El Segundo Hydrogen Plant
214 Main St. PMB 286, El Segundo, CA 90245
Phone: 310-535-3628 • Fax: 310-535-9136

CERTIFIED MAIL RETURN RECEIPT REQUESTED

July 30, 2020

Mr. Tracy A. Goss, P.E.
Planning & Rules Manager
Planning, Rule Development and Area Sources
South Coast Air Quality Management District
21865 East Copley Drive
Diamond Bar, CA 91765-4182

AB2588 AIR TOXICS "HOT SPOTS" HEALTH RISK ASSESSMENT
AIR LIQUIDE EL SEGUNDO HYDROGEN PLANT - FACILITY ID: 148236

Dear Mr. Goss:

Enclosed is a comprehensive AB 2588 Health Risk Assessment (HRA) completed for the Air Liquide El Segundo Hydrogen Plant. It is based on toxic emissions reported in the facility's 2016 Annual Emissions Report (AER), as modified in an Air Toxics Inventory Report (ATIR) approved by the SCAQMD in a letter dated May 1, 2020.

All computer files requested in Table 7 of *SCAQMD's AB 2588 and Rule 1402 Supplemental Guidelines (Supplemental Guidelines for Preparing Risk Assessments for the Air Toxics "Hot Spots" Information and Assessment Act), September 2018* are also being submitted at this time through the SCAQMD OnBase server.

If you have any questions or need additional information, please contact Quinton Cox at (310) 535-3628 ext. 20 or by email at quinton.cox@airliquide.com.

Regards,

Quinton Cox

Air Liquide – Plant Engineer

Reference: HARP2 Access Database (uploaded to the SCAQMD OnBase server on 7/30/20)

AB 2588 Air Toxics "Hot Spots" Information and Assessment Act

Health Risk Assessment RY 2016

Prepared for:

El Segundo Hydrogen Plant
Facility ID: 148236
324 W. El Segundo Blvd.
El Segundo, CA 90245

Prepared by:

Davenport Engineering, Inc.
23705 Crenshaw Blvd., Suite 101
Torrance, CA 90505

July 30, 2020

FORM A	SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT AB 2588 Program, 21865 COPLEY DR., DIAMOND BAR CA 91765-0949	INVENTORY YEAR 2016

AB 2588 AIR TOXICS DOCUMENT CERTIFICATION & SUBMITTAL FORM

Please check the appropriate boxes for purpose of submittal:

☐ *INITIAL INFORMATION for ATIR*	☐ *EARLY ACTION REDUCTION PLAN (EARP)*	☑ *INITIAL*
☐ *AIR TOXICS INVENTORY REPORT (ATIR)*	☐ *VOLUNTARY RISK REDUCTION PLAN (VRRP)*	☐ *REVISION*
☑ *HEALTH RISK ASSESSMENT (HRA)*	☐ *IMPLEMENTATION PROGRESS REPORT for VRRP/RRP*	☐ *FINAL*
☐ *RISK REDUCTION PLAN (RRP)*	☐ *OTHER:*	

Does your facility participate or wish to participate in VRRP program pursuant to Rule 1402(h)? *YES* ☐ ☒

Please provide the following information:

Facility name: Air Liquide El Segundo Hydrogen Plant

South Coast AQMD ID: 148236

Facility SIC/NAICS CODE: 2813/325120

Facility Location Address: 324 W. El Segundo Blvd., El Segundo, CA 90245

Mailing Address: 214 Main Street PMB 286, El Segundo, CA 90245

Contact Person (Company Official)

Name: Arun Mahabirsingh **Title:** Plant Manager

Telephone: (310) 535-3628 ext. 11 **eMail:** arun.mahabirsingh@airliquide.com

Preparer (if different from above)

Name: Trevor Ford **Title:** Senior Engineer

Company: Davenport Engineering, Inc.

Telephone: (310) 787-4600 ext. 19 **eMail:** trevor.ford@davenport-co.com

FAILURE TO SUBMIT REQUIRED INFORMATION OR KNOWINGLY SUPPLYING FALSE INFORMATION IS PUNISHABLE TO THE EXTENT DEFINED IN HEALTH AND SAFETY CODE SECTIONS 44381(a) AND 44381(b), WHICH INCLUDES MINIMUM FINES OF NOT LESS THAN FIVE HUNDRED DOLLARS.

Signature Of Responsible Company Official

Date

Name Of Responsible Company Official: Quinton Cox

Title: Plant Engineer

South Coast Air Quality Management District
21865 Copley Drive, Diamond Bar, CA 91765-4182
(909) 396-2000 • www.aqmd.gov

HEALTH RISK ASSESSMENT SUMMARY FORM

(Required in Executive Summary of HRA)

Facility Name : Air Liquide El Segundo Hydrogen Plant
Facility Address: 324 W. El Segundo Blvd.
El Segundo, CA 90245
Type of Business: Industrial Gases
SCAQMD ID No.: 148236

A. Cancer Risk

(One in a million means one chance in a million of getting cancer from being constantly exposed to a certain level of a chemical over a period of time)

1. Inventory Reporting Year : 2016
2. Maximum Cancer Risk to Receptors : *(Offsite and residence = 30-year exposure, worker = 25-year exposure)*
   a. Offsite 7.1 in a million Location: 370919E, 3752744N
   b. Residence 1.2 in a million Location: 369975E, 3752160N
   c. Worker 0.4 in a million Location: 371000E, 3752800N
3. Substances Accounting for 90% of Cancer Risk: Diesel PM, Chromium (VI), 7,12-Dimethylbenz(a)anthracene
   Processes Accounting for 90% of Cancer Risk: Diesel ICEs, Reformer Heater
4. Cancer Burden for a 70-yr exposure: *(Cancer Burden = [cancer risk] x [# of people exposed to specific cancer risk])*
   a. Cancer Burden 0.0001
   b. Number of people exposed to >1 per million cancer risk for a 70-yr exposure 116
   c. Maximum distance to edge of 70-year, 1 x 10^{-6} cancer risk isopleth (meters) 1,500

B. Hazard Indices

[Long Term Effects (chronic) and Short Term Effects (acute)]
(non-carcinogenic impacts are estimated by comparing calculated concentration to identified Reference Exposure Levels, and expressing this comparison in terms of a "Hazard Index")

1. Maximum Chronic Hazard Indices:
   a. Residence HI: 0.004 Location: 370150E, 3752160N toxicological endpoint: Respiratory tract
   b. Worker HI : 0.017 Location: 371000E, 3752700N toxicological endpoint: Respiratory tract
2. Substances Accounting for 90% of Chronic Hazard Index: Arsenic, Nickel, Diesel PM, Cadmium
3. Maximum 8-hour Chronic Hazard Index:
   8-Hour Chronic HI: 0.002 Location: 370917E, 3752691N toxicological endpoint: Respiratory tract
4. Substances Accounting for 90% of 8-hour Chronic Hazard Index: Nickel, Acrolein, Arsenic, Formaldehyde
5. Maximum Acute Hazard Index:
   PMI: 0.003 Location: 370150E, 3752160N toxicological endpoint: Immune system
6. Substances Accounting for 90% of Acute Hazard Index: Nickel, Benzene

C. Public Notification and Risk Reduction

1. Public Notification Required? ____ Yes X No
   a. If 'Yes', estimated population exposed to risks > 10 in a million for a 30-year exposure, or an HI >1
   _____
2. Risk Reduction Required? ____ Yes X No

GLOSSARY OF TERMS

Assembly Bill 2588 (AB 2588): California's Air Toxics "Hot Spots" Information and Assessment Act of 1987 that requires the California Air Resources Board (ARB) to compile and maintain a list of substances that pose chronic or acute threats to public health when present in the air. Additionally, the "Hot Spots" program includes an emissions inventory, requirements for assessing health risks, and provisions for notifying the public about emissions of toxic air contaminants.

Action Risk Level: Maximum Individual Cancer Risk (MICR) of twenty-five in one million (25 x 10^{-6}), cancer burden of 0.5, or a total acute or chronic HI of three (3.0) for any target organ system at any receptor location.

Acute Health Impact: Health effect that is characterized by sudden and severe exposure and rapid absorption of the substance (e.g., minutes or hours).

Air Resources Board (ARB): Established in 1967 by California's Legislature to 1) attain and maintain healthy air quality and 2) conduct research into the causes of and solutions to air pollution.

Annual Emissions Reporting (AER): Program that was developed by the South Coast Air Quality Management District (SCAQMD) to track emissions of air contaminants from permitted facilities.

Building Downwash: Phenomenon caused by eddies created by air movement around building obstacles. Buildings act as barriers triggering pollutant accumulation that will then increase concentration values.

Building Profile Input Program (BPIP): Software program designed to incorporate the concepts and procedures expressed in the Good Engineering Practice (GEP) technical support document, building downwash guidance, and other related references to calculate building heights and projected building widths for simple, multi-tiered, and groups of structures.

California Air Pollution Control Officers Association (CAPCOA): Association of Air Pollution Control Officers representing all thirty-five local air quality agencies throughout California.

Cancer Burden: Estimated increase in the occurrence of cancer cases in a population subject to a Maximum Individual Cancer Risk (MICR) of greater than or equal to one in one million (1 x 10^{-6}) resulting from exposure to toxic air contaminants.

Cancer Risk: The theoretical probability of contracting cancer when continually exposed for a lifetime (30 years) to a given concentration of a substance.

Chronic Health Impact: Health effect that is characterized by prolonged or repeated exposures over many days, months, or years. Symptoms may not be immediately apparent. 8-hour chronic health impacts result from daily 8-hour exposure periods.

Coarse Grid: Receptors laid out in a grid pattern surrounding a facility at 500 meter spacing. The purpose of the coarse grid is to identify the general locations of large ground-level concentrations.

Fine Grid: Receptors laid out in a grid pattern surrounding a facility at 100 meter spacing in order to look in more detail at areas where concentrations are high. The purpose of the fine grid is to identify maximum ground-level concentration points and to identify local gradients in concentrations.

Hotspots Analysis and Reporting Program (HARP): Single integrated software package that combines the tools of emission inventory database, facility prioritization, air dispersion modeling, and risk assessment analysis.

Hazard Index (HI): The sum of individual acute or chronic hazard quotients for substances that affect the same target organ or organ system.

Health Risk Assessment (HRA): Comprehensive analysis of the dispersion of hazardous substances in the environment, their potential for human exposure, and a quantitative assessment of both individual and population-wide health risks associated with those levels exposed.

Maximum Exposed Individual Resident (MEIR or residential MEI): Location of an actual residence where a person resides or could reside for 30 years and has the highest estimated health impact. Primary exposure pathways include inhalation, ingestion of soils, dermal contact with soils, and ingestion of mother's milk as an infant.

Maximum Exposed Individual Worker (MEIW or worker MEI): Location of an area currently zoned or used for commercial or industrial purposes and has the highest estimated health impact. Exposure pathways include inhalation, soil ingestion, and dermal contact. Exposure durations for workers are typically 8 hours per day, 240 days per year, for 25 years.

Maximum Individual Cancer Risk (MICR): Estimated probability of a potential maximally exposed individual contracting cancer as a result of exposure to toxic air contaminants over a period of 30 years.

Noncancer Risk: Risk associated with acute or chronic health effects.

Office of Environmental Health Hazard Assessment (OEHHA): Specialized department within the cabinet-level California Environmental Protection Agency with responsibility for evaluating health risks from environmental chemical contaminants.

Point of Maximum Impact (PMI): Location of maximum estimated offsite health impact.

Sensitive Receptors: Location of specific sensitive sites where certain populations may exist, such as a school or nursing home.

South Coast Air Quality Management District (SCAQMD): Air pollution control agency for all of Orange County and the urban portions of Los Angeles, Riverside, and San Bernardino counties.

Zone of Impact: Area surrounding a facility where receptors have a potential cancer risk greater than $1x10^{-6}$ (one in one million), or an acute or chronic hazard index of 0.5.

LIST OF ABBREVIATIONS

AB 2588	Assembly Bill 2588
AER	Annual Emissions Reporting
AERMOD	American Meteorological Society / US EPA air dispersion model
ARB	California Air Resources Board
ATIR	Air Toxic Inventory Report
BPIP	Building Profile Input Program
CAPCOA	California Air Pollution Control Officers Association
CAS	Chemical Abstracts Service
CPF	Cancer Potency Factor
CSF	Cancer Slope Factor
DICE	Diesel Internal Combustion Engine
DPM	Diesel Particulate Matter
EF	Emission Factor
EPA	U.S. Environmental Protection Agency
HARP	“Hot Spots” Analysis and Reporting Program
HI	Hazard Index
HRA	Health Risk Assessment
ICE	Internal Combustion Engine
MEI	Maximally Exposed Individual
MEIR	Maximally Exposed Individual Resident
MEIW	Maximally Exposed Individual Worker
MHE	Maximum Hourly Emission
OEHHA	Office of Environmental Health Hazard Assessment
PAHs	Polycyclic Aromatic Hydrocarbons
PF	Potency Factor
PMI	Point of Maximum Impact
REL	Reference Exposure Level
RY	Reporting Year
SCAQMD	South Coast Air Quality Management District
TAC	Toxic Air Contaminant
UTM	Universal Transverse Mercator
WGS84	World Geodetic System 1984

TABLE OF CONTENTS

TABLES

FIGURES

1.0 EXECUTIVE SUMMARY

1.1 Project & Facility Background

The Air Liquide El Segundo Hydrogen Plant (ID 148236) in the city of El Segundo, California is subject to emission and health risk reporting requirements imposed by the California *Air Toxics "Hot Spots" Information and Assessment Act of 1987* (AB 2588). This health risk assessment (HRA) was prepared in response to a request from the South Coast Air Quality Management District (SCAQMD), the lead agency for administering AB 2588 requirements in the region. Source and emissions data used in this HRA were previously submitted to the SCAQMD, and subsequently approved on May 1, 2020.

Facility Name:	Air Liquide El Segundo Hydrogen Plant
SCAQMD FID:	148236
Facility Location:	324 W. El Segundo Blvd. El Segundo, CA 90245 UTMs 11N 370352 m E, 3752482 m N

The Air Liquide El Segundo Hydrogen Plant is a merchant hydrogen plant that provides hydrogen product to the Chevron El Segundo Refinery. The hydrogen plant is located and operates within the refinery. Sources of toxic air emissions include an industrial heater, ground flare, process vents, piping components, and various maintenance and repair equipment.

