Appendix C

Air Quality Technical Appendix

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Reuse of Affected Materials
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Union Oil Company of California

Guadalupe, California

Guadalupe Restoration Project, Diesel Exhaust Particulate Matter Health Risk Assessment for Off-Site Trucking

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1.0 INTRODUCTION

The California Air Resources Board (CARB) has identified diesel exhaust particulate matter as a toxic air contaminant (TAC). CARB determined that long-term exposure to diesel exhaust particulate matter has the potential to increase the risk of contracting cancer. The California Office of Environmental Health Hazard Assessment (OEHHA) has also determined that long-term exposure to diesel exhaust particulate matter can have adverse non-cancer health effects. A health risk assessment (HRA) was conducted to evaluate potential adverse human health risks that might be posed by diesel exhaust particulate matter emitted by diesel-fueled haul trucks transporting material to the Santa Maria Landfill during the Guadalupe Oil Field Remediation and Abandonment Project.

Health risks from exposure to cancer-causing TACs are expressed as an increased probability of contracting cancer. Most air pollution control districts in California, including the Santa Barbara County Air Pollution Control District (SBAPCD), have established an increased risk of contracting cancer of 10 per million as a significance threshold for evaluating cancer risks from emission sources. The probability of contracting cancer from exposure to a TAC is assumed to be proportional to the total exposure over an entire lifetime. OEHHA (2003) has established cancer potency factors for TACs. These factors are estimates of the probability of contracting cancer from an average exposure to one milligram (mg) of a TAC per kilogram (kg) of body weight per day during a 70-year lifetime. For example, if the cancer potency factor for a TAC is equal to one per milligram per kilogram per day, and a person inhales one millionth of a milligram of the TAC for every kilogram of body weight every day during 70 years, the increased probability of contracting cancer from exposure to the TAC would be one-in-one-million. OEHHA (2003) has adopted a cancer potency factor for diesel exhaust particulate matter of 1.1 per mg/kg-day, based on a 70-year exposure.

Non-cancer health risks are evaluated by comparing atmospheric concentrations of individual TACs to reference concentrations, where reference concentrations are defined as concentrations that can be breathed continuously without causing adverse health effects. OEHHA (2003) has established a reference concentration for long-term exposure to diesel exhaust particulate matter of 5 $\mu g/m^3$. This means that breathing air containing 5 $\mu g/m^3$ or less of diesel exhaust particulate matter would not cause adverse non-cancer health effects.

An air quality dispersion model was used to estimate atmospheric diesel exhaust particulate matter concentrations that might be caused by emissions from the haul trucks. These concentrations were multiplied by average daily breathing rates per kilogram of body weight to estimate the average daily dose. Separate doses were calculated for children and for adults, because children tend to inhale more air per kilogram of body weight than adults. The “high-end”

estimates[1] of average daily breathing rates of 581 and 393 liters per kilogram of body weight for children and adults, respectively, provided by OEHHA (2003) were used.

The off-site haul truck trips are anticipated to occur five days per week, 50 weeks per year, during a three-year period. Although the duration of potential exposure to diesel exhaust particulate matter from the truck emissions is three years, OEHHA (2003) does not support the use of current cancer potency factors to evaluate cancer risk for exposures of less than nine years, because the cancer potency factors have been derived from long-term exposure studies. Therefore, OEHHA (2003) recommends assuming that the average daily dose occurs for a nine-year duration to evaluate risks from short-term exposures. In accordance with this recommendation, a nine-year exposure was assumed for this health risk analysis. Since the assumed nine-year exposure is three times greater than the actual three-year duration of the off-site trucking operations, this assumption likely leads to a conservatively high estimate of carcinogenic risks from the off-site trucking operations.

Since the assumed nine-year exposure duration is less than the 70 years of continuous exposure that is the basis for the cancer potency factor, the average daily doses were adjusted by a factor of 9 years / 70 years to reflect the shorter exposure duration and by an additional factor of 250 days exposure per year / 365 days per year to reflect that operations would not occur every day. The resulting adjusted average daily doses were then multiplied by the diesel exhaust particulate matter cancer potency factor to calculate the increased cancer risk.

