Appendix C

Risk of Upset Supporting Information

Appendix C.1

Transportation Quantitative Risk Assessment (TQRA)

LAS FLORES CANYON
INTERIM TRUCKING PROJECT

TRANSPORTATION
QUANTITATIVE RISK ASSESSMENT

FEBRUARY 2020

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EXECUTIVE SUMMARY

ExxonMobil Production Company (ExxonMobil) is requesting approval for Interim Trucking to transport Santa Ynez Unit (SYU) processed crude oil from the Las Flores Canyon (LFC) facility to market destinations. The facility is located at 12000 Calle Real, approximately twelve miles west of the city of Goleta.

Since 1993, the Plains All American Pipeline (PAAPL) Lines 901 and 903 have been the only means of transporting crude oil to markets from LFC. Operations at LFC have been temporarily suspended as a result of the PAAPL 901 pipeline incident in May 2015 and subsequent pipeline shutdown. ExxonMobil is seeking a permit to conduct interim crude oil trucking until a transport pipeline becomes available. This will enable limited production to resume at the Santa Ynez Unit.

This Transportation Quantitative Risk Assessment (TQRA) assesses the potential hazardous materials risks to the public from the proposed interim crude oil truck transportation. Limited crude oil production with a maximum of 70 crude oil truck loads per day have been assessed from LFC to two designated unloading stations; Phillips 66 Santa Maria Pump Station, and PAAPL Pentland Pump Station in Maricopa.

ExxonMobil propose to use contract carriers to haul the crude oil. Contractor selection and auditing procedures will ensure the contractor meets or exceeds all applicable health, safety, security, and environmental compliance standards. The Crude Oil Transportation Risk Management & Prevention Program (CO-TRMPP) has been developed to ensure that the interim trucking is conducted in a safe and efficient manner.

Route specific truck accident rates have been developed from an analysis of California accident data. Local influences on accident data associated with road access, road gradients, visibility and weather are therefore inherently included within these route specific accident rates.

The total public risks have been calculated for both proposed truck routes, and the highest risks per one kilometer (0.62 miles) road segment have been identified to assess the acceptability of potential serious injury and fatality risks.

The significance of risk has been assessed utilizing the Santa Barbara County (SBC) Risk Profile. The thresholds for acceptable risk to the public are defined by the SBC Risk Criteria in three zones; green, amber and red. The mitigated risks are within the following zones of acceptability for both proposed truck routes:

- Mitigated risk of serious injury profile is within the green “Insignificant Risk” zone for acceptability.
- Mitigated risk of fatality profile is within the green “Insignificant Risk” zone for acceptability.

1. INTRODUCTION

1.1 Background

ExxonMobil Production Company (ExxonMobil) is requesting approval for Interim Trucking to transport Santa Ynez Unit (SYU) processed crude oil from the Las Flores Canyon (LFC) facility to market destinations. The facility is located at 12000 Calle Real, approximately twelve miles west of the city of Goleta.

Since 1993, the Plains All American Pipeline (PAAPL) Lines 901 and 903 have been the only means of transporting crude oil to markets from LFC. Operations at LFC have been temporarily suspended as a result of the PAAPL 901 pipeline incident in May 2015 and subsequent pipeline shutdown. ExxonMobil is seeking a permit to conduct interim crude oil trucking until a transport pipeline becomes available. This will enable limited production to resume at the Santa Ynez Unit.

The proposed interim crude oil truck transportation is subject to discretionary land-use permits and environmental review by Santa Barbara County (SBC). This includes the analysis of potential public exposure to acute risks associated with significant quantities of hazardous materials. ExxonMobil has requested that Dixon Risk Consulting (DRC) conduct a Transportation Quantitative Risk Assessment (TQRA) to assess the significance of risks to the public associated with truck transportation of crude oil from LFC to proposed unloading facilities.

1.2 Scope of Work

This TQRA assesses the potential hazardous materials risks to the public from the proposed interim crude oil truck transportation. The following activities have been assessed:

- Limited crude oil production with a maximum of 70 crude oil truck loads per day, at 160 barrels per load. During operations, one or both locations may be utilized for crude oil delivery on any day, totaling 70 trucks a day.
- Transportation routes have been assessed from LFC to two designated unloading stations; Phillips 66 Santa Maria Pump Station, and PAAPL Pentland Pump Station in Maricopa.
- Route specific truck accidents rates on public roads have been utilized to calculate incident rates and societal risk.

The public risks of a hazardous material release have been assessed for the transportation of crude oil from LFC to the designated unloading facilities. The total public risks have been calculated for both truck routes. The highest risks per one kilometer (0.62 miles) road segment have been identified to assess the acceptability of potential serious injury and fatality risks.

The significance of risk has been assessed utilizing the Santa Barbara County (SBC) Risk Profile[24]. The thresholds for acceptable risk of serious injury or fatality to the public are as defined by the SBC Risk Criteria. The County has published thresholds of acceptability in order to determine the significance of impacts in a consistent manner.

Within this report, an accident is defined as an event that occurs when a vehicle is involved in a collision. The terms accident, collision and crash have been used interchangeably. An incident is defined as a release of crude oil that may occur as a result of a tanker truck collision, or a truck failure of containment in transit.

1.3 Transportation Quantitative Risk Assessment Methodology

Transportation Quantitative Risk Assessment is an established methodology to quantify the risk of a potential incident by estimating the likelihood and consequence of the event. The risk of serious injury or fatality has been assessed using the following steps:

- Evaluation of proposed truck routes for road characteristics.
- Quantify traffic volumes along the proposed routes.
- Development of accident frequencies utilizing California accident data and published national accident data.
- Estimate the probability of release, size of release, and ignition.
- Determine the consequences and potential impact of a crude oil release.
- Combine the likelihood and consequences of a release to calculate the societal risk for the highest one kilometer segment, and present as a risk profile.
- Quantify mitigation measures to minimize the risk.
- Assess the significance of risk of serious injury or fatality against the SBC Risk Profile Criteria.

TQRA provides an estimate of the risks, which tends to err on the side of conservatism. The approach was to make reasonable assumptions on the likelihood and severity of an incident, and the potential impact of a hazardous material release. In the process of TQRA, numerous assumptions must be made based on best available information. Where appropriate, sources of these assumptions, estimates and reasoning have been described.

2. LAS FLORES CANYON CRUDE OIL TRANSPORTATION

2.1 Project Description

The Santa Ynez Unit facility is located in Las Flores Canyon, approximately twelve miles west of Goleta. The facility processes crude oil from the offshore platforms; Hondo, Harmony and Heritage, with an average density of about 19 degrees API gravity. Production is currently suspended as a result of the PAAPL 901 pipeline incident in May 2015, and subsequent pipeline shutdown.

Under the LFC Interim Trucking proposal, SYU will operate at a production level of approximately 10,000 to 12,000 barrels of oil per day. This will be transported to markets using no more than seventy crude transport truck trips per day.

Trucks will travel from LFC to one or both of two designated offsite locations; Phillips 66 Santa Maria Pump Station in Santa Barbara County, and Plains Pentland Pump Station in Kern County. These designated facilities are currently permitted to handle this type of crude transport truck unloading and have the equipment and capacity to accommodate the expected number of trucks for the LFC interim trucking.

Two transport truck scenarios have been assessed for the TQRA. In Scenario 1, all of the trucks will load product at LFC and travel to the Phillips 66 Pump Station in Santa Maria for unloading. In Scenario 2, all the trucks will load product at LFC and travel to the Pentland PAAPL Station in Maricopa for unloading. In actual operation, trucks could deliver product to one or the other or both of the two facilities on a given day. For risk calculation purposes, after unloading, it has been assumed the trucks return directly back to LFC to reload.

The following average daily laden truck traffic is proposed:

Scenario 1 to Phillips 66 Pump Station in Santa Maria

- Maximum number of trucks = 70 per day
- Maximum volume of product per truck = 160 barrels (bbls)
- Annual number of truck trips = 70 x 365 = 25,550
- Total distance to Phillips 66 = 54.3 miles

Scenario 2 to Pentland PAAPL Station in Maricopa

- Maximum number of trucks = 68 per day
- Maximum volume of product per truck = 160 barrels (bbls)
- Annual number of truck trips = 68 x 365 = 24,820
- Total distance to Pentland PAAPL = 140.0 miles

All trucks entering and leaving the LFC facility would use the Refugio Road junction for access to United States Highway (US) 101. Trucks will be routed northbound from LFC and utilize US 101 and State Route (SR) 166. The following roadways will be utilized:

Destination Facility	Facility Address	Roadways
Phillips 66 Santa Maria Pump Station	1580 East Battles Road, Santa Maria, CA 93454	- LFC facility interior road - Corral Canyon Road - Calle Real Road - Refugio Road - Highway US 101 to Santa Maria - E. Betteravia Road - Rosemary Road - E. Battles Road to Phillips 66
Plains All American Pipeline Pentland Pump Station	2311 Basic School Road, Maricopa, CA 93252	- LFC facility interior road - Corral Canyon Road - Calle Real Road - Refugio Road - Highway US 101 to Santa Maria - Highway SR 166 (Santa Maria to Maricopa) - Basic School Road to PAAPL

The location of the LFC facility and proposed trucking routes are shown on Figure 2.1, and described below in Section 2.3.

2.2 Truck Descriptions

Crude oil will be transported by selected contract carriers that meet or exceed all regulatory requirements and safety standards. Trucks will have 2017 or newer engines, and will incorporate safety controls and complete inspections and oversight prior to leaving LFC.

Crude oil will be transported by cargo trucks designed to comply with US Department of Transport (DOT) 406 or DOT 407 specifications in 160 barrel loads. These trucks are designed according to construction requirements for cargo tank motor vehicles specifications in the Code of Federal Regulations (CFR), 49 CFR 178.346 and 178.347. These regulations prescribe the requirements for packaging and containers used in the transportation of hazardous materials. DOT 406/407 tank trucks are constructed of stainless steel or aluminum steel. Typical design parameters are as follows:

DOT 406 Trucks

- Atmospheric pressure tank, Maximum Allowable Working Pressure (MAWP) = 3 psig
- Single shell with wall thickness 0.188 to 0.25 inches
- Oval shaped cross section
- Flat or nearly flat tank ends

DOT 407 Trucks

- Low pressure cargo tank, MAWP up to 40 psig
- May be double shell with insulation
- Circular cross section
- Rounded tank ends

The cargo tank may be divided into compartments by internal bulkheads, which reduces the movement of liquid during the road trip. The inlet/outlet valves are self-closing stop valves which are located within the tank to provide protection from damage in the event of a collision.

ExxonMobil propose to use contract carriers to haul the crude oil. Contractor selection and auditing procedures will ensure the contractor meets or exceeds all applicable health, safety, security, and environmental compliance standards. The Crude Oil Transportation Risk Management & Prevention Program (CO-TRMPP) has been developed to ensure that the interim trucking is conducted in a safe and efficient manner, including:

- LFC operations personnel will conduct a safety and operability inspection checklist of trucks prior to loading and prior to transport from LFC to verify proper operation and no leaks.
- During loading both the ExxonMobil operator and the truck driver will be in attendance at all times.
- As required by SBC regulations, the Lease Automatic Custody Transfer (LACT) unit will incorporate a grounding/overfill protection system. Truck loading will stop in the case of an interrupted ground or determination of high truck level.
- Trucks will be equipped with an operating speed monitoring system.
- An annual inspection of truck transport trailers will be conducted to verify all ports are sealing properly, and repair any leaking ports prior to use.

2.3 Truck Route Descriptions

The proposed truck routes were surveyed by driving the routes and completing a form to describe the type of road, distances, and road conditions that may impact the transportation risk. The routes were divided into segments with similar characteristics, for example; the number of lanes, divided/undivided road, number of interchanges, the density of housing/businesses, how traffic feeds onto the road, passing lanes, visibility and topography. The proposed transportation routes are described below, and the road segments to each proposed truck unloading station shown on Figure 2.1. Facility access roads from LFC to highway US 101, and roads to the designated pump stations are shown on Figures 2.2, 2.3 and 2.4.

Highways may be classified as a freeway or expressway, depending on the type of access controls. A freeway will have road access at designated locations with on and off ramps. An expressway will have intersections that are not controlled by an on or off-ramp. US 101 is a divided freeway. At some locations along US 101, the freeway designation is changed on some rural sections to allow access to properties. SR 166 is a 2-lane undivided arterial highway with no road access controls.

Truck route segments were classified according to the definitions described in Table 2.1, and listed in Tables 2.2 and 2.3.

Scenarios 1 and 2 – LFC to Santa Maria via Highway US 101

Both proposed truck routes use the same roads from LFC to Santa Maria via highway US 101. The route to Phillips 66 Terminal in Santa Maria exits the highway at the Betteravia Road junction. The route to Pentland PAAPL Terminal continues north through Santa Maria, and exits US 101 onto SR 166 east.

The route to Santa Maria is approximately 52.4 miles in length, and has been divided into 10 segments, designated A through J. Trucks will follow the main LFC plant road to the front gate on Calle Real. Calle Real from the LFC facility to US 101 is a rural 2-lane road. The road passes ranchland, and accesses the US 101 at Refugio State Beach area. All trucks entering and leaving the LFC facility will access US 101 at the Refugio Road junction, as shown on Figure 2.2.

Highway US 101 is a four-lane divided freeway in populated areas from Refugio Road junction to Betteravia Road junction. In some rural areas, the freeway designation is changed to allow access to properties and rural roads. The route initially travels west parallel to the Pacific Ocean, with state beaches to the south and primarily ranchland to the north of the road. At Gaviota, the road turns north over Gaviota State Park. The road passes a rest area, a short tunnel, and a winding section over the hills. North of the junction with State Route 1, the highway goes across gently rolling hills, past ranchland and scattered farms to the small town of Buellton. North of Buellton to Santa Maria, the highway passes through gently rolling hills, ranchland, vineyards, and the small town of Los Alamos. In Santa Maria, the road widens to a 6-lane divided highway.

Scenario 1 - Highway US 101 to Phillips 66 Terminal in Santa Maria

For scenario 1, trucks exit US 101 at Betteravia Road, and travel 1.9 miles to Phillips 66 Terminal. The total route from LFC is approximately 54.3 miles in length, and has been divided into 13 segments, designated A to M.

Betteravia Road east of US 101 is a 2-lane arterial road used for access to agricultural and oil production areas. For a short section, the road has four lanes to provide access to the truck stop and service stations. The truck route uses Betteravia Road for about 1.0 miles, then turns north onto Rosemary Road, then west onto Battles Road to the Phillips 66 Terminal. Rosemary Road and Battles Road are 2-lane collector roads that serve mostly agricultural and oil production areas. The route segments are defined in Table 2.1 and shown on Figures 2.1 and 2.3.

Scenario 2 - Highway US 101 to Pentland PAAPL Terminal in Maricopa

For scenario 2, trucks continue north on US 101 through Santa Maria and exit US 101 east onto SR 166. The total route from LFC to Pentland PAAPL Terminal in Maricopa is approximately 140.0 miles in length, and has been divided into a total of 20 segments, designated A to J and N to W.

State Route 166 is a 2-lane undivided arterial highway. The road passes across the Sierra Madre Mountains. The route is rural with some ranch and farm land in the Cuyama River Valley, and passes through the small rural town of New Cuyama. SR 166 combines with SR 33 for a 13.7 mile section up to the town of Maricopa, where the highways separate. As SR 166/SR 33 passes down the mountains into the San Joaquin Valley, the gradient is 4 to 7%, and slow truck passing lanes are provided. After Maricopa, SR 166 continues east through mainly flat land with oil development and rural areas to Basic School Road and the Pentland PAAPL Terminal. The route segments are defined in Tables 2.1 and 2.2, and shown on Figures 2.1 and 2.4.

2.4 Average Daily Traffic

Average annual daily traffic (AADT) is the primary measure used to evaluate traffic volumes for regional highways. Average daily traffic is measured by the California Department of Transportation(26) (CalTrans) on a sampling basis, and the numbers adjusted for total annual volumes divided by 365 days. These are published annually by CalTrans for vehicles and trucks. This data was obtained for the years 2012 through 2016, and used to calculate an average volume by route segment. The calculated average vehicle and truck AADTs are shown in Tables 3.2 and 3.3.

Potential traffic impacts on local roads associated with the Project have been assessed for existing and future traffic conditions in a separate study by Associated Transportation Engineers (ATE) January 2018(2). The traffic counts were used to estimate current accident rates for non-highway roads, and project future traffic with the addition of potential traffic due to the interim truck project as shown in Tables 3.2 and 3.3.

2.5 Population Densities

The public population primarily at risk from a crude oil release will be those involved in a vehicle collision, or a vehicle stopped on the road due to a collision. There is also the potential for public impact to those in buildings and outdoors in areas adjacent to the road.

The population density has been assessed along the proposed transportation routes by driving the routes and review of aerial photographs. The density has been assigned to a category for each road segment, based on population categories published in the ADL NGL report (1990)(1) and the TNO Green Book(7). These categories are described in Table 2.4, and have been assigned for each transportation road segment as shown in Tables 2.1 through 2.3.

The population present at night will not be the same as during the day for commercial or industrial areas. The population densities listed in Table 2.4 are day time averages, and have been adjusted for night time densities as listed below. The distribution of people indoors and outdoors also varies depending on the population category, and whether it is day or night. Population distributions have been estimated from those published in the TNO Green Book(7) as follows:

Day:	100% of population listed in Table 2.4
Night:	100% present in housing areas
	20% present in industrial areas
	5% present in commercial and agricultural areas

Day:	80% indoors, 20% outdoors in all areas except, 20% indoors, 80% outdoors in agricultural areas
Night:	95% indoors, 5% outdoors

Populations adjacent to the road will not be evenly distributed. Within an area that may be impacted by a hazardous material release, several people may be exposed, whereas other areas may be empty. To account for uneven distribution, residential densities have been grouped into three persons in close proximity, which is the average occupancy of a house. Industrial and commercial areas are assumed to have six people in close proximity.

The LFC facility is not accessible to the public; therefore, there is virtually no potential for public exposure to any hazards that occur within the LFC facility boundaries. The public population on-site is assumed to be zero.

2.6 Weather Data

In the event of a crude oil release during transportation, a flammable vapor cloud and/or fire may occur. To characterize these hazards, two meteorological conditions have been selected to represent worst case and more typical conditions. A worst case of “F” stability and 1.5 meters per second wind speed represents low wind speed during the night when flammable vapors may accumulate. A more typical case of “D” stability and 4 meters per second wind speed represents average weather conditions during the day and part of the night hours. Weather data from the Santa Maria airport station has been used to estimate the following:

Stability Class	Wind Speed	Percent Occurrence
F	1.5 m/s (3.5 mph)	35 %
D	4 m/s (9 mph)	65 %

Figure 2.1 Map of Truck Route Segments

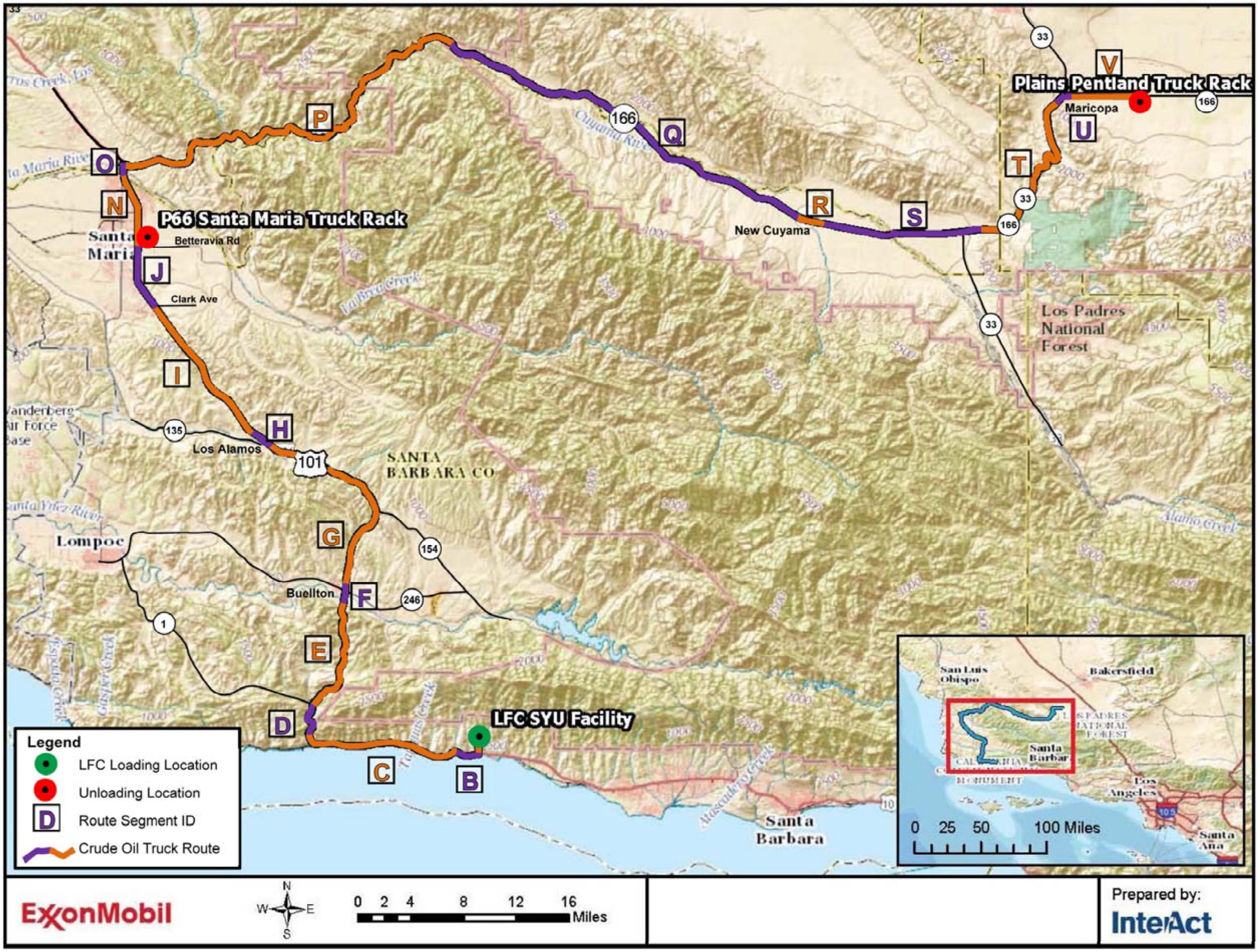


Figure 2.2 Map of Las Flores Canyon Access Road Segments

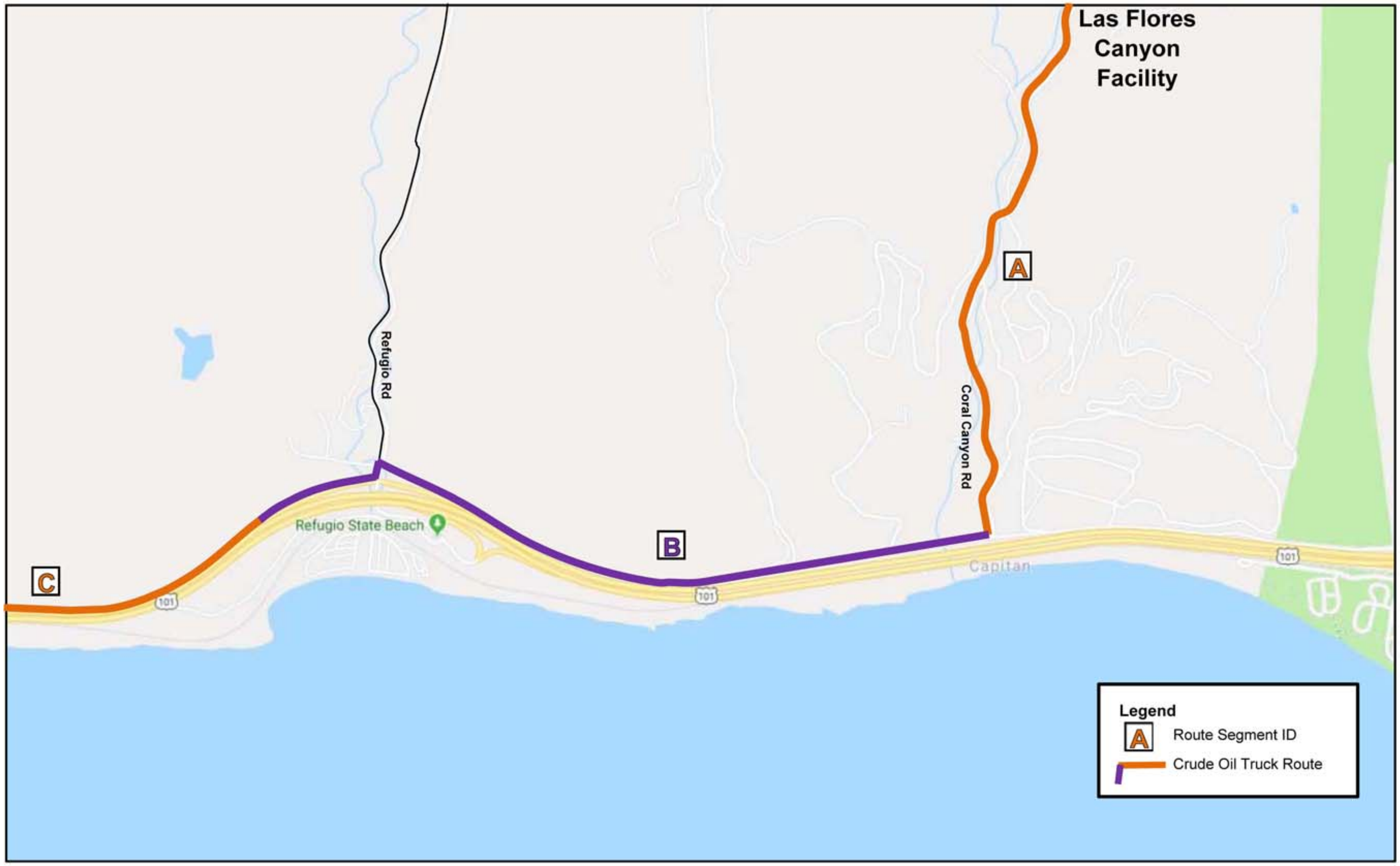


Figure 2.3 Map of Phillips 66 Terminal Access Road Segments

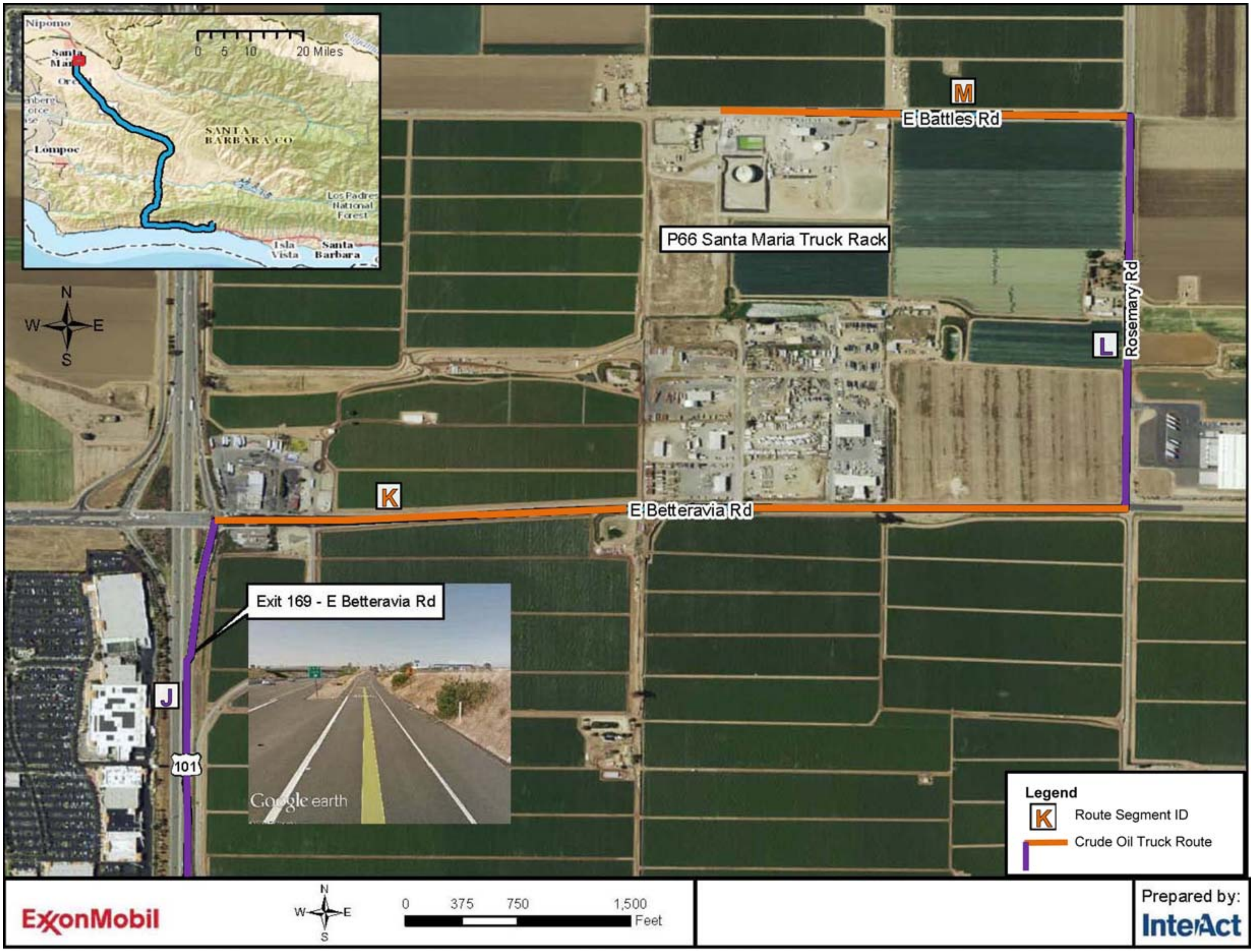


Figure 2.4 Map of Pentland PAAPL Terminal Access Road Segments

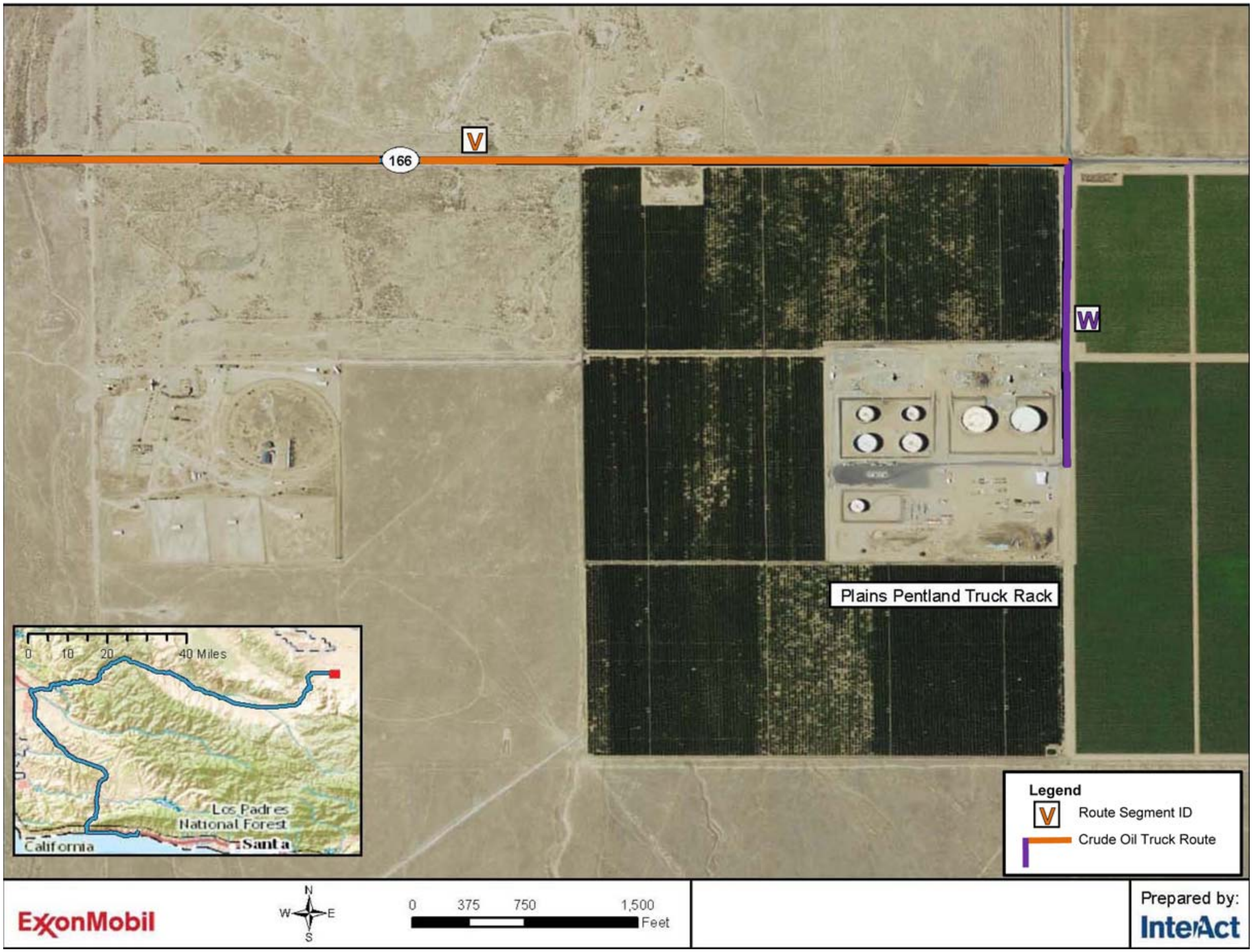


Table 2.1 Road Type Classifications

Road Type	ID	Description
Urban	U	Urbanized areas and small urban areas designated by the Bureau of the Census as having a population of five thousand (5,000) or more.
Rural	R	Rural areas comprise the areas outside the boundaries of small urban and urbanized areas.
Local	L	Local roads provide primary access to residential areas, businesses, farms, and other local areas. Posted speed limits are usually between 20 and 45 mph.
Collector	C	Collectors are major and minor roads that connect local roads and streets with arterials. Posted speed limits are usually between 35 and 55 mph.
Arterial	A	Arterials are major through roads that carry large volumes of traffic. Arterials are often divided into major and minor arterials.
Freeway	F	Limited access roads that provide largely uninterrupted travel, often using partial or full access control.
Divided Road	Di	Road with division barrier or separation between directions of travel.
Undivided Road	Un	Road without division barrier or separation between directions of travel.

Table 2.2 Route 1 – Road Segments from LFC to Phillips 66 Terminal in Santa Maria

ID	H'Way / Road	Section		Length (miles)	Lanes (both ways)	Road Type*	Population Category**	Population Density per mile^2	Description
		From	To						
A	Coral Canyon	LFC Loading Area	LFC Exit	0.8	2	RLUn	Non-public road	0	LFC internal road through rural canyon.
B	Calle Real	LFC Exit	Jct Refugio Rd / US 101 J-120	1.6	2	RCUn	Rural	20	Collector road to freeway junction. Access to ranches and beaches.
C	US 101	Jct Refugio Rd / US 101 J-120	Gaviota Rest Area	10.2	4	RFDi	Rural / Rec	30	Freeway parallel to the pacific ocean, with beaches / 25% recreation areas to the south and ranchland to the north.
D	US 101	Gaviota Rest Area	Jct US 101/SR 1, End State Park	2.1	4	RFDi	UnPop	2	Freeway across the hills of Gaviota State Park. Some steep sections and winding road.
E	US 101	Jct US 101/SR 1, End State Park	US 101 J-139, start Buellton	7.6	4	RFDi	Rural	20	Gently rolling hills, ranchland and scattered farms.
F	US 101	US 101 J-139, start Buellton	US 101 J-140B, end Buellton	1.1	4	UFDi	Mixed-L	1,000	Small town of Buellton, population approx 5,000. Mixed commercial and housing, with good setbacks from freeway.
G	US 101	US 101 J-140B, end Buellton	Start Los Alamos area	12.8	4	RFDi	Rural	20	Gently rolling hills, ranchland and vineyards.
H	US 101	Start Los Alamos area	End Los Alamos area	1.2	4	RFDi	Mixed-L	1,000	Los Alamos, small rural town of less than 2,000. Mixed commercial and housing adjacent to freeway.
I	US 101	End Los Alamos area	US 101 J-165 Clark Ave	10.6	4	RFDi	Rural	20	Gently rolling hills, ranchland and vineyards.

Table 2.2 Route 1 – Road Segments from LFC to Phillips 66 Terminal in Santa Maria

ID	H'Way / Road	Section		Length (miles)	Lanes (both ways)	Road Type*	Population Category**	Population Density per mile^2	Description
		From	To						
J	US 101	US 101 J-165 Clark Ave	US 101 J-169 / Betteravia Rd	4.4	4 / 6	UFDi	Mixed-M / Ag	2,100	Urban freeway through the town of Santa Maria. Mainly level, with good visibility. Mixed housing and commercial to west of freeway, agricultural to east.
K	Betteravia	US 101 J-169 / Betteravia Rd	Jct Betteravia / Rosemary	1.0	2	UCUn	Com-L / Ag	600	2-lane arterial road serves mainly agricultural areas. Short 4-lane section to the east of US 101 junction, provides access to truck stop and service stations.
L/M	Rosemary / Battles	Jct Betteravia / Rosemary	Rosemary Rd, Battles Rd and P66 Entrance	0.9	2	RCUn	Ag / Rural	110	Mainly agricultural area. Rosemary Rd is a 2-lane collector road. Battles Rd is a rural road with traffic mainly to the Phlilps 66 facility.
Route Length (miles)				**54.3**					

* Road Types defined in Table 2.1
** Population Density categories defined in Table 2.4

Table 2.3 Route 2 – Road Segments from LFC to Pentland PAAPL Terminal in Kern County

ID	H'Way / Road	Section		Length (miles)	Lanes (both ways)	Road Type*	Population Category**	Population Density per mile^2	Description
		From	To						
Segments A through J described in Route 1 Table 2.2.									
N	US 101	US 101 J-169 / Betteravia Rd	Start Santa Maria River Bridge	4.4	6	UFDi	Mixed-M	4,000	Urban freeway through the town of Santa Maria. Mainly level with good visibility. Mixed housing and commercial.
O	US 101	Start Santa Maria River Bridge	Jct US 101 / SR 166 East	0.8	6	UFDi	UnPop	2	6-lane divided highway bridge across the Santa Maria River area. Unpopulated canyon.
P	SR 166	Jct US 101 / SR 166 East	Start of Cuyama River Valley	28.3	2	RAUn	Rural / UnPop	11	Rural arterial highway across hills. Winding road, scattered ranches.
Q	SR 166	Start of Cuyama River Valley	Start of town New Cuyama	23.7	2	RAUn	Rural	20	Rural arterial highway through Cuyama River Valley. Farms and ranchland.
R	SR 166	Start of town New Cuyama	End of town New Cuyama	1.1	3	RAUn	Res-L	1,000	Small rural town of New Cuyama, population about 500, surrounded by farmland.
S	SR 166 / 33	End of town New Cuyama	End Cuyama Valley, start of hills	11.2	2	RAUn	Rural	20	Rural arterial highway through Cuyama River Valley. Farms and ranchland.
T	SR 166 / 33	End Cuyama Valley, start of hills	Start of town Maricopa	11.7	2/3/4	RAUn	UnPop	2	Rural arterial highway across hills. Winding road, with steep sections of 4 to 7% gradient. Mainly undeveloped.
U	SR 166 / 33	Start of town Maricopa	End of town Maricopa	1.3	2	RAUn	Res-M	3,000	Small rural town of Maricopa, population 1150. Speed limits 45 / 35 mph, junction with stop sign in town.
V	SR 166	End of town Maricopa	Jct SR 166 / Basic School	4.7	3	RAUn	Rural	20	Oil development, scattered homes and some farms.

Table 2.3 Route 2 – Road Segments from LFC to Pentland PAAPL Terminal in Kern County

ID	H'Way / Road	Section		Length (miles)	Lanes (both ways)	Road Type*	Population Category**	Population Density per mile²	Description
		From	To						
W	Basic School Rd	Jct SR 166 / Basic School	Entrance to PAAPL facility	0.4	4	RAUn	Rural	20	Oil development and farm areas.
Route Length (miles)				**140.0**					

* Road Types defined in Table 2.1
** Population Density categories defined in Table 2.4

Table 2.4 Population Density Categories

Code / Category	Description	Population Density (per square mile)
Com-H - Commercial – High	Office buildings and shopping areas in a town center	10,000
Com-M Commercial – Medium	Office buildings and shopping areas with space surrounding the buildings	5,000
Com-L Commercial – Low	Scattered buildings	1,000
Res-H Residential – High	Busy residential area with a number of multi-family homes	10,000
Res-M Residential – Medium	Quiet residential, single family homes	3,000
Res-L Residential – Low	Scattered housing, semi-rural	1,000
Mixed-H Mixed Use - High	Mix of office buildings, commercial and multi-family homes	10,000
Mixed-M Mixed Use - Medium	Mix of office buildings, commercial and single family homes	4,000
Mixed-L Mixed Use - Low	Scattered buildings	1,000
Ind-M Industrial - Medium	One and two story buildings with industrial facilities surrounding offices	2,000
Ind-L Industrial - Low	Scattered industrial facilities with low density offices	1,000
Ag Agricultural	Cultivated Fields	200
Rec Recreation	Average beach and camp-site areas	100
Rural	Ranchland / Low density oil development	20
UnPop Unpopulated	Undeveloped land, forest or hills	2

3. ACCIDENT / INCIDENT FREQUENCY

The likelihoods of a truck accident have been calculated from published national and state data. Route specific accident rates have been developed where possible, and compared to state and national accident data. In the event of an accident and hazardous material release, a serious injury or fatality to the public may occur.

The terms "accident" and "crash" have been used interchangeably for a vehicle collision. The term "incident" has been used to describe a release of hazardous material, which may occur as the result of a vehicle collision, or a cargo containment failure.

Produced SYU crude oil is classified as hazardous materials (HM) according to the Code of Federal Regulations (49CFR). Hazardous materials are classified into 9 material classes as defined in Table 3.1. Crude oil is classified as a Class 3 Hazardous Material (HM-3), which includes flammable and combustible liquids. This classification system is used within the published incident databases described below.

3.1 Truck and Vehicle Accident Data

Truck accident rates are reported in published data as vehicle miles traveled and are typically quoted per million vehicle miles, or per 10^6 miles (MVMT). Reported accident rates range from 0.32 to 14 accidents per million vehicle miles[11][20] depending on accident reporting threshold, road type, collision speed, and type of vehicle. Truck and vehicle accident rates are affected by specific road conditions, such as; traffic density, urban or rural routes, and divided or undivided highway. An assessment has been made of California accident data, national accident databases, and published accident rates, to develop route specific truck accident rates.

3.1.1 California Accident Data

Accidents that occur on California public roads are recorded by the California Highway Patrol (CHP) in the California Statewide Integrated Traffic Record System (SWITRS). The database serves as a means to collect and process data gathered from a collision scene, and is submitted by city and county jurisdictions. This includes data on the accident location, vehicle types, occupants, level of injury, number of injuries, and cause of the accident.

The SWITRS data is categorized by five levels of severity by the highest level of resulting injury:

- Fatality involved accident,
- Severe injury accident,
- Visible injury accident,
- Pain injury accident, and
- Property Damage Only (PDO) collisions.

Raw data was obtained for the five year period 2012 through 2016[4] in order to develop accident rates by road segment. Data from all of California was analyzed to obtain average state vehicle and truck accident data. This included over 2 million accident records, and over 100,000 truck accidents. Accident data from 3 counties, and 3 municipalities were extracted to identify accidents that occurred over the 5 year period on proposed truck routes. These accidents were then categorized by road segment to calculate the accident rate for vehicles and trucks by segment.

