Modeling PM Air Quality Impacts of the Proposed OBOT Facility

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I. INTRODUCTION

A. Scope of Work

I have been retained by counsel for the defendant in Oakland Bulk & Oversized Terminal, LLC, vs. City of Oakland (Case No. 16-CV-7014) to address, from the perspective of an atmospheric scientist, the issue of whether particulate matter (PM) emitted from the proposed Oakland Bulk and Oversized Terminal (OBOT) facility will substantially contribute to elevated levels of air pollution in the neighborhoods surrounding the proposed facility. I understand that the OBOT facility has been proposed to be constructed and operated in the Gateway Development Area at the location of the former Oakland Army Base adjacent to the Bay Bridge entrance in northwest Oakland.

I address in this report the question of whether fugitive dust emissions from the proposed facility and the associated transportation (rail) operations will substantially contribute to elevated levels of airborne particulate matter (PM) pollution, and if so, to quantify the amount of that contribution. In addition, based on the results of my atmospheric dispersion modeling simulations, I identified and mapped the boundary of the area in which the proposed OBOT's operations contribution to ambient particulate matter pollution will be most significant.

B. Methodology

Based upon my education and professional experience as an atmospheric scientist, I conducted an air dispersion modeling analysis to determine the air quality impacts in the surrounding neighborhoods due to OBOT's proposed operations. I compiled the necessary information to describe the plant's emissions of particulate matter (PM) from each operation at the proposed OBOT facility. I used this information as input to the AERMOD dispersion model which simulated the dispersion of fine particulate matter that would be emitted during OBOT's routine operations into the surrounding community for every hour during the five-year period 2011-2015.

C. Conclusions

Based on the modeling analysis that I conducted, I concluded that emissions from the proposed OBOT operations will, in fact, substantially contribute to elevated levels of fine particulate matter in the ambient air over a large area surrounding the facility. The model estimated that the long-term average $PM_{2.5}$ concentrations[1] will be increased by at least 0.5 $\mu g/m^3$ due to OBOT's emissions over an area of 3.5 square kilometers surrounding the facility, if the northerly mainline rail corridor is used. If the southerly mainline rail corridor is used, OBOT's emissions would be responsible for an

[1] $PM_{2.5}$ refers to particles that are smaller than 2.5 microns in diameter.

increase in long-term average $PM_{2.5}$ concentrations that exceeds 0.5 µg/m^3 over an area of 5.4 square kilometers. The area in which $PM_{2.5}$ concentrations from the proposed OBOT facility would exceed 0.5 µg/m^3 is shown in Figure 1, below, for the northerly mainline rail route.[2] Figure 2 shows the area in which $PM_{2.5}$ concentrations from the proposed OBOT facility would exceed 0.5 µg/m^3 for the southerly mainline rail scenario.

Figure 1. Modeled long-term $PM_{2.5}$ concentrations exceeding 0.5 µg/m^3, north rail scenario

[2] Modeled annual average $PM_{2.5}$ concentrations exceeded 0.5 µg/m^3 within the brown shaded region in Figures 1 and 2.

Figure 2. Modeled long-term $PM_{2.5}$ concentrations exceeding 0.5 µg/m^3, south rail scenario

The model results also demonstrated that short-term $PM_{2.5}$ concentrations would increase substantially in the vicinity of the proposed OBOT facility. According to the model predictions, OBOT's proposed operations would increase the peak 24-hour average $PM_{2.5}$ concentrations by more than 1.0 µg/m^3 at numerous schools and parks within Oakland and Emeryville. At many of the closest sensitive receptors, such as the Bay Bridge toll plaza, the Alexander Zuckerman Bicycle and Pedestrian Path, Gateway Park, Raimondi Park, and Memorial Park, the peak 24-hour average $PM_{2.5}$ concentrations would be increased by more than 2.5 µg/m^3, up to 8.4 µg/m^3 (on the nearby multi-use bike path).

D. Qualifications

I am an environmental engineer and atmospheric scientist with 39 years of professional experience performing air quality dispersion modeling and related analyses. I received my Bachelor of Science (BS) in civil engineering / engineering and public policy from Carnegie-Mellon University in 1979. I earned a Master of Science (MS) and a Ph.D. in environmental engineering science from the California Institute of Technology (Caltech), with a minor emphasis in numerical methods. My doctoral thesis, on the control of atmospheric carbon particles in the Los Angeles region, includes a number of analyses that have been relied upon and cited repeatedly by atmospheric modelers, researchers, and government planners during the last thirty years.

I have developed, evaluated, and applied air pollution dispersion models in academic, regulatory and consulting environments. I developed and applied the methodologies for assessing particulate matter and visibility that were used by the South Coast Air Quality Management District (Southern California) for their air quality management plans during the 1980s and 1990s. I managed a team of researchers that evaluated the MESOPUFF model (the precursor to CALPUFF) for the US Interagency Workgroup on Air Quality Modeling (IWAQM).

As a consultant, I have modeled the air quality impacts of thousands of emission sources, using a variety of air quality models (including AERMOD, CALPUFF, CAMx, CMB, etc.) for various clients, including industry (e.g., diesel engine manufacturers and the off-shore container shipping industry), government (e.g., US EPA and US Dept. of Justice), and environmental organizations (including Sierra Club and National Parks Conservancy Association).

I have authored hundreds of technical reports, many of which have been published in peer-reviewed journals and symposia. I have provided expert testimony regarding air dispersion modeling analyses at numerous hearings, depositions, and at trial. In April 2014, I was invited by the Royal Institute of International Affairs to participate in the “Balancing Global Energy Policy Objectives: A High-Level Roundtable” meeting.

I have expertise in air quality monitoring, statistical analyses, atmospheric chemistry, meteorology, particle processes, atmospheric transport and deposition, numerical methods, computer modeling, air quality control strategy design, and environmental public policy. An integral part of my research has involved developing, applying, and evaluating computer modeling tools to determine the air quality impacts of emission sources in the areas surrounding those sources. My experience and qualifications are described in detail in the attached resume (Attachment A).

E. Compensation

I am compensated for my work on this engagement at a rate of $160 per hour. The opinions I render in this matter are not contingent upon my compensation.

F. Supporting Documentation

I relied on various documents and data in the process of performing my analysis and reaching my opinions in this matter, including facility maps, engineering diagrams, and other documents that characterize the proposed OBOT facility and its operation, including the report by ESA Associates ("ESA Report")[3] and the Basis of Design documents[4]. Land use and topographic data were obtained from the US Geological Survey (USGS), and meteorological data were obtained from the National Oceanic and Atmospheric Administration (NOAA). I also consulted US EPA modeling guidelines and user's guides for the AERMOD model and its associated preprocessing programs. A list of the specific materials that I relied upon in preparing the analysis, opinions, and findings set forth in this report can be found in Appendix A.

G. Previous Testimony

The following is a list of cases in which I have provided expert testimony at deposition or trial during the previous 4 years:

(1) Natural Resources Defense Council, Inc., Sierra Club, Inc., Environmental Law and Policy Center, and Respiratory Health Association (Plaintiffs) vs. Illinois Power Resources, LLC and Illinois Power Resources Generating, LLC (Defendants). United States District Court for the Central District of Illinois, Peoria Division, Case No. 1-13-cv-01181. Expert reports and deposition provided on behalf of plaintiffs.

(2) Sierra Club (Plaintiff) vs. Energy Future Holdings Corporation and Luminant Generation Company LLC (Defendants). United States District Court for the Western District of Texas, Waco Division, Civil Action No. 6:12-cv-00108-WSS. Expert reports, deposition, and testimony at trial, provided on behalf of plaintiffs.

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[3] ESA Associates, Report on the Health and/or Safety Impacts Associated with the Transport, Storage, and/or Handling of Coal and/or Coke In Oakland, Including at the Proposed Oakland Bulk and Oversized Terminal in the West Gateway Area of the Former Oakland Army Base. June 2016.

[4] HDR, Basis of Design (BoD), Oakland Bulk and Oversized Terminal, Preliminary Engineering, Prepared for California Capital Investment Group, Sections 1 -19c and Appendix. (July 2015) (OAK054818 thru OAK054832).

II. PROPOSED OBOT FACILITY

There has been a proposal to construct and operate a bulk and oversized commodity export terminal, the Oakland Bulk and Oversized Terminal (OBOT), at the Gateway Development Area of the former Oakland Army Base in West Oakland, as shown in Figure 3, below. It has further been proposed that coal be considered as a commodity that would be handled, stored, and transported through the OBOT facility.

Figure 3. Location of proposed OBOT facility

The handling of coal at the OBOT facility, including transport by train, unloading, storage, transfer, and loading the coal onto ships (transloading), will result in "fugitive emissions[5] of coal dust, in the form of fine particulate matter (PM). The emitted fine coal dust gets carried by the winds into the nearby communities (and beyond).

[5] The term "fugitive emissions", refers to PM emissions that do not originate from a specific location such as a stack or flue (point sources), and are often emitted across a defined area or volume.

Coal dust contains numerous environmental pollutants, including sulfur, arsenic, chromium, cadmium, mercury, and other toxic metals, many of which have been found to be carcinogenic. As stated in the ESA report[6], the Union of Concerned Scientists have noted that, "Scientific research points to potential health hazards related to coal dust. Inhalation of fugitive coal dust could result in heart and lung issues, cancers, childhood growth and development problems." Numerous scientific studies have clearly demonstrated that there is a causal relationship between both short-term (a day or multiple days) and longer-term (several months to years) exposure to $PM_{2.5}$ and a wide range of adverse health outcomes, including respiratory impairment, asthma exacerbation, non-fatal heart attacks, adverse birth outcomes (premature births, low birth weight), and cardiovascular disease related mortality.

The US EPA has long recognized the inherent dangers associated with the inhalation of fine particulate matter. Airborne fine particles are regulated by the US EPA as a provision of the Clean Air Act. The primary national ambient air quality standards (NAAQS) require that annual average and 24-hour average $PM_{2.5}$ levels be maintained below prescribed values in order to protect public health.

Fugitive coal dust emissions from the proposed OBOT facility have the potential to increase ambient $PM_{2.5}$ concentrations in the neighborhoods adjacent to the facility, including West Oakland. Much of the area adjacent to the main rail lines that are proposed to be used to transport coal to the OBOT facility, as well as adjacent to the proposed OBOT facility itself, have been designated as "California EPA Disadvantaged Communities", which is an indication that concentrations of air pollutants are particularly high in these areas, and the resident populations are most vulnerable to air quality related health impacts. Examination of ambient air quality data confirms that the communities surrounding the OBOT facility currently experience some of the worst air quality in the region.