The SCAQMD identified 2016 as the base operating year for this HRA. The primary risk drivers were particulate matter (PM) exhaust from diesel internal combustion engines (ICEs) and hexavalent chromium from the reformer heater.

1.2 Modeling Approach

This HRA was conducted pursuant to SCAQMD Rule 1402(e)(1) using the California Air Resources Board's current *"Hot Spots" Analysis and Reporting Program* database (HARP2) which integrates the emissions inventory, air dispersion modeling, and risk analysis components of an HRA. This HRA was also prepared in accordance with California Office of Environmental Health Hazard Assessment (OEHHA) guidance and SCAQMD supplemental guidelines.

A total of 54 trace toxic chemicals emitted by the facility were evaluated in this HRA, 24 of which contributed to cancer risk based on OEHHA defined health factors. Human exposure pathways include inhalation, soil and local plant ingestion, dermal absorption, and intake of mother's milk.

1.3 Health Risk Results

Health impacts (i.e., risks) were determined in this HRA after carefully considering the facility's source locations and emissions, their release characteristics, human exposure pathways, and surrounding land use and meteorology. AB 2588 requires quantification and reporting of the following incremental risks:

- Individual lifetime cancer risk
- Population cancer risk (cancer burden)
- Long-term and acute noncancer effects

All cancer and noncancer risks associated with this HRA were found to be:

- Below levels adopted by the SCAQMD for purposes of public notification
- Below levels identified in SCAQMD Rule 1402 requiring a risk reduction plan

Table 1-1 below summarizes all risks relative to AB 2588 and SCAQMD action risk levels. With the exception of cancer burden, all such risks were identified at boundary or offsite receptor locations defined as a point of maximum impact (PMI) or maximally exposed individual (MEI), respectively. Each PMI and MEI was determined independently based on the outcome of model dispersion, individual chemical toxicities, and exposure conditions (e.g., 30 years for residents, 25 years for workers).

Table 1-1 Summary of Risks

Maximally Exposed Individual (MEI)	Risk	Public Notice	Risk Reduction
Residential Cancer Risk	1.2×10^{-6}	10×10^{-6}	25×10^{-6}
Worker Cancer Risk	0.4×10^{-6}	10×10^{-6}	25×10^{-6}
Point of Maximum Impact (PMI)	7.1×10^{-6}		
Residential Chronic HI {RESP}	0.004	1	3
Worker Chronic HI {RESP}	0.017	1	3
PMI Chronic HI {RESP}	0.040		
Residential Acute HI {IMMUNE}	0.003	1	3
Worker Acute HI {IMMUNE}	0.002	1	3
PMI Acute HI {IMMUNE}	0.003		
Cancer Burden [116 population]	0.0001	--	0.5

The primary cancer risk driver in this HRA was particulate matter (PM) exhaust from diesel ICEs. Diesel PM represents 82% and 78% of cancer risk at the residential and worker MEIs, respectively. Inhalation is the only exposure pathway for diesel PM. The highest residential and worker chronic hazard indexes (HIs) were associated with risks to the respiratory organ system. The highest acute HIs were associated with risks to the immune organ system.

Cancer burden is a measure of population risk measured for the population working and residing within the HRA study area, also referred to as the zone of impact. The study area is depicted in Figure 1-1, and shows a distance of 1,500 meters from the facility to its furthest perimeter. The number of people working and residing within the HRA study area (i.e., within the Figure 1-1 contour line) was estimated to be 116. The low cancer burden result of 0.0001 suggests that less than one additional cancer case is estimated among the exposed population.

The facility, its boundary, surrounding land use, and HRA study area, are all represented in Figure 1-1. The location of each cancer MEI in Table 1-1 is identified in Figure 1-2. All risk results presented in Table 1-1 are also summarized in the SCAQMD Health Risk Assessment Summary Form which is included near the front of this HRA report document.

Figure 1-1 Facility, Surrounding Land Use, Study Area[1]

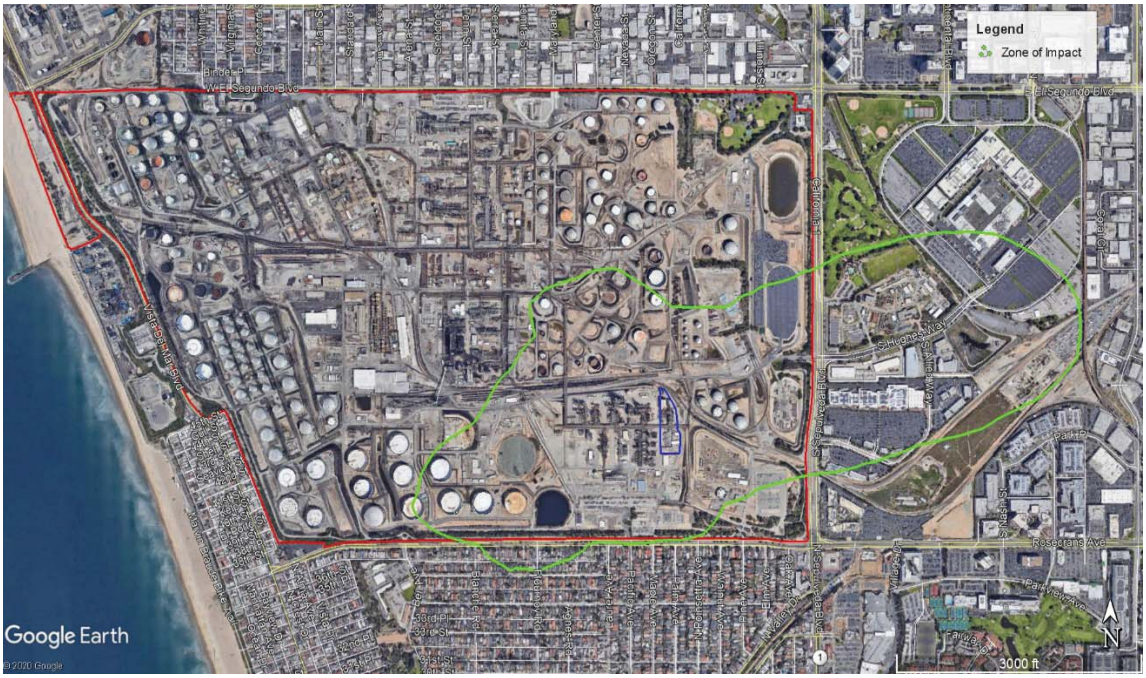


Figure 1-2 Cancer MEIs[2]

[1] The blue line depicts the area of Air Liquide plant operations while the red line represents the refinery boundary.
[2] MEI and PMI locations for noncancer health impacts (chronic and acute) differ from cancer MEIs and PMI (see Figure 6-5 and Figure 6-6).

2.0 INTRODUCTION

Air Liquide Large Industries U.S. LP owns and operates the Air Liquide El Segundo Hydrogen Plant located within the Chevron El Segundo Refinery. Air Liquide and Chevron are independent parties with separate Facility IDs, and share no common ownership or employees. The Air Liquide El Segundo Hydrogen Plant is a merchant hydrogen plant that provides hydrogen product to the refinery.

Per California Assembly Bill 2588 (adopted in 1987), Air Liquide is subject to emission and health risk reporting requirements imposed by the state. AB 2588 is the *Air Toxics "Hot Spots" Information and Assessment Act of 1987*. This document presents results associated with a comprehensive AB 2588 health risk assessment completed for the Air Liquide El Segundo Hydrogen Plant, based on 2016 emissions from an approved Air Toxics Inventory Report (ATIR). The assessment was performed in direct response to a written request made by the SCAQMD in a letter dated May 1, 2020.

2.1 Facility Location & Contact Information

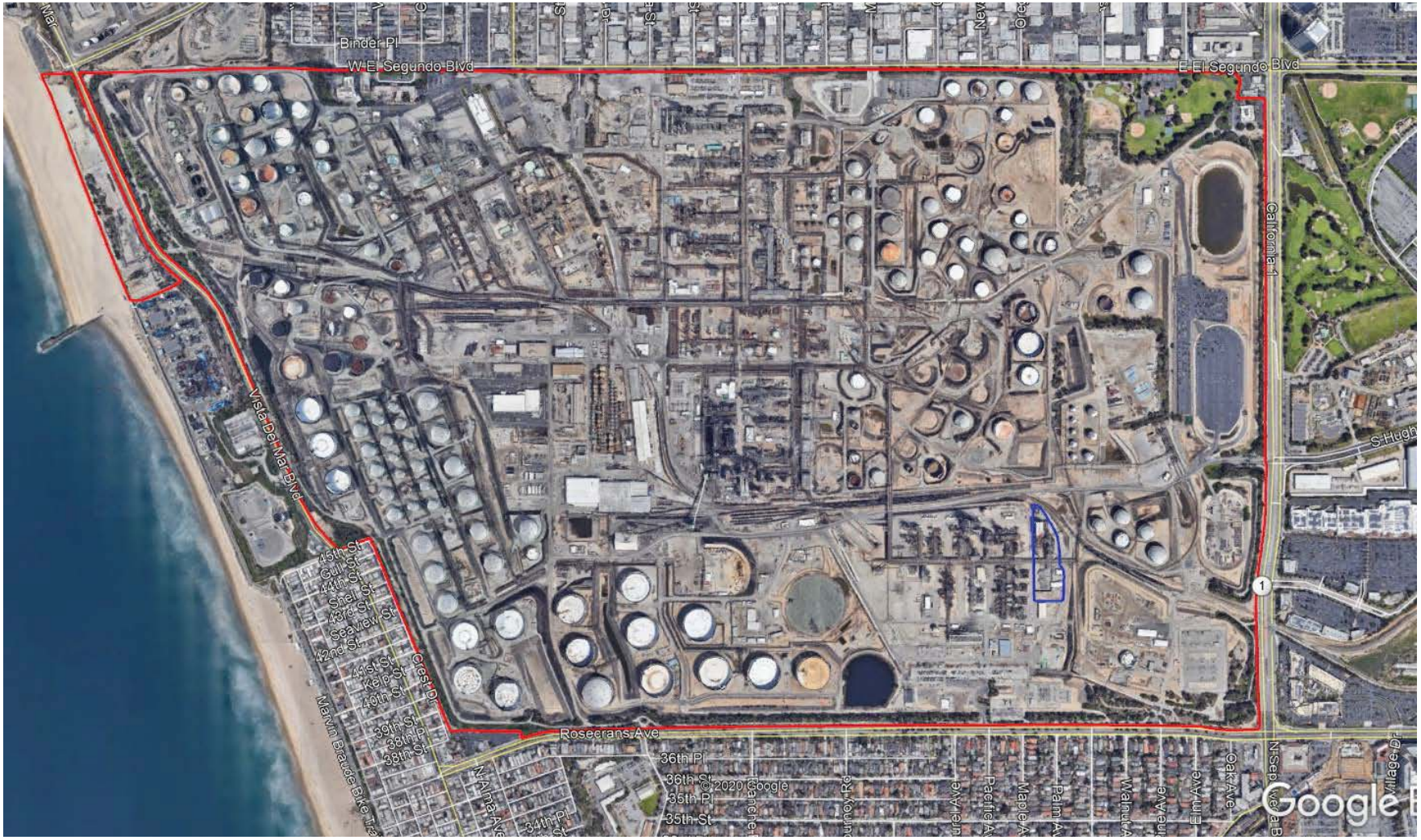
The facility location and contact for this project are as follows:

Facility Name:	Air Liquide El Segundo Hydrogen Plant
SCAQMD FID:	148236
Facility Location:	324 W. El Segundo Blvd. El Segundo, CA 90245 UTMs 11N 370352 m E, 3752482 m N
Facility Contact:	Mr. Arun Mahabirsingh Plant Manager Air Liquide El Segundo Hydrogen Plant (310) 535-3628 ext. 11 arun.mahabirsingh@airliquide.com

Figure 2-1 shows an aerial image of Air Liquide plant operations relative to emission sources and nearby buildings. Emission sources include an industrial heater, ground flare, process vents, piping components, and various maintenance and repair equipment. Figure 2-2 shows the location of the facility within the refinery.

Figure 2-1 Facility Plot Plan

Figure 2-2 Air Liquide Facility Within the Refinery



2.2 AB 2588 History

The SCAQMD administers the AB 2588 program within the South Coast Air District. The facility is subject to ATIR reporting, typically every four years, through the SCAQMD's Annual Emissions Reporting Program (AER). The Air Liquide El Segundo Hydrogen Plant began operations in 2004 and has no history of preparing an AB 2588 HRA.

This HRA is based on toxic emissions reported in the facility's 2016 AER, as modified and reported in ATIR documentation submitted between February 26, 2019 and June 25, 2019. The approved ATIR includes an electronic copy of the HARP database populated with source emissions, related release parameters, building downwash structure dimensions, and prescribed offsite grid receptor coordinates. This HRA was prepared in response to a SCAQMD letter dated May 1, 2020 entitled *Approval of Air Toxics Inventory Report and Notice to Prepare a Health Risk Assessment for Air Liquide Large Industries U.S., LP (South Coast AQMD Facility ID No.: 148236)*. The letter both approved the ATIR and formally requested Air Liquide to prepare and submit this HRA.

2.3 HRA Guidelines

The California Air Pollution Control Officers Association (CAPCOA), in conjunction with the California Air Resources Board (ARB) and California EPA Office of Environmental Health Hazard Assessment (OEHHA), has developed risk assessment guidelines and specific procedures to be used by local administering agencies to implement the health risk portion of AB 2588. By standardizing the risk assessment process, risks between different facilities can be compared evenly. However, it should be noted that following these guidelines may lead to worst-case (i.e., health-conservative) estimates of risk.

ARB and SCAQMD require use of HARP ("Hot Spots" Analysis and Reporting Program) to conduct AB 2588 health risk assessments. HARP is ARB's database program that integrates the emissions inventory, air dispersion modeling, and risk analysis and mapping elements of a health risk assessment. This HRA was also conducted in accordance with SCAQMD *AB 2588 and Rule 1402 Supplemental Guidelines (Supplemental Guidelines for Preparing Risk Assessments for the Air Toxics "Hot Spots" Information and Assessment Act)*, dated September 2018.

The balance of this document is organized sequentially to summarize hazards and emissions, outline the approach for air dispersion modeling, and present results associated with risk characterization. Other supporting documentation, as listed in the Table of Contents, is included in the appendices.