The accuracy of the data is subject to reporting levels of the law enforcement agencies supplying the collision reports. The accident reporting threshold used by the CHP is $500 property damage or personal injury. However, some municipalities follow different reporting thresholds, and may report only tow-away crashes, or crashes with damage of greater than $1,000. The CHP estimates that it receives collision reports from municipalities for approximately 100% of fatal accidents, 90% of injury accidents and 40% of property damage only accidents. A review of SWITRS data collection by the Highway Safety Information System (HSIS) office[21] found that accidents are mostly reported accurately by the Highway Patrol, which respond to freeway accidents (urban and rural), and rural roads outside municipalities. Some municipalities were not as consistent with accident reporting. Accidents occurring on route segments analyzed for this TQRA are primarily within the CHP jurisdiction, and are therefore likely to be reported accurately.

3.1.2 National Accident Data

The two primary Federal crash data sets are the Fatality Analysis Reporting System (FARS) and the General Estimates System (GES) databases. Trucks are identified in each but lack details on the type of truck and cargo.

The **Fatal Accident Reporting System (FARS)** is a census of all motor vehicles in fatal accidents on public roads in which at least one person has died. FARS is maintained by the National Highway Traffic Safety Administration (NHTSA) of the U.S. Department of Transportation (DOT) and the data is obtained from police reports, driver records, vehicle records, and death certificates. FARS is recognized by government agencies and analysts as the most reliable national crash database. A large truck is defined in FARS as a truck with a gross vehicle weight rating (GVWR) of more than 10,000 pounds.

The **Trucks Involved in Fatal Accidents (TIFA)** database is managed by the University of Michigan Transportation Research Institute (UMTRI). Large truck accident data is extracted from FARS, and supplemental data on the crashes are collected by a survey. The TIFA data collection protocol is based on a telephone survey of the motor carrier, driver, dispatcher, or safety director of the truck involved in the crash, as well as the reporting officer, and is considered highly reliable.

The **General Estimates System (GES)** is also maintained by the NHTSA, and is a nationally representative sample of police-reported fatal, injury, and property-damage-only crashes. The categories of injury, and property-damage-only crashes are the same as for the California SWITRS data. GES estimates are subject to sampling error for injury and PDO crashes, but provide data consistent with California data. National estimates of million vehicle miles travelled are also provided for vehicles and trucks. The GES definition of a large truck is the same as the FARS definition.

The **Motor Carrier Management Information System (MCMIS)** crash file is maintained by the Federal Motor Carrier Safety Administration (FMCSA), and submitted by the States from data extracted from police accident reports. A MCMIS reportable crash must involve a truck (a vehicle designed, used, or maintained primarily for carrying property that has at least two axles and six tires) or a bus. The crash must result in at least one fatality, or one injury which requires immediate attention at a medical facility, or one disabled vehicle that is towed from the scene. The MCMIS crash file is a useful source of information on hazardous materials transportation accidents, although not all data is accurately completed and the reporting criteria are different from the FARS, GES and California data. A review by the Hazardous Material Cooperative Research Program (HMCRP) in 2009(27) estimated the reporting rate was about 80%.

The **Hazardous Materials Incident Reporting System (HMIRS)** is maintained by the Pipeline and Hazardous Materials Safety Administration (PHMSA) of the DOT. All carriers of hazardous materials by road, rail, water, or air must fill out a DOT Form and submit it to PHMSA within 30 days of a reportable hazmat incident that results in a release of any quantity of hazardous material. The reportable incident could occur during loading/unloading, while in transit, or while in temporary storage when traveling between the hazmat shipment origin and its final destination. The database is a useful source of information on hazmat releases during transportation, and casualties resulting from exposure to the hazardous material. Prior to 1998, only interstate carriers were required to report hazardous material incidents, and few non-release reports are filed when there is damage to the hazmat container which does not result in a release. Incidents are self-reported by carriers, although PHMSA staff may contact the carrier and request clarification of the information they receive, and all injuries and fatalities are validated to determine if they were caused by a hazardous material release.

The definitions of injury and the level of reporting are not consistent between the state and various national databases, which may explain some inconsistencies in reported accident rates. However, a fatality accident is likely to be reported and is not subject to interpretation by the authority reporting on the accident.

3.1.3 Hazardous Materials Truck Accident Data

A study on the comparative risks of hazardous materials (HM) and non-HM transportation was conducted by Battelle for the FMCSA in 2001(11). The study calculated the risks associated with each category of hazardous material and analyzed data from the HMIRS database, and the MCMIS accident database. Events were analyzed that involved the transportation of hazardous materials that may or may not have resulted in the release of a hazardous material.

In the 2001 FMCSA study, truck accident rates were developed for HM and non-HM truck transportation. HM shipments constituted approximately 5% of the total truck mileage, and ranged in the type of materials carried from perfumes to explosives. HM Class 3 (HM-3) includes flammable and combustible materials, the bulk of which was gasoline transported in cargo tanks. SYU crude oil transported from the LFC will be HM Class 3 materials. It was reported in the 2001 FMCSA study that 52% of the HM vehicles carried Class 3 flammable and combustible liquids, and represented 56% of all of the impacts (1391 accidents). The accident rates were calculated as follows:

- Non-HM truck accident rate = 0.73 per million vehicle miles
- HM truck accident rate = 0.32 per million vehicle miles
- HM Class 3 cargo trucks = 0.5 per million vehicle miles

The truck accident rates quoted are for accidents included in the MCMIS database, which include fatalities, significant injuries and tow-away accidents. The resulting accident rates are therefore lower than those reported in the California SWITRS and GES databases that have different injury and property damage reporting levels. However, the FMCSA data indicates that trucks carrying hazardous materials have an average accident rate of less than half non-HM trucks, and Class 3 cargo trucks an average accident rate about 30% lower than non-HM trucks.

The average truck accident rates reported in the California SWITRS and GES databases do not account for the added safety of HM trucks as identified in the 2001 FMCSA study. The drivers of trucks carrying hazardous materials are required to have more training and experience than the average truck driver. Therefore, for the purpose of this study, average truck accident rates have been reduced by a factor of 30% to reflect the greater safety of HM Class 3 cargo truck drivers over non-HM truck drivers.

3.1.4 Truck Accident Data By Road Type

A study conducted by Harwood and Russell in 1992[20] calculated truck accident rates by road type. This study data has been widely used in literature and by analysts to conduct simplified assessments of hazardous material routes, because it provides truck accident data by road class. Harwood demonstrated that road type such as urban or rural, and divided or undivided highway, has a direct influence on the accident rate and severity of an accident. The high density of traffic in an urban area significantly increases the chance of a collision, whereas the accident rate is reduced by a divided, limited access freeway. Hazardous materials release probabilities were also found to be influenced by road type. Accidents that occurred at higher speed in rural areas were found to have a higher release probability due to the higher impact speed. The following accident rates and HazMat release probabilities were reported:

Area	Roadway	Truck Accident Rate per 10^6 vmt	HazMat Release Probability
Rural	Two-lane	2.19	0.086
Rural	Multilane, undivided	4.49	0.081
Rural	Multilane, divided	2.15	0.082
Rural	Freeway (limited access)	0.64	0.090
Urban	Two-lane	8.66	0.069
Urban	Multilane, undivided	13.92	0.055
Urban	Multilane, divided	12.47	0.062
Urban	Freeway (limited access)	2.18	0.062

Reference: Harwood and Russell (1992)[20]

3.2 Accident Fatality, Injury and Damage Rates

3.2.1 National Truck and Vehicle Accident Rates

Truck and vehicle accident data are collected nationally in the FARS and GES data, and reported annually by the FMCSA(15). The crash severity accident rates have been averaged for the five year period of analysis 2012 to 2016 as follows:

Vehicle Type Involved and Year of Data	Accident Rate per Million Vehicle Miles and % of Total			
	Fatal Crashes	Injury Crashes	Property Damage Only Crashes	Total
Trucks 2012 to 2016	0.014	0.312	1.142	1.47
Percent of Total	0.97%	21.3%	77.8%	
Vehicles 2012 to 2016	0.016	1.055	2.542	3.61
Percent of Total	0.46%	29.1%	70.4%	

The accident data shown above is for the number of vehicles involved. The overall truck accident rate is less than half of the rate for all vehicles. This is likely due to the greater training truck drivers receive, and that a larger percent of truck miles occur on highways or rural roads where the accident rate is lower.

The likelihood of a fatality is higher in a crash between a truck and a passenger vehicle than between two passenger vehicles, due to the difference in vehicle weight. However, due to the lower overall accident rate for trucks, the fatality rate for trucks and all vehicles per million vehicle miles has been calculated to be about the same at 0.014 and 0.016 per mvmt for trucks and vehicles respectively.

3.2.2 Reduction in Accident Rates Over 25 Years

Since the 1990's, vehicle and truck accident rates have been significantly reduced by improvements in roads, vehicles and driver awareness. National vehicle and truck accident rates have been published by the FMCSA(15) and show a significant reduction over the 25 year period, as illustrated in Figure 3.1 for fatal accidents. The following changes have been calculated:

Vehicle Type and Year of Data	Accident Rate per Million Vehicle Miles			
	Fatal Crashes	Injury Crashes	Property Damage Only Crashes	Total
Truck 1991	0.029	0.522	1.66	2.21
Truck 2016	0.015	0.381	1.35	1.74
% Reduction	- 50%	- 27%	- 19%	- 21%
All Vehicles 1991	0.025	1.649	3.26	4.94
All Vehicles 2016	0.017	1.267	2.81	4.09
% Reduction	- 35%	- 23%	- 14%	- 17%

For trucks there has been an overall accident rate reduction of 21% since 1991. For fatal crashes, there has been an accident rate reduction of 50%, greater than for all accident types, which may be due to improved passenger vehicle safety equipment.

3.3 California Route Specific Accident Data

Route specific accident rates have been developed by an analysis of five years of California data obtained from the CHP SWITRS database(4), for years 2012 to 2016. This accident data was categorized by road segment for the proposed truck routes from LFC. Local influences on accident data associated with road access, road gradients, visibility and weather are inherently included within these route specific accident rates. Accident rates have been calculated by route segment for vehicles and trucks as shown in Table 3.2 and 3.3.

Traffic volumes on local roads associated with the Project have been assessed for existing and future traffic conditions in the 2018 traffic study by ATE(2). There was insufficient accident data to calculate historical rates for access roads to the LFC site and the two proposed truck unloading terminals. Average vehicle and truck accident rates were therefore used for these segments.

There was insufficient data to develop statistically significant accident rates on short highway segments through small towns. Adjacent highway segments were therefore used to calculate average accident rates for these segments when the road conditions were similar.

Accident rates for HM Class 3 cargo trucks have been estimated by reducing the route specific average truck rates by 30%, as discussed in Section 3.1.3. The calculated vehicle and truck accident rates by route section are shown in Tables 3.2 and 3.3, and summarized as follows:

Scenario	Description	Vehicle Accident Rate per 10^6 miles	HM Class 3 Truck Accident Rate per 10^6 miles	HM Class 3 Truck Accident Rate per laden trip
1	LFC to Phillips 66 Santa Maria Pump Station via US 101	0.80	0.32	1.8×10^{-5}
2	LFC to PAAPL Pentland Pump Station via US 101 and SR 166	0.95	0.38	5.4×10^{-5}

3.4 Causes of Truck Collisions

A review has been conducted on the causes of truck collisions using published truck accident studies and collision data. This data has then been used to identify the types of accidents more likely to result in a hazardous material spill, identify potential mitigation measures, and quantify the benefit in terms of risk reduction.

California accident data includes vehicle information and the primary collision factor. Truck accident data, for the latest 5 years available, has been grouped into critical events for the years 2011 to 2015, as shown in Table 3.4.

The Large Truck Crash Causation Study (LTCCS)[17] was designed as a one-time study to analyze crash causes and contributing factors. The study was undertaken jointly by FMCSA and NHTSA, utilizing a representative sample of nearly 1,000 injury and fatal crashes involving large trucks that occurred between April 2001 and December 2003. The Report to Congress was published in 2006[17]. The accidents selected were of a greater severity than other national crash databases, and included 23% fatality and 29% incapacitating injury severity levels. The LTCCS critical accident events have been compared to those reported in the California SWITRS data shown in Table 3.4 and summarized as follows:

Primary Collision Factor	CA SWITRS Data 2011 to 2015		LTCCS
	Injuries and Fatalities per year	**%**	**Serious Injury and Fatality %**
Truck Loss of Control	1067	19%	16%
Truck Out of Lane or Unsafe Move	654	12%	18%
Truck Improper Turning or Crossing Intersection	467	8%	6%
Other	280	5%	16%
Truck Driver Not Assigned Fault	3187	56%	45%
Total	5655	100%	100%

The primary collision factor due to truck driver action or inaction totals approximately 50% of injury or fatality collisions.

3.5 Accident Spill Probabilities

A public hazard may occur due to a vehicle collision that causes a rupture or leak of the tanker truck. The likelihood of a release has been calculated from a review of published reports and hazardous materials truck accident data.

The release probability, given an accident, is reported by Harwood[20] to be between 5% and 9%, depending on the speed of the accident. A review of transportation data by Arthur D. Little in 1990[1] reported a conditional probability of a large spill from a gasoline truck as 7%, given a reportable accident.

Five years of accident data (2012 to 2016) reported in the MCMIS database[15] have been analyzed for truck crashes involving hazardous material cargo. Hazardous materials are classified by cargo type, accident severity, and if a release occurred. Class 3 flammable and combustible liquids make up about 49% of the HM accidents and 54% of the HM release incidents. For HM Class 3 liquid cargo trucks, the following release probabilities have been calculated:

- Fatal accidents = 40% probability of release
- Serious injury or tow-away accidents = 15% probability of release

The MCMIS data includes injury and PDO accidents for only those accidents which require immediate medical attention or a tow-away. Less severe accidents, which are less likely to result in a release, are included in the California SWITRS data used for this TQRA. A comparison of accident reporting rates between databases found that only 36% of the accidents included in the GES and SWITRS data are included in the MCMIS hazardous materials data. A correction factor has been applied to estimate the following accident release probabilities for California reporting categories:

- Fatal accidents = 40% probability of release
- Injury or PDO reported accidents = 5% probability of release

The average spill probability for a reportable accident is lower than reported by Harwood[20] in 1992, and ADL[1] in 1990. The introduction of DOT 406/407 truck designs in 1993 have enhanced container integrity over the older MC 306/307 designs, and the use of truck roll stability systems may have also contributed to the reduced frequency of rollover events.

An analysis of the spill probability due to cargo tank rollovers was conducted by Battelle for the FMCSA 2005 study[14]. It was found that cargo tanks are vulnerable to a spill on rollover. Spills were reported to occur in 66% of the rollovers, which makes rollover prevention an important factor in minimizing the risk of a hazardous material release.

An analysis has been conducted of hazardous material releases recorded in the HMIRS database for the years 1991 to 2015. Releases of hazardous material may be associated with a vehicle collision event, or a non-collision event. Non-collision releases were due to equipment failure, human error, or inadequate maintenance. Releases of less than 10% of the tank contents were categorized as “small”. The following in-transit crude oil releases were identified:

Release Type	In-Transit Crude Oil Releases 1991 to 2015						
	Number of Releases	%	Small	Average Size S	Medium / Large	Average Size M/L
Non-Collision	70	21%	64	1 bbl	6	86 bbl
Vehicle Collision	257	79%	122	4 bbl	135	109 bbl
Total	327	100%	186 (57%)	3 bbl	141 (43%)	108 bbl

As shown in the table above, non-collision events were identified as the cause of 21% of crude oil releases. These were primarily small releases due to overfilling, equipment failure, or failure to properly close valves/dome. Six larger non-collision releases occurred which were due to equipment failure in transit. Release sizes were categorized as being 43% medium/large, and 57% small.

A study of LPG road transportation by ADL in 1990[(1)] reported a similar release size distribution, with large spills occurring in 35 to 45% of releases. Non-collision release events were also estimated to occur in about 20% of releases for LPG transportation.

Based on the analysis of crude oil releases reported in the HMIRS database, the accident release probabilities have been increased by 20% to account for non-collision related releases in-transit. Representative spills sizes for all types of releases have been selected as:

- 40% large 160 barrels
- 60% small 16 barrels

3.6 Hazardous Material Ignition Probabilities

The HMIRS database has been analyzed to develop ignition probabilities for a release of crude oil. Gasoline has been included in the table below for comparison purposes. The following crude and gasoline releases and fires were identified over the twenty-five year period 1991 to 2015:

Release Material	Release Size	Releases In-Transit 1991 to 2015		
		Number of Releases	Number of Fires	Ignition %
Crude Oil	Small	186	3	2%
Crude Oil	Medium + Large	141	23	17%
Gasoline	Small	509	15	3%
Gasoline	Medium + Large	857	237	28%
Total		1693	278	16%

The ignition probability for a HM Class 3 release has been reported as 15% by the FMCSA[(11)]. The source data was taken from spills reported in 1996, and is consistent with the average ignition probability identified above for 25 years of HMIRS data.

The probability of ignition is higher for larger spills due to the release being more likely to encounter an ignition source. A review of crude oil releases in the HMIRS database found only 3 out of 186 small releases had ignited. An ignition rate 2% ignition has been selected for a small crude oil release, and 20% ignition has been conservatively selected for a large crude oil release.

- 20% ignition large release
- 2% ignition small release

3.7 Exposure to a Hazardous Material Release

In a tanker truck collision, the primary cause of injury or fatality is due to the force of the collision, not a release of hazardous material. However, a single crash of a hazardous material truck in a crowded area has the potential for deaths and injuries beyond the vehicle occupants.

A release of any quantity of hazardous material must be reported to the PHMSA, and recorded in the HMIRS database. The report includes information on injuries and fatalities due to exposure to a hazardous material release. A search was performed of the HMIRS database to identify casualties due to exposure to crude oil and gasoline releases for the period 1991 to 2015:

Release Material	Releases In-Transit 1991 to 2015					
	Employee Casualty Incidents			Public Casualty Incidents		
	Fatality	Serious Injury	Non-Hospital Injury	Fatality	Serious Injury	Non-Hospital Injury
Crude Oil	4	2	0	1	1	0
Gasoline	106	43	12	12	7	10
Total Incidents	110	45	12	13	8	10
Total Casualties	111	46	13	26	12	13

All fatalities were due to vehicle occupants being trapped and exposed to fire. Public fatalities were associated with occupants of other vehicles involved in a collision, or occupants of a vehicle near the collision. For example, in 1993 an incident occurred when a gasoline truck was hit by a train, and 5 occupants of 3 other vehicles were killed in the fire.

The probability of public fatality due to a release and crude oil fire is 1 in 26 fires, or 4%. The probability of public fatality in a gasoline fire is 12 in 252 fires, or 5%. The probability of fatality in a gasoline fire is statistically more significant than the one crude oil incident, and the hazards of a fire are similar for each hazardous material. A 5% probability of fatality has therefore been assumed for crude oil.

There were fewer serious public injuries reported due to an in-transit hazardous material fire than fatalities. This may be due to under reporting of public injuries by the carrier companies submitting the reports. All fatalities are likely to be reported and investigated by PHMSA staff, but burn injuries may not have been reported if other trauma injuries also occurred.

Due to the likely underreporting of injuries, an assumption has been made that the injury rate is approximately twice that of the fatality rate. The probabilities of a public casualty incident have been estimated for a crude oil release as follows

- large ignited release: 5% fatality event 10% injury event
- small ignited release: 2% fatality event 5% injury event

The number fatalities that have occurred in a crude oil or gasoline truck fire ranged from 1 to 5, with an average of 2 public fatalities per incident. According to the DOT Bureau of Transportation Statistics, the average vehicle occupancy is 1.6 for all roads, and about 1.2 on highways. The distribution of public casualty numbers in each incident has been estimated as follows:

Number of Public Casualties per Incident	Probability
5	4%
4	6%
3	10%
2	20%
1	60%

3.8 Unladen Truck Trips

A laden truck has the potential to release up to 160 barrels of crude oil, which if ignited may result in casualties to on-road or off-road populations. There is also the potential for hazards associated with a small release from an unladen truck.

Unladen trucks typically contain small quantities of oil as residue in the tank, and within the loading lines and hoses underneath the truck. The product piping is known the “wetlines”, and may contain up to 50 gallons of oil. If these lines fail, or are impacted due to a vehicle collision, there may be a small release of crude oil. A review was conducted of historical failures associated with below tank product piping recorded in the PHMSA HMIRS database.

There were a total of 327 crude oil releases in transit recorded in the HMIRS database between 1991 and 2015. Approximately 60% (186 releases) were small releases with an average release size of 3 barrels (126 gallons), as described in Section 3.5 above. From incident descriptions, the following 28 small releases were identified as being associated with a wetline failure:

Wetline Release Cause 1991 to 2015	Number of Incidents	Number of Fires
Other vehicle impact with wetlines	8	0
Rollover event – due to collision or avoiding another vehicle	2	0
Rollover event – due to driver loss of control on a curve	2	0
Non-collision event – equipment failure (e.g. hose, fittings, tire burst or other equipment impacting wetlines)	16	0
Total	28	0

There have been no wetline incidents on crude oil trucks that resulted in fire, injury or fatality in the 25 year period reviewed. There is, however, a small public risk if a wetline release ignited after a vehicle collision. An ignition probability of 2% has been estimated for a small crude oil release, as discussed in Section 3.6. On average, there may be 1 ignited release for every 50 small crude oil releases.

A review was also conducted of the HMIRS database for small ignited releases from gasoline trucks that may be associated with a wetline release. The probability of ignition of a small gasoline release is higher than for a small crude oil release, and due to a greater number of gasoline trucks on the road, the number of historical incidents is higher. There were 509 small gasoline releases over the 25 year period. Of these, 2 were identified as being releases from wetlines during a vehicle collision that ignited causing public fatality.

Using the HMIRS gasoline wetline incident frequency, an estimate has been made of the likelihood of a crude oil wetline incident for the proposed LFC temporary trucking. On Route-1, a casualty associated with wetlines may occur approximately every 30,000 years. On Route-2, a casualty may occur approximately every 10,000 years.

A search was conducted of historical crude oil unladen incidents recorded in the HMIRS database. One of the 28 crude oil wetline release incidents occurred when the truck was empty on the return journey. In another 4 incidents, there was insufficient data in the report to determine if the truck was laden or unladen, and 23 incidents occurred when the truck was laden. The risks associated with the unladen truck trip are very low, and for the TQRA analysis, all historical release incidents have been assumed to occur when the truck is laden.

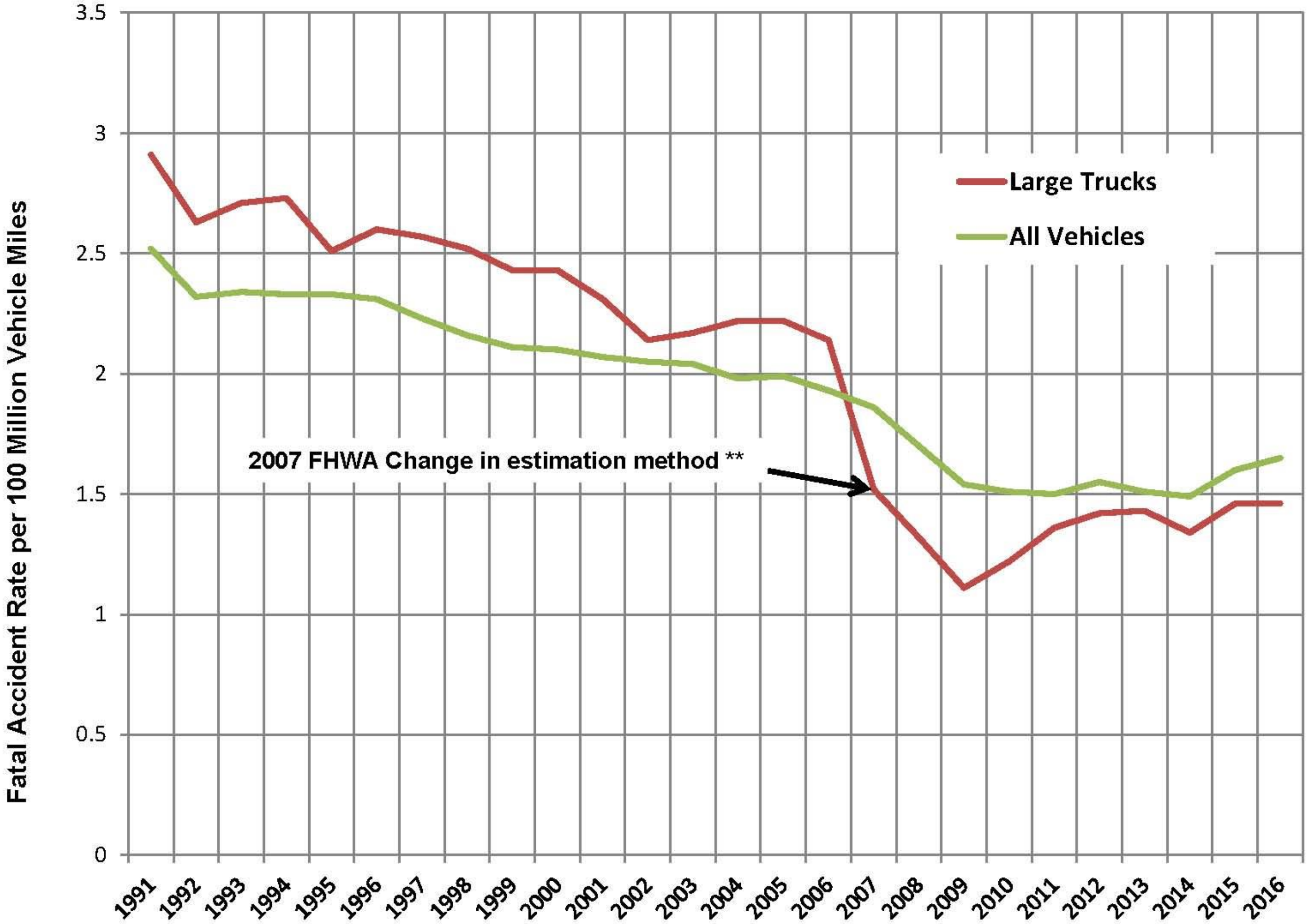
The assumption that all historical incidents occurred during the laden trip results in an overestimate in the likelihood of failure on the laden truck trip in order to include any risk associated with the unladen return journey.

Table 3.1 Hazardous Material Classifications

Hazardous Class Code	Description
Class 1	Explosives
Class 2	Gases
Class 3	Flammable and combustible liquids (includes crude oil, gasoline, diesel and petroleum distillates.
Class 4	Flammable solids, spontaneously combustible materials and dangerous when wet materials
Class 5	Oxidizers and organic peroxides
Class 6	Toxic (poison) materials and infectious substances
Class 7	Radioactive materials
Class 8	Corrosive materials
Class 9	Miscellaneous dangerous goods

Defined in Code of Federal Regulations (CFR) 49

Figure 3.1 Trends in Truck and Vehicle Fatal Accident Rates



The estimation of million vehicle miles traveled (mvmt) is done annually by the Federal Highway Administration (FHWA)[(15)] using the number of registered vehicles. This data is used together with the number of fatal crashes to estimate accident rates per mvmt for different types of vehicles.

** In 2007, the FHWA implemented an enhanced methodology for estimating vehicle miles traveled. This resulted in a 22% increase in the large truck vehicle miles estimate, and no significant change to the estimate of passenger vehicle miles. The apparent reduction in large truck accident rate from 2006 to 2007 is therefore due to the change in calculation method.

The truck accident rate reduction in 2009, is also an anomoly in the calculation method. The number of vehicle miles traveled is based on the number of large trucks registered. The financial crash in 2008/9 caused a significant reduction in commerce, and therefore the number of miles traveled per vehicle. This was not accounted for in the calculation of large truck vehicle miles.

Table 3.2 Route 1 - LFC to Phillips 66 in Santa Maria, Vehicle and Truck Accident Rates

ID	H'Way /Road	Section		Vehicle AADT	Truck AADT	% Trucks on Segment	Accident Rate per Vehicle Involved per 10^6 miles	Accident Rate per Truck Involved per 10^6 miles	HM Class 3 Truck Accident Rate per 10^6 miles
		From / To	Length (miles)						
A	Coral Canyon	LFC Loading Area to LFC Exit	0.8	400	140	35%	2.4 *	1.0 *	0.72 *
B	Calle Real	LFC Exit to Jct Refugio Rd / US 101	1.6	320	144	45%	2.4 *	1.0 *	0.72 *
C	US 101	Jct Refugio Rd / US 101 to Gaviota Rest Area	10.2	29,600	3,200	11%	0.7	0.53	0.37
D	US 101	Gaviota Rest Area to Jct US 101/SR 1	2.1	29,600	3,200	11%	3.1	1.12	0.79
E	US 101	Jct US 101/SR 1 to start Buellton	7.6	23,100	2,800	12%	1.2	0.50	0.35
F	US 101	Start Buellton to End Buellton	1.1	21,900	2,800	13%	0.9	0.58	0.24 **
G	US 101	End Buellton to Start Los Alamos area	12.8	27,800	3,300	12%	0.5	0.23	0.16
H	US 101	Start Los Alamos to End Los Alamos	1.2	29,510	3,600	12%	0.5	0.13	0.21 **
I	US 101	End Los Alamos to Jct US 101 / Clark Ave	10.6	28,600	3,500	12%	0.6	0.4	0.28
J	US 101	Jct US 101 / Clark Ave to Jct US 101 / Betteravia Rd	4.4	46,200	4,500	10%	0.7	0.38	0.27
K	Betteravia	Jct US 101 / Betteravia to Rosemary Rd	1.0	9,300	2,800	30%	2.4 *	1.0 *	0.72 *

Table 3.2 Route 1 - LFC to Phillips 66 in Santa Maria, Vehicle and Truck Accident Rates

ID	H'Way /Road	Section		Vehicle AADT	Truck AADT	% Trucks on Segment	Accident Rate per Vehicle Involved per 10^6 miles	Accident Rate per Truck Involved per 10^6 miles	HM Class 3 Truck Accident Rate per 10^6 miles
		From / To	Length (miles)						
L/M	Rosemary / Battles	Jct Betteravia / Rosemary to Battles Rd and P66 Entrance	0.9	1,260	410	32%	2.4 *	1.0 *	0.72 *
Total Route		LFC to P66 Santa Maria	**54.3**				**0.80**	**0.46**	**0.32**
Accident Rate per Trip									**1.8×10^{-5}**

AADT = Average Annual Daily Traffic on California Highways, published annually by CalTrans(26)
Truck and Vehicle Accident Rates calculated from 5 years of California accident data extracted by road section (2012 to 2016)(4)

* Average vehicle and truck accident rates used for these short segment due to no historical data not statistically significant.
** Short segment. Data not statistically significant. Adjacent highway segments used to calculate average accident rates.

Table 3.3 Route 2 - LFC to Pentland PAAPL in Maricopa, Vehicle and Truck Accident Rates

ID	H'Way /Road	Section From / To	Section Length (miles)	Vehicle AADT	Truck AADT	% Trucks on Segment	Accident Rate per Vehicle Involved per 10^6 miles	Accident Rate per Truck Involved per 10^6 miles	HM Class 3 Truck Accident Rate per 10^6 miles
Accident rates for Segments A through J shown above in Table 3.2									
N	US 101	Jct US 101 / Betteravia to Start Santa Maria River Bridge	4.4	63,000	6,100	10%	1.6	0.92	0.64
O	US 101	Start Santa Maria River Bridge to Jct US 101 / SR 166 East	0.8	67,000	6,700	10%	1.4	0.92 **	0.64 **
P	SR 166	Jct US 101 / SR 166 to Start of Cuyama River Valley	28.3	3,100	860	27%	1.4	0.61	0.42
Q	SR 166	Start of Cuyama River Valley to New Cuyama	23.7	2,800	670	24%	0.8	0.43	0.3
R	SR 166	Start of New Cuyama to End town New Cuyama	1.1	3,000	670	22%	0.6	0.51	0.36 **
S	SR 166 / 33	End town New Cuyama to End Cuyama Valley, start of hills	11.2	3,100	680	22%	0.8	0.73	0.51
T	SR 166 / 33	Start of hills to Maricopa	11.7	3,600	930	26%	1.4	1.2	0.86
U	SR 166 / 33	Start of Maricopa to End of Maricopa	1.3	3,600	930	26%	0.4 ***	0.55 ***	0.38 ***
V	SR 166	End of Maricopa to Jct SR 166 / Basic School	4.7	2,800	830	30%	1.2	1.2	0.81

Table 3.3 Route 2 - LFC to Pentland PAAPL in Maricopa, Vehicle and Truck Accident Rates

ID	H'Way /Road	Section		Vehicle AADT	Truck AADT	% Trucks on Segment	Accident Rate per Vehicle Involved per 10^6 miles	Accident Rate per Truck Involved per 10^6 miles	HM Class 3 Truck Accident Rate per 10^6 miles
		From / To	Length (miles)						
W	Basic School Rd	Jct SR 166 / Basic School to PAAPL Entrance	0.4	450*	340*	75%	2.4 *	1.0 *	0.72 *
Total Route		LFC to PAAPL	**140.0**				**0.95**	**0.55**	**0.38**
Accident Rate per Trip									**5.4 x 10^{-5}**

AADT = Average Annual Daily Traffic on California Highways, published annually by CalTrans(26)
Truck and Vehicle Accident Rates calculated from 5 years of California accident data extracted by road section (2012 to 2016)(4)

* Average vehicle and truck accident rates for non-highways used on these segments.
** Short segment. Data not statistically significant. Adjacent highway segments used to calculate average accident rates.
*** No truck accidents and only 2 vehicle collisions were recorded in Maricopa during the 5 year period. An average truck accident rate has been assigned to account for possible underreporting.

Table 3.4 Truck Critical Accident Events

Primary Collision Factor	CA SWITRS Data 2011 to 2015				LTCCS
	Fatality Accidents per year	**%**	**Injury Accidents per year**	**%**	**Serious Injury and Fatality %**
Unsafe Speed	21.0	8.5	990	18.8	13.0
Driver Impairment	2.2	0.9	40	0.8	
Vehicle Failure (brakes, tires, etc.)	1.2	0.5	13	0.2	
Total Truck Loss of Control	**24.4**	**9.9**	**1043**	**19.8**	**15.6**
Unsafe Lane Change or Passing	5.0	2.0	378	7.2	
Following Too Closely	0.4	0.2	52	1.0	
Unsafe Move, Parking or Other Violation	6.8	2.7	211	4.0	
Total Truck Out of Lane or Unsafe Move	**12.2**	**4.9**	**641**	**12.2**	**17.7**
Total Truck Improper Turning or Crossing Intersection	**22.4**	**9.1**	**445**	**8.4**	**6**
Other Vehicle in Lane	6.0	2.4	218	4.1	12.8
Pedestrian	3.6	1.5	29	0.6	2.8
Unknown	0.6	0.2	22	0.4	
Total Other	**10.2**	**4.1**	**270**	**5.1**	**15.6**
Truck Driver Not At Fault	**192**	**74**	**2995**	**56**	**45.4**
Total	**261**	**100**	**5394**	**100**	**100**

LTCCS = Large Truck Crash Causation Study[17] by FMCSA and NHTSA, using national truck accident data from April 2001 to December 2003.

4. Consequences of Release

In the event of a crude oil truck road incident, there is the potential for a hazardous material release and fire. The public population primarily at risk from a crude oil release will be those involved in the vehicle collision, or within a vehicle stopped on the road due to the collision. However, a single crash of a hazardous material truck in a crowded area has the potential for deaths and injuries beyond the vehicle occupants. There is the potential for public impact to those in buildings and outdoors along the transportation route.

The hazards of a crude oil release to public populations adjacent to the road are assessed in the following section. Crude oil is flammable and if a release is ignited, it will form a pool fire. If ignition is delayed, a flammable vapor cloud may initially develop, which if ignited, may result in a vapor cloud fire and/or pool fire. The likelihood of casualties to the public adjacent to the road is low because a crude oil pool fire takes time to develop, and those in the vicinity would normally have the ability to escape.

Potential vulnerabilities of the public adjacent to the road have been calculated by applying a probability that a person may suffer serious injury or fatality for a minimum defined exposure to fire.

4.1 Material Properties

Material properties of produced crude oil from the Santa Ynez Unit have been used to conduct hazard consequence modeling. A summary of the crude oil properties are shown in Table 4.1.

The crude oil has an average API gravity of about 19 degrees. It has been assumed that the crude oil is transported at 100^{o}F. On release, light oil fractions in the crude oil will start to evaporate and may produce a vapor cloud. The vapor cloud will be flammable where the concentration is between the lower and upper flammable limits of 1.4% and 7.8%. On ignition of crude oil, the fire will burn with an orange flame and emit dense clouds of black smoke.

4.2 Flammable Release Events

A release of crude oil will result in a flammable cloud. The vapor cloud will then disperse to the lower flammable limit, and may ignite if a source of ignition is encountered.

A release of flammable liquid may result in one or more of several different hazards:

- ♦ Immediate ignition causing a pool fire.
- ♦ Pool evaporation and initial dispersion of a flammable vapor cloud, which on delayed ignition may result in:
  - vapor cloud fire and/or
  - liquid pool fire
- ♦ Release with no ignition

4.3 Consequence Modeling

The methodology for calculating the release rates and hazards of a potential release are described in the following section. Published formulas and publicly available dispersion models have been used for the analysis. These methodologies are expected to provide conservative results.

4.3.1 Pool Evaporation

On release, a liquid will spread to a minimum depth of 1 inch (2.5 centimeters) on a flat non-absorbing surface, such as a road surface. The pool is assumed to spread radially to the maximum area for evaporation. The evaporation rates for SYU crude oil have been calculated using the method as provided in the US Environmental Protection Agency (EPA) RMP Guidance(28) and the EPA Technical Guidance for Hazards Analysis(30).

4.3.2 Vapor Dispersion

A liquid pool is assumed to produce a continuous evaporating cloud. This cloud will disperse downwind to the Lower Flammability Limit (LFL), unless the cloud is ignited.

For flammable vapor dispersion, the EPA and National Oceanic and Atmospheric Administration ALOHA(29) model was used. This is a publicly available model and is widely used for estimating hazard release distances. The heavy gas model in ALOHA is based on a simplified form of the DEGADIS model developed by Spicer and Havens (1989).

4.3.3 Pool Fire Radiation Hazards

Liquid releases from a tank truck were modeled as a circular pool fire with a sooty flame. The soot absorbs radiation and obscures the flame, thereby reducing the thermal radiation. The pool fire model used is based on publicly available correlations described in the TNO Yellow Book(6).

4.4 Levels of Concern and Vulnerability Criteria

The following levels of concern have been selected as minimum exposure levels that may result in a serious injury or fatality. However, personnel exposed to a minimum level of concern are not necessarily seriously or fatally injured. Personnel may be sheltered within vehicles or buildings, or be able to find shelter from exposure. This is called the vulnerability, and is the probability that a person exposed within the distance to a level of concern will suffer a serious injury or fatality.

The thermal radiation exposures are also not at the same intensity within the distance to a level of concern. Closer to the fire, the vulnerability will be higher. Average vulnerabilities have been estimated within the distance to a level of concern.

Vapor Cloud Flash Fire Levels of Concern

A flammable release may be ignited on release or shortly after release if the concentration is within the flammable range between the Lower and Upper Flammability Limits (LFL and UFL). An unignited flammable vapor cloud will drift downwind and start to disperse. The calculated concentration levels are time-averaged. The concentration of vapor in air is not uniform and there will be areas where the concentration is higher or lower than the average.

The duration of a flash fire is short, and those outside the flash fire area are unlikely to be exposed to thermal radiation for sufficient time to cause serious injury. The area of the LFL cloud is assumed to be the hazard zone for potential fatality. The area of 1/2 LFL where a flame may ignite is assumed to be the hazard zone for serious injury.

The following average vulnerability levels have been applied, based on a review of incident reports and assumptions made in published QRA reports:

Severity Level	Flammable Range	Average Vulnerability of People In Buildings	Average Vulnerability of People Outdoors
Potential Fatality	Source to LFL	0.2	0.5
Serious Injury	Source to 1/2 LFL	0.2	0.5

Pool Fire Radiation Levels of Concern

Pool fires produce radiant heat, and the effects are dependent on the level of intensity and the duration of exposure. Thermal radiation levels of 5 kW/m^2 and 10 kW/m^2 correspond approximately to the minimum level for serious injury (second degree burns) and potential fatality.

A crude oil pool fire will typically develop slowly allowing personnel outside the burning area time for escape. Personnel are assumed to be fatalities if they are outside within the pool fire area.

The probability of fatality outdoors has been calculated as 1% for an exposure of 10 kW/m^2 for 30 seconds. This is based on the radiation probit equations published in the TNO Green Book(7). The fatality rate will decease within the distance from the pool fire boundary to the minimum fatality distance. An average vulnerability of 10% has been estimated within this area. The remaining outdoor population within this area may suffer serious injury. Additional serious injuries may also occur between the radiation levels of 10 kW/m^2 to 5 kW/m^2. An average serious injury vulnerability of 20% has been estimated from the pool fire boundary to 5 kW/m^2.

Personnel within buildings have protection from a pool fire and radiant heat. Within the pool fire area, a fatality rate of 50% has been assumed, and the remaining population may suffer serious injury. Buildings provided significant protection from radiant heat, and only those near open window or doors that are unable to escape may suffer casualties.

The following average pool fire vulnerabilities have been applied:

Severity Level	Thermal Radiation Range	Average Vulnerability of People In Buildings	Average Vulnerability of People Outdoors
Potential Fatality	Source to Pool Fire Boundary	0.5	1
Serious Injury	Source to Pool Fire Boundary	0.5	0
Potential Fatality	Pool Fire to 10 kW/m^2	0.01	0.1
Serious Injury	Pool Fire to 5 kW/m^2	0.05	0.2

4.5 Calculation of Hazard Distances

Hazard zones have been calculated to the selected levels of concern using the crude oil properties, release quantities, and typical weather conditions.

The following assumptions were made:

- Two representative weather conditions have been selected for performing the dispersion calculations under worst case and typical conditions; stability F with wind speed 1.5 m/s, and stability D with wind speed 4 m/s.
- Rural conditions have been applied for atmospheric dispersion of vapor clouds.
- Crude oil releases are assumed to spill onto a flat non-absorbing surface, and spread to a depth of 1 inch (2.5 centimeters).
- A vapor cloud is assumed to be fully developed to the maximum area before ignition.
- Pool fire hazard areas have been conservatively calculated using the maximum downwind hazard distance.
- No allowance was made for topography.

The calculated hazard distances and impact areas are shown in Tables 4.2 and 4.3, and consequence model input and output files attached in Appendix C.

4.6 Ignition Probability

A flammable release may ignite immediately resulting in a pool fire, or a flammable vapor cloud may form and disperse downwind. As the cloud encounters ignition sources such as vehicles on the highway, it may ignite causing a vapor cloud fire then pool fire. Historical data on the ignition of flammable releases due to cargo truck accidents have been reviewed to estimate the probability of ignition, as discussed in Section 3.6.

The following ignition probabilities have been estimated for large and small crude oil releases:

- 20% ignition large release
- 2% ignition small release

4.7 Release Event Trees

The likelihood that a tanker truck accident results in a large ignited pool fire has been calculated using event trees, as shown in Figure 4.1. The probabilities for each severity level have been calculated in Section 3 as follows:

Accident Severity	Fraction Occurrence	Release Probability
Fatal Accidents	0.01	0.4
Injury or PDO Accidents	0.99	0.05
All Accidents	1	0.054

The probabilities of the various outcomes of a truck accident are illustrated in Figure 4.1 as follows:

- Large pool fire 0.0043 (0.43%)
- Large unignited spill 0.0173 (1.73%)
- Small pool fire 0.0006 (0.06%)
- Small unignited spill 0.0318 (3.18%)
- No release 0.946 (94.6%)

A large pool fire has the potential to cause injury or fatality if those involved in the accident, or public on an adjacent property, are unable to escape quickly. Fatalities and injuries may extend up to 180 or 240 feet respectively from the release source. Small pool fires are assumed to impact only those on the road.