I used a computer model to simulate the dispersion of coal dust particulate matter that would be emitted from each of the proposed OBOT operations (emission sources). The objective of the modeling was to determine the potential impacts to the surrounding community's PM air quality due to OBOT's proposed operations involving the transportation of coal through the facility. The air quality impact was quantified as the increase in ambient $PM_{2.5}$ concentrations[7] due to OBOT's emissions.

[6] ESA report, pg 5-9

[7] The ambient $PM_{2.5}$ concentration ($\mu g/m^3$) equals the mass of particles (smaller than 2.5 microns in diameter) in the air near ground level divided by the volume of air.

III. MODEL APPLICATION

A. Model Selection

The AERMOD air quality model was used to determine the increase in ambient $PM_{2.5}$ concentrations in the area surrounding the OBOT facility due to fugitive dust emissions within the facility and during transport of coal to the facility. AERMOD[8,9,10] is a steady-state plume model that considers atmospheric dispersion based on the planetary boundary layer turbulence structure and scaling concepts. AERMOD has been adopted by the US Environmental Protection Agency (EPA) in Appendix W to its Guideline on Air Quality Models[11] as the preferred near-field dispersion model for regulatory assessments of industrial point sources, including determinations of compliance with the National Ambient Air Quality Standards (NAAQS) and evaluations of proposed new emission sources.

In addition to the AERMOD dispersion module, the AERMOD modeling system includes AERMET, a meteorological data preprocessor, and AERMAP, a terrain data preprocessor for treatment of complex terrain. The protocol that I used for this modeling analysis follows the guidance for AERMOD application established in US EPA's modeling guidelines[12] and the AERMOD implementation guide.[13]

This report describes the modeling exercise that I conducted using the AERMOD model to evaluate the impact of fugitive dust emissions from the proposed OBOT facility on ambient $PM_{2.5}$ concentrations in the area surrounding the facility. The necessary input data including source characteristics, receptor and meteorological data, and modeling options are described below, followed by a summary of the model results.

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[8] U.S. Environmental Protection Agency. AERMOD: Description of Model Formulation. EPA-454/R-03-004. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. September 2004.
[9] U.S. Environmental Protection Agency. Addendum: User's Guide for the AMS/EPA Regulatory Model – AERMOD. EPA-454/B-03-001. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711, March 2011.
[10] U.S. Environmental Protection Agency. User's Guide for the AMS/EPA Regulatory Model – AERMOD. EPA-454/B-16-011. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. December 2016.
[11] U.S. Environmental Protection Agency. Guideline on Air Quality Models, 40 CFR Part 51, Appendix W. Published in the Federal Register, Vol. 70, No. 216, November 9, 2005.
[12] Ibid.
[13] U.S. Environmental Protection Agency. AERMOD Implementation Guide. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. 2009. http://www.epa.gov/ttn/scram/7thconf/aermod/aermod_implmtn_guide_19March2009.pdf

B. Source Data

Routine operations at the proposed OBOT facility were divided into various different operations, each defined as a separate emission source for modeling purposes. Each emission source was associated with a specific location, physical size, and emission rate. The emission sources associated with the handling, storage, and transloading of coal at the proposed OBOT facility were:

- Mainline Rail Transport
- Staging at the Port Railyard and OBOT Spur
- Unloading of Coal
- Coal Storage
- Transfer to Storage and Shiploaders via Conveyors
- Transloading to Ships

The approximate locations where each of the emission sources would occur were determined using "basis of design" conceptual design maps for the OBOT facility[14,15] and Google Earth. Mainline rail shipments were considered to approach the port railyard and OBOT spur from either from the north or the south along the Union Pacific RR mainline rail corridor, each terminating at the location of the proposed TLS terminal facility. The location of the three rail sources (northerly route, southerly route, and spur to the OBOT facility) are shown in Figure 4, below.[16]

[14] HDR, Basis of Design (BoD), Oakland Bulk and Oversized Terminal, Preliminary Engineering, Prepared for California Capital Investment Group, Sections 1 -19c and Appendix. (OAK054818 thru OAK054832).
[15] ESA report, and OBOT Master Plan (OAK 054822), and OBOT Plan Diagrams OAK054829.
[16] The southerly route is under construction north of Adeline St. and was assumed to follow tracks along a westerly route through the new rail yards past the intermodal terminal.

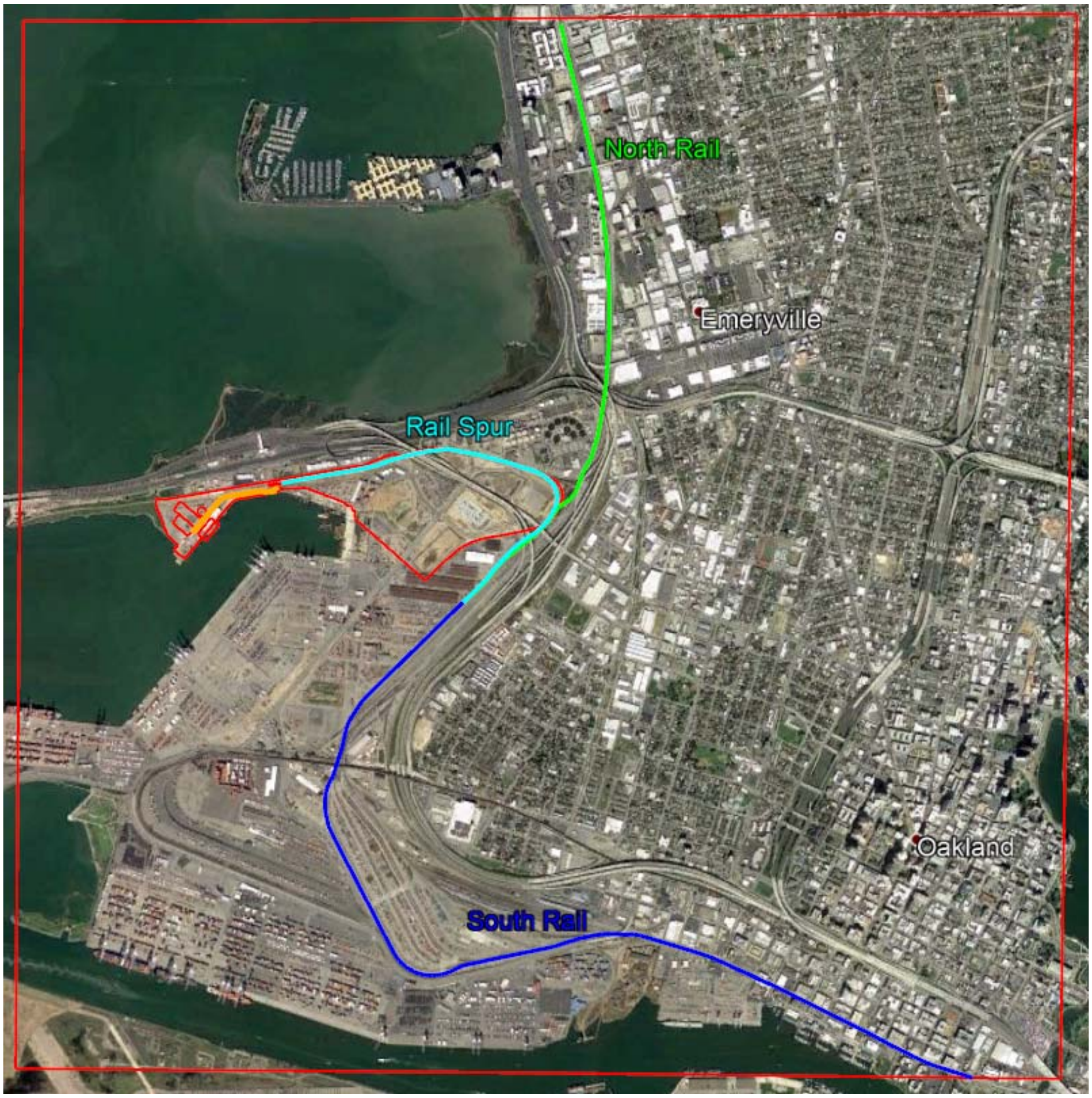

Figure 4. Location of rail emission sources

The modeled locations for the unloading, storage, transfer, and transloading operations at the OBOT facility are shown in Figure 5. The transfer operations were positioned to approximate the path of the conveyors from the unloading hoppers to the storage and transloading sites.

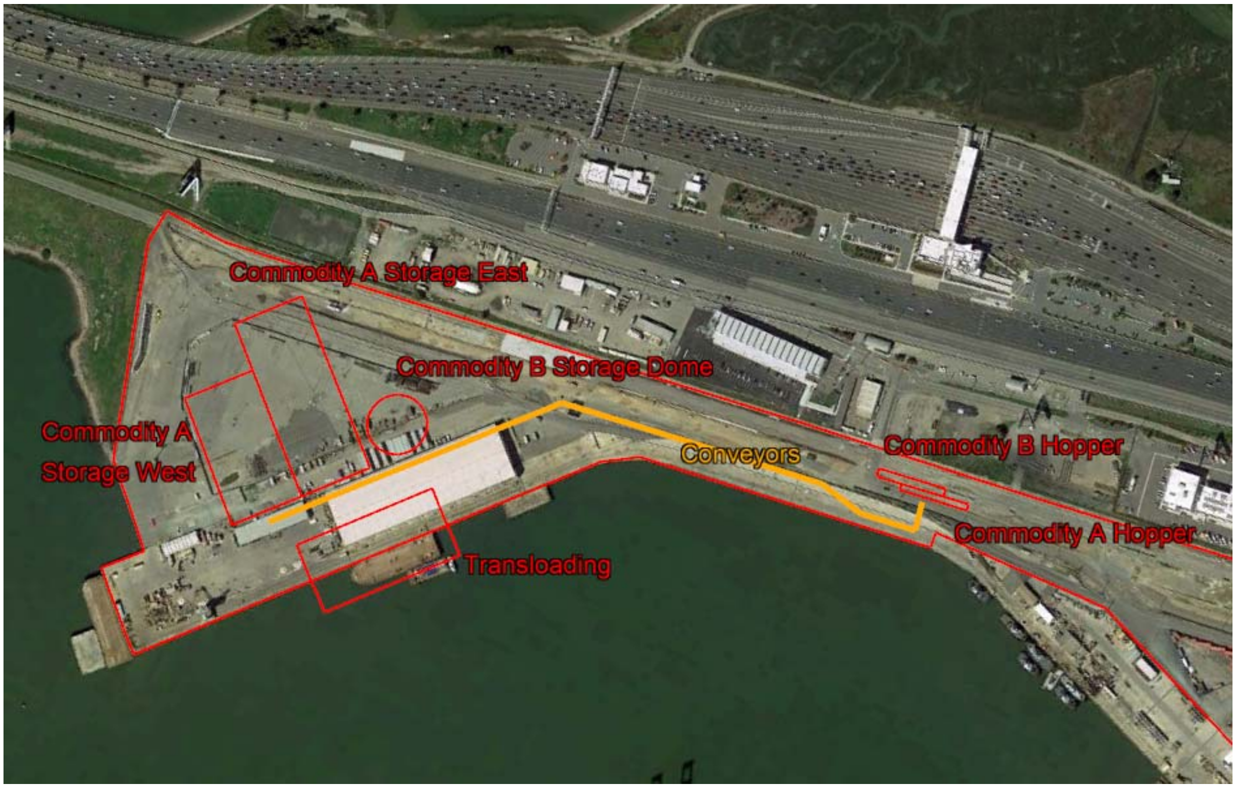

Figure 5. Location of OBOT emission sources

In addition to each source's location, the AERMOD model requires, for fugitive dust sources, specification of the height (above ground) of release, the initial lateral and vertical dimension of the emitted dust plume, and the pollutant emission rate.[17]

