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Comments on the VMT / Orcem Revised Operational Alternative Air Quality and Health Risk Assessment Vallejo, CA

Prepared by:

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1. Introduction

I reviewed the June 2018 Air Quality Evaluation and Health Risk Assessment for the Revised Operations Alternative (ROA) of the Orcem California (Orcem) and Vallejo Marine Terminal (VMT) Project in Vallejo California. The purpose of the ROA is to supplement the 2015 Draft Environmental Impact Report (DEIR) prepared by the City of Vallejo, the lead agency for this project. This analysis includes a quantitative assessment of the ROA, and is intended for inclusion in the Project Final EIR. The ROA analysis was funded by Orcem and VMT as an alternative to the original project description.

This project consists of two main components: The VMT and an onshore facility operated by Orcem. The VMT is planned as an operational deep draft port facility, capable of handling a variety of commodities via marine vessels ranging from 40,000 to 70,000 metric tons. Marine vessels of this size are commonly referred to as "Handymax," which is a generic term for ship carrying capacity.

The Orcem component of the project is an adjacent onshore industrial facility that plans to produce cement material for use in construction projects. The site of the proposed Orcem project is located at 790 and 800 Derr Street, in the southwestern portion of the City of Vallejo, California.

The ROA is tasked with determining whether the proposed project alternative will cause significant environmental impacts, including effects on ambient air quality and health risks due to exposure of toxic air contaminants. The ROA is not a stand-alone analysis, as it draws on previous analyses performed in the DEIR. This piecemeal analysis makes the ROA considerably more difficult to review, since familiarity with prior air quality and health risk analyses is required. The analyses preceding the ROA include:

- Draft FEIR for the Vallejo Marine Terminal and Orcem Project, February 2017. Prepared by Dudek.
- Orcem / VMT Project, Air Quality and Greenhouse Gas Evaluation, DEIR Appendix D-1, July 2015. Prepared by Ramboll Environ.
- VMT / Orcem Health Risk Assessment, May 2015. Prepared by Ramboll Environ.
- Appendix X, Carbon monoxide and $PM_{2.5}$ emission inventory and impact assessment of Orcem and VMT facilities, Vallejo, CA, May 12, 2015. Prepared by AWN Consulting.
- Annex A – Detailed CO and $PM_{2.5}$ Inventory Calculations. Prepared by AWN Consulting.
- Annex B – AERMOD Air Model Input Parameters. Prepared by AWN Consulting.

In addition to the above documents, I reviewed the following materials:

- Ramboll Environ air modeling files
- AWN Material Handling Health Risk Assessment (HARP) files
- Ramboll Environ Emission Calculation spreadsheets
- Comments and communications with the California Air Resources Board
- Comments and communications with the Bay Area Air Quality Management District (BAAQMD)

The ROA concludes that the most significant impacts from the proposed project alternative is excess cancer risks. The ROA also concludes that these impacts can be mitigated to insignificance by limiting ship loading activities and various mixes of biodiesel fuel for marine vessels (ROA, p. 13 of 19). The significance level for excess cancer risk is 10 per million. The mitigated ROA excess cancer risk is found to be 9 per million.

The ROA, however, employs a number of faulty assumptions that significantly understate the excess cancer risks from the project. In particular, excess cancer risks from ship hoteling have been significantly understated. I used Ramboll Environ's model input files as a basis for my analysis, with certain additions and modifications as discussed in the following comments.

I specialize in atmospheric dispersion modeling, which uses regulatory-approved computer programs to estimate chemical concentrations in the air and deposition fluxes to the ground. I hold B.S. (1978) and M.S. (1980) degrees in Atmospheric Science from the University of California at Davis. In the past 38 years I have prepared well over 1,000 air dispersion modeling analyses. During this period, I have also prepared several hundred health risk assessments. A copy of my curriculum vitae is included in Exhibit A.

2. The ROA Understates Health Risks from Hoteling Auxiliary Engine Diesel Particulate Matter Emissions

Diesel engine exhaust is classified by the State of California as a toxic air contaminant (TAC) and as a chemical known to cause cancer in humans.[1] Diesel engine exhaust is also a Proposition 65 listed carcinogen, which requires notification to individuals when the exposure exceeds the No Significant Risk Level (NSRL) of 10 per million excess cancer risk.[2]

Although there are many toxic constituents in diesel exhaust, e.g. benzene, aldehydes, and metals, it is diesel particulate matter (DPM) that is used to assess excess cancer risks from diesel engine exhaust. The California Air Resources Board (CARB) and the California Office of Environmental Hazard Assessment (OEHHA) developed a DPM inhalation cancer potency factor which is used to assess diesel engine exhaust excess cancer risks. From OEHHA and CARB:

> The inhalation cancer potency factor was derived from whole diesel exhaust and should be used only for impacts from the inhalation pathway (based on diesel PM measurements). The inhalation impacts from speciated emissions from diesel-fueled engines are already accounted for in the inhalation cancer potency factor.[3]

The DPM inhalation cancer potency factor, with units of inverse air concentration ($(\mu g/m^3)^{-1}$), is used to convert DPM air concentrations to a unitless value of excess cancer risk. For DPM, OEHHA

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[1] California Office of Environmental Health Hazard Assessment, Health Risk Assessment for Diesel Exhaust, May 1998.

