ExxonMobil SYU LFC Interim Trucking
Quantitative Risk Analysis

Application to County of Santa Barbara

Planning & Development Department
Energy & Minerals Division

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1.0 Introduction

ExxonMobil is proposing interim trucking to transport Santa Ynez Unit (SYU) crude from the Las Flores Canyon (LFC) facility located at 12000 Calle Real Road in Goleta to one or more destinations: (1) Phillips 66 Santa Maria station, and (2) Plains All American Pipeline Pentland (PAAPL) station. This report evaluates the public risk from a truck accident associated with the transportation of crude oil from LFC to these destinations via truck.

Santa Barbara County thresholds were used to evaluate trucking risk. The public safety risks were calculated to be below the thresholds, and therefore the impacts to public risk from the proposed Interim Trucking are considered less than significant (Class III).

Product trucking is proposed as described in Table 1 below.

Table 1 Product Trucking Details

Parameter	Value
Maximum number of trucks	70 trucks per day
Maximum volume of product per truck	160 barrels (bbls) (worst case scenario for a single truck incident, which is the maximum volume of oil potentially spilled from a single truck)
Annual number of truck trips	70 x 365 = 25,550
Maximum duration of Interim Trucking	From the approval of the Interim Trucking Permit until a pipeline alternative becomes available
Annual volume of oil transported	Approximately 4 million barrels (MM BBL)

This quantitative risk assessment (QRA) was prepared in accordance with the requirements of the Santa Barbara County Planning and Development Department Environmental Thresholds and Guidelines Manual [Ref. 1], which specifies thresholds for significant impacts to public safety (Section 15). These thresholds focus on involuntary public exposure to acute risks that stem from certain types of activities with significant quantities of hazardous materials. In this case, the hazardous material of concern is crude oil (product) transported by trucks on public roads. In general, a QRA goal is to address worst case scenarios such that the maximum consequence can be evaluated.

This QRA estimates the potential public safety risks associated with the proposed crude oil (product) trucking activities. Risks were estimated using a transportation risk model which includes volume data, accident rates, population data, and probabilities of release and ignition. The public risk is presented on an F-N plot. An F-N curve is a plot of cumulative frequency vs consequence (expressed as a number of injuries or fatalities). The estimated public risks were compared to the Santa Barbara collective risk thresholds, the two straight lines in the F-N plot, to determine the significance of an adverse impact to public safety.

Public safety risks stem from a potential for a transportation-related incident involving trucks transporting LFC product. Under a worst-case scenario, an incident could lead to a product spill that, if ignited, could result in a pool fire that could cause significant injury or fatality. Members of

the public that could be exposed are those living or working in the areas that could be affected by a potential fire.

2.0 Description of the Proposed Interim Trucking

Trucking of product from LFC was evaluated under two scenarios. In Scenario 1 all seventy (70) trucks per day would deliver product to Phillips 66 Station in Santa Maria consistent with the project. In Scenario 2 all seventy (70) trucks per day would deliver product to PAAPL Pentland Station in Maricopa, though a maximum of 68 are proposed for the project itself. In actual operation, trucks could deliver product to one or the other or both of the two facilities on a given day. The details of the routes and facilities descriptions are provided in Table 2. The maps of the trucking routes are provided in Appendix 1.

Table 2 Trucking Routes Details

Parameter	Unloading Facility 1: Phillips 66 Santa Maria Station	Unloading Facility 2: PAAPL Pentland Station
Address	1580 East Battles Road Santa Maria, CA 93454	2311 Basic School Road, Maricopa, CA
Distance from LFC	55 miles	139 miles
County	Santa Barbara	Kern
Route Details from LFC to the Unloading Facility	• South on internal LFC/SYU Road • Right onto Calle Real - 1.5 mi • Left onto Refugio Rd. - 197 ft • Right onto US-101 N ramp - 0.3 mi • Merge onto US-101 N - 49.2 mi • Exit 169, Betteravia Rd. - 0.2 mi • Left onto Rosemary Rd - 0.5 mi • Left onto E Battles Rd - 0.3 mi • Left into facility	• South on internal LFC/SYU Road • Right onto Calle Real - 1.5 mi • Left onto Refugio Rd. - 197 ft • Right onto US-101 N ramp - 0.3 mi • Merge onto US-101 N - 54.4 mi • Exit 175, CA-166 E to Maricopa - 0.2 mi • Right onto CA-166 E/Cuyama Hwy - 80.7 mi • Right onto Basic School Rd - 0.3 mi • Right into facility

Methodology

The QRA evaluated risks using the following steps:

1. Potential hazards identification
2. Probability analysis
3. Consequence analysis
4. Public safety risk estimates

3.1 Hazards Identification

A typical hazard scenario that arises from crude oil trucking is a release of flammable hydrocarbons due to a truck incident (e.g., collision, overturning, or a truck mechanical failure). More severe hazards would involve an accident that leads to a spill and thermal radiation or toxic concentrations from a subsequent pool fire (crude oil is a Class 1 flammable liquid). An explosion or Boiling Liquid Expanding Vapor Explosion (BLEVE) is not expected from a truck accident because the product transported has relatively low vapor pressure, thus formation of appreciable volume of flammable gas that can lead to an explosion is not expected.

A truck incident can result in two spill scenarios. The first spill scenario is a full rupture of the tanker (large spill) and pool fire. The second spill scenario is a hole that leads to a 10% spill volume and pool fire. Table 3 summarizes the trucking hazard scenarios examined in this study.

Table 3 Trucking Hazard scenarios

No.	Equipment	Potential Hazard Scenario	Hazards
1	DOT 407 Tanker Truck	Truck accident, large spill and pool fire	Thermal radiation, toxic combustion products release
2	DOT 407 Tanker Truck	Truck accident, small spill and pool fire	Thermal radiation, toxic combustion products release

3.2 Probability Analysis

3.2.1 Truck Accident Probability

Accident rates were obtained from available studies related to truck collision rates and conditional probabilities. The probability of a truck road collision or accident is 0.528 per million miles for California rural freeway, 1.59 per million miles for California urban freeway, and 1.720 per million miles for rural two-lane roads (based on a study by Harwood, 1993 [Ref. 2]). Accident probabilities can be reduced by using control factors which have been documented and statistically proven to reduce the risk of an accident. In this case, the accident probability was reduced using the following control factors:

- Implementation of safety programs reduces accidents by 41% [Ref. 3].
- Speed control reduces accidents by 26% as listed by MRS, 2004 [Ref. 3].

ExxonMobil's Final Development Plan Permit with Santa Barbara County requires the implementation of a Crude Oil Transportation Risk Management and Prevention Program (CO-TRMPP) as provided in Attachment C.4. Implementation of this program will further reduce risk by requiring trucks transporting LFC product to have those controls through driver safety training and equipment installation. All trucks transporting the LFC product, regardless of the route and mileage, will have a speed control.

Additionally, non-collision, in-transit accident rates were assumed to occur at a base rate of 20% of the collision accident rate [Ref. 3]. The non-collision rate was reduced by 37.5% due to a regular maintenance program for trucks utilized by ExxonMobil, and a reduction of 45% due to pre-trip truck inspection, as listed by MRS, 2004 [Ref. 3]

The resulting adjusted truck accident rates (AR) were estimated to be as follows:

AR = [0.528/million miles x (1-(0.41+0.26))] + [0.2 x 0.528/million miles x (1-(0.375+0.45))]

AR = 0.193 accidents per million truck-miles travelled (rural freeway)

AR = [1.720/million miles x (1-(0.41+0.26))] + [0.2 x 1.720/million miles x (1-(0.375+0.45))]

AR = 0.628 accidents per million truck-miles travelled (rural two-lane roads)

AR = [1.59/million miles x (1-(0.41+0.26))] + [0.2 x 1.59/million miles x (1-(0.375+0.45))]

AR = 0.580 accidents per million truck-miles travelled (urban freeway)

3.2.2 Spill and Pool Fire Probability

To estimate the probability of a pool fire, given that an accident has happened, the following conditional probabilities should be considered: probability of a spill, probability of a large or small spill, and probability of ignition (e.g., a spark or static electricity).

The 1993 Harwood study [Ref. 2] estimated the probability of a hazardous material release, once an accident occurred, to be 9%. A chance of ignition of a pool fire was estimated at 2% based on the Golder, 2007 [Ref. 4]. It was assumed that large spills occurred 25% of the time, and leaks occurred 75% of the time, as a worst case scenario. Thus, the likelihood of a pool fire (pool fire rate or PFR) is estimated as follows:

PFR Large (rural freeway) = (0.193/million miles) x 0.09 x 0.02 x 0.25 = 8.7×10^{-11} per mile

PFR Small (rural freeway) = (0.193/million miles) x 0.09 x 0.02 x 0.75 = 2.6×10^{-10} per mile

PFR Large (rural two-lane) = (0.628/million miles) x 0.09 x 0.02 x 0.25 = 2.8×10^{-10} per mile

PFR Small (rural two-lane) = (0.628/million miles) x 0.09 x 0.02 x 0.75 = 8.5×10^{-10} per mile

PFR Large (urban freeway) = (0.580/million miles) x 0.09 x 0.02 x 0.25 = 2.6×10^{-10} per mile

PFR Small (urban freeway) = (0.580/million miles) x 0.09 x 0.02 x 0.75 = 7.8×10^{-10} per mile

To define the incident outcome for these scenarios, two event trees have been constructed (Figures 1, 2, and 3).

Figure 1 Trucking Hazards Event Tree (rural freeway)

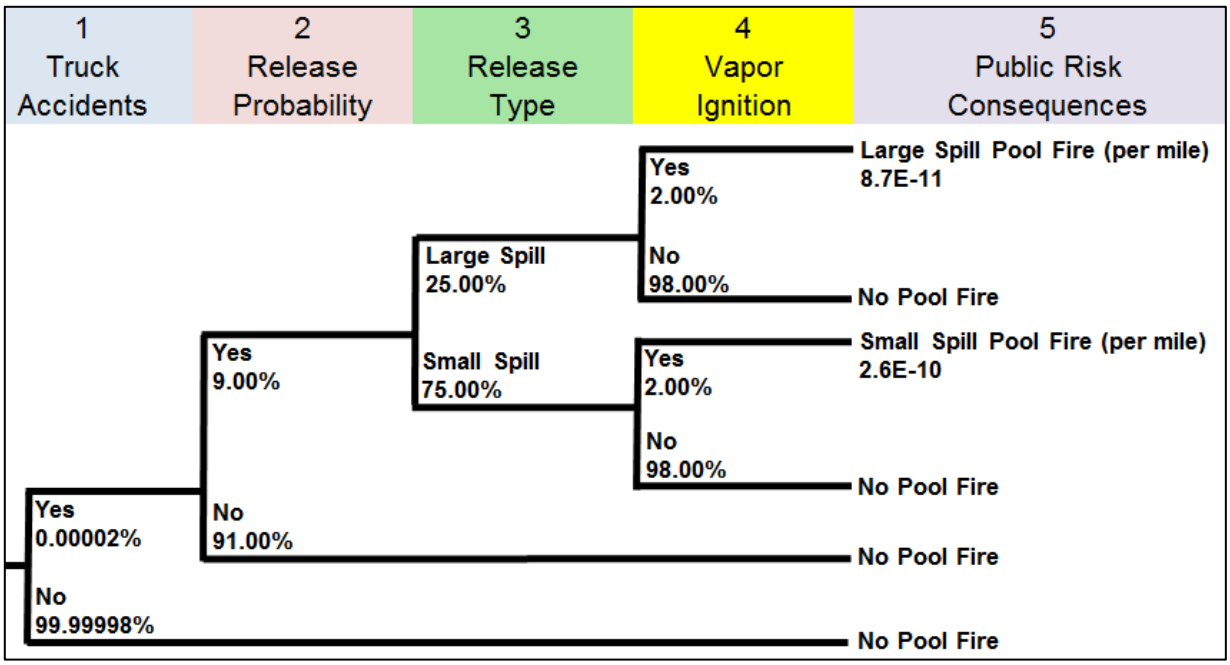


Figure 2 Trucking Hazards Event Tree (rural two-lane)

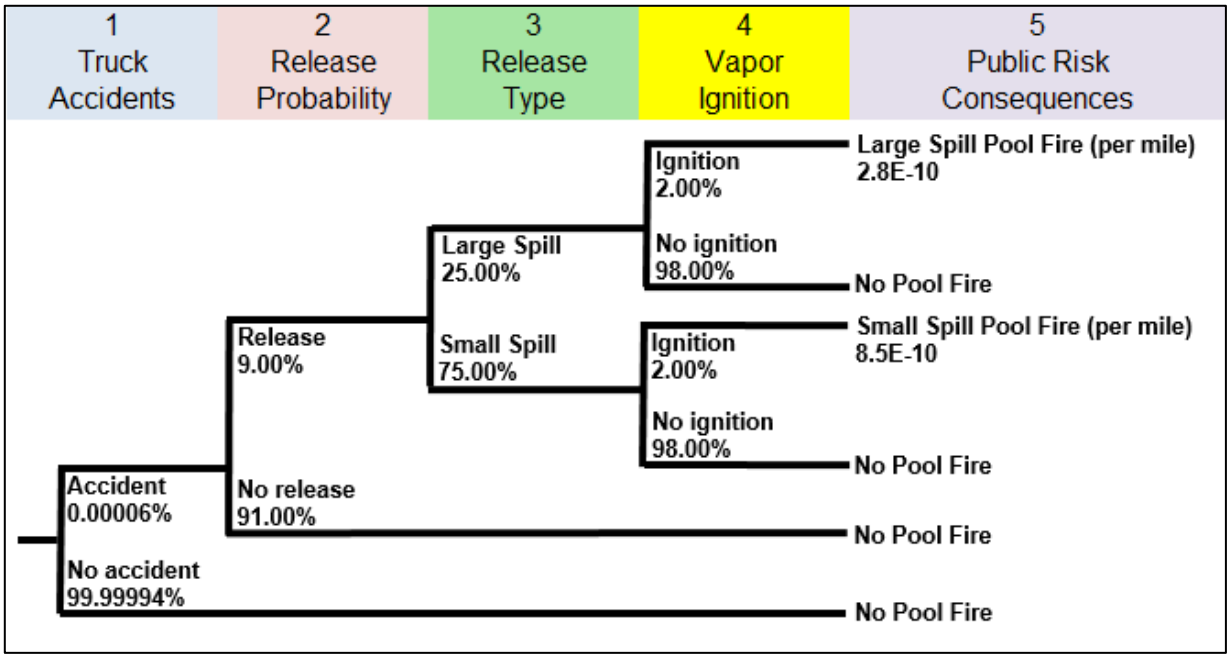
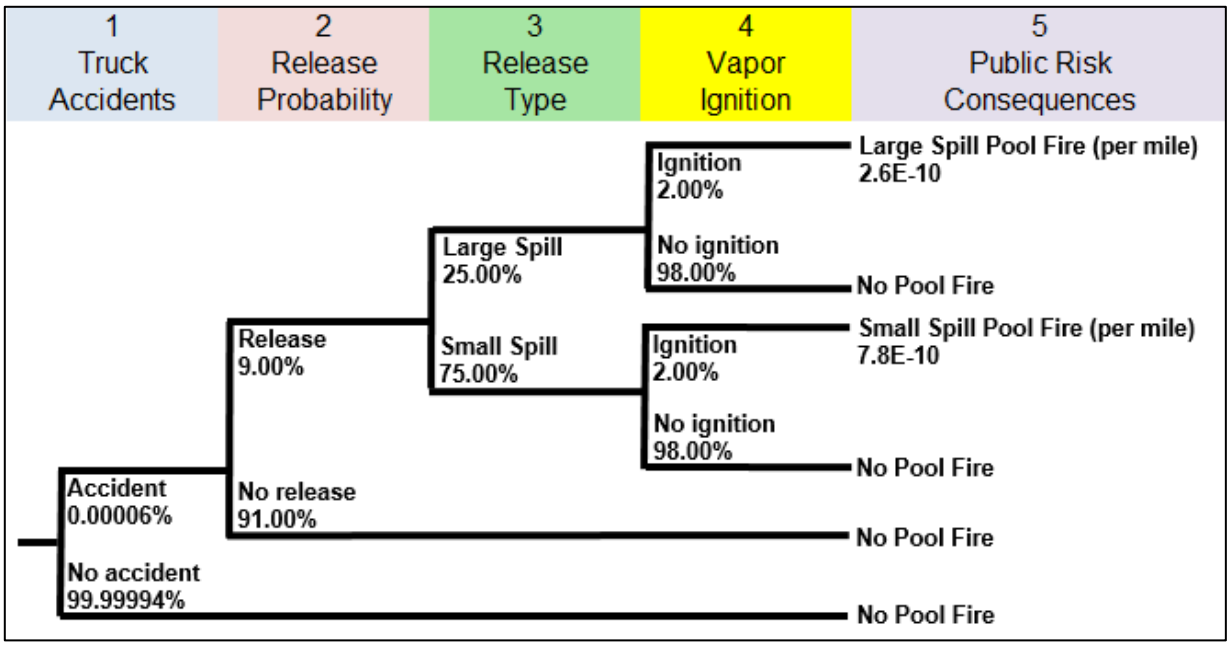