The physical dimensions of the rail cars, unloading hoppers, conveyors, storage units, and ship loaders were obtained from "basis of design" diagrams and maps.[18,19] These data were used to estimate the Initial lateral and vertical volume source spreading parameters required by AERMOD, following guidance in the AERMOD User's Guide.[20]

The rail lines were modeled within AERMOD as strings of individual volume sources, located every 40 meters, which resulted in 92 modeled rail segments along the north route, 150 rail segments along the southern route, and 64 rail segments for the spur from the port rail yard to the proposed OBOT facility. The conveyor operations

[17] "Pollutant emission rate" is the mass of pollutant ($PM_{2.5}$) released into the atmosphere per unit time (lb/hr).
[18] HDR, Basis of Design (BoD), Oakland Bulk and Oversized Terminal, Preliminary Engineering, Prepared for California Capital Investment Group, Sections 1 -19c and Appendix. (OAK054818 thru OAK054832).
[19] ESA report, and OBOT Master Plan (OAK 054822), and OBOT Plan Diagrams OAK054829.
[20] U.S. Environmental Protection Agency. User's Guide for the AMS/EPA Regulatory Model – AERMOD. EPA-454/B-16-011. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. December 2016.

were also split along the length of the conveyors from the unloading hoppers to the storage facilities, accounting for 16 separately located segments.

ESA[21] estimated fugitive coal dust emission rates for each of the operations of the proposed OBOT facility, based on a number of assumptions regarding the length of trains, number of trips, effectiveness of proposed control measures, etc. Dr. Sahu has revised the estimated particulate matter emission rates for each emission source,[22] which are shown in Table 1. Dr. Sahu estimated annual average emission rates based on expected routine operations, and also maximum 24-hour average emission rates, which were used to model the peak 24-hour impacts.

Table 1. Modeled Fugitive $PM_{2.5}$ Emissions for the Proposed OBOT Facility

Modeled Source	Annual Average (lb/day)	Max 24-hr Average (lb/day)
North rail[23]	22.61	33.95
South rail	36.86	55.35
Spur rail	63.95	66.69
Unloading	2.29	4.73
Storage	1.26	1.27
Transfer (conveyors)	20.07	20.24
Transloading	4.69	4.73
Total: North rail scenario	114.88	131.61
Total: South rail scenario	129.13	153.01

I modeled two different scenarios using Dr. Sahu's estimated emission rates, as shown in Table 1. The first scenario ("North rail") includes transport of coal along the northerly route, and then along the spur to OBOT, plus operation of the hoppers (loading was assumed to be split evenly between Hopper A and Hopper B), conveyors, storage (activity is split evenly between all three storage units), and transloading onto ships. The second scenario ("South rail") includes transport of coal along the southerly route rather than the northerly route, followed by the same operations as the "North rail" scenario (spur, unloading, transfer, storage, and transloading).

[21] ESA report.
[22] Expert report of Dr. Ranajit Sahu.
[23] The north rail and south rail $PM_{2.5}$ emissions were computed using Dr. Sahu's estimates of 9.89 lb/day per track mile for the annual average, and 14.85 lb/day track mile for peak 24-hour average.

C. Receptor Data

The AERMOD model is designed to estimate pollutant concentrations at a specified set of locations within the modeling domain, which are referred to as the modeled "receptors". For the current AERMOD application, I defined a set of gridded modeled receptors on a 6 km x 6 km grid surrounding the proposed OBOT facility using 50 m grid spacing, accounting for 14,641 virtual receptors (121 E/W x 121 N/S). The modeling domain is shown in Figure 6, below. Receptor elevations were determined using the AERMAP program (v11103), for which the 1/3 arc-second National Elevation Dataset (NED) data[24] were input.

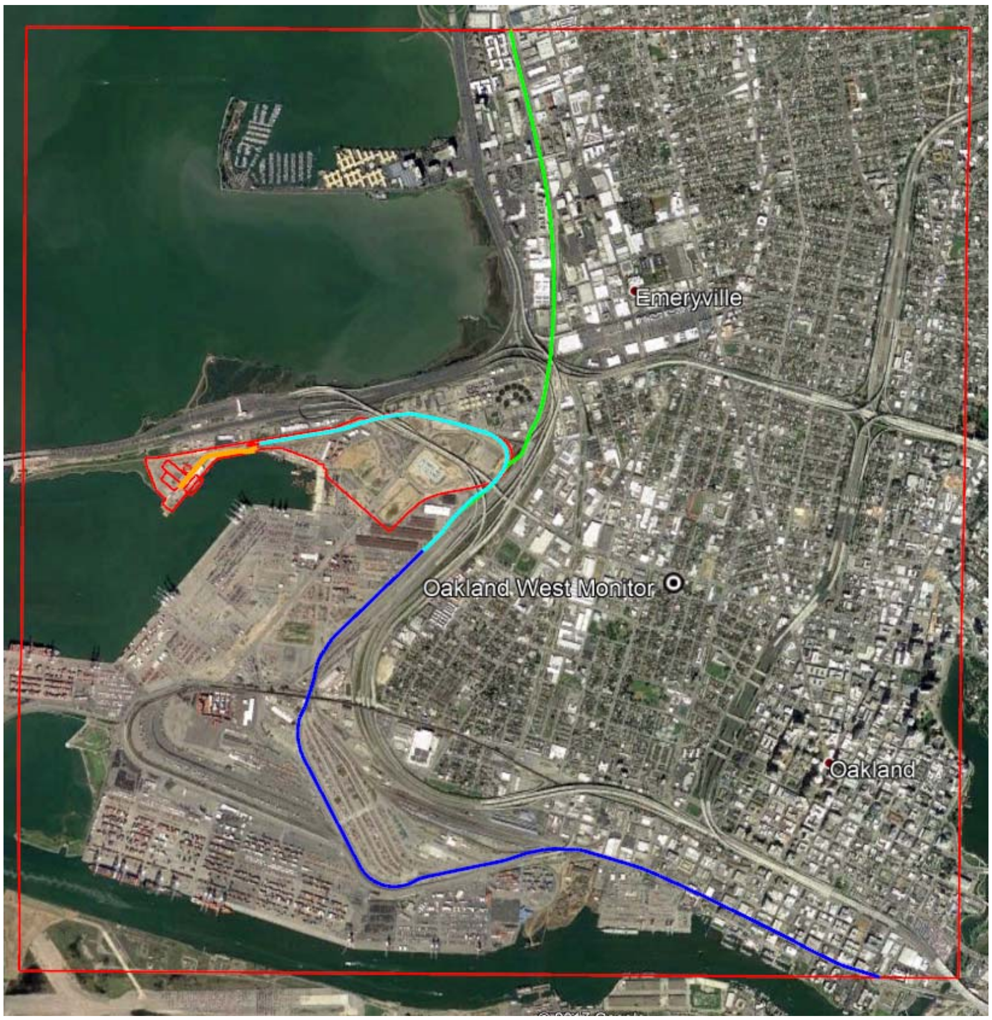

Figure 6. AERMOD modeling domain (6 km x 6 km)

[24] Multi-Resolution Land Characteristics Consortium (MRLC). https://www.mrlc.gov/

In addition to the gridded receptors, a set of sensitive receptors were identified, which includes nearby parks (and playgrounds), schools (and day-care centers), the multi-use bicycle path[25], and the toll plaza for the Bay Bridge, as shown in Table 2, below.