3.0 HAZARD IDENTIFICATION

The Air Liquide El Segundo Hydrogen Plant operates continuously, 24 hours per day, 7 days per week. Chemical hazards exist in this setting, ranging from short-term (acute) exposure to benzene to long-term (chronic) exposure to diesel PM and other combustion byproducts.

3.1 Health Tables

SCAQMD guidelines require the facility to identify and evaluate all chemicals regulated by AB 2588, regardless of total facility emission levels. Chemicals emitted by the facility, for which AB 2588 dose-response or health impact factors are published, are listed in Table 3-1. Table 3-1 distinguishes between chemicals evaluated for cancer risk, noncancer chronic, and noncancer acute health impacts.

Table 3-1 Dose Response Table

Pollutants	CAS	Cancer Risk Factor		Chronic			Acute
		Inhalation Cancer Potency Factor (mg/kg-day)$^{-1}$	Oral Slope Factor (mg/kg-day)$^{-1}$	Inhalation REL (µg/m^3)	8-Hour Inhalation REL (µg/m^3)	Oral REL (mg/kg-day)	Inhalation REL (µg/m^3)
1,3-Butadiene	106-99-0	6.0E-01		2.0E+00	9.0E+00		6.6E+02
2-Methyl naphthalene (PAHs)	91-57-6						
3-Methyl cholanthrene	56-49-5	2.2E+01	2.2E+01				
7,12-Dimethyl benz(a)anthracene	57-97-6	2.5E+02	2.5E+02				
Acenaphthene (PAHs)	83-32-9						
Acenaphthylene (PAHs)	208-96-8						
Acetaldehyde	75-07-0	1.0E-02		1.4E+02	3.0E+02		4.7E+02
Acrolein	107-02-8			3.5E-01	7.0E-01		2.5E+00
Ammonia	7664-41-7			2.0E+02			3.2E+03
Anthracene	120-12-7						
Arsenic	7440-38-2	1.2E+01	1.5E+00	1.5E-02	1.5E-02	3.5E-06	2.0E-01
Benz(a)anthracene (PAHs)	56-55-3	3.9E-01	1.2E+00				
Benzene	71-43-2	1.0E-01		3.0E+00	3.0E+00		2.7E+01
Benzo(a)pyrene	50-32-8	3.9E+00	1.2E+01				
Benzo(b)fluoranthene (PAHs)	205-99-2	3.9E-01	1.2E+00				
Benzo(g,h,i)perylene (PAHs)	191-24-2						

Table 3-1 Dose Response Table

Pollutants	CAS	Cancer Risk Factor		Chronic			Acute
		Inhalation Cancer Potency Factor (mg/kg-day)$^{-1}$	Oral Slope Factor (mg/kg-day)$^{-1}$	Inhalation REL (µg/m^3)	8-Hour Inhalation REL (µg/m^3)	Oral REL (mg/kg-day)	Inhalation REL (µg/m^3)
Benzo(k)fluoranthene (PAHs)	207-08-9	3.9E-01	1.2E+00				
Beryllium	7440-41-7	8.4E+00		7.0E-03		2.0E-03	
Cadmium	7440-43-9	1.5E+01		2.0E-02		5.0E-04	
Carbonyl sulfide	463-58-1			1.0E+01	1.0E+01		6.6E+02
Chlorine	7782-50-5			2.0E-01			2.1E+02
Chromium, hexavalent	18540-29-9	5.1E+02	5.0E-01	2.0E-01		2.0E-02	
Chrysene (PAHs)	218-01-9	3.9E-02	1.2E-01				
Copper	7440-50-8						1.0E+02
Dibenz(a,h)anthracene (PAHs)	53-70-3	4.1E+00	4.1E+00				
Dichlorobenzenes (mixed isomers)	25321-22-6	4.0E-02		8.0E+02			
Diesel PM	9901	1.1E+00		5.0E+00			
Ethyl benzene	100-41-4	8.7E-03		2.0E+03			
Fluoranthene (PAHs)	206-44-0						
Fluorene (PAHs)	86-73-7						
Formaldehyde	50-00-0	2.1E-02		9.0E+00	9.0E+00		5.5E+01
Hexane	110-54-3			7.0E+03			
Hydrogen sulfide	7783-06-4			1.0E+01			4.2E+01
Indeno(1,2,3-cd)pyrene (PAHs)	193-39-5	3.9E-01	1.2E+00				
Lead (inorganic)	7439-92-1	4.2E-02	8.5E-03				
Manganese	7439-96-5			9.0E-02	1.7E-01		
Mercury	7439-97-6			3.0E-02	6.0E-02	1.6E-04	6.0E-01
Methanol	67-56-1			4.0E+03			2.8E+04
Methyl ethyl ketone	78-93-3						1.3E+04
Methyl tert-butyl ether	1634-04-4	1.8E-03		8.0E+03			
Naphthalene	91-20-3	1.2E-01		9.0E+00			
Nickel	7440-02-0	9.1E-01		1.4E-02	6.0E-02	1.1E-02	2.0E-01
PAHs, total, w/o ind. comp.	1151	3.9E+00	1.2E+01				
Phenanthrene (PAHs)	85-01-8						
Phenol	108-95-2			2.0E+02			5.8E+03
Phosphorus	7723-14-0						

Table 3-1 Dose Response Table

Pollutants	CAS	Cancer Risk Factor		Chronic			Acute
		Inhalation Cancer Potency Factor (mg/kg-day)$^{-1}$	Oral Slope Factor (mg/kg-day)$^{-1}$	Inhalation REL (µg/m^3)	8-Hour Inhalation REL (µg/m^3)	Oral REL (mg/kg-day)	Inhalation REL (µg/m^3)
Propylene	115-07-1			3.0E+03			
Pyrene	129-00-0						
Selenium	7782-49-2			2.0E+01		5.0E-03	
Styrene	100-42-5			9.0E+02			2.1E+04
Sulfuric acid	7664-93-9			1.0E+00			1.2E+02
Toluene	108-88-3			3.0E+02			3.7E+04
Vanadium	7440-62-2						3.0E+01
Xylenes (mixed isomers)	1330-20-7			7.0E+02			2.2E+04

3.2 Multi-Pathways & Organ Systems

While most chemicals emitted from the facility present inhalation risk, a few pose health impacts from other exposure pathways as well. Table 3-2 lists multi-pathway exposures for chemicals emitted from the facility.

Chemicals with noncancer chronic and acute health impacts are evaluated for their cumulative effects on human organ systems. Table 3-3 lists the noncancer health impacts by organ system associated with each chemical emitted from the facility.

Many chemicals are emitted from the facility continuously, as various processes and combustion equipment operate around the clock. Intermittent, yet predictable, emission sources include flaring and various maintenance activities.

Table 3-2 Multi-Pathway Pollutants

Pollutants	Inhalation	Plant	Soil Ingestion	Dermal	Mother's Milk
3-Methyl cholanthrene	X	X	X	X	X
7,12-Dimethyl benz(a)anthracene	X	X	X	X	X
Arsenic	X	X	X	X	
Benz(a)anthracene (PAHs)	X	X	X	X	X
Benzo(a)pyrene	X	X	X	X	X
Benzo(b)fluoranthene (PAHs)	X	X	X	X	X
Benzo(k)fluoranthene (PAHs)	X	X	X	X	X
Beryllium	X	X	X	X	
Cadmium	X	X	X	X	
Chromium, hexavalent	X	X	X	X	
Chrysene (PAHs)	X	X	X	X	X
Dibenz(a,h)anthracene (PAHs)	X	X	X	X	X
Indeno(1,2,3-cd)pyrene (PAHs)	X	X	X	X	X
Lead (inorganic)	X	X	X	X	X
Mercury	X	X	X	X	
Nickel	X	X	X	X	
PAHs, total, w/o ind. comp.	X	X	X	X	X

Table 3-3 Target Organs Table

Pollutants	CAS	AT	BO	CV	DV	EN	EY	HE	IM	KI	NE	RE	RP	SK
1,3-Butadiene	106-99-0	--	--	--	A	--	--	--	--	--	--	8 C	--	--
2-Methyl naphthalene (PAHs)	91-57-6	--	--	--	--	--	--	--	--	--	--	--	--	--
3-Methyl cholanthrene	56-49-5	--	--	--	--	--	--	--	--	--	--	--	--	--
7,12-Dimethyl benz(a)anthracene	57-97-6	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene (PAHs)	83-32-9	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene (PAHs)	208-96-8	--	--	--	--	--	--	--	--	--	--	--	--	--
Acetaldehyde	75-07-0	--	--	--	--	--	A	--	--	--	--	A 8 C	--	--
Acrolein	107-02-8	--	--	--	--	--	A	--	--	--	--	A 8 C	--	--
Ammonia	7664-41-7	--	--	--	--	--	A	--	--	--	--	A C	--	--
Anthracene (PAHs)	120-12-7	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	7440-38-2	--	--	A 8 C	A 8 C	--	--	--	--	--	A 8 C	8 C	--	8 C
Benz[a]anthracene (PAHs)	56-55-3	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzene	71-43-2	--	--	--	A	--	--	A 8 C	A	--	--	--	--	--
Benzo[a]pyrene	50-32-8	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo[b]fluoranthene (PAHs)	205-99-2	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo[g,h,i]perylene (PAHs)	191-24-2	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo[k]fluoranthene (PAHs)	207-08-9	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	7440-41-7	C	--	--	--	--	--	--	C	--	--	C	--	--
Cadmium	7440-43-9	--	--	--	--	--	--	--	--	C	--	C	--	--
Carbonyl sulfide	463-58-1	--	--	--	--	--	--	--	--	--	A 8 C	--	--	--
Chlorine	7782-50-5	--	--	--	--	--	A	--	--	--	--	A C	--	--
Chromium VI, and compounds	18540-29-9	--	--	--	--	--	--	C	--	--	--	C	--	--
Chrysene (PAHs)	218-01-9	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	7440-50-8	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 3-3 Target Organs Table

Pollutants	CAS	AT	BO	CV	DV	EN	EY	HE	IM	KI	NE	RE	RP	SK
Dibenz[a,h]anthracene	53-70-3	--	--	--	--	--	--	--	--	--	--	--	--	--
Dichlorobenzenes (mixed isomers)	25321-22-6	C	--	--	--	--	--	--	--	C	--	--	--	--
Diesel PM	9901	--	--	--	--	--	--	--	--	--	--	C	--	--
Ethyl benzene	100-41-4	C	--	--	C	C	--	--	--	C	--	--	--	--
Fluoranthene (PAHs)	206-44-0	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene (PAHs)	86-73-7	--	--	--	--	--	--	--	--	--	--	--	--	--
Formaldehyde	50-00-0	--	--	--	--	--	A	--	--	--	--	A 8 C	--	--
Hexane	110-54-3	--	--	--	--	--	--	--	--	--	C	--	--	--
Hydrogen sulfide	7783-06-4	--	--	--	--	--	--	--	--	--	A	C	--	--
Indeno[1,2,3-cd]pyrene (PAHs)	193-39-5	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	7439-92-1	--	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	7439-96-5	--	--	--	--	--	--	--	--	--	8 C	--	--	--
Mercury	7439-97-6	--	--	--	A 8 C	--	--	--	--	8C	A 8 C	--	--	--
Methanol	67-56-1	--	--	--	C	--	--	--	--	--	A	--	--	--
Methyl ethyl ketone	78-93-3	--	--	--	--	--	A	--	--	--	--	A	--	--
Methyl tert-butyl ether	1634-04-4	C	--	--	--	--	C	--	--	C	--	--	--	--
Naphthalene	91-20-3	--	--	--	--	--	--	--	--	--	--	C	--	--
Nickel	7440-02-0	--	--	--	C	--	--	C	A 8	--	--	8 C	--	--
PAHs, w/o ind. Components	1151	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene (PAHs)	85-01-8	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenol	108-95-2	C	--	C	--	--	A	--	--	C	C	A	--	--
Phosphorus	7723-14-0	--	--	--	--	--	--	--	--	--	--	C	--	--
Propylene	115-07-1	--	--	--	--	--	--	--	--	--	--	C	--	--
Pyrene	129-00-0	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 3-3 Target Organs Table

Pollutants	CAS	AT	BO	CV	DV	EN	EY	HE	IM	KI	NE	RE	RP	SK
Selenium	7782-49-2	C	--	C	--	--	--	--	--	--	C	--	--	--
Styrene	100-42-5	--	--	--	A	--	A	--	--	--	C	A	A	--
Sulfuric acid	7664-93-9	--	--	--	--	--	--	--	--	--	--	A C	--	--
Toluene	108-88-3	--	--	--	A C	--	A	--	--	--	A C	A C	A	--
Vanadium (fume or dust)	7440-62-2	--	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes (mixed)	1330-20-7	--	--	--	--	--	A	--	--	--	A	A	--	--

Note: AT = Alimentary, BO = Bone, CV = Cardiovascular, DV = Developmental, EN = Endocrine, EY = Eyes, HE = Hematologic, IM = Immune, KI = Kidney, NE = Nervous, RE = Respiratory, RP = Reproductive, SK = Ski

Note:
A = acute exposure
8 = 8-hour exposure
C = chronic exposure
-- = not applicable

4.0 EXPOSURE ASSESSMENT

The exposure assessment for this HRA began with a thorough evaluation of facility operations to identify all emission sources, their annual and maximum hourly emission quantities, and release characteristics. The offsite use of land in the surrounding communities was also evaluated.

4.1 Land Use

The Air Liquide El Segundo Hydrogen Plant facility is located on a relatively flat area within the southeastern portion of the Chevron El Segundo Refinery. The immediate area surrounding the refinery is zoned for industrial, commercial, and residential uses. A facility plot plan and surrounding land use are represented in Figures 2-1 and 2-2.

4.2 Human Exposure Pathways

To identify potential exposure pathways for this HRA, three things were considered: 1) the type of pollutants, 2) land use in the area, and 3) lifestyle (i.e., urban versus rural). Exposure pathways considered include inhalation, soil ingestion, dermal contact, plant ingestion (vegetation), drinking water ingestion, and human milk ingestion.

Activities that may lead to exposure are different for workers and residents in the vicinity of the facility. Offsite workers might reasonably be exposed via inhalation, dermal contact, and soil ingestion. Other exposure pathways, while reasonable for residential populations, are not likely for worker populations and so could reasonably be excluded from the evaluation. An example of this is plant ingestion. This pathway was excluded from worker exposure calculations because crops are not grown and subsequently consumed by onsite workers in the industrial areas surrounding the facility and refinery.

