 0.2 Level Three: 0.0
Map 8-14: HCl Formation from 1,3-DCP Combustion – Run2	HCl is created as one of the by-products from the combustion of 1,3-DCP released from one vertical storage tank	Level Two: 0.4 Level Three: 0.0

Map 8-15: Methyl Bromide Railcar Release – One railcar	Sudden rupture of one railcar (175,000 pounds), releasing methyl bromide vapors	Level Two: 3.8
		Level Three: 2.3

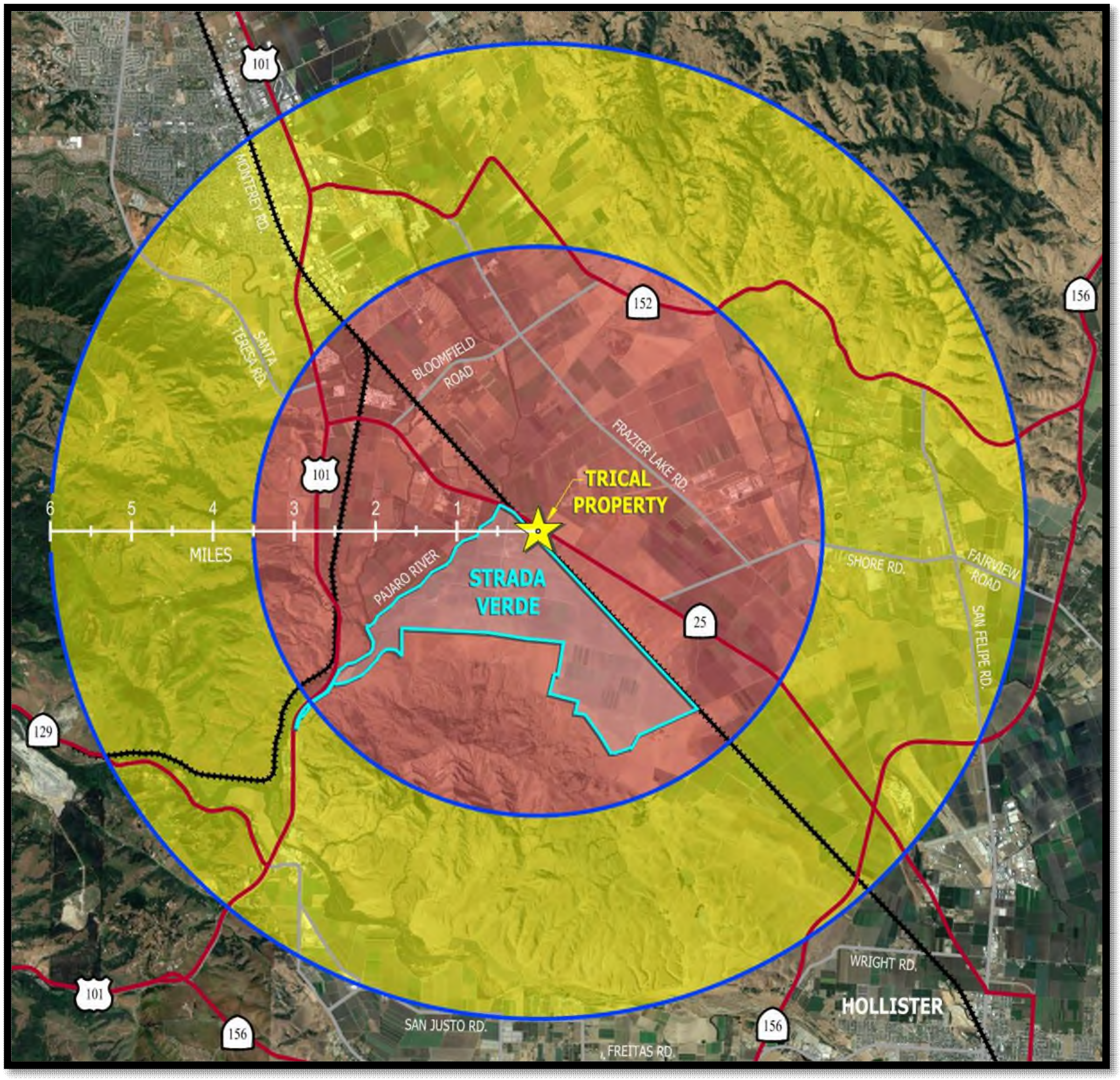
Map 8-1. ALOHA Chloropicrin Hazard Zone for 163 m² Pool - Tank



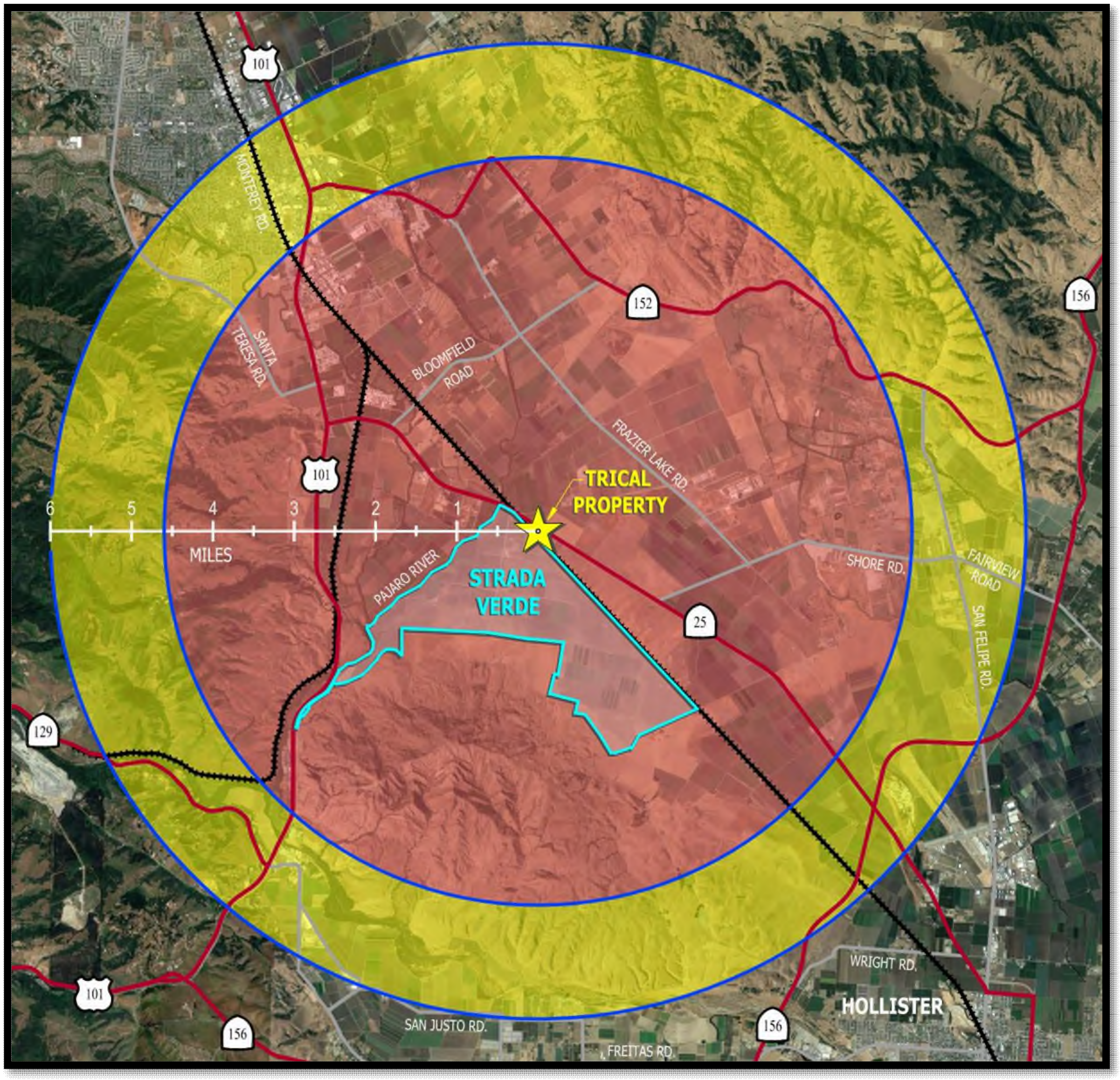
Map 8-2. ALOHA Chloropicrin Hazard Zone for 250 m² Pool - Tank



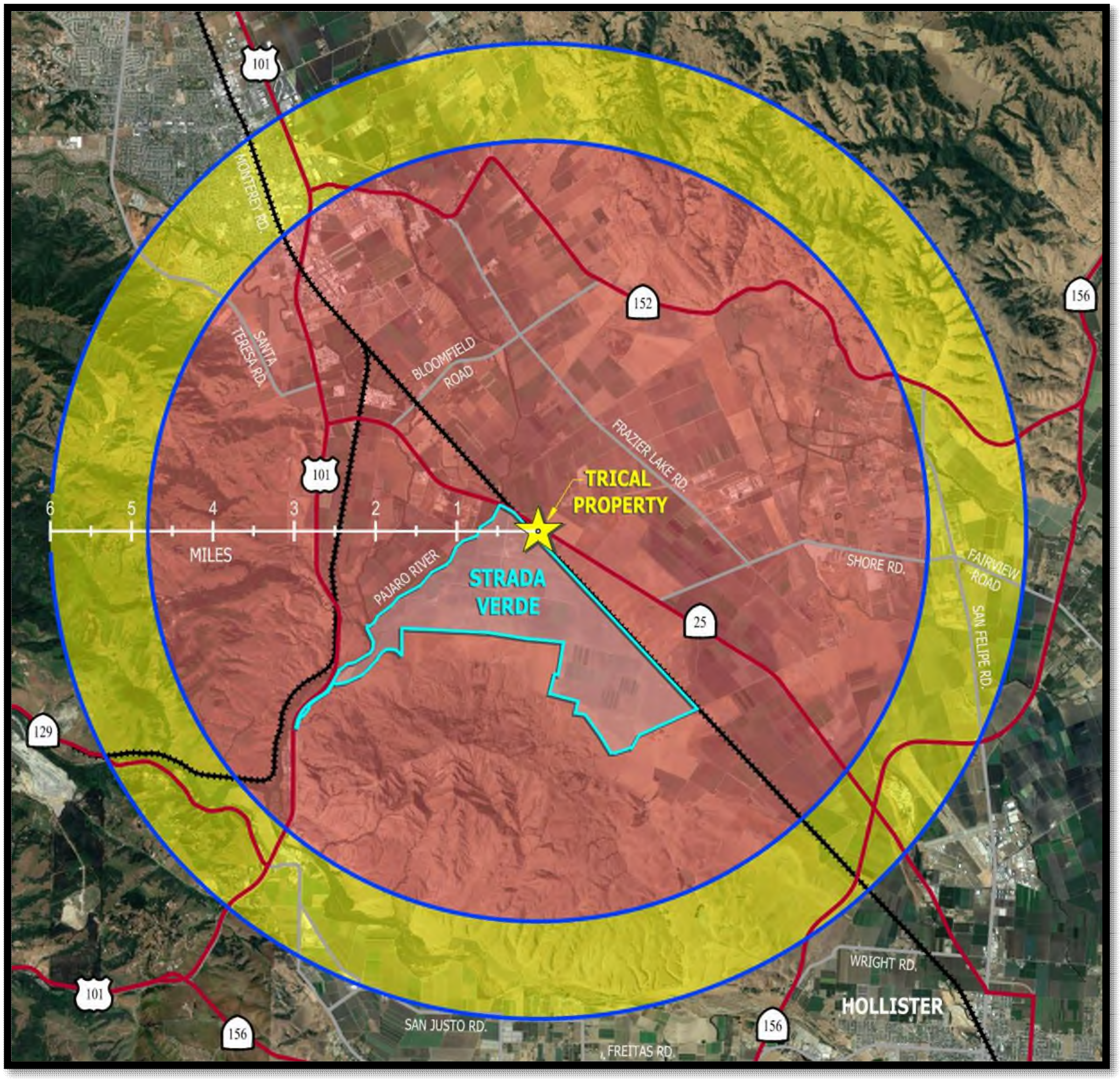
Map 8-3. ALOHA Chloropicrin Hazard Zone for 500 m² Pool - Tank



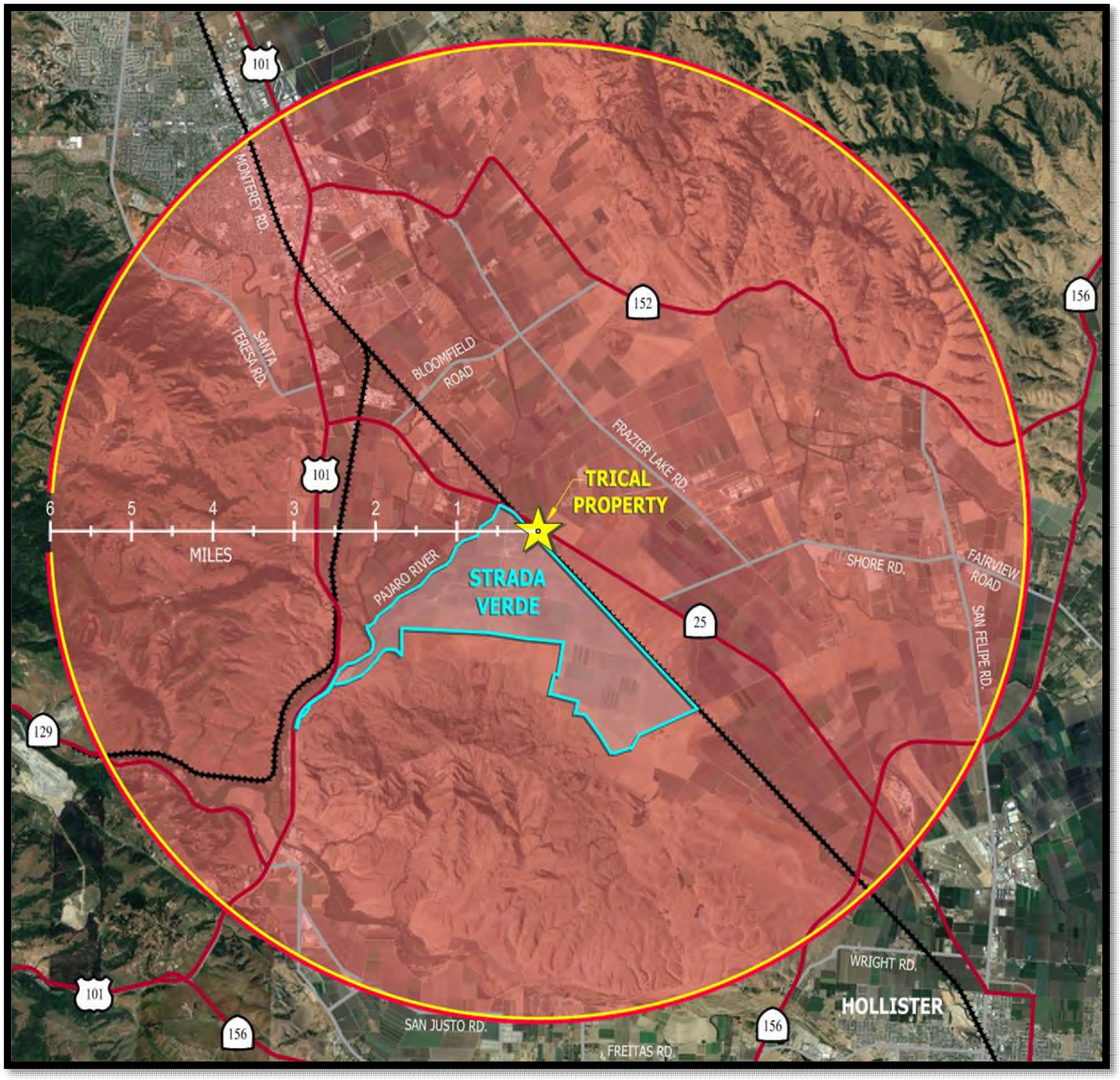
Map 8-4. ALOHA Chloropicrin Hazard Zone for 1,000 m² Pool - Tank