[2] California Office of Environmental Health Hazard Assessment, Safe Drinking Water and Toxic Enforcement Act of 1986, Chemicals Known to the State to Cause Cancer or Reproductive Toxicity, June 19, 2015.

[3] Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values, Updated August 20, 2018, p. 15.

and CARB have identified an inhalation cancer potency factor of 3.00E-04 $(\mu g/m^3)^{-1}$, and an oral potency slope of 1.1 $(mg/(kg\text{-}day))^{-1}$ for dose calculations.[4]

DPM emissions during ship hoteling are the largest contributor to excess cancer risks identified in the ROA. This is due to the significant amount of DPM emissions associated with marine vessel auxiliary engines and the relatively high cancer potency factor linked with DPM exposure. The ROA, however, employs a number of faulty assumptions that significantly understate the health impacts from ship hoteling. These errors are discussed below.

First, the ROA assumes that the Handymax auxiliary engine stack exit velocity is 25 meters/second (over 55 miles/hour) and the stack diameter is 0.8 meter.[5] This is an unrealistically high stack gas exit velocity for auxiliary engines with load factors of 10% or less, especially when combined with a rather large stack diameter. A 25 meters/second stack gas exit velocity is typical of engines running at much higher load levels.

Other similar analyses of DPM health impacts from marine vessel auxiliary engines have used more realistic stack exit velocities and stack diameters. For example, the Los Angeles Harbor Department prepared a recent Environmental Impact Report, using a modeled marine vessel auxiliary engine stack gas velocity of 7.5 meters/second and a stack diameter of 0.539 meter.[6] Similarly, an air quality assessment for the Newfoundland and Labrador Refinery Project modeled Handymax loading emissions using a modeled marine vessel auxiliary engine stack gas velocity of 10 meters/second and a stack diameter of 0.54 meter.[7]

Over-stating the stack exit velocity can significantly under-predict air impacts downwind of the emission source. This is because increasing exit velocity results in higher plume rise, which in turn results in lower air pollution impacts at ground-level.

To add to this concern, the ROA fails to provide a reference for either the assumed 25 meters/second auxiliary generator stack gas exit velocity or the 0.8 meter stack diameter. A previous analysis by AWN Consulting references the Port of Los Angeles (POLA) 2012 emission inventory report as the source of these values.[8] This reference, however, has no information whatsoever on stack gas exit velocities.[9] In other words, the ROA relies on unsupported auxiliary generator stack exit velocity and diameter values, resulting in significantly understated air and health impacts.

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[4] Id., p.7.

[5] Obtained from Ramboll Environ AERMOD input files.

[6] LAHD, Draft Supplemental Environmental 13 Impact Report (Draft SEIR) to the Berths 97-109 [China Shipping] Container Terminal 14 Project Environmental Impact Statement/Environmental Impact Report, June 2017, p. B2-5.

[7] Newfoundland and Labrador Refinery Project, Environmental Impact Assessment Component Study, Air Quality Component Study, July 2007, p. 17.

[8] AWN Consulting, Annex B – AERMOD Air Model Input Parameters, page 1 of 4.

[9] Port of Los Angeles, Inventory of Air Emissions – 2012, Technical Report ADP# 121011-529, July 2013.

Second, the ROA models the Handymax auxiliary generator emissions as two separate locations, separated by about 170 meters. In reality, Handymax-sized ships have only one auxiliary generator stack. In addition to modeling two separate auxiliary generator stack locations, the ROA divides the total emissions evenly between the two assumed points. This modeling approach (dividing and separating emissions) greatly dilutes DPM exposure compared to what would occur from the actual single auxiliary generator stack. Since there is no proposed permit condition on record requiring the Handymax ships to dock in opposite orientation (bow-first exactly 50% of the time, and stern-first exactly 50% of the time), all the auxiliary generator emissions should be modeled as a single point source.

Third, the ROA fails to include building downwash for the auxiliary generator and boiler emissions from the Handymax ship loading activities. This is particularly important for hoteling, but also for maneuvering into and out of the marine terminal. Neglecting downwash from the two distinctive tiers of a Handymax ship will significantly understate health impacts. This is because building downwash reduces effective stack heights, resulting in higher downwind air pollution concentrations. The ROA should have assessed building downwash impacts for all possible ship sizes proposed for the project, as larger ships may have greater downwash effects than smaller ships. A photo of a typical Handymax-sized ship is shown below.[10]

[10] http://maritime-connector.com/wiki/handymax/ .