Figure 3 Trucking Hazards Event Tree (urban freeway)



3.3 Consequence Analysis

Consequences from traffic accidents without a spill and a fire were used as identified in the Harwood 1993 study [Ref. 2]. Consequences from a pool fire were identified as follows for a small and large spill:

1. Volumes of potential spills were estimated
2. Spill area and radius were calculated
3. Thermal radiation distances for injury and fatality were calculated
4. Population affected by the respective thermal radiation levels was estimated

Toxic impacts from hydrogen sulfide (H_2S) are not expected because the product prepared for sales has a negligible H_2S content, and combustion does not create appreciable amounts of H_2S. However, the LFC product has 5.2% of sulfur by weight, thus formation of sulfur dioxide (SO_2), which is a toxic gas, as a combustion product in a pool fire could occur. Potential consequences of SO_2 formation are discussed further below (also see Appendix 2).

3.3.1 Spill Volume

Two types of oil spills were considered:

- A full truck rupture releasing the entire 160 bbls (6,720 gallons); and
- A leak resulting in a 10% loss, or 16 bbls (672 gallons).

The spill of 160 bbls from a single largest truck was used as a worst case scenario, although some trucks may be transporting smaller volumes.

3.3.2 Spill Pool Area and Radius

Spill areas were estimated assuming 1 inch deep circular pool with the truck as a center of the circle.

$$R = \sqrt{(Spill\ Area/\pi)}$$

3.3.3 Thermal Radiation Impact Areas

For thermal exposure to fires or flames, the fatality exposure level was estimated to be 10 kilowatts per square meter (kw/m^2) and the injury level to be 5 kw/m^2 [Ref. 3]. These levels are based on the time it takes to develop second degree burns.

The thermal radiation to injury and fatality levels are calculated per the methodology presented by Department of Transportation (DOT) and Environmental Protection Agency (EPA) [Ref. 5]:

$$X_{10} = 0.30 \times R \times EP^{0.57}$$

$$X_{05} = 0.43 \times R \times EP^{0.57}$$

Where R is the product spill pool radius determined in Section 3.3.2 above, EP is emissive power equal to 20 kW/m^2, X_{10} is a radius where thermal radiation is 10 kW/m^2 or higher, and X_5 is a radius where thermal radiation is 5 kW/m^2 or higher.

Thermal impact areas A_{10} and A_{05} are assumed to be uniform circular areas assuming static meteorological conditions.

$$A_{10} = \pi \times (X_{10})^2$$

$$A_{05} = \pi \times (X_{05})^2$$

Where A_{10} is area for ≥ 10 kW/m^2 (fatality outcome), and A_{05} is area for ≥ 5 kW/m^2 (injury outcome). Therefore in a full tank spill pool fire, the fatality zone has a radius of 97 feet from the center of the pool. The potential injury zone has a radius of 139 feet.

Table 4 below provides the details of the calculations.

Table 4 Product Release Volume, Area and Thermal Hazard Details

Truck Release Scenario	Spill Volume			Pool Area 1 inch deep pool		Spill Radius	Thermal Hazard	
							Radius	Area
	bbls	gal.	cu. inch	sq. inch	sq. ft.	ft	ft	sq. ft.
Rupture (100%)	160	6,720	1,552,320	1,552,320	10,780	59	**X_{05}:** 139 (injury zone)	**A_{05}:** 60,636
							X_{10}: 97 (fatality zone)	**A_{10}:** 29,515
Leak (10%)	16	672	155,232	155,232	1,078	19	**X_{05}:** 44 (injury zone)	**A_{05}:** 6,064
							X_{10}: 31 (fatality zone)	**A_{10}:** 2,952

3.3.4 Toxic Emissions Impact Areas

The Immediate Dangerous to Life or Health Concentration (IDLH) of SO_2 is 100 parts per million (ppm). The evaluation below shows that the ground level concentrations of SO_2 would not reach hazardous levels outside of the fatality zone identified for pool fire above.

Burning rate of crude in a pool fire is 3 to 4 millimeters per minute (mm/min) according to both D. Evans and H. Koseki [Refs 8, 9], 3.6 mm/min is assumed here for heavier crudes. Rate of SO_2 formation is estimated from the crude combustion rate.

According to the references: "due to high-temperature buoyancy effects, the plume first rises, then the plume becomes heavier than air by cooling leading to plume subsidence" [Refs 10, 11]. Therefore to model hot combustion products dispersion, a pool fire is approximated as a tilted cylinder with the base as the spill pool circle area; dispersion of combustion products (e.g., SO_2) is modeled as originating at the top of the fire cylinder according to Witlox and Ufuah [Refs 10, 11, 12]. The flame height was calculated using Thomas (1963) correlation for circular pool fires [Ref. 17]. See Appendix 2 for details.

SO_2 formation is assumed to occur across the whole volume of the "fire cylinder". SO_2 starting concentration for dispersion modeling determined from the SO_2 formation rate and "fire cylinder" volume. See Appendix 2 for the details of the combustion products dispersion modeling.

It was assumed that in the fire all sulfur is converted to SO_2 (5.2 wt. %) in a stoichiometric ratio:

$$S + O_2 \rightarrow SO_2$$

Downwind ground level concentrations of SO_2, C_x (g/m^3), are found using the Gaussian dispersion model [Ref 14] with the parameters listed in Table 5.

$$C_x = \frac{Q}{\pi \sigma_y \sigma_z u} e^{\left[-\frac{1}{2}\left(\frac{H}{\sigma_z}\right)^2\right]}$$

Where Q = SO_2 release rate, g/sec; u = wind speed, 4 m/s;
X = distance downwind, m; H = height of fire, m;
Atmospheric stability "D" has been chosen as a neutral stability.

σ_y = sigma y for "D" stability = $0.08 * X * (1+0.0001 * X)^{-0.5}$ [Ref 14]

σ_z = sigma z for "D" stability = $0.06 * X (1+0.0015 * X)^{-0.5}$ [Ref 14]

Table 5 Determination of ground level SO_2 Concentration

Scenario	Spill Area	Spill Radius	Fatality Zone Radius 10 kW/m^2	Volume of Spill	Oil Burn Rate	Oil com-busted	SO_2 release rate, Q
	sq ft	ft	ft	ft^3	ft3/min	kg oil/min	g/sec
Rupture	10,780	59	97	898	127	3412	5909.0
Leak	1,078	19	31	90	13	341	590.9

Scenario	Pool Fire Diameter		Down-wind Distance from fire	Height of Fire (Release)	Sigma y for "D" stability	Sigma z for "D" Stability	Maximum SO_2 Concentration
	ft	m	X, m	H, m	σ_y, m	σ_z, m	ppm
Rupture	117.2	35.5	600	39	46.6	26.1	48.3
Leak	37.0	11.2	230	17.5	18.2	11.9	28

Table 5 shows that the maximum ground level concentrations of SO_2 for a full rupture scenario and a leak scenario are 48.3 ppm (at 600 m) and 28 ppm (at 230 m), respectively. These distances were calculated by checking to see when the plume would reach ground level and then extracting the SO_2 concentration and distance from the fire at that point. These concentrations are below 100 ppm (injury level), and therefore are below the level of an injury or a fatality for short exposures (with the burn rate of 3.6 mm/min, the entire spilled pool of oil will be combusted in 7 minutes). This means that toxicity from the formed SO_2 does not create additional injuries or fatalities than those from the fire heat.

Thus the potential consequence from transporting the LFC product by truck is not greater than the consequence of transporting any other similar material by trucks of the same volume that are currently on the roads.

3.3.5 Impacted Population

Exposure to high heat levels can produce severe injury or fatality to exposed population within the specified area. Per Muhlbauer, 2004 ([Ref. 15], heat of 10 kW/m^2 would result in a fatality in approximately 40% of exposed population; heat of 5 kW/m^2 would result in injury after 15-20 seconds of exposure. Thus the number of fatalities and injuries for each pool and fire scenario were estimated as follows:

No. of Fatalities = $(40\% \times A_{10}) \times PD$

No. of Injuries = $(60\% A_{10} + A_{05}) \times PD$

Where PD is population density as number of people per square foot.

3.3.6 Population Densities

Population densities were estimated for accident scenarios along the trucking routes. The trucking route was subdivided into segments based on the different population density category along the roads. The population density was assumed to be constant over the entire length of a particular segment. If one side of the road was of a different population category than the opposite side of the road population category, an average of the two categories was used. This population data also assumes presence of people immediately upon the accident. In reality, once the accident has occurred, emergency personnel would move people away from the accident site therefore reducing the likelihood of injury.

Population densities were estimated based on aerial imagery, local zoning and field reconnaissance. Table 6 summarizes the population densities used in this study, per the data published by Arthur D. Little, 1990 [Ref. 16].

Table 6 Population Densities Categories

Category	Population Density (No. of People / Sq. Mile)
Commercial High	10,000
Commercial Medium	5,000
Commercial Low	1,000
Residential High	10,000
Residential Medium	3,000
Residential Low	1,000
Mixed Use High	10,000
Mixed Use Medium	3,000
Mixed Use Low	1,000

Category	Population Density (No. of People / Sq. Mile)
Industrial	2,000
Rural/Farm	20
Recreational	100
Unpopulated/Open Space	5
Onsite / Private	0

Population categories and related population densities specific to the segments of each transportation route are contained in the tables in Appendix 4.

3.4 Public Safety Risks Analysis

Public safety risks are based on the estimated probabilities (chance of occurrence) and consequences (serious injury or fatality) of the evaluated accident scenarios. The estimated annual accident risks were compared to the Santa Barbara County's thresholds to determine if adverse impacts from the proposed Interim Trucking are potentially significant. The two figures in Appendix 3 show the County's thresholds for Fatalities and Injuries respectively [Ref. 1]. Per the County, the plotted risk results should be interpreted as follows:

Class I – Adverse significant unavoidable impacts that cannot be mitigated: risks that fall into the Red and Amber Zones on the F-N curve.

Class II – Adverse significant impacts that can be potentially mitigated: risks that fall into the Red and Amber Zones, but that move into the Green zone with application of available mitigation measures.

Class III – Adverse impacts that are considered insignificant. For example, severe consequences that are unlikely or high likelihood hazardous events that do not have severe consequences are considered less than significant.

3.0 Probability and Consequence Analysis

Proposed product trucking probability and consequence analysis was conducted according to the methodology presented in Section 3.2 and 3.3, respectively. The details of the calculations conducted per the methodology outlined in Section 3 above, are presented in Appendix 4.

4.0 Public Safety Risks

Fatality and Injury F-N curves were constructed to show public safety risks from the proposed Interim Trucking, see Figures in Appendix 5. The calculated public risk was found to be less than 10^{-5} (frequency/year) of 1 or more fatalities and less than 10^{-3} (frequency/year) of 1 or more injuries for both trucking scenarios. Therefore, the risk curves for both scenarios fall inside the low risk criteria (green zone).

5.0 Conclusions

Public safety risks were calculated to be below the Santa Barbara County thresholds. The resulting F-N curves are entirely in the "Green" zone of the constructed F-N curves for injuries and fatalities, for both transportation scenarios. Therefore, the impacts to public risk from the proposed Interim Trucking are considered less than significant in the context of CEQA (Class III).