An analysis of hazardous material releases has been conducted to estimate the probability of public casualties within vehicles on the road, as discussed in Section 3.7. The following casualty probabilities were developed for a crude oil release:

- large ignited release: 5% fatality event 10% injury event
- small ignited release: 2% fatality event 5% injury event

The number of off-road public casualties will depend on the speed of liquid release, the probability of immediate ignition, and the ability of people to escape. The following probabilities have been conservatively assumed from a review of HMIRS accident reports, where sufficient information is provided:

- Rapid liquid release 0.25 (25%)
- Immediate ignition 0.5 (50%)

The predicted number of off-road fire casualties has been estimated using the probability of a large pool fire, half the potential impact area (the other half impacting the road area), and the vulnerability criteria discussed in Section 4.4.

The hazard areas associated with a flammable vapor cloud are significantly smaller than the pool fire hazard areas, as shown in Tables 4.2 and 4.3. A vapor cloud may develop downwind of a release if ignition is delayed. In this case, downwind public persons near the release may be exposed to both a vapor cloud fire then pool fire radiation. There may be a small risk of additional casualties within this area. Conservative pool fire hazard areas have been applied to simplify the calculation process, and compensate for potential vapor cloud fire casualties.

Table 4.1 Crude Oil Properties

Property	Light Crude Oil
Average properties:	
LFL % mol	1.4
UFL % mol	7.8
TVP @ 130°F	2.68 psia
Specific Gravity 60/60	0.940
API Gravity	19
Transportation Temperature	130°F

Table 4.2 Flammable Vapor Dispersion

Release Source	Release Rate / Pool Evaporation Rate (lb/min)	Weather Conditions**	Distance to Flammable Concentration from Release (ft)		Flammable Hazard Areas (ft^2)	
			LFL	1/2 LFL	LFL	1/2 LFL
Large Crude Oil Truck Release – 160 bbls						
Crude Oil Release to pavement	150	F/1.5	130	180	15,000	28,000
	320	D/4	96	150	2,000	4,600
Small Crude Oil Truck Release – 16 bbls						
Crude Oil Release to pavement	15	F/1.5	36	57	850	1,600
	32	D/4	36	51	340	560

** Weather conditions D stability, 4 m/s wind (typical conditions during the day), and F stability 1.5 m/s wind (worst case weather conditions at night).

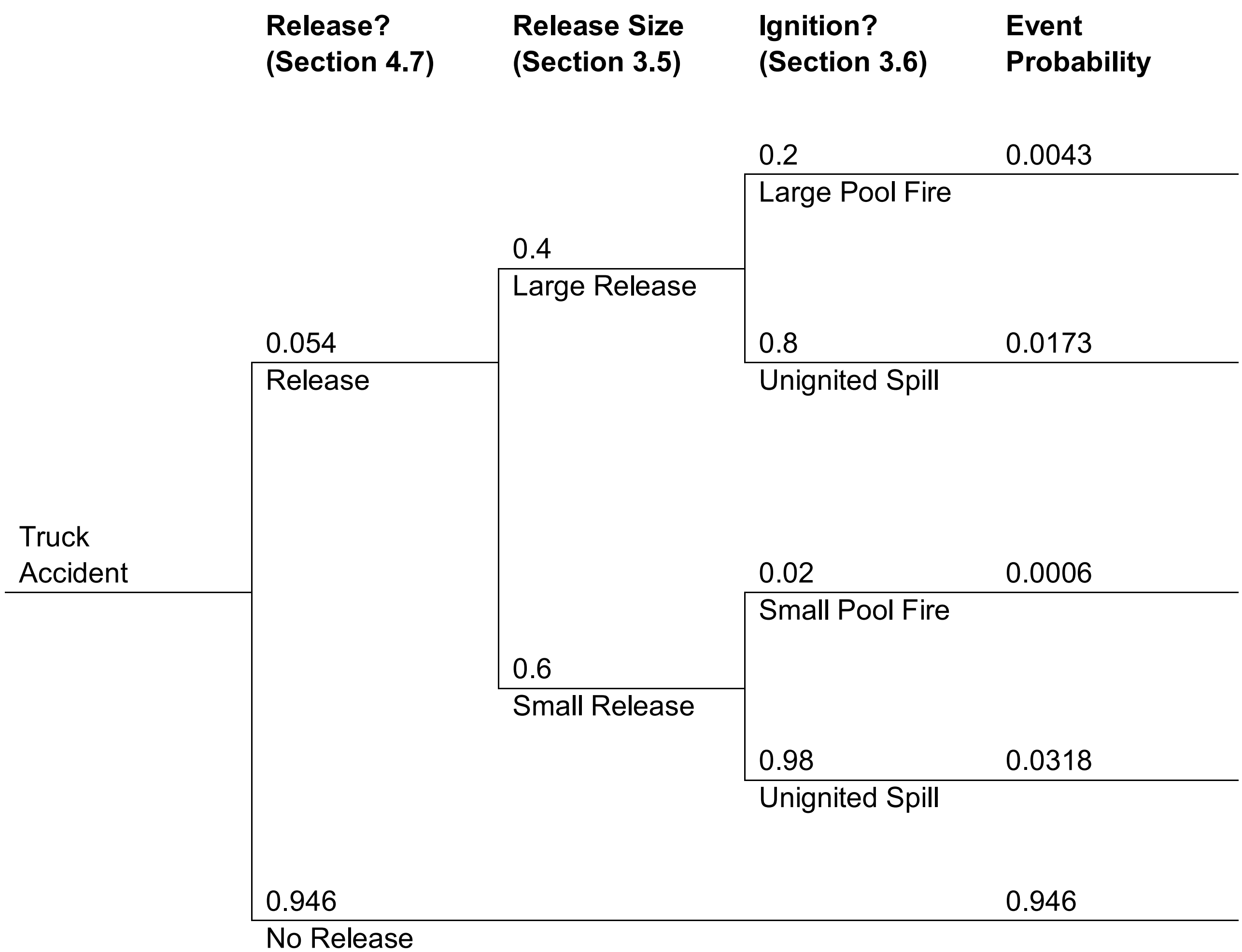
Table 4.3 Fire Radiation Hazards

Release Source	Pool Dimensions	Weather Conditions**	Hazard Distance from Release (ft)		Pool Fire and Radiation Hazard Areas (ft^2)		
			Fatality***	Injury***	Pool Fire	Fatality***	Injury***
Large Crude Oil Truck Release – 160 bbls							
Crude Release	Average depth = 1 inch	F/1.5	110	160	11,000	38,000	80,000
to Pavement	Average radius = 59 ft	D/4	180	240	11,000	100.000	180,000
Small Crude Oil Truck Release – 16 bbls							
Crude Release	Average depth = 1 inch	F/1.5	83	110	1,100	5,400	38,000
to Pavement	Average radius = 19 ft	D/4	110	130	1,100	38,000	53,000

** Weather conditions D stability, 4 m/s wind (typical conditions during the day), and F stability 1.5 m/s wind (worst case weather conditions at night).

*** Pool fire radiation hazards:
Potential fatality = 10 kW/m^2
Potential injury = 5 kW/m^2

Figure 4.1 Event Tree For Truck Accident Release



5. TRUCK HAZARD MITIGATION

The mitigation of hazards associated with truck transportation can be addressed using improved safety culture, driver selection and training, improved vehicle maintenance, and onboard safety systems (OBSS). Modern trucks often feature one or more OBSSs to help the driver mitigate or avoid a crash, and studies have been conducted to quantify the benefits.

Literature has been reviewed to assess the potential effectiveness of improved safety culture and onboard safety systems at reducing the likelihood of a crash and release of a hazardous material. This assessment has been used to quantify proposed mitigation measures for the interim crude oil transportation from LFC.

5.1 Safety Culture

Organizational and safety culture can play an important role in reducing accident rates. For example, an organization with a poor safety culture is more likely to utilize a young driver with little experience. Hazardous material carriers have lower accident rates than the average truck carrier. This is likely due to better safety culture of the hazardous material haulers, increased driver safety training, and the hiring of more experienced drivers. An accident reduction rate of 30% has been applied to the average truck rate for HM Class 3 truck carriers based on a study for the FMCSA, as discussed in Section 3.1.3.

Hazardous material regulations have specific training requirements for drivers transporting hazardous cargo. These include:

- The properties and hazards of the material transported.
- Loading and unloading of materials.
- Vehicle inspection before every trip as well as periodically while on the road.
- Use of vehicle controls and equipment, including operation of emergency equipment.
- Training in vehicle characteristics including those that affect vehicle stability, such as effects of braking and curves, effects of speed on vehicle control, and dangers associated with maneuvering through curves.
- Emergency response training.

Large truck carrier companies currently employ a range of safety programs. This has likely contributed to the steady reduction in truck crash rates. National vehicle and truck accident rates have been published by the FMCSA[15] over a 25 year period, which show a reduction in truck accident rates of about 20% overall, and a 50% reduction in fatality rate, as discussed in Section 3.2.2. This has been attributed to improvements in roads, vehicles and driver training.

5.2 Contractor Selection and Driver Training

Contractor selection and auditing procedures will be used by ExxonMobil to ensure contract carriers meet or exceed all applicable health, safety, security, and environmental compliance standards. Carriers will complete the "Crude Oil - Motor Carrier Safety Survey" prior to starting shipments, as described in the Crude Oil Transportation Risk Management and Prevention Program (CO-TRMPP).

Many of the factors that relate to driver risk, such as; age, experience, training, and driver fatigue, have been researched. The results are published in literature by the FMCSA, Transportation Research Board (TRB), Murray (2005)[(22)], Short (2007)[(25)], and numerous others.

Driver Experience
In the Large Truck Crash Causation Study (LTCCS 2005)[(17)], information was recorded on driver experience. This included the number of years driving a truck, the number of years driving the class of vehicle involved in the crash, and the date and type of driver training. Comparison data on the historical driver performance was used to estimate the value of hiring safe drivers.

Experience driving a large truck is clearly a factor in driver safety. In the LTCCS, driver performance was identified as the critical collision reason in nearly 50% of crashes. This included driver drowsiness, inattention, driving too fast for conditions, and failure to control vehicle. A well trained experienced driver would be expected to have better control of the vehicle in a hazardous situation.

The selection of experienced drivers with a good safety record will reduce the probability of a crash, and provide a reduction in the probability of a truck rollover and hazardous material spill in a collision event. Hazardous material driver training includes rollover prevention awareness. Data from the FMCSA 2007[(10)] rollover study indicates that driver error is a contributing factor in over 75% of rollovers. Drivers who are well trained and experienced are more likely to avoid sudden movements that may lead to rollovers, and control the load during turns. The FMCSA 2007[(10)] study found that drivers with less than 5 years' experience were almost twice as likely to roll the truck in a serious crash, than more experienced drivers. The potential benefit of improved driver training on the likelihood of a crash and rollover was estimated to result in a risk reduction of up to 10% for less experienced drivers.

Driver Fatigue
Truck driver impairment due to drowsiness has been reported to be a contributing factor in approximately 30% of crashes. Truck drivers behind the wheel for more than eight hours are reported to be twice as likely to be involved in a crash[(12)].

Current FMCSA regulations specify Hours of Service (HOS) requirements to reduce the likelihood of driver fatigue. Since 2017, electronic logging devices have been required to monitor HOS. This is assumed to be incorporated within the crash data.

Employment Screening
An analysis by the FMCSA (2013)[18] found that motor carriers utilizing an employment screening program had a decline in crash rates by about 8%. Employment screening is likely to result in the selection of experienced drivers with a good safety record. The selection of a contractor with effective employment screening programs is likely to provide a minimum of an 8% reduction in crash rate.

Collision Risk Reduction for Contractor Selection and Driver Training
Contractor selection and auditing procedures are likely to ensure the carrier contractors exceed all applicable standards, and hire experienced drivers with a good safety record. The risk reduction has been estimated as:

- Collision risk reduction for contractor selection = 10%

5.3 Truck Speed Limiters

Speed limiting technology is a standard feature on new trucks. Speed limiters are devices that interact with a truck engine to prevent trucks from exceeding a pre-programmed maximum speed. Therefore, speed limiters cannot address speeding on roads with speed limits lower than the speed setting, nor ensure the speed limiter is appropriately set.

Traveling too fast for conditions is a major contributor to large truck crashes. The Large Truck Crash Causation Study[17] reported that unsafe truck speed was the critical factor in 13% of all large truck crashes. Truck collision factors for California crash data report unsafe truck speed in 19% of injury or fatality crashes (Table 3.4). However, only 10% all of the speeding events listed in the LTCCS occurred above posted speed limits. A study conducted by the National Highway Traffic Safety Administration (NHTSA) in 1987 found similar results, with only 6.6% of the truck unsafe speed collisions being above the posted speed limit. Most collision events occurred due to driving too fast for conditions.

Truck crash rates published in recent years will include trucks that have speed limiters installed, and the benefit will already be partially incorporated into the base crash rate. The risk reduction for ensuring the appropriate use of truck speed limiters has been estimated as:

- Collision risk reduction 10% of 19% speed initiating events = 1.9%

5.4 Truck Loading / Unloading Procedures

From a review of HMIRS hazardous release incident reports, approximately 20% of in-transit releases are due to non-collision events, as discussed in Section 3.5. About half of these were due to human error such as; overfilling the tank, or failure to properly close valves or secure equipment. The other half were due to equipment failure.

Hazardous material cargo drivers are required to have training for loading / unloading, and conducting a vehicle inspection before every trip. To reduce the likelihood of human error, LFC operations personnel will conduct a safety and operability inspection checklist of trucks prior to loading and prior to transport from LFC to verify proper operation and no leaks occur. During loading both the ExxonMobil operator and the truck driver will be in attendance at all times.

To minimize the risk of overfilling the truck tank, the LACT unit will incorporate a grounding/overfill protection system that will stop the loading process in the case of an interrupted ground or determination of high level.

The application of these safety measures is estimated to reduce the likelihood of human error by about 50% from the average HM cargo industry performance.

- ♦ Non-collision risk reduction: 50% due to human error failure x 50% reduction = 25%

5.5 Vehicle Inspection / Maintenance

From a review of HMIRS hazardous release incident reports, approximately 20% of in-transit releases are due to non-collision events, as discussed in Section 3.5. Approximately half of these were due to equipment failure.

Most carriers are reported to conduct vehicle maintenance every 30 to 90 days, and drivers are required to inspect their vehicle prior to every trip. The use of modern trucks with 2017 or newer diesel engines and regular maintenance will reduce the likelihood of equipment failure.

The use of new trucks with regular maintenance is estimated to reduce the likelihood of equipment failure by about 50% from the average HM cargo industry performance.

- ♦ Non-collision risk reduction: 50% due to equipment failures x 50% reduction = 25%

5.6 Summary of Potential Collision Reduction Systems

The following table summarizes the potential risk reduction of collision related events for each safety program or OBSS assessed.

Safety System	**Crashes Related to Safety System (%)**	**Effectiveness (%)**	**Crash Rate Reduction (%)**
Safety Culture	Risk reduction of 30% for a hazardous material truck incorporated into the HM-3 truck incident rate.		
Contractor Selection and Driver Training	100%	10%	10%
Truck Speed Limiters	19%	10%	1.9%
Total Collision Risk Reduction			**12%**

The following table summarizes the potential risk reduction of non-collision in-transit releases for each safety program:

Safety System	**Non-Collision Related Releases**(%)**	**Effectiveness (%)**	**Release Rate Reduction (%)**
Loading / Unloading Procedures and Overfill Protection	50%	50%	25%
Modern truck fleet with LFC Operations personnel inspection prior to and after loading	50%	50%	25%
Total Non-Collision Risk Reduction			**50%**

** Non-collision related releases account for an additional 20% of the total number of collision events.

6. TRANSPORTATION RISK

The risks associated with transporting LFC crude oil to market by truck have been calculated in terms of the public risk of serious injury or fatality due to exposure to a hazardous material. The acceptability of these risks has been evaluated against the Santa Barbara County societal risk criteria, with the selected mitigation measures applied.

6.1 Truck Routes

Risks have been calculated along transportation routes to two potential unloading terminals. The following transportation scenarios have been assessed:

Scenario 1 to Phillips 66 Pump Station in Santa Maria

- Maximum number of trucks = 70 per day
- Truck route north via US 101 to Santa Maria
- Total distance to Phillips 66 = 54.3 miles

Scenario 2 to Pentland PAAPL Pump Station in Maricopa

- Maximum number of trucks = 68 per day
- Truck route north via US 101 to Santa Maria, then east via SR 166 to Maricopa
- Total distance to Pentland PAAPL = 140.0 miles

Route specific truck accident rates have been developed from an analysis of California accident data. This accident data was categorized by road segment for the proposed crude oil truck routes. Local influences on accident data associated with road access, road gradients, visibility and weather are therefore inherently included within these route specific accident rates. The truck accident rates for each segment are shown in Tables 3.2 and 3.3. Accident rates for Hazardous Material Class 3 cargo trucks have been estimated by reducing the route specific average truck rates by 30% to account for the lower accident rates reported for hazardous material trucks.

The calculated vehicle and truck accident rates by route segment are shown in Tables 3.2 and 3.3, and summarized as follows

Scenario	Description	Vehicle Accident Rate per 10^6 miles	HM Class 3 Truck Accident Rate per 10^6 miles	HM Class 3 Truck Accident Rate per laden trip
1	LFC to Phillips 66 Santa Maria Pump Station via US 101	0.80	0.32	1.8×10^{-5}
2	LFC to PAAPL Pentland Pump Station via US 101 and SR 166	0.95	0.38	5.4×10^{-5}

6.2 Calculation of Societal Risks

Transportation risks have been calculated for the hazards associated with a crude oil release for both on and off-road public populations. The calculation of "Risk" is as follows:

Risk = Likelihood of hazardous event X Probability of serious injury or fatality

The likelihood of a hazardous event has been calculated by multiplying the frequency of release on each road segment, with the probability of the outcome being a fire. The probability of serious injury or fatality in the event of a fire, has been calculated separately for on and off-road populations, then combined to calculate the risk per road segment length. The on-road public risks are primarily to persons within vehicles involved in the accident. Both small and large pool fires may result in on-road casualties due to the close proximity of persons within vehicles and the possibility of being unable to escape. Off-road casualties will depend on the speed of liquid release, the probability of ignition and the ability of people to escape. Only large releases that escalate quickly are assumed to have the potential to impact offsite populations. The population densities along each road segment have been characterized as day or night, and the probability that persons will be within buildings or outside.

In the calculation of potential serious injury and fatality a minimum of one casualty has been assumed. The risk of casualty to less than one person makes no sense; therefore the frequency of impact has been adjusted.

The public risks due to a hazardous material release along the crude oil transportation routes have been calculated for each road segment per one-kilometer (0.62 miles) length, to identify the highest risk segment, and evaluate the risk against the SBC acceptability criteria, as described below. The risk profiles for serious injury and fatality for the proposed interim crude oil transportation are shown as F-N curves in Figures 6.1 and 6.2 for Route 1, and Figures 6.3 and 6.4 for Route 2.

6.3 SBC Societal Risk Criteria

Santa Barbara County requires an assessment of the significance of impacts to public safety associated with an application for a land-use permit. The safety thresholds are intended to measure the acceptability of involuntary public exposure to hazardous materials. Such activities include facilities that handle or transport hazardous materials.

A societal risk profile is required for gas and hazardous liquid pipelines, including oil if a significant risk is expected, and the transport of compressed natural gas or natural gas liquids(23). The risk profiles for acute risk from a crude oil release have been calculated to assess the level of risk as defined the SBC societal risk criteria.

The thresholds for risk acceptability of serious injury or fatality to the public are defined by the SBC societal risk criteria(24). These thresholds provide three zones of significance; green, amber and red, for determining the acceptability of involuntary public exposure to acute hazardous material risks resulting from new or modified developments. The same SBC risk criteria thresholds are applied to fixed facilities and to the highest risk one kilometer (0.62 miles) segment of a transportation route. This effectively makes the level of significant societal risk from a fixed facility equivalent to that of the highest one kilometer segment of road. This is the same approach used to assess acceptability of transportation societal risk as applied in several European countries, and adopted in other countries around the world. The level of significance selected by SBC is 10 times more stringent than the transportation societal risk criteria applied in the Dutch and Swiss criteria.

The three SBC risk criteria zones are defined as follows and shown on the societal risk profiles in Figures 6.1 through 6.8:

- Green: Less than significant impact to public safety and no mitigation (or additional mitigation) is required for purposes of compliance.
- Amber: Potentially significant public impact, which can be reduced or avoided by implementation of mitigation measures.
- Red: Significant public impact, which can be reduced by implementation of mitigation measures.

The Santa Barbara County definition of a “serious injury” is physical harm to a person that requires significant medical intervention.

6.4 Mitigation Measures

ExxonMobil propose to use contract carriers to haul the crude oil. Contractor selection and auditing procedures will ensure the contractor meets or exceeds all applicable health, safety, security, and environmental compliance standards. The Crude Oil Transportation Risk Management & Prevention Program (CO-TRMPP) has been developed to ensure that the interim trucking is conducted in a safe and efficient manner, including:

- LFC operation personnel will conduct a safety and operability inspection checklist of trucks prior to loading and prior to transport from LFC to verify proper operation and no leaks.
- During loading both the ExxonMobil operator and the truck driver will be in attendance at all times.
- As required by SBC regulations, LACT units will incorporate a grounding/overfill protection system. Truck loading will stop in the case of an interrupted ground or determination of high truck level.
- Trucks will be equipped with an operating speed monitoring system.
- An annual inspection of truck transport trailers will be conducted to verify all ports are sealing properly, and repair any leaking ports prior to use.

Proposed mitigation measures to reduce the likelihood of a hazardous material release have been assessed and quantified in Section 5, Truck Hazard Mitigation. The following risk reduction measures have been applied to the truck transportation incident rates to calculate mitigated societal risks.

Mitigation Measure	**Collision Risk Reduction (%)**	**Non-Collision Risk Reduction** (%)**
Contractor Selection and Driver Training	10%	
Truck Speed Limiters	2%	
Loading / Unloading Procedures and Overfill Protection		25%
Modern truck fleet with LFC Operations personnel inspection prior to and after loading		25%
Total	12%	50%

** Non-collision related releases account for an additional 20% of the total number of collision events.

6.5 Mitigated Societal Risk Profiles

The risks of serious injury and fatality to the public due to a crude oil truck transportation incident have been calculated. The mitigated risks of casualty were calculated for on and off-road populations by route segment, then the results combined by segment and total route. A summary of the average route incident rates, frequencies of release and frequencies of casualty for the two proposed routes are shown in Table 6.1.

The mitigated public risks have been calculated for each road segment per one kilometer (0.62 miles) length to identify the highest risk segments for each route, as described above in Section 6.2. The highest risk segments for each route have been identified as:

- Route 1 – Segment D on Highway US 101 across the hills of Gaviota State Park.
- Route 2 – Segment N on Highway US 101 north of Betteravia Road junction to the Santa Barbara County line.

The combined on and off-road casualties for these two segments are shown in Table 6.2. Detailed calculation tables for all segments are provided in Appendix B. The frequencies of one or more casualties for the highest risk one-kilometer segments are:

Route 1 – Segment D

- Frequency of one or more serious injuries = 5.6 x 10^{-6} per km-year
- Frequency of one or more fatalities = 2.8 x 10^{-6} per km-year

Route 2 – Segment N

- Frequency of one or more serious injuries = 6.2 x 10^{-6} per km-year
- Frequency of one or more fatalities = 3.7 x 10^{-6} per km-year

Societal risks are often presented as F-N curves, also called risk profiles. F-N curves are logarithmic plots of the cumulative frequency (F) of an event against the number (N) of one or more potential injuries or fatalities. Societal risk provides a measure of one or more public casualties along a transportation segment or fixed facility. The mitigated risk profiles for serious injury and fatality for the proposed interim crude oil transportation are shown as F-N curves in Figures 6.5 and 6.6 for Route 1, and Figures 6.7 and 6.8 for Route 2.

For the total transportation route lengths, off-road serious injury and fatality risks are about 5% of the total public casualty risks. The highway routes primarily pass through rural or undeveloped areas. Within residential areas, off-road public risk may be up to 50% of the total risk. The distribution of public risk on the highest risk road segments have been calculated as:

- Route 1 – Segment D off-road public casualty = 0.06%
- Route 2 – Segment N off-road public casualty = 40%

The Santa Barbara County societal risk profiles have been established to evaluate the acceptability of hazardous material facilities or activities for public risk of serious injury and fatality. Mitigated societal risk profiles for the highest risk transportation route segment are shown in Figures 6.5 through 6.8 against the SBC acceptability criteria. The mitigated truck transportation risks are within the following zones for acceptability:

Route 1 – Segment D

- Mitigated risk of serious injury profile is within the green “Insignificant Risk” zone for acceptability.
- Mitigated risk of fatality profile is within the green “Insignificant Risk” zone for acceptability.

Route 2 – Segment N

- Mitigated risk of serious injury profile is within the green “Insignificant Risk” zone for acceptability.
- Mitigated risk of fatality profile is within the green “Insignificant Risk” zone for acceptability.

Table 6.1 Hazardous Material Frequency of Release and Casualty

	Truck Route 1 to Phillips 66, Santa Maria	**Truck Route 2 to Pentland PAAPL Kern County**
Route Length	54.3 miles (87.4 km)	140.0 miles (225.3 km)
Mitigated Incident Rate per 10^6 miles**	0.32	0.38
Truck Incident Rate per trip***	1.7×10^{-5}	5.3×10^{-5}
Number of Daily Trips	70	68
Number of Annual Trips	25,550	24,820
Truck Incidents per year	0.44	1.3
Probability of Large Fire on Incident	0.0043	0.0043
Probability of Small Fire on Incident	0.00064	0.00064
Frequency of Large Fire per year	1.9×10^{-3} (1 in 530 years)	5.6×10^{-3} (1 in 180 years)
Frequency of Small Fire per year	2.8×10^{-4} (1 in 3,500 years)	8.4×10^{-4} (1 in 1,200 years)
Frequency of 1 or More Serious Injuries per year (total route)	2.1×10^{-4} (1 in 4,800 years)	6.2×10^{-4} (1 in 1,600 years)
Frequency of 1 or More Fatalities per year (total route)	1.1×10^{-4} (1 in 9,500 years)	3.2×10^{-4} (1 in 3,200 years)
Location of Public Casualties	5% Off-Road 95% On-Road	5% Off-Road 95% On-Road

** Truck Mitigated Incident Rate includes incidents due to truck collisions and non-collision containment failures. Mitigation measures have been applied to both collision and non-collision incident rates as described in Section 6.4

*** The risk of a small release associated with the unladen return trip has been included with the laden trip incident rate as described in Section 3.8.

Table 6.2 Casualty Frequencies for Mitigated F-N Societal Risk Profiles (highest 1-km Segments)

Route 1 to Phillips 66 Pump Station, Santa Maria – Road Segment D

Number of Serious Injuries	Frequency of Public Injuries per km-year	Frequency of N or More Public Injuries per km-year
5	2.3E-07	2.3E-07
4	3.4E-07	5.6E-07
3	5.6E-07	1.1E-06
2	1.1E-06	2.3E-06
1	3.4E-06	5.6E-06

Number of Fatalities	Frequency of Public Fatalities per km-year	Frequency of N or More Public Fatalities per km-year
5	1.1E-07	1.1E-07
4	1.7E-07	2.8E-07
3	2.8E-07	5.6E-07
2	5.6E-07	1.1E-06
1	1.7E-06	2.8E-06

Route 2 to Pentland PAAPL Pump Station, Kern County – Road Segment N

Number of Serious Injuries	Frequency of Public Injuries per km-year	Frequency of N or More Public Injuries per km-year
5	1.8E-07	1.8E-07
4	1.1E-06	1.3E-06
3	4.5E-07	1.7E-06
2	1.1E-06	2.8E-06
1	3.3E-06	6.2E-06

Number of Fatalities	Frequency of Public Fatalities per km-year	Frequency of N or More Public Fatalities per km-year
5	8.8E-08	8.8E-08
4	1.3E-07	2.2E-07
3	2.2E-07	4.4E-07
2	1.3E-06	1.7E-06
1	2.0E-06	3.7E-06

Figure 6.1 Route-1 Highest Non-Mitigated Risk Segment for HazMat Injury per One-Kilometer - SBC Risk Criteria

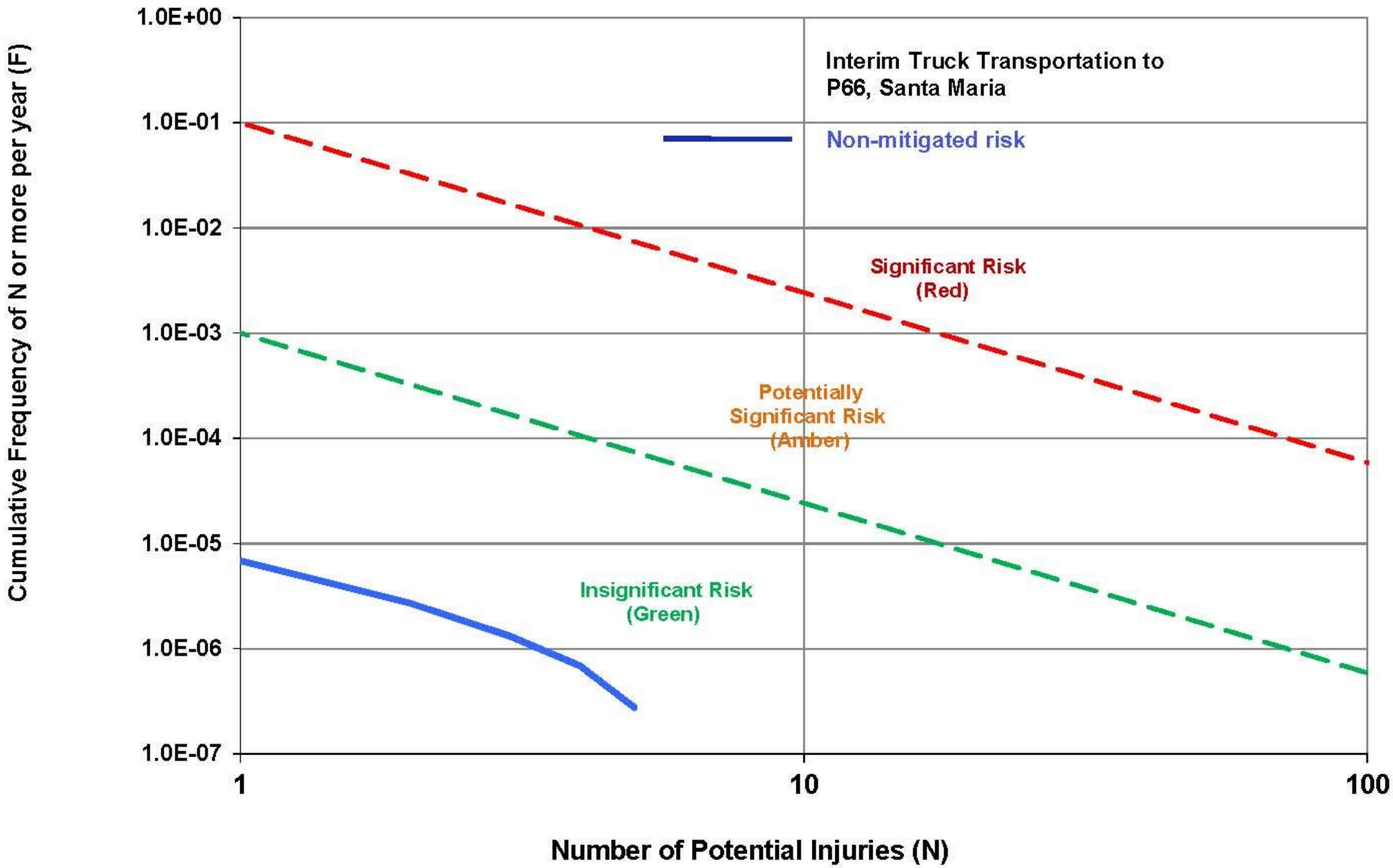


Figure 6.2 Route-1 Highest Non-Mitigated Risk Segment for HazMat Fatality per One-Kilometer - SBC Risk Criteria

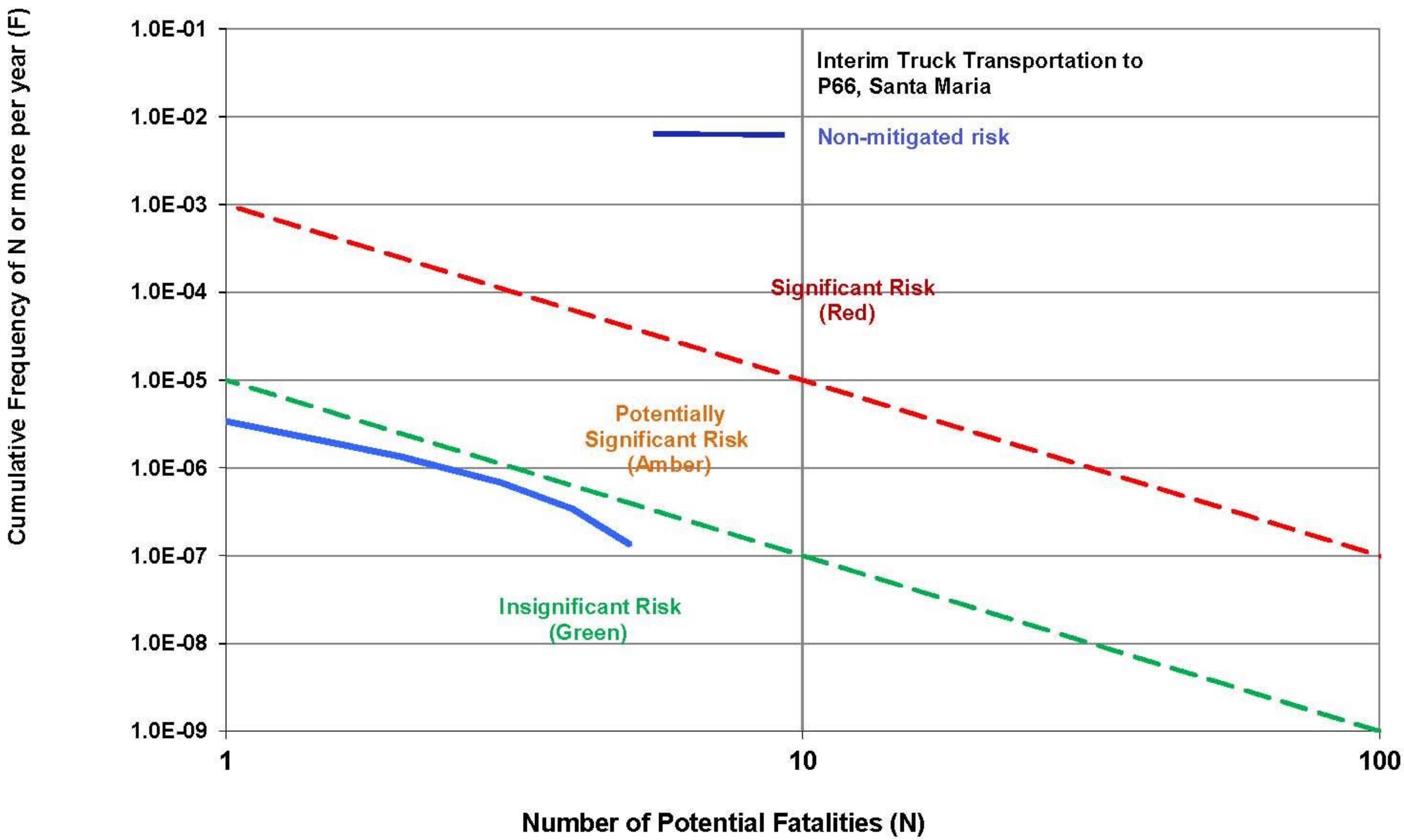


Figure 6.3 Route-2 Highest Non-Mitigated Risk Segment for HazMat Injury per One-Kilometer - SBC Risk Criteria

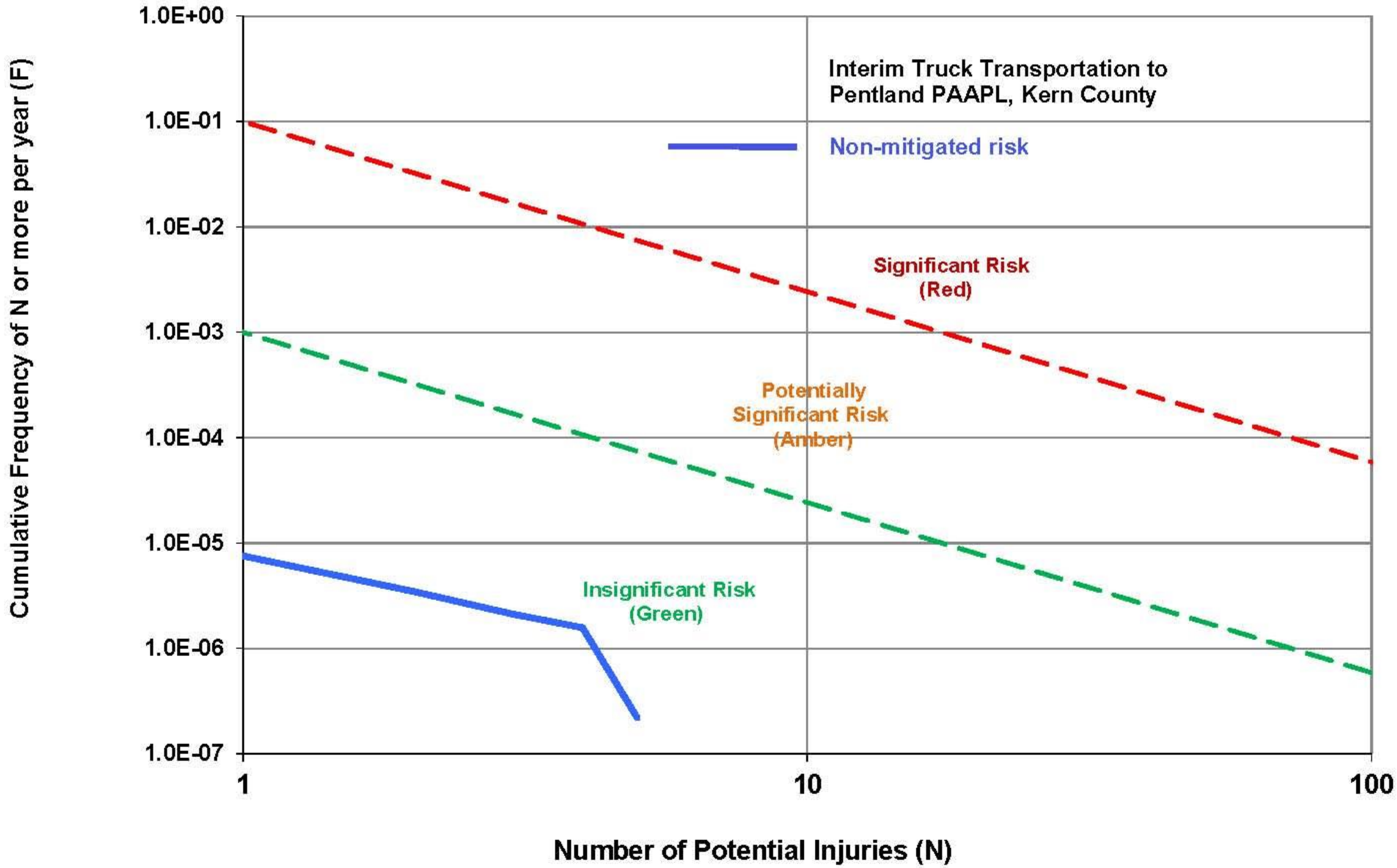


Figure 6.4 Route-2 Highest Non-Mitigated Risk Segment for HazMat Fatality per One-Kilometer - SBC Risk Criteria

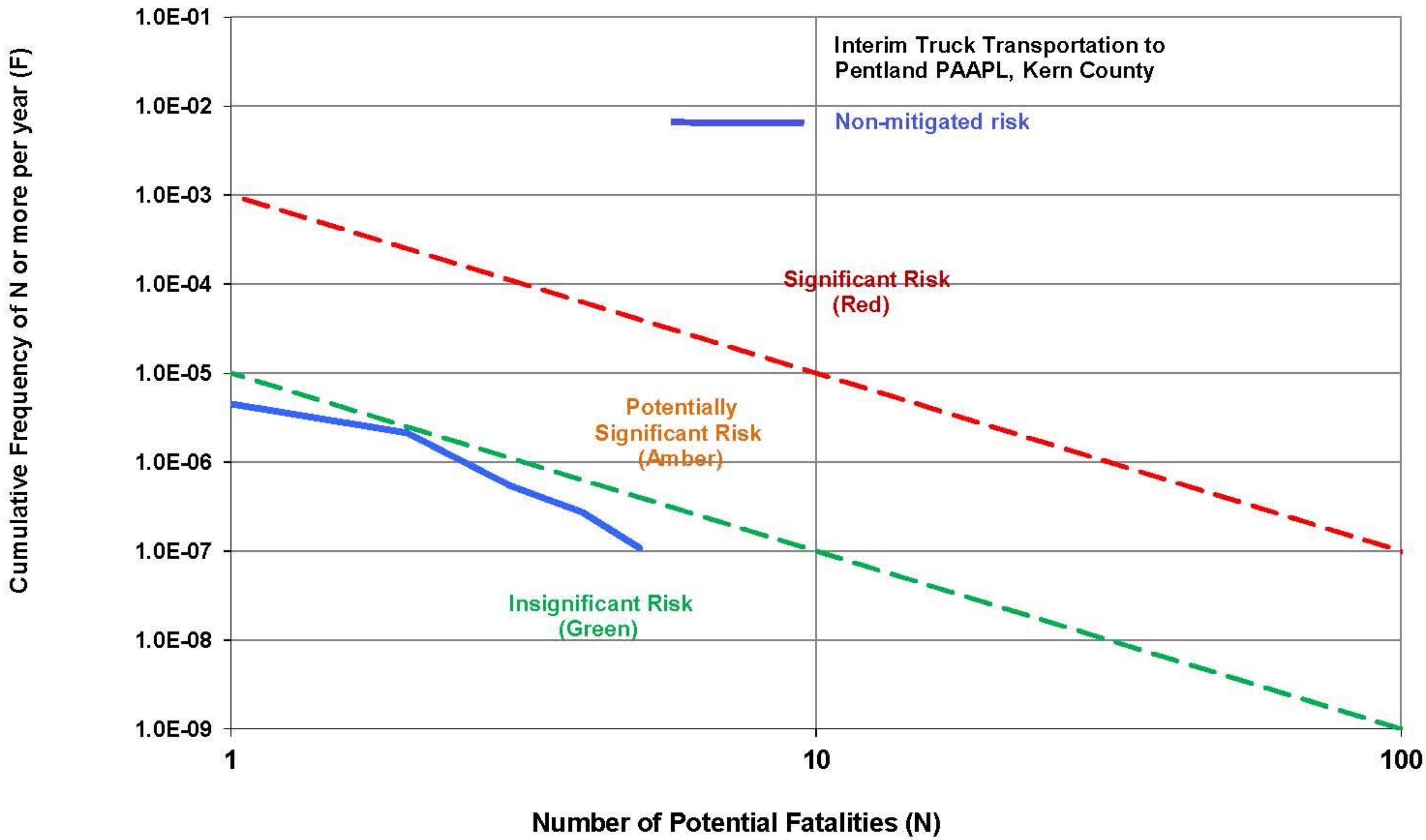


Figure 6.5 Route-1 Highest Mitigated Risk Segment for HazMat Injury per One-Kilometer - SBC Risk Criteria