Table 2. Locations of modeled sensitive receptors

	Sensitive Receptor Location	Latitude	Longitude	UTMx (m)	UTMy (m)	Elevation (m)		Distance (km) to Hopper A	Spur/Yard
Toll Plaza	Bay Bridge Toll Plaza	37.824816	-122.313867	560384.00	4186600.00	4.4		0.27	1.49
Bike Path	Alexander Zuckermann Bicycle and Pedestrian Path (1)	37.821541	-122.329592	559002.72	4186226.60	2.2		1.49	2.61
	Alexander Zuckermann Bicycle and Pedestrian Path (2)	37.821845	-122.325059	559401.43	4186263.20	4.0		1.08	2.23
	Alexander Zuckermann Bicycle and Pedestrian Path (3)	37.822390	-122.320568	559796.25	4186326.54	3.8		0.69	1.88
	Alexander Zuckermann Bicycle and Pedestrian Path (4)	37.823078	-122.316132	560186.10	4186405.72	3.4		0.30	1.55
	Alexander Zuckermann Bicycle and Pedestrian Path (5)	37.823747	-122.311694	560576.14	4186482.81	2.6		0.16	1.26
	Alexander Zuckermann Bicycle and Pedestrian Path (6)	37.824314	-122.307196	560971.54	4186548.65	3.5		0.53	1.04
	Alexander Zuckermann Bicycle and Pedestrian Path (7)	37.825065	-122.302830	561355.16	4186634.83	3.0		0.92	0.97
	Alexander Zuckermann Bicycle and Pedestrian Path (8)	37.826131	-122.298498	561735.52	4186755.96	4.5		1.32	1.08
	Alexander Zuckermann Bicycle and Pedestrian Path (9)	37.827368	-122.294245	562108.77	4186896.02	4.5		1.71	1.33
	Alexander Zuckermann Bicycle and Pedestrian Path (10)	37.830277	-122.293117	562205.60	4187219.53	4.1		1.93	1.66
Oakland Parks	Gateway Park (new)	37.821133	-122.321762	559692.18	4186186.31	2.4		0.81	1.93
	Raimondi Park W	37.816746	-122.294375	562106.23	4185717.42	2.4		1.74	0.55
	Raimondi Park E	37.815793	-122.293121	562217.40	4185612.52	3.7		1.89	0.66
	Memorial Park (1)	37.823324	-122.288946	562578.52	4186450.87	3.4		2.10	1.27
	Memorial Park (2)	37.821975	-122.289038	562571.56	4186301.14	3.9		2.09	1.18
	Memorial Park (3)	37.820506	-122.289155	562562.50	4186138.07	3.3		2.09	1.10
	Memorial Park (4)	37.818363	-122.289317	562550.05	4185900.20	3.6		2.12	1.01
	Memorial Park (5)	37.817254	-122.289447	562539.55	4185777.07	3.1		2.14	0.98
	Memorial Park (6)	37.815023	-122.289937	562498.30	4185529.21	3.8		2.18	0.95
	Memorial Park (7)	37.813108	-122.290657	562436.54	4185316.26	4.4		2.21	0.95
	Memorial Park (8)	37.810603	-122.291661	562350.27	4185037.65	6.0		2.28	1.02
	Memorial Park (9)	37.808963	-122.292140	562309.49	4184855.38	6.7		2.36	1.12
	Memorial Park (10)	37.807618	-122.292629	562267.57	4184705.82	6.4		2.43	1.21
	Memorial Park (11)	37.806325	-122.293127	562224.82	4184562.03	5.5		2.50	1.31
	14th Street Pocket Park	37.813556	-122.298388	561755.67	4185360.82	3.2		1.61	0.38
	Willow Park	37.812210	-122.296661	561908.81	4185212.63	4.8		1.83	0.59
	McClymonds Mini-Park	37.818046	-122.280436	563332.00	4185871.00	5.9		2.89	1.78
	South Prescott Park	37.802889	-122.299197	561693.34	4184176.78	4.6		2.49	1.52
	Wade Johnson Park	37.809136	-122.290346	562467.26	4184875.77	6.6		2.47	1.22
	DeFremery Recreation Center	37.812575	-122.287878	562681.60	4185258.98	6.0		2.46	1.20
	Lowell Park	37.808711	-122.285228	562918.14	4184832.05	6.3		2.87	1.61
	Marston Campbell Park	37.809693	-122.279813	563393.96	4184944.66	9.7		3.23	1.98
	Poplar Playground	37.822958	-122.284355	562982.88	4186413.35	4.7		2.50	1.60
	Union Plaza Park	37.825856	-122.282824	563115.16	4186735.92	6.6		2.66	1.87
	Fitzgerald Park	37.826161	-122.282469	563146.14	4186770.00	7.0		2.70	1.92
	Grove Shafter Park	37.823936	-122.269289	564307.99	4186532.12	19.6		3.83	2.87
	Mosswood Park	37.824344	-122.261673	564977.90	4186582.66	22.0		4.50	3.53
	Lafayette Square Park	37.803623	-122.277270	563623.02	4184272.92	11.7		3.77	2.50
	Jefferson Square Playground	37.800898	-122.278669	563502.20	4183969.63	8.4		3.85	2.59
	Frank H. Ogawa Plaza	37.805110	-122.271921	564092.62	4184441.56	13.0		4.08	2.82
	Henry J. Kaiser Memorial Park	37.808743	-122.271313	564143.00	4184845.06	9.3		3.96	2.72
	Lincoln Square Park	37.800102	-122.268375	564409.13	4183888.35	12.5		4.64	3.37
	Chinese Garden Park / Harrison Square	37.797371	-122.270314	564240.79	4183584.01	8.7		4.67	3.41
	Madison Park	37.798098	-122.267265	564508.59	4183666.77	10.0		4.84	3.58
	Snow Park	37.806953	-122.264581	564737.16	4184651.10	5.3		4.58	3.34
	Dover Park	37.842611	-122.268331	564376.07	4188604.80	30.3		4.50	4.05
	Bushrod Recreation Center	37.845207	-122.264912	564674.63	4188895.19	36.7		4.90	4.47
	Jack London Square	37.794742	-122.277190	563637.68	4183287.62	3.2		4.40	3.18
Emeryville Parks	Golden Gate Playground	37.844771	-122.283801	563013.08	4188833.90	12.2		3.54	3.46
	Temescal Creek Park	37.837080	-122.277216	563599.06	4187985.04	18.2		3.52	3.07
	Emeryville Community Organic Garden Park	37.841728	-122.288299	562619.90	4188493.25	7.6		3.03	3.00
	Doyle Hollis Park	37.842996	-122.289586	562505.59	4188633.07	5.9		3.05	3.09
	Park Ave Playground	37.843292	-122.288378	562611.63	4188666.73	6.7		3.15	3.16
	Christie Park	37.842086	-122.294897	562039.06	4188528.57	3.7		2.68	2.88
	Marina Park	37.838722	-122.315173	560257.78	4188142.05	3.5		1.80	2.78
	Joseph Emery Park	37.833147	-122.281416	563232.85	4187545.82	12.8		3.00	2.50

[25] The East Bay Regional Park District's (EBRPD) Alexander Zuckermann Bicycle and Pedestrian Path runs along the southern edge of the eastern span of the San Francisco-Oakland Bay Bridge,

Table 2, continued[26]

	Sensitive Receptor Location	Latitude	Longitude	UTMx (m)	UTMy (m)	Elevation (m)		Distance (km) to Hopper A	Spur/Yard
Oakland Schools	Prescott Elementary School	37.808655	-122.297482	561839.51	4184817.65	6.1		2.05	0.92
	Ralph J. Bunche High School	37.813548	-122.287732	562693.63	4185367.03	4.4		2.42	1.18
	Lafayette Elementary School	37.810224	-122.279760	563398.18	4185003.61	8.6		3.21	1.96
	McClymonds High School	37.819091	-122.280755	563303.02	4185986.74	6.2		2.84	1.77
	New Day Pre School	37.811982	-122.268286	564406.65	4185206.51	6.5		4.09	2.89
	West Oakland Middle School	37.808324	-122.282640	563146.28	4184790.85	8.0		3.09	1.82
	Cole Elementary School	37.807842	-122.289818	562514.83	4184732.55	6.8		2.60	1.35
	Martin Luther King Jr Elementary School	37.806610	-122.283033	563113.15	4184600.42	8.6		3.16	1.90
	Saint Vincent's Day Home - Preschool	37.804877	-122.286556	562804.49	4184405.77	8.0		3.03	1.79
	City of Oakland Head Start	37.815601	-122.282085	563188.93	4185598.62	3.8		2.81	1.63
	YMCA Preschool	37.811976	-122.275834	563742.26	4185200.67	7.5		3.46	2.24
	Oakland School For the Arts	37.808060	-122.271391	564136.73	4184769.22	9.9		3.98	2.74
	Starlite Child Development Center - Day Care Center	37.802587	-122.265983	564617.55	4184165.72	11.7		4.68	3.42
	Oakland Charter High School	37.801670	-122.269508	564308.02	4184061.54	13.1		4.46	3.19
	Lake Merritt Child Care Center	37.801517	-122.268879	564363.53	4184045.00	13.0		4.51	3.25
	Lincoln Elementary School	37.800225	-122.268276	564417.74	4183902.07	12.5		4.64	3.37
	American Indian Public Charter School	37.800121	-122.265521	564660.37	4183892.43	10.7		4.85	3.58
	Little Stars Pre-School	37.801559	-122.264614	564738.96	4184052.61	10.4		4.84	3.58
	Bright Future Early Learning	37.806364	-122.273757	563929.92	4184579.43	12.3		3.88	2.62
	Laney College	37.796364	-122.262828	564900.74	4183477.46	6.5		5.27	4.01
	Street Academy Alternative School	37.817417	-122.265570	564640.98	4185811.40	20.1		4.19	3.08
	Westlake Middle School	37.814744	-122.261984	564958.95	4185517.32	12.9		4.55	3.40
	St Mary's Center Preschool	37.822857	-122.277044	563626.41	4186407.10	9.5		3.14	2.19
	Hoover Elementary School	37.823385	-122.275101	563796.96	4186467.01	12.2		3.32	2.37
	Oakland Military Institute / Longfellow School	37.829227	-122.273332	563947.60	4187116.39	18.7		3.55	2.78
	North Oakland Community Charter School	37.833187	-122.276563	563659.86	4187553.55	18.2		3.40	2.81
	Emery Secondary School	37.837743	-122.274271	563857.63	4188060.61	22.2		3.78	3.30
	Aspire Berkley Maynard Academy	37.845610	-122.283640	563026.53	4188927.10	13.5		3.62	3.55
	Grace Children's Academy - Day Care Center	37.837391	-122.277277	563593.42	4188019.50	18.5		3.53	3.09
Emeryvile Schools	Anna Yates Elementary	37.832448	-122.278604	563480.89	4187470.17	15.6		3.20	2.62
	Pacific Rim International School - Montessori School	37.838721	-122.287395	562701.99	4188160.23	7.7		2.86	2.72
	Emeryville Child Development Center - Preschool	37.836741	-122.285239	562893.38	4187941.99	8.1		2.89	2.62
	Emery High School	37.836173	-122.283554	563042.13	4187880.11	10.6		2.98	2.64

The distance from each sensitive receptor location to the Commodity Hopper A unloading structure within the OBOT facility (see Figure 5), and to a second location near the end of the spur rail line at the new port rail yard[27], is shown in Table 2. The locations of the sensitive receptor parks and schools are also shown in Figures 7 and 8, below.

[26] The UTM (Universal Transverse Mercator) coordinates shown in Table 2 are located in UTM Zone 10S.
[27] The Spur/Yard location on the spur rail line is at UTM coordinates: 561560.0, 4185690.0.