It should be noted that, although the off-site trucking activities are anticipated to be completed in three years, future activities associated with restoration of the Guadalupe Oil Field that would involve off-site diesel truck traffic may potentially occur. Although such activities have not been identified at this time, the assumption of a nine-year exposure duration for this health risk assessment would likely account for potential cancer risks from those activities, as well.

The concentrations were also compared with the 5 $\mu g/m^3$ diesel exhaust particulate matter reference concentration to evaluate the potential for adverse non-cancer health effects.

[1] The "high-end" values are estimates of the 95th percentile of the breathing rates. The average daily breathing rates for children and adults from OEHHA (2003) are 452 and 271 liters per kilogram body weight.

2.0 AIR QUALITY DISPERSION MODELING

The U.S. Environmental Protection Agency's (EPA) Industrial Source Complex-Short Term (ISCST3) version 02035 air dispersion computer modeling program was used to estimate diesel exhaust particulate matter concentrations along the haul truck route. The ISCST3 model is a steady-state Gaussian plume model that can be used to assess downwind concentrations from a wide variety of emission sources types. The model can account for point, area, line and volume sources; building downwash, plume rise as a function of downwind distance; separation of point sources and limited terrain adjustment; rural or urban areas; transport distances less than 50 kilometers and 1 hour to annual averaging times.

Input requirements for the model include source data, meteorological data, terrain data and receptor data. Source data includes location, emission rate, physical stack height, stack gas exit velocity, stack inside diameter and stack gas temperature. Optional inputs include source elevation and building dimensions. Meteorological data inputs are hourly surface weather data that provides hourly stability class, wind direction, wind speed, temperature and mixing height. Receptor data includes coordinates and ground elevation for each receptor.

In this analysis, the ISCST3 model's regulatory default options and values were used. The analysis also used the model's rural dispersion coefficient option because the bulk of the truck route is through rural countryside.

The truck emissions were modeled as volume sources. Truck traffic on the roadway was approximated as equally spaced volume sources along the entire length of the truck route. Table 2-1 provides the volume source parameters input into the ISCST3 model. As allowed by the ISCST3 User's Guide, the road was approximated by a series of volume sources spaced apart at twice the nominal width of the road.

Table 2-1 Volume Source Parameters Input into the ISCST3 Model

Volume Source	Number of Volume Source[a]	Side Length[b] (m)	Height of Release (m)	Initial Sigma Y[c] (m)	Initial Sigma Z[d] (m)	Location (UTM Zone 11, NAD27
Highway Sources	572	50	4.3	23.3	2.0	Varies

[a] Approximate 28,600 meter one-way trip length (57,200 meter or 35.5 mile roundtrip).
[b] Approximate width of roadway estimated as 25 meters (average). Approximate length of each volume source approximated as twice the width of the roadway per ISCST3 User's Guide.
[c] Estimated as side length divided by 2.15 for highway sources (line source represented by adjoining volume sources) as per ISCST3 User's Guide.
[d] Estimated as height of release divided by 2.15 as per ISCST3 User's Guide for a surface-based volume source.

A unit emission rate of 1 gram per second per 50 meters of road length was used for modeling each volume source. The resultant annual-average concentration estimates produced by the model are in terms of concentrations per unit of emission rate. To obtain the expected exposure concentration at each receptor, the unit concentrations were multiplied by the average emission rate of each volume source (in grams/second/50 meters) to account for the actual emissions.

Transporting the entire Tier 3 material volume of 860,000 cubic yards (CY) with 8 CY capacity haul trucks would require a total of 107,500 round trips. The daily average number of round trips would be 143.33, based on 250 days per year (five days/week x 50 weeks/year) of operations over a three-year period. Thus, a total of 286.67 one-way trips would occur each day. Although the average capacity of the haul trucks would probably be larger than 8 CY, the smaller truck capacity was used to ensure that the results are a conservatively high estimate of the emissions.

The PM10 exhaust emission factor for the haul trucks is 0.24 grams per mile (g/mi). Daily haul truck diesel exhaust particulate matter emissions per mile of roadway would be 68.8 g/mi-day over an eight-hour daily duration, which corresponds to 7.42 x 10^{-5} grams/second/50 meters.