4.3 Dose Response

The human response to any given level of an exposure is measured with a dose-response assessment. A dose-response assessment produces three factors for use in evaluating potential adverse health effects: cancer potency factors (CPFs) for carcinogens, chronic noncancer reference exposure levels (RELs) for substances not considered to be carcinogenic or for the noncarcinogenic toxicity of carcinogens, and acute noncancer reference exposure levels (acute RELs) for acutely toxic compounds.

4.4 Emissions Inventory

The following emission source types are represented at the Air Liquide El Segundo Hydrogen Plant facility:

- Reformer Heater
- Process Vents
- Ground Flare
- Component Fugitives
- Internal Combustion Engines
- Maintenance Equipment (e.g., welding)

Appendix A contains a complete listing of individual emission sources, their respective modeling parameters, and coordinate locations. Chemical emissions for each modeled emission source are included in Appendix C.

Table 4-1 lists total facility emissions associated with this HRA. Fifty-four (54) emitted chemicals were identified, thirty (30) of which were also reported in the 2016 AER.

Table 4-1 2016 Facility-Wide AB 2588 Quantifiable Emissions
[Total Emission Rates by Substance]

Substance Name	CAS No.	Annual Average (lb/yr)	Maximum Hourly (lb/hr)	Annual Average (g/s)	Maximum Hourly (g/s)
1,3-Butadiene	106-99-0	5.15E-01	5.86E-05	7.40E-06	7.38E-06
2-Methyl naphthalene (PAHs)	91-57-6	8.95E-02	1.02E-05	1.29E-06	1.28E-06
3-Methyl cholanthrene	56-49-5	6.71E-03	7.64E-07	9.65E-08	9.63E-08
7,12-Dimethyl benz(a)anthracene	57-97-6	5.96E-02	6.79E-06	8.58E-07	8.56E-07
Acenaphthene (PAHs)	83-32-9	8.95E-03	1.02E-06	1.29E-07	1.28E-07
Acenaphthylene (PAHs)	208-96-8	2.42E-02	2.76E-06	3.48E-07	3.48E-07
Acetaldehyde	75-07-0	4.51E+01	5.13E-03	6.48E-04	6.47E-04
Acrolein	107-02-8	6.35E+01	7.22E-03	9.13E-04	9.10E-04
Ammonia	7664-41-7	9.10E+03	1.04E+00	1.31E-01	1.30E-01
Anthracene	120-12-7	1.75E-02	1.99E-06	2.52E-07	2.51E-07
Arsenic	7440-38-2	7.46E-01	8.49E-05	1.07E-05	1.07E-05
Benz(a)anthracene (PAHs)	56-55-3	8.20E-02	9.34E-06	1.18E-06	1.18E-06

Table 4-1 2016 Facility-Wide AB 2588 Quantifiable Emissions
[Total Emission Rates by Substance]

Substance Name	CAS No.	Annual Average (lb/yr)	Maximum Hourly (lb/hr)	Annual Average (g/s)	Maximum Hourly (g/s)
Benzene	71-43-2	9.27E+00	1.06E-03	1.33E-04	1.33E-04
Benzo(a)pyrene	50-32-8	2.12E-01	2.42E-05	3.06E-06	3.05E-06
Benzo(b)fluoranthene (PAHs)	205-99-2	1.01E-01	1.15E-05	1.45E-06	1.44E-06
Benzo(g,h,i)perylene (PAHs)	191-24-2	4.85E-03	5.52E-07	6.97E-08	6.95E-08
Benzo(k)fluoranthene (PAHs)	207-08-9	6.34E-02	7.21E-06	9.11E-07	9.09E-07
Beryllium	7440-41-7	4.85E-01	5.52E-05	6.97E-06	6.95E-06
Cadmium	7440-43-9	4.10E+00	4.67E-04	5.90E-05	5.88E-05
Carbonyl sulfide	463-58-1	3.90E-03	4.44E-07	5.61E-08	5.59E-08
Chlorine	7782-50-5	1.16E-01	1.32E-05	1.66E-06	1.66E-06
Chromium, hexavalent	18540-29-9	2.31E-01	2.63E-05	3.32E-06	3.31E-06
Chrysene (PAHs)	218-01-9	5.96E-03	6.79E-07	8.58E-08	8.56E-08
Copper	7440-50-8	3.10E+00	3.53E-04	4.46E-05	4.45E-05
Dibenz(a,h)anthracene (PAHs)	53-70-3	4.47E-03	5.09E-07	6.43E-08	6.42E-08
Dichlorobenzenes (mixed isomers)	25321-22-6	4.47E+00	5.09E-04	6.43E-05	6.42E-05
Diesel PM	9901	2.27E+01	2.59E-03	3.27E-04	3.26E-04
Ethyl benzene	100-41-4	4.76E+00	5.42E-04	6.84E-05	6.82E-05
Fluoranthene (PAHs)	206-44-0	1.08E-02	1.23E-06	1.55E-07	1.55E-07
Fluorene (PAHs)	86-73-7	1.01E-02	1.15E-06	1.45E-07	1.44E-07
Formaldehyde	50-00-0	2.80E+02	3.19E-02	4.03E-03	4.02E-03
Hexane	110-54-3	6.71E+03	7.64E-01	9.65E-02	9.63E-02
Hydrogen sulfide	7783-06-4	7.07E+01	8.05E-03	1.02E-03	1.01E-03
Indeno(1,2,3-cd)pyrene (PAHs)	193-39-5	2.65E-01	3.01E-05	3.81E-06	3.80E-06
Lead	7439-92-1	1.83E+00	2.08E-04	2.63E-05	2.62E-05
Manganese	7439-96-5	1.44E+00	1.64E-04	2.08E-05	2.07E-05
Mercury	7439-97-6	9.32E-01	1.06E-04	1.34E-05	1.34E-05
Methanol	67-56-1	2.00E+01	2.28E-03	2.88E-04	2.87E-04
Methyl ethyl ketone	78-93-3	1.69E-02	1.92E-06	2.43E-07	2.42E-07
Methyl tert-butyl ether	1634-04-4	5.23E-01	5.95E-05	7.52E-06	7.50E-06
Naphthalene	91-20-3	2.31E+00	2.63E-04	3.32E-05	3.31E-05
Nickel	7440-02-0	7.83E+00	8.92E-04	1.13E-04	1.12E-04

Table 4-1 2016 Facility-Wide AB 2588 Quantifiable Emissions
[Total Emission Rates by Substance]

Substance Name	CAS No.	Annual Average (lb/yr)	Maximum Hourly (lb/hr)	Annual Average (g/s)	Maximum Hourly (g/s)
PAHs, total, w/o ind. comp.	1151	9.01E-03	1.03E-06	1.30E-07	1.29E-07
Phenanthrene (PAHs)	85-01-8	6.34E-02	7.21E-06	9.11E-07	9.09E-07
Phenol	108-95-2	1.49E+01	1.70E-03	2.14E-04	2.14E-04
Phosphorus	7723-14-0	2.39E+00	2.72E-04	3.43E-05	3.42E-05
Propylene	115-07-1	5.84E+02	6.65E-02	8.40E-03	8.37E-03
Pyrene	129-00-0	1.83E-02	2.08E-06	2.63E-07	2.62E-07
Selenium	7782-49-2	3.28E+00	3.73E-04	4.72E-05	4.71E-05
Styrene	100-42-5	3.65E-02	4.16E-06	5.26E-07	5.24E-07
Sulfuric Acid	7664-93-9	7.51E+01	8.55E-03	1.08E-03	1.08E-03
Toluene	108-88-3	1.44E+01	1.64E-03	2.07E-04	2.06E-04
Vanadium	7440-62-2	8.57E+00	9.76E-04	1.23E-04	1.23E-04
Xylenes (mixed isomers)	1330-20-7	9.52E+01	1.08E-02	1.37E-03	1.37E-03

5.0 AIR DISPERSION MODELING

Emissions from the facility are released into the atmosphere through point and area sources. Using the publicly available ADMRT module of the HARP database, toxic air pollutants from these sources were modeled following SCAQMD and OEHHA guidelines.

5.1 Model Selection

The dispersion model used in this HRA is U.S. EPA's current AMS/EPA Regulatory Model (AERMOD), an imbedded module of the HARP database program. Terrain elevation data was obtained in the format of DEM (Digital Elevation Model) files from the United States Geological Survey (USGS). The DEM file for the associated facility location was selected, and data was electronically referenced by the HARP database program to determine source and receptor elevations.

Table 5-1 below outlines the basic inputs and assumptions utilized in this model per these guidelines:

Table 5-1 Basic Inputs to Dispersion Model

Modeling Option	Selection
ADMRT Version:	19121
Coordinate System:	Universal Transverse Mercator (UTM)
Datum	WGS84 – World Geodetic System 1984
UTM Zone:	11 N
Use Regulatory Default?	Yes
Urban or Rural?	Urban
Flagpole Height	0 m
Meteorological Data	SCAQMD KLAX Version 9 Data (30 m elev.)
Include Building Downwash?	Yes

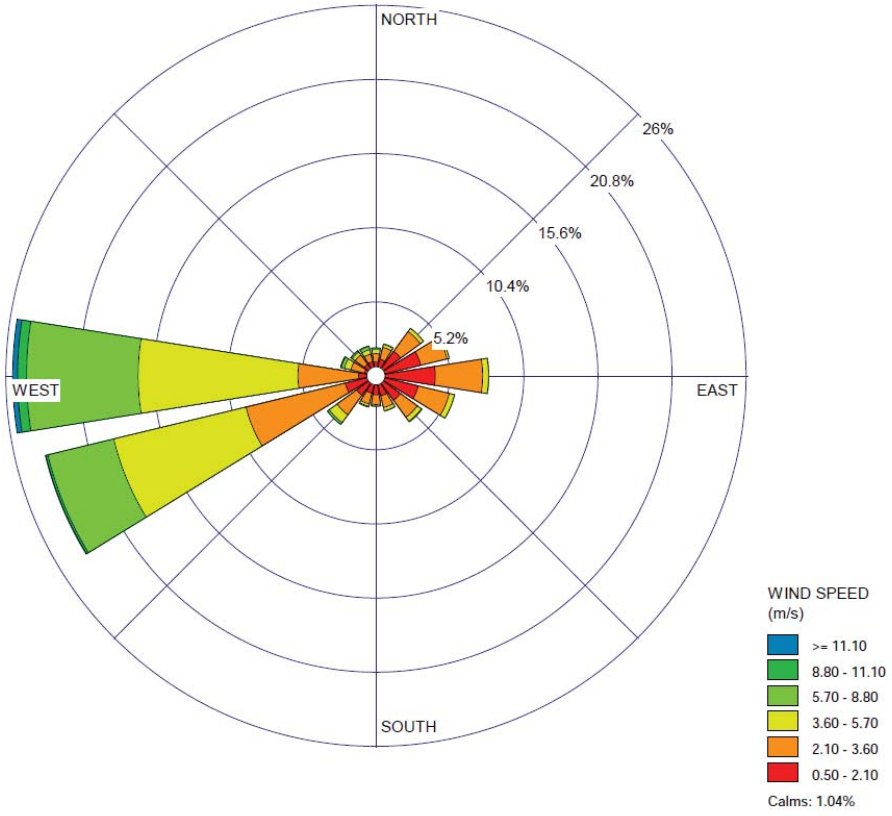
The meteorological data used in this risk assessment was available online from SCAQMD.

5.2 Meteorological Data

SCAQMD provides AERMOD-ready meteorological data for local stations in the South Coast on its website. All facilities are required to use five years of daily meteorological data from the most representative meteorological station. Version 9 of the Los Angeles

International Airport (KLAX) meteorological station was determined to be the closest, best available, and most representative data for this HRA. The meteorological data spans 5 years (2012-2016), collected from a location approximately 2.5 miles from the facility with no major interfering terrain elements in between. A wind rose for this met data is provided in Figure 5-1.

Figure 5-1 KLAX Wind Rose



This data set includes measurements of wind speed and direction, surface temperature, and stability. The AERMOD dispersion model runs a separate dispersion for every day of meteorological data within this 5-year span and interpolates an average dispersion of the daily dispersion results.

5.3 Building Downwash

U.S. EPA's Building Profile Input Program (BPIP), also an imbedded module of the HARP database program, was used to determine the effects of aerodynamic building wakes on the dispersion of facility point source emissions. The program identifies point sources for which downwash has an effect and calculates directional downwash parameters for those sources.

5.4 Modeled Sources

A total of 10 individual emission sources were modeled in this HRA. Combustion devices and process vents were modeled as point sources; component fugitive and welding emissions were modeled as area sources. Modeling parameters and UTM coordinates for each emission source are provided in Appendix A.

5.5 Model Receptors

Table 5-2 categorizes 1,852 total receptors modeled in this HRA.

Table 5-2 Summary of Receptors

Receptor Type	Receptor Quantity
Property Boundary Receptors	196
Grid Receptors	1,032
Fine Grid Receptors	34
Census Receptors	590
Sensitive Receptors	0
Total Receptors	1,852

The refinery's property boundary was used for this HRA. A Cartesian grid of offsite receptors with 100 meter spacing was used to identify the points of highest exposure (PMI, MEIR, MEIW). An additional fine line of receptors with 25 meter spacing, placed south of the refinery boundary in the adjacent neighborhood on Rosecrans Avenue, was included to identify the points of highest residential exposure.

Census receptors were used for the cancer burden analysis. The locations of census tract centroids were automatically determined by the HARP 2010 Census Database program. Census tracts within a conservative 5 km radial distance from the Air Liquide facility and containing a population greater than zero were identified and modeled in the HRA. Any census receptors within the study area (i.e., 1 x 10^{-6} cancer risk isopleth for 70-year exposure) were considered in the cancer burden analysis.

No sensitive receptors were modeled in this HRA, as none were identified within the study area (i.e., hospitals, schools, day care facilities, and convalescent homes).

Appendix B contains tables and Google Earth plots of all receptors modeled in this HRA.

6.0 RISK CHARACTERIZATION

Risk characterization is the final step in the risk assessment process where the results of the exposure and dose-response assessments are combined to determine the potential for health risk. Health effects evaluated include:

- An estimate of the lifetime incremental risk of developing cancer
- Increased number of cancer cases in the exposed population (burden)
- Potential for chronic or long-term noncancer effects, and
- Potential for acute or short-term noncancer effects.