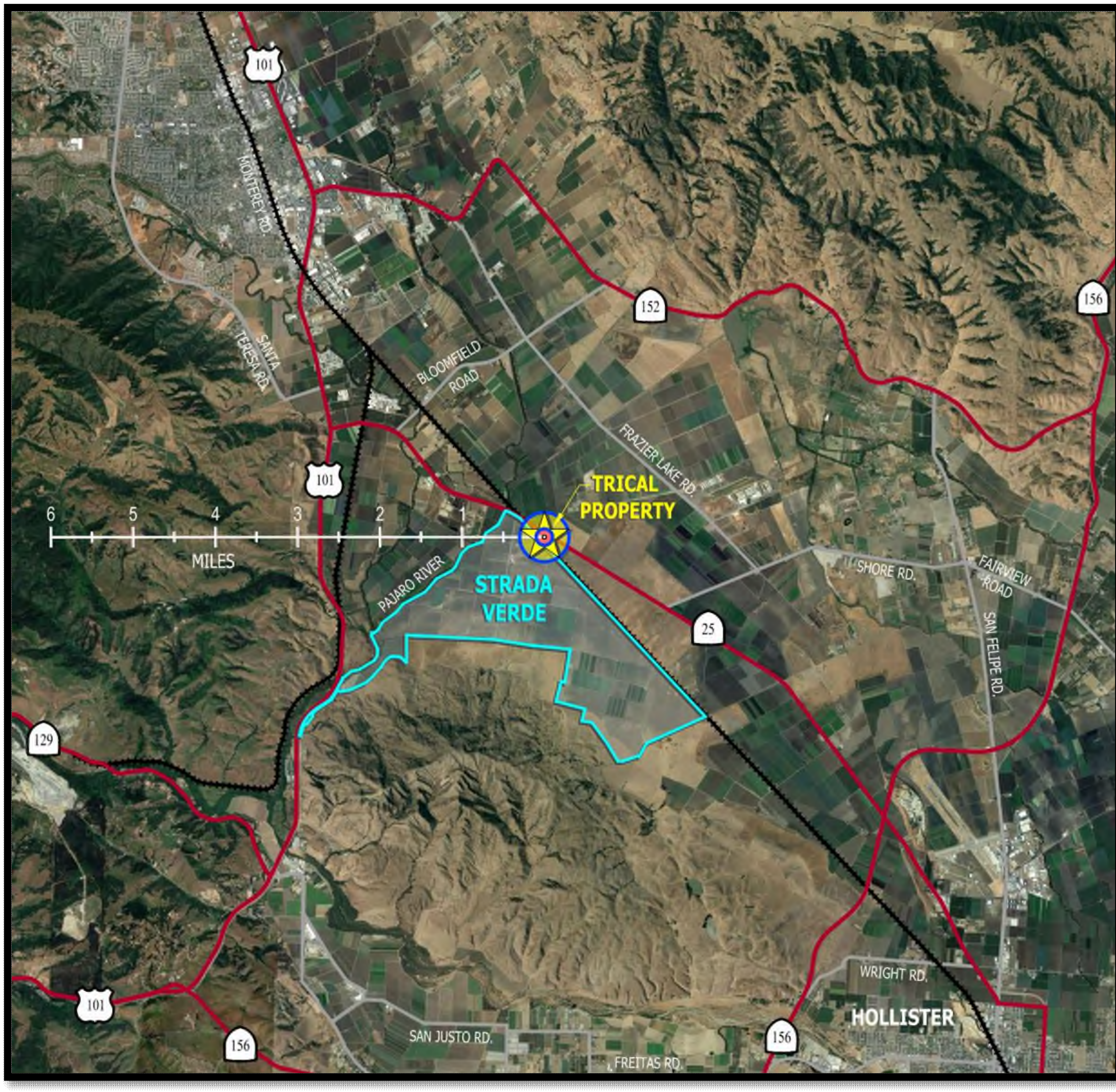
Map 8-5. ALOHA Chloropicrin Hazard Zone for 1,000 m² Pool - Railcar



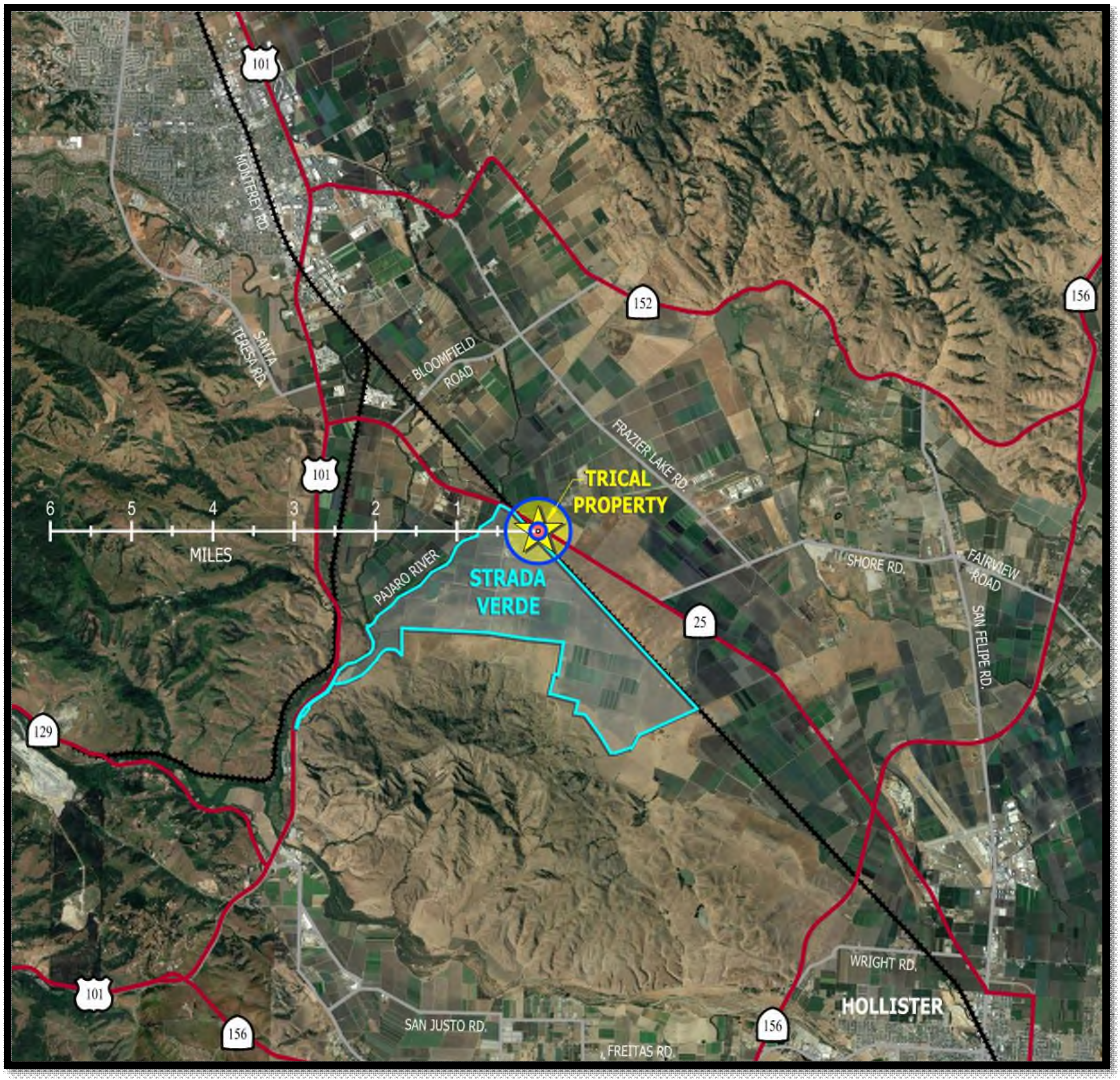
Map 8-6. Phosgene Hazard Zone



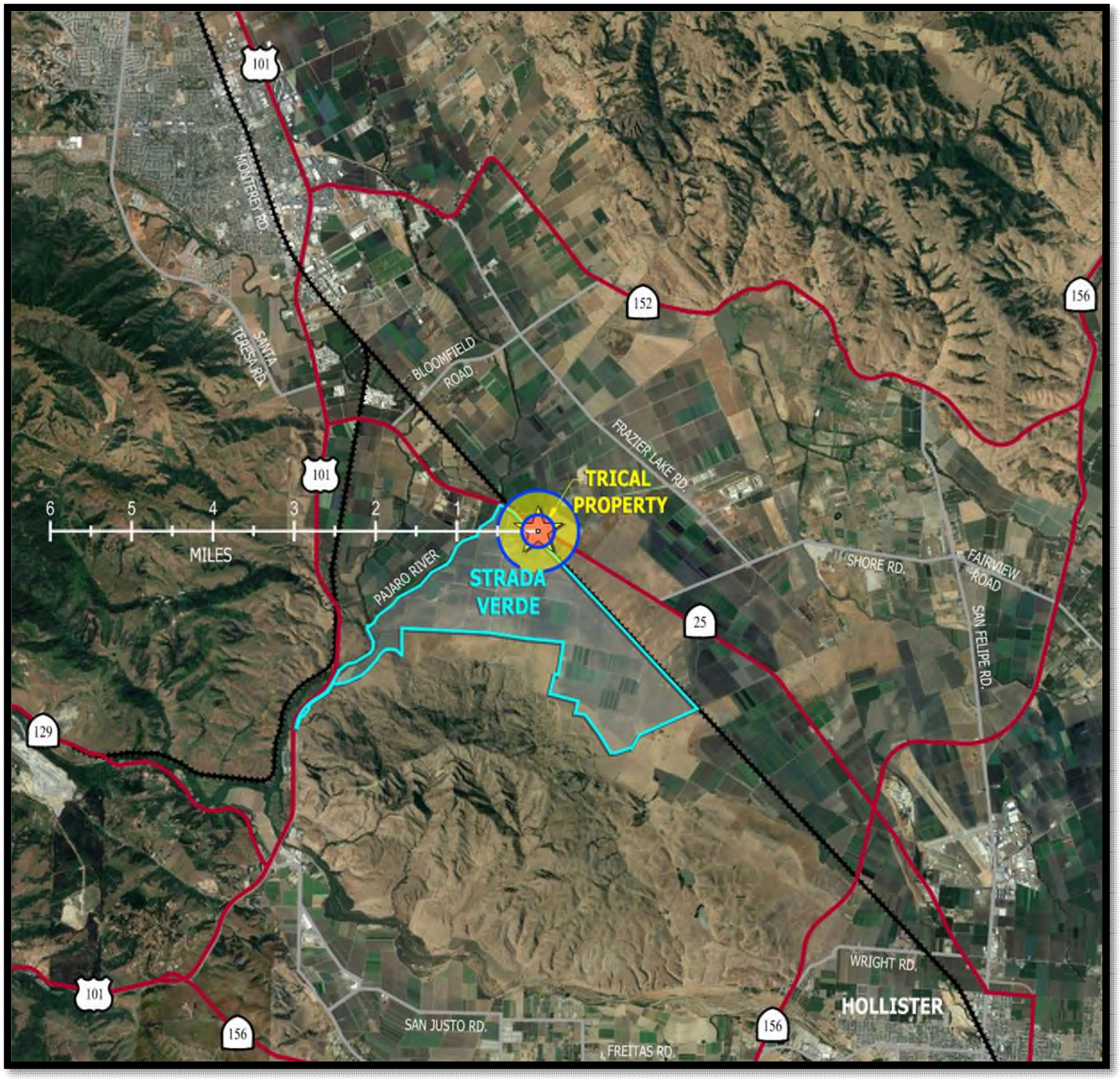
Map 8-7. ALOHA 1,3-DCP Hazard Zone for 140 m² Pool - Tank



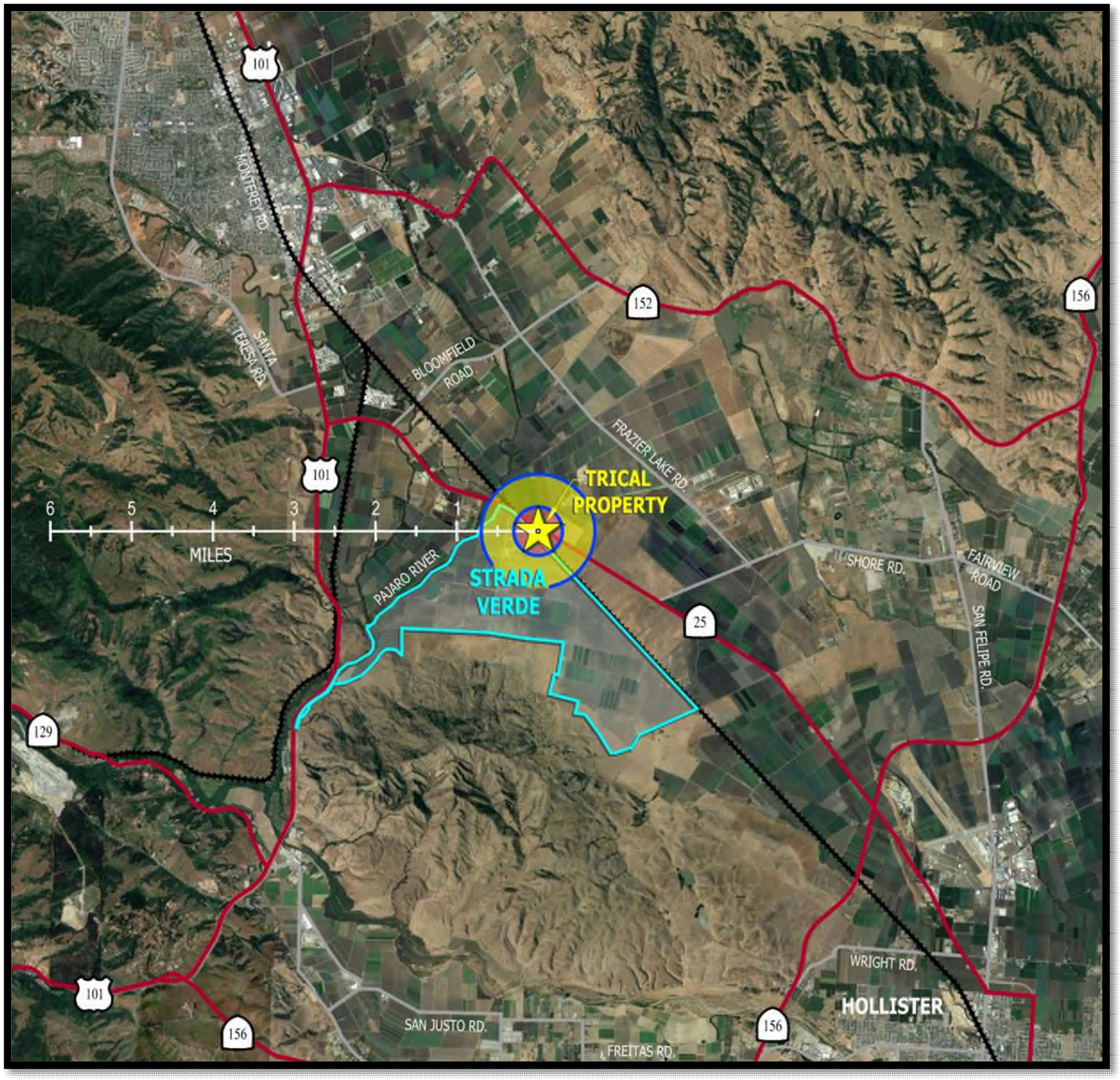
Map 8-8. ALOHA 1,3-DCP Hazard Zone for 250 m² Pool - Tank