6.0 References

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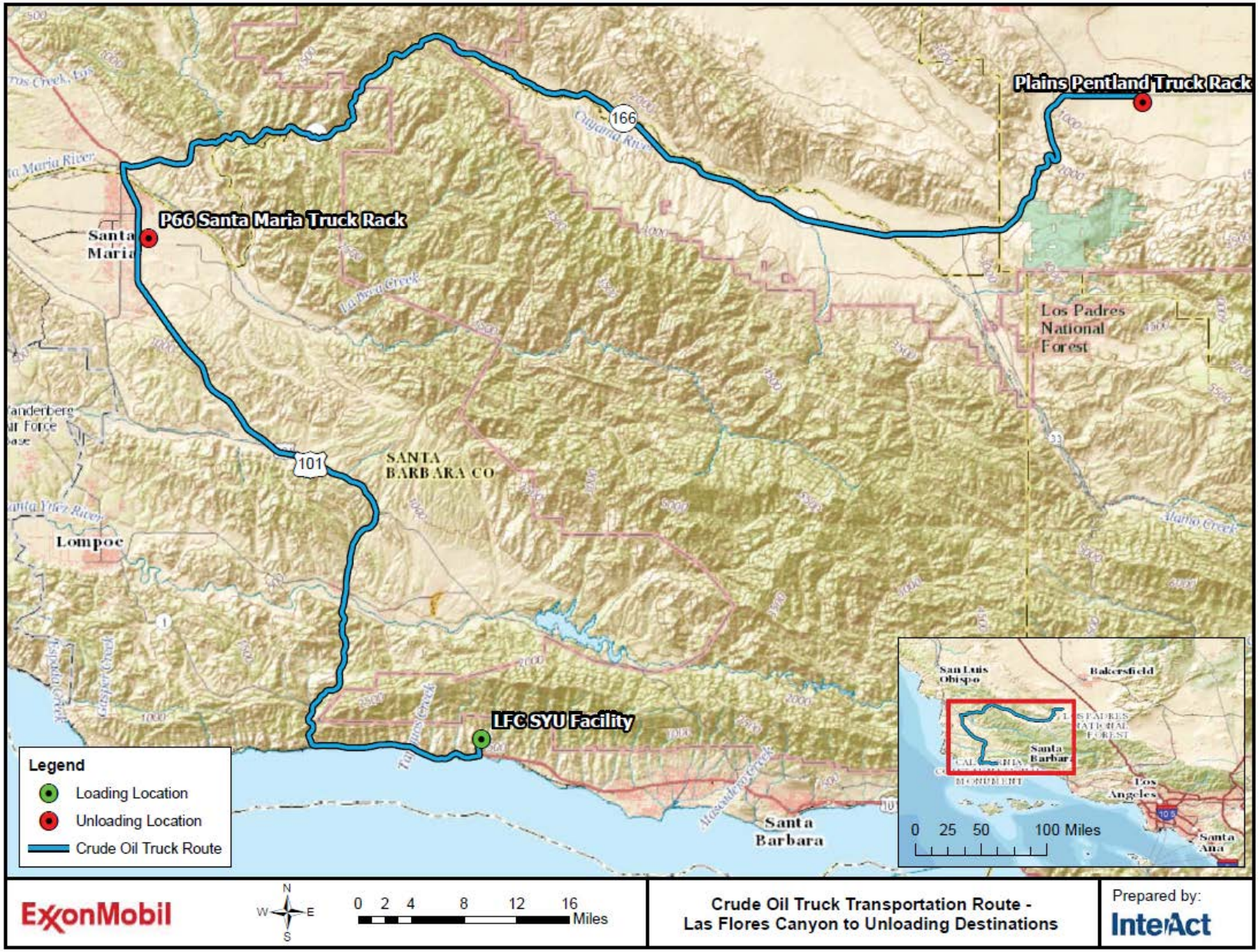
APPENDIX 1

TRUCK ROUTES MAPS


Plains Pentland Truck Rack
P66 Santa Maria Truck Rack
LFC SYU Facility
166
101
Santa Maria
Lompoc
SANTA BARBARA CO
Los Padres National Forest
Santa Barbara
Legend
Loading Location
Unloading Location
Crude Oil Truck Route
San Luis Obispo
Bakersfield
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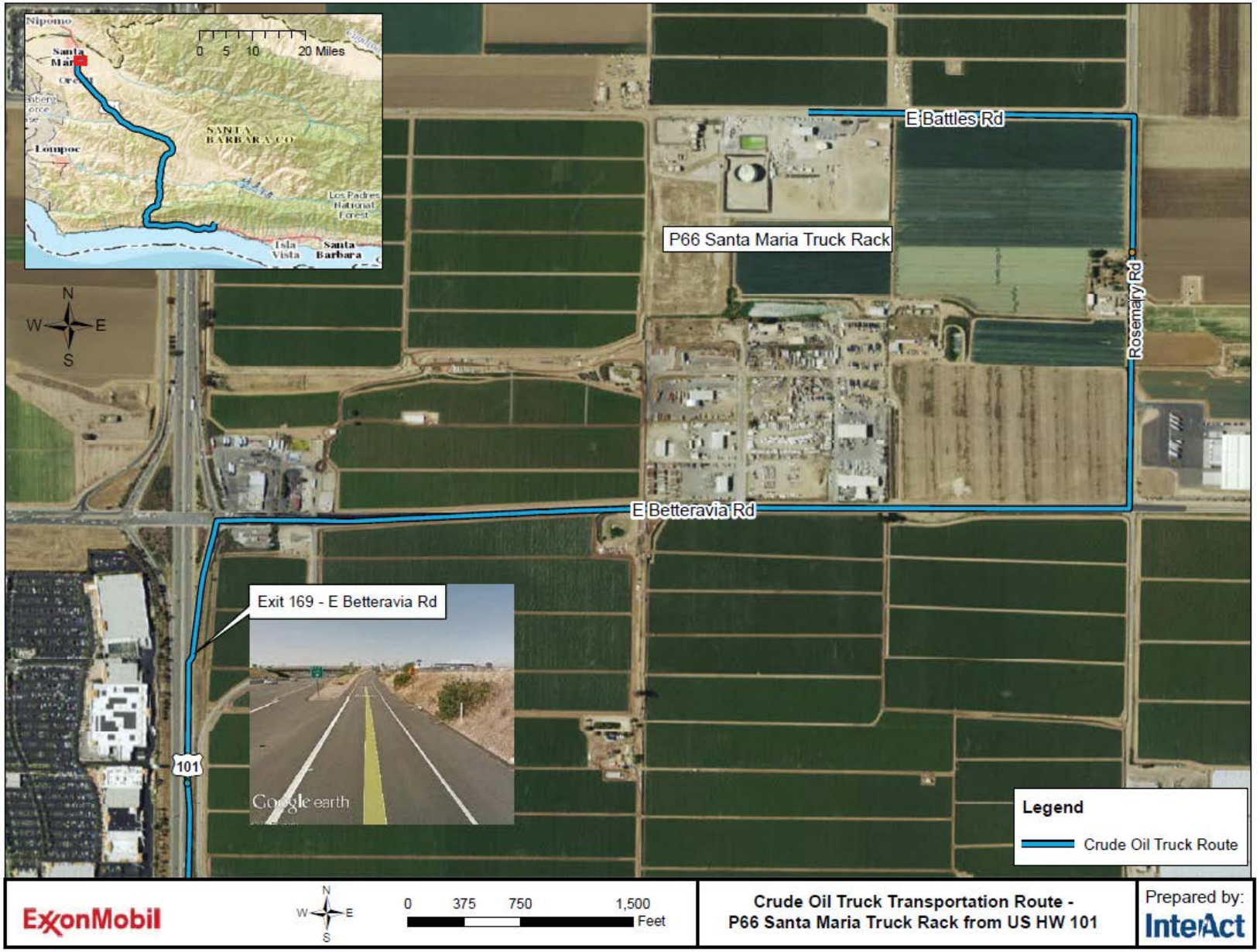
Crude Oil Truck Transportation Route -
Las Flores Canyon to Unloading Destinations
Prepared by:
InterAct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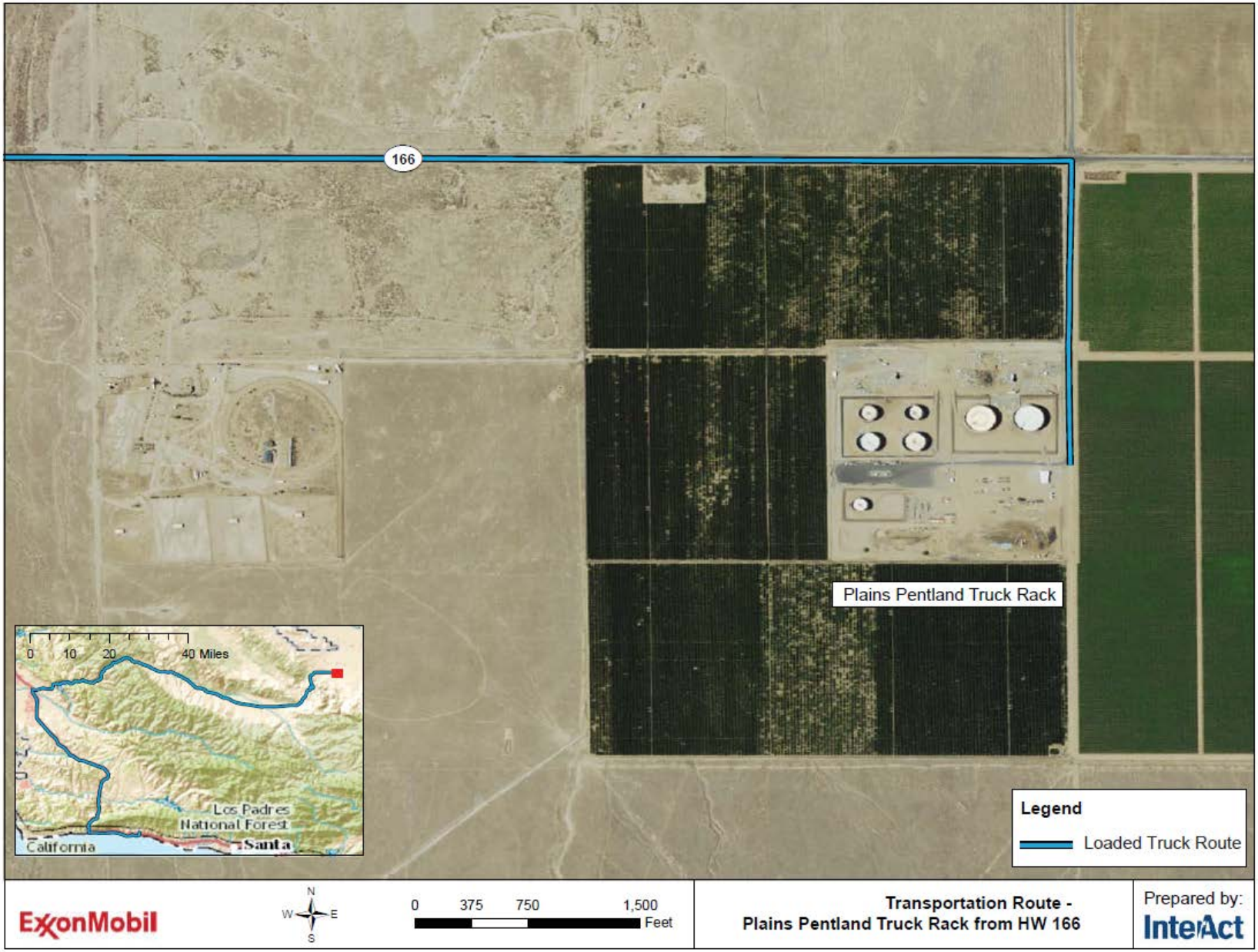
P66 Santa Maria Truck Rack from US HW 101
Prepared by:
InterAct