OEHHA requires risk calculations for a hypothetical residential maximally exposed individual, or resident MEI. This individual is assumed to live at the point of highest concentration of facility emissions, in a residentially zoned area, for up to 24 hours per day (fraction of time at home assumed to differ for ages >16), 365 days per year, for 30 continuous years. The MEI concept ensures that exposure will not be underestimated due to time spent at work, on vacation, commuting locally, or moving from one residence to another.

Also calculated in this HRA is the exposure and risk to a hypothetical occupational maximally exposed individual, or worker MEI. This individual is assumed to work at the point of highest impact in nonresidential areas, for 8 hours per day, 240 days per year, for 25 years.

6.1 Study Area

The HRA study area or zone of impact, as defined in the OEHHA guidelines, encompasses the geographical area subject to the calculated hypothetical individual lifetime cancer risk of 1 x 10^{-6} or greater over a 70-year exposure period. For this facility, the study area is shown in Figure 6-1.

6.2 Cancer Risk

Carcinogenic risks in this 2016-based health risk assessment were determined for the residential MEI, worker MEI, and a Point of Maximum Impact (PMI). MEIs and the PMI were identified from the model receptors.

The lifetime risk of developing cancer at the residential MEI was estimated to be 1.2 in one million (1.2 x 10^{-6}). The residential MEI is located south of the refinery at UTM coordinates 369975E, 3752160N. Table 6-1 presents cancer risk at the residential MEI by substance and exposure pathway. Diesel PM, hexavalent chromium, and 7,12-

dimethyl ben(a)anthracene account for the majority of cancer risk at the residential MEI. Diesel ICEs account for approximately 82% of the residential MEI cancer risk as shown in Table 6-2.

The lifetime risk of developing cancer at the worker MEI was estimated to be 0.4 in one million (0.4×10^{-6}). The worker MEI is located east of the refinery at UTM coordinates 371000E, 3752800N. Table 6-3 presents cancer risk at the worker MEI by substance and exposure pathway. Diesel PM, hexavalent chromium, and cadmium account for the majority of cancer risk at the worker MEI. Diesel ICEs account for approximately 78% of the worker MEI cancer risk as shown in Table 6-4.

Estimated residential and worker cancer risks at other locations surrounding the facility will be lower than risks identified at the respective MEIs. The distance from the facility to the farthest edge of the 1×10^{-6} 70-year cancer risk isopleth is an estimated 1,500 meters to the northeast.

Figure 6-2 shows the distinct locations of the cancer risk residential and worker MEIs along with the cancer risk PMI. Figures 6-3 and 6-4 display cancer risk isopleths for residents and workers, respectively, as required by AB 2588 and the SCAQMD.

6.3 Cancer Burden

In addition to the individual cancer risks for the residential MEI, the maximum increased number of cancer cases that might be expected to occur within the zone of impact was evaluated (called cancer burden or population risk). Total cancer burden for the facility was estimated to be 0.0001. This means that less than one additional cancer case is estimated from among the exposed population, assuming that all inhabitants within the zone of impact reside there for a continuous 70-year period.

6.4 Sensitive Receptor Risk

Sensitive receptors consist of schools, day care centers, convalescent homes, and hospitals. No sensitive receptors were identified within the zone of impact based on a search using internet tools and resources.

6.5 Chronic Noncancer Effects

Residential and worker chronic noncancer hazard indices for each target organ or system are summarized in Table 6-5 and Table 6-6, respectively. As shown in the tables, the chronic noncancer hazard index value for each target organ or system is below 1.0, which indicates that chronic noncancer effects from exposure to facility emissions are unlikely. The highest residential chronic hazard index (HI) is 0.004 (respiratory tract), and the highest worker chronic HI is 0.017 (respiratory tract). The maximum residential chronic HI is located south of the refinery at UTM coordinates 370150E, 3752160N. The maximum worker chronic HI is located east of the refinery at UTM coordinates 371000E, 3752700N. Figure 6-5 shows distinct locations of the chronic HI residential MEI, the chronic HI worker MEI, and the chronic HI PMI. Noncancer chronic risk isopleths were not prepared because all residential and worker chronic hazard indices were too low (less than 0.1).

6.6 Acute Effects

Results of the acute analysis, which compares acceptable ambient concentrations with maximum one-hour concentrations from facility emissions, are shown in Table 6-7 and Table 6-8. As shown in the tables, the acute HIs were exceptionally low (less than 0.01). The maximum residential acute HI was determined to be 0.003 (immune system) and is located south of the refinery at UTM coordinates 370150E, 3752160N. The maximum worker acute HI was determined to be 0.002 (immune system) and is located east of the refinery at UTM coordinates 371000E, 3752900N. Figure 6-6 shows distinct locations of the acute HI residential MEI, the acute HI worker MEI, and the acute HI PMI. Noncancer acute risk isopleths were not prepared because all residential and worker acute hazard indices were too low (less than 0.01).

Table 6-1 Cancer Risk at the Residential MEI

Substance	Inhalation	Soil Ingestion	Plant Ingestion	Dermal Absorption	Mother's Milk	Total
Diesel PM	9.85E-07					9.85E-07
Chromium, hexavalent	4.90E-08	8.66E-10	2.84E-08	3.32E-11		7.83E-08
7,12-Dimethyl b(a)a	4.08E-09	4.94E-09	2.42E-08	1.23E-09	1.17E-08	4.62E-08
Arsenic	2.45E-09	1.85E-08	1.19E-08	8.98E-10	0.00E+00	3.37E-08
Cadmium	2.38E-08					2.38E-08
1,3-Butadiene	1.03E-08					1.03E-08
Benzo(a)pyrene	2.27E-10	8.44E-10	4.14E-09	2.10E-10	2.01E-09	7.43E-09
Benzene	4.19E-09					4.19E-09
Formaldehyde	3.08E-09					3.08E-09
Nickel	2.83E-09					2.83E-09
Beryllium	1.58E-09					1.58E-09
PAHs, w/o ind. comp.	3.59E-11	1.34E-10	6.55E-10	3.33E-11	3.18E-10	1.18E-09
Other Carcinogens	8.98E-10	5.14E-10	1.32E-09	7.05E-11	6.19E-10	3.42E-09
Total	1.09E-06	2.57E-08	7.06E-08	2.48E-09	1.47E-08	1.20E-06

Table 6-2 Top Sources Contributing to Cancer Risk at the Residential MEI

Rank	Modeling Source No.	Source Description	Cancer Risk	Percent of Total Risk
1	S0008	ICE DIESEL	9.85E-07	82.01%
2	S0001	REFORMER HEATER	1.94E-07	16.13%
3	S0009	ICE GASOLINE	1.05E-08	0.88%
4	S0010	WELDING	5.59E-09	0.47%
5	S0006	FUGITIVE S	2.71E-09	0.23%
6	S0007	FUGITIVE N	2.11E-09	0.18%
7	S0002	GROUND FLARE	1.41E-09	0.12%
8	S0003	PROCESS VENT D12		0.00%
9	S0004	PROCESS VENT D10		0.00%
10	S0005	PROCESS VENT D30		0.00%

Table 6-3 Cancer Risk at the Worker MEI

Substance	Inhalation	Soil Ingestion	Plant Ingestion[1]	Dermal Absorption	Mother's Milk[1]	Total
Diesel PM	3.21E-07					3.21E-07
Chromium, hexavalent	3.56E-08	7.54E-10		5.23E-11		3.64E-08
Cadmium	1.82E-08					1.82E-08
Arsenic	1.96E-09	7.16E-09		2.86E-09		1.20E-08
7,12-Dimethyl b(a)a	4.42E-09	4.53E-09		2.04E-09		1.10E-08
1,3-Butadiene	2.73E-09					2.73E-09
Nickel	2.13E-09					2.13E-09
Formaldehyde	2.05E-09					2.05E-09
Benzo(a)pyrene	1.82E-10	7.74E-10		6.71E-10		1.63E-09
Benzene	1.54E-09					1.54E-09
Beryllium	1.21E-09					1.21E-09
PAHs, w/o ind. comp.	3.42E-11	1.46E-10		1.26E-10		3.06E-10
Other Carcinogens	5.27E-10	3.36E-10		1.94E-10		1.06E-09
Total	3.92E-07	1.37E-08		5.95E-09		4.12E-07

[1] The Plant Ingestion and Mother's Milk pathways are not considered for work exposure and risk

Table 6-4 Top Sources Contributing to Cancer Risk at the Worker MEI

Rank	Modeling Source No.	Source Description	Cancer Risk	Percent of Total Risk
1	S0008	ICE DIESEL	3.21E-07	78.07%
2	S0001	REFORMER HEATER	8.46E-08	20.55%
3	S0009	ICE GASOLINE	3.43E-09	0.83%
4	S0010	WELDING	7.75E-10	0.19%
5	S0007	FUGITIVE N	5.25E-10	0.13%
6	S0002	GROUND FLARE	5.22E-10	0.13%
7	S0006	FUGITIVE S	4.00E-10	0.10%
8	S0003	PROCESS VENT D12		0.00%
9	S0004	PROCESS VENT D10		0.00%
10	S0005	PROCESS VENT D30		0.00%

[1] The Plant Ingestion and Mother's Milk pathways are not considered for work exposure and risk

Table 6-5 Chronic HIs by Target Organ at the Residential MEI

Target Organ/System	Substance	Organ-Specific Hazard Index
Cardiovascular System	Arsenic	2.71E-03
	Phenol	4.63E-08
	Selenium	1.99E-05
	Total	**2.73E-03**
Central Nervous System	Arsenic	2.71E-03
	Carbonyl sulfide	1.67E-08
	Hexane	6.03E-07
	Manganese	3.74E-05
	Mercury	7.44E-05
	Phenol	4.63E-08
	Selenium	1.99E-05
	Styrene	1.60E-09
	Toluene	2.78E-07
	Xylenes (mixed isomers)	1.94E-07
	Total	**2.85E-03**
Circulatory System	Benzene	1.47E-05
	Chromium, hexavalent	1.86E-06
	Nickel	3.54E-04
	Total	**3.70E-04**
Endocrine System	Ethyl benzene	1.29E-08
	Total	**1.29E-08**
Gastrointestinal/ Liver	Beryllium	1.82E-06
	Ethyl benzene	1.29E-08
	Methyl tert-butyl ether	2.58E-09
	Phenol	4.63E-08
	Selenium	1.99E-05
	Total	**2.18E-05**
Immune System	Beryllium	4.29E-05
	Total	**4.29E-05**
Kidney	Cadmium	2.51E-04
	Ethyl benzene	1.29E-08
	Mercury	7.44E-05
	Methyl tert-butyl ether	2.58E-09
	Phenol	4.63E-08
	Total	**3.26E-04**
Reproductive/ Developmental Systems	1,3-Butadiene	1.06E-05
	Arsenic	2.71E-03
	Ethyl benzene	1.29E-08

Table 6-5 Chronic HIs by Target Organ at the Residential MEI

Target Organ/System	Substance	Organ-Specific Hazard Index
	Mercury	7.44E-05
	Methanol	9.11E-08
	Nickel	6.60E-06
	Toluene	2.78E-07
	Total	**2.81E-03**
Respiratory System	Acetaldehyde	2.60E-07
	Acrolein	1.18E-04
	Ammonia	2.82E-05
	Arsenic	2.71E-03
	Beryllium	4.29E-05
	Cadmium	1.27E-04
	Chlorine	2.28E-05
	Chromium, hexavalent	7.64E-07
	Diesel PM	1.79E-04
	Formaldehyde	2.37E-05
	Hydrogen sulfide	4.39E-06
	Naphthalene	3.22E-07
	Nickel	3.54E-04
	Propylene	4.68E-07
	Sulfuric acid	4.66E-05
	Toluene	2.78E-07
	Xylenes (mixed isomers)	1.94E-07
	Total	**3.66E-03**
Skin	Arsenic	2.71E-03
	Total	**2.71E-03**
Vision	Methyl tert-butyl ether	2.58E-09
	Xylenes (mixed isomers)	1.94E-07
	Total	**1.97E-07**

Table 6-6 Chronic HIs by Target Organ at the Worker MEI

Target Organ/System	Substance	Organ-Specific Hazard Index
Cardiovascular System	Arsenic	8.55E-03
	Phenol	4.52E-07
	Selenium	2.36E-05
	Total	**8.57E-03**
Central Nervous System	Arsenic	8.55E-03
	Carbonyl sulfide	4.24E-08
	Hexane	5.83E-06
	Manganese	1.71E-04
	Mercury	3.97E-04
	Phenol	4.52E-07
	Selenium	2.36E-05
	Styrene	7.14E-09
	Toluene	1.38E-06
	Xylenes (mixed isomers)	1.27E-06
	Total	**9.15E-03**
Circulatory System	Benzene	7.56E-05
	Chromium, hexavalent	3.87E-07
	Nickel	3.41E-03
	Total	**3.49E-03**
Endocrine System	Ethyl benzene	7.86E-08
	Total	**7.86E-08**
Gastrointestinal/ Liver	Beryllium	8.34E-06
	Ethyl benzene	7.86E-08
	Methyl tert-butyl ether	1.15E-08
	Phenol	4.52E-07
	Selenium	2.36E-05
	Total	**3.24E-05**
Immune System	Beryllium	4.20E-04
	Total	**4.20E-04**
Kidney	Cadmium	1.49E-03
	Ethyl benzene	7.86E-08
	Mercury	3.97E-04
	Methyl tert-butyl ether	1.15E-08
	Phenol	4.52E-07
	Total	**1.89E-03**
Reproductive/ Developmental Systems	1,3-Butadiene	3.58E-05
	Arsenic	8.55E-03
	Ethyl benzene	7.86E-08