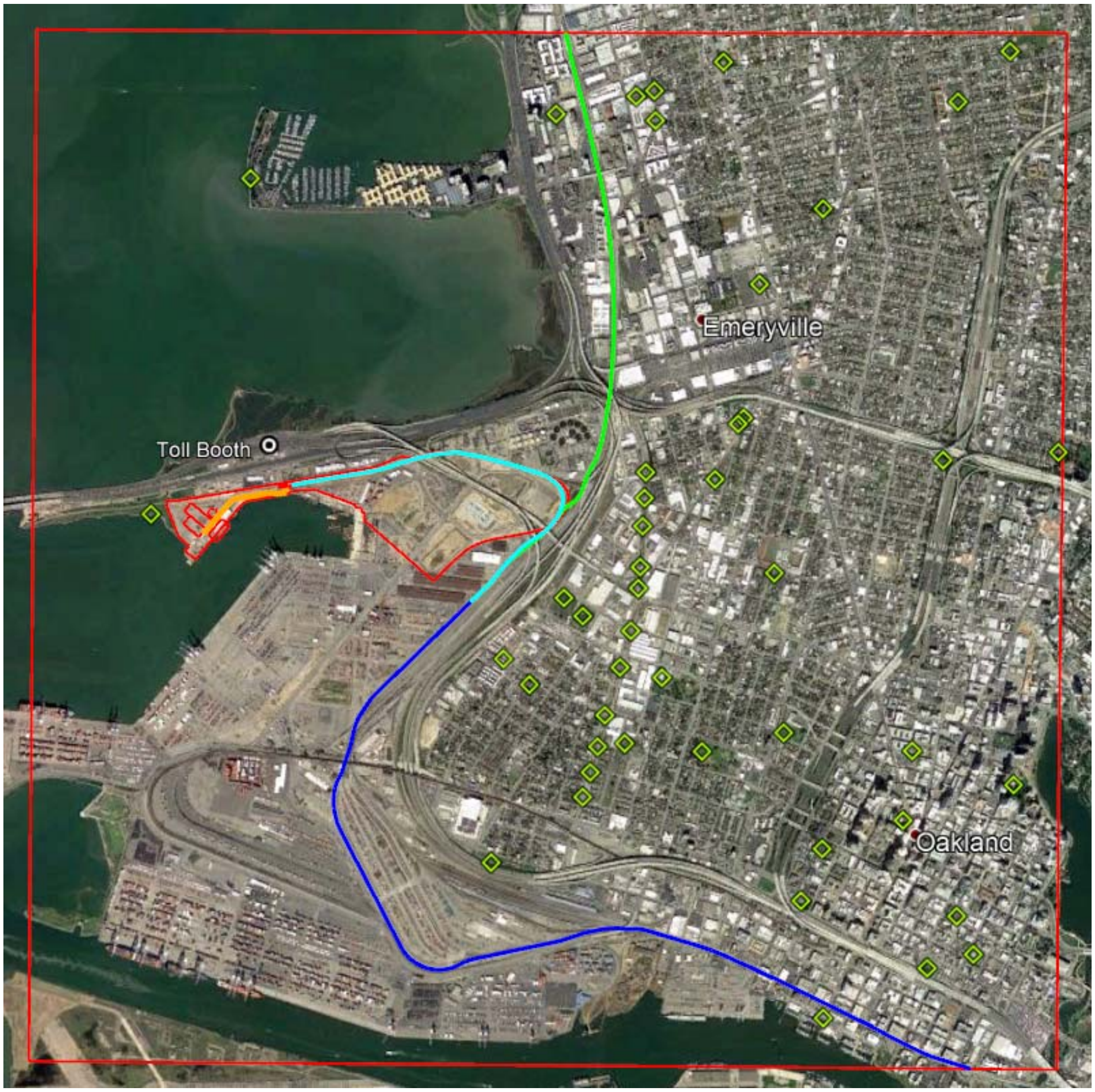

Figure 7. Location of sensitive receptors: Parks

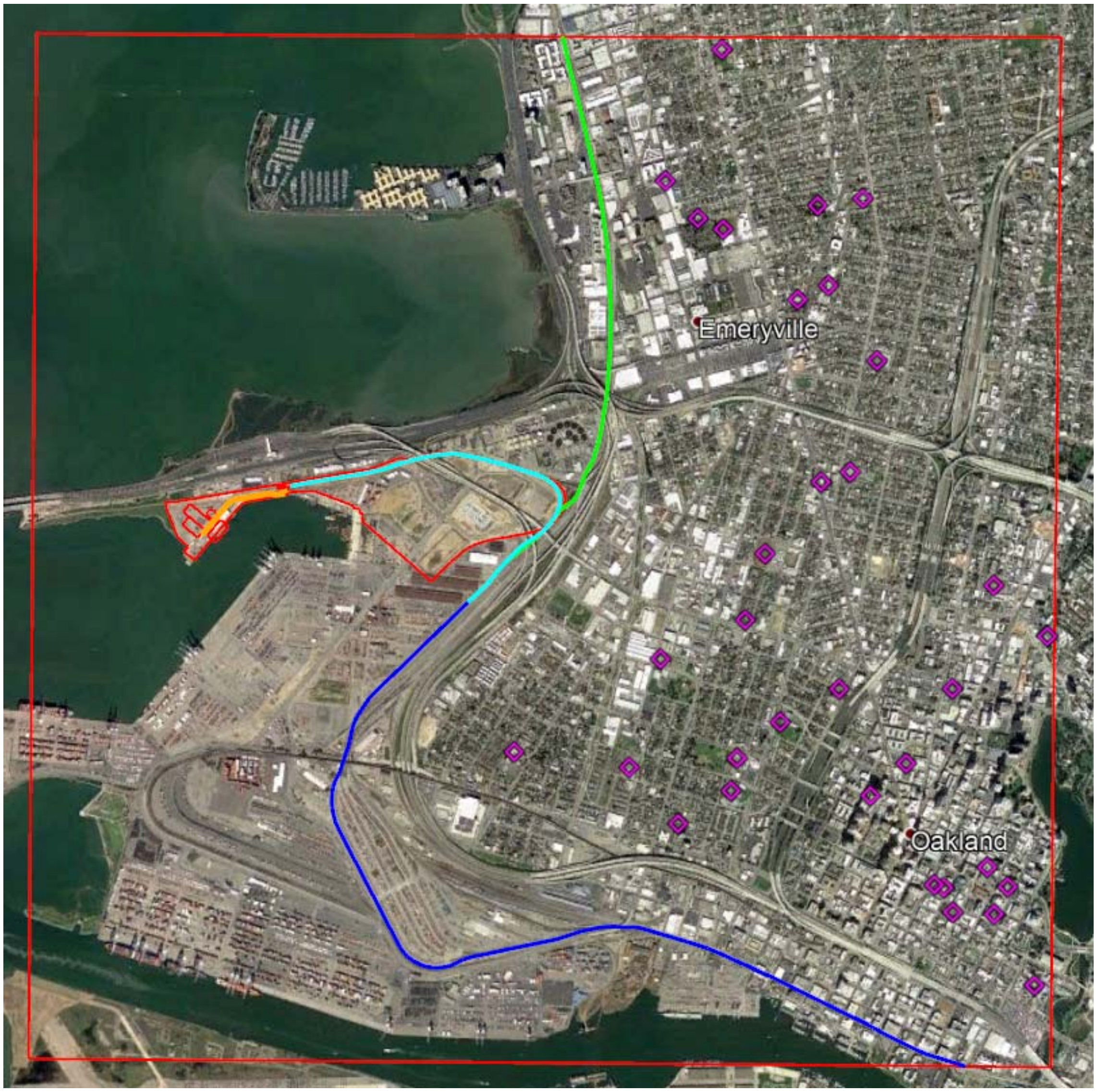

Figure 8. Location of sensitive receptors: Schools

D. Meteorological Data

I assembled meteorological data for 2011-2015 for input to the AERMOD model. The model requires continuous records of surface and upper air meteorological data (including wind speeds and directions, temperatures, ambient air pressures, etc.). These data were all obtained from measurements taken at the Oakland Airport. The surface data includes (1) hourly Integrated Surface Data (ISD) from the Oakland

International Airport (OAK),[28] located about 14 km SE of the proposed OBOT facility, and (2) 1-minute Automated Surface Observing System (ASOS) wind data from OAK.[29] The upper air data consisted of morning radiosonde measurements (soundings) recorded each day at 1200 GMT at the Oakland Airport.[30]

AERMOD ignores hours with variable wind (i.e., undefined wind direction) or calm (low wind speed) conditions, resulting in zero concentrations for those hours, which can lead to an underestimation of long-term average concentrations. To address the issue of calm and variable winds associated with the hourly averaged surface wind data that is typically input to AERMOD, US EPA developed the AERMINUTE preprocessor.[31] AERMINUTE processes 1-minute ASOS wind data, resulting in significantly fewer hours with calm and missing winds. I used AERMINUTE (Version 15272) to reduce the number of calm wind conditions (zero wind speed) within the hourly Oakland surface data for 2011-2015 from 7,134 to 541 (out of 43,824 total modeled hours).

AERSURFACE,[32] a non-regulatory component of the AERMOD modeling system, was used to develop the surface characteristics at OAK, as required by AERMET. I obtained land cover/land use data from the US Geological Survey (USGS) National Land Cover Database (NLCD)[33] and processed the data using AERSURFACE (Version 13016) in order to determine the required micrometeorological parameters (noon-time albedo, daytime Bowen ratio, and surface roughness length) at OAK using twelve 30-degree sectors for each month. Average surface moisture was assumed for the Oakland Airport location.[34]

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[28] National Climatic Data Center, Integrated Surface Data (ISD) for OAK (WBAN: 23230) 2011-2015, National Oceanic and Atmospheric Administration (NOAA). ftp://ftp.ncdc.noaa.gov/pub/data/noaa/readme.txt

[29] National Centers for Environmental Information (NCEI), Automated Surface Observing System (ASOS) Data for OAK (WBAN: 23230) 2011-2015. National Oceanic and Atmospheric Administration (NOAA). https://www.ncdc.noaa.gov/data-access/land-based-station-data/land-based-datasets/automated-surface-observing-system-asos

[30] Earth System Research Laboratory (ESRL), ESRL Radiosonde Database, FSL Data for OAK (WBAN: 23230) 2011-2015. National Oceanic and Atmospheric Administration (NOAA). https://ruc.noaa.gov/raobs/General_Information.html

[31] U.S. Environmental Protection Agency. AERMINUTE User's Guide. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. 2011. http://www.epa.gov/ttn/scram/7thconf/aermod/aerminute_v11059.zip

[32] U.S. Environmental Protection Agency. AERSURFACE User's Guide. EPA-454/B-08-001. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. 2008. (http://www.epa.gov/ttn/scram/7thconf/aermod/aersurface_userguide.pdf)

[33] Multi-Resolution Land Characteristics Consortium (MRLC). https://www.mrlc.gov/

[34] According to Climate Data for US Cities (http://www.usclimatedata.com/climate/oakland/california/united-states/usca2500), the average annual precipitation for Oakland, CA is 24 inches. AERSURFACE guidelines recommend using the wet surface moisture option for locations in the top 30 percent of annual precipitation (greater than about 45 inches).

I used the AERMET meteorological preprocessor (Version 16216)[35] to merge the hourly surface and upper air data, and to estimate a number of required boundary layer parameters using the meteorological data and surface characteristics.

Figure 9 shows a “wind rose” frequency diagram for the 5-year meteorological data set that I used for modeling the impacts of the proposed OBOT facility. The wind rose diagram displays the frequency of hourly averaged wind speeds and directions (indicating the direction of wind origin). As can be seen from Figure 9, stronger winds are usually associated with wind directions from the W and WNW, whereas near-calm and light wind conditions, which are typically responsible for higher concentration impacts, are more often from the E through NE.