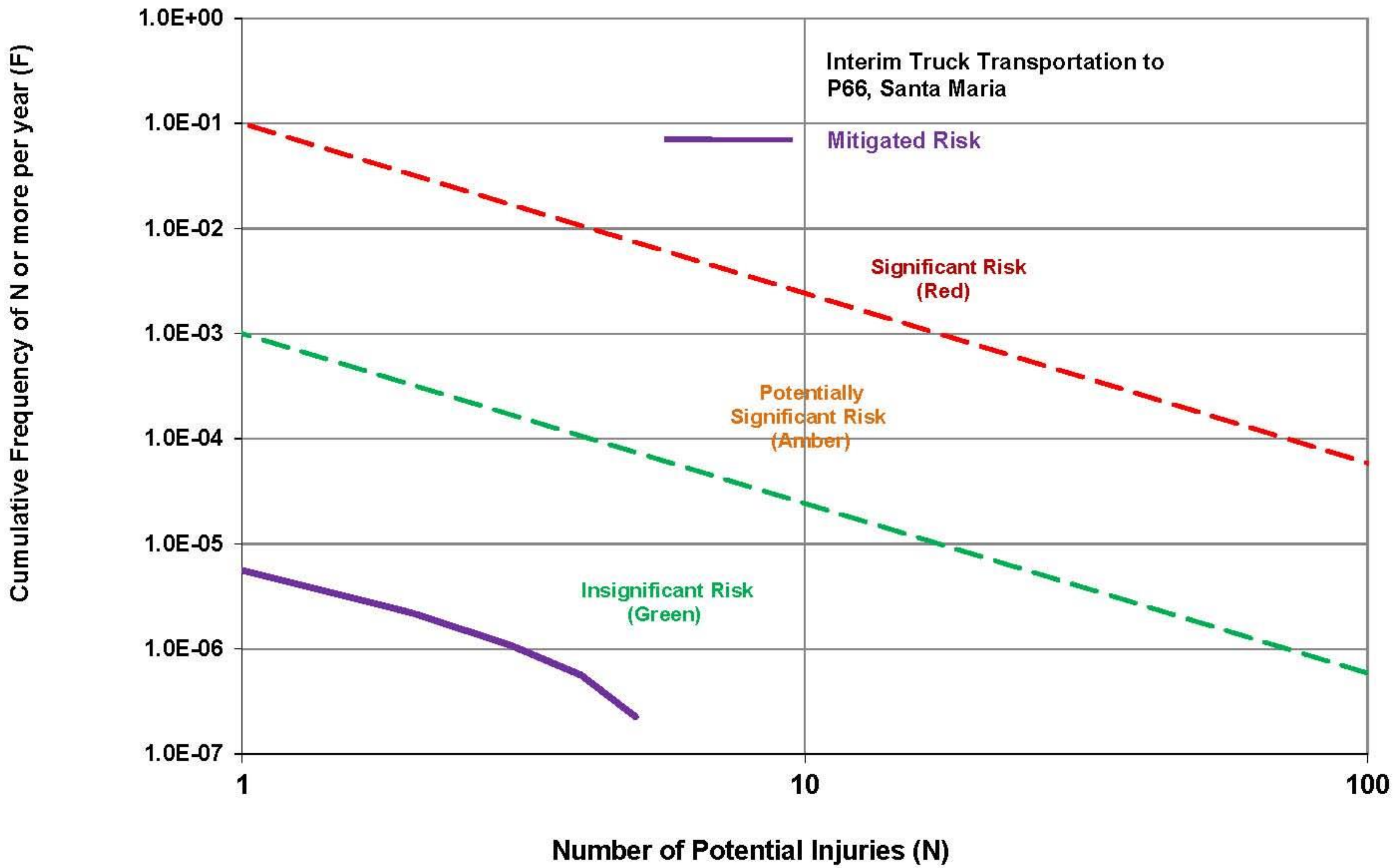


Figure 6.6 Route-1 Highest Mitigated Risk Segment for HazMat Fatality per One-Kilometer - SBC Risk Criteria

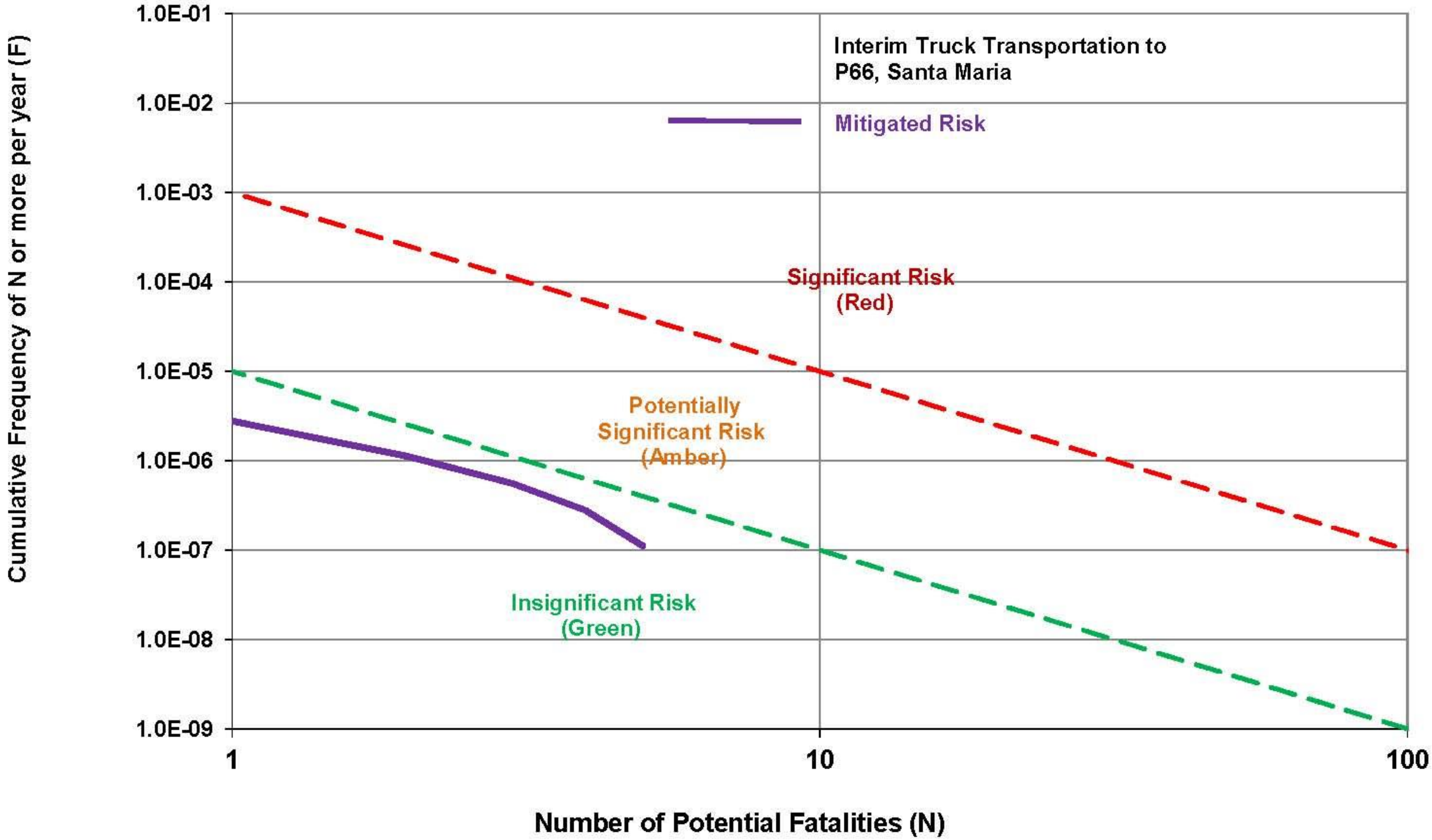


Figure 6.7 Route-2 Highest Mitigated Risk Segment for HazMat Injury per One-Kilometer - SBC Risk Criteria

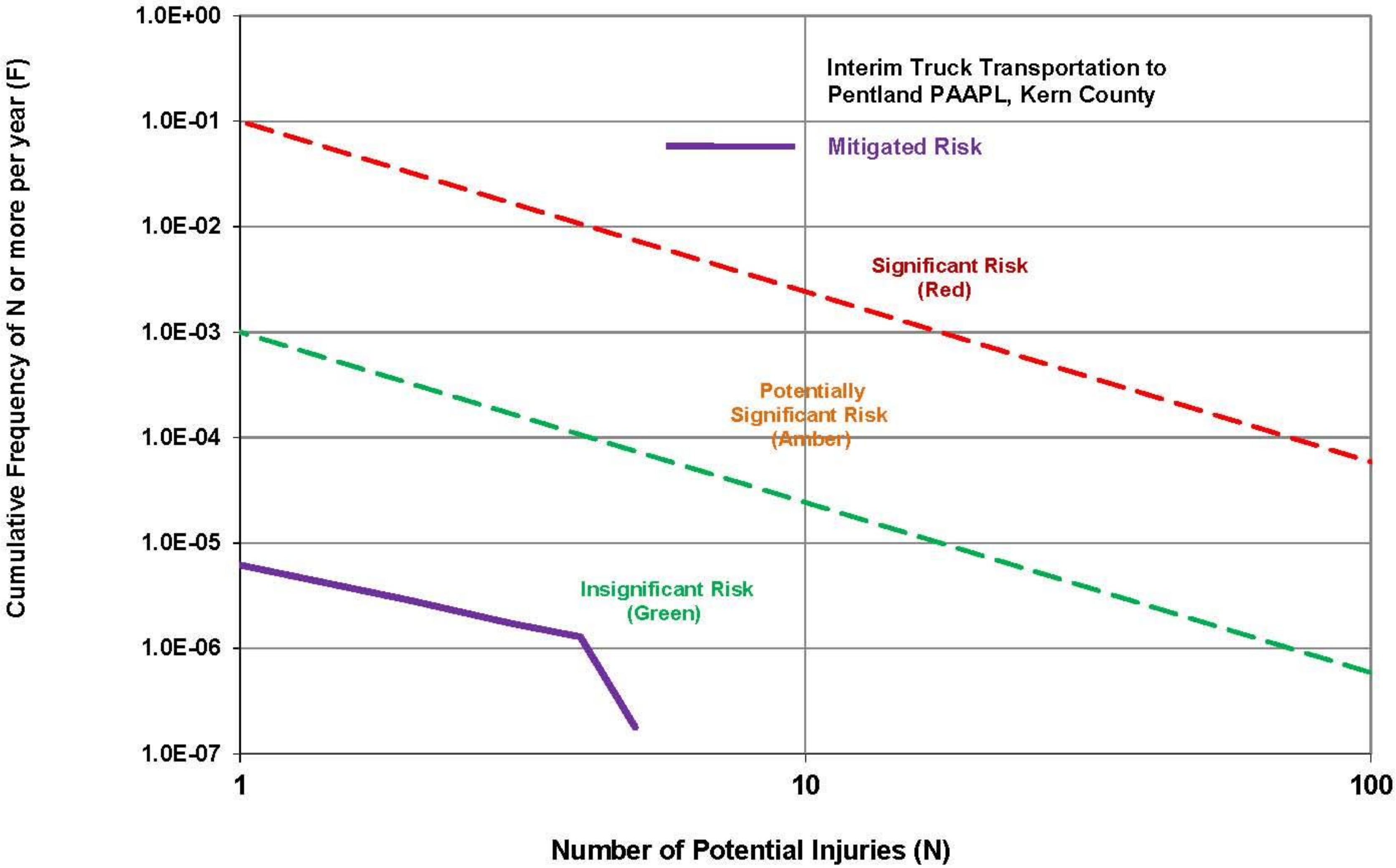
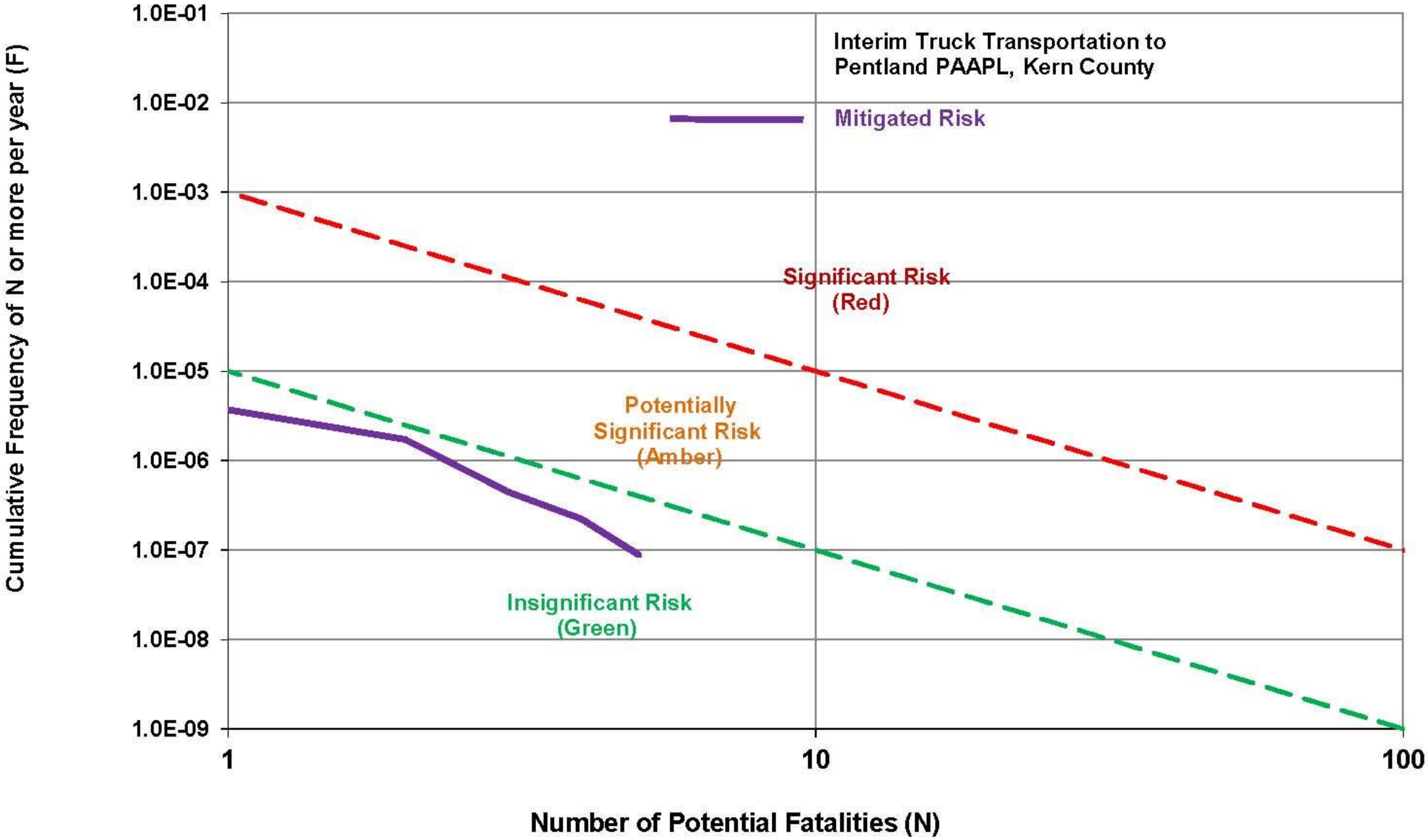


Figure 6.8 Route-2 Highest Mitigated Risk Segment for HazMat Fatality per One-Kilometer - SBC Risk Criteria



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APPENDIX A

ACRONYMS AND ABBREVIATIONS

A	Arterial
AADT	Average Annual Daily Traffic
ADL	Arthur D. Little
ALOHA	Areal Locations of Hazardous Atmospheres
API gravity	American Petroleum Institute gravity
ATE	Associated Transportation Engineers
bbl	barrel
BIT	Biennial Inspection of Terminals
BOPD	barrels oil per day
C	Collector
CA	California
Cal OSHA	California Occupational, Safety and Health Administration
CalTrans	California Department of Transportation
CHP	California Highway Patrol
CFR	Code of Federal Regulations
CO-TRMPP	Crude Oil Transportation Risk Management and Prevention Program
DEGADIS	Dense Gas Dispersion model
Di	Divided Road
DOT	U.S. Department of Transportation
DRC	Dixon Risk Consulting
EPA	US Environmental Protection Agency
ExxonMobil	ExxonMobil Production Company
F	Freeway
^{o}F	degree Fahrenheit
F-N	Cumulative Frequency-Number of 1 or more
FARS	Fatality Analysis Reporting System
FMCSA	Federal Motor Carrier Safety Administration
ft	feet / foot
GES	General Estimates System
GVWR	gross vehicle weight rating

HazMat	Hazardous Material
HM	Hazardous Material
HM-3	Hazardous Material Class 3
HMCRP	Hazardous Material Cooperative Research Program
HMIRS	Hazardous Materials Incident Reporting System
HOS	Hours of Service
HSIS	Highway Safety Information System
Hwy	Highway
IIHS	Insurance Institute of Highway Safety
km	kilometer
kW/m^2	kilowatts per meter squared
L	Local
LACT	Lease Automatic Custody Transfer
lb/min	pounds per minute
LFC	Las Flores Canyon
LFL	lower flammability limit
LPG	liquid petroleum gas
LTCCS	Large Truck Crash Causation Study
MAWP	Maximum Allowable Working Pressure
MCMIS	Motor Carrier Management Information System
mins	minutes
m/s	meters per second
mph	miles per hour
MVMT	Million Vehicle Miles Traveled
NHTSA	National Highway Traffic Safety Administration
NGL	natural gas liquids
OBSS	Onboard Safety Systems
PAAPL	Plains All American Pipeline
PDO	Property Damage Only
PHMSA	Pipeline and Hazardous Materials Safety Administration
psig	pounds per square inch gauge
R	Rural
RMP	Risk Management Program
SBC	Santa Barbara County
SR	State Route
SWITRS	California Statewide Integrated Traffic Record System

SYU	Santa Ynez Unit
TIFA	Trucks Involved in Fatal Accidents
TNO	Toegepast Natuurwetenschappelijk Onderzoek (The Netherlands Organization for Applied Scientific Research)
TQRA	Transportation Quantitative Risk Assessment
TRB	Transportation Research Board
TVP	True Vapor Pressure
U	Urban
UFL	upper flammability limit
UMTRI	University of Michigan Transportation Research Institute
Un	Undivided Road
VNTSC	Volpe National Transportation Systems Center

APPENDIX B

TQRA CALCULATION TABLES

Truck Transportation Data

Item	Number	Report Ref
Scenario 1 to Phillips 66 Pump Station in Santa Maria		
Number of Daily Trips	70	Section 2.1
Number of Annual of Trips	25,550	Section 2.1
Section ID's	A to M	Section 2.3
Scenario 2 to Pentland PAAPL Station in Maricopa		
Number of Daily Trips	68	Section 2.1
Number of Annual of Trips	24,820	Section 2.1
Section ID's	A to J and N to W	Section 2.3

The risk of public impact has been calculated separately for on-road and off-road populations due to different exposure risks and population densities for these two groups. The results of the on-road and off-road risks per 1-kilometer (0.62 miles) segment are then combined to calculate the societal risk profiles for serious injury and fatality.

Calculation of Release Frequencies by Road Segment

Section ID (Report Section 2)	H'Way / Road	Section Length miles	HM-3 Truck Accident Rate MVMT	Accident Release Rate per mile-trip	Non-Collision Release Rate per mile-trip	Total Release Rate per mile-trip	Mitigated Accident Release Rate per mile-trip	Mitigated Non-Collision Rate per mile-trip	Total Mitigated Release Rate per mile-trip
A	Coral Cny	0.8	0.72	3.9E-08	7.7E-09	4.6E-08	3.4E-08	3.9E-09	3.8E-08
B	Calle Real	1.6	0.72	3.9E-08	7.7E-09	4.6E-08	3.4E-08	3.9E-09	3.8E-08
C	101	10.2	0.37	2.0E-08	4.0E-09	2.4E-08	1.8E-08	2.0E-09	2.0E-08
D	101	2.1	0.79	4.2E-08	8.4E-09	5.1E-08	3.7E-08	4.2E-09	4.1E-08
E	101	7.6	0.35	1.9E-08	3.7E-09	2.2E-08	1.6E-08	1.9E-09	1.8E-08
F	101	1.1	0.24	1.3E-08	2.6E-09	1.6E-08	1.1E-08	1.3E-09	1.3E-08
G	101	12.8	0.16	8.8E-09	1.8E-09	1.1E-08	7.7E-09	8.8E-10	8.6E-09
H	101	1.2	0.21	1.1E-08	2.3E-09	1.4E-08	9.9E-09	1.1E-09	1.1E-08
I	101	10.6	0.28	1.5E-08	3.0E-09	1.8E-08	1.3E-08	1.5E-09	1.5E-08
J	101	4.4	0.27	1.4E-08	2.9E-09	1.7E-08	1.3E-08	1.4E-09	1.4E-08
K	Betteravia	1.0	0.72	3.9E-08	7.7E-09	4.6E-08	3.4E-08	3.9E-09	3.8E-08
L/M	Rose/Battl	0.9	0.72	3.9E-08	7.7E-09	4.6E-08	3.4E-08	3.9E-09	3.8E-08
N	101	4.4	0.64	3.4E-08	6.9E-09	4.1E-08	3.0E-08	3.4E-09	3.4E-08
O	101	0.8	0.64	3.4E-08	6.9E-09	4.1E-08	3.0E-08	3.4E-09	3.4E-08
P	166	28.3	0.42	2.3E-08	4.5E-09	2.7E-08	2.0E-08	2.3E-09	2.2E-08
Q	166	23.7	0.30	1.6E-08	3.2E-09	1.9E-08	1.4E-08	1.6E-09	1.6E-08
R	166	1.1	0.36	1.9E-08	3.8E-09	2.3E-08	1.7E-08	1.9E-09	1.9E-08
S	166/33	11.2	0.51	2.7E-08	5.5E-09	3.3E-08	2.4E-08	2.7E-09	2.7E-08
T	166/33	11.7	0.86	4.6E-08	9.2E-09	5.5E-08	4.0E-08	4.6E-09	4.5E-08
U	166/33	1.3	0.38	2.1E-08	4.1E-09	2.5E-08	1.8E-08	2.1E-09	2.0E-08
V	166	4.7	0.81	4.3E-08	8.6E-09	5.2E-08	3.8E-08	4.3E-09	4.2E-08
W	Basic Sch	0.4	0.72	3.9E-08	7.7E-09	4.6E-08	3.4E-08	3.9E-09	3.8E-08
Total	**Scenario 1**	**54.3**	**0.32**						
	Scenario 2	**140.0**	**0.38**						

HM-3 truck accident rate per MVMT		Tables 3.2 and 3.3
Probability of release on accident =	0.054	Section 3.5 / 4.7
Probability of release non- collision =	0.2 x accident rate	Section 3.5
Mitigated accident release rate =	0.88 x accident rate	Section 6.4
Mitigated non-collision release rate =	0.5 x non-collision rate	Section 6.4
Number of truck trips per year	Scenario 1 = 25550 Scenario 2 = 22820	Section 2.1

Calculation of Fire Frequencies by Road Segment

Section ID (Report Section 2)	**H'Way / Road**	**Section Length** kilometers	**Release Rate** per km-trip	**Mitigated Release Rate** per km-trip	**Mitigated Large Fire Freq** per km-year	**Mitigated Small Fire Freq** per km-year
A	Coral Cny	1.3	2.9E-08	2.4E-08	4.8E-05	7.2E-06
B	Calle Real	2.6	2.9E-08	2.4E-08	4.8E-05	7.2E-06
C	101	16.4	1.5E-08	1.2E-08	2.5E-05	3.7E-06
D	101	3.4	3.1E-08	2.6E-08	5.2E-05	7.9E-06
E	101	12.2	1.4E-08	1.1E-08	2.3E-05	3.5E-06
F	101	1.8	9.6E-09	7.9E-09	1.6E-05	2.4E-06
G	101	20.6	6.5E-09	5.3E-09	1.1E-05	1.6E-06
H	101	1.9	8.4E-09	6.9E-09	1.4E-05	2.1E-06
I	101	17.1	1.1E-08	9.2E-09	1.9E-05	2.8E-06
J	101	7.1	1.1E-08	8.7E-09	1.8E-05	2.7E-06
K	Betteravia	1.6	2.9E-08	2.4E-08	4.8E-05	7.2E-06
L/M	Rose/Battles	1.4	2.9E-08	2.4E-08	4.8E-05	7.2E-06
N	101	7.1	2.6E-08	2.1E-08	4.2E-05	6.2E-06
O	101	1.3	2.6E-08	2.1E-08	4.2E-05	6.2E-06
P	166	45.5	1.7E-08	1.4E-08	2.7E-05	4.1E-06
Q	166	38.1	1.2E-08	9.9E-09	2.0E-05	2.9E-06
R	166	1.8	1.4E-08	1.2E-08	2.3E-05	3.5E-06
S	166/33	18.0	2.0E-08	1.7E-08	3.3E-05	5.0E-06
T	166/33	18.8	3.4E-08	2.8E-08	5.5E-05	8.3E-06
U	166/33	2.1	1.5E-08	1.2E-08	2.5E-05	3.7E-06
V	166	7.6	3.2E-08	2.6E-08	5.2E-05	7.8E-06
W	Basic School	0.6	2.9E-08	2.4E-08	4.7E-05	7.0E-06
Total	**Scenario 1**	87.4				
	Scenario 2	225.3				

Conversion of miles to kilometers	miles x 1.6	
Probability of large fire on release	0.4 x 0.2 = 0.08	Section 3.5 and 3.6
Probability of small fire on release	0.6 x 0.02 = 0.012	Section 3.5 and 3.6
Number of truck trips per year	Scenario 1 = 25550 Scenario 2 = 22820	Section 2.1

Off-Road Population Impact Tables

Weather	ID	Probability	Report Ref
F Stability, 1.5 m/s wind, night	F/1.5/N	0.35	Section 2.6
D Stability, 4 m/s wind, night	D/4/N	0.15	Section 2.6
D Stability, 4 m/s wind, day	D/4/D	0.5	Section 2.6

Population Distribution by location – Fraction of Day Numbers (Section 2.5)

Population Type	Day	Day Inside	Day Outside	Night	Night Inside	Night Outside
Residential / Rural / Unpopulated	1	0.8	0.2	1	0.95	0.05
Commercial	1	0.8	0.2	0.05	0.0475	0.0025
Industrial	1	0.8	0.2	0.2	0.19	0.01
Agricultural	1	0.2	0.8	0.05	0.0475	0.0025
Mixed Residential / Commercial	1	0.8	0.2	0.525	0.4988	0.0263
Agricultural / Rural / Rec	1	0.2	0.8	0.1	0.095	0.005
Industrial-Low / Rural	1	0.8	0.2	0.2	0.19	0.01

Pool Fire Impact Areas (source Table 4.3)

Fire Hazard	Weather	Radius (ft)	Area $(ft)^2$	0.5 x Area $(ft)^2$	0.5 x Area minus PF $(ft)^2$
Pool fire (PF)		59	1.1×10^4	5.5×10^3	
Distance to 10 kW/m^2	F/1.5	110	3.8×10^4	1.9×10^4	1.4×10^4
Distance to 10 kW/m^2	D/4	180	1.0 x 105	5.1×10^4	4.5×10^4
Distance to 5 kW/m^2	F/1.5	160	8.0×10^4	4.0×10^4	3.5×10^4
Distance to 5 kW/m^2	D/4	240	1.8×10^5	9.1×10^4	8.5×10^4

50% of pool fire area impacts assumed to be off-road, 50% on-road.

Pool Fire Vulnerabilities (source Section 4.4)

Location	Within Pool Fire Area		Pool Fire to 10kW/m^2	Pool Fire to 5kW/m^2
	Fatal Prob	Injury Prob	Fatal Prob	Injury Prob
Outdoor	1	0	0.1	0.2
Indoor	0.5	0.5	0.01	0.05

Off-Road Public Population Distribution

Section ID (Section 2)	**Population Category** (Section 2)	**Population Density per mile^2** (Section 2)	**Population per Group** (Section 2)	**Group Density per ft^2** (Section 2)	**Weather / Day / Night**	**Outdoor Probability**	**Indoor Probability**
A	Non-Public	0	-	-	F/1.5/N	-	-
					D/4/N	-	-
					D/4/D	-	-
B	Rural	20	3	2.2E-06	F/1.5/N	0.050	0.950
					D/4/N	0.050	0.950
					D/4/D	0.200	0.800
C	Rural / Rec	30	3	3.2E-06	F/1.5/N	0.005	0.095
					D/4/N	0.005	0.095
					D/4/D	0.800	0.200
D	UnPop	2	1	7.2E-08	F/1.5/N	0.050	0.950
					D/4/N	0.050	0.950
					D/4/D	0.200	0.800
E	Rural	20	3	2.2E-06	F/1.5/N	0.005	0.095
					D/4/N	0.005	0.095
					D/4/D	0.800	0.200
F	Mix-L	1000	6	2.2E-04	F/1.5/N	0.026	0.499
					D/4/N	0.026	0.499
					D/4/D	0.200	0.800
G	Rural	20	3	2.2E-06	F/1.5/N	0.050	0.950
					D/4/N	0.050	0.950
					D/4/D	0.200	0.800
H	Mix-L	1000	6	2.2E-04	F/1.5/N	0.026	0.499
					D/4/N	0.026	0.499
					D/4/D	0.200	0.800
I	Rural	20	3	2.2E-06	F/1.5/N	0.005	0.095
					D/4/N	0.005	0.095
					D/4/D	0.800	0.200
J	Mix-M / Ag	2100	3	2.3E-04	F/1.5/N	0.026	0.499
					D/4/N	0.026	0.499
					D/4/D	0.200	0.800
K	Com-L / Ag	600	3	6.5E-05	F/1.5/N	0.010	0.190
					D/4/N	0.010	0.190
					D/4/D	0.010	0.800
L/M	Rural / Ag	110	3	1.2E-05	F/1.5/N	0.005	0.095
					D/4/N	0.005	0.095
					D/4/D	0.800	0.200

Section ID (Section 2)	**Population Category** (Section 2)	**Population Density per mile^2** (Section 2)	**Population per Group** (Section 2)	**Group Density per ft^2** (Section 2)	**Weather / Day / Night**	**Outdoor Probability**	**Indoor Probability**
N	Mix-M	4000	3	4.3E-04	F/1.5/N	0.026	0.499
					D/4/N	0.026	0.499
					D/4/D	0.200	0.800
O	UnPop	2	1	7.2E-08	F/1.5/N	0.050	0.950
					D/4/N	0.050	0.950
					D/4/D	0.200	0.800
P	Rur/UnPop	11	3	1.2E-06	F/1.5/N	0.050	0.950
					D/4/N	0.050	0.950
					D/4/D	0.200	0.800
Q	Rural	20	3	2.2E-06	F/1.5/N	0.005	0.095
					D/4/N	0.005	0.095
					D/4/D	0.800	0.200
R	Res-L	1000	3	1.1E-04	F/1.5/N	0.050	0.950
					D/4/N	0.050	0.950
					D/4/D	0.200	0.800
S	Rural	20	3	2.2E-06	F/1.5/N	0.005	0.095
					D/4/N	0.005	0.095
					D/4/D	0.800	0.200
T	UnPop	2	1	7.2E-08	F/1.5/N	0.050	0.950
					D/4/N	0.050	0.950
					D/4/D	0.200	0.800
U	Res-M	3000	3	3.2E-04	F/1.5/N	0.050	0.950
					D/4/N	0.050	0.950
					D/4/D	0.200	0.800
V	Rural	20	3	2.2E-06	F/1.5/N	0.010	0.190
					D/4/N	0.010	0.190
					D/4/D	0.010	0.800
W	Rural	20	3	2.2E-06	F/1.5/N	0.010	0.190
					D/4/N	0.010	0.190
					D/4/D	0.010	0.800

Group Density = Population density per mile^2 x population per group x 3.587×10^{-8}

Calculation of Off-Road Public Population Impacts

Section ID	Mitigated Large Fire Freq per km-year	Weather / Day / Night	Prob of Weather/ Day / Night	Frequency of Casualty Event per km-year	Population Within Pool Fire Area	Population in Pool Fire Area to $10kw/m^2$	Population in Pool Fire Area to $5kw/m^2$
A	4.8E-05	F/1.5/N	0.35	2.1E-06	0.000	0.00	0.00
		D/4/N	0.15	9.0E-07	0.000	0.00	0.00
		D/4/D	0.50	3.0E-06	0.000	0.00	0.00
B	4.8E-05	F/1.5/N	0.35	7.0E-07	0.012	0.03	0.07
		D/4/N	0.15	3.0E-07	0.012	0.10	0.18
		D/4/D	0.50	1.0E-06	0.012	0.10	0.18
C	2.5E-05	F/1.5/N	0.35	3.6E-07	0.018	0.04	0.11
		D/4/N	0.15	1.6E-07	0.018	0.15	0.27
		D/4/D	0.50	5.2E-07	0.018	0.15	0.27
D	5.2E-05	F/1.5/N	0.35	2.3E-06	0.0004	0.001	0.002
		D/4/N	0.15	9.8E-07	0.0004	0.003	0.006
		D/4/D	0.50	3.3E-06	0.0004	0.003	0.006
E	2.3E-05	F/1.5/N	0.35	3.4E-07	0.012	0.03	0.07
		D/4/N	0.15	1.5E-07	0.012	0.10	0.18
		D/4/D	0.50	4.8E-07	0.012	0.10	0.18
F	1.6E-05	F/1.5/N	0.35	1.2E-07	1.177	2.91	7.48
		D/4/N	0.15	5.0E-08	1.177	9.78	18.30
		D/4/D	0.50	1.7E-07	1.177	9.78	18.30
G	1.1E-05	F/1.5/N	0.35	1.6E-07	0.012	0.03	0.07
		D/4/N	0.15	6.8E-08	0.012	0.10	0.18
		D/4/D	0.50	2.3E-07	0.012	0.10	0.18
H	1.4E-05	F/1.5/N	0.35	1.0E-07	1.177	2.91	7.48
		D/4/N	0.15	4.4E-08	1.177	9.78	18.30
		D/4/D	0.50	1.5E-07	1.177	9.78	18.30
I	1.9E-05	F/1.5/N	0.35	2.7E-07	0.012	0.03	0.07
		D/4/N	0.15	1.2E-07	0.012	0.10	0.18
		D/4/D	0.50	3.9E-07	0.012	0.10	0.18
J	1.8E-05	F/1.5/N	0.35	2.6E-07	1.236	3.06	7.85
		D/4/N	0.15	1.1E-07	1.236	10.27	19.21
		D/4/D	0.50	3.7E-07	1.236	10.27	19.21
K	4.8E-05	F/1.5/N	0.35	7.0E-07	0.353	0.87	2.24
		D/4/N	0.15	3.0E-07	0.353	2.93	5.49
		D/4/D	0.50	1.0E-06	0.353	2.93	5.49
L/M	4.8E-05	F/1.5/N	0.35	7.0E-07	0.065	0.16	0.41
		D/4/N	0.15	3.0E-07	0.065	0.54	1.01
		D/4/D	0.50	1.0E-06	0.065	0.54	1.01

Section ID	Mitigated Large Fire Freq per km-year	Weather / Day / Night	Prob of Weather/ Day / Night	Frequency of Casualty Event per km-year	Population Within Pool Fire Area	Population in Pool Fire Area to 10kw/m^2	Population in Pool Fire Area to 5kw/m^2
N	4.2E-05	F/1.5/N	0.35	6.1E-07	2.354	5.83	14.96
		D/4/N	0.15	2.6E-07	2.354	19.55	36.59
		D/4/D	0.50	8.7E-07	2.354	19.55	36.59
O	4.2E-05	F/1.5/N	0.35	1.8E-06	0.0004	0.001	0.002
		D/4/N	0.15	7.8E-07	0.0004	0.003	0.006
		D/4/D	0.50	2.6E-06	0.0004	0.003	0.006
P	2.7E-05	F/1.5/N	0.35	4.0E-07	0.006	0.02	0.04
		D/4/N	0.15	1.7E-07	0.006	0.05	0.10
		D/4/D	0.50	5.7E-07	0.006	0.05	0.10
Q	2.0E-05	F/1.5/N	0.35	2.9E-07	0.012	0.03	0.07
		D/4/N	0.15	1.2E-07	0.012	0.10	0.18
		D/4/D	0.50	4.1E-07	0.012	0.10	0.18
R	2.3E-05	F/1.5/N	0.35	3.4E-07	0.588	1.46	3.74
		D/4/N	0.15	1.4E-07	0.588	4.89	9.15
		D/4/D	0.50	4.8E-07	0.588	4.89	9.15
S	3.3E-05	F/1.5/N	0.35	4.8E-07	0.012	0.03	0.07
		D/4/N	0.15	2.1E-07	0.012	0.10	0.18
		D/4/D	0.50	6.9E-07	0.012	0.10	0.18
T	5.5E-05	F/1.5/N	0.35	2.4E-06	0.0004	0.001	0.002
		D/4/N	0.15	1.0E-06	0.0004	0.003	0.006
		D/4/D	0.50	3.5E-06	0.0004	0.003	0.006
U	2.5E-05	F/1.5/N	0.35	3.6E-07	1.765	4.37	11.22
		D/4/N	0.15	1.6E-07	1.765	14.66	27.44
		D/4/D	0.50	5.2E-07	1.765	14.66	27.44
V	5.2E-05	F/1.5/N	0.35	7.6E-07	0.012	0.03	0.07
		D/4/N	0.15	3.3E-07	0.012	0.10	0.18
		D/4/D	0.50	1.1E-06	0.012	0.10	0.18
W	4.7E-06	F/1.5/N	0.35	6.8E-07	0.012	0.03	0.07
		D/4/N	0.15	2.9E-07	0.012	0.10	0.18
		D/4/D	0.50	9.8E-07	0.012	0.10	0.18

Calculation of Population Group Impact per year:

Frequency of large fire per km-year		by road segment above
X Probability of weather / time		Section 2.6
X Rapid release and immediate ignition	0.25 x 0.5 = 0.125	Section 4.7
/ Number in each group		Section 2

Calculation of Max Population Within Pool Fire Area:

Group Density per ft^2 x Off-Road Pool Fire Area ft^2

Calculation of Off-Road Public Fatality and Serious Injury Numbers

Section ID	Outdoor Fatality		Indoor Fatality		Total Fatality Number	Outdoor Injury		Indoor Injury		Total Serious Injury Number
	Within Pool Fire Area	Pool Fire to 10kw/m^2	Within Pool Fire Area	Pool Fire to 10kw/m^2		Within Pool Fire Area	Pool Fire to 5kw/m^2	Within Pool Fire Area	Pool Fire to 5kw/m^2	
A	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
B	0.0006	0.0001	0.0056	0.0003	0.0066	0.0000	0.0007	0.0056	0.0036	0.0099
	0.0006	0.0005	0.0056	0.0009	0.0076	0.0000	0.0018	0.0056	0.0087	0.0161
	0.0024	0.0020	0.0047	0.0008	0.0098	0.0000	0.0073	0.0047	0.0073	0.0193
C	0.0001	0.0000	0.0008	0.0000	0.0010	0.0000	0.0001	0.0008	0.0005	0.0015
	0.0001	0.0001	0.0008	0.0001	0.0011	0.0000	0.0003	0.0008	0.0013	0.0024
	0.0141	0.0117	0.0018	0.0003	0.0279	0.0000	0.0439	0.0018	0.0027	0.0484
D	0.0000	0.0000	0.0002	0.0000	0.0002	0.0000	0.0000	0.0002	0.0001	0.0003
	0.0000	0.0000	0.0002	0.0000	0.0003	0.0000	0.0001	0.0002	0.0003	0.0005
	0.0001	0.0001	0.0002	0.0000	0.0003	0.0000	0.0002	0.0002	0.0002	0.0006
E	0.0001	0.0000	0.0006	0.0000	0.0007	0.0000	0.0001	0.0006	0.0004	0.0010
	0.0001	0.0000	0.0006	0.0001	0.0008	0.0000	0.0002	0.0006	0.0009	0.0016
	0.0094	0.0078	0.0012	0.0002	0.0186	0.0000	0.0293	0.0012	0.0018	0.0323
F	0.0309	0.0076	0.2935	0.0145	0.3465	0.0000	0.0393	0.2935	0.1865	0.5192
	0.0309	0.0257	0.2935	0.0488	0.3988	0.0000	0.0961	0.2935	0.4563	0.8458
	0.2354	0.1955	0.4707	0.0782	0.9798	0.0000	0.7318	0.4707	0.7318	1.9344
G	0.0006	0.0001	0.0056	0.0003	0.0066	0.0000	0.0007	0.0056	0.0036	0.0099
	0.0006	0.0005	0.0056	0.0009	0.0076	0.0000	0.0018	0.0056	0.0087	0.0161
	0.0024	0.0020	0.0047	0.0008	0.0098	0.0000	0.0073	0.0047	0.0073	0.0193
H	0.0309	0.0076	0.2935	0.0145	0.3465	0.0000	0.0393	0.2935	0.1865	0.5192
	0.0309	0.0257	0.2935	0.0488	0.3988	0.0000	0.0961	0.2935	0.4563	0.8458
	0.2354	0.1955	0.4707	0.0782	0.9798	0.0000	0.7318	0.4707	0.7318	1.9344

Section ID	Outdoor Fatality		Indoor Fatality		Total Fatality Number	Outdoor Injury		Indoor Injury		Total Serious Injury Number
	Within Pool Fire Area	Pool Fire to 10kw/m²	Within Pool Fire Area	Pool Fire to 10kw/m²		Within Pool Fire Area	Pool Fire to 5kw/m²	Within Pool Fire Area	Pool Fire to 5kw/m²	
I	0.0001	0.0000	0.0006	0.0000	0.0007	0.0000	0.0001	0.0006	0.0004	0.0010
	0.0001	0.0000	0.0006	0.0001	0.0008	0.0000	0.0002	0.0006	0.0009	0.0016
	0.0094	0.0078	0.0012	0.0002	0.0186	0.0000	0.0293	0.0012	0.0018	0.0323
J	0.0324	0.0080	0.3081	0.0153	0.3639	0.0000	0.0412	0.3081	0.1958	0.5452
	0.0324	0.0269	0.3081	0.0512	0.4187	0.0000	0.1009	0.3081	0.4791	0.8881
	0.2471	0.2053	0.4943	0.0821	1.0288	0.0000	0.7684	0.4943	0.7684	2.0311
K	0.0035	0.0009	0.0335	0.0017	0.0396	0.0000	0.0045	0.0335	0.0213	0.0593
	0.0035	0.0029	0.0335	0.0056	0.0456	0.0000	0.0110	0.0335	0.0521	0.0967
	0.0035	0.0029	0.1412	0.0235	0.1711	0.0000	0.0110	0.1412	0.2196	0.3717
L/M	0.0003	0.0001	0.0031	0.0002	0.0036	0.0000	0.0004	0.0031	0.0020	0.0054
	0.0003	0.0003	0.0031	0.0005	0.0042	0.0000	0.0010	0.0031	0.0048	0.0089
	0.0518	0.0430	0.0065	0.0011	0.1023	0.0000	0.1610	0.0065	0.0101	0.1775
N	0.0618	0.0153	0.5869	0.0291	0.6931	0.0000	0.0785	0.5869	0.3730	1.0384
	0.0618	0.0513	0.5869	0.0975	0.7976	0.0000	0.1921	0.5869	0.9125	1.6915
	0.4707	0.3911	0.9414	0.1564	1.9597	0.0000	1.4637	0.9414	1.4637	3.8688
O	0.0000	0.0000	0.0002	0.0000	0.0002	0.0000	0.0000	0.0002	0.0001	0.0003
	0.0000	0.0000	0.0002	0.0000	0.0003	0.0000	0.0001	0.0002	0.0003	0.0005
	0.0001	0.0001	0.0002	0.0000	0.0003	0.0000	0.0002	0.0002	0.0002	0.0006
P	0.0003	0.0001	0.0031	0.0002	0.0036	0.0000	0.0004	0.0031	0.0020	0.0054
	0.0003	0.0003	0.0031	0.0005	0.0042	0.0000	0.0010	0.0031	0.0048	0.0089
	0.0013	0.0011	0.0026	0.0004	0.0054	0.0000	0.0040	0.0026	0.0040	0.0106
Q	0.0001	0.0000	0.0006	0.0000	0.0007	0.0000	0.0001	0.0006	0.0004	0.0010
	0.0001	0.0000	0.0006	0.0001	0.0008	0.0000	0.0002	0.0006	0.0009	0.0016
	0.0094	0.0078	0.0012	0.0002	0.0186	0.0000	0.0293	0.0012	0.0018	0.0323