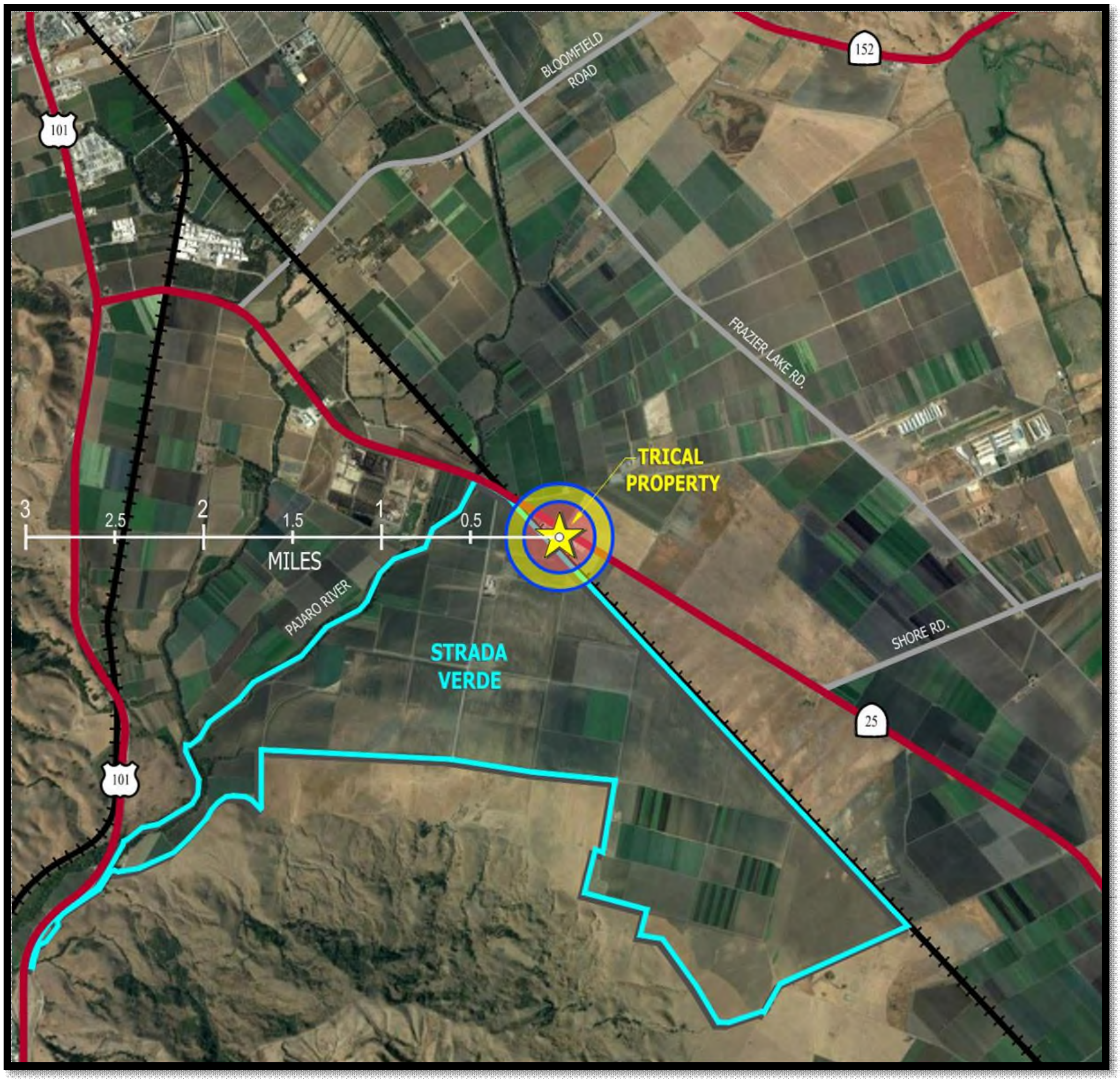
Map 8-9. ALOHA 1,3-DCP Hazard Zone for 500 m² Pool - Tank



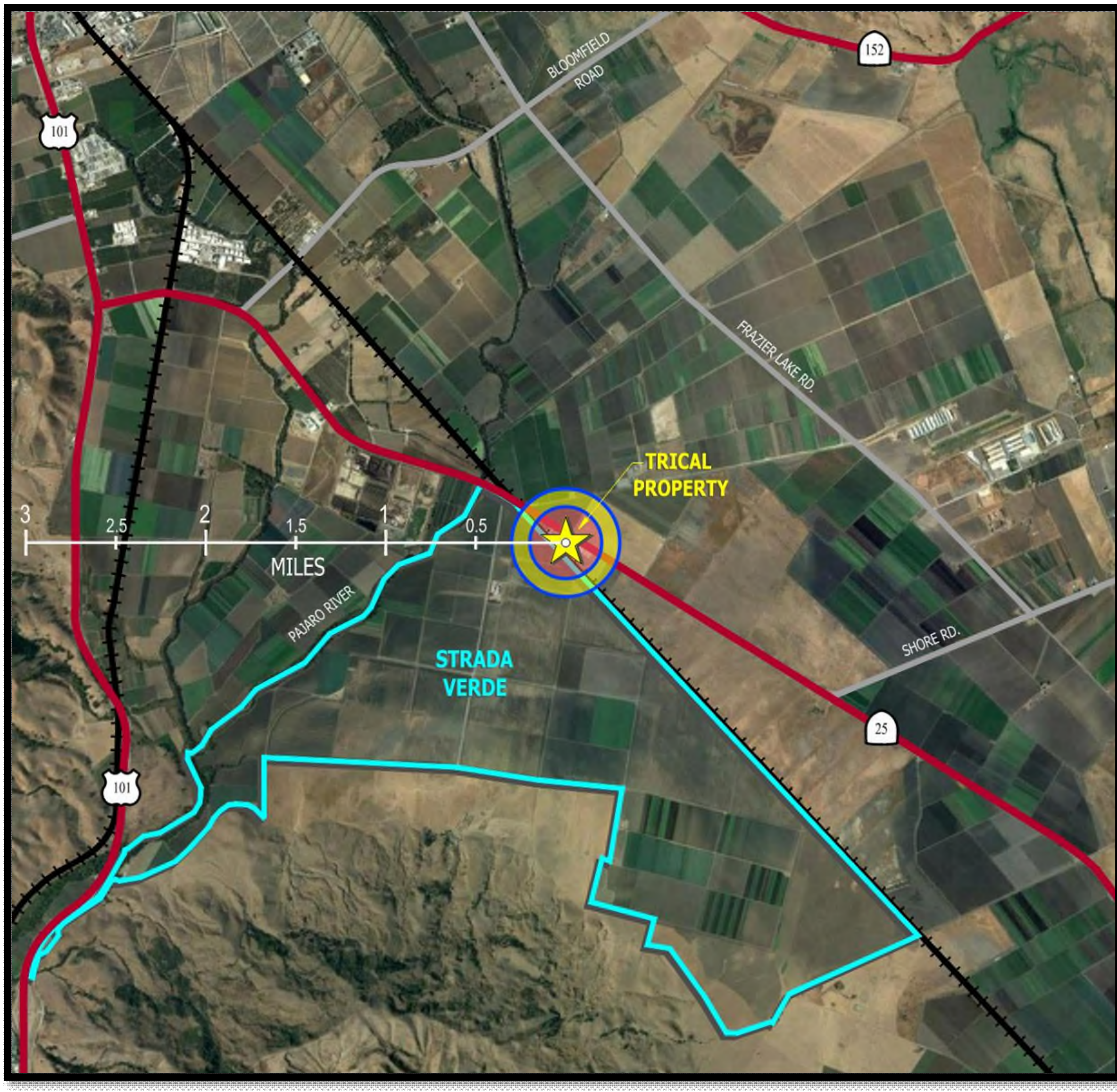
Map 8-10. ALOHA 1,3-DCP Hazard Zone for 1,000 m² Pool - Tank



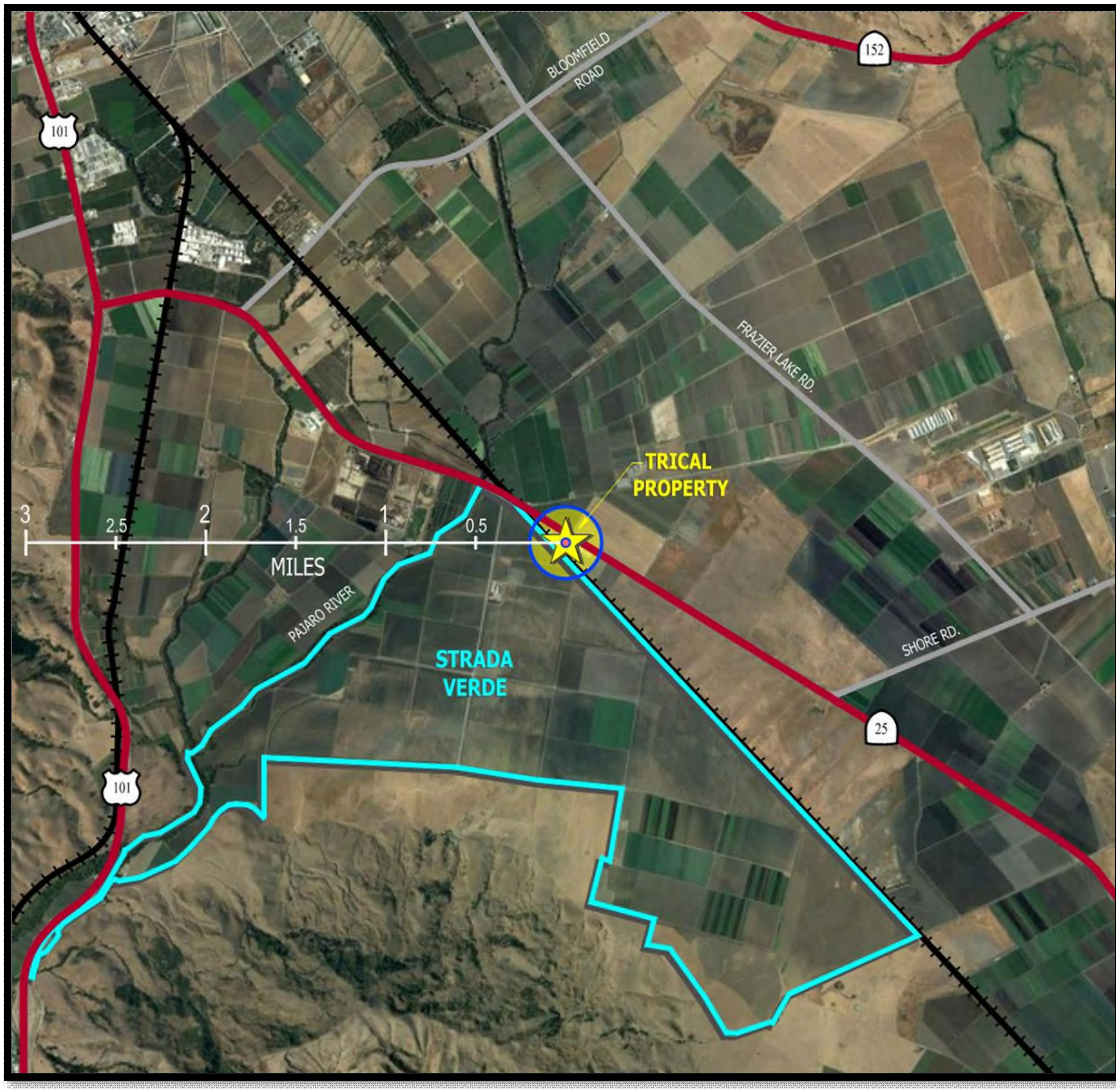
Map 8-11. ALOHA 1,3-DCP Fire Thermal Radiation Hazard Zone



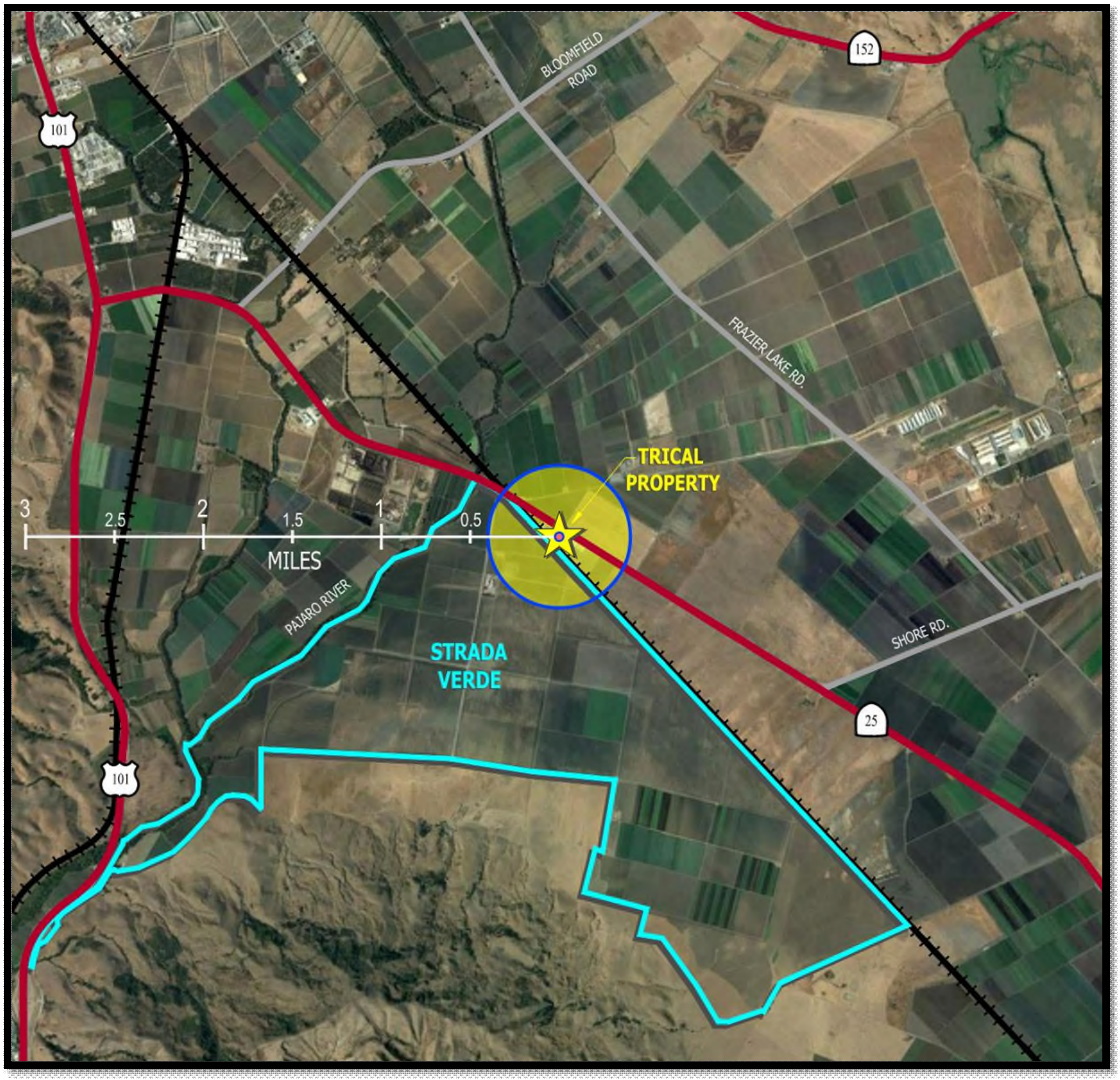
Map 8-12. ALOHA 1,3-DCP Explosion Over-Pressure Hazard Zone



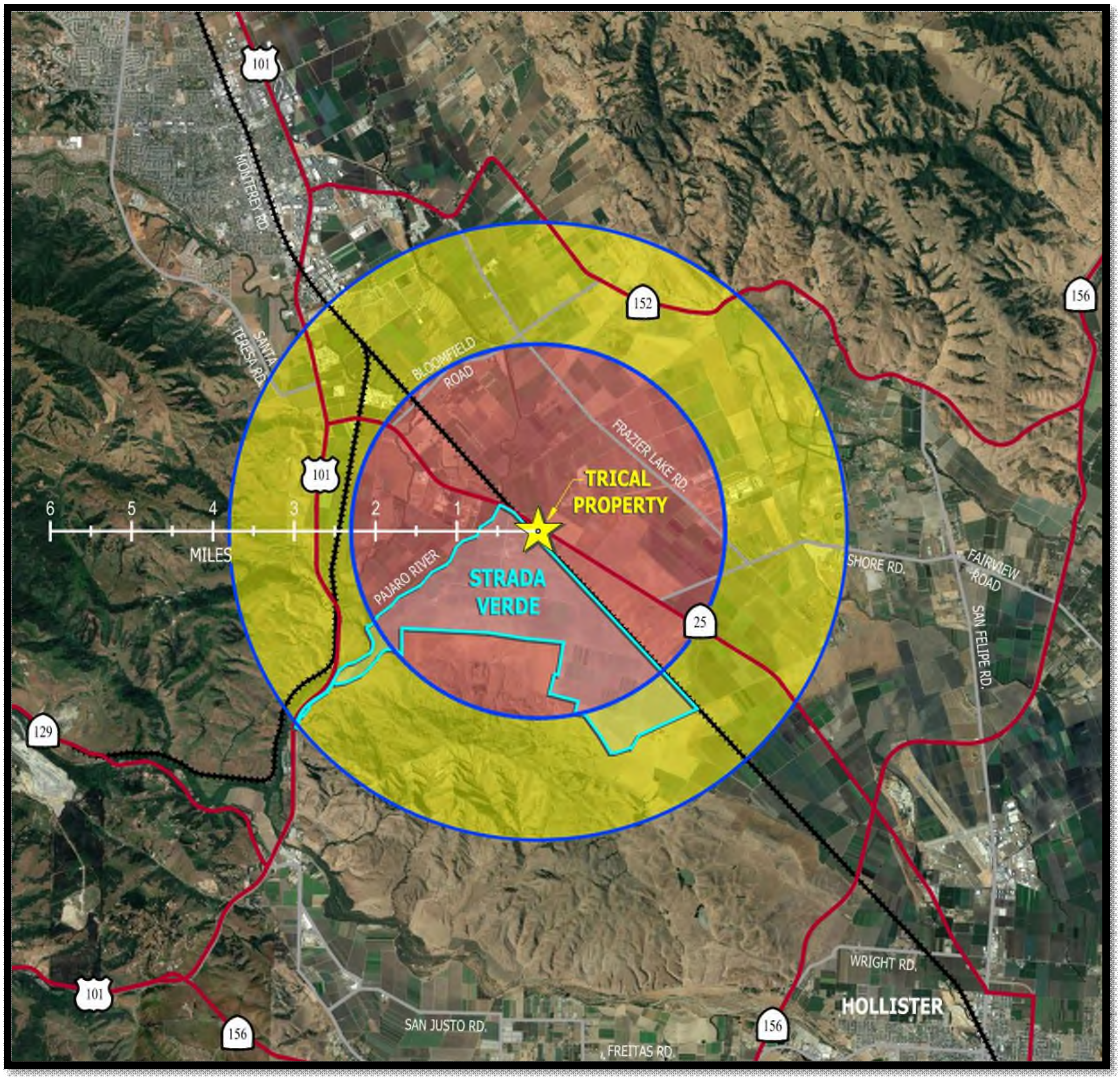
Map 8-13. HCl Hazard Zone for Run1



Map 8-14. HCl Hazard Zone for Run2



Map 8-15. ALOHA Methyl Bromide Hazard Zone for One Railcar



9.
Buffer Zone Evaluation

9.1 PURPOSE OF BUFFER ZONE

San Benito County's 2035 General Plan includes health and safety policies designed to protect residents, workers, visitors and properties from unreasonable risks associated with potential hazards. The General Plan's Health and Safety Policy (Policy HS 6.9) applies to new sensitive land uses near industrial facilities that handle industrial or agricultural chemicals. That policy provides that a "buffer shall be maintained between new sensitive land uses" and certain facilities that can handle or receive "chemicals regulated as potentially hazardous." Policy HS 6.9 also provides that "the appropriate buffer zone shall be established on a case-by-case basis," depending on, among other factors, the degree of hazard associated with existing industrial facilities.