166
Plains Pentland Truck Rack
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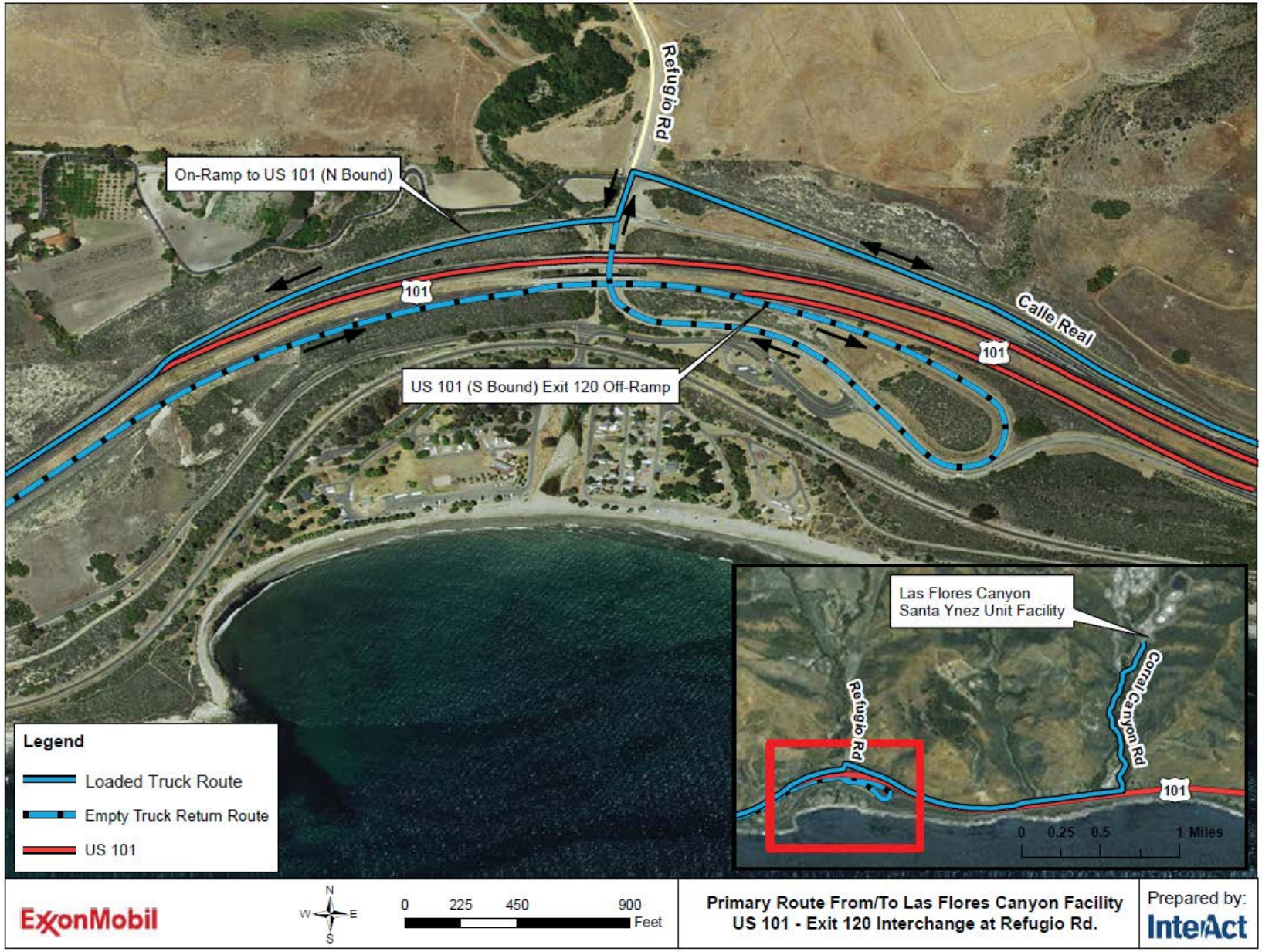
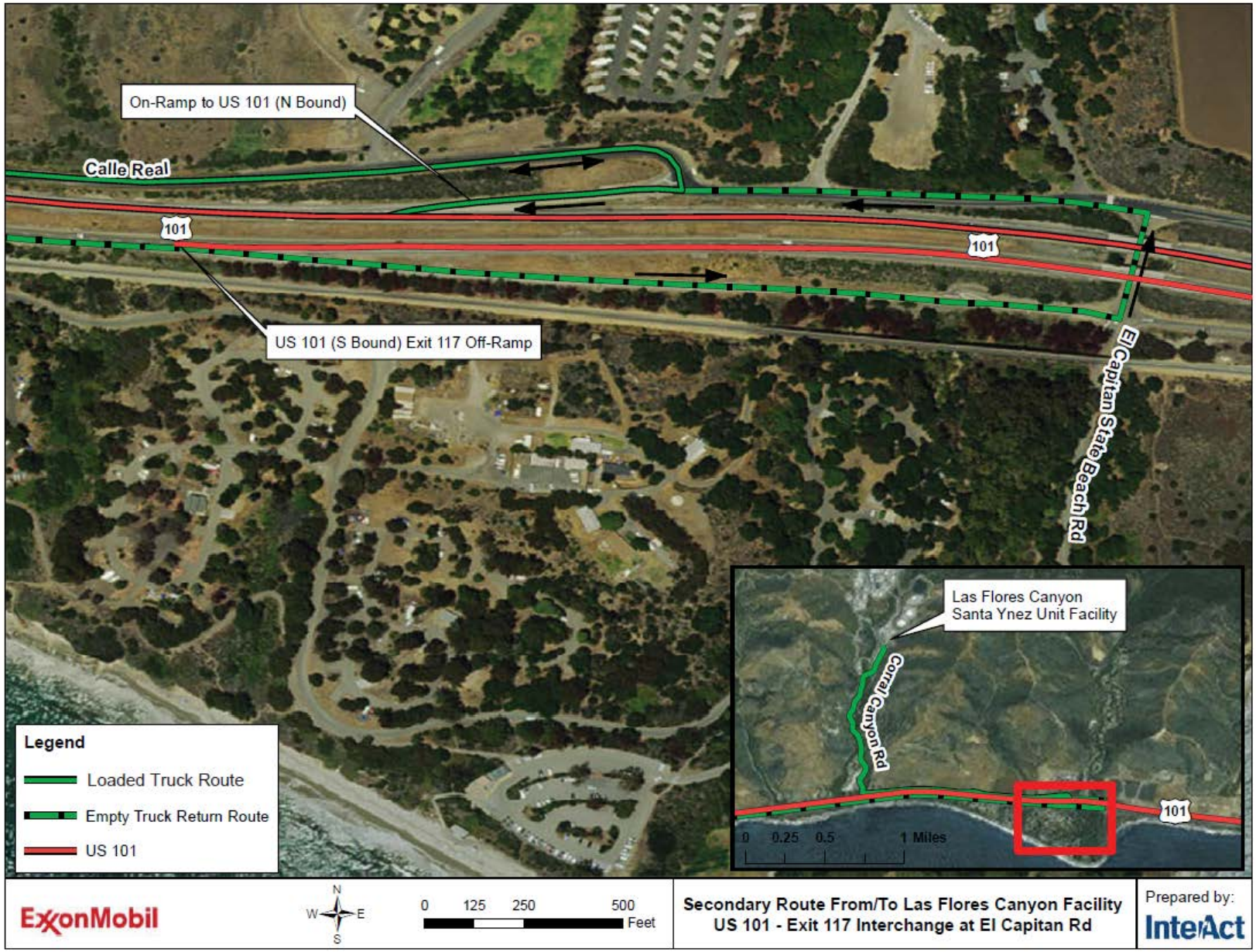
Prepared by:
InterAct


Refugio Rd
On-Ramp to US 101 (N Bound)
101
Calle Real
101
US 101 (S Bound) Exit 120 Off-Ramp
Las Flores Canyon
Santa Ynez Unit Facility
Refugio Rd
Coral Canyon Rd
101
0 0.25 0.5 1 Miles
Legend
Loaded Truck Route
Empty Truck Return Route
US 101
N
W
E
S
0 225 450 900
Feet
Primary Route From/To Las Flores Canyon Facility
US 101 - Exit 120 Interchange at Refugio Rd.
Prepared by:
InterAct


On-Ramp to US 101 (N Bound)
Calle Real
101
101
US 101 (S Bound) Exit 117 Off-Ramp
El Capitan State Beach Rd
Las Flores Canyon
Santa Ynez Unit Facility
Corral Canyon Rd
101
0 0.25 0.5 1 Miles
Legend
Loaded Truck Route
Empty Truck Return Route
US 101
ExxonMobil
N
W
E
S
0 125 250 500
Feet
Secondary Route From/To Las Flores Canyon Facility
US 101 - Exit 117 Interchange at El Capitan Rd
Prepared by:
InterAct

APPENDIX 2

COMBUSTION PRODUCTS DISPERSION MODELING DETAILS

Burning Pool				
Input Data				
API Gravity	18			
SG	0.946488			
Density	946	kg/m^3		
Burning Rate	3.6	mm/min	6.00E-05	m/s
Mass Burning Rate	5.68E-02	kg/m^2 s		
Air Density	1.2	kg/m^3		
S MW	32			
SO2 MW	64			
Sulfur Content	5.2	% by weight		
Wind Speed	4	m/s		

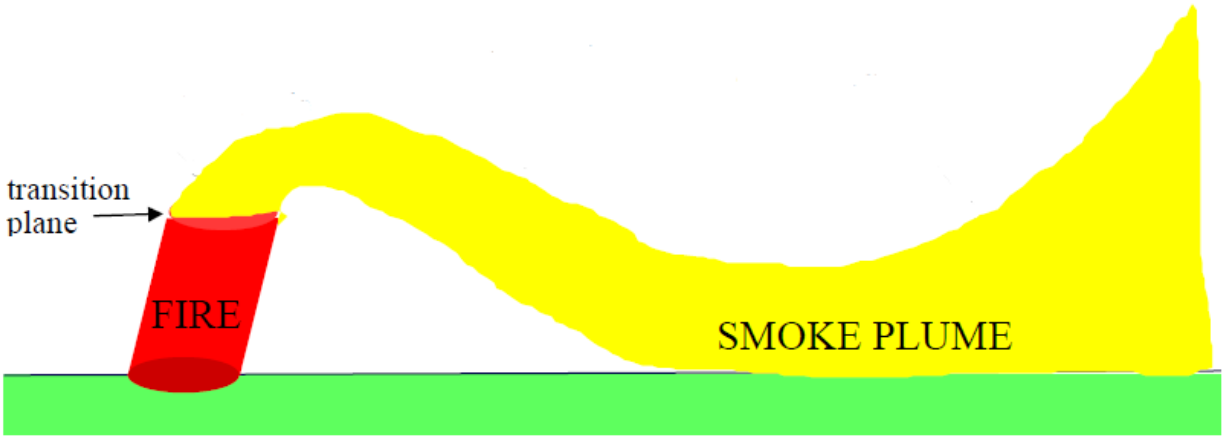
The SO_2 release was modeled as a plume with continuous steady-state source with an effective release height (i.e., flame height) and wind moving in the X direction at constant velocity. As liquid fuels gasify, due to thermal radiation, the hot gas will rise to the combustion region because of buoyancy effect. The combustion products will continue to rise and form a high temperature plume with air. This plume will then disperse downwind. Thus, modeling of fire and combustion products dispersion is typically approximated with two shapes: a tilted cylinder and a smoke plume [Refs 12, 13].

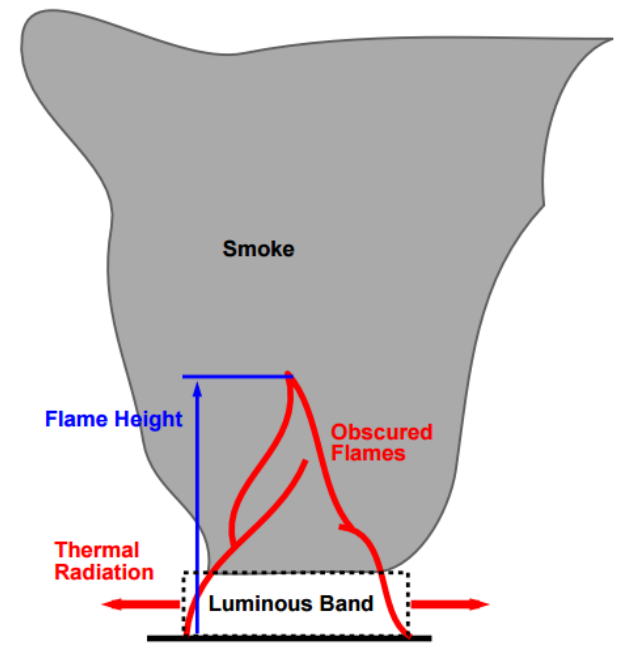
In the combustion region, where S is converted to SO_2 in a stoichiometric ratio, the momentum and heat of combustion products increase rapidly in the vertical direction. The upward rise is slowed and eventually stopped as the combustion products mix with ambient air and the momentum is dissipated [Ref. 18]. As the plume travels downwind, the concentration profile spreads out and decreases (gets diluted). Ground level concentrations of SO2 within 100 m of pool fire are less than significant due to the SO2 rise during the combustion process. By the time it reaches ground level, it will have a maximum SO_2 concentration of 48 ppm (at 600 m) and 28 ppm (at 230 m) for a full rupture scenario, and a leak scenario, respectively. These distances were calculated by checking to see when the plume would reach ground level and then extracting the SO_2 concentration and distance from the fire at that point.

This rise above ground level (effective height) was assumed to be equal to the flame height. To calculate the height of the fire, the following equation was used:

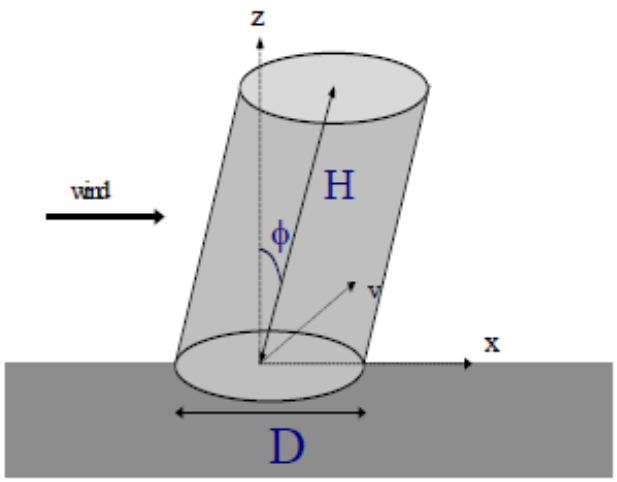
$$\frac{H}{D} = 42\left(\frac{m_B}{\rho_{air}\sqrt{gD}}\right)^{0.61}$$

Where H is the flame height in m, D is the spill diameter in m, m_B is the mass burning rate in kg/m^{2}s, ρ_{air} density of air in kg/m^3, and g is the acceleration of gravity in m/s^2. The flame height was calculated to be 39 m and 17.5 m for both scenarios full rupture and leak, respectively.





Schematic diagram of a large liquid fuel fire [Ref 13]

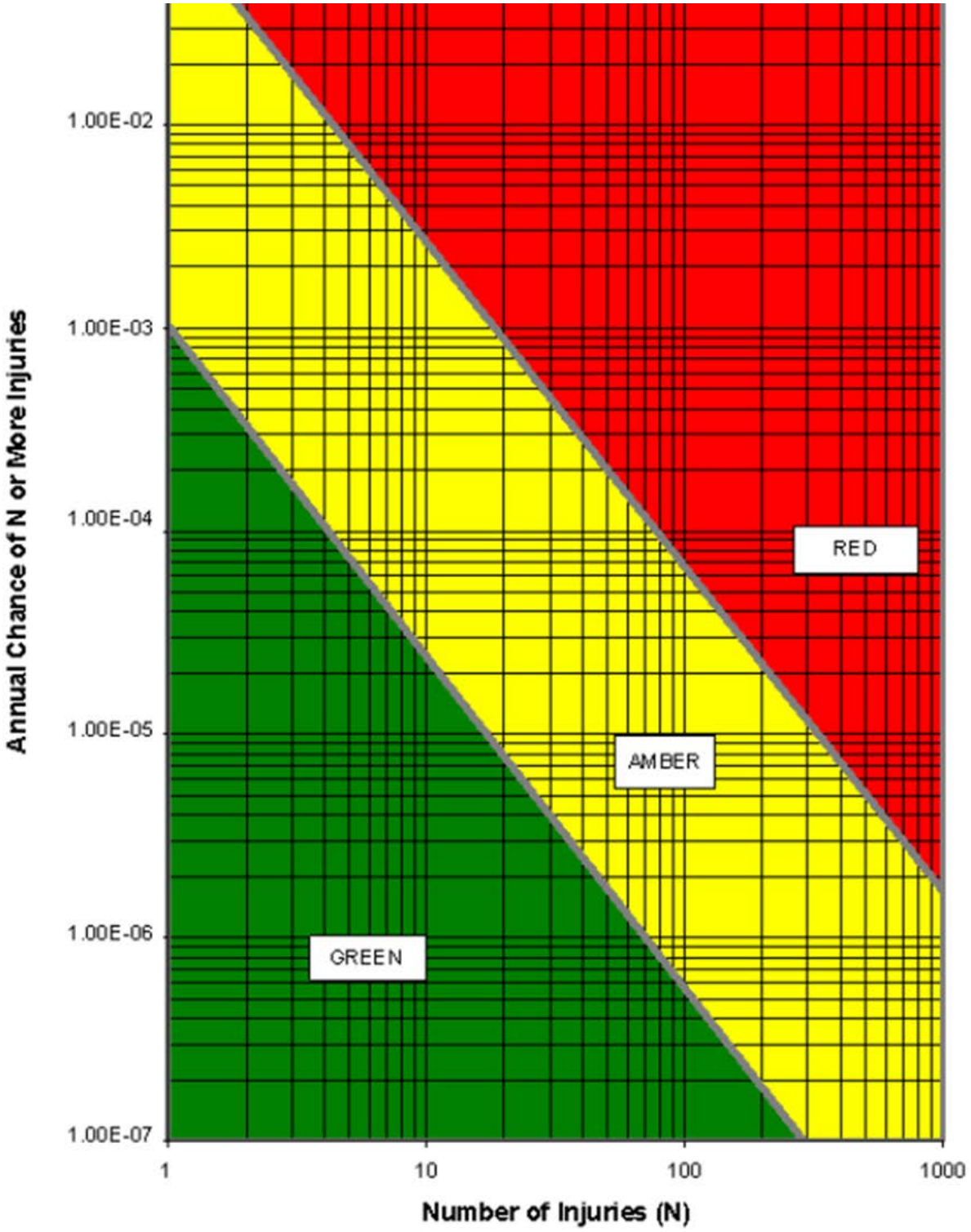


Pool fire Model [12]