Section ID	Outdoor Fatality		Indoor Fatality		Total Fatality Number	Outdoor Injury		Indoor Injury		Total Serious Injury Number
	Within Pool Fire Area	Pool Fire to 10kw/m^2	Within Pool Fire Area	Pool Fire to 10kw/m^2		Within Pool Fire Area	Pool Fire to 5kw/m^2	Within Pool Fire Area	Pool Fire to 5kw/m^2	
R	0.0294	0.0073	0.2795	0.0138	0.3300	0.0000	0.0374	0.2795	0.1776	0.4945
	0.0294	0.0244	0.2795	0.0464	0.3798	0.0000	0.0915	0.2795	0.4345	0.8055
	0.1177	0.0978	0.2354	0.0391	0.4899	0.0000	0.3659	0.2354	0.3659	0.9672
S	0.0001	0.0000	0.0006	0.0000	0.0007	0.0000	0.0001	0.0006	0.0004	0.0010
	0.0001	0.0000	0.0006	0.0001	0.0008	0.0000	0.0002	0.0006	0.0009	0.0016
	0.0094	0.0078	0.0012	0.0002	0.0186	0.0000	0.0293	0.0012	0.0018	0.0323
T	0.0000	0.0000	0.0002	0.0000	0.0002	0.0000	0.0000	0.0002	0.0001	0.0003
	0.0000	0.0000	0.0002	0.0000	0.0003	0.0000	0.0001	0.0002	0.0003	0.0005
	0.0001	0.0001	0.0002	0.0000	0.0003	0.0000	0.0002	0.0002	0.0002	0.0006
U	0.0883	0.0219	0.8385	0.0415	0.9901	0.0000	0.1122	0.8385	0.5328	1.4834
	0.0883	0.0733	0.8385	0.1393	1.1394	0.0000	0.2744	0.8385	1.3036	2.4165
	0.3530	0.2933	0.7061	0.1173	1.4697	0.0000	1.0978	0.7061	1.0978	2.9016
V	0.0001	0.0000	0.0011	0.0001	0.0013	0.0000	0.0001	0.0011	0.0007	0.0020
	0.0001	0.0001	0.0011	0.0002	0.0015	0.0000	0.0004	0.0011	0.0017	0.0032
	0.0001	0.0001	0.0047	0.0008	0.0057	0.0000	0.0004	0.0047	0.0073	0.0124
W	0.0001	0.0000	0.0011	0.0001	0.0013	0.0000	0.0001	0.0011	0.0007	0.0020
	0.0001	0.0001	0.0011	0.0002	0.0015	0.0000	0.0004	0.0011	0.0017	0.0032
	0.0001	0.0001	0.0047	0.0008	0.0057	0.0000	0.0004	0.0047	0.0073	0.0124

Outdoor Casualty = Population Within Impact Area x Population Fraction Outdoors x Vulnerability
Indoor Casualty = Population Within Impact Area x Population Fraction Indoors x Vulnerability

Event Frequencies Adjusted for Minimum of One Public Casualty

Section ID	Frequency of Casualty Event (per km-year)	Fatality Number	Rounded Fatality Number (min of 1)	Adjusted Frequency of Fatality Event (per km-year)	Serious Injury Number	Rounded Injury Number (min of 1)	Adjusted Frequency of Injury Event (per km-year)
A	2.1E-06	0.0000	0	0.0E+00	0.0000	0	0.0E+00
	9.0E-07	0.0000	0	0.0E+00	0.0000	0	0.0E+00
	3.0E-06	0.0000	0	0.0E+00	0.0000	0	0.0E+00
B	7.0E-07	0.0066	1	4.6E-09	0.0099	1	7.0E-09
	3.0E-07	0.0076	1	2.3E-09	0.0161	1	4.9E-09
	1.0E-06	0.0098	1	9.8E-09	0.0193	1	1.9E-08
C	3.6E-07	0.0010	1	3.6E-10	0.0015	1	5.4E-10
	1.6E-07	0.0011	1	1.8E-10	0.0024	1	3.8E-10
	5.2E-07	0.0279	1	1.4E-08	0.0484	1	2.5E-08
D	2.3E-06	0.0002	1	5.0E-10	0.0003	1	7.6E-10
	9.8E-07	0.0003	1	2.5E-10	0.0005	1	5.3E-10
	3.3E-06	0.0003	1	1.1E-09	0.0006	1	2.1E-09
E	3.4E-07	0.0007	1	2.2E-10	0.0010	1	3.4E-10
	1.5E-07	0.0008	1	1.1E-10	0.0016	1	2.3E-10
	4.8E-07	0.0186	1	9.0E-09	0.0323	1	1.6E-08
F	1.2E-07	0.3465	1	4.1E-08	0.5192	1	6.1E-08
	5.0E-08	0.3988	1	2.0E-08	0.8458	1	4.3E-08
	1.7E-07	0.9798	1	1.6E-07	1.9344	2	1.6E-07
G	1.6E-07	0.0066	1	1.0E-09	0.0099	1	1.6E-09
	6.8E-08	0.0076	1	5.2E-10	0.0161	1	1.1E-09
	2.3E-07	0.0098	1	2.2E-09	0.0193	1	4.4E-09
H	1.0E-07	0.3465	1	3.5E-08	0.5192	1	5.3E-08
	4.4E-08	0.3988	1	1.8E-08	0.8458	1	3.7E-08
	1.5E-07	0.9798	1	1.4E-07	1.9344	2	1.4E-07
I	2.7E-07	0.0007	1	1.8E-10	0.0010	1	2.7E-10
	1.2E-07	0.0008	1	8.9E-11	0.0016	1	1.9E-10
	3.9E-07	0.0186	1	7.3E-09	0.0323	1	1.3E-08
J	2.6E-07	0.3639	1	9.5E-08	0.5452	1	1.4E-07
	1.1E-07	0.4187	1	4.7E-08	0.8881	1	9.9E-08
	3.7E-07	1.0288	1	3.8E-07	2.0311	2	3.8E-07
K	7.0E-07	0.0396	1	2.8E-08	0.0593	1	4.2E-08
	3.0E-07	0.0456	1	1.4E-08	0.0967	1	2.9E-08
	1.0E-06	0.1711	1	1.7E-07	0.3717	1	3.7E-07
L/M	7.0E-07	0.0036	1	2.6E-09	0.0054	1	3.8E-09
	3.0E-07	0.0042	1	1.3E-09	0.0089	1	2.7E-09
	1.0E-06	0.1023	1	1.0E-07	0.1775	1	1.8E-07

Section ID	Frequency of Casualty Event (per km-year)	Fatality Number	Rounded Fatality Number (min of 1)	Adjusted Frequency of Fatality Event (per km-year)	Serious Injury Number	Rounded Injury Number (min of 1)	Adjusted Frequency of Injury Event (per km-year)
N	6.1E-07	0.6931	1	4.2E-07	1.0384	1	6.3E-07
	2.6E-07	0.7976	1	2.1E-07	1.6915	2	2.2E-07
	8.7E-07	1.9597	2	8.5E-07	3.8688	4	8.4E-07
O	1.8E-06	0.0002	1	4.0E-10	0.0003	1	6.0E-10
	7.8E-07	0.0003	1	2.0E-10	0.0005	1	4.2E-10
	2.6E-06	0.0003	1	8.5E-10	0.0006	1	1.7E-09
P	4.0E-07	0.0036	1	1.5E-09	0.0054	1	2.2E-09
	1.7E-07	0.0042	1	7.2E-10	0.0089	1	1.5E-09
	5.7E-07	0.0054	1	3.1E-09	0.0106	1	6.1E-09
Q	2.9E-07	0.0007	1	1.9E-10	0.0010	1	2.8E-10
	1.2E-07	0.0008	1	9.3E-11	0.0016	1	2.0E-10
	4.1E-07	0.0186	1	7.6E-09	0.0323	1	1.3E-08
R	3.4E-07	0.3300	1	1.1E-07	0.4945	1	1.7E-07
	1.4E-07	0.3798	1	5.5E-08	0.8055	1	1.2E-07
	4.8E-07	0.4899	1	2.4E-07	0.9672	1	4.7E-07
S	4.8E-07	0.0007	1	3.2E-10	0.0010	1	4.8E-10
	2.1E-07	0.0008	1	1.6E-10	0.0016	1	3.3E-10
	6.9E-07	0.0186	1	1.3E-08	0.0323	1	2.2E-08
T	2.4E-06	0.0002	1	5.3E-10	0.0003	1	8.0E-10
	1.0E-06	0.0003	1	2.6E-10	0.0005	1	5.6E-10
	3.5E-06	0.0003	1	1.1E-09	0.0006	1	2.2E-09
U	3.6E-07	0.9901	1	3.6E-07	1.4834	1	5.4E-07
	1.6E-07	1.1394	1	1.8E-07	2.4165	2	1.9E-07
	5.2E-07	1.4697	1	7.6E-07	2.9016	3	5.0E-07
V	7.6E-07	0.0013	1	1.0E-09	0.0020	1	1.5E-09
	3.3E-07	0.0015	1	5.0E-10	0.0032	1	1.1E-09
	1.1E-06	0.0057	1	6.2E-09	0.0124	1	1.3E-08
W	6.8E-07	0.0013	1	9.0E-10	0.0020	1	1.4E-09
	2.9E-07	0.0015	1	4.4E-10	0.0032	1	9.4E-10
	9.8E-07	0.0057	1	5.6E-09	0.0124	1	1.2E-08

Sum of On-Road and Off-Road Public Casualties by Road Segment

Section ID (Report Section 2)	Mitigated Large Fire Freq per km-year	Mitigated Small Fire Freq per km-year	Freq of On-Road Public Fatality per km-year	Freq of On-Road Public Injury per km-year	Freq of Off-Road Public Fatality per km-year	Freq of Off-Road Public Injury per km-year	Total Freq of Public Fatality per km-year	Total Freq of Public Injury per km-year
A	4.8E-05	7.2E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
B	4.8E-05	7.2E-06	2.6E-06	5.2E-06	1.7E-08	3.1E-08	2.6E-06	5.2E-06
C	2.5E-05	3.7E-06	1.3E-06	2.7E-06	1.5E-08	2.6E-08	1.3E-06	2.7E-06
D	5.2E-05	7.9E-06	2.8E-06	5.6E-06	1.8E-09	3.4E-09	2.8E-06	5.6E-06
E	2.3E-05	3.5E-06	1.2E-06	2.5E-06	9.3E-09	1.6E-08	1.2E-06	2.5E-06
F	1.6E-05	2.4E-06	8.5E-07	1.7E-06	2.2E-07	2.7E-07	1.1E-06	2.0E-06
G	1.1E-05	1.6E-06	5.8E-07	1.2E-06	3.8E-09	7.1E-09	5.8E-07	1.2E-06
H	1.4E-05	2.1E-06	7.4E-07	1.5E-06	2.0E-07	2.3E-07	9.4E-07	1.7E-06
I	1.9E-05	2.8E-06	9.9E-07	2.0E-06	7.5E-09	1.3E-08	1.0E-06	2.0E-06
J	1.8E-05	2.7E-06	9.5E-07	1.9E-06	5.2E-07	6.2E-07	1.5E-06	2.5E-06
K	4.8E-05	7.2E-06	2.6E-06	5.2E-06	2.1E-07	4.4E-07	2.8E-06	5.6E-06
L/M	4.8E-05	7.2E-06	2.6E-06	5.2E-06	1.1E-07	1.8E-07	2.7E-06	5.4E-06
N	4.2E-05	6.2E-06	2.2E-06	4.5E-06	1.5E-06	1.7E-06	3.7E-06	6.2E-06
O	4.2E-05	6.2E-06	2.2E-06	4.5E-06	1.4E-09	2.7E-09	2.2E-06	4.5E-06
P	2.7E-05	4.1E-06	1.5E-06	3.0E-06	5.3E-09	9.8E-09	1.5E-06	3.0E-06
Q	2.0E-05	2.9E-06	1.0E-06	2.1E-06	7.9E-09	1.4E-08	1.0E-06	2.1E-06
R	2.3E-05	3.5E-06	1.2E-06	2.5E-06	4.0E-07	7.5E-07	1.6E-06	3.2E-06
S	3.3E-05	5.0E-06	1.8E-06	3.6E-06	1.3E-08	2.3E-08	1.8E-06	3.6E-06
T	5.5E-05	8.3E-06	2.9E-06	6.0E-06	1.9E-09	3.6E-09	2.9E-06	6.0E-06
U	2.5E-05	3.7E-06	1.3E-06	2.7E-06	1.3E-06	1.2E-06	2.6E-06	3.9E-06
V	5.2E-05	7.8E-06	2.8E-06	5.6E-06	7.7E-09	1.6E-08	2.8E-06	5.6E-06
W	4.7E-05	7.0E-06	2.5E-06	5.0E-06	6.9E-09	1.4E-08	2.5E-06	5.0E-06

Fire frequencies from table above

On-Road probabilities of public casualties

Large fire probability of public fatality =	0.05	Section 3.7
Small fire probability of public fatality =	0.02	Section 3.7
Large fire probability of public serious injury =	0.1	Section 3.7
Small fire probability of public serious injury =	0.05	Section 3.7
Off-Road frequency of public casualties =	Day + Night	Total 24 hr frequency

Route 1 - Calculation for Societal Risk on the Highest Risk 1-km Segment

On Route 1, the highest risk is segment D on Highway 101 across the hills of Gaviota State Park to the junction with State Route 1. This has been selected for the calculation of societal risk.

Segment D on-road frequency of casualty event:

Frequency of On-Road Public Fatality per km-year = 2.8E-06

Frequency of On-Road Public Injury per km-year = 5.6E-06

Number of Casualties per Event	Probability of Casualty Number (Section 3.7)	Frequency of On-Road Public Fatalities (per km-year)	Frequency of On-Road Public Serious Injury (per km-year)
5	0.04	1.1E-07	2.3E-07
4	0.06	1.7E-07	3.4E-07
3	0.1	2.8E-07	5.6E-07
2	0.2	5.6E-07	1.1E-06
1	0.6	1.7E-06	3.4E-06

Segment D off-road frequency of casualty event:

Segment ID	Fatality Number (min of 1)	Adjusted Frequency of Fatality Event (per km-year)	Serious Injury Number (min of 1)	Adjusted Frequency of Injury Event (per km-year)
D	5	-	5	-
	4	-	4	-
	3	-	3	-
	2	-	2	-
	1	1.8E-09	1	3.4E-09

Route 1 - Combined On and Off-Road Casualties for F-N Societal Profiles

Risk per highest 1-km Segment D

Number of Fatalities	Frequency of Public Fatalities per km-year	Frequency of N or More Public Fatalities per km-year
5	1.1E-07	1.1E-07
4	1.7E-07	2.8E-07
3	2.8E-07	5.6E-07
2	5.6E-07	1.1E-06
1	1.7E-06	2.8E-06

Number of Serious Injuries	Frequency of Public Injuries per km-year	Frequency of N or More Public Injuries per km-year
5	2.3E-07	2.3E-07
4	3.4E-07	5.6E-07
3	5.6E-07	1.1E-06
2	1.1E-06	2.3E-06
1	3.4E-06	5.6E-06

Route 2 - Calculation for Societal Risk on the Highest Risk 1-km Segment

On Route 2, the highest risk is segment N on Highway 101 between Betteravia Road and the Santa Maria River Bridge in Santa Maria. This has been selected for the calculation of societal risk.

Segment N on-road frequency of casualty event:

Frequency of On-Road Public Fatality per km-year = 2.2E-06
Frequency of On-Road Public Injury per km-year = 4.5E-06

Number of Casualties per Event	Probability of Casualty Number (Section 3.7)	Frequency of On-Road Public Fatalities (per km-year)	Frequency of On-Road Public Serious Injury (per km-year)
5	0.04	8.8E-08	1.8E-07
4	0.06	1.3E-07	2.7E-07
3	0.1	2.2E-07	4.5E-07
2	0.2	4.4E-07	8.9E-07
1	0.6	1.3E-06	2.7E-06

Segment N off-road frequency of casualty event:

Segment ID	Fatality Number (min of 1)	Adjusted Frequency of Fatality Event (per km-year)	Serious Injury Number (min of 1)	Adjusted Frequency of Injury Event (per km-year)
N	5	-	5	-
	4	-	4	8.4E-07
	3	-	3	-
	2	8.5E-07	2	2.2E-07
	1	6.3E-07	1	6.3E-07

Route 2 - Combined On and Off-Road Casualties for F-N Societal Profiles

Risk per highest 1-km Segment N

Number of Fatalities	Frequency of Public Fatalities per km-year	Frequency of N or More Public Fatalities per km-year
5	8.8E-08	8.8E-08
4	1.3E-07	2.2E-07
3	2.2E-07	4.4E-07
2	1.3E-06	1.7E-06
1	2.0E-06	3.7E-06

Number of Serious Injuries	Frequency of Public Injuries per km-year	Frequency of N or More Public Injuries per km-year
5	1.8E-07	1.8E-07
4	1.1E-06	1.3E-06
3	4.5E-07	1.7E-06
2	1.1E-06	2.8E-06
1	3.3E-06	6.2E-06

APPENDIX C

CONSEQUENCE MODELING INPUT AND OUTPUT FILES

Text Summary **ALOHA® 5.4.4**

```
SITE DATA:
  Location: SANTA BARBARA, CALIFORNIA
  Building Air Exchanges Per Hour: 0.66 (sheltered single storied)
  Time: June 1, 2018  1201 hours PDT (user specified)

CHEMICAL DATA:
  Chemical Name: N-PENTANE              Molecular Weight: 72.15 g/mol
  PAC-1: 120 ppm     PAC-2: 610 ppm     PAC-3: 15000 ppm
  IDLH: 1500 ppm     LEL: 14000 ppm     UEL: 78000 ppm
  Ambient Boiling Point: 96.7° F
  Vapor Pressure at Ambient Temperature: 0.68 atm
  Ambient Saturation Concentration: 677,493 ppm or 67.7%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
  Wind: 4 meters/second from n at 3 meters
  Ground Roughness: open country         Cloud Cover: 10 tenths
  Air Temperature: 25° C                 Stability Class: D
  No Inversion Height                    Relative Humidity: 50%

SOURCE STRENGTH:
  Direct Source: 320 pounds/min          Source Height: 0
  Release Duration: 60 minutes
  Release Rate: 320 pounds/min
  Total Amount Released: 19,200 pounds

THREAT ZONE:
  Threat Modeled: Flammable Area of Vapor Cloud
  Model Run: Heavy Gas
  Red   : 32 yards --- (14000 ppm = LEL)
  Note: Threat zone was not drawn because effects of near-field patchiness
    make dispersion predictions less reliable for short distances.
  Orange: 49 yards --- (7000 ppm)
  Note: Threat zone was not drawn because effects of near-field patchiness
    make dispersion predictions less reliable for short distances.
  Yellow: 135 yards --- (1400 ppm = 10% LEL)
```

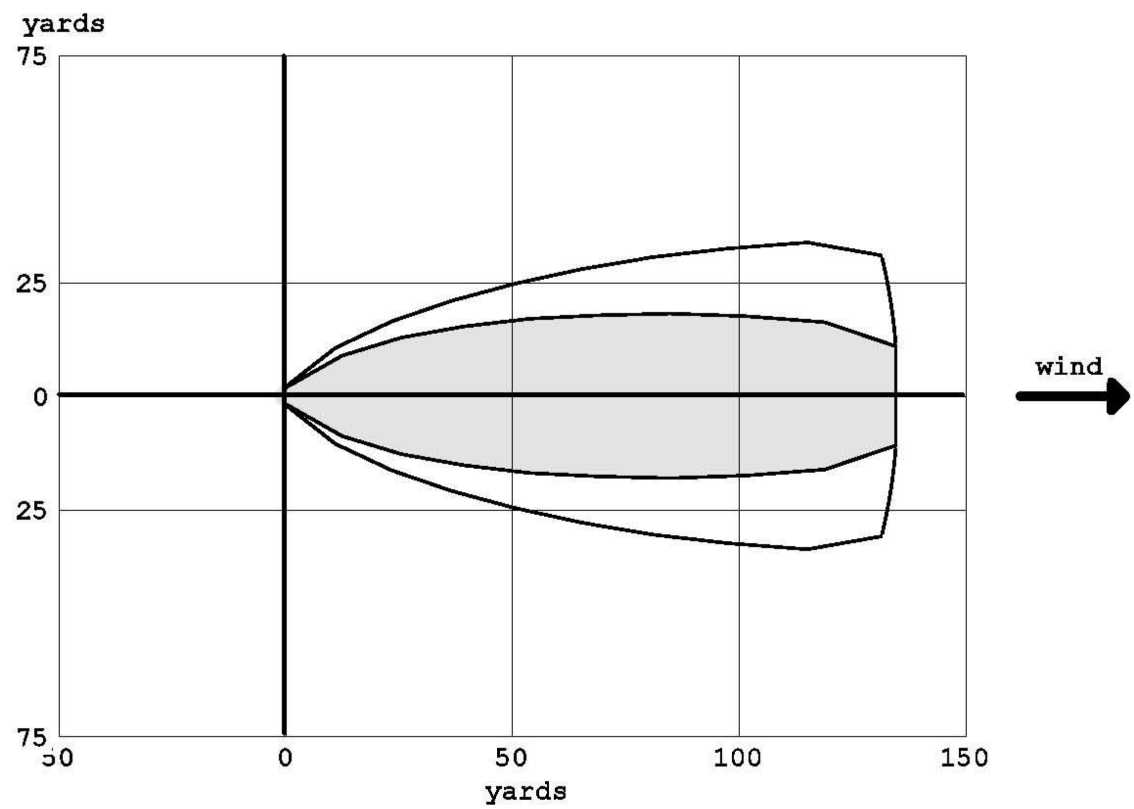
Flammable Threat Zone **ALOHA® 5.4.4**

```
Time: June 1, 2018  1201 hours PDT (user specified)

Chemical Name: N-PENTANE

Wind: 4 meters/second from n at 3 meters

THREAT ZONE:
  Threat Modeled: Flammable Area of Vapor Cloud
  Model Run: Heavy Gas
  Red   : 32 yards --- (14000 ppm = LEL)
  Note: Threat zone was not drawn because effects of near-field patchiness
    make dispersion predictions less reliable for short distances.
  Orange: 49 yards --- (7000 ppm)
  Note: Threat zone was not drawn because effects of near-field patchiness
    make dispersion predictions less reliable for short distances.
  Yellow: 135 yards --- (1400 ppm = 10% LEL)
```



greater than 14000 ppm (LEL) (not drawn)
greater than 7000 ppm (not drawn)
greater than 1400 ppm (10% LEL)
wind direction confidence lines

Text Summary **ALOHA® 5.4.4**

```
SITE DATA:
  Location: SANTA BARBARA, CALIFORNIA
  Building Air Exchanges Per Hour: 0.32 (sheltered single storied)
  Time: June 1, 2018  0101 hours PDT (user specified)

CHEMICAL DATA:
  Chemical Name: N-PENTANE               Molecular Weight: 72.15 g/mol
  PAC-1: 120 ppm     PAC-2: 610 ppm      PAC-3: 15000 ppm
  IDLH: 1500 ppm     LEL: 14000 ppm      UEL: 78000 ppm
  Ambient Boiling Point: 96.7° F
  Vapor Pressure at Ambient Temperature: 0.68 atm
  Ambient Saturation Concentration: 677,493 ppm or 67.7%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
  Wind: 1.5 meters/second from n at 3 meters
  Ground Roughness: open country         Cloud Cover: 0 tenths
  Air Temperature: 25° C                 Stability Class: F
  No Inversion Height                    Relative Humidity: 50%

SOURCE STRENGTH:
  Direct Source: 150 pounds/min          Source Height: 0
  Release Duration: 60 minutes
  Release Rate: 150 pounds/min
  Total Amount Released: 9,000 pounds

THREAT ZONE: (HEAVY GAS SELECTED)
  Threat Modeled: Flammable Area of Vapor Cloud
  Model Run: Heavy Gas
  Red   : 43 yards --- (14000 ppm = LEL)
  Note: Threat zone was not drawn because effects of near-field patchiness
    make dispersion predictions less reliable for short distances.
  Orange: 59 yards --- (7000 ppm)
  Yellow: 145 yards --- (1400 ppm = 10% LEL)
```

Flammable Threat Zone

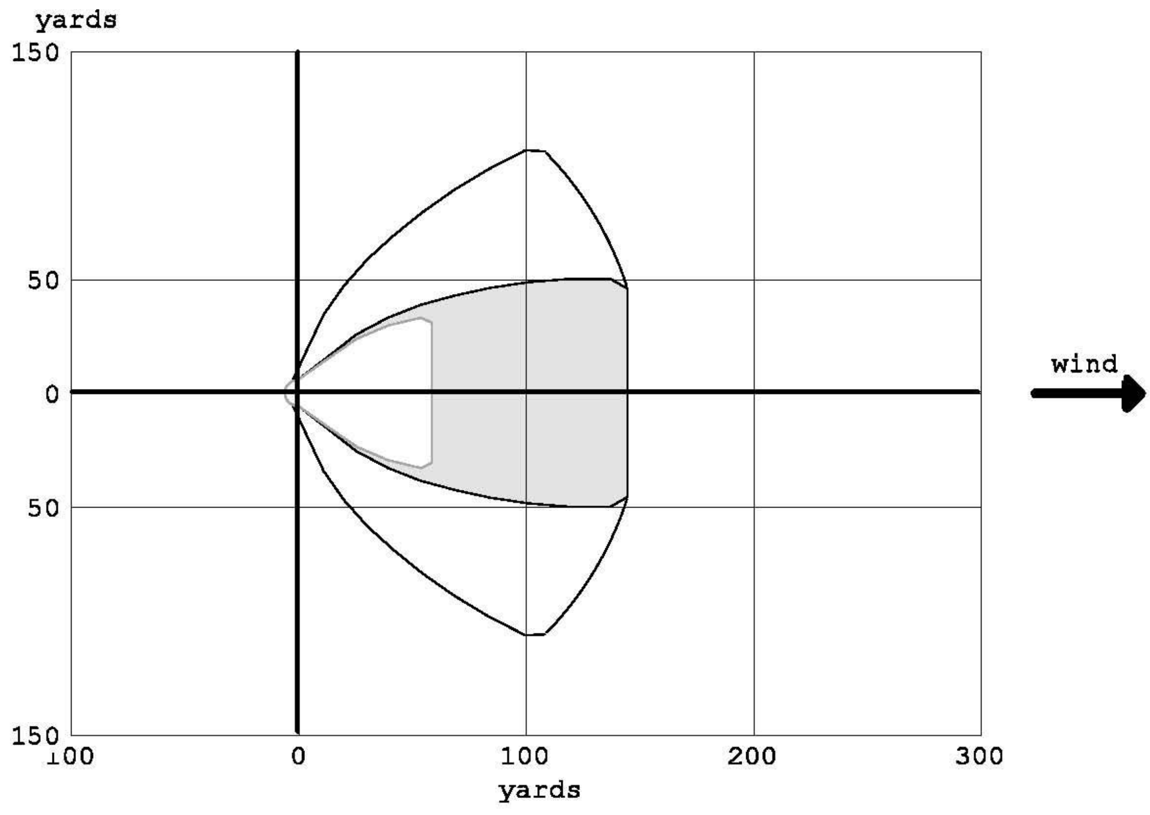
ALOHA® 5.4.4

```
Time: June 1, 2018  0101 hours PDT (user specified)

Chemical Name: N-PENTANE

Wind: 1.5 meters/second from n at 3 meters

THREAT ZONE: (HEAVY GAS SELECTED)
  Threat Modeled: Flammable Area of Vapor Cloud
  Model Run: Heavy Gas
  Red   : 43 yards --- (14000 ppm = LEL)
  Note: Threat zone was not drawn because effects of near-field patchiness
    make dispersion predictions less reliable for short distances.
  Orange: 59 yards --- (7000 ppm)
  Yellow: 145 yards --- (1400 ppm = 10% LEL)
```



greater than 14000 ppm (LEL) (not drawn)
greater than 7000 ppm
greater than 1400 ppm (10% LEL)
wind direction confidence lines

Text Summary **ALOHA® 5.4.4**

```
SITE DATA:
  Location: SANTA BARBARA, CALIFORNIA
  Building Air Exchanges Per Hour: 0.66 (sheltered single storied)
  Time: June 1, 2018  1201 hours PDT (user specified)

CHEMICAL DATA:
  Chemical Name: N-PENTANE                Molecular Weight: 72.15 g/mol
  PAC-1: 120 ppm      PAC-2: 610 ppm      PAC-3: 15000 ppm
  IDLH: 1500 ppm      LEL: 14000 ppm      UEL: 78000 ppm
  Ambient Boiling Point: 96.7° F
  Vapor Pressure at Ambient Temperature: 0.68 atm
  Ambient Saturation Concentration: 677,493 ppm or 67.7%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
  Wind: 4 meters/second from n at 3 meters
  Ground Roughness: open country         Cloud Cover: 10 tenths
  Air Temperature: 25° C                 Stability Class: D
  No Inversion Height                    Relative Humidity: 50%

SOURCE STRENGTH:
  Direct Source: 32 pounds/min           Source Height: 0
  Release Duration: 60 minutes
  Release Rate: 32 pounds/min
  Total Amount Released: 1,920 pounds

THREAT ZONE:
  Threat Modeled: Flammable Area of Vapor Cloud
  Model Run: Heavy Gas
  Red   : 12 yards --- (14000 ppm = LEL)
  Note: Threat zone was not drawn because effects of near-field patchiness
    make dispersion predictions less reliable for short distances.
  Orange: 17 yards --- (7000 ppm)
  Note: Threat zone was not drawn because effects of near-field patchiness
    make dispersion predictions less reliable for short distances.
  Yellow: 72 yards --- (700 ppm)
```

Flammable Threat Zone

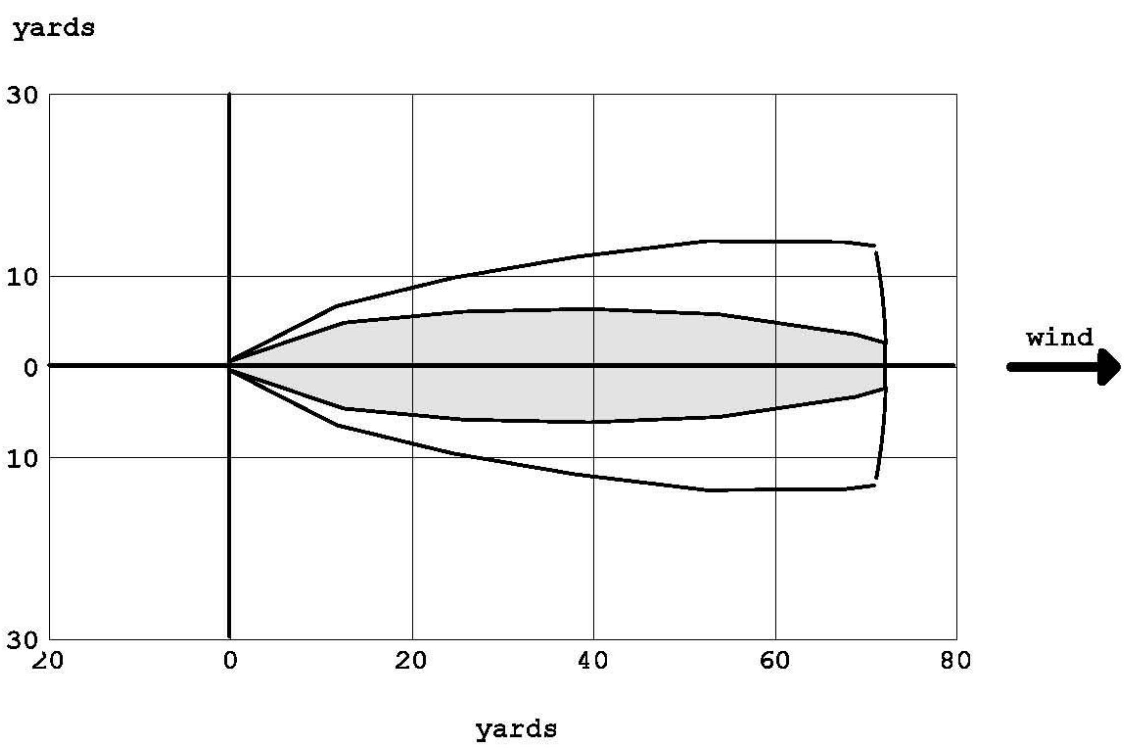
ALOHA® 5.4.4

```
Time: June 1, 2018  1201 hours PDT (user specified)

Chemical Name: N-PENTANE

Wind: 4 meters/second from n at 3 meters

THREAT ZONE:
  Threat Modeled: Flammable Area of Vapor Cloud
  Model Run: Heavy Gas
  Red   : 12 yards --- (14000 ppm = LEL)
  Note: Threat zone was not drawn because effects of near-field patchiness
    make dispersion predictions less reliable for short distances.
  Orange: 17 yards --- (7000 ppm)
  Note: Threat zone was not drawn because effects of near-field patchiness
    make dispersion predictions less reliable for short distances.
  Yellow: 72 yards --- (700 ppm)
```



greater than 14000 ppm (LEL) (not drawn)
greater than 7000 ppm (not drawn)
greater than 700 ppm
wind direction confidence lines

```
SITE DATA:
  Location: SANTA BARBARA, CALIFORNIA
  Building Air Exchanges Per Hour: 0.32 (sheltered single storied)
  Time: June 1, 2018  0101 hours PDT (user specified)

CHEMICAL DATA:
  Chemical Name: N-PENTANE                Molecular Weight: 72.15 g/mol
  PAC-1: 120 ppm     PAC-2: 610 ppm       PAC-3: 15000 ppm
  IDLH: 1500 ppm     LEL: 14000 ppm       UEL: 78000 ppm
  Ambient Boiling Point: 96.7° F
  Vapor Pressure at Ambient Temperature: 0.68 atm
  Ambient Saturation Concentration: 677,493 ppm or 67.7%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
  Wind: 1.5 meters/second from n at 3 meters
  Ground Roughness: open country          Cloud Cover: 0 tenths
  Air Temperature: 25° C                  Stability Class: F
  No Inversion Height                     Relative Humidity: 50%

SOURCE STRENGTH:
  Direct Source: 15 pounds/min            Source Height: 0
  Release Duration: 60 minutes
  Release Rate: 15 pounds/min
  Total Amount Released: 900 pounds

THREAT ZONE: (HEAVY GAS SELECTED)
  Threat Modeled: Flammable Area of Vapor Cloud
  Model Run: Heavy Gas
  Red   : 12 yards --- (14000 ppm = LEL)
  Note: Threat zone was not drawn because effects of near-field patchiness
    make dispersion predictions less reliable for short distances.
  Orange: 19 yards --- (7000 ppm)
  Note: Threat zone was not drawn because effects of near-field patchiness
    make dispersion predictions less reliable for short distances.
  Yellow: 64 yards --- (700 ppm)
```

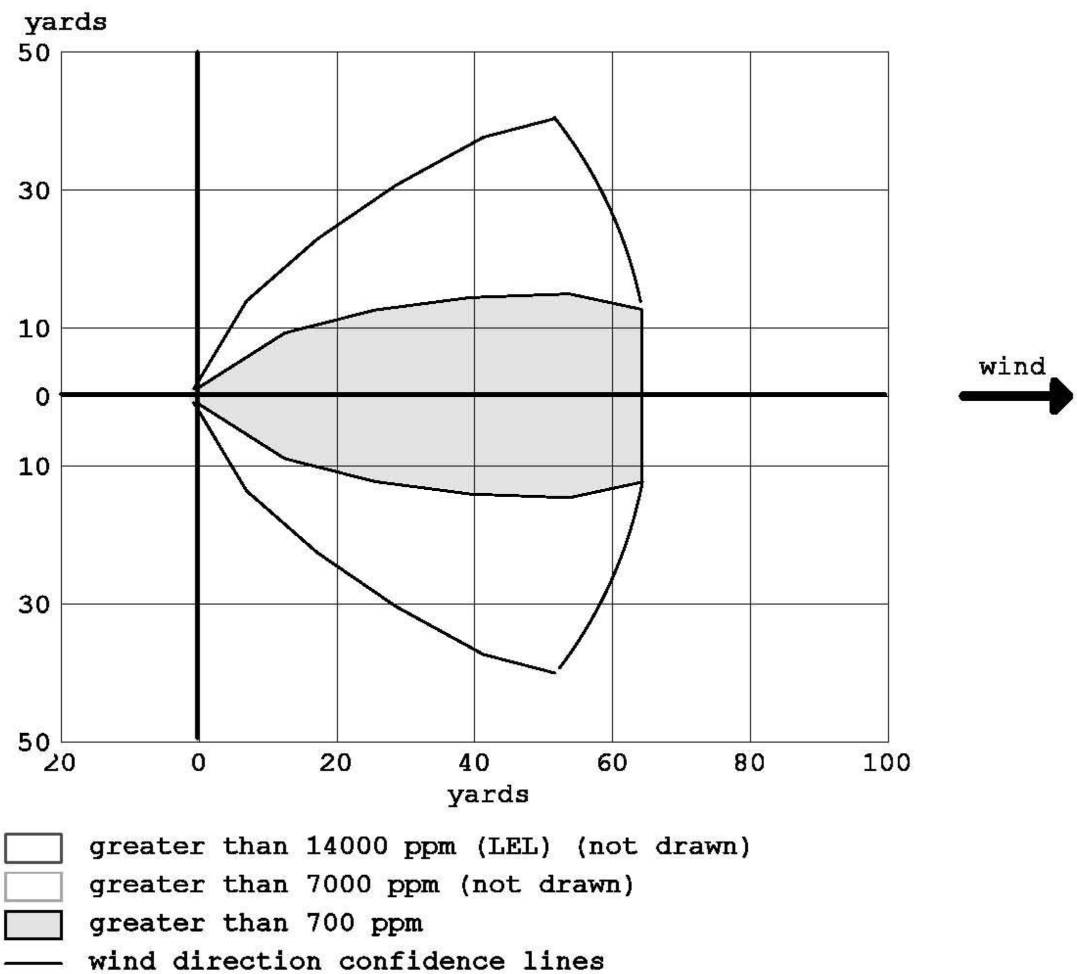
Flammable Threat Zone **ALOHA® 5.4.4**

```
Time: June 1, 2018  0101 hours PDT (user specified)

Chemical Name: N-PENTANE

Wind: 1.5 meters/second from n at 3 meters

THREAT ZONE: (HEAVY GAS SELECTED)
  Threat Modeled: Flammable Area of Vapor Cloud
  Model Run: Heavy Gas
  Red   : 12 yards --- (14000 ppm = LEL)
  Note: Threat zone was not drawn because effects of near-field patchiness
    make dispersion predictions less reliable for short distances.
  Orange: 19 yards --- (7000 ppm)
  Note: Threat zone was not drawn because effects of near-field patchiness
    make dispersion predictions less reliable for short distances.
  Yellow: 64 yards --- (700 ppm)
```



TNO Yellow Book Calcs - Pool Fire on Land - Section 6.5.4
ExxonMobil LFC Crude Oil Truck Small Release

Input Values and Constants

	Crude Oil		
D	pool diameter	11.3 m	37.1 ft
MW	molecular weight	100 g/mol	
ρL	liquid density	940 kg/m3	
Tf	flame temperature	1300 C	1573.0 K
SEP	emissive power	140 kW/m2	
SEPsoot	soot emissive power	20 kW/m2	
ΔHc	heat of combustion	4.40E+07 J/kg	
mv	burn velocity	6.70E-05 m/s	
RH	relative humidity	0.5	

Wind Speeds

D/4	Typical D, Uw1	4 m/s
F/1.5	Night F, Uw2	1.5 m/s

Outputs

Uw1 Radiation Calcs

5 kw/m2	Downwind distance	40 m	131.2 ft
5 kw/m2	Upwind distance	14.6 m	47.9 ft
10 kw/m2	Downwind distance	32.6 m	107.0 ft
10 kw/m2	Upwind distance	10.3 m	33.8 ft

Uw2 Radiation Calcs

5 kw/m2	Downwind distance	34.6 m	113.5 ft
5 kw/m2	Upwind distance	22.9 m	75.1 ft
10 kw/m2	Downwind distance	25.4 m	83.3 ft
10 kw/m2	Upwind distance	14.7 m	48.2 ft

TNO Yellow Book Calcs - Pool Fire on Land - Section 6.5.4
ExxonMobil LFC Crude Oil Truck Large Release

Input Values and Constants

	Crude Oil		
D	pool diameter	35.7 m	117.1 ft
MW	molecular weight	100 g/mol	
ρL	liquid density	940 kg/m3	
Tf	flame temperature	1300 C	1573.0 K
SEP	emissive power	140 kW/m2	
SEPsoot	soot emissive power	20 kW/m2	
ΔHc	heat of combustion	4.40E+07 J/kg	
mv	burn velocity	6.70E-05 m/s	
RH	relative humidity	0.5	

Wind Speeds

D/4	Typical D, Uw1	4 m/s
F/1.5	Night F, Uw2	1.5 m/s

Outputs

Uw1 Radiation Calcs

5 kw/m2	Downwind distance	72.6 m	238.2 ft
5 kw/m2	Upwind distance	26.7 m	87.6 ft
10 kw/m2	Downwind distance	54.6 m	179.1 ft
10 kw/m2	Upwind distance	22.6 m	74.2 ft

Uw2 Radiation Calcs

5 kw/m2	Downwind distance	49.2 m	161.4 ft
5 kw/m2	Upwind distance	43.9 m	144.0 ft
10 kw/m2	Downwind distance	34.3 m	112.5 ft
10 kw/m2	Upwind distance	29 m	95.1 ft

Appendix C.2

LFC Facility Truck Loading Consequence Modeling

```
        +-----------------------------------------------------------------+
        |                 CANARY by Quest - Version 4.6.2                 |
        |                        CANARY Case Input                        |
        |                     Case Name - Loading                         |
        |                   Thu Jan  3 12:42:06 2019                      |
        |          Quest Consultants Inc., Norman, Oklahoma, USA          |
        |        www.questconsult.com      canary@questconsult.com        |
        |         telephone (405) 329-7475     fax (405) 329-7734         |
        +-----------------------------------------------------------------+

        Title: LoadingSpill

Case Type           : Vapor Dispersion
Case Name           : Loading
User ID             :
Project Number      :
Type of Units       : English Units

  NOTES:

MATERIAL MENU
Materials Released  : Number  Formula   Name                         Fraction
Component  1        :     7 = C5H12     n-Pentane                    0.050000
Component  2        :     9 = C7H16     n-Heptane                    0.240000
Component  3        :    36 = C17H36    n-Heptadecane                0.710000
Component  4        :
Component  5        :
Component  6        :
Component  7        :
Component  8        :
Component  9        :
Component 10        :

Temperature         :       100.00 °F
Pressure            :        76.00 psia
The material is LIQUID

  NOTES:

ENVIRONMENT MENU
Wind speed                                      3.36 mph
Wind speed measurement height                   32.8 feet
Stability class &lt;A-F&gt;                              F
Relative humidity                                 70 %
Air temperature                                 80.3 °F
Spill surface temperature                       80.3 °F

Substrate name                            Low density concrete
  Substrate thermal conductivity              0.0546 Btu/hr-ft-F
  Substrate density                               34 lb/cu.ft
  Substrate heat Capacity                       0.30 Btu/lb-F
  Substrate delay time                             0 sec
Surrounding terrain                       Long grass or crops > 15 cm (6 in)

  NOTES:
```