9.2 RECOMMENDED BUFFER ZONE

As noted above, Policy HS 6.9 of the County's General Plan requires that an appropriate buffer be established on a case-by-case basis for new sensitive land uses adjacent to industrial facilities that handle agricultural fumigants, such as the Trical facility. The purpose of the buffer is to protect human health and property from adverse consequences in the event of a large, unexpected chemical release.

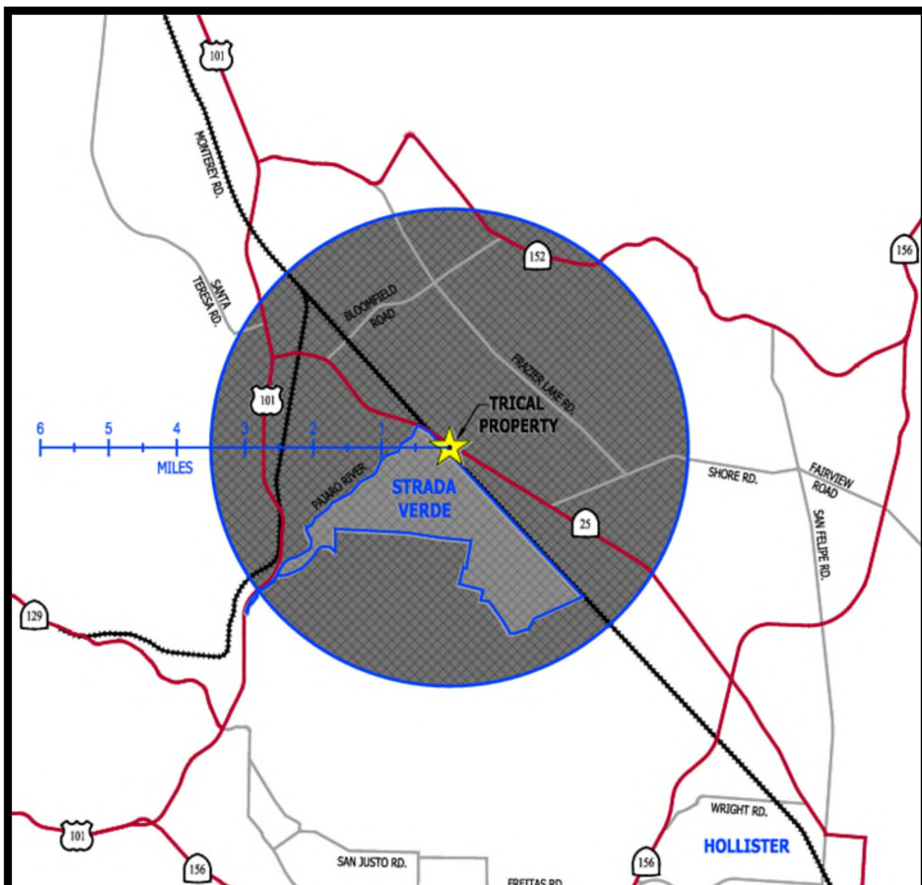
The Trical facility is currently operating with a conditional use permit in an area zoned "Agricultural" in the County. If approved, the Strada Verde proposal would rezone approximately 2,777 acres of land immediately adjacent to Trical from Agricultural to a custom zoning district allowing a wide range of sensitive land uses including hotels, colleges, daycare facilities, event centers, medical facilities as well as automobile-related employment uses. If ultimately developed, the Strada Verde project would bring thousands of workers and hundreds of visitors on a daily basis in close proximity to Trical, which handles large quantities of many hazardous chemicals.

As set forth in Section 8 of this report (Table 8-1), multiple release scenarios could result in Level Three (serious, life-threatening health effects or death) hazard zones ranging from 2.3 miles to greater than 6 miles in radius from the Trical site. In addition, those same scenarios could result in Level Two (irreversible or other serious health effects) hazard zones ranging from 3.8 miles to more than 6 miles from the site. And prolonged exposures to Level Two chemical concentrations also could lead to even more serious adverse consequences consistent with Level Three impacts.

Thus, based on the findings of this report, the land uses that would be allowed if the Strada Verde proposal were approved should maintain a minimum buffer of 3.5 miles from the Trical facility. Any buffer zone less than 3.5 miles would place human life in jeopardy because multiple release scenarios result in unacceptably high concentrations of hazardous chemicals within 3.5 miles of the Trical site.

Below is a map showing that the Strada Verde project lies entirely within the 3.5-mile recommended minimum buffer zone. Given the findings of this report and degree of hazard at the Trical facility, the land uses that would be allowed under the Strada Verde proposal are not appropriate within this minimum buffer zone and should not be approved.

Below is a diagram showing the recommended 3.5-mile buffer zone and its relation to the Strada Verde project:



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9.0 Buffer Zone Evaluation

PREPARED BY:

Michael Groves
EMC Planning Group, Inc.

Dr. Ranajit Sahu

COMPLETE REPORT WITH APPENDICES IS ON FILE WITH THE SAN BENITO COUNTY DEPARTMENT OF ENVIRONMENTAL HEALTH

APPENDIX AA: EXPERT RESUMES

SAHU RESUME

RANAJIT (RON) SAHU, Ph.D, QEP, CEM (Nevada)

CONSULTANT, ENVIRONMENTAL AND ENERGY ISSUES

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EXPERIENCE SUMMARY

Dr. Sahu has over thirty years of experience in the fields of environmental, mechanical, and chemical engineering including: program and project management services; design and specification of pollution control equipment for a wide range of emissions sources including stationary and mobile sources; soils and groundwater remediation including landfills as remedy; combustion engineering evaluations; energy studies; multimedia environmental regulatory compliance (involving statutes and regulations such as the Federal CAA and its Amendments, Clean Water Act, TSCA, RCRA, CERCLA, SARA, OSHA, NEPA as well as various related state statutes); transportation air quality impact analysis; multimedia compliance audits; multimedia permitting (including air quality NSR/PSD permitting, Title V permitting, NPDES permitting for industrial and storm water discharges, RCRA permitting, etc.), multimedia/multi-pathway human health risk assessments for toxics; air dispersion modeling; and regulatory strategy development and support including negotiation of consent agreements and orders.

He has over twenty seven years of project management experience and has successfully managed and executed numerous projects in this time period. This includes basic and applied research projects, design projects, regulatory compliance projects, permitting projects, energy studies, risk assessment projects, and projects involving the communication of environmental data and information to the public.

He has provided consulting services to numerous private sector, public sector and public interest group clients. His major clients over the past twenty five years include various trade associations as well as individual companies such as steel mills, petroleum refineries, cement manufacturers, aerospace companies, power generation facilities, lawn and garden equipment manufacturers, spa manufacturers, chemical distribution facilities, and various entities in the public sector including EPA, the US Dept. of Justice, several states, various agencies such as the California DTSC, various municipalities, etc.). Dr. Sahu has performed projects in all 50 states, numerous local jurisdictions and internationally.

In addition to consulting, for approximately twenty years, Dr. Sahu taught numerous courses in several Southern California universities including UCLA (air pollution), UC Riverside (air pollution, process hazard analysis), and Loyola Marymount University (air pollution, risk assessment, hazardous waste management). He also taught at Caltech, his alma mater (various engineering courses), at the University of Southern California (air pollution controls) and at California State University, Fullerton (transportation and air quality).

Dr. Sahu has and continues to provide expert witness services in a number of environmental areas discussed above in both state and Federal courts as well as before administrative bodies (please see Annex A).

EXPERIENCE RECORD

2000-present **Independent Consultant.** Providing a variety of private sector (industrial companies, land development companies, law firms, etc.), public sector (such as the US Department of Justice), and public interest group clients with project management, environmental consulting, project management, as well as regulatory and engineering support consulting services.

1995-2000 Parsons ES, **Associate, Senior Project Manager and Department Manager for** Air Quality/Geosciences/Hazardous Waste Groups, Pasadena. Responsible for the management of a group of approximately 24 air quality and environmental professionals, 15 geoscience, and 10 hazardous waste professionals providing full-service consulting, project management, regulatory compliance and A/E design assistance in all areas.

Parsons ES, **Manager for Air Source Testing Services**. Responsible for the management of 8 individuals in the area of air source testing and air regulatory permitting projects located in Bakersfield, California.

1992-1995 Engineering-Science, Inc. **Principal Engineer and Senior Project Manager** in the air quality department. Responsibilities included multimedia regulatory compliance and permitting (including hazardous and nuclear materials), air pollution engineering (emissions from stationary and mobile sources, control of criteria and air toxics, dispersion modeling, risk assessment, visibility analysis, odor analysis), supervisory functions and project management.

1990-1992 Engineering-Science, Inc. **Principal Engineer and Project Manager** in the air quality department. Responsibilities included permitting, tracking regulatory issues, technical analysis, and supervisory functions on numerous air, water, and hazardous waste projects. Responsibilities also include client and agency interfacing, project cost and schedule control, and reporting to internal and external upper management regarding project status.

1989-1990 Kinetics Technology International, Corp. **Development Engineer.** Involved in thermal engineering R&D and project work related to low-NOx ceramic radiant burners, fired heater NOx reduction, SCR design, and fired heater retrofitting.

1988-1989 Heat Transfer Research, Inc. **Research Engineer**. Involved in the design of fired heaters, heat exchangers, air coolers, and other non-fired equipment. Also did research in the area of heat exchanger tube vibrations.

EDUCATION

1984-1988 Ph.D., Mechanical Engineering, California Institute of Technology (Caltech), Pasadena, CA.

1984 M. S., Mechanical Engineering, California Institute of Technology (Caltech), Pasadena, CA.

1978-1983 B. Tech (Honors), Mechanical Engineering, Indian Institute of Technology (IIT) Kharagpur, India

TEACHING EXPERIENCE

Caltech

"Thermodynamics," Teaching Assistant, California Institute of Technology, 1983, 1987.

"Air Pollution Control," Teaching Assistant, California Institute of Technology, 1985.

"Caltech Secondary and High School Saturday Program," - taught various mathematics (algebra through calculus) and science (physics and chemistry) courses to high school students, 1983-1989.

"Heat Transfer," - taught this course in the Fall and Winter terms of 1994-1995 in the Division of Engineering and Applied Science.

“Thermodynamics and Heat Transfer,” Fall and Winter Terms of 1996-1997.

U.C. Riverside, Extension

"Toxic and Hazardous Air Contaminants," University of California Extension Program, Riverside, California. Various years since 1992.

"Prevention and Management of Accidental Air Emissions," University of California Extension Program, Riverside, California. Various years since 1992.

"Air Pollution Control Systems and Strategies," University of California Extension Program, Riverside, California, Summer 1992-93, Summer 1993-1994.

"Air Pollution Calculations," University of California Extension Program, Riverside, California, Fall 1993-94, Winter 1993-94, Fall 1994-95.

"Process Safety Management," University of California Extension Program, Riverside, California. Various years since 1992-2010.

"Process Safety Management," University of California Extension Program, Riverside, California, at SCAQMD, Spring 1993-94.

"Advanced Hazard Analysis - A Special Course for LEPCs," University of California Extension Program, Riverside, California, taught at San Diego, California, Spring 1993-1994.

“Advanced Hazardous Waste Management” University of California Extension Program, Riverside, California. 2005.

Loyola Marymount University

"Fundamentals of Air Pollution - Regulations, Controls and Engineering," Loyola Marymount University, Dept. of Civil Engineering. Various years since 1993.

"Air Pollution Control," Loyola Marymount University, Dept. of Civil Engineering, Fall 1994.

“Environmental Risk Assessment,” Loyola Marymount University, Dept. of Civil Engineering. Various years since 1998.

“Hazardous Waste Remediation” Loyola Marymount University, Dept. of Civil Engineering. Various years since 2006.

University of Southern California

"Air Pollution Controls," University of Southern California, Dept. of Civil Engineering, Fall 1993, Fall 1994.

"Air Pollution Fundamentals," University of Southern California, Dept. of Civil Engineering, Winter 1994.

University of California, Los Angeles

"Air Pollution Fundamentals," University of California, Los Angeles, Dept. of Civil and Environmental Engineering, Spring 1994, Spring 1999, Spring 2000, Spring 2003, Spring 2006, Spring 2007, Spring 2008, Spring 2009.

International Programs

“Environmental Planning and Management,” 5 week program for visiting Chinese delegation, 1994.

“Environmental Planning and Management,” 1 day program for visiting Russian delegation, 1995.

“Air Pollution Planning and Management,” IEP, UCR, Spring 1996.

“Environmental Issues and Air Pollution,” IEP, UCR, October 1996.

PROFESSIONAL AFFILIATIONS AND HONORS

President of India Gold Medal, IIT Kharagpur, India, 1983.

Member of the Alternatives Assessment Committee of the Grand Canyon Visibility Transport Commission, established by the Clean Air Act Amendments of 1990, 1992.

American Society of Mechanical Engineers: Los Angeles Section Executive Committee, Heat Transfer Division, and Fuels and Combustion Technology Division, 1987-mid-1990s.

Air and Waste Management Association, West Coast Section, 1989-mid-2000s.

PROFESSIONAL CERTIFICATIONS

EIT, California (#XE088305), 1993.

REA I, California (#07438), 2000.

Certified Permitting Professional, South Coast AQMD (#C8320), since 1993.

QEP, Institute of Professional Environmental Practice, since 2000.

CEM, State of Nevada (#EM-1699). Expiration 10/07/2021.

PUBLICATIONS (PARTIAL LIST)

"Physical Properties and Oxidation Rates of Chars from Bituminous Coals," with Y.A. Levendis, R.C. Flagan and G.R. Gavalas, *Fuel*, **67**, 275-283 (1988).

"Char Combustion: Measurement and Analysis of Particle Temperature Histories," with R.C. Flagan, G.R. Gavalas and P.S. Northrop, *Comb. Sci. Tech.* **60**, 215-230 (1988).

"On the Combustion of Bituminous Coal Chars," PhD Thesis, California Institute of Technology (1988).

"Optical Pyrometry: A Powerful Tool for Coal Combustion Diagnostics," *J. Coal Quality*, **8**, 17-22 (1989).

"Post-Ignition Transients in the Combustion of Single Char Particles," with Y.A. Levendis, R.C. Flagan and G.R. Gavalas, *Fuel*, **68**, 849-855 (1989).

"A Model for Single Particle Combustion of Bituminous Coal Char." Proc. ASME National Heat Transfer Conference, Philadelphia, **HTD-Vol. 106**, 505-513 (1989).

"Discrete Simulation of Cenospheric Coal-Char Combustion," with R.C. Flagan and G.R. Gavalas, *Combust. Flame*, **77**, 337-346 (1989).

"Particle Measurements in Coal Combustion," with R.C. Flagan, in "**Combustion Measurements**" (ed. N. Chigier), Hemisphere Publishing Corp. (1991).

"Cross Linking in Pore Structures and Its Effect on Reactivity," with G.R. Gavalas in preparation.

"Natural Frequencies and Mode Shapes of Straight Tubes," Proprietary Report for Heat Transfer Research Institute, Alhambra, CA (1990).