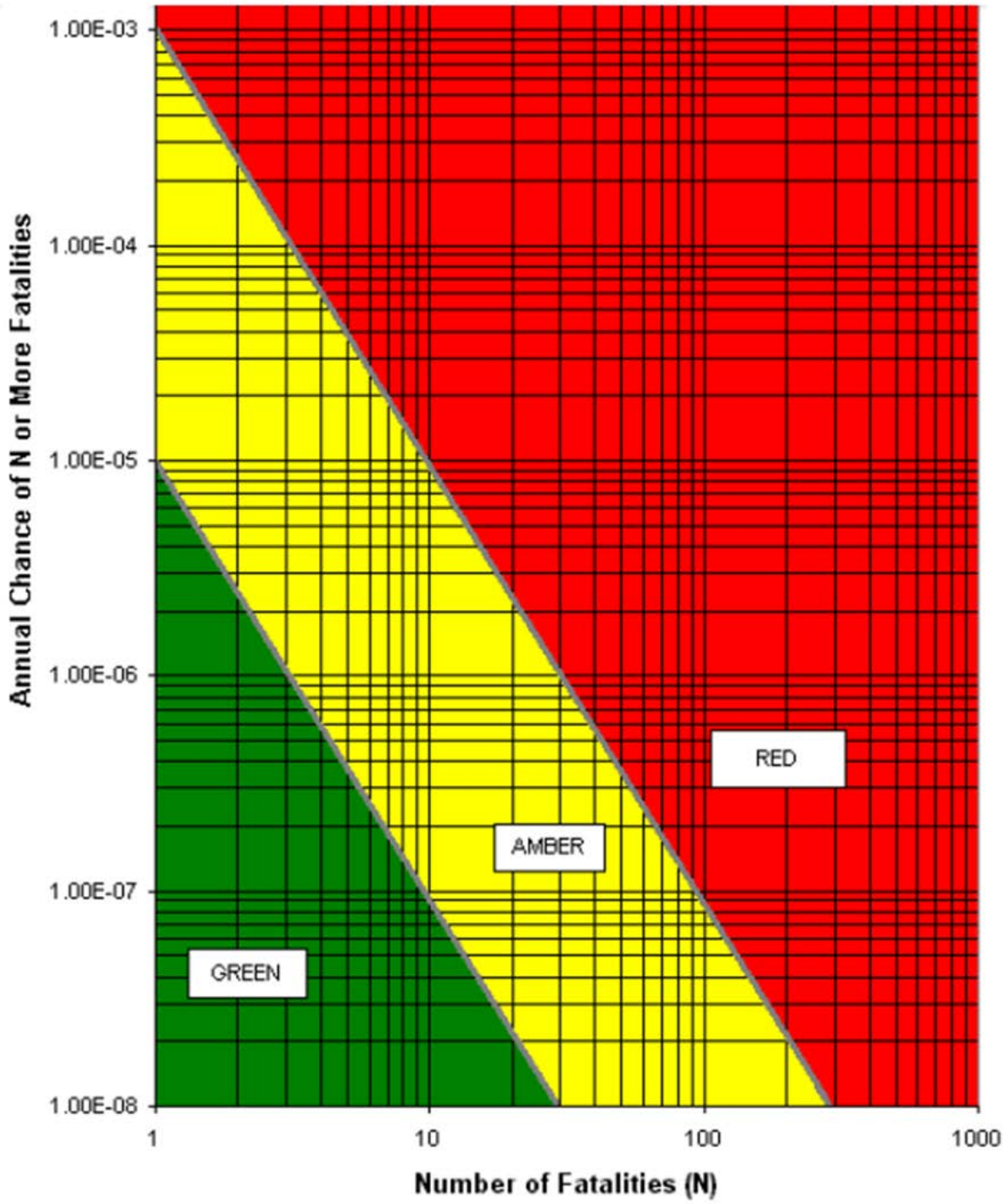
APPENDIX 3

SANTA BARBARA COUNTY PUBLIC RISK THRESHOLDS

Santa Barbara County Public Injury Risk Spectrum



Santa Barbara County Public Fatality Risk Spectrum



APPENDIX 4

RISK CALCULATION DETAILS

ROUTE FROM LFC to PHILLIPS 66 STATION in SANTA MARIA

F-N CURVE DATA

Santa Barbara County Fatality Criteria

Red	/yr	Amber	/yr
1	1.00E-03	1	1.00E-05
300	1.00E-08	30	1.00E-08

Santa Barbara County Injury Criteria

Red	/yr	Amber	/yr
1	1.00E-01	1	1.00E-03
900	2.00E-06	300	1.00E-07

1	sq foot =	3.59E-08	sq mile
1	sq mile =	27,878,399	sq feet

Probabilities

Base case of truck accidents (1): **0.528** per million miles (Rural freeway in California, per Harwood 1993)
Base case of truck accidents (2): **1.590** per million miles (Urban freeway in California, per Harwood 1993)

Collision accident reduction factors - (accident with collisions)
41.0 % reduction factor, due to safety programs
26.0 % reduction factor, due to speed control (See Ref. 3)

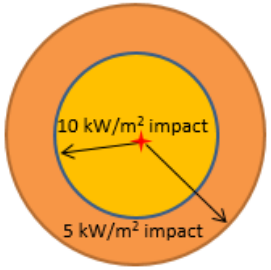
Non-collision Accident reduction factors (non-collision accidents - 20% that of accidents w/ collision)
37.5 % reduction factor, due to maintenance programs
45.0 % reduction factor, due to pre-trip-inspection (See Ref. 3)

Formula for Adjusted Probability of a truck accident per million miles
0.528 x [(1-0.41-0.26) + 0.2 x (1-0.375-0.45)]

Adjusted truck accident rate (1): **0.193** per million miles (Rural freeway)
Adjusted truck accident rate (2): **0.580** per million miles (Urban freeway)

40% of people in 10 kW/m2 area will have

60% of people in 10 kW/m2 area + all people in 5 kW/m2 area will have



Scenario, Volume and Impact Area Calculations

Scenario	Spilled	Volume Spilled			Area		Radius	10 kW/m² Radius	5 kW/m² Radius	10 kW/m² Area	5 kW/m² Area*	Probability of Accident, Release & Ignition	Probability of Accident, Release & Ignition
	% of truck	bbls	gallons	cu. inch	sq. inch	sq ft	ft	ft	ft	sq ft	sq ft	per mile	per mile
Rupture	100%	160	6,720	1,552,320	1,552,320	10,780	58.58	96.93	138.93	29,515	31,121	8.7E-11	2.6E-10
Leak	10%	16	672	155,232	155,232	1,078	18.52	30.65	43.93	2,951	3,112	2.6E-10	7.8E-10

Note: * the area with the 5 kW/m2 heat is a ring with the inside radius eqal to the 10 kW/m2 heat impact, and outside radius equal to the 5 kW/m2 heat impact

Trucks/day to P66	Truck trips per year	Total Miles per year	Accident Rate 1 per mile	Accident Rate 2 per mile	Probability of Release	Probability of Large Spill	Probability of small Spill	Probability of Ignition
70	25,550	1.37E+06	1.93E-07	5.80E-07	0.09	0.25	0.75	0.02

Total Volume trucked, bbl
4,088,000

ROUTE FROM LFC to PHILLIPS 66 STATION in SANTA MARIA

Probability Data by Route Segment									Consequence Data by Route Segment					
Road Type	Segmt. No.	Area on Segment	Segment Population category	Population		Mileage of Segment	Mileage of Segment	Total Trucking	Large Pool Fire Frequency (per year)	Small Pool Fire Frequency (per year)	Large Spill		Small Spill	
				ppl/sq mile	ppl/sq ft	feet	miles	miles			Injuries	Fatalities	Injuries	Fatalities
Rural freeway	1	LFC to Camino R.	Private/Open Sp.	5	1.79E-07	5,750	1.09	27,824.3	2.41E-06	7.24E-06	0.01	0.00	0.00	0.00
Rural freeway	2	from LFC to Camp	Rural	20	7.17E-07	5,790	1.10	28,017.9	2.43E-06	7.29E-06	0.04	0.01	0.00	0.00
Rural freeway	3	Refugio camp	Recreation	100	3.59E-06	4,960	0.94	24,001.5	2.08E-06	6.24E-06	0.18	0.04	0.02	0.00
Rural freeway	4	Rural Residence**	Rural	20	7.17E-07	3,750	0.71	18,146.3	1.57E-06	4.72E-06	0.04	0.01	0.00	0.00
Rural freeway	5	Beach	Recreation	100	3.59E-06	834	0.16	4,035.7	3.50E-07	1.05E-06	0.18	0.04	0.02	0.00
Rural freeway	6	Rural area	Rural	20	7.17E-07	3,110	0.59	15,049.3	1.31E-06	3.92E-06	0.04	0.01	0.00	0.00
Rural freeway	7	Rural residential	Rural	20	7.17E-07	12,350	2.34	59,761.8	5.18E-06	1.55E-05	0.04	0.01	0.00	0.00
Rural freeway	8	Beach, camps	Recreation	100	3.59E-06	16,400	3.11	79,359.8	6.88E-06	2.06E-05	0.18	0.04	0.02	0.00
Rural freeway	9	Gaviota plant**	Recreation	100	3.59E-06	3,340	0.63	16,162.3	1.40E-06	4.20E-06	0.18	0.04	0.02	0.00
Rural freeway	10	Beach, camps	Recreation	100	3.59E-06	1,187	0.22	5,743.9	4.98E-07	1.49E-06	0.18	0.04	0.02	0.00
Rural freeway	11	Rural w/ Fire Sta.	Rural	20	7.17E-07	1,196	0.23	5,787.5	5.02E-07	1.51E-06	0.04	0.01	0.00	0.00
Rural freeway	12	Motel or Rest Stop	Recreation	100	3.59E-06	17,800	3.37	86,134.5	7.47E-06	2.24E-05	0.18	0.04	0.02	0.00
Rural freeway	13	Rural Recreation	Recreation	100	3.59E-06	1,012	0.19	4,897.1	4.25E-07	1.27E-06	0.18	0.04	0.02	0.00
Rural freeway	14	Grazing/Open*	Unpopulated	5	1.79E-07	40,600	7.69	196,464.0	1.70E-05	5.11E-05	0.01	0.00	0.00	0.00
Rural freeway	15	Shops (Rte 240)	Commercial Low	1000	3.59E-05	8,319	1.58	40,255.8	3.49E-06	1.05E-05	1.75	0.42	0.18	0.04
Rural freeway	16	Grazing	Rural	20	7.17E-07	1,446	0.27	6,997.2	6.07E-07	1.82E-06	0.04	0.01	0.00	0.00
Rural freeway	17	Rural residence	Resid. very low	200	7.17E-06	1,004	0.19	4,858.4	4.21E-07	1.26E-06	0.35	0.08	0.04	0.01
Rural freeway	18	Shops	Commercial Low	1000	3.59E-05	342	0.06	1,654.9	1.44E-07	4.31E-07	1.75	0.42	0.18	0.04
Rural freeway	19	Open space	Unpopulated	5	1.79E-07	60,400	11.44	292,276.5	2.53E-05	7.60E-05	0.01	0.00	0.00	0.00
Rural freeway	20	Rural	Rural	20	7.17E-07	1,217	0.23	5,889.1	5.11E-07	1.53E-06	0.04	0.01	0.00	0.00
Urban freeway	21	Shops at Rte 135	Commercial Low	1000	3.59E-05	1,378	0.26	6,668.2	1.74E-06	5.22E-06	1.75	0.42	0.18	0.04
Urban freeway	22	Rte 135	Residential Low	1000	3.59E-05	548	0.10	2,651.8	6.93E-07	2.08E-06	1.75	0.42	0.18	0.04
Urban freeway	23	Shops at Rte 135	Commercial Low	1000	3.59E-05	916	0.17	4,432.5	1.16E-06	3.47E-06	1.75	0.42	0.18	0.04
Urban freeway	24	at Pepertree Ln.	Residential Low	1000	3.59E-05	3,175	0.60	15,363.9	4.01E-06	1.20E-05	1.75	0.42	0.18	0.04
Rural freeway	25	South of S. Maria	Open Space	5	1.79E-07	48,780	9.24	236,047.2	2.05E-05	6.14E-05	0.01	0.00	0.00	0.00
Rural freeway	26	Approach S. Maria	Residential Low	1000	3.59E-05	5,680	1.08	27,485.6	2.38E-06	7.15E-06	1.75	0.42	0.18	0.04
Rural freeway	27	S. Maria	Commercial Low	1000	3.59E-05	3,500	0.66	16,936.6	1.47E-06	4.41E-06	1.75	0.42	0.18	0.04
Rural freeway	28	S. Maria	Residential Med	3000	1.08E-04	6,975	1.32	33,752.1	2.93E-06	8.78E-06	5.25	1.27	0.53	0.13
Rural freeway	29	S. Maria	Residential Med	3000	1.08E-04	1,695	0.32	8,202.1	7.11E-07	2.13E-06	5.25	1.27	0.53	0.13
Rural freeway	30	S. Maria	Residential Low	1000	3.59E-05	9,430	1.79	45,631.9	3.96E-06	1.19E-05	1.75	0.42	0.18	0.04
Rural freeway	31	Betteravia Exit	Comm. Med+Rura	2510	9.00E-05	856	0.16	4,142.2	3.59E-07	1.08E-06	4.40	1.06	0.44	0.11
Rural freeway	32	from 101 to Station	Rural	20	7.17E-07	8,976	1.70	43,435.0	3.77E-06	1.13E-05	0.04	0.01	0.00	0.00