Case continued on page 2.

```
+-----------------------------------------------------------------+
|                CANARY by Quest - Version 4.6.2                  |
|                       CANARY Case Input                         |
|                      Case Name - Loading                        |
|                    Thu Jan  3 12:42:06 2019                     |
+-----------------------------------------------------------------+

Page 2  Title: LoadingSpill


RELEASE MENU
Type of release: Unregulated, Continuous release
Release duration                                    30 min
Normal flow rate                                 16.16 lb/sec
Duration of normal flow                              5 min
Volume of vessel                                  0.00 cu.ft
Pipe inner diameter                               4.03 inches
Equivalent release diameter                       4.00 inches
Pipe length upstream of break                     50.0 feet
Height of release point                            0.0 feet
Angle of release from horizontal                   0.0 degrees

  NOTES:

IMPOUNDMENT MENU
Unconfined

  NOTES:

VDVE MENU
Vapor generation and dispersion - Flammable calculation
Concentration endpoint 1                               LFL mol%
Concentration endpoint 2                           1/2 LFL mol%
Concentration endpoint 3                          1/10 LFL mol%

Dispersion coefficient averaging time                1 min


  NOTES:
```

```
+-----------------------------------------------------------------+
|                 CANARY by Quest - Version 4.6.2                 |
|              Liquid Pool Vapor Generation Model                 |
|                     Case Name - Loading                         |
|                    Thu Jan  3 12:42:06 2019                     |
|         Quest Consultants Inc., Norman, Oklahoma, USA           |
|       www.questconsult.com     canary@questconsult.com          |
|         telephone (405) 329-7475    fax (405) 329-7734          |
+-----------------------------------------------------------------+
```

TITLE: LoadingSpill

Time (sec)	Liquid Remaining (ft3)	Pool/Dike Radius (feet)	Vapor Rate (lb/sec)
0.00000	0.00000	0.00000	0.00000
20.0000	6.84010	4.52690	0.368392E-01
40.0000	13.6692	5.70210	0.558122E-01
60.0000	20.4917	6.52559	0.711630E-01
80.0000	27.3078	7.18045	0.845429E-01
100.000	34.1186	7.73360	0.966242E-01
120.000	40.9226	8.21654	0.107762
140.000	47.7242	8.64829	0.118170
160.000	54.5223	9.04035	0.127992
180.000	61.3169	9.40092	0.137328
200.000	68.1043	9.73556	0.146252
220.000	74.8883	10.0482	0.154822
240.000	81.6722	10.3425	0.163080
260.000	88.4491	10.6207	0.171061
280.000	95.2260	10.8852	0.178799
300.000	101.996	11.1371	0.186317
320.000	101.918	11.1342	0.183720
340.000	101.840	11.1316	0.182097
360.000	101.763	11.1286	0.180850
380.000	101.689	11.1260	0.179844
400.000	101.611	11.1230	0.179015
420.000	101.537	11.1204	0.178325
440.000	101.459	11.1175	0.177745
715.000	100.435	11.0801	0.175193
990.000	99.4179	11.0427	0.174128
1265.00	98.4043	11.0049	0.173061
1540.00	97.4014	10.9672	0.171998
1815.00	96.4020	10.9298	0.170938
2090.00	95.4096	10.8921	0.169882
2365.00	94.4208	10.8543	0.168826
2640.00	93.4391	10.8169	0.167774
2915.00	92.4644	10.7792	0.166722
3190.00	91.4968	10.7415	0.165675
3465.00	90.5362	10.7037	0.164632
3600.00	90.0665	10.6850	0.164117

Ending Message: Normal Ending

```
+-----------------------------------------------------------------+
|                 CANARY by Quest - Version 4.6.2                 |
|                   Pool Fire Radiation Model                     |
|                  Case Name - LoadingPoolD                       |
|                  Thu Jan  3 12:42:41 2019                       |
|          Quest Consultants Inc., Norman, Oklahoma, USA          |
|        www.questconsult.com      canary@questconsult.com        |
|         telephone (405) 329-7475     fax (405) 329-7734         |
+-----------------------------------------------------------------+
```

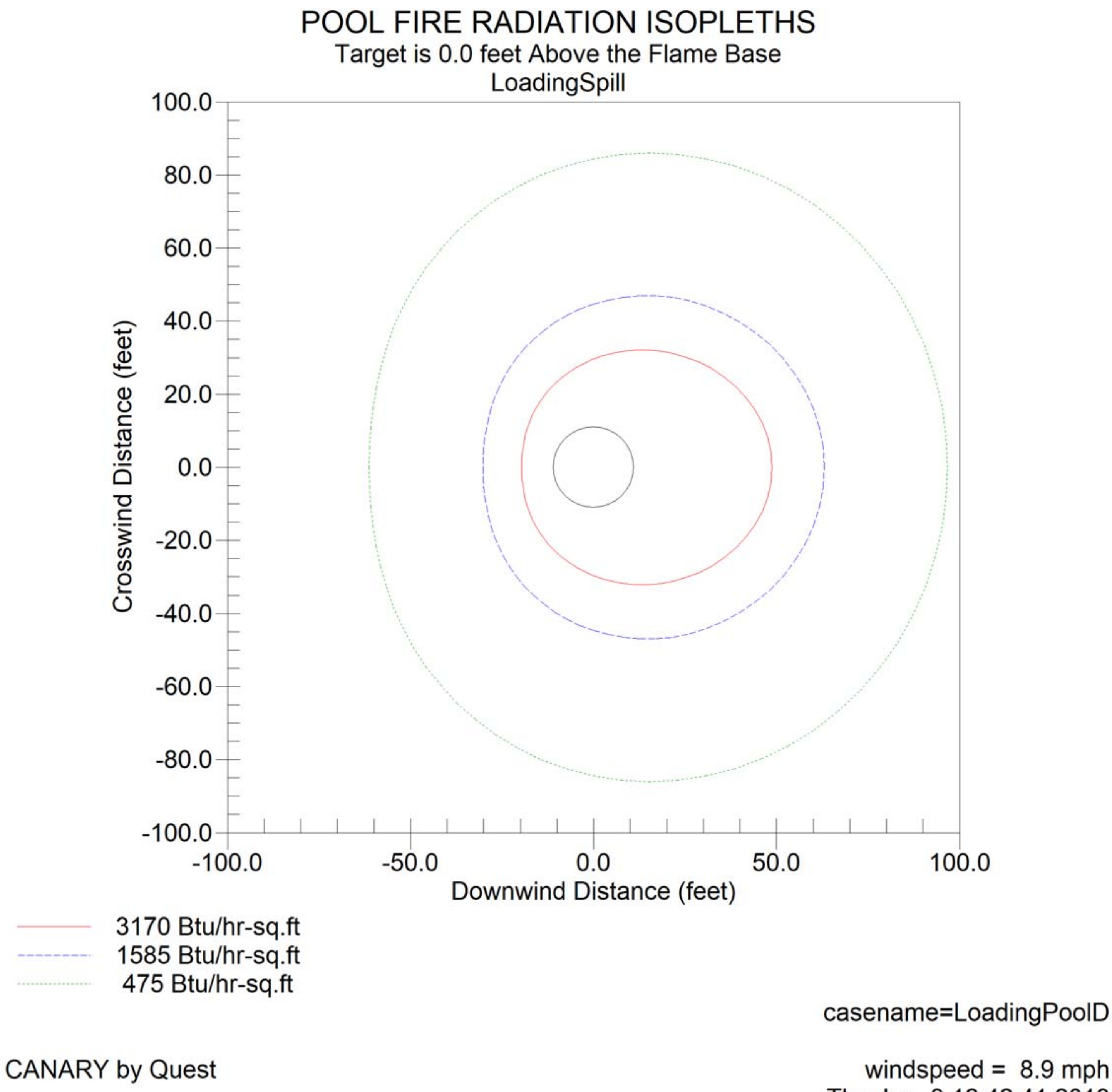
Title: LoadingSpill

Length of Flame	: 35.1	feet
Flame Tilt from Vertical	: 42.1	degrees
Target Elevation	: 0.0	feet
Pool Elevation	: 0.0	feet
Wind Speed	: 8.9	mph
Substrate	: Land	

Downwind Distance from Center of Pool (feet)	Flux to Vertical Target (Btu/hr-sq.ft)	Flux to Horizontal Target (Btu/hr-sq.ft)	Maximum Flux (Btu/hr-sq.ft)
20.0	13484	18928	23240
21.3	12397	17089	21112
22.6	11470	15186	19031
23.9	10641	13450	17150
25.4	9882	11791	15384
27.0	9170	10178	13700
28.6	8456	8630	12083
30.4	7672	7206	10525
32.2	6845	5960	9076
34.2	6037	4925	7791
36.3	5288	4078	6678
38.5	4628	3389	5736
40.9	4056	2816	4938
43.4	3567	2333	4262
46.0	3135	1917	3674
48.8	2748	1558	3159
51.8	2401	1251	2707
55.0	2085	991	2309
58.4	1801	777	1961
62.0	1548	604	1662
65.7	1325	466	1404
69.8	1130	358	1185
74.0	962	274	1000
78.6	818	210	844
83.4	696	162	714
88.5	592	124	605
93.9	504	96	513
99.6	430	74	436
105.8	367	58	371
112.2	314	45	317

Downwind Distances to Endpoints:

Distance (feet)	Maximum Flux (Btu/hr-sq.ft)
48.8	3170
63.1	1585
96.7	475


POOL FIRE RADIATION ISOPLETHS
Target is 0.0 feet Above the Flame Base
LoadingSpill
Crosswind Distance (feet)
Downwind Distance (feet)
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
-60.0
-80.0
-100.0
-50.0
50.0
3170 Btu/hr-sq.ft
1585 Btu/hr-sq.ft
475 Btu/hr-sq.ft
casename=LoadingPoolD
CANARY by Quest
windspeed = 8.9 mph
Thu Jan 3 12:42:41 2019

```
+-----------------------------------------------------------------+
|                  CANARY by Quest - Version 4.6.2                |
|                         CANARY Case Input                       |
|                          Case Name - Pump                       |
|                      Thu Jan  3 12:41:52 2019                   |
|           Quest Consultants Inc., Norman, Oklahoma, USA         |
|         www.questconsult.com      canary@questconsult.com       |
|          telephone (405) 329-7475     fax (405) 329-7734        |
+-----------------------------------------------------------------+

        Title: Pump Spill

Case Type           : Vapor Dispersion
Case Name           : Pump
User ID             :
Project Number      :
Type of Units       : English Units

  NOTES:

MATERIAL MENU
Materials Released  : Number  Formula   Name                        Fraction
Component  1        :     7 = C5H12     n-Pentane                   0.050000
Component  2        :     9 = C7H16     n-Heptane                   0.240000
Component  3        :    36 = C17H36    n-Heptadecane               0.710000
Component  4        :
Component  5        :
Component  6        :
Component  7        :
Component  8        :
Component  9        :
Component 10        :

Temperature         :       100.00 °F
Pressure            :        76.00 psia
The material is LIQUID

  NOTES:

ENVIRONMENT MENU
Wind speed                                      3.36 mph
Wind speed measurement height                   32.8 feet
Stability class <A-F>                              F
Relative humidity                                 70 %
Air temperature                                 80.3 °F
Spill surface temperature                       80.3 °F

Substrate name                            Low density concrete
  Substrate thermal conductivity              0.0546 Btu/hr-ft-F
  Substrate density                               34 lb/cu.ft
  Substrate heat Capacity                       0.30 Btu/lb-F
  Substrate delay time                             0 sec
Surrounding terrain                       Long grass or crops > 15 cm (6 in)

  NOTES:
```

Case continued on page 2.

```
+-----------------------------------------------------------------+
|                CANARY by Quest - Version 4.6.2                  |
|                       CANARY Case Input                         |
|                        Case Name - Pump                         |
|                    Thu Jan  3 12:41:52 2019                     |
+-----------------------------------------------------------------+
```

Page 2 Title: Pump Spill

```
RELEASE MENU
Type of release: Unregulated, Continuous release
Release duration                                     5 min
Normal flow rate                                 62.15 lb/sec
Duration of normal flow                             30 min
Volume of vessel                                  0.00 cu.ft
Pipe inner diameter                              10.02 inches
Equivalent release diameter                      10.00 inches
Pipe length upstream of break                    500.0 feet
Pipe length downstream of break                   0.0 feet
Height of release point                            0.0 feet
Angle of release from horizontal                   0.0 degrees

  NOTES:

IMPOUNDMENT MENU
Unconfined

  NOTES:

VDVE MENU
Vapor generation and dispersion - Flammable calculation
Concentration endpoint 1                           LFL mol%
Concentration endpoint 2                       1/2 LFL mol%
Concentration endpoint 3                      1/10 LFL mol%

Dispersion coefficient averaging time               1 min


  NOTES:
```

```
+-----------------------------------------------------------------+
|              CANARY by Quest - Version 4.6.2                    |
|           Liquid Pool Vapor Generation Model                    |
|                    Case Name - Pump                             |
|                Thu Jan  3 12:41:52 2019                         |
|       Quest Consultants Inc., Norman, Oklahoma, USA             |
|      www.questconsult.com     canary@questconsult.com           |
|       telephone (405) 329-7475    fax (405) 329-7734            |
+-----------------------------------------------------------------+
```

TITLE: Pump Spill

Time (sec)	Liquid Remaining (ft3)	Pool/Dike Radius (feet)	Vapor Rate (lb/sec)
0.00000	0.00000	0.00000	0.00000
20.0000	26.3165	7.37566	0.886743E-01
40.0000	52.6083	9.29265	0.134425
60.0000	78.8824	10.6362	0.171445
80.0000	105.139	11.7051	0.203718
100.000	131.385	12.6073	0.232874
120.000	157.620	13.3953	0.259749
140.000	183.845	14.0997	0.284859
160.000	210.055	14.7398	0.308559
180.000	236.259	15.3281	0.331090
200.000	262.452	15.8743	0.352629
220.000	288.637	16.3852	0.373309
240.000	314.813	16.8658	0.393261
260.000	340.981	17.3202	0.412529
280.000	367.131	17.7520	0.431224
300.000	393.299	18.1634	0.449390
320.000	393.088	18.1604	0.443217
340.000	392.911	18.1575	0.439381
360.000	392.734	18.1549	0.436449
380.000	392.558	18.1519	0.434090
400.000	392.346	18.1489	0.432172
420.000	392.169	18.1463	0.430563
440.000	391.993	18.1434	0.429240
715.000	389.521	18.1050	0.424015
990.000	387.049	18.0666	0.422406
1265.00	384.612	18.0282	0.420796
1540.00	382.140	17.9902	0.419187
1815.00	379.703	17.9518	0.417578
2090.00	377.267	17.9137	0.415990
2365.00	374.865	17.8753	0.414403
2640.00	372.464	17.8369	0.412794
2915.00	370.062	17.7986	0.411206
3190.00	367.661	17.7605	0.409597
3465.00	365.295	17.7218	0.408009
3600.00	364.130	17.7028	0.407216

Ending Message: Normal Ending

```
+-----------------------------------------------------------------+
|                CANARY by Quest - Version 4.6.2                  |
|                   Pool Fire Radiation Model                     |
|                    Case Name - PumpPoolD                        |
|                   Thu Jan  3 12:42:28 2019                      |
|          Quest Consultants Inc., Norman, Oklahoma, USA          |
|        www.questconsult.com      canary@questconsult.com        |
|         telephone (405) 329-7475     fax (405) 329-7734         |
+-----------------------------------------------------------------+
```

Title: Pump Spill

Length of Flame	: 51.0 feet
Flame Tilt from Vertical	: 35.2 degrees
Target Elevation	: 0.0 feet
Pool Elevation	: 0.0 feet
Wind Speed	: 8.9 mph
Substrate	: Land

Downwind Distance from Center of Pool (feet)	Flux to Vertical Target (Btu/hr-sq.ft)	Flux to Horizontal Target (Btu/hr-sq.ft)	Maximum Flux (Btu/hr-sq.ft)
31.9	12900	16630	21046
33.7	11924	13788	18229
35.5	11002	11011	15566
37.5	9854	8526	13031
39.5	8512	6564	10749
41.7	7215	5160	8870
43.9	6101	4190	7401
46.4	5199	3504	6270
48.9	4479	2994	5387
51.6	3899	2589	4680
54.4	3432	2255	4107
57.4	3044	1963	3623
60.5	2720	1706	3210
63.8	2436	1472	2846
67.3	2183	1260	2521
71.0	1955	1068	2228
74.9	1746	896	1963
79.0	1554	744	1723
83.3	1378	612	1508
87.9	1217	499	1316
92.7	1070	405	1144
97.8	939	326	994
103.1	821	262	862
108.8	716	210	746
114.7	624	168	646
121.0	543	134	560
127.6	473	107	485
134.6	412	86	421
142.0	358	69	365
149.7	312	55	317

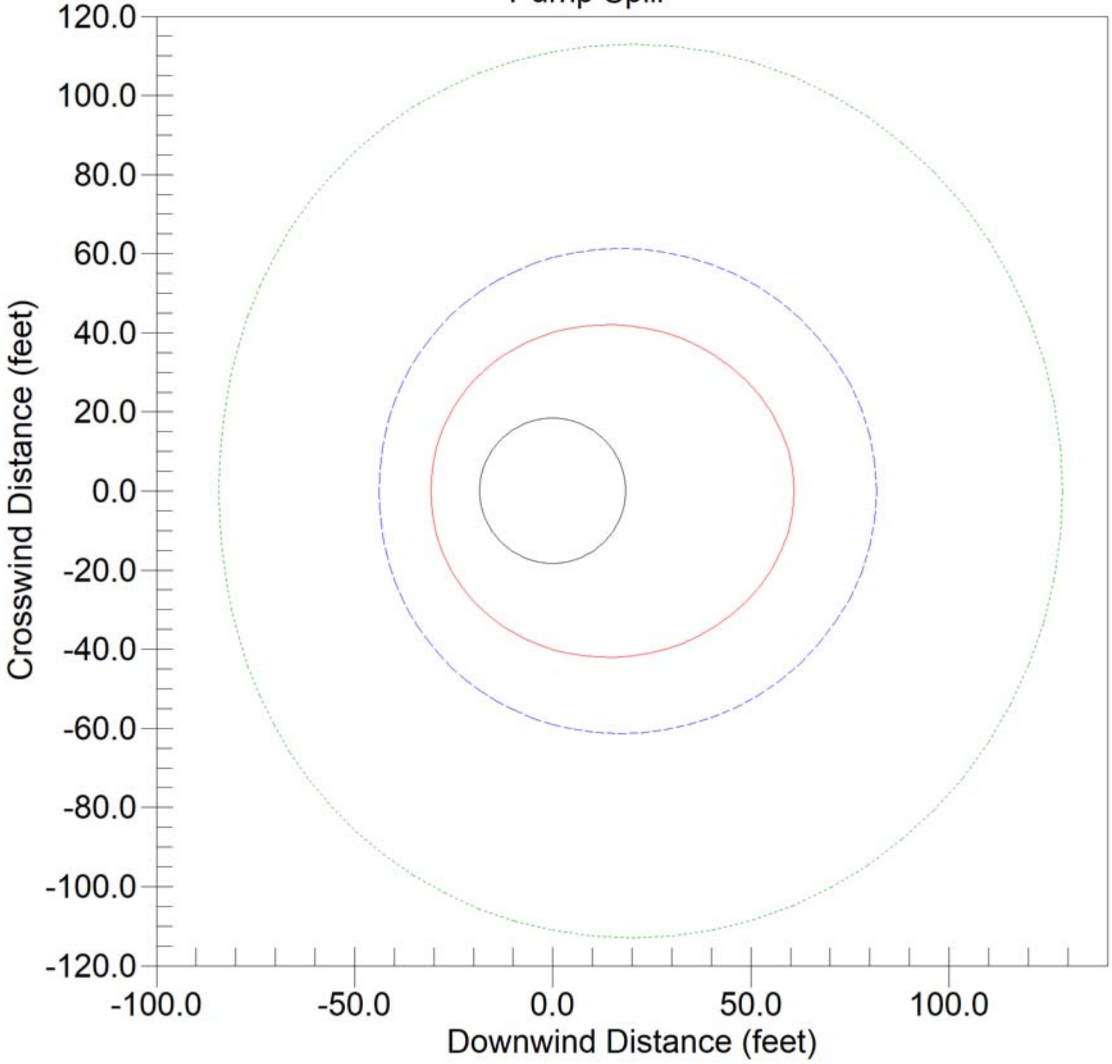
Downwind Distances to Endpoints:

Distance (feet)	Maximum Flux (Btu/hr-sq.ft)
60.9	3170
81.8	1585
128.6	475

POOL FIRE RADIATION ISOPLETHS

Target is 0.0 feet Above the Flame Base

Pump Spill



3170 Btu/hr-sq.ft

1585 Btu/hr-sq.ft

475 Btu/hr-sq.ft

casename=PumpPoolD

CANARY by Quest

windspeed = 8.9 mph

Thu Jan 3 12:42:28 2019

Appendix C.3

SO2 Emissions from Crude Fires

Modeling Results for SO_2 Emissions from Crude Oil Tanker Truck Fire

Burning of crude oil can produce emissions of toxic materials, particularly sulfur dioxide (SO_2). The extent to which a crude oil fire resulting from a truck accident will cause toxic impacts that can produce serious injuries or fatalities are discussed in this analysis.

MRS Environmental, Inc. conducted modeling to determine the potential impacts of SO_2 emissions from a crude oil fire. The analysis has included a blended crude with a 5.4% total sulfur content.

Sulfur from Crude Oil Fires

As the production, storage and transportation of crude oil occurs at an oil field, a fire involving a crude oil spill could generate impacts. The impacts of a crude oil fire in the TQRA were associated with thermal radiation from the fire. Additional impacts may occur due to sulfur dioxide (SO_2) in the smoke plume that is generated during combustion of the crude oil containing sulfur. This analysis examines the potential for impacts from SO_2 associated with a crude oil fire.

The smoke from a large crude oil fire includes carbon dioxide, water vapor, smoke particulate, carbon monoxide, hydrocarbons, sulfur compounds, oxides of nitrogen, and other aerosols and gases. The pollutant of greatest interest in assessing the potential health effects from exposure to the smoke is particulate because it has been shown (NIST 1997) to be the most likely combustion product to violate ambient air quality standards. Also, exposure to SO_2, which at certain concentrations can be acutely hazardous, can lead to serious injury or fatality.

There are three principle factors that determine the quantity of pollutants produced by a crude oil fire. These include the fire area, the average oil burning rate, and the average soot yield. The fire area is the area of the burning oil. The burning rate is the rate at which the oil mass is consumed by the fire, and the soot yield is the mass fraction of the oil that is converted to particulate matter instead of being combusted. Both the burning rate and soot yields are functions of the oil type and the burning conditions.

Historical experimental burns in Alaska and Canada have provided important empirical data for estimating crude oil fire plumes. These experiments were performed in the 1990s and multiple reports have been disseminated about the results. Measurements included burn rates for various types of oils, atmospheric measurements of particulates (total, less than 10 micrometers and less than 2.5 micrometers) as well as SO_2, NO_x and other combustion byproducts. In combination with burn rates, emission factors have also been developed for a range of pollutants, including SO_2 (NIST 1997).

SO_2 is produced during the burning of the crude oil as a function of the sulfur content of the crude oil. Emission factors developed as part of test burns indicate a range from 3 grams SO_2/kg of crude oil burned for lighter crudes with low sulfur content to 25 grams SO_2/kg for Alaska ANS crude oil, with sulfur content that ranges up to 2.6% with an average of 1.3 % between 1989 and 2010 according to ANS sampling data (Finga 2010).

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SO_2 is a toxic material with ERPG levels of 25 ppm and 3 ppm (ERPG-3 and ERPG-2, respectively). A concern for areas near a crude oil fire is the potential for SO_2 levels to exceed those ERPG-2 and ERPG-3 levels that could cause serious injury or fatality as a result of exposure. Historical investigations of crude oil burns indicate that particulate levels have not exceeded 2,000 ug/m3 (NIST 1997), with other studies indicating a substantially lower impact, down to 100 ug/m3, (Evans 2003, NIST 2011). Corresponding SO_2 levels would therefore not be above 1 ppm based on the measurements of particulates and the ratio of the emission factors between particulates and SO_2 (a ratio of PM/SO_2 ranges from 1.4 – 150 depending on the crude type, with the 1.4 ratio being the equivalent of a 5.4% crude sulfur level). Note that the conversion of SO_2 from ug/m3 to ppm is 1 ppm = 2,620 ug/m3 as per CARB.

Modeling of crude oil fires has been conducted historically using specialized models, such as the ALOFT (NIST 2011) and Fire Dynamics Simulator (FDS) models as well as conventional dispersion models such as IST and AERMOD (Evans 2003). Dispersion models can estimate the downwind ground level pollutant impacts by incorporating the thermal induced buoyancy and plume rise along with meteorological components. Source terms have historically been developed for crude fires similar to the manner in which source terms are developed for flares using the flare model (Evans 2003, EPA 2016) where the height is determined by the heat release rate and the diameter is determined by the heat release rate in combination with the radiative heat loss fraction (EPA 2016). The flare model also assumes a release temperature of 1273 kelvin and a release velocity of 20 meters/second.

Historical test burns have indicated a range of values for burn rates, ranging from 0.019 to 0.056 kg/m2-s (Evans 2003, NIST 1997). Crude oil heating values have also been measured and estimated in the crude oil burn studies and generally range up to about 44 MJ/kg. Radiative heat loss fraction estimates have varied and are a function of a number of factors, including the extent to which the crude oil produces soot and the size of the burn area due to the fact that more heat is absorbed by the smoke plume if the burn area is larger. Modeling efforts by Evans (Evans 2003) utilized the flare model (EPA 2016) default radiative heat loss fraction of 0.55. However, other studies of crude oil burns have indicated that radiative heat loss fractions could be as low as 0.10 for crude oil for larger fires and crude fires involving a substantial amount of soot (Yang 1994, NIST 1997). Generally, the lower the radiative heat losses, the more thermal buoyancy the plume would generate as more heat would be absorbed by the plume, as opposed to being lost to radiation. The associated increase in thermal buoyancy would decrease nearby ground level pollutant concentrations by promoting mixing with ambient air and downwind transport. AERMOD modeling indicates that the ground level impacts would decrease with a decreasing radiative heat loss factor. Therefore, the default radiative heat loss factor 0f 0.55 was utilized in this analysis to be conservative.

In order to provide estimates of SO_2 ground level concentrations around crude oil fires to access potential impacts, the AERMOD model was run assuming a crude oil spill. The source terms and assumptions are listed below in Table 1. The AERMOD model was run to determine the peak 1-hour ground-level concentrations using the Santa Maria Airport meteorological data for the years 2010-2014. Calms were set to a default minimum wind speed of 0.5 m/s. The use of 5 years of actual meteorological data allows for an estimate of downwind impacts over a realistic and large range of wind and stability conditions. Attachment 1 provides the AERMOD modeling files.

Table 1 AERMOD and Modeling Inputs

Source Term	Value	Basis
Spilled area	about 1,394 m2 (150’x100’)	Estimated area of the spills volume
Burn rate	0.056 kg/s/m2	Peak burn rate associated with 6 burns in the NIST 1997 study
Radiative heat loss fraction	0.55	Flare model default values, also used by Evans 2003, and the most conservative value
SO2 emission factor	104 g/kg	NIST 1997 for ANS crude emission factor of 25 g/kg with an average sulfur content of 1.3%; ratio to 5.4% sulfur content of the project crude.
AERMOD version	16216r	
Point source parameters	83.1 m height 1273 K temperature 20 m/s velocity 18.98 m diameter	Based on flare model (EPA 2016)
Receptor grid	Polar orientation	Flat terrain
Meteorological files	Santa Maria Airport 2010-2014	Calms set to 0.5 m/s
Averaging time	Peak 1 hour	

The results of the AERMOD modeling show that, in the area immediately around the crude oil fire at ground level, SO_2 (and the corresponding particulate levels) remain low as the thermal buoyancy produced by the burning crude oil lift the plume substantially. In this near-field area, thermal radiation is the primary issue of concern for serious injuries and fatalities. The peak ground level value for SO_2 is modeled to be 0.48 ppm at a distance of close to 3 km from the crude oil fire, as the plume has cooled and mixed with ambient air as it moves downwind. Figure 1 shows the maximum 1-hour concentrations around the crude oil fire location as produced by the AERMOD model and Santa Maria Airport meteorological dataset. Note that these maximum 1-hour concentrations do not occur simultaneously but are the highest levels that could occur if the crude oil fire were to occur at any hour during the 5-year meteorological dataset.

The analysis indicates that the peak ground level SO_2 concentration of 0.48 ppm is substantially below the levels that could cause serious injury or fatality (3-25 ppm). However, the levels may exceed those established by regulatory agencies for more chronic health effects, such as the California 1-hour standard for SO_2 of 0.25 ppm. The results of this modeling analysis show that SO_2 emissions from a crude oil fire would not change the risk profiles in the Crude Oil Transportation QRA.

The methodology and approach used in this analysis is supported by actual field testing results as well as EPA approved models and modeling methodology.

References

EPA 1974, Effective Stack Height and Plume Rise, Air Pollution Training Institute, SI:406

EPA 2004, Aermod: Description of Model Formulation, EPA-454/R-03-004, September 2004

EPA 2016 AERSCREEN User Guide EPA-454/B-16-004, December 2016

Evans 2003 In-Situ Burning of Oil Spills; Mesoscale Experiments

Finga 2010, Review of the North Slope Oil Properties Relevant to Environmental Assessment and Prediction, June 2010

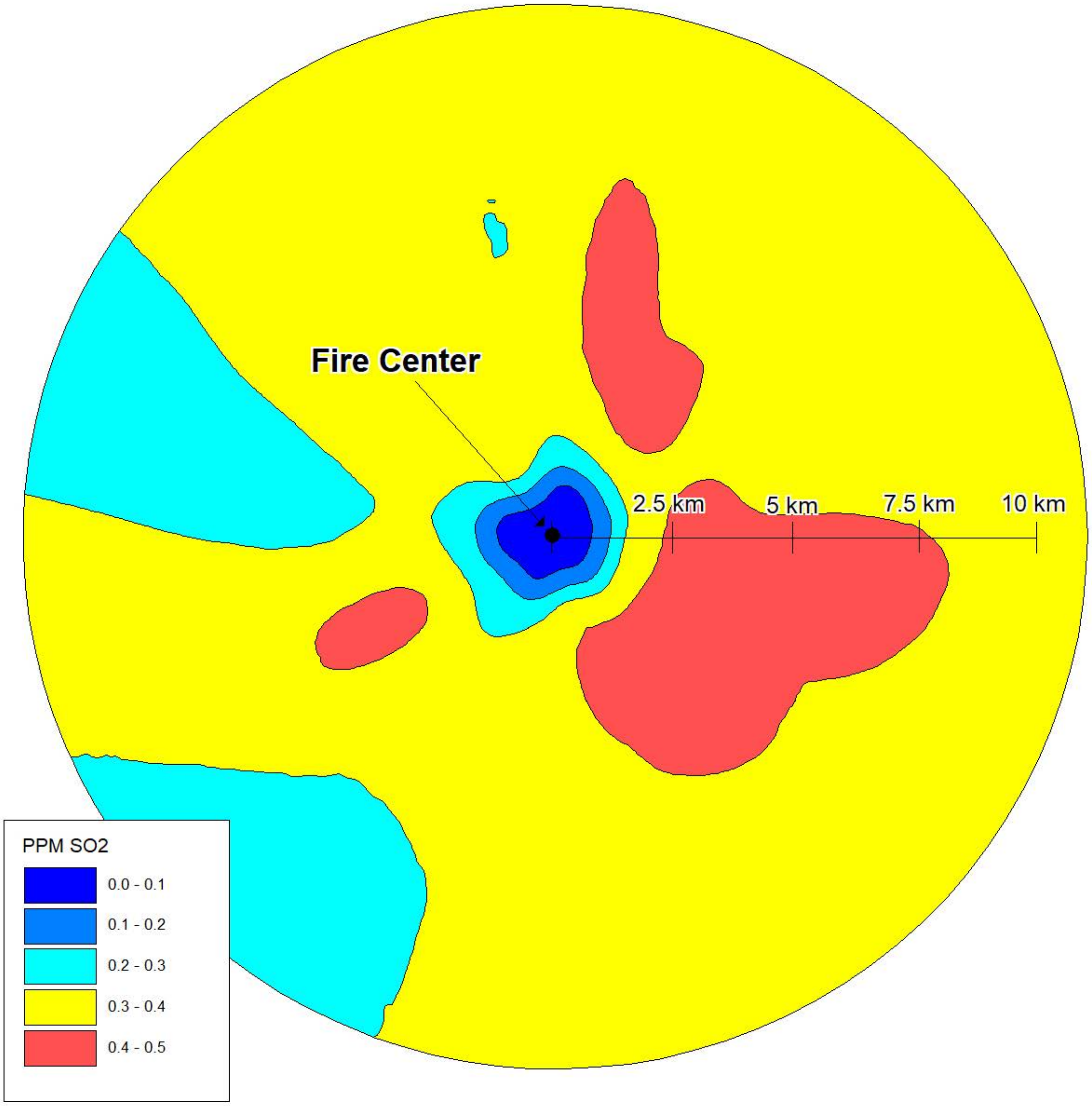
NIST 1997 Smoke Plume Trajectory from IN-Situ Burning of Crude Oil IN Alaska – Field Experiments and Modeling of Complex Terrain, (McGratten, Baum, Walton, Trelles), NISTIR 5958, January 1997

NIST 2011 Smoke Plume Trajectory from IN-Situ Burning of Crude Oil in Alaska Updated Simulation Results (National Institute of Standards and Technology, Walton, McGrattan), NIST Technical Note 1706, July 2011

Witlox Undated, Modelling of Phosphorus Fires with Hydrolysis in The Plume, DNV Technica, London, UK. Available online at: https://www.dnvgl.com/Images/Modelling%20of%20phosphorus_fires%20with%20hydrolysis%20in%20the%20plume_1998_Witlox_LPS_tcm8-13444.pdf

Yang 1994 Estimate of the Effect of Scale on Radiative Heat Loss Fraction and Combustion Efficiency (Yang, Hamins, Kashiwagi), July 1993

Figure 1 Ground Level Peak 1-hour SO_2 Concentrations, PPM



Note: crude sulfur at 5.4%, assumed complete conversion to SO_2.

Attachment 1 – AERMOD Modeling Files

```
** FLARE DATA          Rate    Height        Heat  HeatLoss
**              0.1000E+01     0      3.2E+08     0.550

** BUILDING DATA   no buildings

** EMISSION RATE -  UNIT RATE OF 1 G/S

CO STARTING
   TITLEONE CRUDE FIRE, FLAT, NO DOWNWASH
   MODELOPT CONC FLAT
   AVERTIME 1
   POLLUTID OTHER
   RUNORNOT RUN
CO FINISHED

SO STARTING
   LOCATION SOURCE POINT        0.0     0.0
**  rate(g/s)    height(m)    temp (K)    velocity (m/s)    diameter (m)
   SRCPARAM SOURCE   1.0  83.1   1273.000   20.000    18.98

   SRCGROUP  ALL

SO FINISHED

RE STARTING

** Polar receptors
   GRIDPOLR  POL1  STA
   GRIDPOLR  POL1  ORIG 0  0
   GRIDPOLR  POL1  DIST 10 50 100 250 500 750 1000 1500 2000 2500 3000 3500 4000 4500 5000 6000 7000 8000 10000
   GRIDPOLR  POL1  GDIR 36  10  10
   GRIDPOLR  POL1  END

RE FINISHED

ME STARTING
   SURFFILE  SM_airport.sfc
   PROFFILE  SM_airport.pfl
   SURFDATA  23273   2010
   UAIRDATA  93214   2010
   PROFBASE    79.6 METERS
ME FINISHED

OU STARTING
   RECTABLE 1  FIRST
   MAXTABLE  ALLAVE  50

   FILEFORM  EXP
   RANKFILE  1 10 CrudeFire.FIL
   PLOTFILE  1 ALL  FIRST  CrudeFire.PLT
OU FINISHED


  *** Message Summary For AERMOD Model Setup ***

  --------- Summary of Total Messages --------

 A Total of            0 Fatal Error Message(s)
 A Total of            1 Warning Message(s)
 A Total of            0 Informational Message(s)
```

```
   ******** FATAL ERROR MESSAGES ********
               ***  NONE  ***


   ********   WARNING MESSAGES   ********
 ME W186      67       MEOPEN: THRESH_1MIN 1-min ASOS wind speed threshold used           0.50

 ***********************************
 *** SETUP Finishes Successfully ***
 ***********************************

 *** AERMOD - VERSION 16216r ***   *** CRUDE FIRE, FLAT, NO DOWNWASH                                        ***        03/08/18
 *** AERMET - VERSION  14134 ***   ***                                                                      ***        11:02:47
                                                                                                                       PAGE   1
 *** MODELOPTs:    NonDFAULT  CONC  FLAT  RURAL

                                          ***     MODEL SETUP OPTIONS SUMMARY       ***
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

 **Model Is Setup For Calculation of Average CONCentration Values.

   --  DEPOSITION LOGIC  --
 **NO GAS DEPOSITION Data Provided.
 **NO PARTICLE DEPOSITION Data Provided.
 **Model Uses NO DRY DEPLETION.  DRYDPLT  =  F
 **Model Uses NO WET DEPLETION.  WETDPLT  =  F

 **Model Uses RURAL Dispersion Only.

 **Model Allows User-Specified Options:
         1. Stack-tip Downwash.
         2. Model Assumes Receptors on FLAT Terrain.
         3. Use Calms Processing Routine.
         4. Use Missing Data Processing Routine.
         5. No Exponential Decay.

 **Other Options Specified:
         CCVR_Sub - Meteorological data includes CCVR substitutions
         TEMP_Sub - Meteorological data includes TEMP substitutions

 **Model Assumes No FLAGPOLE Receptor Heights.

 **The User Specified a Pollutant Type of:  OTHER

 **Model Calculates  1 Short Term Average(s) of:   1-HR

 **This Run Includes:      1 Source(s);       1 Source Group(s); and     684 Receptor(s)

                with:      1 POINT(s), including
                           0 POINTCAP(s) and      0 POINTHOR(s)
                 and:      0 VOLUME source(s)
                 and:      0 AREA type source(s)
                 and:      0 LINE source(s)
                 and:      0 OPENPIT source(s)
                 and:      0 BUOYANT LINE source(s) with      0 line(s)


 **Model Set To Continue RUNning After the Setup Testing.

 **The AERMET Input Meteorological Data Version Date:  14134

 **Output Options Selected:
```

AERMOD CRUDE FIRE

Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)
Model Outputs Tables of Overall Maximum Short Term Values (MAXTABLE Keyword)
Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)
Model Outputs External File(s) of Ranked Values (RANKFILE Keyword)

NOTE: Option for EXPonential format used in formatted output result files (FILEFORM Keyword)

**NOTE: The Following Flags May Appear Following CONC Values: c for Calm Hours
m for Missing Hours
b for Both Calm and Missing Hours

**Misc. Inputs: Base Elev. for Pot. Temp. Profile (m MSL) = 79.60 ; Decay Coef. = 0.000 ; Rot. Angle = 0.0
Emission Units = GRAMS/SEC ; Emission Rate Unit Factor = 0.10000E+07
Output Units = MICROGRAMS/M**3

**Approximate Storage Requirements of Model = 3.6 MB of RAM.

*** MODELOPTs: NonDFAULT CONC FLAT RURAL

*** POINT SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC)	X (METERS)	Y (METERS)	BASE ELEV. (METERS)	STACK HEIGHT (METERS)	STACK TEMP. (DEG.K)	STACK EXIT VEL. (M/SEC)	STACK DIAMETER (METERS)	BLDG EXISTS	URBAN SOURCE	CAP/ HOR	EMIS RATE SCALAR VARY BY
SOURCE	0	0.10000E+01	0.0	0.0	79.6	83.10	1273.00	20.00	18.98	NO	NO	NO	

*** MODELOPTs: NonDFAULT CONC FLAT RURAL

*** SOURCE IDs DEFINING SOURCE GROUPS ***

SRCGROUP ID	SOURCE IDs
ALL	SOURCE ,

*** MODELOPTs: NonDFAULT CONC FLAT RURAL

*** GRIDDED RECEPTOR NETWORK SUMMARY ***

*** NETWORK ID: POL1 ; NETWORK TYPE: GRIDPOLR ***

*** ORIGIN FOR POLAR NETWORK ***
X-ORIG = 0.00 ; Y-ORIG = 0.00 (METERS)

*** DISTANCE RANGES OF NETWORK ***
(METERS)

10.0, 50.0, 100.0, 250.0, 500.0, 750.0, 1000.0, 1500.0, 2000.0, 2500.0,
3000.0, 3500.0, 4000.0, 4500.0, 5000.0, 6000.0, 7000.0, 8000.0, 10000.0,

AERMOD CRUDE FIRE
*** DIRECTION RADIALS OF NETWORK ***
(DEGREES)

```
     10.0,      20.0,      30.0,      40.0,      50.0,      60.0,      70.0,      80.0,      90.0,     100.0,
    110.0,     120.0,     130.0,     140.0,     150.0,     160.0,     170.0,     180.0,     190.0,     200.0,
    210.0,     220.0,     230.0,     240.0,     250.0,     260.0,     270.0,     280.0,     290.0,     300.0,
    310.0,     320.0,     330.0,     340.0,     350.0,     360.0,
```


*** MODELOPTs: NonDFAULT CONC FLAT RURAL

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
(1=YES; 0=NO)

```
1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1  1 1 1 1 1
```

NOTE: METEOROLOGICAL DATA ACTUALLY PROCESSED WILL ALSO DEPEND ON WHAT IS INCLUDED IN THE DATA FILE.