"Optimal Tube Layouts for Kamui SL-Series Exchangers," with K. Ishihara, Proprietary Report for Kamui Company Limited, Tokyo, Japan (1990).

"HTRI Process Heater Conceptual Design," Proprietary Report for Heat Transfer Research Institute, Alhambra, CA (1990).

"Asymptotic Theory of Transonic Wind Tunnel Wall Interference," with N.D. Malmuth and others, Arnold Engineering Development Center, Air Force Systems Command, USAF (1990).

"Gas Radiation in a Fired Heater Convection Section," Proprietary Report for Heat Transfer Research Institute, College Station, TX (1990).

"Heat Transfer and Pressure Drop in NTIW Heat Exchangers," Proprietary Report for Heat Transfer Research Institute, College Station, TX (1991).

"NOx Control and Thermal Design," Thermal Engineering Tech Briefs, (1994).

“From Purchase of Landmark Environmental Insurance to Remediation: Case Study in Henderson, Nevada,” with Robin E. Bain and Jill Quillin, presented at the AQMA Annual Meeting, Florida, 2001.

“The Jones Act Contribution to Global Warming, Acid Rain and Toxic Air Contaminants,” with Charles W. Botsford, presented at the AQMA Annual Meeting, Florida, 2001.

PRESENTATIONS (PARTIAL LIST)

"Pore Structure and Combustion Kinetics - Interpretation of Single Particle Temperature-Time Histories," with P.S. Northrop, R.C. Flagan and G.R. Gavalas, presented at the AIChE Annual Meeting, New York (1987).

"Measurement of Temperature-Time Histories of Burning Single Coal Char Particles," with R.C. Flagan, presented at the American Flame Research Committee Fall International Symposium, Pittsburgh, (1988).

"Physical Characterization of a Cenospheric Coal Char Burned at High Temperatures," with R.C. Flagan and G.R. Gavalas, presented at the Fall Meeting of the Western States Section of the Combustion Institute, Laguna Beach, California (1988).

"Control of Nitrogen Oxide Emissions in Gas Fired Heaters - The Retrofit Experience," with G. P. Croce and R. Patel, presented at the International Conference on Environmental Control of Combustion Processes (Jointly sponsored by the American Flame Research Committee and the Japan Flame Research Committee), Honolulu, Hawaii (1991).

"Air Toxics - Past, Present and the Future," presented at the Joint AIChE/AAEE Breakfast Meeting at the AIChE 1991 Annual Meeting, Los Angeles, California, November 17-22 (1991).

"Air Toxics Emissions and Risk Impacts from Automobiles Using Reformulated Gasolines," presented at the Third Annual Current Issues in Air Toxics Conference, Sacramento, California, November 9-10 (1992).

"Air Toxics from Mobile Sources," presented at the Environmental Health Sciences (ESE) Seminar Series, UCLA, Los Angeles, California, November 12, (1992).

"Kilns, Ovens, and Dryers - Present and Future," presented at the Gas Company Air Quality Permit Assistance Seminar, Industry Hills Sheraton, California, November 20, (1992).

"The Design and Implementation of Vehicle Scrapping Programs," presented at the 86th Annual Meeting of the Air and Waste Management Association, Denver, Colorado, June 12, 1993.

"Air Quality Planning and Control in Beijing, China," presented at the 87th Annual Meeting of the Air and Waste Management Association, Cincinnati, Ohio, June 19-24, 1994.

Annex A

Expert Litigation Support

A. Occasions where Dr. Sahu has provided Written or Oral testimony before Congress:

1. In July 2012, provided expert written and oral testimony to the House Subcommittee on Energy and the Environment, Committee on Science, Space, and Technology at a Hearing entitled "Hitting the Ethanol Blend Wall – Examining the Science on E15."

B. Matters for which Dr. Sahu has provided affidavits and expert reports include:

2. Affidavit for Rocky Mountain Steel Mills, Inc. located in Pueblo Colorado – dealing with the technical uncertainties associated with night-time opacity measurements in general and at this steel mini-mill.

3. Expert reports and depositions (2/28/2002 and 3/1/2002; 12/2/2003 and 12/3/2003; 5/24/2004) on behalf of the United States in connection with the Ohio Edison NSR Cases. *United States, et al. v. Ohio Edison Co., et al.*, C2-99-1181 (Southern District of Ohio).

4. Expert reports and depositions (5/23/2002 and 5/24/2002) on behalf of the United States in connection with the Illinois Power NSR Case. *United States v. Illinois Power Co., et al.*, 99-833-MJR (Southern District of Illinois).

5. Expert reports and depositions (11/25/2002 and 11/26/2002) on behalf of the United States in connection with the Duke Power NSR Case. *United States, et al. v. Duke Energy Corp.*, 1:00-CV-1262 (Middle District of North Carolina).

6. Expert reports and depositions (10/6/2004 and 10/7/2004; 7/10/2006) on behalf of the United States in connection with the American Electric Power NSR Cases. *United States, et al. v. American Electric Power Service Corp., et al.*, C2-99-1182, C2-99-1250 (Southern District of Ohio).

7. Affidavit (March 2005) on behalf of the Minnesota Center for Environmental Advocacy and others in the matter of the Application of Heron Lake BioEnergy LLC to construct and operate an ethanol production facility – submitted to the Minnesota Pollution Control Agency.

8. Expert Report and Deposition (10/31/2005 and 11/1/2005) on behalf of the United States in connection with the East Kentucky Power Cooperative NSR Case. *United States v. East Kentucky Power Cooperative, Inc*., 5:04-cv-00034-KSF (Eastern District of Kentucky).

9. Affidavits and deposition on behalf of Basic Management Inc. (BMI) Companies in connection with the BMI vs. USA remediation cost recovery Case.

10. Expert Report on behalf of Penn Future and others in the Cambria Coke plant permit challenge in Pennsylvania.

11. Expert Report on behalf of the Appalachian Center for the Economy and the Environment and others in the Western Greenbrier permit challenge in West Virginia.

12. Expert Report, deposition (via telephone on January 26, 2007) on behalf of various Montana petitioners (Citizens Awareness Network (CAN), Women's Voices for the Earth (WVE) and the Clark Fork Coalition (CFC)) in the Thompson River Cogeneration LLC Permit No. 3175-04 challenge.

13. Expert Report and deposition (2/2/07) on behalf of the Texas Clean Air Cities Coalition at the Texas State Office of Administrative Hearings (SOAH) in the matter of the permit challenges to TXU Project Apollo's eight new proposed PRB-fired PC boilers located at seven TX sites.

14. Expert Testimony (July 2007) on behalf of the Izaak Walton League of America and others in connection with the acquisition of power by Xcel Energy from the proposed Gascoyne Power Plant – at the State of Minnesota, Office of Administrative Hearings for the Minnesota PUC (MPUC No. E002/CN-06-1518; OAH No. 12-2500-17857-2).

15. Affidavit (July 2007) Comments on the Big Cajun I Draft Permit on behalf of the Sierra Club – submitted to the Louisiana DEQ.

16. Expert Report and Deposition (12/13/2007) on behalf of Commonwealth of Pennsylvania – Dept. of Environmental Protection, State of Connecticut, State of New York, and State of New Jersey (Plaintiffs) in connection with the Allegheny Energy NSR Case. *Plaintiffs v. Allegheny Energy Inc., et al.*, 2:05cv0885 (Western District of Pennsylvania).

17. Expert Reports and Pre-filed Testimony before the Utah Air Quality Board on behalf of Sierra Club in the Sevier Power Plant permit challenge.

18. Expert Report and Deposition (October 2007) on behalf of MTD Products Inc., in connection with *General Power Products, LLC v MTD Products Inc.*, 1:06 CVA 0143 (Southern District of Ohio, Western Division) .

19. Expert Report and Deposition (June 2008) on behalf of Sierra Club and others in the matter of permit challenges (Title V: 28.0801-29 and PSD: 28.0803-PSD) for the Big Stone II unit, proposed to be located near Milbank, South Dakota.

20. Expert Reports, Affidavit, and Deposition (August 15, 2008) on behalf of Earthjustice in the matter of air permit challenge (CT-4631) for the Basin Electric Dry Fork station, under construction near Gillette, Wyoming before the Environmental Quality Council of the State of Wyoming.

21. Affidavits (May 2010/June 2010 in the Office of Administrative Hearings))/Declaration and Expert Report (November 2009 in the Office of Administrative Hearings) on behalf of NRDC and the Southern Environmental Law Center in the matter of the air permit challenge for Duke Cliffside Unit 6. Office of Administrative Hearing Matters 08 EHR 0771, 0835 and 0836 and 09 HER 3102, 3174, and 3176 (consolidated).

22. Declaration (August 2008), Expert Report (January 2009), and Declaration (May 2009) on behalf of Southern Alliance for Clean Energy in the matter of the air permit challenge for Duke Cliffside Unit 6. *Southern Alliance for Clean Energy et al., v. Duke Energy Carolinas, LLC*, Case No. 1:08-cv-00318-LHT-DLH (Western District of North Carolina, Asheville Division).

23. Declaration (August 2008) on behalf of the Sierra Club in the matter of Dominion Wise County plant MACT.us

24. Expert Report (June 2008) on behalf of Sierra Club for the Green Energy Resource Recovery Project, MACT Analysis.

25. Expert Report (February 2009) on behalf of Sierra Club and the Environmental Integrity Project in the matter of the air permit challenge for NRG Limestone's proposed Unit 3 in Texas.

26. Expert Report (June 2009) on behalf of MTD Products, Inc., in the matter of *Alice Holmes and Vernon Holmes v. Home Depot USA, Inc., et al.*

27. Expert Report (August 2009) on behalf of Sierra Club and the Southern Environmental Law Center in the matter of the air permit challenge for Santee Cooper's proposed Pee Dee plant in South Carolina).

28. Statements (May 2008 and September 2009) on behalf of the Minnesota Center for Environmental Advocacy to the Minnesota Pollution Control Agency in the matter of the Minnesota Haze State Implementation Plans.

29. Expert Report (August 2009) on behalf of Environmental Defense, in the matter of permit challenges to the proposed Las Brisas coal fired power plant project at the Texas State Office of Administrative Hearings (SOAH).

30. Expert Report and Rebuttal Report (September 2009) on behalf of the Sierra Club, in the matter of challenges to the proposed Medicine Bow Fuel and Power IGL plant in Cheyenne, Wyoming.

31. Expert Report (December 2009) and Rebuttal reports (May 2010 and June 2010) on behalf of the United States in connection with the Alabama Power Company NSR Case. *United States v. Alabama Power Company*, CV-01-HS-152-S (Northern District of Alabama, Southern Division).

32. Pre-filed Testimony (October 2009) on behalf of Environmental Defense and others, in the matter of challenges to the proposed White Stallion Energy Center coal fired power plant project at the Texas State Office of Administrative Hearings (SOAH).

33. Pre-filed Testimony (July 2010) and Written Rebuttal Testimony (August 2010) on behalf of the State of New Mexico Environment Department in the matter of Proposed Regulation 20.2.350 NMAC – *Greenhouse Gas Cap and Trade Provisions*, No. EIB 10-04 (R), to the State of New Mexico, Environmental Improvement Board.

34. Expert Report (August 2010) and Rebuttal Expert Report (October 2010) on behalf of the United States in connection with the Louisiana Generating NSR

Case. *United States v. Louisiana Generating, LLC*, 09-CV100-RET-CN (Middle District of Louisiana) – Liability Phase.

35. Declaration (August 2010), Reply Declaration (November 2010), Expert Report (April 2011), Supplemental and Rebuttal Expert Report (July 2011) on behalf of the United States in the matter of DTE Energy Company and Detroit Edison Company (Monroe Unit 2). *United States of America v. DTE Energy Company and Detroit Edison Company*, Civil Action No. 2:10-cv-13101-BAF-RSW (Eastern District of Michigan).

36. Expert Report and Deposition (August 2010) as well as Affidavit (September 2010) on behalf of Kentucky Waterways Alliance, Sierra Club, and Valley Watch in the matter of challenges to the NPDES permit issued for the Trimble County power plant by the Kentucky Energy and Environment Cabinet to Louisville Gas and Electric, File No. DOW-41106-047.

37. Expert Report (August 2010), Rebuttal Expert Report (September 2010), Supplemental Expert Report (September 2011), and Declaration (November 2011) on behalf of Wild Earth Guardians in the matter of opacity exceedances and monitor downtime at the Public Service Company of Colorado (Xcel)'s Cherokee power plant. No. 09-cv-1862 (District of Colorado).

38. Written Direct Expert Testimony (August 2010) and Affidavit (February 2012) on behalf of Fall-Line Alliance for a Clean Environment and others in the matter of the PSD Air Permit for Plant Washington issued by Georgia DNR at the Office of State Administrative Hearing, State of Georgia (OSAH-BNR-AQ-1031707-98-WALKER).

39. Deposition (August 2010) on behalf of Environmental Defense, in the matter of the remanded permit challenge to the proposed Las Brisas coal fired power plant project at the Texas State Office of Administrative Hearings (SOAH).

40. Expert Report, Supplemental/Rebuttal Expert Report, and Declarations (October 2010, November 2010, September 2012) on behalf of New Mexico Environment Department (Plaintiff-Intervenor), Grand Canyon Trust and Sierra Club (Plaintiffs) in the matter of *Plaintiffs v. Public Service Company of New Mexico* (PNM), Civil No. 1:02-CV-0552 BB/ATC (ACE) (District of New Mexico).

41. Expert Report (October 2010) and Rebuttal Expert Report (November 2010) (BART Determinations for PSCo Hayden and CSU Martin Drake units) to the Colorado Air Quality Commission on behalf of Coalition of Environmental Organizations.

42. Expert Report (November 2010) (BART Determinations for TriState Craig Units, CSU Nixon Unit, and PRPA Rawhide Unit) to the Colorado Air Quality Commission on behalf of Coalition of Environmental Organizations.

43. Declaration (November 2010) on behalf of the Sierra Club in connection with the Martin Lake Station Units 1, 2, and 3. *Sierra Club v. Energy Future Holdings Corporation and Luminant Generation Company LLC*, Case No. 5:10-cv-00156-DF-CMC (Eastern District of Texas, Texarkana Division).

44. Pre-Filed Testimony (January 2011) and Declaration (February 2011) to the Georgia Office of State Administrative Hearings (OSAH) in the matter of Minor Source HAPs status for the proposed Longleaf Energy Associates power plant (OSAH-BNR-AQ-1115157-60-HOWELLS) on behalf of the Friends of the Chattahoochee and the Sierra Club).

45. Declaration (February 2011) in the matter of the Draft Title V Permit for RRI Energy MidAtlantic Power Holdings LLC Shawville Generating Station (Pennsylvania), ID No. 17-00001 on behalf of the Sierra Club.

46. Expert Report (March 2011), Rebuttal Expert Report (June 2011) on behalf of the United States in *United States of America v. Cemex, Inc.*, Civil Action No. 09-cv-00019-MSK-MEH (District of Colorado).

47. Declaration (April 2011) and Expert Report (July 16, 2012) in the matter of the Lower Colorado River Authority (LCRA)'s Fayette (Sam Seymour) Power Plant on behalf of the Texas Campaign for the Environment. *Texas Campaign for the Environment v. Lower Colorado River Authority,* Civil Action No. 4:11-cv-00791 (Southern District of Texas, Houston Division).

48. Declaration (June 2011) on behalf of the Plaintiffs MYTAPN in the matter of Microsoft-Yes, Toxic Air Pollution-No (MYTAPN) v. State of Washington, Department of Ecology and Microsoft Corporation Columbia Data Center to the Pollution Control Hearings Board, State of Washington, Matter No. PCHB No. 10-162.

49. Expert Report (June 2011) on behalf of the New Hampshire Sierra Club at the State of New Hampshire Public Utilities Commission, Docket No. 10-261 – the 2010 Least Cost Integrated Resource Plan (LCIRP) submitted by the Public Service Company of New Hampshire (re. Merrimack Station Units 1 and 2).

50. Declaration (August 2011) in the matter of the Sandy Creek Energy Associates L.P. Sandy Creek Power Plant on behalf of Sierra Club and Public Citizen. *Sierra Club, Inc. and Public Citizen, Inc. v. Sandy Creek Energy Associates, L.P.*, Civil Action No. A-08-CA-648-LY (Western District of Texas, Austin Division).

51. Expert Report (October 2011) on behalf of the Defendants in the matter of *John Quiles and Jeanette Quiles et al. v. Bradford-White Corporation, MTD Products, Inc., Kohler Co., et al.,* Case No. 3:10-cv-747 (TJM/DEP) (Northern District of New York).