ROUTE FROM LFC to PHILLIPS 66 STATION in SANTA MARIA

Injury Data for the FN Curve

Injuries	Pool Fire Frequency (per year)	Cumulative Frequency (per year)
5.25	7.11E-07	7.11E-07
5.25	2.93E-06	3.64E-06
4.40	3.59E-07	4.00E-06
1.75	1.44E-07	4.14E-06
1.75	6.93E-07	4.83E-06
1.75	1.16E-06	5.99E-06
1.75	1.47E-06	7.46E-06
1.75	1.74E-06	9.20E-06
1.75	2.38E-06	1.16E-05
1.75	3.49E-06	1.51E-05
1.75	3.96E-06	1.90E-05
1.75	4.01E-06	2.30E-05
0.53	2.13E-06	2.52E-05
0.53	8.78E-06	3.40E-05
0.44	1.08E-06	3.50E-05
0.35	4.21E-07	3.55E-05
0.18	3.50E-07	3.58E-05
0.18	4.25E-07	3.62E-05
0.18	4.31E-07	3.67E-05
0.18	4.98E-07	3.72E-05
0.18	1.40E-06	3.86E-05
0.18	2.08E-06	4.06E-05
0.18	2.08E-06	4.27E-05
0.18	3.47E-06	4.62E-05
0.18	4.41E-06	5.06E-05
0.18	5.22E-06	5.58E-05
0.18	6.88E-06	6.27E-05
0.18	7.15E-06	6.99E-05
0.18	7.47E-06	7.73E-05
0.18	1.05E-05	8.78E-05
0.18	1.19E-05	9.97E-05
0.18	1.20E-05	1.12E-04

Fatality Data for the FN Curve

Fatalities	Pool Fire Frequency (per year)t	Cumulative Frequency (per year)
1.27	7.11E-07	7.11E-07
1.27	2.93E-06	3.64E-06
1.06	3.59E-07	4.00E-06
0.42	1.44E-07	4.14E-06
0.42	6.93E-07	4.83E-06
0.42	1.16E-06	5.99E-06
0.42	1.47E-06	7.46E-06
0.42	1.74E-06	9.20E-06
0.42	2.38E-06	1.16E-05
0.42	3.49E-06	1.51E-05
0.42	3.96E-06	1.90E-05
0.42	4.01E-06	2.30E-05
0.13	2.13E-06	2.52E-05
0.13	8.78E-06	3.40E-05
0.11	1.08E-06	3.50E-05
0.08	4.21E-07	3.55E-05
0.04	3.50E-07	3.58E-05
0.04	4.25E-07	3.62E-05
0.04	4.31E-07	3.67E-05
0.04	4.98E-07	3.72E-05
0.04	1.40E-06	3.86E-05
0.04	2.08E-06	4.06E-05
0.04	2.08E-06	4.27E-05
0.04	3.47E-06	4.62E-05
0.04	4.41E-06	5.06E-05
0.04	5.22E-06	5.58E-05
0.04	6.88E-06	6.27E-05
0.04	7.15E-06	6.99E-05
0.04	7.47E-06	7.73E-05
0.04	1.05E-05	8.78E-05
0.04	1.19E-05	9.97E-05
0.04	1.20E-05	1.12E-04

Injury Data for the FN Curve

Injuries	Pool Fire Frequency (per year)	Cumulative Frequency (per year)
0.04	5.02E-07	1.12E-04
0.04	5.11E-07	1.13E-04
0.04	6.07E-07	1.13E-04
0.04	1.26E-06	1.15E-04
0.04	1.31E-06	1.16E-04
0.04	1.57E-06	1.17E-04
0.04	2.43E-06	1.20E-04
0.04	3.77E-06	1.24E-04
0.04	5.18E-06	1.29E-04
0.02	1.05E-06	1.30E-04
0.02	1.27E-06	1.31E-04
0.02	1.49E-06	1.33E-04
0.02	4.20E-06	1.37E-04
0.02	6.24E-06	1.43E-04
0.02	2.06E-05	1.64E-04
0.02	2.24E-05	1.86E-04
0.01	2.41E-06	1.89E-04
0.01	1.70E-05	2.06E-04
0.01	2.05E-05	2.26E-04
0.01	2.53E-05	2.51E-04
0.00	1.51E-06	2.53E-04
0.00	1.53E-06	2.54E-04
0.00	1.82E-06	2.56E-04
0.00	3.92E-06	2.60E-04
0.00	4.72E-06	2.65E-04
0.00	7.29E-06	2.72E-04
0.00	1.13E-05	2.84E-04
0.00	1.55E-05	2.99E-04
0.00	7.24E-06	3.06E-04
0.00	5.11E-05	3.57E-04
0.00	6.14E-05	4.19E-04
0.00	7.60E-05	4.95E-04

Fatality Data for the FN Curve

Fatalities	Pool Fire Frequency (per year)t	Cumulative Frequency (per year)
0.01	5.02E-07	1.12E-04
0.01	5.11E-07	1.13E-04
0.01	6.07E-07	1.13E-04
0.01	1.26E-06	1.15E-04
0.01	1.31E-06	1.16E-04
0.01	1.57E-06	1.17E-04
0.01	2.43E-06	1.20E-04
0.01	3.77E-06	1.24E-04
0.01	5.18E-06	1.29E-04
0.00	1.05E-06	1.30E-04
0.00	1.27E-06	1.31E-04
0.00	1.49E-06	1.33E-04
0.00	4.20E-06	1.37E-04
0.00	6.24E-06	1.43E-04
0.00	2.06E-05	1.64E-04
0.00	2.24E-05	1.86E-04
0.00	2.41E-06	1.89E-04
0.00	1.70E-05	2.06E-04
0.00	2.05E-05	2.26E-04
0.00	2.53E-05	2.51E-04
0.00	1.51E-06	2.53E-04
0.00	1.53E-06	2.54E-04
0.00	1.82E-06	2.56E-04
0.00	3.92E-06	2.60E-04
0.00	4.72E-06	2.65E-04
0.00	7.29E-06	2.72E-04
0.00	1.13E-05	2.84E-04
0.00	1.55E-05	2.99E-04
0.00	7.24E-06	3.06E-04
0.00	5.11E-05	3.57E-04
0.00	6.14E-05	4.19E-04
0.00	7.60E-05	4.95E-04

ROUTE FROM LFC to PENTLAND STATION in MARICOPA

F-N CURVE DATA

Santa Barbara County Fatality Criteria

Red	/yr	Amber	/yr
1	1.00E-03	1	1.00E-05
300	1.00E-08	30	1.00E-08

Santa Barbara County Injury Criteria

Red	/yr	Amber	/yr
1	1.00E-01	1	1.00E-03
900	2.00E-06	300	1.00E-07

1	sq foot =	3.59E-08	sq mile
1	sq mile =	27,878,399	sq feet

Probabilities

Base case of truck accidents (1): **0.528** per million miles (Rural freeway in California, per Harwood 1993)
Base case of truck accidents (2): **1.720** per million miles (Rural two-lane in California, per Harwood 1993)
Base case of truck accidents (3): **1.59** per million miles (Urban freeway in California, per Harwood 1993)

Collision accident reduction factors - (accident with collisions)
41.0 % reduction factor, due to safety programs
26.0 % reduction factor, due to speed control (See Ref. 3)

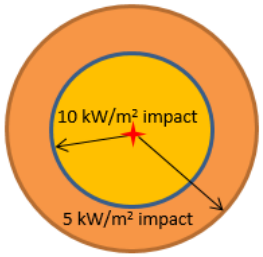
Non-collision Accident reduction factors (non-collision accidents = 20% that of accidents w/ collision)
37.5 % reduction factor, due to maintenance programs
45.0 % reduction factor, due to pre-trip-inspection (See Ref. 3)

Formula for Adjusted Probability of a truck accident per million miles
0.528 x [(1-0.41-0.26) + 0.2 x (1-0.375-0.45)]

Adjusted truck accident rate (1): **0.193** per million miles (Rural freeway)
Adjusted truck accident rate (2): **0.628** per million miles (Rural two-lane)
Adjusted truck accident rate (3): **0.580** per million miles (Urban freeway)

40% of people in 10 kW/m2 area will have Fatality

60% of people in 10 kW/m2 area + all people in 5 kW/m2 area will have Injury



Scenario, Volume and Impact Area Calculations

Scenario	Spilled	Volume Spilled			Area		Radius	10 kW/m² Radius	5 kW/m² Radius	10 kW/m² Area	5 kW/m² Area*	Probability of Accident, Release & Ignition	Probability of Accident, Release & Ignition	Probability of Accident, Release & Ignition
	% of truck	bbls	gallons	cu. inch	sq. inch	sq ft	ft	ft	ft	sq ft	sq ft	per mile	per mile	per mile
Rupture	100%	160	6,720	1,552,320	1,552,320	10,780	58.58	96.93	138.93	29,515	31,121	8.7E-11	2.8E-10	2.6E-10
Leak	10%	16	672	155,232	155,232	1,078	18.52	30.65	43.93	2,951	3,112	2.6E-10	8.5E-10	7.8E-10

Note: * the area with the 5 kW/m2 heat is a ring with the inside radius equal to the 10 kW/m2 heat impact, and outside radius equal to the 5 kW/m2 heat impact

Trucks/day to Pentland	Truck trips per year	Total Miles per year	Accident Rate 1 per mile	Accident Rate 2 per mile	Accident Rate 3 per mile	Probability of Release	Probability of Large Spill	Probability of small Spill	Probability of Ignition
70	25,550	3.56E+06	1.93E-07	6.28E-07	5.80E-07	0.09	0.25	0.75	0.02

Total Volume trucked, bbl
4,088,000

ROUTE FROM LFC to PENTLAND STATION in MARICOPA

Probability Data by Route Segment									Consequence Data by Route Segment						
Road Type	Segmt. No.	Area on Segment	Segment Population category	Population		Mileage of Segment	Mileage of Segment	Total Trucking	Large Pool Fire Frequency (per year)	Small Pool Fire Frequency (per year)	Large Spill		Small Spill		
				ppl/sq mile	ppl/sq ft	feet	miles	mile/yr			Injuries	Fatalities	Injuries	Fatalities	
Rural freeway	1	LFC to Camino R.**	Private/Open Sp.	5	1.79E-07	5,750	1.09	27,824.3	2.41E-06	7.24E-06	0.01	0.00	0.00	0.00	Portion of Route common to both Stations: Phillips 66 & Pentland Station
Rural freeway	2	LFC to Refugio C.**	Rural	20	7.17E-07	5,790	1.10	28,017.9	2.43E-06	7.29E-06	0.04	0.01	0.00	0.00	
Rural freeway	3	Refugio camp	Recreation	100	3.59E-06	4,960	0.94	24,001.5	2.08E-06	6.24E-06	0.18	0.04	0.02	0.00	
Rural freeway	4	Rural Residence**	Rural	20	7.17E-07	3,750	0.71	18,146.3	1.57E-06	4.72E-06	0.04	0.01	0.00	0.00	
Rural freeway	5	Beach	Recreation	100	3.59E-06	834	0.16	4,035.7	3.50E-07	1.05E-06	0.18	0.04	0.02	0.00	
Rural freeway	6	Rural area	Rural	20	7.17E-07	3,110	0.59	15,049.3	1.31E-06	3.92E-06	0.04	0.01	0.00	0.00	
Rural freeway	7	Rural residential	Rural	20	7.17E-07	12,350	2.34	59,761.8	5.18E-06	1.55E-05	0.04	0.01	0.00	0.00	
Rural freeway	8	Beach, camps	Recreation	100	3.59E-06	16,400	3.11	79,359.8	6.88E-06	2.06E-05	0.18	0.04	0.02	0.00	
Rural freeway	9	Gaviota plant**	Recreation	100	3.59E-06	3,340	0.63	16,162.3	1.40E-06	4.20E-06	0.18	0.04	0.02	0.00	
Rural freeway	10	Beach, camps	Recreation	100	3.59E-06	1,187	0.22	5,743.9	4.98E-07	1.49E-06	0.18	0.04	0.02	0.00	
Rural freeway	11	Rural w/ Fire Sta.**	Rural	20	7.17E-07	1,196	0.23	5,787.5	5.02E-07	1.51E-06	0.04	0.01	0.00	0.00	
Rural freeway	12	Motel or Rest Stop	Recreation	100	3.59E-06	17,800	3.37	86,134.5	7.47E-06	2.24E-05	0.18	0.04	0.02	0.00	
Rural freeway	13	Rural Recreation	Recreation	100	3.59E-06	1,012	0.19	4,897.1	4.25E-07	1.27E-06	0.18	0.04	0.02	0.00	
Rural freeway	14	Grazing/Open**	Unpopulated	5	1.79E-07	40,600	7.69	196,464.0	1.70E-05	5.11E-05	0.01	0.00	0.00	0.00	
Rural freeway	15	Shops (Rte 240)	Commercial Low	1000	3.59E-05	8,319	1.58	40,255.8	3.49E-06	1.05E-05	1.75	0.42	0.18	0.04	
Rural freeway	16	Grazing	Rural	20	7.17E-07	1,446	0.27	6,997.2	6.07E-07	1.82E-06	0.04	0.01	0.00	0.00	
Rural freeway	17	Rural residence**	Resid. very low	200	7.17E-06	1,004	0.19	4,858.4	4.21E-07	1.26E-06	0.35	0.08	0.04	0.01	
Rural freeway	18	Shops	Commercial Low	1000	3.59E-05	342	0.06	1,654.9	1.44E-07	4.31E-07	1.75	0.42	0.18	0.04	
Rural freeway	19	Open space**	Unpopulated	5	1.79E-07	60,400	11.44	292,276.5	2.53E-05	7.60E-05	0.01	0.00	0.00	0.00	
Rural freeway	20	Rural**	Rural	20	7.17E-07	1,217	0.23	5,889.1	5.11E-07	1.53E-06	0.04	0.01	0.00	0.00	
Urban freeway	21	Shops at Rte 135	Commercial Low	1000	3.59E-05	1,378	0.26	6,668.2	1.74E-06	5.22E-06	1.75	0.42	0.18	0.04	
Urban freeway	22	Rte 135	Residential Low	1000	3.59E-05	548	0.10	2,651.8	6.93E-07	2.08E-06	1.75	0.42	0.18	0.04	
Urban freeway	23	Shops at Rte 135	Commercial Low	1000	3.59E-05	916	0.17	4,432.5	1.16E-06	3.47E-06	1.75	0.42	0.18	0.04	
Urban freeway	24	at Pepertree Ln.	Residential Low	1000	3.59E-05	3,175	0.60	15,363.9	4.01E-06	1.20E-05	1.75	0.42	0.18	0.04	
Rural freeway	25	South of S. Maria**	Open Space	5	1.79E-07	48,780	9.24	236,047.2	2.05E-05	6.14E-05	0.01	0.00	0.00	0.00	
Rural freeway	26	Approach S. Maria	Residential Low	1000	3.59E-05	5,680	1.08	27,485.6	2.38E-06	7.15E-06	1.75	0.42	0.18	0.04	
Rural freeway	27	S. Maria**	Commercial Low	1000	3.59E-05	3,500	0.66	16,936.6	1.47E-06	4.41E-06	1.75	0.42	0.18	0.04	
Rural freeway	28	S. Maria**	Residential Med	3000	1.08E-04	6,975	1.32	33,752.1	2.93E-06	8.78E-06	5.25	1.27	0.53	0.13	
Rural freeway	29	S. Maria**	Residential Med	3000	1.08E-04	1,695	0.32	8,202.1	7.11E-07	2.13E-06	5.25	1.27	0.53	0.13	
Rural freeway	30	S. Maria**	Residential Low	1000	3.59E-05	9,430	1.79	45,631.9	3.96E-06	1.19E-05	1.75	0.42	0.18	0.04	
Rural freeway	31	Mid of S. Maria	Open Space	20	7.17E-07	3,696	0.70	17,885.0	1.55E-06	4.65E-06	0.04	0.01	0.00	0.00	