*** UPPER BOUND OF FIRST THROUGH FIFTH WIND SPEED CATEGORIES ***
(METERS/SEC)

1.54, 3.09, 5.14, 8.23, 10.80,

*** MODELOPTs: NonDFAULT CONC FLAT RURAL

*** UP TO THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

```
  Surface file:   SM_airport.sfc                                                           Met Version:  14134
  Profile file:   SM_airport.pfl
  Surface format: FREE
  Profile format: FREE
  Surface station no.:    23273                  Upper air station no.:    93214
                Name: UNKNOWN                                    Name: UNKNOWN
                Year:   2010                                     Year:   2010
```

First 24 hours of scalar data

YR	MO	DY	JDY	HR	H0	U*	W*	DT/DZ	ZICNV	ZIMCH	M-O LEN	Z0	BOWEN	ALBEDO	REF WS	WD	HT	REF TA	HT
10	01	01	1	01	-999.0	-9.000	-9.000	-9.000	-999.	-999.	-99999.0	0.05	0.94	1.00	0.00	0.	10.0	278.8	2.0
10	01	01	1	02	-4.6	0.066	-9.000	-9.000	-999.	41.	5.7	0.05	0.94	1.00	1.76	178.	10.0	278.1	2.0
10	01	01	1	03	-3.9	0.061	-9.000	-9.000	-999.	36.	5.3	0.05	0.94	1.00	1.60	323.	10.0	278.8	2.0
10	01	01	1	04	-5.5	0.073	-9.000	-9.000	-999.	47.	6.4	0.06	0.94	1.00	1.89	99.	10.0	278.8	2.0
10	01	01	1	05	-6.2	0.077	-9.000	-9.000	-999.	51.	6.6	0.05	0.94	1.00	2.06	154.	10.0	279.2	2.0
10	01	01	1	06	-3.2	0.056	-9.000	-9.000	-999.	32.	4.9	0.06	0.94	1.00	1.45	100.	10.0	279.2	2.0
10	01	01	1	07	-3.9	0.062	-9.000	-9.000	-999.	37.	5.4	0.06	0.94	1.00	1.59	133.	10.0	278.8	2.0
10	01	01	1	08	-2.3	0.052	-9.000	-9.000	-999.	29.	5.6	0.06	0.94	0.64	1.35	124.	10.0	279.9	2.0
10	01	01	1	09	7.7	0.096	0.196	0.019	35.	72.	-10.5	0.05	0.94	0.36	1.03	171.	10.0	282.5	2.0
10	01	01	1	10	44.3	0.196	0.481	0.016	91.	209.	-15.5	0.06	0.94	0.26	2.06	69.	10.0	283.8	2.0
10	01	01	1	11	47.2	0.125	0.565	0.017	138.	107.	-3.7	0.06	0.94	0.23	1.11	136.	10.0	285.4	2.0
10	01	01	1	12	56.3	0.159	0.663	0.017	188.	152.	-6.5	0.02	0.94	0.22	1.89	247.	10.0	286.4	2.0

10 01 01	1 13	57.2	0.240	0.711	0.012	227.	282.	-21.9	0.05	0.94	0.22	2.71	323.	10.0	287.0	2.0
10 01 01	1 14	22.4	0.184	0.531	0.015	241.	190.	-25.0	0.05	0.94	0.22	2.10	302.	10.0	287.5	2.0
10 01 01	1 15	34.9	0.125	0.632	0.014	261.	107.	-5.0	0.05	0.94	0.25	1.19	329.	10.0	287.5	2.0
10 01 01	1 16	20.6	0.345	0.537	0.009	272.	485.	-179.7	0.05	0.94	0.33	4.38	304.	10.0	287.5	2.0
10 01 01	1 17	-5.2	0.080	-9.000	-9.000	-999.	186.	8.9	0.05	0.94	0.56	2.11	303.	10.0	285.9	2.0
10 01 01	1 18	-9.2	0.095	-9.000	-9.000	-999.	73.	8.3	0.05	0.94	1.00	2.49	305.	10.0	284.9	2.0
10 01 01	1 19	-11.5	0.104	-9.000	-9.000	-999.	81.	8.9	0.04	0.94	1.00	2.88	294.	10.0	284.2	2.0
10 01 01	1 20	-6.9	0.082	-9.000	-9.000	-999.	56.	7.1	0.05	0.94	1.00	2.15	321.	10.0	283.8	2.0
10 01 01	1 21	-10.3	0.100	-9.000	-9.000	-999.	76.	8.8	0.05	0.94	1.00	2.61	334.	10.0	283.1	2.0
10 01 01	1 22	-5.7	0.073	-9.000	-9.000	-999.	48.	6.3	0.04	0.94	1.00	2.03	294.	10.0	283.8	2.0
10 01 01	1 23	-2.7	0.050	-9.000	-9.000	-999.	27.	4.2	0.04	0.94	1.00	1.38	272.	10.0	280.9	2.0
10 01 01	1 24	-8.6	0.091	-9.000	-9.000	-999.	66.	8.0	0.05	0.94	1.00	2.40	300.	10.0	283.1	2.0

First hour of profile data

YR MO DY HR	HEIGHT	F	WDIR	WSPD	AMB_TMP	sigmaA	sigmaW	sigmaV
10 01 01 01	10.0	1	-999.	-99.00	278.8	99.0	-99.00	-99.00

F indicates top of profile (=1) or below (=0)

*** MODELOPTs: NonDFAULT CONC FLAT RURAL

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): SOURCE ,

*** NETWORK ID: POL1 ; NETWORK TYPE: GRIDPOLR ***

** CONC OF OTHER IN MICROGRAMS/M**3 **

DIRECTION (DEGREES)	DISTANCE (METERS) 10.00	50.00	100.00	250.00	500.00
10.0	0.04123 (14022209)	0.00876 (14022209)	0.00570 (12090102)	0.00452 (12062501)	0.00644 (14022714)
20.0	0.04123 (14022209)	0.00877 (14022209)	0.00572 (12090102)	0.00458 (12090102)	0.00611 (10062708)
30.0	0.04123 (14022209)	0.00877 (14022209)	0.00572 (13083002)	0.00457 (13083002)	0.00685 (10062708)
40.0	0.04123 (14022209)	0.00877 (14022209)	0.00570 (10101322)	0.00450 (10092207)	0.00796 (14051413)
50.0	0.04123 (14022209)	0.00877 (14022209)	0.00572 (10101322)	0.00458 (10101322)	0.01158 (14051413)
60.0	0.04123 (14022209)	0.00877 (14022209)	0.00571 (10101322)	0.00453 (12100901)	0.01153 (14051412)
70.0	0.04123 (14022209)	0.00877 (14022209)	0.00565 (10101322)	0.00453 (12092004)	0.01311 (14051412)
80.0	0.04123 (14022209)	0.00877 (14022209)	0.00566 (11041904)	0.00449 (12092004)	0.01187 (14051312)
90.0	0.04123 (14022209)	0.00877 (14022209)	0.00570 (11041904)	0.00534 (14043012)	0.01187 (14051312)
100.0	0.04123 (14022209)	0.00877 (14022209)	0.00571 (13083005)	0.00702 (14043012)	0.01237 (14100313)
110.0	0.04123 (14022209)	0.00876 (14022209)	0.00572 (13083005)	0.00816 (14043012)	0.01219 (14043012)
120.0	0.04123 (14022209)	0.00876 (14022209)	0.00569 (13083005)	0.00856 (14043012)	0.01430 (14100213)
130.0	0.04123 (14022209)	0.00876 (14022209)	0.00567 (10091024)	0.00816 (14043012)	0.01547 (14100513)
140.0	0.04123 (14022209)	0.00876 (14022209)	0.00572 (10091024)	0.00702 (14043012)	0.01414 (14100513)
150.0	0.04058 (14022209)	0.00812 (14022209)	0.00573 (10091024)	0.00653 (14100515)	0.01223 (14043013)
160.0	0.04058 (14022209)	0.00812 (14022209)	0.00571 (10091024)	0.00668 (14100515)	0.01096 (14100515)
170.0	0.04058 (14022209)	0.00812 (14022209)	0.00571 (12082305)	0.00610 (14100515)	0.01055 (14060808)
180.0	0.04058 (14022209)	0.00812 (14022209)	0.00568 (12082305)	0.00504 (14043011)	0.00876 (14060808)
190.0	0.04058 (14022209)	0.00812 (14022209)	0.00562 (12082305)	0.00517 (14043011)	0.00712 (14043011)
200.0	0.04058 (14022209)	0.00812 (14022209)	0.00560 (13020303)	0.00486 (14043011)	0.00667 (14043011)
210.0	0.04058 (14022209)	0.00812 (14022209)	0.00565 (13020303)	0.00451 (13020303)	0.00717 (14102612)
220.0	0.04058 (14022209)	0.00812 (14022209)	0.00566 (13020303)	0.00455 (13020303)	0.00771 (10071110)
230.0	0.04058 (14022209)	0.00812 (14022209)	0.00563 (13020303)	0.00440 (14042801)	0.00793 (10071110)
240.0	0.04058 (14022209)	0.00812 (14022209)	0.00556 (13020303)	0.00447 (14072903)	0.00710 (10071110)
250.0	0.04058 (14022209)	0.00812 (14022209)	0.00556 (13090505)	0.00447 (14072903)	0.00559 (10071110)
260.0	0.04058 (14022209)	0.00812 (14022209)	0.00562 (13090505)	0.00445 (13090505)	0.00573 (14051708)
270.0	0.04058 (14022209)	0.00812 (14022209)	0.00564 (13090505)	0.00455 (13090505)	0.00581 (14051708)

280.0	0.04058 (14022209)	0.00812 (14022209)	0.00563 (11101524)	0.00453 (11101524)	0.00513 (14051708)
290.0	0.04058 (14022209)	0.00812 (14022209)	0.00563 (11101524)	0.00453 (11101524)	0.00462 (14070708)
300.0	0.04058 (14022209)	0.00812 (14022209)	0.00566 (13111804)	0.00448 (12120507)	0.00715 (14070708)
310.0	0.04058 (14022209)	0.00812 (14022209)	0.00571 (13111804)	0.00454 (13111804)	0.01033 (14070708)
320.0	0.04058 (14022209)	0.00812 (14022209)	0.00571 (13111804)	0.00456 (13111804)	0.01301 (14070708)
330.0	0.04058 (14022209)	0.00812 (14022209)	0.00567 (13111804)	0.00453 (10060306)	0.01406 (14070708)
340.0	0.04123 (14022209)	0.00876 (14022209)	0.00560 (13111804)	0.00446 (13051524)	0.01301 (14070708)
350.0	0.04123 (14022209)	0.00876 (14022209)	0.00558 (12062501)	0.00442 (13051524)	0.01033 (14070708)
360.0	0.04123 (14022209)	0.00876 (14022209)	0.00564 (12090102)	0.00452 (12062501)	0.00715 (14070708)

• *** AERMOD - VERSION 16216r *** *** CRUDE FIRE, FLAT, NO DOWNWASH *** 03/08/18
*** AERMET - VERSION 14134 *** *** *** 11:02:47
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*** MODELOPTs: NonDFAULT CONC FLAT RURAL

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): SOURCE ,

*** NETWORK ID: POL1 ; NETWORK TYPE: GRIDPOLR ***

** CONC OF OTHER IN MICROGRAMS/M**3 **

DIRECTION (DEGREES)	DISTANCE (METERS) 750.00	1000.00	1500.00	2000.00	2500.00
10.0	0.01372 (11072009)	0.02869 (11072009)	0.06807 (11072009)	0.09777 (11072009)	0.11921 (12071008)
20.0	0.01445 (13061608)	0.03263 (13061608)	0.07899 (13061608)	0.11034 (13061608)	0.12257 (13061608)
30.0	0.01679 (10062708)	0.03436 (10062708)	0.08121 (10062708)	0.11809 (10062708)	0.13586 (10062708)
40.0	0.01636 (12092610)	0.03558 (12061209)	0.08916 (12061209)	0.12263 (12061209)	0.14047 (11062309)
50.0	0.02337 (14091009)	0.04626 (14091009)	0.08905 (14091009)	0.11919 (12061209)	0.13058 (12061209)
60.0	0.02715 (14091009)	0.05391 (14091009)	0.10264 (14091009)	0.12281 (14091009)	0.12422 (14091009)
70.0	0.02547 (14091009)	0.05052 (14091009)	0.09664 (14091009)	0.11614 (14070209)	0.12610 (14070209)
80.0	0.02012 (14080109)	0.04424 (14080109)	0.08844 (12092010)	0.12355 (12092010)	0.13685 (12092010)
90.0	0.02792 (14080109)	0.06070 (14080109)	0.11126 (14080109)	0.12639 (14080109)	0.13788 (13060810)
100.0	0.03007 (14080109)	0.06513 (14080109)	0.11832 (14080109)	0.13374 (14080109)	0.13534 (14060908)
110.0	0.02527 (14080109)	0.05517 (14080109)	0.10231 (14080109)	0.12555 (10080310)	0.13068 (10080310)
120.0	0.02737 (14063010)	0.06180 (14063010)	0.11048 (14063010)	0.12935 (12071109)	0.14700 (12071109)
130.0	0.02525 (14063010)	0.05736 (14063010)	0.10364 (14063010)	0.12935 (12071109)	0.14700 (12071109)
140.0	0.02359 (14063009)	0.04627 (14063009)	0.09373 (14063009)	0.12009 (14063009)	0.14494 (14080208)
150.0	0.03273 (14060808)	0.06528 (14060808)	0.10576 (14060808)	0.13176 (10081709)	0.14323 (10081709)
160.0	0.03960 (14060808)	0.07774 (14060808)	0.12265 (14060808)	0.13546 (10081709)	0.14714 (10081709)
170.0	0.03960 (14060808)	0.07774 (14060808)	0.12265 (14060808)	0.13007 (14060808)	0.12498 (14060808)
180.0	0.03273 (14060808)	0.06528 (14060808)	0.10576 (14060808)	0.11348 (14060808)	0.12031 (12091910)
190.0	0.02219 (14060808)	0.04525 (14060808)	0.07685 (14060808)	0.10790 (14070408)	0.12169 (14070408)
200.0	0.01544 (10071110)	0.03099 (10071110)	0.06739 (14070408)	0.09672 (14070408)	0.10953 (14070408)
210.0	0.02132 (10071110)	0.04237 (10071110)	0.07293 (10071110)	0.08111 (10071110)	0.09398 (13102311)
220.0	0.02548 (10071110)	0.05007 (10071110)	0.08384 (10071110)	0.09181 (10071110)	0.09705 (11082309)
230.0	0.02624 (10071110)	0.05145 (10071110)	0.08574 (10071110)	0.09365 (10071110)	0.10531 (12080410)
240.0	0.02331 (10071110)	0.04609 (10071110)	0.07827 (10071110)	0.10465 (14063008)	0.13276 (14063008)
250.0	0.01786 (10071110)	0.03603 (11083110)	0.06888 (11083110)	0.09874 (14063008)	0.12533 (14063008)
260.0	0.01370 (14051708)	0.03054 (11083110)	0.06459 (14051708)	0.09274 (14051708)	0.10523 (14051708)
270.0	0.01395 (14051708)	0.02825 (14051708)	0.06581 (14051708)	0.09438 (14051708)	0.10699 (14051708)
280.0	0.01186 (14051708)	0.02370 (14051708)	0.05545 (14051708)	0.08038 (14051708)	0.09181 (14051708)
290.0	0.01261 (14070708)	0.02932 (14061009)	0.06759 (11122711)	0.09582 (11122711)	0.10710 (11122711)
300.0	0.02091 (14070708)	0.03947 (14070708)	0.06797 (10080610)	0.09373 (11122711)	0.10482 (11122711)
310.0	0.03155 (14070708)	0.05910 (14070708)	0.09453 (14070708)	0.10140 (14070708)	0.10904 (14080908)
320.0	0.04040 (14070708)	0.07465 (14070708)	0.11560 (14070708)	0.12187 (14070708)	0.11575 (14070708)
330.0	0.04382 (14070708)	0.08049 (14070708)	0.12320 (14070708)	0.12915 (14070708)	0.12230 (14070708)
340.0	0.04040 (14070708)	0.07465 (14070708)	0.11560 (14070708)	0.12187 (14070708)	0.11575 (14070708)
350.0	0.03155 (14070708)	0.05910 (14070708)	0.09453 (14070708)	0.10363 (12082310)	0.11013 (12082310)
360.0	0.02091 (14070708)	0.03947 (14070708)	0.06653 (14090909)	0.08881 (11072009)	0.10117 (11072009)

• *** AERMOD - VERSION 16216r *** *** CRUDE FIRE, FLAT, NO DOWNWASH *** 03/08/18

*** MODELOPTs: NonDFAULT CONC FLAT RURAL

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): SOURCE ,

*** NETWORK ID: POL1 ; NETWORK TYPE: GRIDPOLR ***

** CONC OF OTHER IN MICROGRAMS/M**3 **

DIRECTION (DEGREES)	DISTANCE (METERS) 3000.00	3500.00	4000.00	4500.00	5000.00
10.0	0.13316 (12071008)	0.13779 (12071008)	0.13797 (14070707)	0.14795 (14070707)	0.15310 (14070707)
20.0	0.12800 (12071008)	0.13242 (12071008)	0.13181 (12071008)	0.12927 (14062208)	0.13029 (14070707)
30.0	0.14066 (10062708)	0.13895 (10062708)	0.13426 (10062708)	0.12825 (10062708)	0.12172 (10062708)
40.0	0.14580 (11062309)	0.14454 (11062309)	0.14023 (11062309)	0.13448 (11062309)	0.12810 (11062309)
50.0	0.13142 (12061209)	0.12771 (12061209)	0.12199 (12061209)	0.12108 (12090209)	0.12429 (10061508)
60.0	0.11940 (12092610)	0.12060 (13081810)	0.11968 (10071009)	0.11766 (10071009)	0.11577 (13080107)
70.0	0.13166 (10071609)	0.13224 (10071609)	0.12944 (10071609)	0.12497 (10071609)	0.11967 (10071609)
80.0	0.13799 (12092010)	0.13374 (12092010)	0.12724 (12092010)	0.12077 (10071609)	0.11597 (12072409)
90.0	0.14065 (13060810)	0.13730 (13060810)	0.13128 (13060810)	0.13320 (12071108)	0.14076 (12071108)
100.0	0.13526 (13071909)	0.13486 (13071909)	0.13514 (10090509)	0.14070 (10090509)	0.14241 (10090509)
110.0	0.13492 (12043010)	0.14267 (12043010)	0.14632 (11082909)	0.14607 (11082909)	0.14473 (12043009)
120.0	0.15049 (12071109)	0.14738 (12071109)	0.14133 (12071109)	0.13404 (12071109)	0.12670 (12043009)
130.0	0.15049 (12071109)	0.14738 (12071109)	0.14133 (12071109)	0.13513 (12080209)	0.12823 (12080209)
140.0	0.15507 (14080208)	0.15645 (14080208)	0.15359 (14080208)	0.14867 (14080208)	0.14280 (14080208)
150.0	0.15006 (14080208)	0.15132 (14080208)	0.14845 (14080208)	0.14361 (14080208)	0.13785 (14080208)
160.0	0.14650 (10081709)	0.14071 (10081709)	0.13291 (10081709)	0.12450 (10081709)	0.11660 (14090609)
170.0	0.12216 (10070410)	0.12733 (10070410)	0.12753 (10070410)	0.12513 (10082709)	0.12618 (10082709)
180.0	0.12067 (12091910)	0.11703 (12091910)	0.11159 (12091910)	0.11362 (10082709)	0.11437 (10082709)
190.0	0.12387 (14070408)	0.12059 (14070408)	0.11712 (10062809)	0.11740 (10062809)	0.11556 (10062809)
200.0	0.11168 (14070408)	0.10878 (14070408)	0.10799 (11082210)	0.10911 (11082210)	0.10831 (11082210)
210.0	0.10628 (13102311)	0.11114 (13102311)	0.11169 (13102311)	0.10995 (13102311)	0.10699 (13102311)
220.0	0.10707 (11082309)	0.10979 (11082309)	0.10860 (13102311)	0.10687 (13102311)	0.10395 (13102311)
230.0	0.11683 (12080410)	0.12057 (12080410)	0.12013 (12080410)	0.11751 (12080410)	0.11371 (12080410)
240.0	0.14637 (14063008)	0.15045 (14063008)	0.14933 (14063008)	0.14551 (14063008)	0.14030 (14063008)
250.0	0.13817 (14063008)	0.14193 (14063008)	0.14071 (14063008)	0.13694 (14063008)	0.13186 (14063008)
260.0	0.10743 (14051708)	0.10469 (14051708)	0.10359 (13042311)	0.10439 (13042311)	0.10469 (14080207)
270.0	0.10919 (14051708)	0.10639 (14051708)	0.10142 (14051708)	0.09559 (14051708)	0.08952 (14051708)
280.0	0.09402 (14051708)	0.09170 (14051708)	0.08741 (14051708)	0.08233 (14051708)	0.07704 (14051708)
290.0	0.10920 (11122711)	0.10723 (11122711)	0.10339 (11122711)	0.09868 (11122711)	0.09360 (11122711)
300.0	0.11110 (14062008)	0.11459 (14080908)	0.11485 (14080908)	0.11365 (13082408)	0.11214 (13082408)
310.0	0.12308 (14080908)	0.12838 (14080908)	0.12886 (14080908)	0.12682 (14080908)	0.12349 (14080908)
320.0	0.12293 (13081709)	0.12364 (13081709)	0.12070 (13081709)	0.12467 (13080309)	0.12587 (13080309)
330.0	0.11237 (13081709)	0.11302 (13081709)	0.11422 (13080309)	0.11837 (13080309)	0.11942 (13080309)
340.0	0.10709 (12082310)	0.10831 (14070109)	0.10774 (14070109)	0.10554 (14070109)	0.10247 (14070109)
350.0	0.10953 (12082310)	0.10597 (12082310)	0.10099 (12082310)	0.09515 (12082310)	0.09009 (12082310)
360.0	0.10379 (11072009)	0.10695 (14060907)	0.10813 (14060907)	0.10671 (14060907)	0.10386 (14060907)

*** MODELOPTs: NonDFAULT CONC FLAT RURAL

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): SOURCE ,

*** NETWORK ID: POL1 ; NETWORK TYPE: GRIDPOLR ***

** CONC OF OTHER IN MICROGRAMS/M**3 **

DIRECTION (DEGREES)	DISTANCE (METERS) 6000.00	7000.00	8000.00	10000.00
10.0	0.15450 (14070707)	0.14985 (14070707)	0.14266 (14070707)	0.12618 (14070707)
20.0	0.13071 (14070707)	0.12604 (14070707)	0.11932 (14070707)	0.10566 (12051008)
30.0	0.11250 (14062208)	0.10375 (14062208)	0.09541 (13072808)	0.09484 (11082908)
40.0	0.11508 (11062309)	0.10635 (10062408)	0.10745 (10062408)	0.10199 (10062408)
50.0	0.12495 (10061508)	0.12100 (10061508)	0.11516 (10061508)	0.10191 (13060807)
60.0	0.11962 (13080107)	0.11769 (13080107)	0.11311 (13080107)	0.10119 (13080107)
70.0	0.11649 (11072309)	0.11119 (11072309)	0.11231 (13071408)	0.11119 (13071408)
80.0	0.11416 (12072409)	0.10953 (13060809)	0.10785 (13060809)	0.09907 (13060809)
90.0	0.14581 (12071108)	0.14354 (12071108)	0.13794 (12071108)	0.12334 (12071108)
100.0	0.13944 (10090509)	0.13246 (10090509)	0.12404 (10090509)	0.11671 (10082608)
110.0	0.14134 (12043009)	0.13421 (12043009)	0.12578 (12043009)	0.10884 (12043009)
120.0	0.12314 (12043009)	0.11925 (14081007)	0.11581 (14081007)	0.11526 (11082708)
130.0	0.12962 (10090409)	0.12969 (10090508)	0.12897 (10090508)	0.12024 (10090508)
140.0	0.13020 (14080208)	0.11979 (12092709)	0.11427 (12092709)	0.10452 (10090308)
150.0	0.12556 (14080208)	0.11340 (14080208)	0.10616 (10081909)	0.11191 (14060807)
160.0	0.11559 (10081909)	0.11193 (10081909)	0.10616 (10081909)	0.09297 (10081909)
170.0	0.12292 (10082709)	0.11625 (10082709)	0.11316 (12062008)	0.10675 (12062008)
180.0	0.11132 (11092410)	0.10711 (11092410)	0.10130 (11092410)	0.08864 (11092410)
190.0	0.10874 (10062809)	0.10032 (10062809)	0.10106 (13051308)	0.11008 (13051308)
200.0	0.10389 (11082210)	0.09800 (11082210)	0.09147 (11082210)	0.09991 (10081908)
210.0	0.09945 (13102311)	0.09262 (11082210)	0.08650 (11082210)	0.08630 (13061607)
220.0	0.09654 (13102311)	0.08950 (10101511)	0.08367 (10101511)	0.07339 (10101511)
230.0	0.10460 (12080410)	0.09512 (12080410)	0.08612 (12080410)	0.07211 (12080410)
240.0	0.12827 (14063008)	0.11613 (14063008)	0.10561 (10101510)	0.08862 (10101510)
250.0	0.12023 (14063008)	0.10857 (14063008)	0.09869 (14080207)	0.09290 (14080207)
260.0	0.12489 (14080207)	0.13388 (14080207)	0.13598 (14080207)	0.13046 (14080207)
270.0	0.08055 (11100109)	0.08638 (12060107)	0.09116 (12071408)	0.09426 (12071408)
280.0	0.07722 (13101208)	0.08119 (11070308)	0.08152 (12082008)	0.09825 (12091408)
290.0	0.08326 (11122711)	0.08400 (11070308)	0.08412 (11070308)	0.07720 (11070308)
300.0	0.10875 (12072509)	0.10496 (12072509)	0.09964 (12072509)	0.08794 (12072509)
310.0	0.11517 (14080908)	0.10618 (14080908)	0.09745 (14080908)	0.10029 (11070307)
320.0	0.12292 (13080309)	0.11666 (13080309)	0.10925 (13080309)	0.12660 (10101408)
330.0	0.11640 (13080309)	0.11027 (13080309)	0.10308 (13080309)	0.08875 (13080309)
340.0	0.10422 (14080108)	0.10791 (14080108)	0.10662 (14080108)	0.10146 (13042907)
350.0	0.08601 (12103110)	0.08662 (14080108)	0.09197 (13071008)	0.09891 (13071008)
360.0	0.10384 (13081808)	0.10025 (13081808)	0.09646 (12070708)	0.09601 (12070708)

*** AERMOD - VERSION 16216r *** *** CRUDE FIRE, FLAT, NO DOWNWASH *** 03/08/18
*** AERMET - VERSION 14134 *** *** *** 11:02:47
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*** MODELOPTs: NonDFAULT CONC FLAT RURAL

*** THE MAXIMUM 50 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): SOURCE ,

** CONC OF OTHER IN MICROGRAMS/M**3 **

RANK	CONC	(YYMMDDHH)	AT	RECEPTOR (XR,YR)	OF TYPE	RANK	CONC	(YYMMDDHH)	AT	RECEPTOR (XR,YR)	OF TYPE
1.	0.15645	(14080208)	AT	(2249.76, -2681.16)	GP	26.	0.14581	(12071108)	AT	(6000.00, 0.00)	GP
2.	0.15507	(14080208)	AT	(1928.36, -2298.13)	GP	27.	0.14580	(11062309)	AT	(1928.36, 2298.13)	GP
3.	0.15450	(14070707)	AT	(1041.89, 5908.85)	GP	28.	0.14579	(12080209)	AT	(2681.16, -2249.76)	GP
4.	0.15359	(14080208)	AT	(2571.15, -3064.18)	GP	29.	0.14551	(14063008)	AT	(-3897.11, -2250.00)	GP
5.	0.15310	(14070707)	AT	(868.24, 4924.04)	GP	30.	0.14494	(14080208)	AT	(1606.97, -1915.11)	GP
6.	0.15132	(14080208)	AT	(1750.00, -3031.09)	GP	31.	0.14473	(12043009)	AT	(4698.46, -1710.10)	GP
7.	0.15049	(12071109)	AT	(2298.13, -1928.36)	GP	32.	0.14454	(11062309)	AT	(2249.76, 2681.16)	GP
8.	0.15049	(12071109)	AT	(2598.08, -1500.00)	GP	33.	0.14440	(12043010)	AT	(3758.77, -1368.08)	GP
9.	0.15045	(14063008)	AT	(-3031.09, -1750.00)	GP	34.	0.14361	(14080208)	AT	(2250.00, -3897.11)	GP

10.	0.15006 (14080208) AT (	1500.00,	-2598.08)	GP		35.	0.14354 (12071108) AT (	7000.00,	0.00)	GP
11.	0.14985 (14070707) AT (	1215.54,	6893.65)	GP		36.	0.14340 (11082909) AT (	4698.46,	-1710.10)	GP
12.	0.14933 (14063008) AT (	-3464.10,	-2000.00)	GP		37.	0.14338 (12043009) AT (	4228.62,	-1539.09)	GP
13.	0.14867 (14080208) AT (	2892.54,	-3447.20)	GP		38.	0.14323 (10081709) AT (	1250.00,	-2165.06)	GP
14.	0.14845 (14080208) AT (	2000.00,	-3464.10)	GP		39.	0.14285 (12043010) AT (	4228.62,	-1539.09)	GP
15.	0.14795 (14070707) AT (	781.42,	4431.63)	GP		40.	0.14280 (14080208) AT (	3213.94,	-3830.22)	GP
16.	0.14738 (12071109) AT (	3031.09,	-1750.00)	GP		41.	0.14267 (12043010) AT (	3288.92,	-1197.07)	GP
17.	0.14738 (12071109) AT (	2681.16,	-2249.76)	GP		42.	0.14266 (14070707) AT (	1389.19,	7878.46)	GP
18.	0.14714 (10081709) AT (	855.05,	-2349.23)	GP		43.	0.14264 (10081709) AT (	1500.00,	-2598.08)	GP
19.	0.14700 (12071109) AT (	1915.11,	-1606.97)	GP		44.	0.14241 (10090509) AT (	4924.04,	-868.24)	GP
20.	0.14700 (12071109) AT (	2165.06,	-1250.00)	GP		45.	0.14231 (11082909) AT (	3288.92,	-1197.07)	GP
21.	0.14650 (10081709) AT (	1026.06,	-2819.08)	GP		46.	0.14193 (14063008) AT (	-3288.92,	-1197.07)	GP
22.	0.14648 (12080209) AT (	2298.13,	-1928.36)	GP		47.	0.14134 (12043009) AT (	5638.16,	-2052.12)	GP
23.	0.14637 (14063008) AT (	-2598.08,	-1500.00)	GP		48.	0.14133 (12071109) AT (	3064.18,	-2571.15)	GP
24.	0.14632 (11082909) AT (	3758.77,	-1368.08)	GP		49.	0.14133 (12071109) AT (	3464.10,	-2000.00)	GP
25.	0.14607 (11082909) AT (	4228.62,	-1539.09)	GP		50.	0.14132 (12080209) AT (	3064.18,	-2571.15)	GP

*** RECEPTOR TYPES: GC = GRIDCART
GP = GRIDPOLR
DC = DISCCART
DP = DISCPOLR

*** MODELOPTs: NonDFAULT CONC FLAT RURAL

*** THE SUMMARY OF HIGHEST 1-HR RESULTS ***

** CONC OF OTHER IN MICROGRAMS/M**3 **

GROUP ID		AVERAGE CONC	DATE (YYMMDDHH)	RECEPTOR (XR, YR, ZELEV, ZHILL, ZFLAG)	OF TYPE	NETWORK GRID-ID
ALL	HIGH 1ST HIGH VALUE IS	0.15645	ON 14080208:	AT (2249.76, -2681.16, 79.60, 79.60, 0.00)	GP	POL1

*** RECEPTOR TYPES: GC = GRIDCART
GP = GRIDPOLR
DC = DISCCART
DP = DISCPOLR

*** MODELOPTs: NonDFAULT CONC FLAT RURAL

*** Message Summary : AERMOD Model Execution ***

--------- Summary of Total Messages --------

A Total of 0 Fatal Error Message(s)
A Total of 1 Warning Message(s)
A Total of 1705 Informational Message(s)

A Total of 43824 Hours Were Processed

A Total of 533 Calm Hours Identified

A Total of 1172 Missing Hours Identified (2.67 Percent)

```
 ******** FATAL ERROR MESSAGES ********
            ***  NONE  ***

 ********   WARNING MESSAGES   ********
ME W186      67       MEOPEN: THRESH_1MIN 1-min ASOS wind speed threshold used           0.50

 ************************************
 *** AERMOD Finishes Successfully ***
 ************************************
```

Appendix C.4

Cumulative Risk Calculations

Cumulative Oil Trucking FN Calculations

Table 1 - Plains Pentland Terminal (Segment N-Betteravia Road Interchange to State Route 166 Interchange)

# of Fatalities/ Serious Injuries	Proposed Project		With Mitigation	
	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries
1	4.51E-06	7.55E-06	3.70E-06	6.20E-06
2	2.12E-06	3.49E-06	1.70E-06	2.80E-06
3	5.40E-07	2.12E-06	4.40E-07	1.70E-06
4	2.70E-07	1.57E-06	2.20E-07	1.30E-06
5	1.08E-07	2.19E-07	8.80E-08	1.80E-07

From ExxonMobil Interim Trucking TQRA, February 2020.

Table 2 - Aera TQRA (Segment B1-Betteravia Road Interchange to State Route 166 Interchange)

# of Fatalities/ Serious Injuries	Proposed Project		With Mitigation	
	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries
1	8.30E-06	1.40E-05	5.60E-06	9.60E-06
2	3.80E-06	6.50E-06	2.60E-06	4.40E-06
3	1.00E-06	3.90E-06	7.00E-07	2.60E-06
4	5.20E-07	2.90E-06	3.50E-07	1.90E-06
5	2.10E-07	4.20E-07	1.40E-07	2.80E-07

From Aera East Cat Canyon TQRA, July 2019.

Table 3 - Peak Year of Overlapping Trucks-US 101
Betteravia Rd to SR 166

Project	# Trucks per day	# Trucks per Year
ExxonMobil	68	24,820
ERG	13	4,745
Other North County	1	365

Data from Cumulative Project Laden Truck Analysis.

Table 3a - Peak Year of Overlapping Trucks-US 101
Clark Rd to Betteravia Rd -FPP Operational

Project	# Trucks per day	# Trucks per Year
ExxonMobil	70	25,550
ERG	13	4,745
Other NC	7	2,555

Data from Cumulative Project Laden Truck Analysis.

Table 3b - Peak Year of Overlapping Trucks-US 101
Clark Rd to Betteravia Rd -No FPP

Project	# Trucks per day	# Trucks per Year
ExxonMobil	70	25,550
ERG	63	22,995
Other NC	7	2,555

Data from Cumulative Project Laden Truck Analysis.

Cumulative Oil Trucking FN Calculations

Table 4 - Cumulative Risk for Highway 101 Betteravia Interchange to State Route 166 East Interchange (Unmitigated)

# of Fatalities/ Serious Injuries	ExxonMobil		ERG		Other North County		Total Cumulative Risk	
	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries
1	4.51E-06	7.55E-06	9.30E-07	1.57E-06	7.16E-08	1.21E-07	5.51E-06	9.24E-06
2	2.12E-06	3.49E-06	4.26E-07	7.28E-07	3.28E-08	5.60E-08	2.58E-06	4.27E-06
3	5.40E-07	2.12E-06	1.12E-07	4.37E-07	8.62E-09	3.36E-08	6.61E-07	2.59E-06
4	2.70E-07	1.57E-06	5.83E-08	3.25E-07	4.48E-09	2.50E-08	3.33E-07	1.92E-06
5	1.08E-07	2.19E-07	2.35E-08	4.71E-08	1.81E-09	3.62E-09	1.33E-07	2.70E-07

ExxonMobil risk number from TQRA, February 2020. Assume no risk reduction measures.

ERG and Other North County risk numbers based upon Aera TQRA, July 2019. Numbers prorated by number of trucks per day. Assume no risk reduction measures.

Risk represents peak one-kilometer per year.

Table 5 - Cumulative Risk for Highway 101 Betteravia Interchange to State Route 166 East Interchange (Mitigated)

# of Fatalities/ Serious Injuries	ExxonMobil		ERG		Other North County		Total Cumulative Risk	
	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries
1	3.70E-06	6.20E-06	9.30E-07	1.57E-06	7.16E-08	1.21E-07	4.70E-06	7.89E-06
2	1.70E-06	2.80E-06	4.26E-07	7.28E-07	3.28E-08	5.60E-08	2.16E-06	3.58E-06
3	4.40E-07	1.70E-06	1.12E-07	4.37E-07	8.62E-09	3.36E-08	5.61E-07	2.17E-06
4	2.20E-07	1.30E-06	5.83E-08	3.25E-07	4.48E-09	2.50E-08	2.83E-07	1.65E-06
5	8.80E-08	1.80E-07	2.35E-08	4.71E-08	1.81E-09	3.62E-09	1.13E-07	2.31E-07

ExxonMobil risk number from TQRA, February 2020 and assume incorporation of Applicant proposed risk reduction measures.

ERG risk numbers based upon Aera TQRA, July 2019. Numbers prorated by number of trucks per day. Assumes no risk reduction measures for ERG.

Risk represents peak one-kilometer per year.

Cumulative Oil Trucking FN Calculations

Table 6 - SMPS (Segment J-Clark Road to Betteravia Road)

Segment	Total Frequency per km-year		Ratio	
	Fatality	Injury	Fatality	Injury
Segment J-Clark Road to Betteravia Road	1.50E-06	2.50E-06	41%	40%
Segment N-Betteravia Road Interchange to State Route 166 Interchange	3.70E-06	6.20E-06		

# of Fatalities/ Serious Injuries	Proposed Project		With Mitigation	
	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries
1	1.83E-06	3.04E-06	1.50E-06	2.50E-06
2	8.59E-07	1.41E-06	6.89E-07	1.13E-06
3	2.19E-07	8.55E-07	1.78E-07	6.85E-07
4	1.09E-07	6.33E-07	8.92E-08	5.24E-07
5	4.38E-08	8.83E-08	3.57E-08	7.26E-08

From ExxonMobil Interim Trucking TQRA, February 2020.

Calculated from ExxonMobil Interim Trucking TQRA based upon ratio of total frequency per kilometer-year for fatality and injury by segment.

Table 7 - Aera (Segment J-Clark Road to Betteravia Road)

Segment	Total Frequency per km-year		Ratio	
	Fatality	Injury	Fatality	Injury
Segment L1-Clark Road to Betteravia Road	1.70E-06	2.90E-06	30%	30%
Segment B1-Betteravia Road Interchange to State Route 166 Interchange	5.60E-06	9.60E-06		

# of Fatalities/ Serious Injuries	Proposed Project		With Mitigation	
	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries
1	2.52E-06	4.23E-06	1.69E-06	2.90E-06
2	1.15E-06	1.96E-06	7.85E-07	1.33E-06
3	3.04E-07	1.18E-06	2.11E-07	7.85E-07
4	1.58E-07	8.76E-07	1.06E-07	5.74E-07
5	6.38E-08	1.27E-07	4.23E-08	8.46E-08

From Aera East Cat Canyon TQRA, July 2019.

Calculated from Aera Trucking TQRA based upon ratio of total frequency per kilometer-year for fatality and injury by segment.

Cumulative Oil Trucking FN Calculations

Table 8 - Cumulative Risk for Clark Road to Betteravia Road (Unmitigated)-With Foxen Canyon Pipeline

# of Fatalities/ Serious Injuries	ExxonMobil		ERG		Other North County		Total Cumulative Risk	
	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries
1	1.83E-06	3.04E-06	2.82E-07	4.74E-07	1.52E-07	2.55E-07	2.26E-06	3.77E-06
2	8.59E-07	1.41E-06	1.29E-07	2.20E-07	6.96E-08	1.18E-07	1.06E-06	1.75E-06
3	2.19E-07	8.55E-07	3.40E-08	1.32E-07	1.83E-08	7.11E-08	2.71E-07	1.06E-06
4	1.09E-07	6.33E-07	1.77E-08	9.82E-08	9.53E-09	5.29E-08	1.37E-07	7.84E-07
5	4.38E-08	8.83E-08	7.14E-09	1.42E-08	3.85E-09	7.66E-09	5.48E-08	1.10E-07

ExxonMobil risk number from TQRA, February 2020. Assume no risk reduction measures.

ERG and Other North County risk numbers based upon Aera TQRA, July 2019. Numbers prorated by number of trucks per day. Assume no risk reduction measures.

Risk represents peak one-kilometer per year.

Table 9 - Cumulative Risk for Clark Road to Betteravia Road (Mitigated)-With Foxen Canyon Pipeline

# of Fatalities/ Serious Injuries	ExxonMobil		ERG		Other North County		Total Cumulative Risk	
	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries
1	1.50E-06	2.50E-06	2.82E-07	4.74E-07	1.52E-07	2.55E-07	1.78E-06	2.97E-06
2	6.89E-07	1.13E-06	1.29E-07	2.20E-07	6.96E-08	1.18E-07	8.18E-07	1.35E-06
3	1.78E-07	6.85E-07	3.40E-08	1.32E-07	1.83E-08	7.11E-08	2.12E-07	8.18E-07
4	8.92E-08	5.24E-07	1.77E-08	9.82E-08	9.53E-09	5.29E-08	1.07E-07	6.22E-07
5	3.57E-08	7.26E-08	7.14E-09	1.42E-08	3.85E-09	7.66E-09	4.28E-08	8.68E-08

ExxonMobil risk number from TQRA, February 2020 and assume incorporation of Applicant proposed risk reduction measures.

ERG and Other North County risk numbers based upon Aera TQRA, July 2019. Numbers prorated by number of trucks per day. Assumes to risk reduction measures.

Risk represents peak one-kilometer per year.

Cumulative Oil Trucking FN Calculations

Table 10 - Cumulative Risk for Clark Road to Betteravia Road (Unmitigated)-Without Foxen Canyon Pipeline

# of Fatalities/ Serious Injuries	ExxonMobil		ERG		Other North County		Total Cumulative Risk	
	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries
1	1.83E-06	3.04E-06	1.37E-06	2.30E-06	1.52E-07	2.55E-07	3.35E-06	5.60E-06
2	8.59E-07	1.41E-06	6.27E-07	1.07E-06	6.96E-08	1.18E-07	1.56E-06	2.59E-06
3	2.19E-07	8.55E-07	1.65E-07	6.40E-07	1.83E-08	7.11E-08	4.02E-07	1.57E-06
4	1.09E-07	6.33E-07	8.57E-08	4.76E-07	9.53E-09	5.29E-08	2.05E-07	1.16E-06
5	4.38E-08	8.83E-08	3.46E-08	6.89E-08	3.85E-09	7.66E-09	8.23E-08	1.65E-07

ExxonMobil risk number from TQRA, February 2020. Assume no risk reduction measures.

ERG and Other North County risk numbers based upon Aera TQRA, July 2019. Numbers prorated by number of trucks per day. Assume no risk reduction measures.

Risk represents peak one-kilometer per year.

Table 11 - Cumulative Risk for Clark Road to Betteravia Road (Mitigated)-Without Foxen Canyon Pipeline

# of Fatalities/ Serious Injuries	ExxonMobil		ERG		Other North County		Total Cumulative Risk	
	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries	Frequency of N or More Fatalities	Frequency of N or More Serious Injuries
1	0.00E+00	0.00E+00	1.37E-06	2.30E-06	1.52E-07	2.55E-07	1.37E-06	2.30E-06
2	0.00E+00	0.00E+00	6.27E-07	1.07E-06	6.96E-08	1.18E-07	6.27E-07	1.07E-06
3	0.00E+00	0.00E+00	1.65E-07	6.40E-07	1.83E-08	7.11E-08	1.65E-07	6.40E-07
4	0.00E+00	0.00E+00	8.57E-08	4.76E-07	9.53E-09	5.29E-08	8.57E-08	4.76E-07
5	0.00E+00	0.00E+00	3.46E-08	6.89E-08	3.85E-09	7.66E-09	3.46E-08	6.89E-08

ExxonMobil risk number from TQRA, February 2020 and assume incorporation of Applicant proposed risk reduction measures.

ERG and Other North County risk numbers based upon Aera TQRA, July 2019. Numbers prorated by number of trucks per day. Assumes to risk reduction measures.

Risk represents peak one-kilometer per year.

Appendix C.5

Draft ExxonMobil Crude Oil Transportation Risk Management and Prevention Program

SYU LFC INTERIM TRUCKING

CRUDE OIL TRANSPORTATION RISK MANAGEMENT AND PREVENTION PROGRAM (CO-TRMPP)

1.0 Introduction and Objective

ExxonMobil's Santa Ynez Unit Facility (SYU) finalized permitted and construction and began operations in 1993. Since that time, all crude oil export has occurred via the Plains All American Pipeline Line 901 and 903 (PAAPL) which is connected to the LFC facilities at the LFC Transportation Terminal. In May 2015, the PAAPL Line 901 pipeline experienced an incident where a failure resulted in the shutdown of both Line 901 and 903 that SYU utilized to transport crude to refineries.

ExxonMobil is submitting the SYU LFC Interim Trucking application to allow production operations to re-start at the Santa Ynez Unit following shutdown of the PAAPL pipeline and subsequent preservation of the SYU facilities. The application requests operation of interim trucking until a pipeline alternative is available. The interim trucking facilities would be located in Las Flores Canyon (LFC) approximately twelve (12) miles west of Goleta and consist of the activities described in Attachment A.3 Description..

All highway transportation from LFC will be limited to State Highway 101; no truck traffic will be directed through State Highway 154. Transportation in urban areas will be limited to the extent feasible.

Truck loading and transportation operations would occur seven days a week, 24-hours per day except as noted below. After unloading at one of the designated facilities, the trucks could return directly back to LFC to reload or they could be reassigned to other operations.