52. Declaration (October 2011) on behalf of the Plaintiffs in the matter of *American Nurses Association et. al. (Plaintiffs), v. US EPA (Defendant)*, Case No. 1:08-cv-02198-RMC (US District Court for the District of Columbia).

53. Declaration (February 2012) and Second Declaration (February 2012) in the matter of *Washington Environmental Council and Sierra Club Washington State Chapter v. Washington State Department of Ecology and Western States Petroleum Association,* Case No. 11-417-MJP (Western District of Washington).

54. Expert Report (March 2012) and Supplemental Expert Report (November 2013) in the matter of *Environment Texas Citizen Lobby, Inc and Sierra Club v.*

ExxonMobil Corporation et al., Civil Action No. 4:10-cv-4969 (Southern District of Texas, Houston Division).

55. Declaration (March 2012) in the matter of *Center for Biological Diversity, et al. v. United States Environmental Protection Agency,* Case No. 11-1101 (consolidated with 11-1285, 11-1328 and 11-1336) (US Court of Appeals for the District of Columbia Circuit).

56. Declaration (March 2012) in the matter of *Sierra Club v. The Kansas Department of Health and Environment*, Case No. 11-105,493-AS (Holcomb power plant) (Supreme Court of the State of Kansas).

57. Declaration (March 2012) in the matter of the Las Brisas Energy Center *Environmental Defense Fund et al., v. Texas Commission on Environmental Quality,* Cause No. D-1-GN-11-001364 (District Court of Travis County, Texas, 261st Judicial District).

58. Expert Report (April 2012), Supplemental and Rebuttal Expert Report (July 2012), and Supplemental Rebuttal Expert Report (August 2012) on behalf of the states of New Jersey and Connecticut in the matter of the Portland Power plant *State of New Jersey and State of Connecticut (Intervenor-Plaintiff) v. RRI Energy Mid-Atlantic Power Holdings et al.,* Civil Action No. 07-CV-5298 (JKG) (Eastern District of Pennsylvania).

59. Declaration (April 2012) in the matter of the EPA's EGU MATS Rule, on behalf of the Environmental Integrity Project.

60. Expert Report (August 2012) on behalf of the United States in connection with the Louisiana Generating NSR Case. *United States v. Louisiana Generating, LLC,* 09-CV100-RET-CN (Middle District of Louisiana) – Harm Phase.

61. Declaration (September 2012) in the Matter of the Application of *Energy Answers Incinerator, Inc.* for a Certificate of Public Convenience and Necessity to Construct a 120 MW Generating Facility in Baltimore City, Maryland, before the Public Service Commission of Maryland, Case No. 9199.

62. Expert Report (October 2012) on behalf of the Appellants (Robert Concilus and Leah Humes) in the matter of Robert Concilus and Leah Humes v. Commonwealth of Pennsylvania Department of Environmental Protection and Crawford Renewable Energy, before the Commonwealth of Pennsylvania Environmental Hearing Board, Docket No. 2011-167-R.

63. Expert Report (October 2012), Supplemental Expert Report (January 2013), and Affidavit (June 2013) in the matter of various Environmental Petitioners v. North Carolina DENR/DAQ and Carolinas Cement Company, before the Office of Administrative Hearings, State of North Carolina.

64. Pre-filed Testimony (October 2012) on behalf of No-Sag in the matter of the North Springfield Sustainable Energy Project before the State of Vermont, Public Service Board.

65. Pre-filed Testimony (November 2012) on behalf of Clean Wisconsin in the matter of Application of Wisconsin Public Service Corporation for Authority to

Construct and Place in Operation a New Multi-Pollutant Control Technology System (ReACT) for Unit 3 of the Weston Generating Station, before the Public Service Commission of Wisconsin, Docket No. 6690-CE-197.

66. Expert Report (February 2013) on behalf of Petitioners in the matter of Credence Crematory, Cause No. 12-A-J-4538 before the Indiana Office of Environmental Adjudication.

67. Expert Report (April 2013), Rebuttal report (July 2013), and Declarations (October 2013, November 2013) on behalf of the Sierra Club in connection with the Luminant Big Brown Case. *Sierra Club v. Energy Future Holdings Corporation and Luminant Generation Company LLC*, Civil Action No. 6:12-cv-00108-WSS (Western District of Texas, Waco Division).

68. Declaration (April 2013) on behalf of Petitioners in the matter of *Sierra Club, et al., (Petitioners) v Environmental Protection Agency et al. (Resppondents)*, Case No., 13-1112, (Court of Appeals, District of Columbia Circuit).

69. Expert Report (May 2013) and Rebuttal Expert Report (July 2013) on behalf of the Sierra Club in connection with the Luminant Martin Lake Case. *Sierra Club v. Energy Future Holdings Corporation and Luminant Generation Company LLC*, Civil Action No. 5:10-cv-0156-MHS-CMC (Eastern District of Texas, Texarkana Division).

70. Declaration (August 2013) on behalf of A. J. Acosta Company, Inc., in the matter of *A. J. Acosta Company, Inc., v. County of San Bernardino*, Case No. CIVSS803651.

71. Comments (October 2013) on behalf of the Washington Environmental Council and the Sierra Club in the matter of the Washington State Oil Refinery RACT (for Greenhouse Gases), submitted to the Washington State Department of Ecology, the Northwest Clean Air Agency, and the Puget Sound Clean Air Agency.

72. Statement (November 2013) on behalf of various Environmental Organizations in the matter of the Boswell Energy Center (BEC) Unit 4 Environmental Retrofit Project, to the Minnesota Public Utilities Commission, Docket No. E-015/M-12-920.

73. Expert Report (December 2013) on behalf of the United States in *United States of America v. Ameren Missouri*, Civil Action No. 4:11-cv-00077-RWS (Eastern District of Missouri, Eastern Division).

74. Expert Testimony (December 2013) on behalf of the Sierra Club in the matter of Public Service Company of New Hampshire Merrimack Station Scrubber Project and Cost Recovery, Docket No. DE 11-250, to the State of New Hampshire Public Utilities Commission.

75. Expert Report (January 2014) on behalf of Baja, Inc., in *Baja, Inc., v. Automotive Testing and Development Services, Inc. et. al*, Civil Action No. 8:13-CV-02057-GRA (District of South Carolina, Anderson/Greenwood Division).

76. Declaration (March 2014) on behalf of the Center for International Environmental Law, Chesapeake Climate Action Network, Friends of the Earth, Pacific

Environment, and the Sierra Club (Plaintiffs) in the matter of *Plaintiffs v. the Export-Import Bank (Ex-Im Bank) of the United States*, Civil Action No. 13-1820 RC (District Court for the District of Columbia).

77. Declaration (April 2014) on behalf of Respondent-Intervenors in the matter of *Mexichem Specialty Resins Inc., et al., (Petitioners) v Environmental Protection Agency et al.,* Case No., 12-1260 (and Consolidated Case Nos. 12-1263, 12-1265, 12-1266, and 12-1267), (Court of Appeals, District of Columbia Circuit).

78. Direct Prefiled Testimony (June 2014) on behalf of the Michigan Environmental Council and the Sierra Club in the matter of the Application of DTE Electric Company for Authority to Implement a Power Supply Cost Recovery (PSCR) Plan in its Rate Schedules for 2014 Metered Jurisdictional Sales of Electricity, Case No. U-17319 (Michigan Public Service Commission).

79. Expert Report (June 2014) on behalf of ECM Biofilms in the matter of the US Federal Trade Commission (FTC) v. ECM Biofilms (FTC Docket #9358).

80. Direct Prefiled Testimony (August 2014) on behalf of the Michigan Environmental Council and the Sierra Club in the matter of the Application of Consumers Energy Company for Authority to Implement a Power Supply Cost Recovery (PSCR) Plan in its Rate Schedules for 2014 Metered Jurisdictional Sales of Electricity, Case No. U-17317 (Michigan Public Service Commission).

81. Declaration (July 2014) on behalf of Public Health Intervenors in the matter of *EME Homer City Generation v. US EPA* (Case No. 11-1302 and consolidated cases) relating to the lifting of the stay entered by the Court on December 30, 2011 (US Court of Appeals for the District of Columbia).

82. Expert Report (September 2014), Rebuttal Expert Report (December 2014) and Supplemental Expert Report (March 2015) on behalf of Plaintiffs in the matter of *Sierra Club and Montana Environmental Information Center (Plaintiffs) v. PPL Montana LLC, Avista Corporation, Puget Sound Energy, Portland General Electric Company, Northwestern Corporation, and Pacificorp (Defendants)*, Civil Action No. CV 13-32-BLG-DLC-JCL (US District Court for the District of Montana, Billings Division).

83. Expert Report (November 2014) on behalf of Niagara County, the Town of Lewiston, and the Villages of Lewiston and Youngstown in the matter of CWM Chemical Services, LLC New York State Department of Environmental Conservation (NYSDEC) Permit Application Nos.: 9-2934-00022/00225, 9-2934-00022/00231, 9-2934-00022/00232, and 9-2934-00022/00249 (pending).

84. *Declaration (January 2015) relating to Startup/Shutdown in the MATS Rule (EPA Docket ID No. EPA-HQ-OAR-2009-0234) on behalf of the Environmental Integrity Project.*

85. Pre-filed Direct Testimony (March 2015), Supplemental Testimony (May 2015), and Surrebuttal Testimony (December 2015) on behalf of Friends of the Columbia Gorge in the matter of the Application for a Site Certificate for the Troutdale Energy Center before the Oregon Energy Facility Siting Council.

86. Brief of Amici Curiae Experts in Air Pollution Control and Air Quality Regulation in Support of the Respondents, On Writs of Certiorari to the US Court of Appeals for the District of Columbia, No. 14-46, 47, 48. *Michigan et. al., (Petitioners) v. EPA et. al., Utility Air Regulatory Group (Petitioners) v. EPA et. al., National Mining Association et. al., (Petitioner) v. EPA et. al.,* (Supreme Court of the United States).

87. Expert Report (March 2015) and Rebuttal Expert Report (January 2016) on behalf of Plaintiffs in the matter of *Conservation Law Foundation v. Broadrock Gas Services LLC, Rhode Island LFG GENCO LLC, and Rhode Island Resource Recovery Corporation (Defendants),* Civil Action No. 1:13-cv-00777-M-PAS (US District Court for the District of Rhode Island).

88. Declaration (April 2015) relating to various Technical Corrections for the MATS Rule (EPA Docket ID No. EPA-HQ-OAR-2009-0234) on behalf of the Environmental Integrity Project.

89. Direct Prefiled Testimony (May 2015) on behalf of the Michigan Environmental Council, the Natural Resources Defense Council, and the Sierra Club in the matter of the Application of DTE Electric Company for Authority to Increase its Rates, Amend its Rate Schedules and Rules Governing the Distribution and Supply of Electric Energy and for Miscellaneous Accounting Authority, Case No. U-17767 (Michigan Public Service Commission).

90. Expert Report (July 2015) and Rebuttal Expert Report (July 2015) on behalf of Plaintiffs in the matter of *Northwest Environmental Defense Center et. al., v. Cascade Kelly Holdings LLC, d/b/a Columbia Pacific Bio-Refinery, and Global Partners LP (Defendants),* Civil Action No. 3:14-cv-01059-SI (US District Court for the District of Oregon, Portland Division).

91. Declaration (August 2015, Docket No. 1570376) in support of "Opposition of Respondent-Intervenors American Lung Association, et. al., to Tri-State Generation's Emergency Motion;" Declaration (September 2015, Docket No. 1574820) in support of "Joint Motion of the State, Local Government, and Public Health Respondent-Intervenors for Remand Without Vacatur;" Declaration (October 2015) in support of "Joint Motion of the State, Local Government, and Public Health Respondent-Intervenors to State and Certain Industry Petitioners' Motion to Govern, *White Stallion Energy Center, LLC v. US EPA,* Case No. 12-1100 (US Court of Appeals for the District of Columbia).

92. Declaration (September 2015) in support of the Draft Title V Permit for Dickerson Generating Station (Proposed Permit No 24-031-0019) on behalf of the Environmental Integrity Project.

93. Expert Report (Liability Phase) (December 2015) and Rebuttal Expert Report (February 2016) on behalf of Plaintiffs in the matter of *Natural Resources Defense Council, Inc., Sierra Club, Inc., Environmental Law and Policy Center, and Respiratory Health Association v. Illinois Power Resources LLC, and Illinois Power Resources Generating LLC (Defendants),* Civil Action No. 1:13-cv-01181 (US District Court for the Central District of Illinois, Peoria Division).

94. Declaration (December 2015) in support of the Petition to Object to the Title V Permit for Morgantown Generating Station (Proposed Permit No 24-017-0014) on behalf of the Environmental Integrity Project.

95. Expert Report (November 2015) on behalf of Appellants in the matter of *Sierra Club, et al. v. Craig W. Butler, Director of Ohio Environmental Protection Agency et al.*, ERAC Case No. 14-256814.

96. Affidavit (January 2016) on behalf of Bridgewatch Detroit in the matter of *Bridgewatch Detroit v. Waterfront Petroleum Terminal Co., and Waterfront Terminal Holdings, LLC.*, in the Circuit Court for the County of Wayne, State of Michigan.

97. Expert Report (February 2016) and Rebuttal Expert Report (July 2016) on behalf of the challengers in the matter of the Delaware Riverkeeper Network, Clean Air Council, et. al., vs. Commonwealth of Pennsylvania Department of Environmental Protection and R. E. Gas Development LLC regarding the Geyer well site before the Pennsylvania Environmental Hearing Board.

98. Direct Testimony (May 2016) in the matter of Tesoro Savage LLC Vancouver Energy Distribution Terminal, Case No. 15-001 before the State of Washington Energy Facility Site Evaluation Council.

99. Declaration (June 2016) relating to deficiencies in air quality analysis for the proposed Millenium Bulk Terminal, Port of Longview, Washington.

100. Declaration (December 2016) relating to EPA's refusal to set limits on PM emissions from coal-fired power plants that reflect pollution reductions achievable with fabric filters on behalf of Environmental Integrity Project, Clean Air Council, Chesapeake Climate Action Network, Downwinders at Risk represented by Earthjustice in the matter of *ARIPPA v EPA, Case No. 15-1180.* (D.C. Circuit Court of Appeals).

101. Expert Report (January 2017) on the Environmental Impacts Analysis associated with the Huntley and Huntley Poseidon Well Pad on behalf citizens in the matter of the special exception use Zoning Hearing Board of Penn Township, Westmoreland County, Pennsylvania.

102. Expert Report (January 2017) on the Environmental Impacts Analysis associated with the Apex Energy Backus Well Pad on behalf citizens in the matter of the special exception use Zoning Hearing Board of Penn Township, Westmoreland County, Pennsylvania.

103. Expert Report (January 2017) on the Environmental Impacts Analysis associated with the Apex Energy Drakulic Well Pad on behalf citizens in the matter of the special exception use Zoning Hearing Board of Penn Township, Westmoreland County, Pennsylvania.

104. Expert Report (January 2017) on the Environmental Impacts Analysis associated with the Apex Energy Deutsch Well Pad on behalf citizens in the matter of the special exception use Zoning Hearing Board of Penn Township, Westmoreland County, Pennsylvania.

105. Affidavit (February 2017) pertaining to deficiencies water discharge compliance issues at the Wood River Refinery in the matter of *People of the State of Illinois (Plaintiff) v. Phillips 66 Company, ConocoPhillips Company, WRB Refining LP (Defendants)*, Case No. 16-CH-656, (Circuit Court for the Third Judicial Circuit, Madison County, Illinois).

106. Expert Report (March 2017) on behalf of the Plaintiff pertaining to non-degradation analysis for waste water discharges from a power plant in the matter of *Sierra Club (Plaintiff) v. Pennsylvania Department of Environmental Protection (PADEP) and Lackawanna Energy Center*, Docket No. 2016-047-L (consolidated), (Pennsylvania Environmental Hearing Board).

107. Expert Report (March 2017) on behalf of the Plaintiff pertaining to air emissions from the Heritage incinerator in East Liverpool, Ohio in the matter of *Save our County (Plaintiff) v. Heritage Thermal Services, Inc. (Defendant), Case No. 4:16-CV-1544-BYP*, (US District Court for the Northern District of Ohio, Eastern Division).

108. Rebuttal Expert Report (June 2017) on behalf of Plaintiffs in the matter of *Casey Voight and Julie Voight (Plaintiffs) v Coyote Creek Mining Company LLC (Defendant),* Civil Action No. 1:15-CV-00109 (US District Court for the District of North Dakota, Western Division).

109. Expert Affidavit (August 2017) and Penalty/Remedy Expert Affidavit (October 2017) on behalf of Plaintiff in the matter of *Wildearth Guardians (Plaintiff) v Colorado Springs Utility Board (Defendant,)* Civil Action No. 1:15-cv-00357-CMA-CBS (US District Court for the District of Colorado).