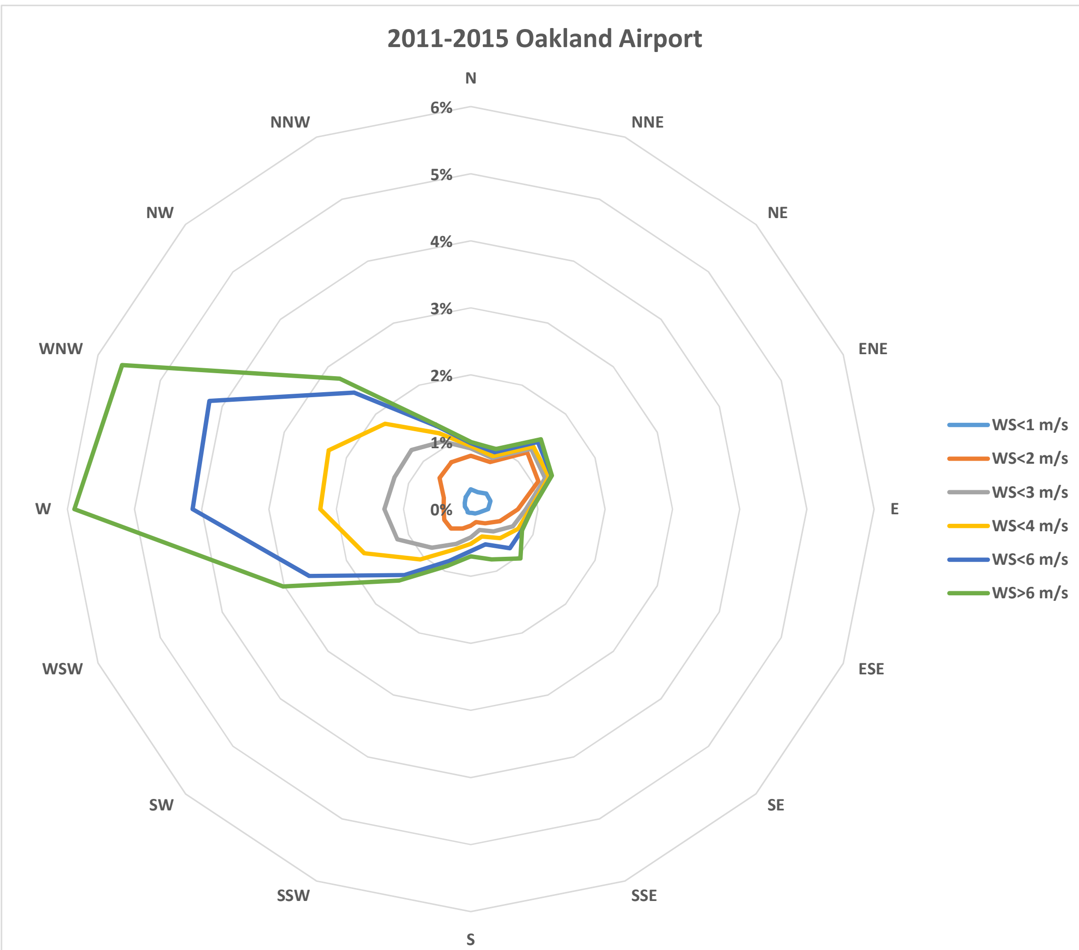

Figure 9. Wind rose frequency plot for the Oakland Airport, 2011-2015

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[35] U.S. Environmental Protection Agency. User’s Guide to the AERMOD Meteorological Preprocessor (AERMET). EPA-454/R-03-003. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. 2004. http://www.epa.gov/ttn/scram/7thconf/aermod/aermet_userguide.zip

E. Modeling Options

A number of control options must be specified in order to execute the AERMOD model. For this application, regulatory default options were used, which includes the use of elevated (non-flat) terrain effects, and the calms and missing data processing as set forth in US EPA's modeling guidelines.[36] The model's averaging time was set to one hour and default flagpole receptor heights were assumed to be 1.5 m. The proposed OBOT facility is located in Oakland, California, an urban area (estimated population: 600,000[37]), and therefore the "URBAN" modeling option was selected within AERMOD.[38]

I used the most recent version of AERMOD (v16216r) to estimate the $PM_{2.5}$ concentration impacts due to emissions from the proposed OBOT facility. No background concentrations were added to the modeled impacts, therefore the modeled $PM_{2.5}$ concentrations represent the incremental impact to the surrounding community from the proposed OBOT facility.

The AERMOD modeling assumed constant $PM_{2.5}$ emissions rates for each modeled source for every modeled hour. The actual emissions for each operation may vary somewhat (with zero emissions during those hours when the source is not operating). Such variability would potentially result in somewhat higher short-term peak concentrations at numerous locations. However, the long-term average concentrations will be well represented by the annual average model results shown below, for which a constant average emission rate was used. Peak (98th percentile) 24-hour average concentrations were estimated using maximum 24-hour emission rates (see Table 1) to account for the potential variability in emission rates.

[36] U.S. Environmental Protection Agency. Guideline on Air Quality Models, 40 CFR Part 51, Appendix W. Published in the Federal Register, Vol. 70, No. 216, November 9, 2005.
[37] According to the US Census, the population of Oakland, CA was approximately 420,000 in 2016 (https://www.census.gov/quickfacts/fact/table/oaklandcitycalifornia,US/PST045216).
[38] The "URBAN" modeling option incorporates the effects of increased surface heating from an urban area on pollutant dispersion under stable nighttime atmospheric conditions.

IV. MODEL RESULTS

I ran the AERMOD model using the estimated $PM_{2.5}$ emission rates for the north rail and south rail scenarios, as shown in Table 1, above. Long-term average $PM_{2.5}$ concentrations were predicted using the annual average emission rates. The average modeled concentrations using five years of meteorological data (2011-2015) represent the long-term average $PM_{2.5}$ concentration impacts to the surrounding area due to emissions from the proposed OBOT facility. Peak (98th percentile) 24-hour average $PM_{2.5}$ concentrations were predicted using the maximum 24-hour average emission rates (also shown in Table 1). The predicted peak 24-hour average $PM_{2.5}$ concentrations represent a worst-case daily impact.

The AERMOD model estimated the average $PM_{2.5}$ concentration due to emissions from the proposed OBOT facility for every hour of the five-year modeling period at every gridded receptor location, and also at every modeled sensitive receptor (see Table 2). Long-term averages of the individual hourly modeled concentrations were computed at each modeled receptor location. Figures 10 and 11 show the modeled five-year average $PM_{2.5}$ concentration impacts for the north rail and south rail scenarios, respectively.

The AERMOD model predicted that elevated $PM_{2.5}$ concentrations would occur over a large area surrounding the proposed OBOT facility under both emission scenarios. For example, the model indicated that the long-term (five-year) average $PM_{2.5}$ concentration increase due to routine OBOT operations under the north rail scenario would exceed 0.5 $\mu g/m^3$ over an area of approximately 3.5 square kilometers, as shown in Figure 10.[39] Similarly, Figure 11 shows an area of approximately 5.4 square kilometers in which long-term $PM_{2.5}$ concentrations from the OBOT operations under the south rail scenario would exceed 0.5 $\mu g/m^3$.

[39] The area inside the orange shading in Figures 10 and 11 represents the area in which the modeled annual average $PM_{2.5}$ concentrations from OBOT's proposed operations exceed 0.5 ug/m3.

Figure 10. Modeled long-term $PM_{2.5}$ concentrations ($\mu g/m^3$), north rail scenario[40]

[40] $PM_{2.5}$ contours are shown in Figures 10 and 11 for concentrations up to 2.0 $\mu g/m^3$. The area inside the gold ring in the center of the contours represents long-term $PM_{2.5}$ concentrations that exceed 2.0 $\mu g/m^3$.

Figure 11. Modeled long-term $PM_{2.5}$ concentrations ($\mu g/m^3$), south rail scenario

The model results show that coal dust emissions from the proposed OBOT facility would have a significant impact on $PM_{2.5}$ concentrations in neighboring areas that are already experiencing some of the worst AQ in the region. Much of the area in West Oakland and southern Emeryville, in which the long-term modeled $PM_{2.5}$ concentration impacts are the greatest (see Figures 10 and 11), have been classified as ""disadvantaged communities". These areas are "disproportionately burdened by and vulnerable to existing multiple sources of pollution."[41]

Air quality measurements taken at the West Oakland monitor have shown very high $PM_{2.5}$ concentrations in recent years, with numerous observed exceedances of the 24-hr NAAQS level (35 μg/m^3). According to BAAQMD data, the West Oakland monitoring location has violated both the 24-hour and annual average $PM_{2.5}$ NAAQS.[42] A short-term special monitoring study[43] conducted by DRI, on behalf of the BAAQMD, showed that there are a number of locations close to the 880 freeway, in the area of peak modeled contributions from the proposed OBOT facility, in which $PM_{2.5}$ concentrations were observed to be much higher than measured at the BAAQMD West Oakland monitor (due largely to enrichment from vehicular traffic).

The contribution of significant additional amounts of $PM_{2.5}$ from the proposed OBOT facility could potentially cause more violations of the 24-hour $PM_{2.5}$ NAAQS. (even a small to moderate increase in long-term PM2.5 concentrations would cause many days that are currently just under the standard level to exceed the standard).

The modeling was also used to determine the peak 24-hour impacts to $PM_{2.5}$ concentrations in the area surrounding the proposed OBOT facility. The model results indicate that many of the modeled sensitive receptor locations will be significantly impacted from coal dust emissions from the proposed OBOT facility. Table 3, below, shows the modeled peak (98th percentile) 24-hour average and the annual average $PM_{2.5}$ concentration impacts at each of the sensitive receptor locations for the two emission scenarios.

Short-term (24-hour average) PM2.5 concentrations are predicted to increase by more than 2.5 μg/m^3, and by as much as 8 μg/m^3, at a number of nearby sensitive receptors, including the Bay Bridge toll plaza, Gateway Park, the Alexander Zuckerman Bicycle and Pedestrian Path, Raimondi Park, and Memorial Park. Many of the sensitive receptors, including a number of Oakland and Emeryville schools, would experience peak short-term $PM_{2.5}$ concentration impacts that exceed 1 μg/m^3.

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[41] ESA report.
[42] The annual average ambient air quality standard for $PM_{2.5}$ is 12 μg /m^3.
[43] West Oakland Monitoring Study (WOMS), Desert Research Institute. 2010.