Table 6-6 Chronic HIs by Target Organ at the Worker MEI

Target Organ/System	Substance	Organ-Specific Hazard Index
	Mercury	3.97E-04
	Methanol	2.78E-07
	Nickel	2.36E-05
	Toluene	1.38E-06
	Total	**9.00E-03**
Respiratory System	Acetaldehyde	2.22E-06
	Acrolein	1.12E-03
	Ammonia	2.76E-04
	Arsenic	8.55E-03
	Beryllium	4.20E-04
	Cadmium	1.24E-03
	Chlorine	1.02E-04
	Chromium, hexavalent	7.12E-06
	Diesel PM	7.99E-04
	Formaldehyde	2.10E-04
	Hydrogen sulfide	4.29E-05
	Naphthalene	2.29E-06
	Nickel	3.41E-03
	Propylene	2.02E-06
	Sulfuric acid	4.55E-04
	Toluene	1.38E-06
	Xylenes (mixed isomers)	1.27E-06
	Total	**1.66E-02**
Skin	Arsenic	8.55E-03
	Total	**8.55E-03**
Vision	Methyl tert-butyl ether	1.15E-08
	Xylenes (mixed isomers)	1.27E-06
	Total	**1.29E-06**

Table 6-7 Acute HIs by Target Organ at the Residential MEI

Target Organ/System	Substance	Organ-Specific Hazard Index
Cardiovascular System	Arsenic	2.65E-04
	Total	**2.65E-04**
Central Nervous System	Arsenic	2.65E-04
	Carbonyl sulfide	1.02E-08
	Hydrogen sulfide	1.20E-04
	Mercury	1.11E-04
	Methanol	5.82E-07
	Toluene	8.74E-08
	Xylenes (mixed isomers)	4.16E-07
	Total	**4.97E-04**
Circulatory System	Benzene	6.76E-05
	Total	**6.76E-05**
Immune System	Benzene	6.76E-05
	Nickel	2.80E-03
	Total	**2.87E-03**
Reproductive/ Developmental Systems	1,3-Butadiene	1.17E-06
	Arsenic	2.65E-04
	Benzene	6.76E-05
	Mercury	1.11E-04
	Styrene	2.12E-09
	Toluene	8.74E-08
	Total	**4.45E-04**
Respiratory System	Acetaldehyde	7.37E-06
	Acrolein	1.83E-03
	Ammonia	2.02E-04
	Chlorine	6.70E-07
	Copper	2.30E-06
	Methyl ethyl ketone	1.58E-09
	Phenol	1.83E-07
	Styrene	2.12E-09
	Sulfuric acid	4.45E-05
	Toluene	8.74E-08
	Vanadium	2.03E-05
	Xylenes (mixed isomers)	4.16E-07
	Total	**2.11E-03**
Vision	Acetaldehyde	7.37E-06
	Acrolein	1.83E-03

Table 6-7 Acute HIs by Target Organ at the Residential MEI

Target Organ/System	Substance	Organ-Specific Hazard Index
	Ammonia	2.02E-04
	Chlorine	6.70E-07
	Formaldehyde	3.88E-04
	Methyl ethyl ketone	1.58E-09
	Phenol	1.83E-07
	Styrene	2.12E-09
	Toluene	8.74E-08
	Vanadium	2.03E-05
	Xylenes (mixed isomers)	4.16E-07
	Total	**2.45E-03**

Table 6-8 Acute HIs by Target Organ at the Worker MEI

Target Organ/System	Substance	Organ-Specific Hazard Index
Cardiovascular System	Arsenic	1.60E-04
	Total	**1.60E-04**
Central Nervous System	Arsenic	1.60E-04
	Carbonyl sulfide	5.76E-09
	Hydrogen sulfide	7.21E-05
	Mercury	6.65E-05
	Methanol	8.33E-07
	Toluene	3.09E-07
	Xylenes (mixed isomers)	6.31E-07
	Total	**3.00E-04**
Circulatory System	Benzene	2.20E-04
	Total	**2.20E-04**
Immune System	Benzene	2.20E-04
	Nickel	1.71E-03
	Total	**1.93E-03**
Reproductive/ Developmental Systems	1,3-Butadiene	2.43E-06
	Arsenic	1.60E-04
	Benzene	2.20E-04
	Mercury	6.65E-05
	Styrene	9.92E-09
	Toluene	3.09E-07
	Total	**4.48E-04**
Respiratory System	Acetaldehyde	6.68E-06
	Acrolein	1.20E-03
	Ammonia	1.22E-04
	Chlorine	3.14E-06
	Copper	1.42E-06
	Methyl ethyl ketone	7.39E-09
	Phenol	1.10E-07
	Styrene	9.92E-09
	Sulfuric acid	2.68E-05
	Toluene	3.09E-07
	Vanadium	1.22E-05
	Xylenes (mixed isomers)	6.31E-07
	Total	**1.38E-03**
Vision	Acetaldehyde	6.68E-06
	Acrolein	1.20E-03
	Ammonia	1.22E-04

Table 6-8 Acute HIs by Target Organ at the Worker MEI

Target Organ/System	Substance	Organ-Specific Hazard Index
	Chlorine	3.14E-06
	Formaldehyde	3.17E-04
	Methyl ethyl ketone	7.39E-09
	Phenol	1.10E-07
	Styrene	9.92E-09
	Toluene	3.09E-07
	Vanadium	1.22E-05
	Xylenes (mixed isomers)	6.31E-07
	Total	**1.66E-03**