110. Expert Report (August 2017) on behalf of Appellant in the matter of *Patricia Ann Troiano (Appellant) v. Upper Burrell Township Zoning Hearing Board (Appellee)*, Court of Common Pleas of Westmoreland County, Pennsylvania, Civil Division.

111. Expert Report (October 2017), Supplemental Expert Report (October 2017), and Rebuttal Expert Report (November 2017) on behalf of Defendant in the matter of *Oakland Bulk and Oversized Terminal (Plaintiff) v City of Oakland (Defendant,)* Civil Action No. 3:16-cv-07014-VC (US District Court for the Northern District of California, San Francisco Division).

112. Declaration (December 2017) on behalf of the Environmental Integrity Project in the matter of permit issuance for ATI Flat Rolled Products Holdings, Breckenridge, PA to the Allegheny County Health Department.

113. Expert Report (Harm Phase) (January 2018), Rebuttal Expert Report (Harm Phase) (May 2018) and Supplemental Expert Report (Harm Phase) (April 2019) on behalf of Plaintiffs in the matter of *Natural Resources Defense Council, Inc., Sierra Club, Inc., and Respiratory Health Association v. Illinois Power Resources LLC, and Illinois Power Resources Generating LLC (Defendants)*, Civil Action No. 1:13-cv-01181 (US District Court for the Central District of Illinois, Peoria Division).

114. Declaration (February 2018) on behalf of the Chesapeake Bay Foundation, et. al., in the matter of the Section 126 Petition filed by the state of Maryland in *State of*

Maryland v. Pruitt (Defendant), Civil Action No. JKB-17-2939 (Consolidated with No. JKB-17-2873) (US District Court for the District of Maryland).

115. Direct Pre-filed Testimony (March 2018) on behalf of the National Parks Conservation Association (NPCA) in the matter of *NPCA v State of Washington, Department of Ecology and BP West Coast Products, LLC*, PCHB No. 17-055 (Pollution Control Hearings Board for the State of Washington.

116. Expert Affidavit (April 2018) and Second Expert Affidavit (May 2018) on behalf of Petitioners in the matter of *Coosa River Basin Initiative and Sierra Club (Petitioners) v State of Georgia Environmental Protection Division, Georgia Department of Natural Resources (Respondent) and Georgia Power Company (Intervenor/Respondent)*, Docket Nos: 1825406-BNR-WW-57-Howells and 1826761-BNR-WW-57-Howells, Office of State Administrative Hearings, State of Georgia.

117. Direct Pre-filed Testimony and Affidavit (December 2018) on behalf of Sierra Club and Texas Campaign for the Environment (Appellants) in the contested case hearing before the Texas State Office of Administrative Hearings in Docket Nos. 582-18-4846, 582-18-4847 (Application of GCGV Asset Holding, LLC for Air Quality Permit Nos. 146425/PSDTX1518 and 146459/PSDTX1520 in San Patricio County, Texas).

118. Expert Report (February 2019) on behalf of Sierra Club in the State of Florida, Division of Administrative Hearings, Case No. 18-2124EPP, Tampa Electric Company Big Bend Unit 1 Modernization Project Power Plant Siting Application No. PA79-12-A2.

119. Declaration (March 2019) on behalf of Earthjustice in the matter of comments on the renewal of the Title V Federal Operating Permit for Valero Houston refinery.

120. Expert Report (March 2019) on behalf of Plaintiffs for Class Certification in the matter of *Resendez et al v Precision Castparts Corporation* in the Circuit Court for the State of Oregon, County of Multnomah, Case No. 16cv16164.

121. Expert Report (June 2019), Affidavit (July 2019) and Rebuttal Expert Report (September 2019) on behalf of Appellants relating to the NPDES permit for the Cheswick power plant in the matter of *Three Rivers Waterkeeper and Sierra Club (Appellees) v. State of Pennsylvania Department of Environmental Protection (Appellee) and NRG Power Midwest (Permittee)*, before the Commonwealth of Pennsylvania Environmental Hearing Board, EHB Docket No. 2018-088-R.

122. Affidavit/Expert Report (August 2019) relating to the appeal of air permits issued to PTTGCA on behalf of Appellants in the matter of *Sierra Club (Appellants) v. Craig Butler, Director, et. al., Ohio EPA (Appellees)* before the State of Ohio Environmental Review Appeals Commission (ERAC), Case Nos. ERAC-19-6988 through -6991.

123. Expert Report (October 2019) relating to the appeal of air permit (Plan Approval) on behalf of Appellants in the matter of *Clean Air Council and Environmental Integrity Project (Appellants) v. Commonwealth of Pennsylvania Department of Environmental Protection and Sunoco Partners Marketing and Terminals L.P.*,

before the Commonwealth of Pennsylvania Environmental Hearing Board, EHB Docket No. 2018-057-L.

124. Expert Report (December 2019) on behalf of Earthjustice in the matter of *Objection to the Issuance of PSD/NSR and Title V permits for Riverview Energy Corporation*, Dale, Indiana, before the Indiana Office of Environmental Adjudication, Cause No. 19-A-J-5073.

125. Affidavit (December 2019) on behalf of Plaintiff-Intervenor (Surfrider Foundation) in the matter of *United States and the State of Indiana (Plaintiffs), Surfrider Foundation (Plaintiff-Intervenor), and City of Chicago (Plaintiff-Intervenor) v. United States Steel Corporation (Defendant),* Civil Action No. 2:18-cv-00127 (US District Court for the Northern District of Indiana, Hammond Division).

126. Declaration (February 2020) in support of Petitioner's Motion for Stay of PSCAA NOC Order of Approval No. 11386 in the matter of the *Puyallup Tribe of Indians v. Puget Sound Clean Air Agency (PSCAA) and Puget Sound Energy (PSE), before the State of Washington Pollution Control Hearings Board*, PCHB No. P19-088.

C. Occasions where Dr. Sahu has provided oral testimony <u>in depositions, at trial or in similar proceedings</u> include the following:

127. Deposition on behalf of Rocky Mountain Steel Mills, Inc. located in Pueblo, Colorado – dealing with the manufacture of steel in mini-mills including methods of air pollution control and BACT in steel mini-mills and opacity issues at this steel mini-mill.

128. Trial Testimony (February 2002) on behalf of Rocky Mountain Steel Mills, Inc. in Denver District Court.

129. Trial Testimony (February 2003) on behalf of the United States in the Ohio Edison NSR Cases, *United States, et al. v. Ohio Edison Co., et al.*, C2-99-1181 (Southern District of Ohio).

130. Trial Testimony (June 2003) on behalf of the United States in the Illinois Power NSR Case, *United States v. Illinois Power Co., et al.*, 99-833-MJR (Southern District of Illinois).

131. Deposition (10/20/2005) on behalf of the United States in connection with the Cinergy NSR Case. *United States, et* al. *v. Cinergy Corp., et al.*, IP 99-1693-C-M/S (Southern District of Indiana).

132. Oral Testimony (August 2006) on behalf of the Appalachian Center for the Economy and the Environment re. the Western Greenbrier plant, WV before the West Virginia DEP.

133. Oral Testimony (May 2007) on behalf of various Montana petitioners (Citizens Awareness Network (CAN), Women's Voices for the Earth (WVE) and the Clark

Fork Coalition (CFC)) re. the Thompson River Cogeneration plant before the Montana Board of Environmental Review.

134. Oral Testimony (October 2007) on behalf of the Sierra Club re. the Sevier Power Plant before the Utah Air Quality Board.

135. Oral Testimony (August 2008) on behalf of the Sierra Club and Clean Water re. Big Stone Unit II before the South Dakota Board of Minerals and the Environment.

136. Oral Testimony (February 2009) on behalf of the Sierra Club and the Southern Environmental Law Center re. Santee Cooper Pee Dee units before the South Carolina Board of Health and Environmental Control.

137. Oral Testimony (February 2009) on behalf of the Sierra Club and the Environmental Integrity Project re. NRG Limestone Unit 3 before the Texas State Office of Administrative Hearings (SOAH) Administrative Law Judges.

138. Deposition (July 2009) on behalf of MTD Products, Inc., in the matter of *Alice Holmes and Vernon Holmes v. Home Depot USA, Inc., et al*.

139. Deposition (October 2009) on behalf of Environmental Defense and others, in the matter of challenges to the proposed Coleto Creek coal fired power plant project at the Texas State Office of Administrative Hearings (SOAH).

140. Deposition (October 2009) on behalf of Environmental Defense, in the matter of permit challenges to the proposed Las Brisas coal fired power plant project at the Texas State Office of Administrative Hearings (SOAH).

141. Deposition (October 2009) on behalf of the Sierra Club, in the matter of challenges to the proposed Medicine Bow Fuel and Power IGL plant in Cheyenne, Wyoming.

142. Deposition (October 2009) on behalf of Environmental Defense and others, in the matter of challenges to the proposed Tenaska coal fired power plant project at the Texas State Office of Administrative Hearings (SOAH). (April 2010).

143. Oral Testimony (November 2009) on behalf of the Environmental Defense Fund re. the Las Brisas Energy Center before the Texas State Office of Administrative Hearings (SOAH) Administrative Law Judges.

144. Deposition (December 2009) on behalf of Environmental Defense and others, in the matter of challenges to the proposed White Stallion Energy Center coal fired power plant project at the Texas State Office of Administrative Hearings (SOAH).

145. Oral Testimony (February 2010) on behalf of the Environmental Defense Fund re. the White Stallion Energy Center before the Texas State Office of Administrative Hearings (SOAH) Administrative Law Judges.

146. Deposition (June 2010) on behalf of the United States in connection with the Alabama Power Company NSR Case. *United States v. Alabama Power Company*, CV-01-HS-152-S (Northern District of Alabama, Southern Division).

147. Trial Testimony (September 2010) on behalf of Commonwealth of Pennsylvania – Dept. of Environmental Protection, State of Connecticut, State of New York, State of Maryland, and State of New Jersey (Plaintiffs) in connection with the Allegheny Energy NSR Case in US District Court in the Western District of Pennsylvania. *Plaintiffs v. Allegheny Energy Inc., et al.,* 2:05cv0885 (Western District of Pennsylvania).

148. Oral Direct and Rebuttal Testimony (September 2010) on behalf of Fall-Line Alliance for a Clean Environment and others in the matter of the PSD Air Permit for Plant Washington issued by Georgia DNR at the Office of State Administrative Hearing, State of Georgia (OSAH-BNR-AQ-1031707-98-WALKER).

149. Oral Testimony (September 2010) on behalf of the State of New Mexico Environment Department in the matter of Proposed Regulation 20.2.350 NMAC – *Greenhouse Gas Cap and Trade Provisions,* No. EIB 10-04 (R), to the State of New Mexico, Environmental Improvement Board.

150. Oral Testimony (October 2010) on behalf of the Environmental Defense Fund re. the Las Brisas Energy Center before the Texas State Office of Administrative Hearings (SOAH) Administrative Law Judges.

151. Oral Testimony (November 2010) regarding BART for PSCo Hayden, CSU Martin Drake units before the Colorado Air Quality Commission on behalf of the Coalition of Environmental Organizations.

152. Oral Testimony (December 2010) regarding BART for TriState Craig Units, CSU Nixon Unit, and PRPA Rawhide Unit) before the Colorado Air Quality Commission on behalf of the Coalition of Environmental Organizations.

153. Deposition (December 2010) on behalf of the United States in connection with the Louisiana Generating NSR Case. *United States v. Louisiana Generating, LLC,* 09-CV100-RET-CN (Middle District of Louisiana).

154. Deposition (February 2011 and January 2012) on behalf of Wild Earth Guardians in the matter of opacity exceedances and monitor downtime at the Public Service Company of Colorado (Xcel)'s Cherokee power plant. No. 09-cv-1862 (D. Colo.).

155. Oral Testimony (February 2011) to the Georgia Office of State Administrative Hearings (OSAH) in the matter of Minor Source HAPs status for the proposed Longleaf Energy Associates power plant (OSAH-BNR-AQ-1115157-60-HOWELLS) on behalf of the Friends of the Chattahoochee and the Sierra Club).

156. Deposition (August 2011) on behalf of the United States in *United States of America v. Cemex, Inc.*, Civil Action No. 09-cv-00019-MSK-MEH (District of Colorado).

157. Deposition (July 2011) and Oral Testimony at Hearing (February 2012) on behalf of the Plaintiffs MYTAPN in the matter of Microsoft-Yes, Toxic Air Pollution-No (MYTAPN) v. State of Washington, Department of Ecology and Microsoft Corporation Columbia Data Center to the Pollution Control Hearings Board, State of Washington, Matter No. PCHB No. 10-162.

158. Oral Testimony at Hearing (March 2012) on behalf of the United States in connection with the Louisiana Generating NSR Case. *United States v. Louisiana Generating, LLC*, 09-CV100-RET-CN (Middle District of Louisiana).

159. Oral Testimony at Hearing (April 2012) on behalf of the New Hampshire Sierra Club at the State of New Hampshire Public Utilities Commission, Docket No. 10-261 – the 2010 Least Cost Integrated Resource Plan (LCIRP) submitted by the Public Service Company of New Hampshire (re. Merrimack Station Units 1 and 2).

160. Oral Testimony at Hearing (November 2012) on behalf of Clean Wisconsin in the matter of Application of Wisconsin Public Service Corporation for Authority to Construct and Place in Operation a New Multi-Pollutant Control Technology System (ReACT) for Unit 3 of the Weston Generating Station, before the Public Service Commission of Wisconsin, Docket No. 6690-CE-197.

161. Deposition (March 2013) in the matter of various Environmental Petitioners v. North Carolina DENR/DAQ and Carolinas Cement Company, before the Office of Administrative Hearings, State of North Carolina.

162. Deposition (August 2013) on behalf of the Sierra Club in connection with the Luminant Big Brown Case. *Sierra Club v. Energy Future Holdings Corporation and Luminant Generation Company LLC*, Civil Action No. 6:12-cv-00108-WSS (Western District of Texas, Waco Division).

163. Deposition (August 2013) on behalf of the Sierra Club in connection with the Luminant Martin Lake Case. *Sierra Club v. Energy Future Holdings Corporation and Luminant Generation Company LLC*, Civil Action No. 5:10-cv-0156-MHS-CMC (Eastern District of Texas, Texarkana Division).

164. Deposition (February 2014) on behalf of the United States in *United States of America v. Ameren Missouri*, Civil Action No. 4:11-cv-00077-RWS (Eastern District of Missouri, Eastern Division).

165. Trial Testimony (February 2014) in the matter of *Environment Texas Citizen Lobby, Inc and Sierra Club v. ExxonMobil Corporation et al.*, Civil Action No. 4:10-cv-4969 (Southern District of Texas, Houston Division).

166. Trial Testimony (February 2014) on behalf of the Sierra Club in connection with the Luminant Big Brown Case. *Sierra Club v. Energy Future Holdings Corporation and Luminant Generation Company LLC*, Civil Action No. 6:12-cv-00108-WSS (Western District of Texas, Waco Division).

167. Deposition (June 2014) and Trial (August 2014) on behalf of ECM Biofilms in the matter of the *US Federal Trade Commission (FTC) v. ECM Biofilms* (FTC Docket #9358).

168. Deposition (February 2015) on behalf of Plaintiffs in the matter of *Sierra Club and Montana Environmental Information Center (Plaintiffs) v. PPL Montana LLC, Avista Corporation, Puget Sound Energy, Portland General Electric Company, Northwestern Corporation, and Pacificorp (Defendants)*, Civil Action No. CV

13-32-BLG-DLC-JCL (US District Court for the District of Montana, Billings Division).

169. Oral Testimony at Hearing (April 2015) on behalf of Niagara County, the Town of Lewiston, and the Villages of Lewiston and Youngstown in the matter of CWM Chemical Services, LLC New York State Department of Environmental Conservation (NYSDEC) Permit Application Nos.: 9-2934-00022/00225, 9-2934-00022/00231, 9-2934-00022/00232, and 9-2934-00022/00249 (pending).

170. Deposition (August 2015) on behalf of Plaintiff in the matter of *Conservation Law Foundation (Plaintiff) v. Broadrock Gas Services LLC, Rhode Island LFG GENCO LLC, and Rhode Island Resource Recovery Corporation (Defendants)*, Civil Action No. 1:13-cv-00777-M-PAS (US District Court for the District of Rhode Island).

171. Testimony at Hearing (August 2015) on behalf of the Sierra Club in the matter of *Amendments to 35 Illinois Administrative Code Parts 214, 217, and 225* before the Illinois Pollution Control Board, R15-21.

172. Deposition (May 2015) on behalf of Plaintiffs in the matter of *Northwest Environmental Defense Center et. al., (Plaintiffs) v. Cascade Kelly Holdings LLC, d/b/a Columbia Pacific Bio-Refinery, and Global Partners LP (Defendants)*, Civil Action No. 3:14-cv-01059-SI (US District Court for the District of Oregon, Portland Division).