Table 3. Modeled $PM_{2.5}$ Concentration ($\mu g/m^3$) at Sensitive Receptors

	Sensitive Receptor Location	Scenario: North Rail PM conc (ug/m3) Annual Average ALL-JS	Scenario: North Rail PM conc (ug/m3) 24-hr Avg 98th %-ile ALL-KS	Scenario: South Rail PM conc (ug/m3) Annual Average ALL-LS	Scenario: South Rail PM conc (ug/m3) 24-hr Avg 98th %-ile ALL-MS
Toll Plaza	Bay Bridge Toll Plaza	1.236	4.005	1.226	4.088
Bike Path	Alexander Zuckermann Bicycle and Pedestrian Path (1)	0.226	1.161	0.234	1.155
	Alexander Zuckermann Bicycle and Pedestrian Path (2)	0.347	1.756	0.355	1.721
	Alexander Zuckermann Bicycle and Pedestrian Path (3)	0.672	2.992	0.678	3.009
	Alexander Zuckermann Bicycle and Pedestrian Path (4)	2.052	6.945	2.052	6.926
	Alexander Zuckermann Bicycle and Pedestrian Path (5)	2.952	8.381	2.939	8.386
	Alexander Zuckermann Bicycle and Pedestrian Path (6)	2.993	7.615	2.958	7.586
	Alexander Zuckermann Bicycle and Pedestrian Path (7)	3.183	8.164	3.111	7.915
	Alexander Zuckermann Bicycle and Pedestrian Path (8)	1.526	3.824	1.391	3.466
	Alexander Zuckermann Bicycle and Pedestrian Path (9)	1.007	2.649	0.695	1.872
	Alexander Zuckermann Bicycle and Pedestrian Path (10)	0.794	2.366	0.374	1.126
Oakland Parks	Gateway Park (new)	0.607	2.889	0.617	2.877
	Raimondi Park W	1.768	4.008	1.597	3.306
	Raimondi Park E	1.243	3.070	1.162	2.561
	Memorial Park (1)	1.317	3.112	0.933	2.399
	Memorial Park (2)	1.412	3.183	1.088	2.553
	Memorial Park (3)	1.441	3.215	1.185	2.646
	Memorial Park (4)	1.227	2.702	1.068	2.260
	Memorial Park (5)	1.084	2.499	0.968	2.056
	Memorial Park (6)	0.839	2.135	0.797	1.786
	Memorial Park (7)	0.669	1.894	0.680	1.632
	Memorial Park (8)	0.484	1.522	0.553	1.428
	Memorial Park (9)	0.402	1.362	0.489	1.315
	Memorial Park (10)	0.344	1.204	0.458	1.216
	Memorial Park (11)	0.297	1.042	0.439	1.129
	14th Street Pocket Park	0.877	2.618	1.048	2.592
	Willow Park	0.656	2.044	0.776	1.988
	McClymonds Mini-Park	0.483	1.284	0.431	1.156
	South Prescott Park	0.203	0.703	0.477	1.196
	Wade Johnson Park	0.398	1.300	0.471	1.249
	DeFremery Recreation Center	0.545	1.578	0.556	1.351
	Lowell Park	0.335	1.071	0.394	0.989
	Marston Campbell Park	0.311	1.061	0.330	0.942
	Poplar Playground	0.708	1.854	0.547	1.519
	Union Plaza Park	0.531	1.481	0.380	1.157
	Fitzgerald Park	0.495	1.457	0.350	1.129
	Grove Shafter Park	0.220	0.817	0.180	0.684
	Mosswood Park	0.156	0.610	0.133	0.523
	Lafayette Square Park	0.196	0.745	0.280	0.748
	Jefferson Square Playground	0.171	0.663	0.351	0.869
	Frank H. Ogawa Plaza	0.190	0.714	0.237	0.687
	Henry J. Kaiser Memorial Park	0.218	0.769	0.238	0.719
	Lincoln Square Park	0.139	0.540	0.233	0.596
	Chinese Garden Park / Harrison Square	0.125	0.496	0.314	0.782
	Madison Park	0.124	0.484	0.247	0.609
	Snow Park	0.162	0.544	0.196	0.519
	Dover Park	0.079	0.380	0.056	0.298
	Bushrod Recreation Center	0.061	0.312	0.046	0.249
	Jack London Square	0.116	0.425	1.163	3.294
Emeryville Parks	Golden Gate Playground	0.140	0.575	0.066	0.340
	Temescal Creek Park	0.166	0.654	0.095	0.463
	Emeryville Community Organic Garden Park	0.342	1.001	0.091	0.406
	Doyle Hollis Park	0.419	1.103	0.100	0.373
	Park Ave Playground	0.317	0.902	0.093	0.370
	Christie Park	0.532	1.908	0.114	0.422
	Marina Park	0.160	0.628	0.139	0.569
	Joseph Emery Park	0.277	0.917	0.148	0.636

Table 3, continued.

Sensitive Receptor Location		Scenario: North Rail PM conc (ug/m3) Annual Average ALL-JS	Scenario: North Rail PM conc (ug/m3) 24-hr Avg 98th %-ile ALL-KS	Scenario: South Rail PM conc (ug/m3) Annual Average ALL-LS	Scenario: South Rail PM conc (ug/m3) 24-hr Avg 98th %-ile ALL-MS
Oakland Schools	Prescott Elementary School	0.375	1.231	0.537	1.404
	Ralph J. Bunche High School	0.602	1.631	0.596	1.401
	Lafayette Elementary School	0.321	1.069	0.337	0.954
	McClymonds High School	0.505	1.387	0.439	1.185
	New Day Pre School	0.209	0.656	0.220	0.598
	West Oakland Middle School	0.308	1.069	0.351	0.954
	Cole Elementary School	0.345	1.164	0.429	1.146
	Martin Luther King Jr Elementary School	0.273	0.986	0.338	0.933
	Saint Vincent's Day Home - Preschool	0.257	0.983	0.366	0.977
	City of Oakland Head Start	0.500	1.334	0.470	1.163
	YMCA Preschool	0.297	0.958	0.300	0.873
	Oakland School For the Arts	0.213	0.766	0.237	0.715
	Starlite Child Development Center - Day Care Center	0.148	0.587	0.204	0.588
	Oakland Charter High School	0.152	0.595	0.230	0.605
	Lake Merritt Child Care Center	0.150	0.587	0.227	0.597
	Lincoln Elementary School	0.139	0.539	0.231	0.593
	American Indian Public Charter School	0.132	0.521	0.213	0.554
	Little Stars Pre-School	0.138	0.544	0.200	0.554
	Bright Future Early Learning	0.212	0.787	0.251	0.740
	Laney College	0.105	0.387	0.226	0.526
	Street Academy Alternative School	0.187	0.660	0.171	0.603
	Westlake Middle School	0.164	0.588	0.159	0.541
	St Mary's Center Preschool	0.365	1.199	0.292	1.002
	Hoover Elementary School	0.315	1.067	0.252	0.892
	Oakland Military Institute / Longfellow School	0.217	0.827	0.156	0.663
	North Oakland Community Charter School	0.203	0.766	0.127	0.565
	Emery Secondary School	0.134	0.548	0.083	0.403
	Aspire Berkley Maynard Academy	0.124	0.546	0.062	0.328
	Grace Children's Academy - Day Care Center	0.163	0.646	0.093	0.461
Emeryvile Schools	Anna Yates Elementary	0.240	0.858	0.144	0.633
	Pacific Rim International School - Montessori School	0.380	1.082	0.113	0.509
	Emeryville Child Development Center - Preschool	0.330	1.024	0.128	0.578
	Emery High School	0.283	0.962	0.125	0.582

V. MODELING OF FIRES

In addition to the modeling of fugitive dust emissions from routine operations at the proposed OBOT facility, I also modeled two scenarios representing unplanned fires at the proposed OBOT facility. Two hypothetical fire scenarios were developed: (1) Fire A: a medium-size fire located at the Commodity A Hopper unloading structure, and (2) Fire B: a large-size fire located at the ship transloading location. The modeled physical dimensions of the two fires and the assumed PM emission rates were obtained from Dr. Pello's expert report.[44]

The medium-size fire (Fire A) was assumed to burn across the top surface area of a rail car (73 m^2) with a $PM_{2.5}$ emission rate of 1.05 g/s.[45] The large-size fire was assumed to burn across ten percent of a ship's coal surface (135 m^2) with a $PM_{2.5}$ emission rate of 2.1 g/s.[46]

I used the AERMOD model, with the same five-year meteorological data and the same set of receptors locations as described above, that was used for modeling routine operations at the proposed OBOT facility, to estimate the short-term (24-hour) impacts to the surrounding community that would be expected to occur in the event of a fire at the proposed OBOT facility. Figures 12 and 13 show the modeled peak (98^{th} percentile) 24-hour average $PM_{2.5}$ concentrations that would result from each of the two fires at the OBOT facility.

The model predicts that both fires would be responsible for significant short-term $PM_{2.5}$ concentration impacts over a large area surrounding the proposed OBOT facility. As shown in Figures 12 and 13, the peak (98^{th} percentile) 24-hour average $PM_{2.5}$ concentration would exceed 0.5 $\mu g/m^3$ across almost all of the 6x6 km modeling domain for both fire scenarios. Peak 24-hour average $PM_{2.5}$ concentrations would exceed 5.0 $\mu g/m^3$ across an area of more than 2.5 square kilometers under both fire scenarios.

The modeled peak (98^{th} percentile) short-term average concentrations due to the two fire scenarios at each of the modeled sensitive receptors are shown in Table 4. As can be seen from these model results, a fire has the potential to create very high 24-hour average PM2.5 concentration levels at many nearby receptor locations.