Meteorological data for the Santa Maria airport for 1963, already processed into the hourly format required by the ISCST3 model, were obtained from the Santa Barbara County APCD. A wind rose for the Santa Maria meteorological data is given in Figure 2-1.

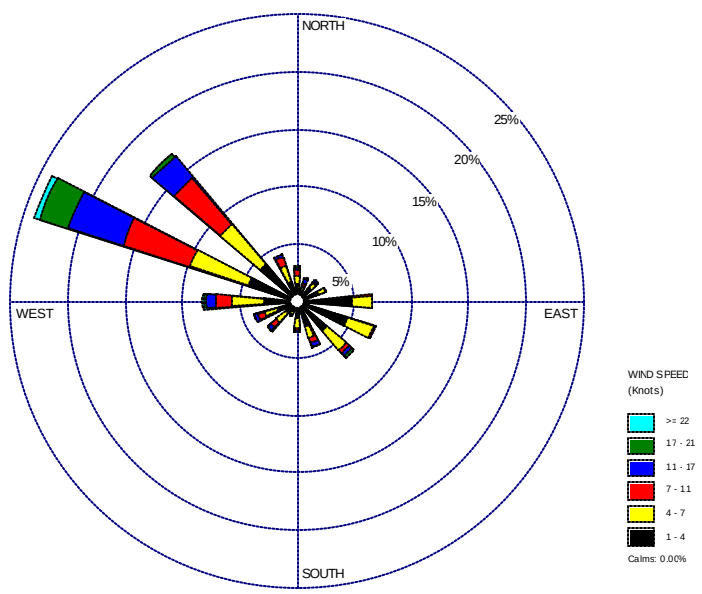

Figure 2-1. Wind Rose for Santa Maria for 1963.

Truck trips were assumed to begin at 7:00 am and to end at 3:00 pm. Although truck trips might begin later than 7:00 am, atmospheric dispersion conditions tend to be poorer in the early morning, which would lead to higher concentrations from the emissions. Therefore, the assumption that trips would begin at 7:00 am provides a conservative estimate of potential impacts from the truck emissions.

Two sets of receptors were modeled: grid receptors and discrete (sensitive) receptors. The grid receptors were spaced 100 meters apart along the entire transport route and extended approximately 500 to 1,000 meters away from the roadway. Because peak impacts from low-level sources such as the volume sources occur immediately adjacent to the roadway, terrain influences on the dispersion in the vicinity of the roadway are insignificant. Therefore, the ISCST3 option to include terrain heights in the modeling was not used in the modeling.

A total of 25 sensitive receptors were defined along the roadway. Figure 2-2 shows a plot of the modeling domain, the sensitive receptors, the extent of the 100 meter grid, and the volume sources modeled. The location of the maximum annual impact grid receptor (ann) is also shown in the figure. The sensitive receptors are listed in Table 2-2.