173. Trial Testimony (October 2015) on behalf of Plaintiffs in the matter of *Northwest Environmental Defense Center et. al., (Plaintiffs) v. Cascade Kelly Holdings LLC, d/b/a Columbia Pacific Bio-Refinery, and Global Partners LP (Defendants)*, Civil Action No. 3:14-cv-01059-SI (US District Court for the District of Oregon, Portland Division).

174. Deposition (April 2016) on behalf of the Plaintiffs in *UNatural Resources Defense Council, Respiratory Health Association, and Sierra Club (Plaintiffs) v. Illinois Power Resources LLC and Illinois Power Resources Generation LLC (Defendants)*, Civil Action No. 1:13-cv-01181 (Central District of Illinois, Peoria Division).

175. Trial Testimony at Hearing (July 2016) in the matter of Tesoro Savage LLC Vancouver Energy Distribution Terminal, Case No. 15-001 before the State of Washington Energy Facility Site Evaluation Council.

176. Trial Testimony (December 2016) on behalf of the challengers in the matter of the Delaware Riverkeeper Network, Clean Air Council, et. al., vs. Commonwealth of Pennsylvania Department of Environmental Protection and R. E. Gas Development LLC regarding the Geyer well site before the Pennsylvania Environmental Hearing Board.

177. Trial Testimony (July-August 2016) on behalf of the United States in *United States of America v. Ameren Missouri*, Civil Action No. 4:11-cv-00077-RWS (Eastern District of Missouri, Eastern Division).

178. Trial Testimony (January 2017) on the Environmental Impacts Analysis associated with the Huntley and Huntley Poseidon Well Pad Hearing on behalf citizens in the matter of the special exception use Zoning Hearing Board of Penn Township, Westmoreland County, Pennsylvania.

179. Trial Testimony (January 2017) on the Environmental Impacts Analysis associated with the Apex energy Backus Well Pad Hearing on behalf citizens in the matter of the special exception use Zoning Hearing Board of Penn Township, Westmoreland County, Pennsylvania.

180. Trial Testimony (January 2017) on the Environmental Impacts Analysis associated with the Apex energy Drakulic Well Pad Hearing on behalf citizens in the matter of the special exception use Zoning Hearing Board of Penn Township, Westmoreland County, Pennsylvania.

181. Trial Testimony (January 2017) on the Environmental Impacts Analysis associated with the Apex energy Deutsch Well Pad Hearing on behalf citizens in the matter of the special exception use Zoning Hearing Board of Penn Township, Westmoreland County, Pennsylvania.

182. Deposition Testimony (July 2017) on behalf of Plaintiffs in the matter of *Casey Voight and Julie Voight v Coyote Creek Mining Company LLC (Defendant)* Civil Action No. 1:15-CV-00109 (US District Court for the District of North Dakota, Western Division).

183. Deposition Testimony (November 2017) on behalf of Defendant in the matter of *Oakland Bulk and Oversized Terminal (Plaintiff) v City of Oakland (Defendant,)* Civil Action No. 3:16-cv-07014-VC (US District Court for the Northern District of California, San Francisco Division).

184. Deposition Testimony (December 2017) on behalf of Plaintiff in the matter of *Wildearth Guardians (Plaintiff) v Colorado Springs Utility Board (Defendant)* Civil Action No. 1:15-cv-00357-CMA-CBS (US District Court for the District of Colorado).

185. Deposition Testimony (January 2018) in the matter of National Parks Conservation Association (NPCA) v. State of Washington Department of Ecology and British Petroleum (BP) before the Washington Pollution Control Hearing Board, Case No. 17-055.

186. Trial Testimony (January 2018) on behalf of Defendant in the matter of *Oakland Bulk and Oversized Terminal (Plaintiff) v City of Oakland (Defendant,)* Civil Action No. 3:16-cv-07014-VC (US District Court for the Northern District of California, San Francisco Division).

187. Trial Testimony (April 2018) on behalf of the National Parks Conservation Association (NPCA) in the matter of NPCA v State of Washington, Department of Ecology and BP West Coast Products, LLC, PCHB No. 17-055 (Pollution Control Hearings Board for the State of Washington.

188. Deposition (June 2018) (harm Phase) on behalf of Plaintiffs in the matter of *Natural Resources Defense Council, Inc., Sierra Club, Inc., and Respiratory*

Health Association v. Illinois Power Resources LLC, and Illinois Power Resources Generating LLC (Defendants), Civil Action No. 1:13-cv-01181 (US District Court for the Central District of Illinois, Peoria Division).

189. Trial Testimony (July 2018) on behalf of Petitioners in the matter of *Coosa River Basin Initiative and Sierra Club (Petitioners) v State of Georgia Environmental Protection Division, Georgia Department of Natural Resources (Respondent) and Georgia Power Company (Intervenor/Respondent)*, Docket Nos: 1825406-BNR-WW-57-Howells and 1826761-BNR-WW-57-Howells, Office of State Administrative Hearings, State of Georgia.

190. Deposition (January 2019) and Trial Testimony (January 2019) on behalf of Sierra Club and Texas Campaign for the Environment (Appellants) in the contested case hearing before the Texas State Office of Administrative Hearings in Docket Nos. 582-18-4846, 582-18-4847 (Application of GCGV Asset Holding, LLC for Air Quality Permit Nos. 146425/PSDTX1518 and 146459/PSDTX1520 in San Patricio County, Texas).

191. Deposition (February 2019) and Trial Testimony (March 2019) on behalf of Sierra Club in the State of Florida, Division of Administrative Hearings, Case No. 18-2124EPP, Tampa Electric Company Big Bend Unit 1 Modernization Project Power Plant Siting Application No. PA79-12-A2.

192. Deposition (June 2019) relating to the appeal of air permits issued to PTTGCA on behalf of Appellants in the matter of *Sierra Club (Appellants) v. Craig Butler, Director, et. al., Ohio EPA (Appellees)* before the State of Ohio Environmental Review Appeals Commission (ERAC), Case Nos. ERAC-19-6988 through -6991.

193. Deposition (September 2019) on behalf of Appellants relating to the NPDES permit for the Cheswick power plant in the matter of *Three Rivers Waterkeeper and Sierra Club (Appellees) v. State of Pennsylvania Department of Environmental Protection (Appellee) and NRG Power Midwest (Permittee)*, before the Commonwealth of Pennsylvania Environmental Hearing Board, EHB Docket No. 2018-088-R.

194. Deposition (December 2019) on behalf of the Plaintiffs in the matter of David Kovac, individually and on behalf of wrongful death class of Irene Kovac v. Bp Corporation North America Inc., Circuit Court of Jackson County, Missouri (Independence), Case No. 1816-CV12417.

195. Deposition (February 2020) on behalf of Earthjustice in the matter of *Objection to the Issuance of PSD/NSR and Title V permits for Riverview Energy Corporation*, Dale, Indiana, before the Indiana Office of Environmental Adjudication, Cause No. 19-A-J-5073.

JING RESUME

Qiguo Jing, PhD, PE

Managing Scientific Software Specialist/Consultant **— Dallas**
Southern Methodist University Adjunct Professor

AREAS OF SPECIALIZATION

- Air Quality/Dispersion (Local, regional, and hybrid scales)
- Regional Haze Modeling (CAMx, CMAQ)
- Mesoscale Prognostic Meteorological Data Modeling (WRF)
- Boundary Layer Micrometeorology
- Numerical Model Development
- Blast Impact Assessment
- Accidental Release Assessment
- Sustainable Development Indicator System
- Mobile Source Emission Measurement and Analysis (PEMS)
- Wet Flue Gas Desulfurization
- Control Technology and Feasibility Analysis
- OSHA PSM and EPA RMP
- API 752/753
- FORTRAN/ Parallel Programming

EDUCATION

Ph.D., Mechanical Engineering
University of California, Riverside
M.S., Environmental Science and Engineering
Tsinghua University
B.S., Environmental Monitoring
Nanjing University of Science and Technology

AFFILIATIONS

American Meteorological Society
Air & Waste management Association

CERTIFICATIONS

Licensed Professional Engineer in Texas

TECHNICAL EXPERTISE

CalEEMod. Managed, developed and maintained the California Emission Estimator Model (CalEEMod). Designed and updated the backend database, including on-road and off-road mobile emission factors, land use characteristics, building energy use. Prepared model design requirement document, user interface design document, and user's guide. Developed methodology to quantify potential criteria pollutant and greenhouse gas (GHG) emissions associated with both construction and operations from a variety of land use projects. Provided technical support for end-users.

SUMMARY OF EXPERIENCE

Dr. Jing currently serves as a Managing Scientific Software Specialist/Consultant for Trinity's BREEZE Software/Data Division. He received his doctoral degree in Mechanical Engineering from University of California, Riverside. He has a keen interest in air dispersion, boundary layer micrometeorology and programming.

Dr. Jing has extensive experience in solving environmental issues, particularly air dispersion at local scale. He has authored more than 20 technical publications in various research areas. At Trinity, Dr. Jing serves as Product Manager of BREEZE ExDAM, BREEZE TankESP, BREEZE AERMOD, BREEZE AERSCREEN, BREEZE CALPUFF, BREEZE Incident Analyst, BREEZE Roads, and BREEZE Risk Analyst. His duties include designing, developing and enhancing BREEZE/Parallel AERMOD, designing, developing and debugging complex FORTRAN source codes, testing various products, providing support from scientific perspective, and applying scientific models to various consulting projects.

Since joining Trinity in 2011, Dr. Jing has been involved with projects related to air quality management and engineering, air quality modeling, regional scale modeling including photochemical modeling and regional haze modeling, process safety management, risk management planning, toxic/fire/blast hazard assessment, explosion modeling and barricade design for Site Plan Exception, mesoscale prognostic meteorological data modeling (WRF/MM5), meteorological data assessment and applications, commercial EH&S software solutions, and litigation expert/support.

Prior to joining Trinity, Dr. Jing participated in projects related to air quality impacts of distributed generation, air dispersion of low level buoyant emission in urban areas, hybrid modeling over multiple length scales, and boundary layer micrometeorology. He developed a graphic user interface for a sustainable environment and transportation indicator system. For the first time ever in China, he led, designed, and conducted on-road diesel vehicle emission measurements.

Regional Haze Modeling. Evaluated electric generating stations for Best Available Retrofit Technology (BART) eligibility. Provided information related to the Regional Haze requirements in Louisiana/Texas to EPA. CAMx modeling system was applied to conduct the screening analysis.

Mesoscale Prognostic Meteorological Modeling - Managed and performed Mesoscale Prognostic Meteorological Modeling (WRF) projects. Provided gridded meteorological data for dispersion models such as AERMOD, ADMS, etc. Provided 3-Dimension gridded meteorological data for complex dispersion model such as CALPUFF, CAMx, and CMAQ. Provided performance evaluation of the modeled prognostic meteorological data.

Development of AERCOMBO. Developed a software post-processor tool that allows the compilation of AERMOD model output files generated as part of the 1-hour SO_2 nonattainment SIP demonstration. The tool compile results derived from full sets of model output including every concentration estimated at every receptor for every hour modeled for each source group. The post-processor generates outputs in the form of the 1-hour averaged SO_2 NAAQS.

Explosion Modeling and Barricade Design for Site Plan Waiver. Managed and conducted projects to evaluate and design barricade which provides protection to process buildings from Storage tank explosion. The design is based on DoD 4145.26-M, Contractor's Safety Manual for Ammunition and Explosives.

Vapor Explosion Impact Assessment. Managed, conducted and coordinated projects to evaluate the vapor cloud explosion impacts. Analyzed the overpressure, impulse, building damage, person injury and structure shielding effects due to vapor cloud explosion using BREEZE EXDAM. Performed permanent and portable building locating practice as required by API 752/753. Experience has been gained through structure modeling, vapor cloud explosion modeling and blast impact analysis. Sensitivity studies have been conducted on structure material, vapor cloud material, vapor cloud size, and source-receptor distance.

Hazard Assessment. Managed, conducted and coordinated projects to evaluate the accidental release of ammonia (NH_3), Chlorine dioxide (ClO_2) and LNG as required by the EPA Risk Management Program. Analyzed source characteristics, and determined toxic end points for worst-case scenarios as well as alternative scenarios. Applied accidental release models such as ALOHA, DEGADIS, SLAB, INPUFF, and AFTOX.

Near field air quality and air dispersion. Thoroughly studied AERMOD, fully understood its inputs, its formulations, its source codes and its outputs, and had the ability to modify and improve AERMOD. Modeled air dispersion of buoyant emissions from low level point sources in urban areas. Evaluated AERMOD with data collected in the vicinity of a distributed generation. Managed, conducted and coordinated projects to model and evaluate the regional and local air quality impacts of distributed generation, particularly the relative impacts of distributed and centralized generation of electricity on local air quality in the South Coast Air Basin.

Long-rang air dispersion modeling. Developed and applied hybrid methods to estimate the air quality impacts of urban emissions over multiple length scales. The methods achieve the required computational efficiency by separating transport and chemistry using the concept of species age. Evaluated CALPUFF with data collected in the vicinity of a copper smelter; evaluated CALPUFF's performance in modeling fugitive sources.

Boundary layer micrometeorology. Predicted vertical wind speed and temperature profiles (in addition to surface level incoming and outgoing radiations) by solving mass, momentum and energy equations numerically and matching the temperature at the surface level based on surface energy balance. Boundary layer height, surface friction velocity and turbulent fluctuations can also be predicted using this numerical method.

FORTRAN programming. Wrote a program to convert 3-D meteorological inputs for a grid dispersion model to those for 2-D local AERMOD model. Wrote a simplified program, which requires minimum inputs, to generate AERMOD meteorological inputs based on EPA AERMET method. Reinforced the source codes of BREEZE AERMOD executable to better process multiple pollutants and flare sources and output variety files. Extensive experience has gained through debugging the source codes of BREEZE/parallel AERMOD executables in order to provide identical results to EPA AERMOD executable. Enhanced BREEZE FORTRAN source codes for CAL3QHC, CAL3QHCR, CALINE4, DEGADIS, SLAB, INPUFF, SCREEN3, VExDAM, HExDAM, ISC3, and so on.

Parallel programming. Implemented the parallel version of AERMOD for EPA AERMOD version of, 18081, 16216r, 15181, 14134, 13350, 12060, 11353, 11103, and 09292. Improved BREEZE AERMOD UI to read inputs from mapped drives when using parallel executables. Developed the parallel version of AERMAP for EPA AERMAP version of 11103. Developed the parallel version of CALPUFF version 5, version 6 and version 7.

PUBLICATIONS AND PRESENTATIONS

Qiguo Jing, Brian Holland, Tiffany Gardner, Yumna Moazzam and Weiping Dai, (2015). Large-Scale VCE Consequence Modeling for Industrial Facility Siting, Risk Assessment, Hazard Mitigation Design, and Response Planning. Presented at the Mary Kay O'Connor Process Safety Center 2015 International Symposium, October, 2015.

Qiguo Jing, Brian Holland, Gang Wang, Xi Yang, and Weiping Dai, (2013). Dispersion of non-buoyant low-level fugitive sources: a case study. Presented at the April 2013 U.S. EPA Regional, State, and Local Modelers Conference, Dallas, TX.

Qiguo Jing, Akula Venkatram, Marko Princevac, and Dave Pankratz, (2012). Dispersion of buoyant emissions from a low level urban source. 10th Modeling Conference, US Environmental Protection Agency, Raleigh, NC.

Qiguo Jing, (2011). Air Quality Impact of Distributed Generation of Electricity. PhD Thesis, University of California, Riverside.

Qiguo Jing and Akula Venkatram, (2011). The relative impacts of distributed and centralized generation of electricity on local air quality in the South Coast Air Basin of California. Energy Policy 39, 4999-5007.

Qiguo Jing, Sam Pournazeri, and Akula Venkatram, (2011). Development and application of methods to estimate the air quality impact of urban emissions over multiple length scales. 14th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes, Kos Island, Greece.

Qiguo Jing, Akula Venkatram, Marko Princevac, Dave Pankratz and Wenjun Qian, (2010). Modeling dispersion of buoyant emissions from a low level source in an urban area. 16th Conference on Air Pollution Meteorology in the 90th American Meteorological Society Annual Meeting, Atlanta, GA.

EMPLOYMENT HISTORY

November 2011 - Present	Trinity Consultants, Dallas, TX
2004 - 2006	Environmental Engineer at SAES, Shanghai, China

HONORS AND AWARDS

Science and Technology Achievement Award in Shanghai, China (2006)
Excellent Undergraduate of Nanjing University of Science and Technology, China (2001)
Second Prize in the Advance Mathematics Contest in Jiangsu Province, China (1998)