Figure 6-1 Zone of Impact

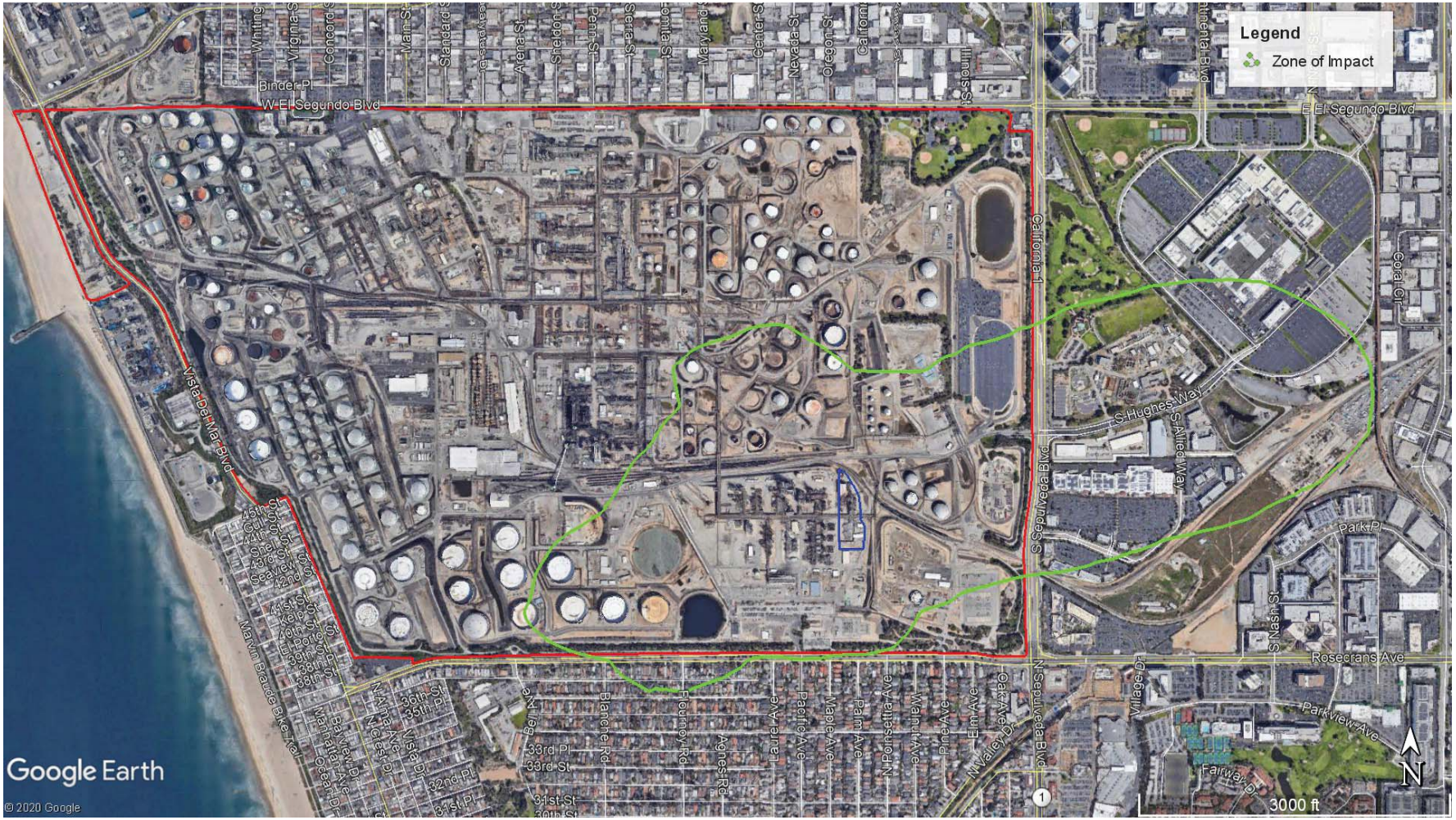


Figure 6-2 Location of Cancer Risk MEIs and PMI

Figure 6-3 Cancer Risk Isopleths for Residential MEI

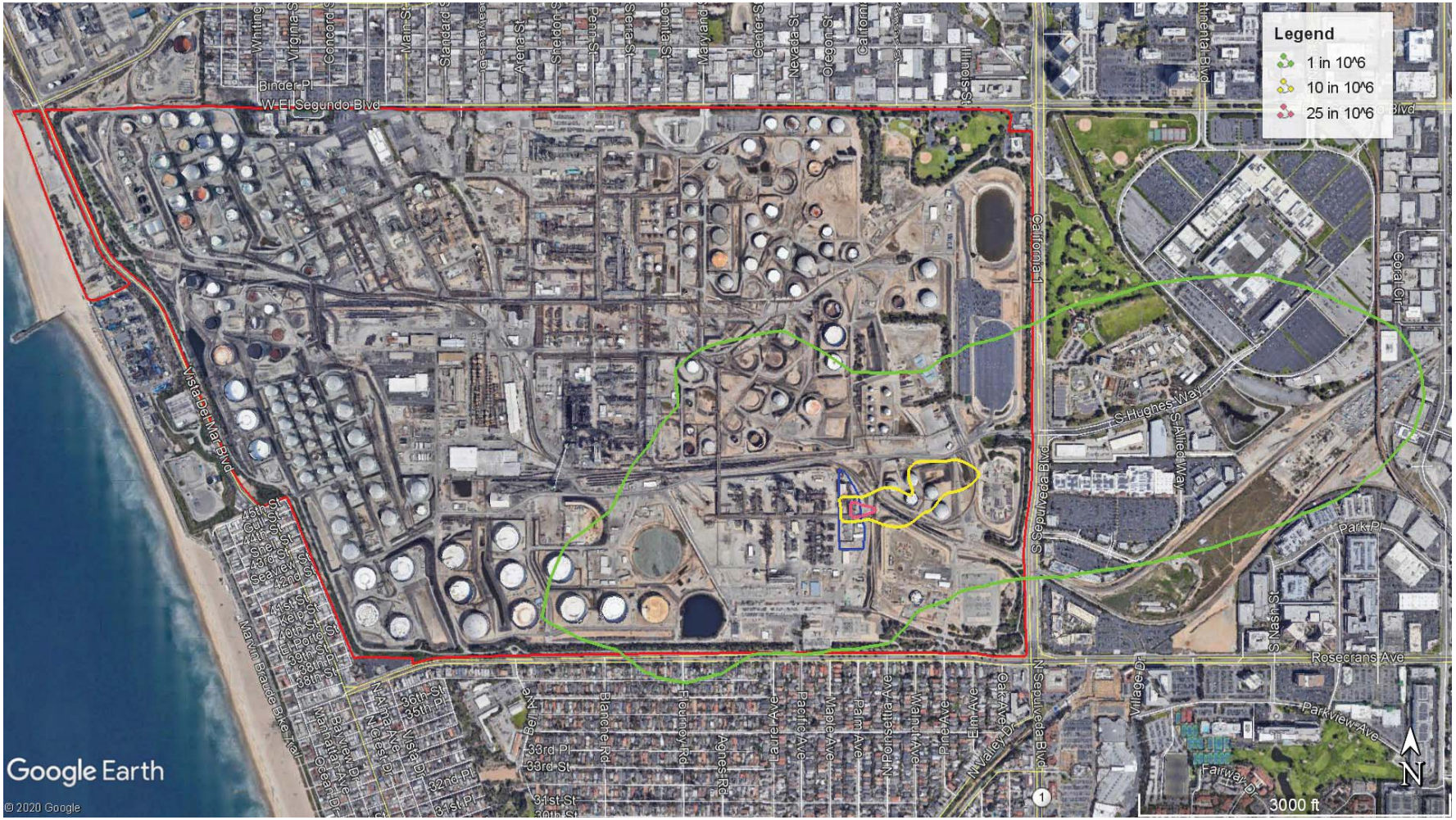


Figure 6-4 Cancer Risk Isopleths for Worker MEI

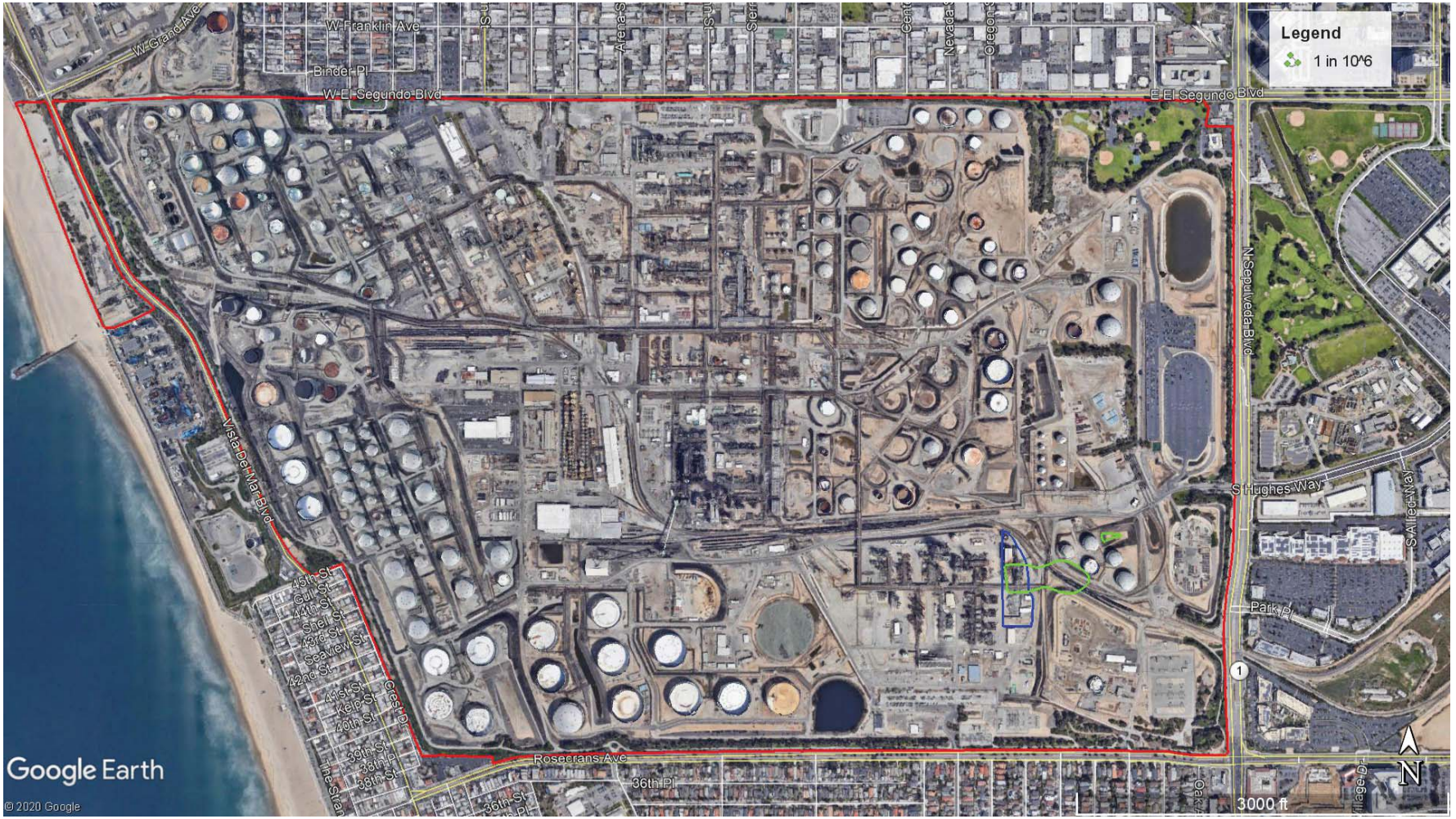


Figure 6-5 Location of Chronic HI Risk MEIs and PMI

Figure 6-6 Location of Acute HI Risk MEIs and PMI

APPENDIX A - SOURCE INFORMATION

Figure A-1 Facility Point Sources

Figure A-2 Facility Area Sources

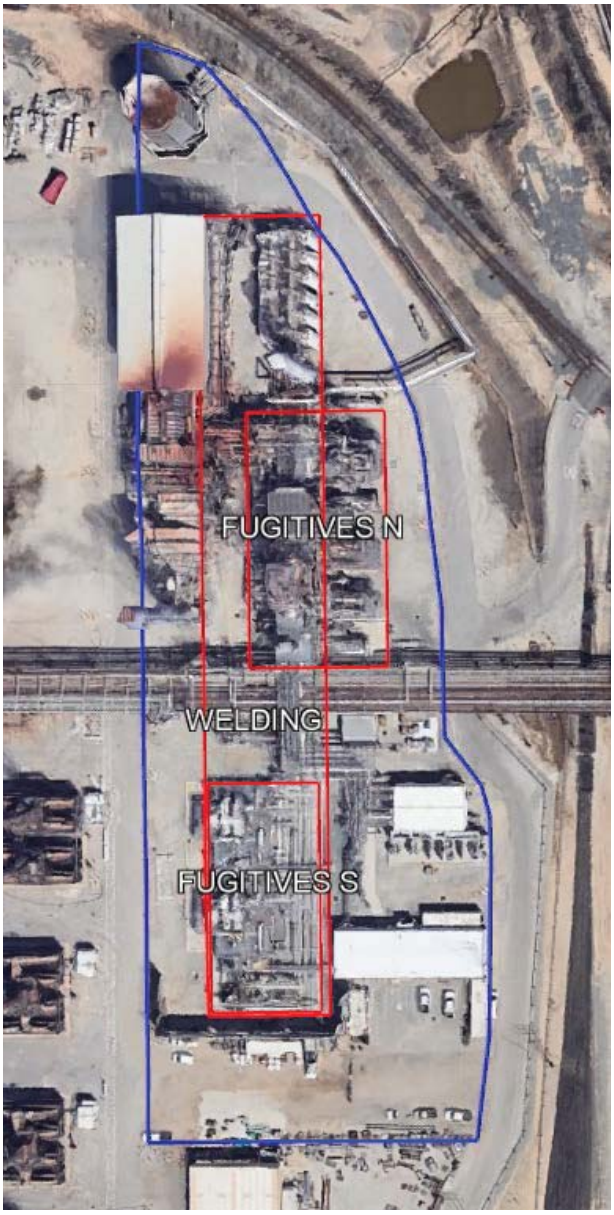


Table A-1 - Point Source Modeling Parameters

Source Name	HARP Source ID	Center Point Coordinates		Stk Ht. (m)	Stk Dia. (m)	Stack Exit Vel. (m/s)	Stk gas Vol. flow rate (ACFM)	Stack Temp. (K)	Operating Time		
		UTM E	UTM N						Hours/ day	Days/ week	Weeks /year
HEATER STACK	1	370360	3752592	38	4	7	624,200	425	24	7	52
GROUND FLARE	2	370360	3752700	18	11	0	54,151	1027	24	7	52
PROCESS VENT D12	3	370388	3752640	34	0	1	649	294	24	7	52
PROCESS VENT D10	4	370378	3752629	23	0	2	769	389	24	7	52
PROCESS VENT D30	5	370370	3752619	12	0	5	1,968	373	24	7	52
ICE DIESEL	8	370378	3752592	2	0	37	2,045	864	0.6	7	52
ICE GASOLINE	9	370378	3752592	2	0	37	2,045	864	0.4	7	52

Table A-2 - Area Source Modeling Parameters

Description	HARP Source ID	SW Coordinates		Height (m)	yL (m)	xL (m)	Aspect Ratio (L:W)	Area (m^2)	Angle	Operating Time		
		UTM E	UTM N							Hours/ day	Days/ week	Weeks/ year
FUGITIVE S	6	370366	3752509	2	48	23	2.06	1,137	0	24	7	52
FUGITIVE N	7	370375	3752582	2	54	29	1.85	1,589	0	24	7	52
WELDING	10	370365	3752508	1	169	26	6.53	4,383	0	8	5	52

APPENDIX B - MODEL RECEPTORS

Table B-1 - Summary of Receptors

Receptor Type	Receptor Quantity
Property Boundary Receptors	196
Grid Receptors	1,032
Fine Grid Receptors	34
Census Receptors	590
Sensitive Receptors	0
Total Receptors	1,852

Table B-2 - Receptor Grid Parameters

Receptor Parameter	Input
UTM Zone	11N
Bottom Left Grid Corner	368900 m E, 3751700 m N
No. of Points (x-direction)	43
No. of Points (y-direction)	24
Grid spacing	100 m
Refinery Property Boundary Spacing	100 m

Table B-3 - Residential Fine Grid Receptors

Receptor Label	UTM E	UTM N
Res_1	369600	3752160
Res_2	369625	3752160
Res_3	369650	3752160
Res_4	369675	3752160
Res_5	369700	3752160
Res_6	369725	3752160
Res_7	369750	3752160
Res_8	369775	3752160
Res_9	369800	3752160
Res_10	369825	3752160
Res_11	369850	3752160
Res_12	369875	3752160
Res_13	369900	3752160
Res_14	369925	3752160
Res_15	369950	3752160
Res_16	369975	3752160
Res_17	370000	3752160
Res_18	370025	3752160
Res_19	370050	3752160
Res_20	370075	3752160
Res_21	370100	3752160
Res_22	370125	3752160
Res_23	370150	3752160
Res_24	370175	3752155
Res_25	370200	3752155
Res_26	370225	3752155
Res_27	370250	3752155
Res_28	370275	3752155
Res_29	370300	3752155
Res_30	370325	3752155
Res_31	370350	3752155
Res_32	370375	3752155
Res_33	370400	3752155
Res_34	370425	3752155

Figure B-1 - Grid and Property Boundary Receptor Plot

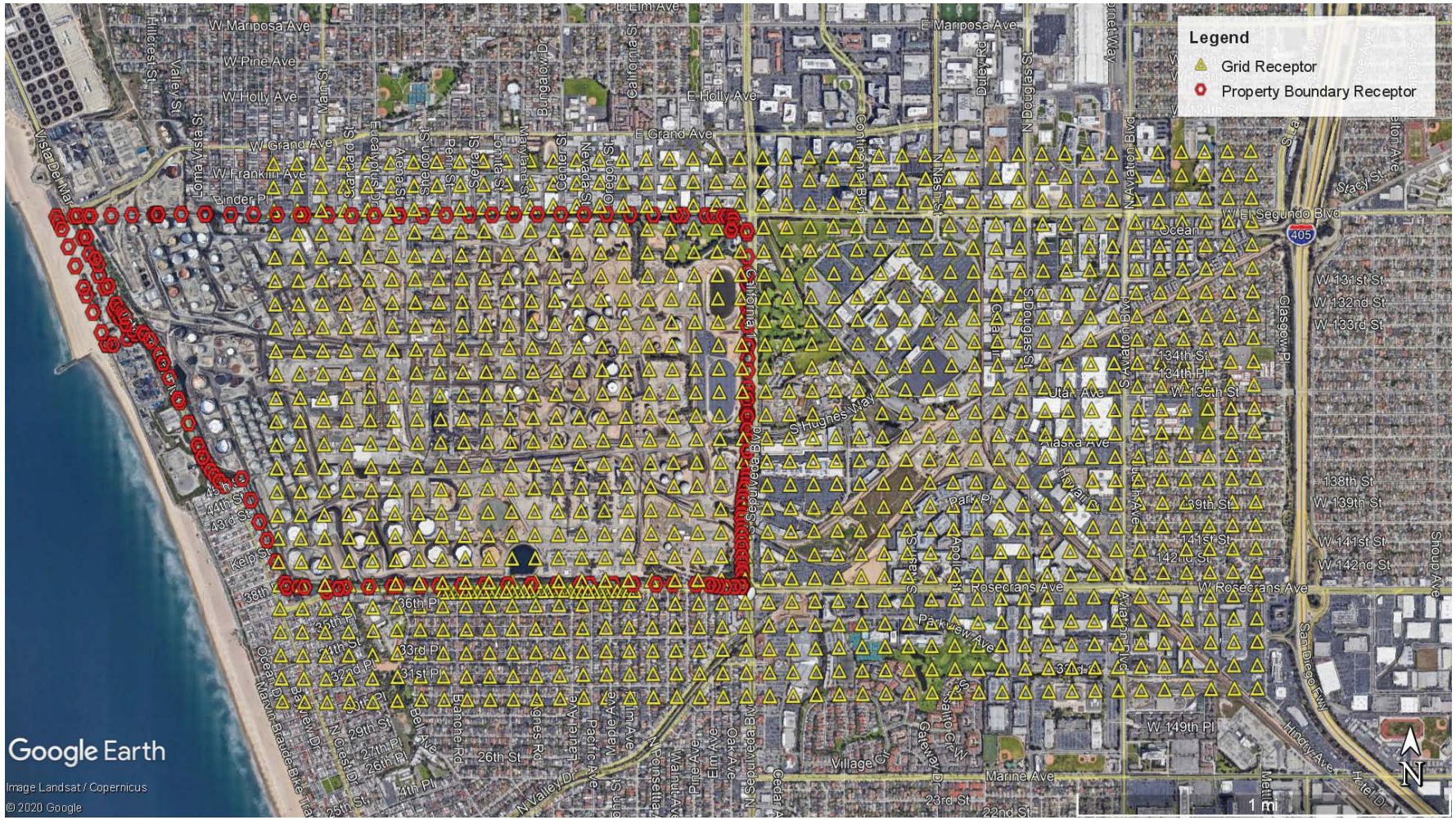
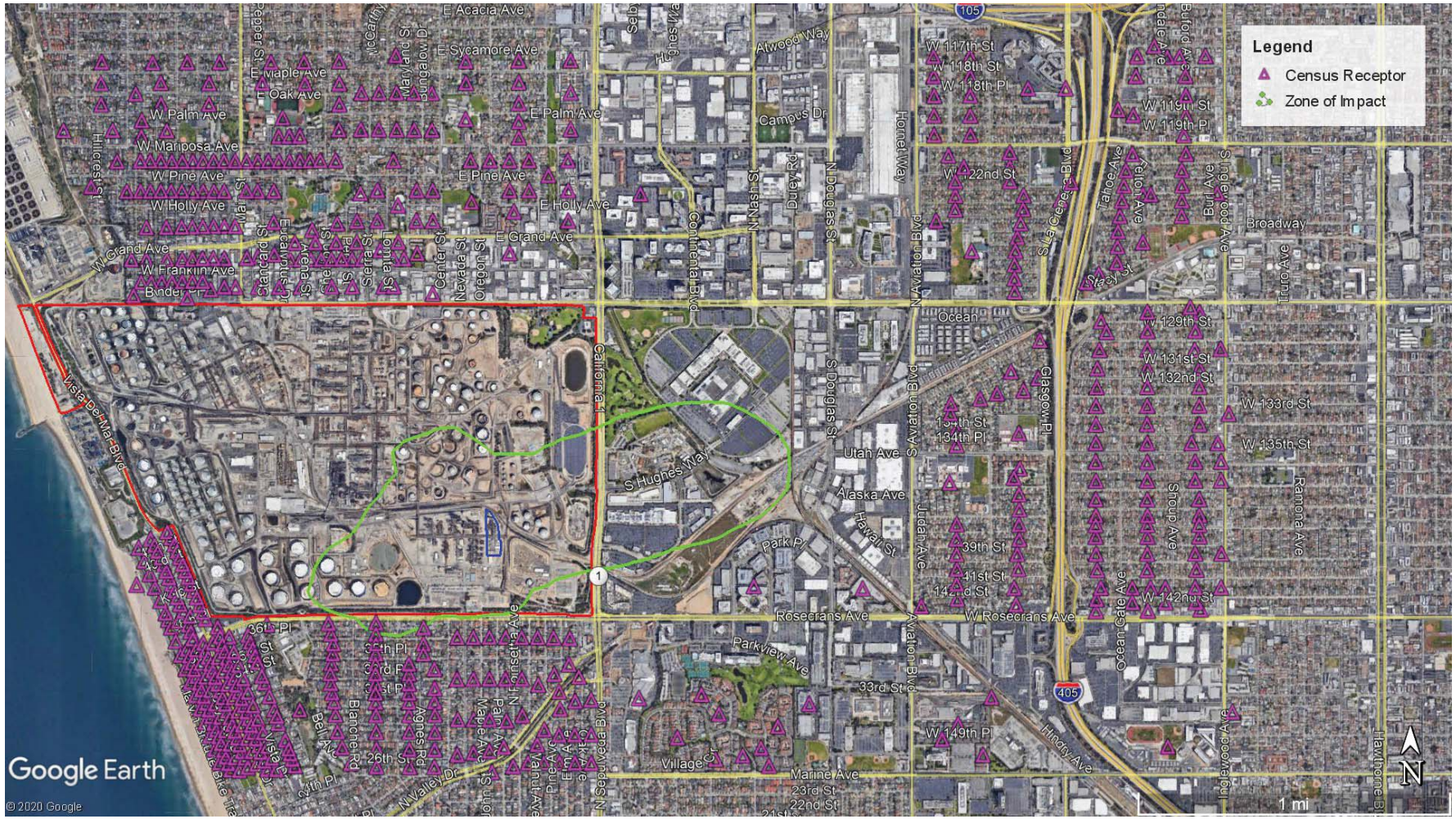