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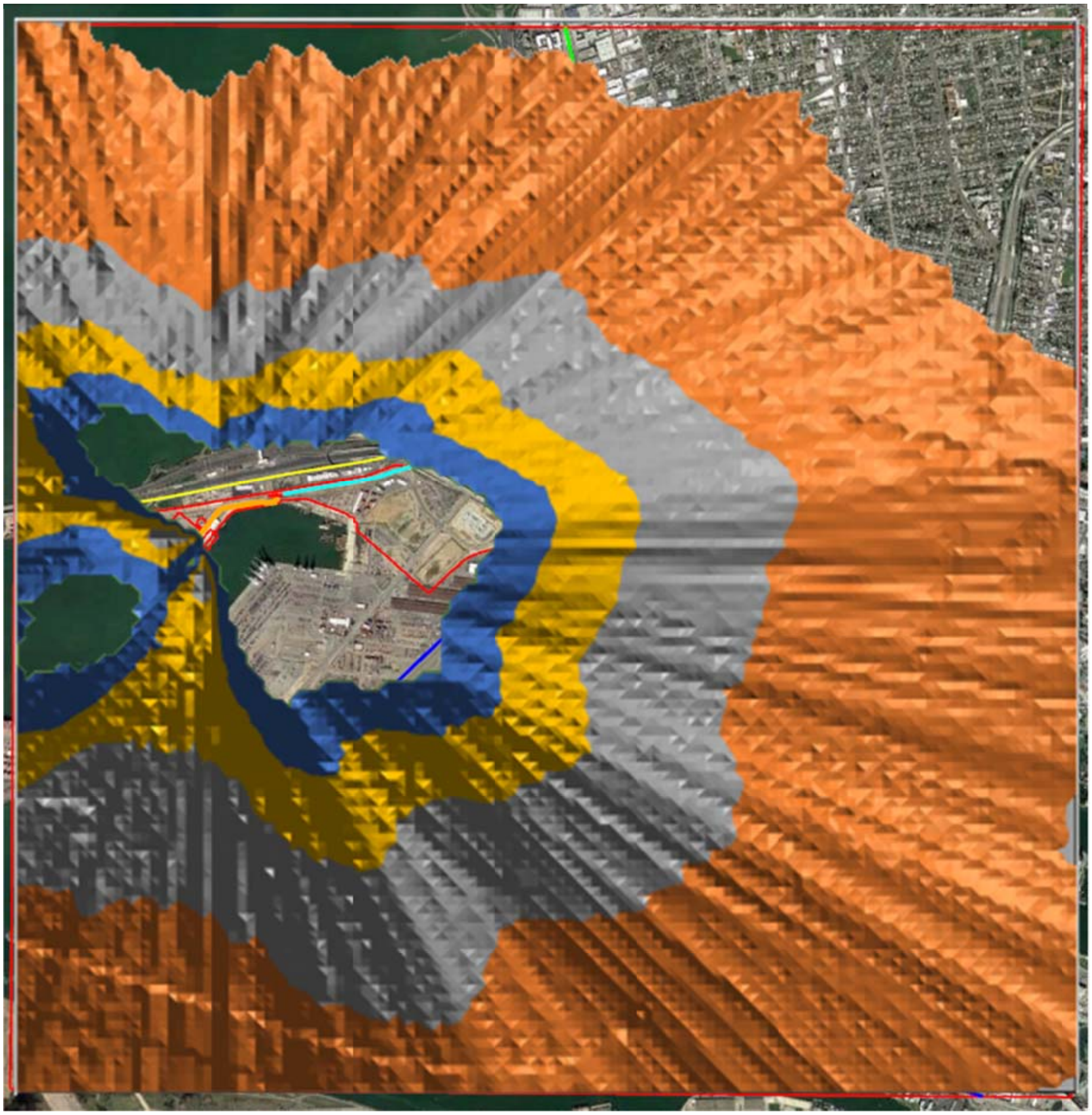
[44] Expert report of Dr. Pello. Environmental Effects of Coal Fires.
[45] Dr. Pello estimated the total PM emission rate for a medium fire to be 15 g/s. It was assumed that about 7 percent of the total emitted PM would be $PM_{2.5}$ (using AP-42 size factors for coal burning).
[46] Dr. Pello estimated the total PM emission rate for a large fire to be 30 g/s.

Figure 12. Peak modeled 24-hour average $PM_{2.5}$ concentrations ($\mu g/m^3$), Fire A



0.00-1.00	1.00-2.00	2.00-3.00	3.00-4.00	4.00-5.00

Figure 13. Peak modeled 24-hour average $PM_{2.5}$ concentrations ($\mu g/m^3$), Fire B

Table 4. Peak Modeled 24-hour Average $PM_{2.5}$ Concentrations at Sensitive Receptors due to Fires

	Sensitive Receptor Location	Scenario: Medium Fire at Hopper A PM conc (ug/m3) 24-hr Avg 98th %-ile FA_NS	Scenario: Large Fire at Transloading PM conc (ug/m3) 24-hr Avg 98th %-ile FB_NS
Toll Plaza	Bay Bridge Toll Plaza	13.705	5.026
Bike Path	Alexander Zuckermann Bicycle and Pedestrian Path (1)	3.174	3.607
	Alexander Zuckermann Bicycle and Pedestrian Path (2)	4.260	3.730
	Alexander Zuckermann Bicycle and Pedestrian Path (3)	6.268	11.673
	Alexander Zuckermann Bicycle and Pedestrian Path (4)	7.485	9.382
	Alexander Zuckermann Bicycle and Pedestrian Path (5)	20.548	7.754
	Alexander Zuckermann Bicycle and Pedestrian Path (6)	11.893	5.870
	Alexander Zuckermann Bicycle and Pedestrian Path (7)	6.337	4.276
	Alexander Zuckermann Bicycle and Pedestrian Path (8)	3.860	3.291
	Alexander Zuckermann Bicycle and Pedestrian Path (9)	2.575	2.600
	Alexander Zuckermann Bicycle and Pedestrian Path (10)	1.944	2.104
Oakland Parks	Gateway Park (new)	6.108	3.414
	Raimondi Park W	3.071	3.391
	Raimondi Park E	2.858	3.115
	Memorial Park (1)	2.339	2.816
	Memorial Park (2)	2.358	2.943
	Memorial Park (3)	2.279	2.915
	Memorial Park (4)	2.243	2.799
	Memorial Park (5)	2.187	2.763
	Memorial Park (6)	2.316	2.676
	Memorial Park (7)	2.403	2.608
	Memorial Park (8)	2.156	2.784
	Memorial Park (9)	2.027	2.875
	Memorial Park (10)	1.866	2.740
	Memorial Park (11)	1.741	2.641
	14th Street Pocket Park	3.401	3.963
	Willow Park	2.838	3.628
	McClymonds Mini-Park	1.401	1.896
	South Prescott Park	1.893	2.237
	Wade Johnson Park	1.919	2.616
	DeFremery Recreation Center	2.036	2.339
	Lowell Park	1.640	2.167
	Marston Campbell Park	1.390	1.662
	Poplar Playground	1.796	2.367
	Union Plaza Park	1.611	1.957
	Fitzgerald Park	1.554	1.889
	Grove Shafter Park	0.969	1.420
	Mosswood Park	0.762	1.162
	Lafayette Square Park	1.085	1.572
	Jefferson Square Playground	0.995	1.559
	Frank H. Ogawa Plaza	0.978	1.361
	Henry J. Kaiser Memorial Park	0.957	1.282
	Lincoln Square Park	0.826	1.213
	Chinese Garden Park / Harrison Square	0.768	1.258
	Madison Park	0.748	1.184
	Snow Park	0.757	1.056
	Dover Park	0.496	0.735
	Bushrod Recreation Center	0.429	0.637
	Jack London Square	0.767	1.281
Emeryville Parks	Golden Gate Playground	0.616	0.825
	Temescal Creek Park	0.760	1.046
	Emeryville Community Organic Garden Park	0.800	1.013
	Doyle Hollis Park	0.788	0.976
	Park Ave Playground	0.729	0.926
	Christie Park	0.920	1.111
	Marina Park	1.178	1.277
	Joseph Emery Park	1.051	1.287

Table 4, continued.

	Sensitive Receptor Location	Scenario: Medium Fire at Hopper A PM conc (ug/m3) 24-hr Avg 98th %-ile FA_NS	Scenario: Large Fire at Transloading PM conc (ug/m3) 24-hr Avg 98th %-ile FB_NS
Oakland Schools	Prescott Elementary School	2.143	3.162
	Ralph J. Bunche High School	2.036	2.368
	Lafayette Elementary School	1.386	1.683
	McClymonds High School	1.454	1.974
	New Day Pre School	0.839	1.253
	West Oakland Middle School	1.510	1.913
	Cole Elementary School	1.762	2.593
	Martin Luther King Jr Elementary School	1.392	1.973
	Saint Vincent's Day Home - Preschool	1.450	2.116
	City of Oakland Head Start	1.492	1.996
	YMCA Preschool	1.062	1.564
	Oakland School For the Arts	0.999	1.297
	Starlite Child Development Center - Day Care Center	0.805	1.147
	Oakland Charter High School	0.887	1.306
	Lake Merritt Child Care Center	0.883	1.294
	Lincoln Elementary School	0.824	1.222
	American Indian Public Charter School	0.791	1.185
	Little Stars Pre-School	0.775	1.144
	Bright Future Early Learning	1.071	1.396
	Laney College	0.669	1.051
	Street Academy Alternative School	0.796	1.168
	Westlake Middle School	0.713	1.086
	St Mary's Center Preschool	1.295	1.844
	Hoover Elementary School	1.201	1.708
	Oakland Military Institute / Longfellow School	0.982	1.283
	North Oakland Community Charter School	0.912	1.191
	Emery Secondary School	0.689	0.936
	Aspire Berkley Maynard Academy	0.596	0.803
	Grace Children's Academy - Day Care Center	0.762	1.025
Emeryvile Schools	Anna Yates Elementary	0.998	1.288
	Pacific Rim International School - Montessori School	1.003	1.307
	Emeryville Child Development Center - Preschool	1.049	1.350
	Emery High School	0.996	1.286

VI. SUMMARY AND CONCLUSIONS

I compiled the necessary information in order to characterize the proposed OBOT facility, specifically related to the emissions of particulate matter (PM) from the transfer and handling of coal. I also constructed the required meteorological data, representing a five-year period from 2011 to 2015, necessary to evaluate long-term transport patterns and the resulting long-term air quality impacts.

The source and meteorological data were input to the AERMOD dispersion model which was used to estimate the air quality impacts in the surrounding community due to routine operations at the proposed OBOT facility. The model results indicate that coal dust emissions from the proposed OBOT facility would have a significant effect on $PM_{2.5}$ air quality in a large area surrounding the facility. For example, the model estimated that emissions from the proposed OBOT facility, under the north rail scenario, would be responsible for an increase in long-term average $PM_{2.5}$ levels of at least 0.5 $\mu g/m^3$ over an area of 3.5 square kilometers (km^2), which is equivalent to the area of a circle with a diameter of 2.1 km. For the south rail scenario, the model estimated that routine OBOT operations would cause an increase in long-term $PM_{2.5}$ concentrations of at least 0.5 $\mu g/m^3$ over an area of 5.4 square kilometers (km^2), equivalent to a circular area with a diameter of 2.6 km.

The model also showed that coal dust emissions from the OBOT facility would contribute to short-term concentration impacts in the vicinity of the proposed facility and rail lines. Peak (98^{th} percentile) 24-hour average $PM_{2.5}$ concentrations from the proposed OBOT facility would exceed 2.5 $\mu g/m^3$, and could be as high as 8 $\mu g/m^3$, at many nearby locations including the Alexander Zuckerman Bicycle and Pedestrian Path.

I also evaluated the air quality impacts that would be expected to occur due to an unplanned fire at the proposed OBOT facility using the same modeling platform. The model results demonstrated that either a medium-size fire at the unloading hopper location or a larger fire at the ship transloading location would result in a widespread increase in short-term (24-hour average) $PM_{2.5}$ concentrations in the neighborhoods surrounding the proposed OBOT facility.

These conclusions were reached based upon the information I have reviewed to-date, including the materials identified in Appendix A (Materials Considered). I reserve the right to alter this report and its conclusions based on new or revised information.

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I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

Executed on October 6, 2017, at San Rafael, California.

H. Andrew Gray