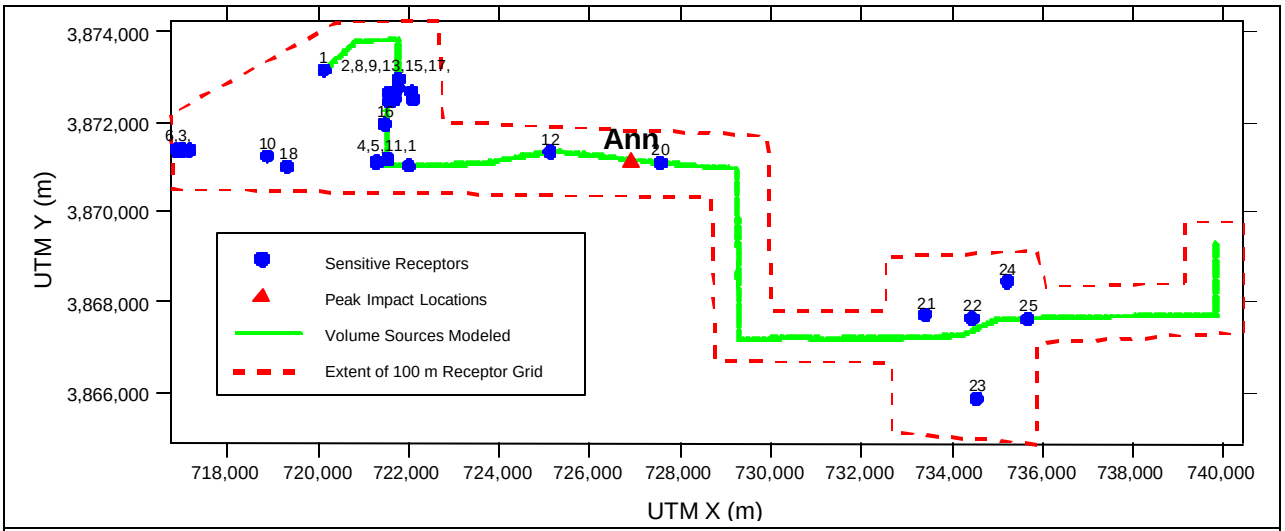

Figure 2-2. Modeling Domain Used for the Health Risk Assessment.

Table 2-2 Sensitive Receptor Locations

Sensitive Receptor	Name	Address/Location	UTM X (m)	UTM Y (m)
1	Residence (Ranch)	End of Thornberry Rd.	720,126	3,873,143
2	Residences in Guadalupe	Hwy 1 north end of Guadalupe	721,775	3,872,935
3	Residence	5795 West Main St.	716,987	3,871,372
4	Guadalupe Head Start	120 Tognazzini St.	721,295	3,871,092
5	Guadalupe Day Care	130 Tognazzini St.	721,295	3,871,127
6	Rancho Guadalupe County Park and beachfront	End of West Main St.	716,867	3,871,369
7	North end of Pacific Dunes Way, Point Sal Dunes residential area	W. Main St.	717,161	3,871,369
8	LeRoy County Park	North of 11th St., adjacent to City of Guadalupe	721,759	3,872,743
9	Mary Buren Elementary School	1050 Peralta St.	722,101	3,872,498
10	Kermit McKenzie Jr. High School	4710 W. Main St.	718,861	3,871,233
11	Residences	After intersection of Hwy 1 and 166, between Obispo St. and Flower Ave.	721,999	3,871,019
12	Residence	Hwy 166 between Hwy 1 and Black Rd.	725,122	3,871,325
13	Guadalupe Branch of Santa Maria City Library	1005 Guadalupe St.	721,580	3,872,444
14	Guadalupe Foursquare Church	177 Guadalupe St.	721,527	3,871,165
15	Apostolic Church	893 Pioneer St.	721,566	3,872,649
16	Guadalupe Community Church	4635 6th St.	721,473	3,871,938
17	Our Lady of Guadalupe	1164 Obispo St.	722,057	3,872,668
18	Guadalupe Cemetery	4655 W. Main St.	719,313	3,870,994
19	Central Park	South of 10th St.	721,673	3,872,498
20	Bonita Elementary School	2715 W. Main St., Santa Maria	727,555	3,871,082
21	Residences	Carmen Lane, N. Westgate Rd.	733,404	3,867,700
22	Residences at intersection of Betteravia Rd. and Miller Rd.	Daniel Dr., Douglas Way	734,441	3,867,629
23	Valley Christian Preschool	2970 Santa Maria Way, Santa Maria	734,544	3,865,840

Table 2-2 Sensitive Receptor Locations

Sensitive Receptor	Name	Address/Location	UTM X (m)	UTM Y (m)
24	Battles (George Washington) Elementary School	605 E. Battles Road, Santa Maria	735,222	3,868,442
25	Single Residence	E. Betteravia Rd.	735,666	3,867,611

3.0 HEALTH RISKS

Estimated annual-average concentrations from the dispersion modeling and the resulting estimated cancer risks are listed in Table 3-1 for each sensitive receptor and for the maximum concentration within the modeling domain. As seen in the table, the cancer risks are well below the significance threshold of 10 per million. The highest child cancer risk within the modeling domain is about 1.3 per million, and the highest adult cancer risk is about 0.9 per million. The highest child cancer risk at a sensitive receptor is also about 1.0 per million, at Bonita Elementary School (Sensitive Receptor Number 20).