ROUTE FROM LFC to PENTLAND STATION in MARICOPA

Probability Data by Route Segment									Consequence Data by Route Segment						
Road Type	Segmt. No.	Area on Segment	Segment Population category	Population		Mileage of Segment	Mileage of Segment	Total Trucking	Large Pool Fire Frequency (per year)	Small Pool Fire Frequency (per year)	Large Spill		Small Spill		
				ppl/sq mile	ppl/sq ft	feet	miles	mile/yr			Injuries	Fatalities	Injuries	Fatalities	
Rural freeway	32	Mid of S. Maria	Comm Med+Rural	2510	9.00E-05	5,285	1.00	25,574.2	2.22E-06	6.65E-06	4.40	1.06	0.44	0.11	Portion of the Route only to Pentland Station
Urban freeway	33	Mid of S. Maria**	Residential Low	1000	3.59E-05	11,445	2.17	55,382.5	1.45E-05	4.34E-05	1.75	0.42	0.18	0.04	
Rural freeway	34	Mid of S. Maria	Commercial Low	1000	3.59E-05	3,250	0.62	15,726.8	1.36E-06	4.09E-06	1.75	0.42	0.18	0.04	
Rural freeway	35	Mid of S. Maria	Residential Med	3000	1.08E-04	1,010	0.19	4,887.4	4.24E-07	1.27E-06	5.25	1.27	0.53	0.13	
Rural freeway	36	River Bridge	Unpopulated	5	1.79E-07	2,521	0.48	12,199.2	1.06E-06	3.17E-06	0.01	0.00	0.00	0.00	
Rural freeway	37	N of S. Maria	Commercial Low	1000	3.59E-05	1,145	0.22	5,540.7	4.81E-07	1.44E-06	1.75	0.42	0.18	0.04	
Two-lane	38	Sparse population	Rural	20	7.17E-07	85,350	16.16	413,009.9	1.17E-04	3.50E-04	0.04	0.01	0.00	0.00	
Two-lane	39	Hills on Rte 166	Unpopulated	5	1.79E-07	48,300	9.15	233,724.4	6.60E-05	1.98E-04	0.01	0.00	0.00	0.00	
Two-lane	40	Brown Cyn	Rural	20	7.17E-07	3,700	0.70	17,904.4	5.06E-06	1.52E-05	0.04	0.01	0.00	0.00	
Two-lane	41	To Green Cyn.	Unpopulated	5	1.79E-07	94,100	17.82	455,351.3	1.29E-04	3.86E-04	0.01	0.00	0.00	0.00	
Two-lane	42	Green Cyn.	Rural	20	7.17E-07	8,450	1.60	40,889.7	1.16E-05	3.47E-05	0.04	0.01	0.00	0.00	
Two-lane	43	East of Green Cyn.	Unpopulated	5	1.79E-07	11,600	2.20	56,132.6	1.59E-05	4.76E-05	0.01	0.00	0.00	0.00	
Two-lane	44	Small shop area	Commercial Low	1000	3.59E-05	528	0.10	2,555.0	7.22E-07	2.17E-06	1.75	0.42	0.18	0.04	
Two-lane	45	West of N Cuyama	Unpopulated	5	1.79E-07	4,224	0.80	20,440.0	5.77E-06	1.73E-05	0.01	0.00	0.00	0.00	
Two-lane	46	to New Cuyama	Rural	20	7.17E-07	17,980	3.41	87,005.5	2.46E-05	7.37E-05	0.04	0.01	0.00	0.00	
Two-lane	47	New Cuyama	Residential Low	1000	3.59E-05	6,340	1.20	30,679.4	8.67E-06	2.60E-05	1.75	0.42	0.18	0.04	
Two-lane	48	to Cuyama	Rural	20	7.17E-07	14,800	2.80	71,617.4	2.02E-05	6.07E-05	0.04	0.01	0.00	0.00	
Two-lane	49	Cuyama	Residential Low	1000	3.59E-05	5,280	1.00	25,550.0	7.22E-06	2.17E-05	1.75	0.42	0.18	0.04	
Two-lane	50	east of Cuyama	Rural	20	7.17E-07	37,650	7.13	182,188.9	5.15E-05	1.54E-04	0.04	0.01	0.00	0.00	
Two-lane	51	to Maricopa	Unpopulated	5	1.79E-07	59,400	11.25	287,437.5	8.12E-05	2.44E-04	0.01	0.00	0.00	0.00	
Two-lane	52	Maricopa	Residential Low	1000	3.59E-05	5,290	1.00	25,598.4	7.23E-06	2.17E-05	1.75	0.42	0.18	0.04	
Two-lane	53	east of Maricopa	Rural	20	7.17E-07	30,800	5.83	149,041.7	4.21E-05	1.26E-04	0.04	0.01	0.00	0.00	
						TOTAL	139.21	3,556,812							

ROUTE FROM LFC to PENTLAND STATION in MARICOPA

Injury Data for the FN Curve

Injuries	Pool Fire Frequency (per year)	Cumulative Frequency (per year)
5.2546	4.24E-07	4.24E-07
5.2546	7.11E-07	1.14E-06
5.2546	2.93E-06	4.06E-06
4.3964	2.22E-06	6.28E-06
1.7515	1.44E-07	6.42E-06
1.7515	4.81E-07	6.90E-06
1.7515	6.93E-07	7.60E-06
1.7515	7.22E-07	8.32E-06
1.7515	1.16E-06	9.48E-06
1.7515	1.36E-06	1.08E-05
1.7515	1.47E-06	1.23E-05
1.7515	1.74E-06	1.41E-05
1.7515	2.38E-06	1.64E-05
1.7515	3.49E-06	1.99E-05
1.7515	3.96E-06	2.39E-05
1.7515	4.01E-06	2.79E-05
1.7515	7.22E-06	3.51E-05
1.7515	7.23E-06	4.23E-05
1.7515	8.67E-06	5.10E-05
1.7515	1.45E-05	6.55E-05
0.5255	1.27E-06	6.67E-05
0.5255	2.13E-06	6.89E-05
0.5255	8.78E-06	7.77E-05
0.4396	6.65E-06	8.43E-05
0.3503	4.21E-07	8.47E-05
0.1752	3.50E-07	8.51E-05
0.1752	4.25E-07	8.55E-05
0.1752	4.31E-07	8.59E-05
0.1752	4.98E-07	8.64E-05
0.1752	1.40E-06	8.78E-05
0.1752	1.44E-06	8.93E-05
0.1752	2.08E-06	9.14E-05
0.1752	2.08E-06	9.34E-05
0.1752	2.17E-06	9.56E-05
0.1752	3.47E-06	9.91E-05
0.1752	4.09E-06	1.03E-04

Fatality Data for the FN Curve

Fatalities	Pool Fire Frequency (per year)	Cumulative Frequency (per year)
1.2704	4.24E-07	4.24E-07
1.2704	7.11E-07	1.14E-06
1.2704	2.93E-06	4.06E-06
1.0629	2.22E-06	6.28E-06
0.4235	1.44E-07	6.42E-06
0.4235	4.81E-07	6.90E-06
0.4235	6.93E-07	7.60E-06
0.4235	7.22E-07	8.32E-06
0.4235	1.16E-06	9.48E-06
0.4235	1.36E-06	1.08E-05
0.4235	1.47E-06	1.23E-05
0.4235	1.74E-06	1.41E-05
0.4235	2.38E-06	1.64E-05
0.4235	3.49E-06	1.99E-05
0.4235	3.96E-06	2.39E-05
0.4235	4.01E-06	2.79E-05
0.4235	7.22E-06	3.51E-05
0.4235	7.23E-06	4.23E-05
0.4235	8.67E-06	5.10E-05
0.4235	1.45E-05	6.55E-05
0.1270	1.27E-06	6.67E-05
0.1270	2.13E-06	6.89E-05
0.1270	8.78E-06	7.77E-05
0.1063	6.65E-06	8.43E-05
0.0847	4.21E-07	8.47E-05
0.0423	3.50E-07	8.51E-05
0.0423	4.25E-07	8.55E-05
0.0423	4.31E-07	8.59E-05
0.0423	4.98E-07	8.64E-05
0.0423	1.40E-06	8.78E-05
0.0423	1.44E-06	8.93E-05
0.0423	2.08E-06	9.14E-05
0.0423	2.08E-06	9.34E-05
0.0423	2.17E-06	9.56E-05
0.0423	3.47E-06	9.91E-05
0.0423	4.09E-06	1.03E-04

ROUTE FROM LFC to PENTLAND STATION in MARICOPA

Injury Data for the FN Curve

Injuries	Pool Fire Frequency (per year)	Cumulative Frequency (per year)
0.1752	4.41E-06	1.08E-04
0.1752	5.22E-06	1.13E-04
0.1752	6.88E-06	1.20E-04
0.1752	7.15E-06	1.27E-04
0.1752	7.47E-06	1.34E-04
0.1752	1.05E-05	1.45E-04
0.1752	1.19E-05	1.57E-04
0.1752	1.20E-05	1.69E-04
0.1752	2.17E-05	1.90E-04
0.1752	2.17E-05	2.12E-04
0.1752	2.60E-05	2.38E-04
0.1752	4.34E-05	2.81E-04
0.0350	5.02E-07	2.82E-04
0.0350	5.11E-07	2.82E-04
0.0350	6.07E-07	2.83E-04
0.0350	1.26E-06	2.84E-04
0.0350	1.31E-06	2.86E-04
0.0350	1.55E-06	2.87E-04
0.0350	1.57E-06	2.89E-04
0.0350	2.43E-06	2.91E-04
0.0350	5.06E-06	2.96E-04
0.0350	5.18E-06	3.01E-04
0.0350	1.16E-05	3.13E-04
0.0350	2.02E-05	3.33E-04
0.0350	2.46E-05	3.58E-04
0.0350	4.21E-05	4.00E-04
0.0350	5.15E-05	4.51E-04
0.0350	1.17E-04	5.68E-04
0.0175	1.05E-06	5.69E-04
0.0175	1.27E-06	5.70E-04
0.0175	1.49E-06	5.72E-04
0.0175	4.20E-06	5.76E-04
0.0175	6.24E-06	5.82E-04
0.0175	2.06E-05	6.03E-04
0.0175	2.24E-05	6.25E-04

Fatality Data for the FN Curve

Fatalities	Pool Fire Frequency (per year)	Cumulative Frequency (per year)
0.0423	4.41E-06	1.08E-04
0.0423	5.22E-06	1.13E-04
0.0423	6.88E-06	1.20E-04
0.0423	7.15E-06	1.27E-04
0.0423	7.47E-06	1.34E-04
0.0423	1.05E-05	1.45E-04
0.0423	1.19E-05	1.57E-04
0.0423	1.20E-05	1.69E-04
0.0423	2.17E-05	1.90E-04
0.0423	2.17E-05	2.12E-04
0.0423	2.60E-05	2.38E-04
0.0423	4.34E-05	2.81E-04
0.0085	5.02E-07	2.82E-04
0.0085	5.11E-07	2.82E-04
0.0085	6.07E-07	2.83E-04
0.0085	1.26E-06	2.84E-04
0.0085	1.31E-06	2.86E-04
0.0085	1.55E-06	2.87E-04
0.0085	1.57E-06	2.89E-04
0.0085	2.43E-06	2.91E-04
0.0085	5.06E-06	2.96E-04
0.0085	5.18E-06	3.01E-04
0.0085	1.16E-05	3.13E-04
0.0085	2.02E-05	3.33E-04
0.0085	2.46E-05	3.58E-04
0.0085	4.21E-05	4.00E-04
0.0085	5.15E-05	4.51E-04
0.0085	1.17E-04	5.68E-04
0.0042	1.05E-06	5.69E-04
0.0042	1.27E-06	5.70E-04
0.0042	1.49E-06	5.72E-04
0.0042	4.20E-06	5.76E-04
0.0042	6.24E-06	5.82E-04
0.0042	2.06E-05	6.03E-04
0.0042	2.24E-05	6.25E-04

ROUTE FROM LFC to PENTLAND STATION in MARICOPA

Injury Data for the FN Curve

Injuries	Pool Fire Frequency (per year)	Cumulative Frequency (per year)
0.0088	1.06E-06	6.26E-04
0.0088	2.41E-06	6.29E-04
0.0088	5.77E-06	6.35E-04
0.0088	1.59E-05	6.50E-04
0.0088	1.70E-05	6.68E-04
0.0088	2.05E-05	6.88E-04
0.0088	2.53E-05	7.13E-04
0.0088	6.60E-05	7.79E-04
0.0088	8.12E-05	8.61E-04
0.0088	1.29E-04	9.89E-04
0.0035	1.51E-06	9.91E-04
0.0035	1.53E-06	9.92E-04
0.0035	1.82E-06	9.94E-04
0.0035	3.92E-06	9.98E-04
0.0035	4.65E-06	1.00E-03
0.0035	4.72E-06	1.01E-03
0.0035	7.29E-06	1.01E-03
0.0035	1.52E-05	1.03E-03
0.0035	1.55E-05	1.05E-03
0.0035	3.47E-05	1.08E-03
0.0035	6.07E-05	1.14E-03
0.0035	7.37E-05	1.21E-03
0.0035	1.26E-04	1.34E-03
0.0035	1.54E-04	1.50E-03
0.0035	3.50E-04	1.85E-03
0.0009	3.17E-06	1.85E-03
0.0009	7.24E-06	1.86E-03
0.0009	1.73E-05	1.87E-03
0.0009	4.76E-05	1.92E-03
0.0009	5.11E-05	1.97E-03
0.0009	6.14E-05	2.03E-03
0.0009	7.60E-05	2.11E-03
0.0009	1.98E-04	2.31E-03
0.0009	2.44E-04	2.55E-03
0.0009	3.86E-04	2.94E-03