Figure B-2 – Census Receptor Mapping



APPENDIX C - DETAILED AIR TOXIC EMISSIONS

Table C-1 – Emission Rates by Source and Substance

Source ID	Source Name	Substance Name	CAS No.	Annual Average (lb/yr)	Maximum Hourly (lb/hr)	Annual Average (g/s)	Maximum Hourly (g/s)
S0001	REFORMER HEATER	2-Methyl naphthalene (PAHs)	91-57-6	0.0895	0.000010	1.29E-06	1.28E-06
S0001	REFORMER HEATER	3-Methyl cholanthrene	56-49-5	0.0067	0.000001	9.65E-08	9.63E-08
S0001	REFORMER HEATER	7,12-Dimethyl benz(a)anthracene	57-97-6	0.0596	0.000007	8.58E-07	8.56E-07
S0001	REFORMER HEATER	Acenaphthene (PAHs)	83-32-9	0.0089	0.000001	1.29E-07	1.28E-07
S0001	REFORMER HEATER	Acenaphthylene (PAHs)	208-96-8	0.0242	0.000003	3.48E-07	3.48E-07
S0001	REFORMER HEATER	Acetaldehyde	75-07-0	44.7355	0.005093	6.43E-04	6.42E-04
S0001	REFORMER HEATER	Acrolein	107-02-8	63.3754	0.007215	9.11E-04	9.09E-04
S0001	REFORMER HEATER	Ammonia	7664-41-7	9095.0742	1.035414	1.31E-01	1.30E-01
S0001	REFORMER HEATER	Anthracene	120-12-7	0.0175	0.000002	2.52E-07	2.51E-07
S0001	REFORMER HEATER	Arsenic	7440-38-2	0.7456	0.000085	1.07E-05	1.07E-05
S0001	REFORMER HEATER	Benz(a)anthracene (PAHs)	56-55-3	0.0820	0.000009	1.18E-06	1.18E-06
S0001	REFORMER HEATER	Benzene	71-43-2	7.8287	0.000891	1.13E-04	1.12E-04
S0001	REFORMER HEATER	Benzo(a)pyrene	50-32-8	0.2125	0.000024	3.06E-06	3.05E-06
S0001	REFORMER HEATER	Benzo(b)fluoranthene (PAHs)	205-99-2	0.1007	0.000011	1.45E-06	1.44E-06
S0001	REFORMER HEATER	Benzo(g,h,i)perylene (PAHs)	191-24-2	0.0048	0.000001	6.97E-08	6.95E-08
S0001	REFORMER HEATER	Benzo(k)fluoranthene (PAHs)	207-08-9	0.0634	0.000007	9.11E-07	9.09E-07
S0001	REFORMER HEATER	Beryllium	7440-41-7	0.4846	0.000055	6.97E-06	6.95E-06
S0001	REFORMER HEATER	Cadmium	7440-43-9	4.1008	0.000467	5.90E-05	5.88E-05
S0001	REFORMER HEATER	Chromium, hexavalent	18540-29-9	0.2305	0.000026	3.31E-06	3.31E-06
S0001	REFORMER HEATER	Chrysene (PAHs)	218-01-9	0.0060	0.000001	8.58E-08	8.56E-08
S0001	REFORMER HEATER	Copper	7440-50-8	3.0942	0.000352	4.45E-05	4.44E-05
S0001	REFORMER HEATER	Dibenz(a,h)anthracene (PAHs)	53-70-3	0.0045	0.000001	6.43E-08	6.42E-08
S0001	REFORMER HEATER	Dichlorobenzenes (mixed isomers)	25321-22-6	4.4736	0.000509	6.43E-05	6.42E-05
S0001	REFORMER HEATER	Fluoranthene (PAHs)	206-44-0	0.0108	0.000001	1.55E-07	1.55E-07
S0001	REFORMER HEATER	Fluorene (PAHs)	86-73-7	0.0101	0.000001	1.45E-07	1.44E-07

Table C-1 – Emission Rates by Source and Substance

Source ID	Source Name	Substance Name	CAS No.	Annual Average (lb/yr)	Maximum Hourly (lb/hr)	Annual Average (g/s)	Maximum Hourly (g/s)
S0001	REFORMER HEATER	Formaldehyde	50-00-0	275.8692	0.031406	3.97E-03	3.96E-03
S0001	REFORMER HEATER	Hexane	110-54-3	6710.3314	0.763927	9.65E-02	9.63E-02
S0001	REFORMER HEATER	Hydrogen sulfide	7783-06-4	70.7339	0.008053	1.02E-03	1.01E-03
S0001	REFORMER HEATER	Indeno(1,2,3-cd)pyrene (PAHs)	193-39-5	0.2647	0.000030	3.81E-06	3.80E-06
S0001	REFORMER HEATER	Lead	7439-92-1	1.8267	0.000208	2.63E-05	2.62E-05
S0001	REFORMER HEATER	Manganese	7439-96-5	1.3793	0.000157	1.98E-05	1.98E-05
S0001	REFORMER HEATER	Mercury	7439-97-6	0.9320	0.000106	1.34E-05	1.34E-05
S0001	REFORMER HEATER	Methanol	67-56-1	0.4228	0.000048	6.08E-06	6.06E-06
S0001	REFORMER HEATER	Naphthalene	91-20-3	2.2368	0.000255	3.22E-05	3.21E-05
S0001	REFORMER HEATER	Nickel	7440-02-0	7.8287	0.000891	1.13E-04	1.12E-04
S0001	REFORMER HEATER	Phenanthrene (PAHs)	85-01-8	0.0634	0.000007	9.11E-07	9.09E-07
S0001	REFORMER HEATER	Phenol	108-95-2	14.9118	0.001698	2.14E-04	2.14E-04
S0001	REFORMER HEATER	Phosphorus	7723-14-0	2.3859	0.000272	3.43E-05	3.42E-05
S0001	REFORMER HEATER	Propylene	115-07-1	559.1943	0.063661	8.04E-03	8.02E-03
S0001	REFORMER HEATER	Pyrene	129-00-0	0.0183	0.000002	2.63E-07	2.62E-07
S0001	REFORMER HEATER	Selenium	7782-49-2	3.2806	0.000373	4.72E-05	4.71E-05
S0001	REFORMER HEATER	Sulfuric acid	7664-93-9	75.1280	0.008553	1.08E-03	1.08E-03
S0001	REFORMER HEATER	Toluene	108-88-3	12.3023	0.001401	1.77E-04	1.76E-04
S0001	REFORMER HEATER	Vanadium	7440-62-2	8.5743	0.000976	1.23E-04	1.23E-04
S0001	REFORMER HEATER	Xylenes (mixed isomers)	1330-20-7	93.1990	0.010610	1.34E-03	1.34E-03
S0002	GROUND FLARE	Acetaldehyde	75-07-0	0.1291	0.000015	1.86E-06	1.85E-06
S0002	GROUND FLARE	Acrolein	107-02-8	0.0300	0.000003	4.32E-07	4.31E-07
S0002	GROUND FLARE	Benzene	71-43-2	0.4774	0.000054	6.87E-06	6.85E-06
S0002	GROUND FLARE	Ethyl benzene	100-41-4	4.3357	0.000494	6.24E-05	6.22E-05
S0002	GROUND FLARE	Formaldehyde	50-00-0	3.5100	0.000400	5.05E-05	5.03E-05
S0002	GROUND FLARE	Hexane	110-54-3	0.0871	0.000010	1.25E-06	1.25E-06
S0002	GROUND FLARE	Methanol	67-56-1	0.1917	0.000022	2.76E-06	2.75E-06
S0002	GROUND FLARE	Naphthalene	91-20-3	0.0330	0.000004	4.75E-07	4.74E-07

Table C-1 – Emission Rates by Source and Substance

Source ID	Source Name	Substance Name	CAS No.	Annual Average (lb/yr)	Maximum Hourly (lb/hr)	Annual Average (g/s)	Maximum Hourly (g/s)
S0002	GROUND FLARE	PAHs-w/o ind. comp.	1151	0.0090	0.000001	1.30E-07	1.29E-07
S0002	GROUND FLARE	Toluene	108-88-3	0.1741	0.000020	2.50E-06	2.50E-06
S0002	GROUND FLARE	Xylenes (mixed isomers)	1330-20-7	0.0871	0.000010	1.25E-06	1.25E-06
S0003	PROCESS VENT D12	Methanol	67-56-1	7.9965	0.000910	1.15E-04	1.15E-04
S0004	PROCESS VENT D10	Methanol	67-56-1	5.6155	0.000639	8.08E-05	8.05E-05
S0005	PROCESS VENT D30	Methanol	67-56-1	5.6155	0.000639	8.08E-05	8.05E-05
S0006	FUGITIVE S	1,3-Butadiene	106-99-0	0.1406	0.000016	2.02E-06	2.02E-06
S0006	FUGITIVE S	Carbonyl sulfide	463-58-1	0.0019	0.000000	2.80E-08	2.80E-08
S0006	FUGITIVE S	Hexane	110-54-3	0.5299	0.000060	7.62E-06	7.60E-06
S0006	FUGITIVE S	Propylene	115-07-1	12.3332	0.001404	1.77E-04	1.77E-04
S0006	FUGITIVE S	Xylenes (mixed isomers)	1330-20-7	0.1334	0.000015	1.92E-06	1.91E-06
S0007	FUGITIVE N	1,3-Butadiene	106-99-0	0.1406	0.000016	2.02E-06	2.02E-06
S0007	FUGITIVE N	Carbonyl sulfide	463-58-1	0.0019	0.000000	2.80E-08	2.80E-08
S0007	FUGITIVE N	Hexane	110-54-3	0.5299	0.000060	7.62E-06	7.60E-06
S0007	FUGITIVE N	Propylene	115-07-1	12.3332	0.001404	1.77E-04	1.77E-04
S0007	FUGITIVE N	Xylenes (mixed isomers)	1330-20-7	0.1334	0.000015	1.92E-06	1.91E-06
S0008	ICE DIESEL	Diesel PM	9-90-1	22.7184	0.002586	3.27E-04	3.26E-04
S0009	ICE GASOLINE	1,3-Butadiene	106-99-0	0.2334	0.000027	3.36E-06	3.35E-06
S0009	ICE GASOLINE	Acetaldehyde	75-07-0	0.2109	0.000024	3.03E-06	3.02E-06
S0009	ICE GASOLINE	Acrolein	107-02-8	0.0506	0.000006	7.28E-07	7.26E-07
S0009	ICE GASOLINE	Benzene	71-43-2	0.9672	0.000110	1.39E-05	1.39E-05
S0009	ICE GASOLINE	Chlorine	7782-50-5	0.1156	0.000013	1.66E-06	1.66E-06
S0009	ICE GASOLINE	Copper	7440-50-8	0.0008	0.000000	1.19E-08	1.18E-08
S0009	ICE GASOLINE	Ethyl benzene	100-41-4	0.4217	0.000048	6.07E-06	6.05E-06
S0009	ICE GASOLINE	Formaldehyde	50-00-0	0.8772	0.000100	1.26E-05	1.26E-05
S0009	ICE GASOLINE	Hexane	110-54-3	0.3683	0.000042	5.30E-06	5.28E-06
S0009	ICE GASOLINE	Manganese	7439-96-5	0.0008	0.000000	1.19E-08	1.18E-08
S0009	ICE GASOLINE	Methanol	67-56-1	0.1968	0.000022	2.83E-06	2.82E-06

Table C-1 – Emission Rates by Source and Substance

Source ID	Source Name	Substance Name	CAS No.	Annual Average (lb/yr)	Maximum Hourly (lb/hr)	Annual Average (g/s)	Maximum Hourly (g/s)
S0009	ICE GASOLINE	Methyl ethyl ketone	78-93-3	0.0169	0.000002	2.43E-07	2.42E-07
S0009	ICE GASOLINE	Methyl tert-butyl ether	1634-04-4	0.5229	0.000060	7.52E-06	7.50E-06
S0009	ICE GASOLINE	Naphthalene	91-20-3	0.0365	0.000004	5.26E-07	5.24E-07
S0009	ICE GASOLINE	Nickel	7440-02-0	0.0008	0.000000	1.19E-08	1.18E-08
S0009	ICE GASOLINE	Styrene	100-42-5	0.0365	0.000004	5.26E-07	5.24E-07
S0009	ICE GASOLINE	Toluene	108-88-3	1.9090	0.000217	2.75E-05	2.74E-05
S0009	ICE GASOLINE	Xylenes (mixed isomers)	1330-20-7	1.6869	0.000192	2.43E-05	2.42E-05
S0010	WELDING	Chromium, hexavalent	18540-29-9	0.0003	0.000000	3.71E-09	3.70E-09
S0010	WELDING	Copper	7440-50-8	0.0050	0.000001	7.19E-08	7.17E-08
S0010	WELDING	Manganese	7439-96-5	0.0645	0.000007	9.28E-07	9.26E-07
S0010	WELDING	Nickel	7440-02-0	0.0017	0.000000	2.37E-08	2.37E-08