This Crude Oil Transportation Risk Management and Prevention Program (CO-TRMPP) has been developed to ensure that the interim trucking is conducted in a safe and efficient manner.

2.0 Elements of the CO-TRMPP

The CO-TRMPP shall apply to any and all highway shipments of product from ExxonMobil's SYU facility in Las Flores Canyon to the regional receiving locations as part of the LFC interim trucking.

Product carriers shall be required to complete the "Crude Oil - Motor Carrier Safety Survey" (Exhibit A) prior to starting shipments from LFC. LFC Operations personnel will verify that each carrier meets or exceeds the safety standards. LFC Operations personnel will also conduct a safety and operability inspection (checklist) of trucks prior to loading and prior to transport from LFC. Any truck that receives an unsatisfactory inspection will no longer be permitted to transport product until the issue has been corrected.

LFC Operations has also developed a procedure for the trucks to follow during the truck loading. If, based on ExxonMobil operator observations, the carrier's actual performance in loading at LFC is inconsistent with the Safety Survey, safety inspection, or the procedure, ExxonMobil will re-evaluate the carrier's ability to safely load and haul product. If the issues cannot be resolved to demonstrate the carrier's ability to safely load and haul product, use of that carrier will be discontinued until they successfully satisfy ExxonMobil's requirements.

There are no specific, pre-established criteria for terminating use of a carrier insofar as there are potentially many different situations in which ExxonMobil may decide to take such action. For the most part, this decision will be based on operational and technical judgment made by LFC operating and engineering personnel after reviewing the facts of the situation at that time. In general, any human or mechanical issues that pose the potential to compromise safe operations will be cause for discontinuing use of any carrier until such issues are resolved to ExxonMobil's satisfaction.

An ExxonMobil operator will be present during the loading activities. The operators will be trained prior to commencing loading operations and what to inspect using the developed procedure and checklist. The operator will advise his or her supervisor if there is an issue with the truck or driver. If an issue is observed prior to loading, the truck will not be loaded and the carrier's dispatcher will be notified to correct the issue before the truck will be loaded or to send another truck. If an issue is discovered after a truck is loaded (e.g., overload, leak), the driver will be instructed not to leave LFC until the issue is corrected.

In addition to the ExxonMobil LFC company compliance plans, the selected carrier will have compliance plans in place to respond to accidents and other incidents such as listed below:

- Emergency Action Plan
- Spill Prevention Emergency Response Containment Plan
- Incident Investigation and Reporting Policy
- Incident Reporting Flow Chart

ExxonMobil will include provisions in its contracts with each carrier to require a number of safety and operational requirements. The requirements are included in the Crude Truck Loading Procedure and the LFC Site Specific Safety Training for All Truck Drivers.

A number of the safety and operational requirements are summarized below (Reference Crude Transport Truck Driver Training):

Required Pre-Mobilization Training Requirements

- Carrier(s) Driver Orientation and Passport Safety Training
- ExxonMobil Las Flores Canyon Site Specific Training
- LFC Crude Transport Truck Driver Training

Required Clothing and PPE for Drivers in LFC:

- Compliance with Facial Hair Policy
- FRCs (Coveralls or Long Sleeve Shirt and Long Paints)
- Sturdy Steel-Toed Work Boots
- Safety Glasses/Goggles, Impact Resistant Gloves, and Hardhat
- Personal H_2S Monitor
- Earplugs

Reminders:

- Smoking not allowed when within LFC
- Zero tolerance for Alcohol / Drugs / Firearms – Do not bring on site; Subject to random search
- No liquids (e.g., water, coffee, etc.) allowed to be poured on the ground when within LFC

Truck Restrictions:

- Truck equipped with operating speed monitoring system
- Truck trailer empty when arriving at LFC per contract
  - Trailers used for The LFC interim trucking exclusively dedicated to crude oil transportation service
  - Trailer empty prior to loading
- Truck/Trailer placards in accordance with DOT regulations
- Crude Oil Safety Data Sheet (SDS) in Truck
- Crude Transport Truck Driver Training document in Truck
- Maximum Truck/Trailer height cannot exceed 13.5 feet
- Maximum Truck/Trailer weight with full load cannot exceed 80,000 pound limit

Truck Route Restrictions

- Routes to and from LFC restricted
  - Use of Hwy 101 El Capitan Beach exit not allowed
- Truck operations to occur 24-Hours per day, 7 days per week
  - Exception: All trucks involved in the LFC interim trucking will observe a curfew when travelling on Calle Real if deemed appropriate. Truck traffic will not travel on Calle Real between El Capitan exit and Refugio exit during the hours of 7:45 am to 8:30 am and 2:55 pm to 3:40 pm. This restriction only applies when the school is in regular operation and students are being bussed.

Driving in LFC

- Protected species known to be on site
  - Do not approach, harass or intentionally harm any wildlife
- Watch for wildlife on and adjacent to road: Avoid where safe to do so; All wildlife is protected on site. Includes deer, rabbits, foxes, bobcats, frogs, turtles, etc.
- Report observations of injured, dead or potentially dangerous wildlife to ExxonMobil representative
- Truck speed limit within LFC is 15 MPH – no exceptions
- Watch for oncoming traffic. Some areas of the road are narrow and have blind curves
- Watch for directional signs to Weigh Area, Holding Area, and Loading Area

- Drivers to have an operating cell phone; Phone use prohibited within LFC facility (includes driving, waiting or loading)

EXHIBIT A - Crude Oil - Motor Carrier Safety Survey

EXHIBIT A
Crude Oil- Motor Carrier Safety Survey
Santa Ynez Unit Facility

General Information

Interview Location ____________________

Carrier Personnel Interviewed ____________________

Date of Interview ____________________

Equipment: No. of tractors owned by Company/Operator ____________________

Replacement Policy for Tractors ____________________

No. of trailers/tanks owned by Company/Operator ____________________

Replacement Policy for Tanks/Trailers ____________________

No. of Drivers ____________________

Company Safety Indicators

a. DOT reportable accident rate per million vehicle miles: ____________________

b. Insurance premium cost per one hundred dollars of gross receipts: ____________

c. Insurance Carriers ____________________

d. Liability Limits ____________________

e. Deductible ____________________

f. Does your insurance extend to subhaulers? ____________________

g. Current Bureau of Motor Carrier Safety (BMCS) rating ____________________

h. Date of last BMCS Safety Survey ____________________

i. Type of BMCS Violations Recorded ____________________

j. Citations/fines, if any, by Department of Transportation during past 3 years.

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Company Drivers

a. Minimum Years Driving Experience ____________________________

b. Physical Examination Required? ______________________________

c. Number of Moving Violations permitted _________________________

d. Number of reportable accidents permitted ________________________

Driver Training

a. Length of New Driver Training _____________________________________

b. Frequency of Existing Driver Training _______________________________

c. Type of Training Used (Circle those that apply): Lecture Video Literature

d. Training Administered by: Company Staff Driver/trainer Professional Firm

e. Records of training maintained for each driver?

f. Training Topics Covered

	Yes	No
1. Speeding Policy	________	________
2. Alcohol/narcotics/ drug abuse	________	________
3. Hazardous Materials	________	________
4. Placarding	________	________
5. Emergency Procedures	________	________
6. Emergency Communications	________	________
7. Rail/highway crossing procedures	________	________
8. Vehicle Inspections	________	________
9. Drivers Logs	________	________
10. Loading/bracing/blocking	________	________
11. Site Safety Rule Policy	________	________
12. Bulk Truck Specifics		
i. Loading/Unloading	________	________
ii. Equipment Operation	________	________
iii. Equipment Inspection	________	________
iv. Emergency Response	________	________

Driver Management

a. Do you have a speed limit policy? If so, summarize.

b. Do you have automated speed controls on trucks? If so, summarize.

c. Do you use remote electronic monitoring of driver performance? If so, summarize.

d. Are drivers required to report traffic violations? If so, summarize.

e. Do you have policies for logging violations? If so, summarize.

f. Do you have a method to allow for address public complaints? If so, summarize.

g. Are passengers allowed in the truck cab? If so, summarize.

h. Do you perform regular driver performance reviews, including safety compliance?

i. Do you employ a full-time safety coordinator and or team?

Vehicle Inspections & Maintenance

a. Do you drivers conduct pre-trip inspections? If so, are records kept?

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____

b. Do you drivers conduct post-trip inspections? If so, are records kept?

____

____

c. Are vehicle inspections and maintenance performed at an in-house facility or an outside professional repair facility?

____

____

d. At what frequency are the following tractor items proactively inspected/replaced?

1. Steering Controls ____________________
2. Brakes ____________________
3. Safety/Emergency Equipment ____________________
4. Lights ____________________
5. Windshield Glass ____________________
6. Engine Hoses ____________________
7. Fluid Levels ____________________
8. Tires ____________________
9. Couplings/Air Hose Condition ____________________
10. Fifth Wheel Lube/Locking ____________________
11. Undercarriage ____________________

e. Where and how often are visual inspections of tank trailers performed?

____

f. Where and how often are hydrostatic tests of tank trailers performed?

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Appendix C.6

Cultural Resources within 500 feet of the Trucking Routes

Cultural Resources within 500 Feet of the Trucking Routes

Primary No.	Trinomial	Type	Age	Recorded by	Distance from Project Area
P-40-000084	CA-SLO-000084	Site	Prehistoric	1950 (Lathrop, Pilling, Fenenga, University of California, Santa Barbara) 1970 (T. Anderson, J. M. Farrar, Archaeological Research, Inc.) 1999 (A. Ruby, M. Darcangelo, Far Western Anthropological Research)	Within
P-40-000094	CA-SLO-000094	Site	Prehistoric	1870 (Schumacher, none given) 1968 (H. & I. Wadhams, none given)	Outside (Within 500 feet)
P-40-000095	CA-SLO-000095	Site	Historic	1874 (Schumacher, none given) 1968 (Homer & Lillian Wadhams, none given) 1968 (R. Desautels (?), none given) 1968 (Al McCurdy, none given) 2013 (Patricia Mikkelsen, Far Western)	Outside (Within 500 feet)
P-40-000288	CA-SLO-000288	Site	Prehistoric	1960 (Wire, University of California)	Outside (Within 500 feet)
P-40-000298	CA-SLO-000298	Site	Prehistoric	1959 (Jack Smith, University of California)	Outside (Within 500 feet)
P-40-000576	CA-SLO-000576	Site	Prehistoric	1970 (T. Anderson and J. M. Farrar, Archaeological Research Inc. Costa Mesa) 2013 (Deborah Jones, Far Western Anthropological Research Group)	Within
P-40-000577	CA-SLO-000577	Site	Prehistoric	1970 (T. Anderson and J. M. Farrar, Archaeological Research Inc. Costa Mesa)	Outside (Within 500 feet)
P-40-000578	CA-SLO-000578/H	Site	Prehistoric, Historic	1970 (J. M. Farrar and T. Anderson, Archaeological Research Inc. Costa Mesa)	Outside (Within 500 feet)
P-40-000579	CA-SLO-000579	Site	Prehistoric	1970 (J. M. Farrar and T. Anderson, Archaeological Research Inc. Costa Mesa)	Outside (Within 500 feet)
P-40-001084	CA-SLO-001084	Site	Prehistoric	1983 (Dennis K. Quillen, R. Franklin, Westec Services, Inc.)	Outside (Within 500 feet)
P-40-001140	CA-SLO-001140	Site	Prehistoric	1985 (H. Neff, A. Ruela, J. Harmon, UCSB)	Within
P-40-001141	CA-SLO-001141	Site	Prehistoric	1985 (B. Johnson, A. Ruelas, H. Neff, UCSB)	Outside (Within 500 feet)
P-40-001142	CA-SLO-001142	Site	Prehistoric	1985 (B. Johnson, A. Ruelas, H. Neff, UCSB)	Outside (Within 500 feet)
P-40-001143	CA-SLO-001143	Site	Prehistoric	1985 (H. Neff, J, Hanson, P. Lagrez)	Outside (Within 500 feet)
P-40-001144	CA-SLO-001144	Site	Prehistoric	1985 (C Webb, J. Wighhill, B.Glover, UCSB) 1999 (M. Darcangelo, Far Western)	Within
P-40-001153	CA-SLO-001153	Site	Prehistoric	1986 (Taffe Semenza, Center for Archaeological Studies, UCSB)	Within
P-40-002045	CA-SLO-002045	Site	Prehistoric	1999 (M. Darcangelo, Far Western Anthropological Research Group, Inc.)	Within
P-40-002191	CA-SLO-002191	Site	Prehistoric	2001 (Terry Jostlin, Krista Kiaha, Kelda Wilson, Caltrans District 05)	Outside (Within 500 feet)
P-40-002843	CA-SLO-002843	Site	Prehistoric	2017 (Gerrit Fenenga, CAL FIRE)	Within
P-40-038037	N/A	Other	Prehistoric	1986 (Semenza, UCSB)	Outside (Within 500 feet)
P-40-038038	N/A	Other	Prehistoric	1986 (Jim Mayberry, NMSU (Las Cruces NM))	Outside (Within 500 feet)

Cultural Resources within 500 Feet of the Trucking Routes

Primary No.	Trinomial	Type	Age	Recorded by	Distance from Project Area
P-40-038183	N/A	Other	Prehistoric	1999 (A. Ruby, Far Western)	Outside (Within 500 feet)
P-40-038294	N/A	Other	Prehistoric	2013 (Terry L. Joslin)	Outside (Within 500 feet)
P-40-041033	N/A	Other	Historic	1999 (L. Leach Palm (FW), S. Mikesell (JRP), Far Western Anthropological Research Group Inc.; JRP Historical Consulting Services)	Outside (Within 500 feet)
P-40-041034	N/A	Structure	Historic	1999 (L. Leach Palm (FW), T. Joslin (Caltrans District 5), Far Western Anthropological Research Group, Inc.; Caltrans District 5)	Outside (Within 500 feet)
P-42-000085	CA-SBA-000085	Site	Prehistoric	1928 (David B. Rogers) 1991 (Robert Sheets)	Outside (Within 500 feet)
P-42-000086	CA-SBA-000086	Site	Prehistoric	1929 (Rogers) 1985 (Joe D. Hood, California State Parks and Recreation) 2001 (Ivan Strudwick, LSA Assoc.) 2003 (Bob Sheet, Mike Imalle, Leeann Haslouer, Santa Barbara Trust for Historic Preservation) 2014 (M. Mealey, M. Graham, E. Pawlowski, B. Tehada, Janet Hall Garcia, Various)	Within
P-42-000087	CA-SBA-000087	Site	Prehistoric	1926 (D. B. Rogers) 1960 (Klug, University of California, Department of Anthropology) 1985 (Semenza, New Mexico State University) 1989 (P. Hines, B. Rivers, T. Wheeler, California Department of Parks and Recreation) 2001 (L. Haslouer and I. Strudwick, LSA Associates) 2003 (Bob Sheets, Mike Imwalle, Leeann Haslouer, Santa Barbara Trust for Historic Preservation) 2014 (M. Mealey, M. Graham, E. Pawlowski, B. Tejada, Janet Hall Garcia, Various)	Outside (Within 500 feet)
P-42-000089	CA-SBA-000089	Site	Prehistoric	1929 (David B. Rogers) 1999 (A. Ruby) 2015	Outside (Within 500 feet)
P-42-000090	CA-SBA-000090	Site	Prehistoric	1929 (David B. Rogers) 1999 (A. Ruby)	Within
P-42-000091	CA-SBA-000091	Site	Prehistoric	1929 (David B. Rogers) 1962 (E. McKinney)	Outside (Within 500 feet)
P-42-000092	CA-SBA-000092	Site	Prehistoric	1929 (David B. Rogers) 1999 (A. Ruby)	Within
P-42-000093	CA-SBA-000093	Site	Prehistoric	1929 (David B. Rogers) 2003 (B. Sheets, L, Haslouer, M. Imwalle)	Outside (Within 500 feet)
P-42-000095	CA-SBA-000095	Site	Prehistoric	1929 (David B. Rogers) 2003 (B. Sheets, L. Haslouer, M. Imwalle)	Outside (Within 500 feet)
P-42-000096	CA-SBA-000096	Site	Prehistoric	1929 (David B. Rogers) 2004 (James J. Schmidt)	Outside (Within 500 feet)
P-42-000108	CA-SBA-000108	Site	Prehistoric	1928 (David B. Rogers) 1989 (P. Hines, B. Rivers, T. Wheeler) 2003 (B. Sheets, M. Imwall. L. Haslouer)	Within
P-42-000166	CA-SBA-000166	Site	Prehistoric	1944 (Orr)	Outside (Within 500 feet)

Cultural Resources within 500 Feet of the Trucking Routes

Primary No.	Trinomial	Type	Age	Recorded by	Distance from Project Area
P-42-000245	CA-SBA-000245	Site	Prehistoric	1936 (Ruth) 2001 (Ivan Strudwick)	Outside (Within 500 feet)
P-42-000557	CA-SBA-000557	Site	Prehistoric	1934 1949 (W.D. Strong)	Within
P-42-000574	CA-SBA-000574	Site	Prehistoric	1968 2009 (T. Carpenter) 2013 (Nathan Stevens and Patricia Mikkelsen, Far Western Anthropological Research Group)	Within
P-42-000585	CA-SBA-000585	Site	Prehistoric	1970 (T. Anderson, JM Farrar, none given) 1999 (A. Ruby, T. Carpenter) 2013 (Patricia Mikkelsen and Valerie Levulett, Far Western Anthropological Research Group)	Within
P-42-000586	CA-SBA-000586	Site	Prehistoric	1970 1999 (A. Ruby); 2013 (Patricia Mikkelsen, Valerie Levulett, Far Western Anthropological Research Group; Caltrans District 5)	Within
P-42-001101	CA-SBA-001101	Site	Prehistoric	1971 2003 (F.A. Riddell)	Outside (Within 500 feet)
P-42-001151	CA-SBA-001151	Site	Prehistoric	1980 1999 (J. Johnson)	Outside (Within 500 feet)
P-42-001152	CA-SBA-001152	Site	Prehistoric	1980 1999 (J.Johnson)	Outside (Within 500 feet)
P-42-001156	CA-SBA-001156	Site	Prehistoric	1980 1989 (John Erlandson)	Outside (Within 500 feet)
P-42-001157	CA-SBA-001157	Site	Prehistoric, Historic	1981 2003 (Jon Erlandson)	Outside (Within 500 feet)
P-42-001184	CA-SBA-001184	Site	Prehistoric	1980 (J. Johnson, J. Hudson, Anth 181 field class.)	Outside (Within 500 feet)
P-42-001185	CA-SBA-001185	Site	Prehistoric	1980 1999 (J.Johnson, J. Hudson, Anth 181 field class)	Outside (Within 500 feet)
P-42-001204	CA-SBA-001204	Site	Prehistoric	1981 1999 (Jon Erlandson)	Within
P-42-001506	CA-SBA-001506	Site	Prehistoric	1974 (L. Wilcoxon)	Within
P-42-001555	CA-SBA-001555/H	Site	Prehistoric, Historic	1984 (R. Peterson, F. Duncan, Office of Public Archaeology, Anthropology, UCSB); 1984 (R. Peterson, F. Duncan, J. Erlandson, Office of Public Archaeology, Dept. of Anthroplogy, UCSB); 1984 (M. Wendorf, University of California, Los Angeles Regional Office); 1989 (A. George Toren, ERC Environmental and Energy Services Co.); 2014 (Jay Rehor, URS Corporation)	Within
P-42-001675	CA-SBA-001675	Site	Prehistoric	1981 1992 (Jon Erlandson)	Outside (Within 500 feet)
P-42-001731	CA-SBA-001731	Site	Prehistoric	1982 2001 (Hector Neff)	Outside (Within 500 feet)
P-42-001732	CA-SBA-001732	Site	Historic	1981 (L. Spanne and J.Weighill)	Within

Cultural Resources within 500 Feet of the Trucking Routes

Primary No.	Trinomial	Type	Age	Recorded by	Distance from Project Area
P-42-001733	CA-SBA-001733	Site	Prehistoric, Historic	1982 (L. Spanne, I. Weighill)	Within
P-42-001766	CA-SBA-001766	Site	Prehistoric	1982 2001 (Dr. E.G. Stickel)	Outside (Within 500 feet)
P-42-001786	CA-SBA-001786	Site	Prehistoric	1982 2003 (K. Osland)	Outside (Within 500 feet)
P-42-001821	CA-SBA-001821	Site	Historic	1983; 1998 (T. Jacques, J. Thesken)	Outside (Within 500 feet)
P-42-001822	CA-SBA-001822	Site	Prehistoric, Historic	1983 (Terri Jacques)	Outside (Within 500 feet)
P-42-001828	CA-SBA-001828	Site	Prehistoric	1983 (S, Arter, K. Osland, D. Quillen, R. Franklin)	Outside (Within 500 feet)
P-42-001900	CA-SBA-001900	Site	Prehistoric	1984 1999 (Brain C. Amme)	Outside (Within 500 feet)
P-42-001901	CA-SBA-001901	Site	Prehistoric	1984 1999 (Brian C. Amme)	Outside (Within 500 feet)
P-42-001916	CA-SBA-001916	Site	Prehistoric	1985 1985 (J.D.Hood)	Outside (Within 500 feet)
P-42-001952	CA-SBA-001952	Site	Prehistoric, Historic	1985 (Joyce Clevenger, Theodore Cooley, WESTEC Services Inc., Ventura)	Within
P-42-001954	CA-SBA-001954	Site	Prehistoric	1985 (L. Wilcoxon, Brenda Bowser, Michael Imwalle, Consulting Archaeologist, 1322-A Montecito Pl. Santa Barbara, Ca.) 1987 (T. Gonzalez R. Hawkins, Dames and Moore, 820 fifth ave, San Diego, Ca. 92101) 1991 (L. Santoro, A.G. Toren, T. Hazeltine, Ogden Environmental and Energy Services Co. 510 State Street Suite B Santa Barbara 93101) 1999 (A. Ruby, Far Western, PO Box 413, Davis Ca 95617)	Within
P-42-001969	CA-SBA-001969	Site	Prehistoric	1985 (Jon McVey Erlandson, Dept. Anth. UCSB)	Outside (Within 500 feet)
P-42-001979	CA-SBA-001979	Site	Prehistoric	1985 (J. Pjerrou, B. Johnson, P. Lagreze, J. Schmidt, CAS (UCSB))	Outside (Within 500 feet)
P-42-001980	CA-SBA-001980	Site	Prehistoric	1985 (J. Pjerrou, B. Johnson, J. Schmidt, P. Lagreze, CAS (UCSB))	Outside (Within 500 feet)
P-42-001982	CA-SBA-001982	Site	Prehistoric	1985 (J. Pjerrou, B. Johnson, P. Lagreze, J. Schmidt, CAS (UCSB))	Outside (Within 500 feet)
P-42-001986	CA-SBA-001986	Site	Prehistoric	1985 (Pjerrou, Lagreze, Johnson, Schmidt, CAS (UCSB))	Outside (Within 500 feet)
P-42-001987	CA-SBA-001987	Site	Prehistoric	1985 (Pjerrou, Schmidt, Lagreze, CAS (UCSB))	Outside (Within 500 feet)
P-42-001988	CA-SBA-001988	Site	Prehistoric, Unknown	1985 (J. Semenza, B. Glover, CAS (UCSB)) 1992 (L. Santoro, A.G. Toren, T. Hazeltine, Ogden Enviornmental and Energy Services Co., 510 State Street, Suite B, Santa Barbara CA93101)	Outside (Within 500 feet)
P-42-001990	CA-SBA-001990	Site	Prehistoric	1985 (Pjerrou,Lagreze, Schmidt, Ruiz, CAS (UCSB)) 1992 (L. Santoro, A.G. Torren, T. Hazeltine, Ogden Enviornmental and Energy Services Co., 510 State Street, suite B, Santa Barabra, 93101)	Outside (Within 500 feet)

Cultural Resources within 500 Feet of the Trucking Routes

Primary No.	Trinomial	Type	Age	Recorded by	Distance from Project Area
P-42-002011	CA-SBA-002011	Site	Prehistoric	1985 (P. de Barros, C.E. Drover, CCP, 10557 Beach Blvd., Stanton, CA 90680)	Outside (Within 500 feet)
P-42-002028	CA-SBA-002028	Site	Prehistoric, Historic	1986 (J. Erlandson, T. Cooley, WESTEC, 3211 5th Ave., San Diego, CA 93102)	Outside (Within 500 feet)
P-42-002038	CA-SBA-002038/H	Site	Prehistoric, Historic	1985 (Chriss Webb, Center for Archaeological Studies, UCSB) 1991 (L. Santoro, A.G. Toren, T. Hazeltine, Ogden Environemental and Energy Services, Co.) 2017 (Sarah Nicchitta and Reilly Murphy, Albion Environmental, Inc.)	Outside (Within 500 feet)
P-42-002046	CA-SBA-002046	Site	Historic	1986 (A.York, Dames &Moore, 820 Fifth Ave., San Diego, CA 92101)	Within
P-42-002048	CA-SBA-002048	Site	Prehistoric	1986 (Glover, Harmon, CAS (UCSB))	Outside (Within 500 feet)
P-42-002067	CA-SBA-002067	Site	Prehistoric, Historic	1986 (Knight, Berry, Erlandson, UCSB Anth Dept./ WESTEC Serviced)	Outside (Within 500 feet)
P-42-002087	CA-SBA-002087	Site	Prehistoric, Historic	1986 (R. Carrico, T. Cooley, S. Briggs, WESTEC Services, Inc. 5510 Morehouse Drive, San Diego, CA 92121) 1990 (L. Michals, Dames & Moore, 175 Cremona Drive, Goleta, CA 93117) 1999 (J. Berg, Far Western); 2003 (B. Sheets, M. Imwalle, L. Haslouer, Santa Barbara Trust for Historic Preservation, PO Box 388, Santa Barbara, CA 93102) 2014 (Eric Nocerino, Applied EarthWorks, Inc.)	Outside (Within 500 feet)
P-42-002149	CA-SBA-002149	Site	Prehistoric	1987 (Chester King, C. King & Assoc. PO Box 1324, Topanga, 90290) 1992 (L.Santoro. AG Toren, T. Hazeltine, Ogden Environmental and Energy Services Co.)	Outside (Within 500 feet)
P-42-002191	CA-SBA-002191	Site	Prehistoric	1988 (Shelly Slekus, Joyce Gerber, Dame and Moore, 175 Cremona Ave, Goleta CA 93117)	Outside (Within 500 feet)
P-42-002484	CA-SBA-002484	Structure, Site	Historic	1986 (D. Roy, CAS, Department of Anthropology, UCSB); 2002 (B. Hatoff, URS Corporation, 500 12th St., Suite 200, Oakland, CA 94607-4014); 2004 (M. Bischoff, Historian II, California State Parks, Central Service Center, 21 Lower Ragsdale Drive, Monterey, CA 93940)	Outside (Within 500 feet)
P-42-002485	CA-SBA-002485	Structure, Site	Historic	1985 (M. Imwalle, CAS, Department of Anthropology, UCSB); 1999 (J. Berg, Far Western, PO Box 413, Davis, CA 95617)	Within
P-42-002588	CA-SBA-002588	Site	Prehistoric, Historic	1991 (Melinda Peak, Robert Gerry, James Oglesby, Peak and Associates)	Outside (Within 500 feet)
P-42-002604	CA-SBA-002604	Site	Prehistoric	1990 (L.R. Wilcoxon, J.M. Harmon, Larry R. Wilcoxon Archneological Consultants, 7671 Dartmoor Avenue, Goleta, CA 93117)	Outside (Within 500 feet)
P-42-002625	CA-SBA-002625	Site	Historic	1990 (Lauren Michals, Dames and Moore, 175 Cremona Drive, Goleta, CA 93117)	Outside (Within 500 feet)

Cultural Resources within 500 Feet of the Trucking Routes

Primary No.	Trinomial	Type	Age	Recorded by	Distance from Project Area
P-42-002633	CA-SBA-002633	Site	Prehistoric	1982 (Karen Osland)	Within
P-42-002644	CA-SBA-002644	Site	Prehistoric	1976 (L. Spanne)	Outside (Within 500 feet)
P-42-002647	CA-SBA-002647	Site	Prehistoric	1994 (M. Valentine-Maki, J. Ruiz, Fugro West Inc. 2140 Eastman Ave., Ventura, CA 93003)	Outside (Within 500 feet)
P-42-002736	CA-SBA-002736	Site	Historic	1995 (G. Romani, A.G. Toren, D. Kay, L. Haslouer, ISERA Group, 5370 Hollister Ave. #5, Santa Barbara, CA. 93111.)	Outside (Within 500 feet)
P-42-002753	CA-SBA-002753	Site	Prehistoric, Historic	1988 (James M. JArmon, L. Wilcoxon Archaeological Consultants, 7671 Dartmoor Avenue, Goleta Ca, 93117)	Outside (Within 500 feet)
P-42-003387	CA-SBA-003387	Site	Prehistoric	1996 (Rebecca McKim and Douglas Harro, Applied EarthWorks, Inc., 5088 N. Fruit Ave., Suite 101, Fresno, California 93711-6138)	Outside (Within 500 feet)
P-42-003395	CA-SBA-003395	Site	Prehistoric	1995 (Larry Wilcoxon & Jose Castillo, Wilcoxon Archaeological Consultants. 6542 Covington Way. Goleta. CA 93117)	Outside (Within 500 feet)
P-42-003404	CA-SBA-003404	Site	Prehistoric, Protohistoric, Historic	1996 (Larry Wilcoxon and Ethan Bertrando, Wilcoxon Archaeological Consultants, 6542 Covington Way, Goleta , CA 93117)	Within
P-42-003405	CA-SBA-003405	Site	Prehistoric	1997 (Brian Haley, Cindy Klink, Wilcoxon Archaeological Consultants, 6542 Covington Way, Goleta, CA 93117)	Outside (Within 500 feet)
P-42-003486	CA-SBA-003486	Site	Historic	1997 (Larry Wilcoxon and Brian Haley, Wilcoxon archaeological Consultants, 6542 Covington Way, Goleta, CA 93117) 1997 (K. Syda, Far Western Anthropological Research Group. Inc.)	Outside (Within 500 feet)
P-42-003602	CA-SBA-003602	Site	Prehistoric	1999 (L. Leach-Palm, Far Western Anthropological Research Group, Inc., P.O. Box 413, Davis, CA 95617)	Outside (Within 500 feet)
P-42-003604	CA-SBA-003604	Site	Prehistoric	1999 (J. Berg, Far Western Anthropological Research Group, Inc ., P.O. Box 413, Davis, CA 95617)	Within
P-42-003618	CA-SBA-003618	Site	Historic	1999 (M. Darcangelo (FW), S. Mikesell (JRP), Far Western Anthropological Research Group, Inc., P.O. Box 413, Davis, CA 95617; JRP Historical Consulting Services, 1490 Drew Ave, Suite110, Davis, CA 95616)	Outside (Within 500 feet)
P-42-003621	CA-SBA-003621	Site	Historic	1999 (L. Leach-Palm, S. Mikesell, Far Western) 2002 (S. Baker, D. Shoup, M. Smith, A/HC- 609 Aileen Street Oakland, CA 94609)	Outside (Within 500 feet)
P-42-003637	CA-SBA-003637	Site	Prehistoric	2001 (Ivan Strudwick, LSA Associates. Inc., I Park Plaza. Suite 500 Irvine. CA 92614-5981)	Outside (Within 500 feet)
P-42-003639	CA-SBA-003639	Site	Historic	2001 (Ivan Strudwick and Al Knight, LSA Assoc., Inc., I Park Plaza, Suite 500 Irvine, CA 92614)	Outside (Within 500 feet)
P-42-003679	CA-SBA-003679	Site	Prehistoric	2002 (S. Baker, M. Smith, J. Doty, D. Shoup, A/HC-609 Aileen Street, Oakland, CA 94609)	Outside (Within 500 feet)
P-42-003680	CA-SBA-003680	Site	Prehistoric, Historic	2002 (S. Baker, M. Smith, J. Doty, D. Shoup, A/HC-609 Aileen St. Oakland, CA 94609)	Outside (Within 500 feet)

Cultural Resources within 500 Feet of the Trucking Routes

Primary No.	Trinomial	Type	Age	Recorded by	Distance from Project Area
P-42-003681	CA-SBA-003681	Site	Prehistoric	2002 (S. Baker. M. Smith. J. Dory, D. Shoup,, A/HG-609 Aileen Street Oakland. CA 94609)	Outside (Within 500 feet)
P-42-003727	CA-SBA-003727	Site	Prehistoric	2003 (Bob Sheets, Leeann Haslouer, Mike Imwalle, Santa Barbara Trust for Historic Preservation)	Outside (Within 500 feet)
P-42-003751	CA-SBA-003751	Site	Prehistoric	2005 (Herb Dallas, Natalie Brodie, State of California, Department of Parks and Recreation, Southern Service Center)	Outside (Within 500 feet)
P-42-003812	CA-SBA-003812H	Site	Historic	2006 (Thor Conway, Heritage Discoveries Inc.)	Outside (Within 500 feet)
P-42-003991	CA-SBA-003991	Site	Prehistoric	2009 (K. Osland, A. Munns, Applied Earthworks)	Outside (Within 500 feet)
P-42-004005	CA-SBA-004005	Site	Prehistoric	2009	Outside (Within 500 feet)
P-42-004088	CA-SBA-004088	Site	Prehistoric	2016 (John M. Foster, Greenwood and Associates)	Outside (Within 500 feet)
P-42-004110	CA-SBA-004110	Site	Prehistoric	2015 (None given, Applied EarthWorks, Inc.)	Outside (Within 500 feet)
P-42-004120	CA-SBA-004120H	Structure	Historic	2015 (Josh Smallwood, Applied EarthWorks)	Outside (Within 500 feet)
P-42-004121	N/A	Structure	Historic	2015 (Josh Smallwood, Applied EarthWorks)	Outside (Within 500 feet)
P-42-004122	CA-SBA-004122	Site	Prehistoric	(Eric Nocerino, Applied Earthworks)	Outside (Within 500 feet)
P-42-004123	CA-SBA-004123/H	Site	Prehistoric, Historic	2015	Outside (Within 500 feet)
P-42-038083	N/A	Other	Prehistoric	1989 (P. Hines, B. Rivers, T. Wheeler, California Department of Parks and Recreation, Cultural Heritage Section)	Outside (Within 500 feet)
P-42-038291	N/A	Other	Prehistoric	1991 (A.G. Toren, ERCE)	Outside (Within 500 feet)
P-42-038292	N/A	Other	Prehistoric	1991 (A.G. Toren, ERCE)	Outside (Within 500 feet)
P-42-038293	N/A	Other	Prehistoric	1991 (A.G. Toren, ERCE)	Outside (Within 500 feet)
P-42-038294	N/A	Other	Prehistoric	1991 (A.G. Toren, ERCE)	Outside (Within 500 feet)
P-42-038295	N/A	Other	Prehistoric	1991 (A.G. Toren, ERCE)	Outside (Within 500 feet)
P-42-038296	N/A	Other	Prehistoric	1991 (A.G. Toren, ERCE)	Outside (Within 500 feet)
P-42-038297	N/A	Other	Prehistoric	1991 (A.G. Toren, ERCE)	Outside (Within 500 feet)
P-42-038298	N/A	Other	Historic	1991 (A.G. Toren, ERCE)	Outside (Within 500 feet)
P-42-038299	N/A	Other	Prehistoric	1991 (A.G. Toren, ERCE)	Outside (Within 500 feet)
P-42-038300	N/A	Other	Prehistoric	1991 (A.G. Toren, ERCE)	Outside (Within 500 feet)
P-42-038301	N/A	Other	Prehistoric	1991 (A.G. Toren, ERCE)	Outside (Within 500 feet)

Cultural Resources within 500 Feet of the Trucking Routes

Primary No.	Trinomial	Type	Age	Recorded by	Distance from Project Area
P-42-038352	N/A	Other	Prehistoric, Historic	1986 (A. Hobbs, UCSB)	Outside (Within 500 feet)
P-42-038353	N/A	Other	Historic	1986 (D. Roy, UCSB) 1999 (J. Berg, Far Western)	Outside (Within 500 feet)
P-42-038419	N/A	Other	Prehistoric	1988 (S. Sirkus, Dames & Moore)	Outside (Within 500 feet)
P-42-038422	N/A	Other	Prehistoric	1988 (S. Sirkus, E. Ruiz, Dames & Moore)	Within
P-42-038423	N/A	Other	Prehistoric	1988 (S. Sirkus, E. Ruiz, Dames & Moore)	Within
P-42-038458	N/A	Other	Prehistoric	1990 (L. Michals, Dames & Moore)	Outside (Within 500 feet)
P-42-038459	N/A	Other	Prehistoric	1990 (J. Gerber, Dames & Moore)	Outside (Within 500 feet)
P-42-038476	N/A	Other	Prehistoric	1994 (M. Valentine-Maki, J. Ruiz, Fugro West Inc.)	Outside (Within 500 feet)
P-42-038555	N/A	Other	Prehistoric	1994 (T. Fulton, L. Eaglefeather, INFOTEC Research, Inc.)	Outside (Within 500 feet)
P-42-038581	N/A	Other	Prehistoric	1984 (C. Cagle, K. Laustsen, ACT, Inc.)	Outside (Within 500 feet)
P-42-038662	N/A	Other	Prehistoric	1999 (L. Leach-Palm, Far Western Anthropological Research Group)	Outside (Within 500 feet)
P-42-038668	N/A	Other	Prehistoric	1999 (L. Leach-Palm, Far Western Anthropological Research Group)	Outside (Within 500 feet)
P-42-038872	N/A	Other	Historic	2014	Outside (Within 500 feet)
P-42-040477	N/A	Other	Historic		Outside (Within 500 feet)
P-42-040478	N/A	Other	Historic		Within
P-42-040499	N/A	Other	Historic		Outside (Within 500 feet)
P-42-040656	N/A	Other	Historic		Outside (Within 500 feet)
P-42-040657	N/A	Other	Historic		Outside (Within 500 feet)
P-42-040659	N/A	Other	Historic		Outside (Within 500 feet)
P-42-040682	N/A	Other	Historic		Outside (Within 500 feet)
P-42-040683	N/A	Other	Historic		Within
P-42-040718	N/A	Structure	Historic	1999 (L. Leach-Palm, S. Mikesell, Far Western Anthropological Research Group, Inc.)	Outside (Within 500 feet)
P-42-040719	N/A	Structure	Historic	1999 (L. Leach-Palm, S. Mikesell, Far Western Anthropological Research Group, Inc.)	Within
P-42-040720	N/A	Structure	Historic	1999 (L. Leach-Palm, Far Western Anthropological Research Group, Inc.)	Outside (Within 500 feet)
P-42-040721	N/A	Structure	Historic	1999 (L. Leach-Palm, S. Mikesell, Far Western Anthropological Research Group, Inc.)	Outside (Within 500 feet)
P-42-040731	N/A	District	Historic	1999 (a. Ruby, M. Darcangelo, S. Mikesell, Far Western Anthropological Research Group, Inc.)	Within
P-42-040750	N/A	Site	Historic	2002 (S. Baker, M. Smith, J. Doty, D. Shoup)	Outside (Within 500 feet)

Cultural Resources within 500 Feet of the Trucking Routes

Primary No.	Trinomial	Type	Age	Recorded by	Distance from Project Area
P-42-041120	N/A	Building	Historic	1988 (Jason Marmor, Archaeologist)	Outside (Within 500 feet)
P-42-041121	N/A	Building	Historic	1988 (Jason Marmor, Los Padres National Forest)	Outside (Within 500 feet)
P-42-041122	N/A	Building	Historic	1988 (Jason Marmor, Los Padres National Forest)	Outside (Within 500 feet)
P-42-041123	N/A	Building	Historic	1988 (Jason Marmor, Los Padres National Forest)	Outside (Within 500 feet)
P-42-041133	N/A	District	Historic	2015 (Josh Smallwood, Applied EarthWorks)	Outside (Within 500 feet)
P-42-041134	N/A	Element of district	Historic	2015 (Josh Smallwood, Applied EarthWorks)	Outside (Within 500 feet)
P-42-041135	N/A	Element of district	Historic	2015 (Josh Smallwood, Applied EarthWorks)	Outside (Within 500 feet)
P-42-041136	N/A	Element of district	Historic	2015 (Josh Smallwood, Applied EarthWorks)	Outside (Within 500 feet)
P-42-041138	N/A	Element of district	Historic	2015 (Josh Smallwood, Applied EarthWorks)	Outside (Within 500 feet)
P-42-041205	N/A	Structure	Historic	2018 (Carole Denardo, Provenience Group, Inc.)	Within
P-15-000186	CA-KER-000186	Site	Prehistoric	1950 (M.L.)	Within
P-15-003853	CA-KER-003853H	Site	Historic	1993 (Scott Baxter, Greg Clift, Cultural Resource Facility, CSUB)	Outside (Within 500 feet)
P-15-003854	CA-KER-003854H	Site	Historic	1993 (Scott Baxter, Greg Clift, Cultural Resource Facility, CSUB)	Within
P-15-003855	CA-KER-003855H	Building, Structure, Site	Historic	1993 (Patrice Jeppson, CRF CSUB)	Within
P-15-003856	CA-KER-003856H	Building, Structure, Site	Historic	1993 (Patrice Jeppson, CRF CSUB)	Within
P-15-004024	CA-KER-004023H	Structure	Historic	1994 (David J. Scott, Bruce Steidl, Woodward-Clyde Consultants) 1999 (Scott M. Hudlow, Hudlow Cultural Resource Associates); 2009 (Steven J. Melvin, Rebecca Flores, JRP Historical Consulting); 2009 (K. Larsen, N. Sims, A. Stevenson, Pacific Legacy, Inc.); 2010 (M. Armstrong, D. Curtis, Pacific Legacy, Inc.); 2011 (M. Armstrong, Applied Earthworks, Inc.); 2012 (Shannon Loftus, ACE Environmental, LLC.); 2013 (A. Bell, C. Rambo, ASM Affiliates, Inc.); 2015 (ASM Affiliates, Inc.); 2019 (Unknown, Padre Associates, Inc.)	Outside (Within 500 feet)
P-15-006045	CA-KER-005052	Site	Prehistoric	1997 (Christine Chamberlin, Mandy Marine, California State University, Fresno, Laboratory of Anthropology)	Outside (Within 500 feet)
P-15-006046	N/A	Other	Prehistoric	1997 (Christine Chamberlin, Mandy Marine, California State University, Fresno, Laboratory of Anthropology)	Outside (Within 500 feet)
P-15-006047	N/A	Other	Prehistoric	1997 (Christine Chamberlin, Mandy Marine, California State University, Fresno, Laboratory of Anthropology)	Outside (Within 500 feet)

Cultural Resources within 500 Feet of the Trucking Routes

Primary No.	Trinomial	Type	Age	Recorded by	Distance from Project Area
P-15-006048	N/A	Other	Prehistoric	1997 (Christine Chamberlin, Mandy Marine, California State University, Fresno, Laboratory of Anthropology)	Outside (Within 500 feet)
P-15-006674	N/A	Other	Prehistoric	1984 (J. McManus, M. Rondeau, Caltrans)	Outside (Within 500 feet)
P-15-008490	N/A	Building	Historic	1989 (Unknown)	Outside (Within 500 feet)
P-15-011692	N/A	Site	Historic	2005 (Catherine Lewis Pruett, Dorothy Fleagle, Three Girls and a Shovel); 2016 (C. Letter, V. Kirstine, Padre Associates)	Outside (Within 500 feet)
P-15-011693	N/A	Site	Historic	2005 (Catherine Lewis Pruett, Dorothy Fleagle, Three Girls and a Shovel); 2016 (C. Letter, V. Kirstine, Padre Associates)	Outside (Within 500 feet)
P-15-017370	CA-KER-009531H	Site	Historic	2013 (Colin Rambo, ASM Affiliates, Inc.)	Outside (Within 500 feet)
P-15-019171	CA-KER-010450H	Site	Historic	2016 (Rachael Letter, Padre Associates)	Within