Fatality Data for the FN Curve

Fatalities	Pool Fire Frequency (per year)	Cumulative Frequency (per year)
0.0021	1.06E-06	6.26E-04
0.0021	2.41E-06	6.29E-04
0.0021	5.77E-06	6.35E-04
0.0021	1.59E-05	6.50E-04
0.0021	1.70E-05	6.68E-04
0.0021	2.05E-05	6.88E-04
0.0021	2.53E-05	7.13E-04
0.0021	6.60E-05	7.79E-04
0.0021	8.12E-05	8.61E-04
0.0021	1.29E-04	9.89E-04
0.0008	1.51E-06	9.91E-04
0.0008	1.53E-06	9.92E-04
0.0008	1.82E-06	9.94E-04
0.0008	3.92E-06	9.98E-04
0.0008	4.65E-06	1.00E-03
0.0008	4.72E-06	1.01E-03
0.0008	7.29E-06	1.01E-03
0.0008	1.52E-05	1.03E-03
0.0008	1.55E-05	1.05E-03
0.0008	3.47E-05	1.08E-03
0.0008	6.07E-05	1.14E-03
0.0008	7.37E-05	1.21E-03
0.0008	1.26E-04	1.34E-03
0.0008	1.54E-04	1.50E-03
0.0008	3.50E-04	1.85E-03
0.0002	3.17E-06	1.85E-03
0.0002	7.24E-06	1.86E-03
0.0002	1.73E-05	1.87E-03
0.0002	4.76E-05	1.92E-03
0.0002	5.11E-05	1.97E-03
0.0002	6.14E-05	2.03E-03
0.0002	7.60E-05	2.11E-03
0.0002	1.98E-04	2.31E-03
0.0002	2.44E-04	2.55E-03
0.0002	3.86E-04	2.94E-03

APPENDIX 5

PROPOSED PRODUCT TRUCKING PUBLIC INJURY AND FATALITY F-N CURVES

Injury Curve, Scenario 1: 70 Trucks to Phillips 66 Station

Fatality Curve, Scenario 1: 70 Trucks to Phillips 66 Station

Injury Curve, Scenario 2: 70 Trucks to PAAPL Pentland Station

Fatality Curve, Scenario 2: 70 Trucks to PAAPL Pentland Station

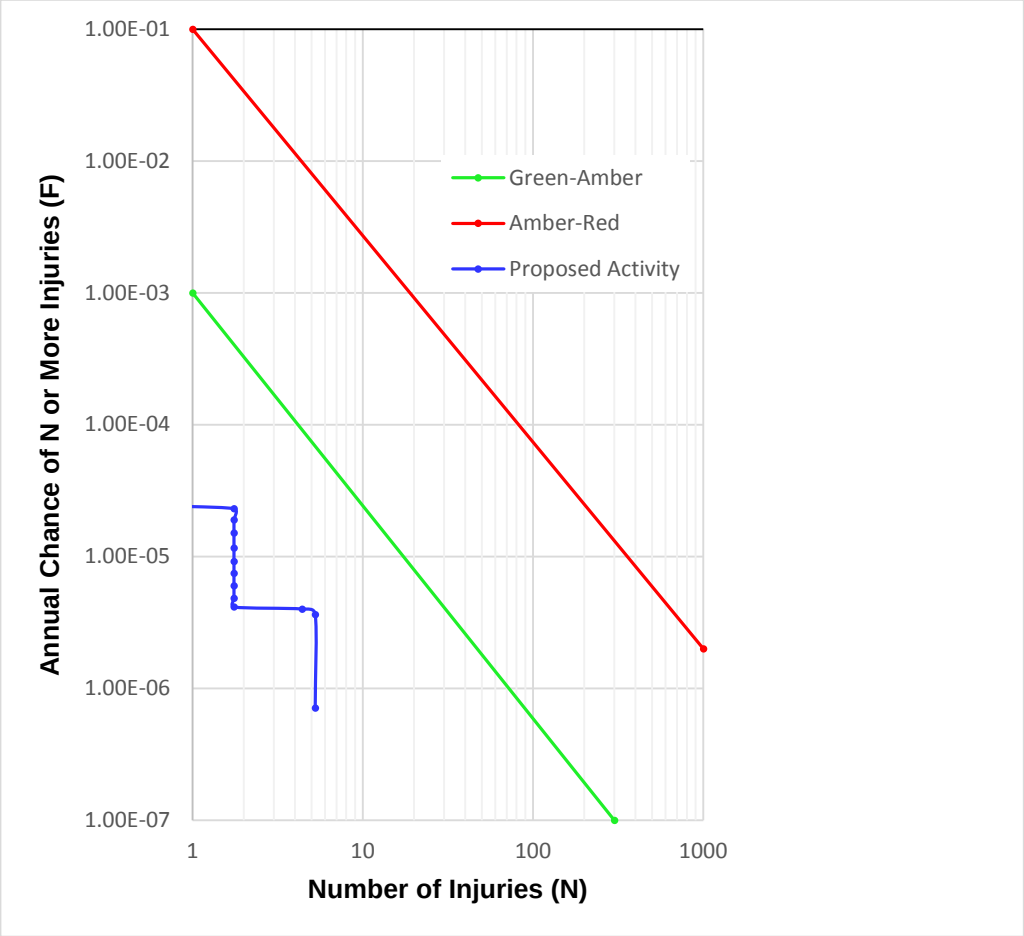


Figure 1 LFC product trucking public injury F-N curve 70 trucks per day to Phillips 66 Station

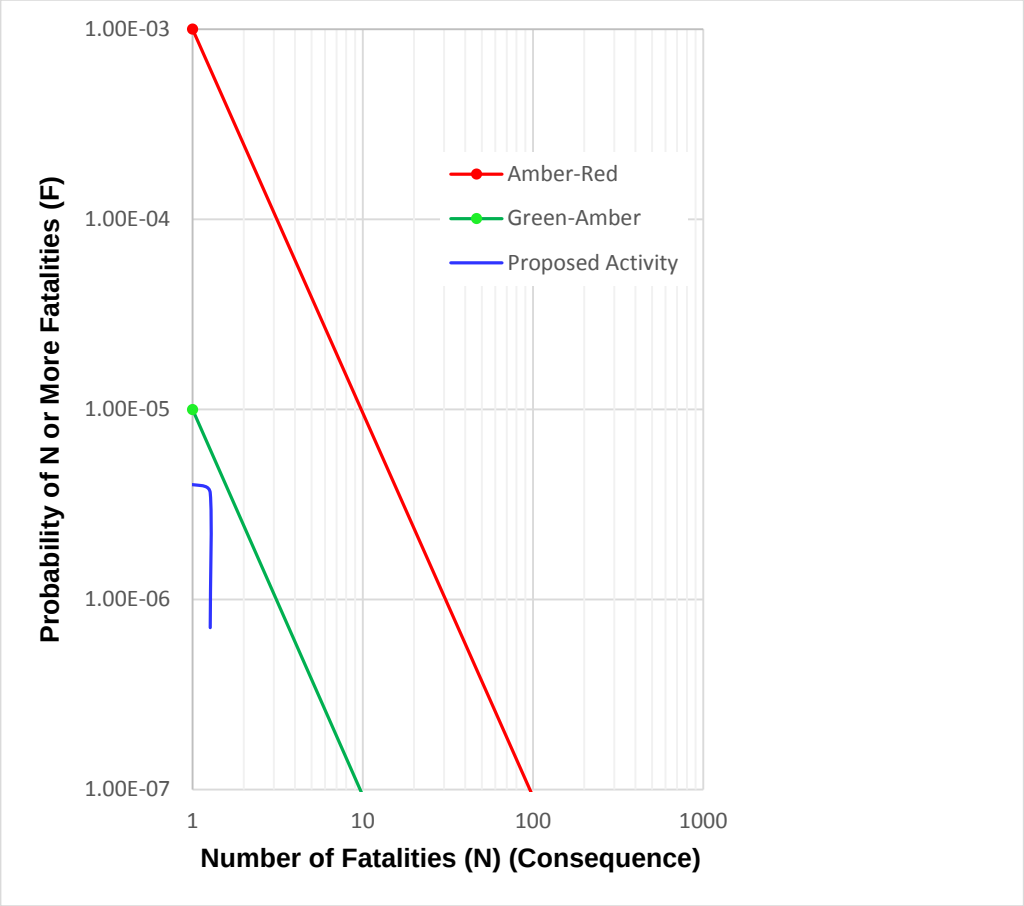


Figure 2 LFC product trucking public fatality F-N curve 70 trucks per day to Phillips 66 Station

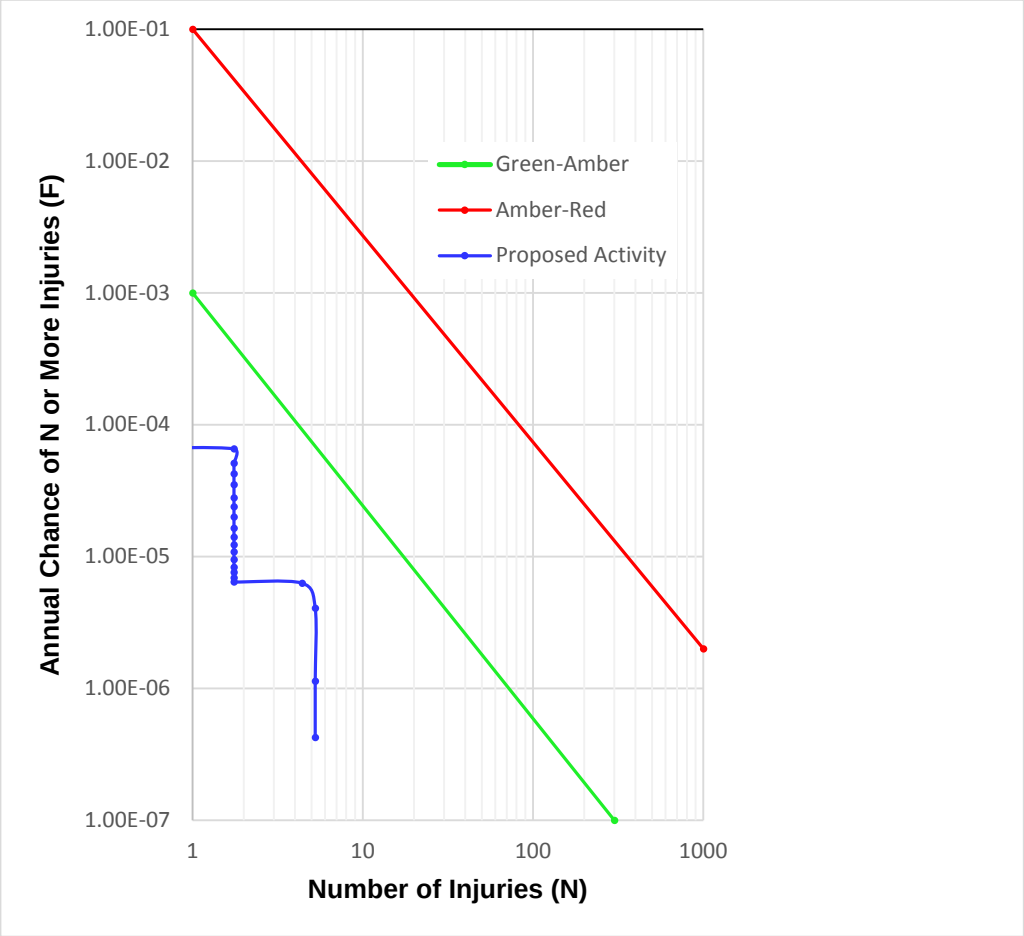


Figure 3 LFC product trucking public injury F-N curve 70 trucks per day to PAAPL Pentland Station

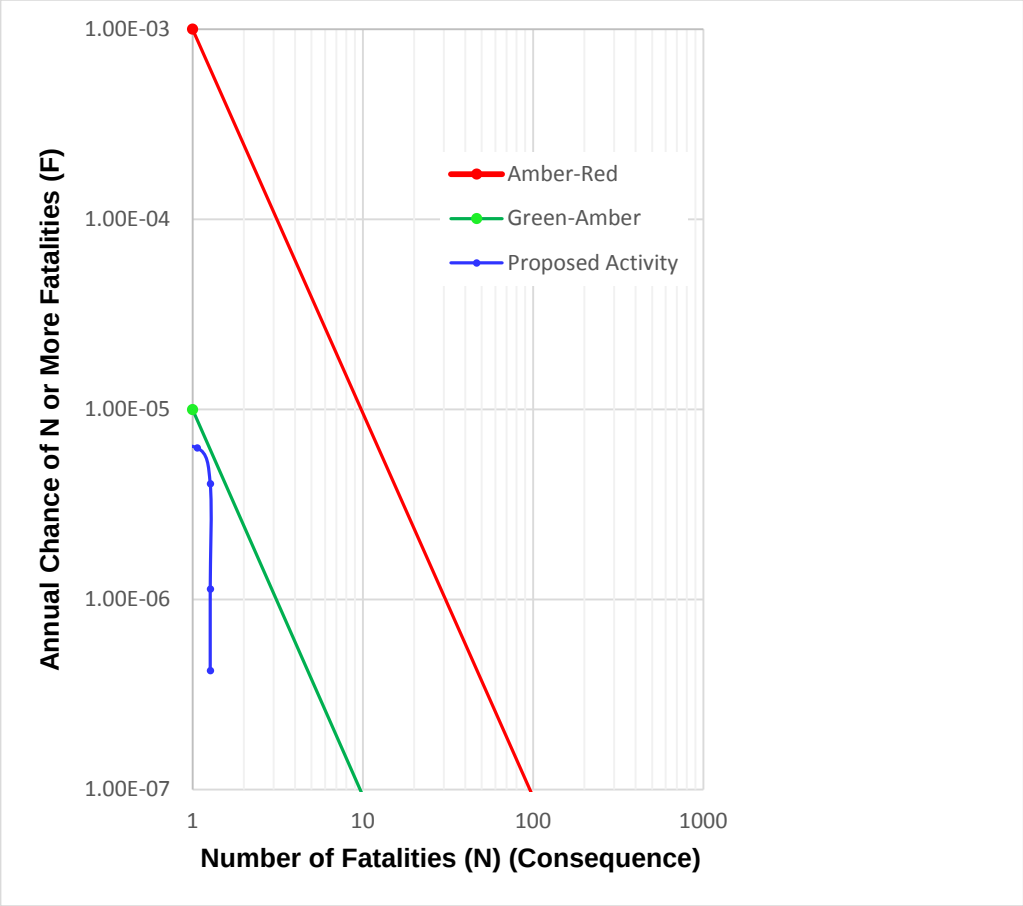


Figure 4 LFC product trucking public fatality F-N curve 70 trucks per day to PAAPL Pentland Station