The estimated risks are conservatively high values because:

- The entire volume of material was assumed to be hauled by 8 CY trucks, which leads to a larger number of truck trips and higher emissions than if larger trucks were used;
- The exposure duration was assumed to be nine years, in accordance with OEHHA (2003) guidelines, rather than the anticipated three-year duration of off-site trucking operations, which leads to an estimated dose that is three times higher than the potential dose that would actually occur;
- Truck trips were assumed to begin at 7:00 am every day, which causes atmospheric dispersion to be poorer and the resulting modeled diesel exhaust particulate matter concentrations to be higher than if the trips were to begin later in the day, and;
- The "high-end" estimates for breathing rates were used, which leads to a larger estimated dose and resulting risk than if average estimated breathing rates were used.

Table 3-1 Diesel Exhaust Particulate Matter Concentrations and Cancer Risks

Sensitive Receptor	Name	Address/Location	Annual Average Concentration ($\mu g/m^3$)	Cancer Risk (per million)	
				Child	Adult
1	Residence (Ranch)	End of Thornberry Rd.	0.0061	0.343	0.232
2	Residences in Guadalupe	Hwy 1 north end of Guadalupe	0.0087	0.489	0.331
3	Residence	5795 West Main St.	0.0009	0.049	0.033
4	Guadalupe Head Start	120 Tognazzini St.	0.0075	0.421	0.285

Table 3-1 Diesel Exhaust Particulate Matter Concentrations and Cancer Risks

Sensitive Receptor	Name	Address/Location	Annual Average Concentration (mg/m^3)	Cancer Risk (per million)	
				Child	Adult
5	Guadalupe Day Care	130 Tognazzini St.	0.0079	0.442	0.299
6	Rancho Guadalupe County Park and beachfront	End of West Main St.	0.0009	0.048	0.033
7	North end of Pacific Dunes Way, Point Sal Dunes residential area	W. Main St.	0.0009	0.050	0.034
8	LeRoy County Park	North of 11th St., adjacent to City of Guadalupe	0.0110	0.618	0.418
9	Mary Buren Elementary School	1050 Peralta St.	0.0059	0.332	0.224
10	Kermit McKenzie Jr. High School	4710 W. Main St.	0.0012	0.068	0.046
11	Residences	After intersection of Hwy 1 and 166, between Obispo St. and Flower Ave.	0.0182	1.025	0.694
12	Residence	Hwy 166 between Hwy 1 and Black Rd.	0.0162	0.909	0.615
13	Guadalupe Branch of Santa Maria City Library	1005 Guadalupe St.	0.0076	0.429	0.290
14	Guadalupe Foursquare Church	177 Guadalupe St.	0.0116	0.651	0.440
15	Apostolic Church	893 Pioneer St.	0.0122	0.689	0.466
16	Guadalupe Community Church	4635 6th St.	0.0102	0.577	0.390
17	Our Lady of Guadalupe	1164 Obispo St.	0.0067	0.378	0.256
18	Guadalupe Cemetery	4655 W. Main St.	0.0013	0.072	0.049
19	Central Park	South of 10th St.	0.0161	0.909	0.615
20	Bonita Elementary School	2715 W. Main St., Santa Maria	0.0185	1.044	0.706
21	Residences	Carmen Lane, N. Westgate Rd.	0.0044	0.246	0.166
22	Residences at intersection of Betteravia Rd. and Miller Rd.	Daniel Dr., Douglas Way	0.0069	0.388	0.262

Table 3-1 Diesel Exhaust Particulate Matter Concentrations and Cancer Risks

Sensitive Receptor	Name	Address/Location	Annual Average Concentration (mg/m^3)	Cancer Risk (per million)	
				Child	Adult
23	Valley Christian Preschool	2970 Santa Maria Way, Santa Maria	0.0022	0.123	0.083
24	Battles (George Washington) Elementary School	605 E. Battles Road, Santa Maria	0.0027	0.150	0.102
25	Single Residence	E. Betteravia Rd.	0.0162	0.909	0.615
-	Modeling Domain Maximum		0.0225	1.266	0.856

The highest annual average diesel exhaust particulate matter concentration is about 0.023 μg/m^3, which is well below the reference concentration of 5 μg/m^3.

4.0 REFERENCES

Office of Health Environmental Hazard Assessment (2003). The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments, August 2003.