In order to assess the degree to which the ROA understates excess cancer risk calculations, I remodeled the DPM emissions from the Handymax auxiliary generator stack while hoteling at the VMT. This includes correcting the unrealistically high stack exit velocity used in the ROA, including building downwash, and modeling the auxiliary generator stack as a single source. These modeling corrections alone increased the DPM excess cancer risks from the Handymax auxiliary generator by more than a factor six.[11] The methodology I used is described as follows:

Using OEHHA's 2015 Health Risk Assessment Guidelines, I calculated the excess cancer risk from exposure to 1.0 $\mu g/m^3$ of DPM for the first nine years of a child's life, from birth onwards. This is the most sensitive 9-year period of life, and OEHHA has developed age sensitivity factors and age-specific breathing rates for children which greatly increase the excess cancer risk compared to the same exposure for adults.[12] Applying OEHHA's guidelines, I calculate an excess cancer risk of 6.27E-04 (627 per million) for exposure to 1.0 $\mu g/m^3$ of DPM for the first nine years of a child's life. This value, which is calculated as shown in Exhibit B, is applied during post-processing of the modeled DPM air concentrations.

I used USEPA's AERMOD v. 18081 to calculate period-average construction DPM concentrations, modeled with five-years of Conoco-Phillips Rodeo Refinery meteorological data (the same data used in the ROA and DEIR assessments). I modeled the auxiliary generator stack with a unit emission rate of 1.0 g/s and I developed building downwash parameters using USEPA's BPIPPRM program. The resulting DPM air concentrations are converted to excess cancer risk values using the auxiliary generator emissions and risk calculation information provided in Exhibit B. The model input files I used are shown in Exhibit C.

3. The ROA Understates Health Risks from Hoteling Boiler Particulate Matter Toxic Air Contaminant Emissions

Emissions from fuel combustion (internal or external) are comprised of a variety of particulates and volatile organic compounds (VOC). The weight fraction of specific particulate matter compounds and VOCs are often determined using established speciation profiles, or by source-testing the emissions from the actual source. Both USEPA and CARB have developed particulate matter and VOC speciation profiles for use when source-testing is not available.[13]

Marine vessel boilers use a type of fuel oil known as distillate. For the proposed VMT, a low-sulfur marine distillate is used, which when fired in an external-combustion boiler produce emissions of particulates and VOCs. The ROA used speciation profiles to estimate these emissions. The ROA, however, applied incorrect speciation profiles when estimating the amount of particulate emissions from the boiler exhaust.

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[11] Averaged across all 3,169 receptor locations developed by Ramboll Environ. Corrected DPM modeling (from hoteling auxiliary engines alone) results in excess cancer risks greater than 20 per million in adjacent residential areas.

[12] California Office of Environmental Health Assessment, Air Toxics Hot Spots Program Risk Assessment Guidelines, Guidance Manual for Preparation of Health Risk Assessments, February 2015.

[13] https://cfpub.epa.gov/speciate/
https://www.arb.ca.gov/ei/speciate/speciate.htm

The particulate matter emission profiles used in the ROA are likely to understate ship boiler health impacts due to omission of key metals in boiler exhaust plumes. The clue to this concern lies in the ROA modeling 0.00% mass fractions of metal TACs typically found in distillate fuel combustion.

The ROA (and DEIR) quantifies Handymax boiler particulate TAC emissions using USEPA particulate matter speciation profiles 5676 (Marine Vessel - Auxiliary Boiler - Heavy Fuel Oil) and 127102.5 (Boiler - #2 Fuel Oil Fired). Conversely, the ROA models VOC emissions using CARB VOC speciation profile 504 (DEIR HRA, p. 10 of 36). CARB VOC profile 504 is titled: External combustion boilers - distillate or residual.

The ROA should have relied on CARB PM profile 112 (fuel combustion-distillate) for external combustion boiler particulate metal TAC fractions. For example, while the ROA assumes 0.00% arsenic, cadmium, and chromium emissions from boiler exhaust, CARB profile 112 lists:

Arsenic	(SAROAD #12103); 0.53% (0.0053 mass fraction)
Cadmium	(SAROAD #12110); 0.05% (0.0005 mass fraction)
Chromium	(SAROAD #12112); 0.53% (0.0053 mass fraction)

Also, the ROA assumes lead emissions of 0.03% from ship boiler exhaust, based on the USEPA profiles. CARB particulate matter profile 112, however, assigns a mass fraction for lead (SAROAD #12128) of 0.0055, or 0.55% by weight. This is about 18 times the level assumed in the ROA.

Alternatively, the project applicant could perform source-testing on actual Handymax boiler exhaust to develop particulate matter and VOC mass fractions. This could be required as a permit condition, and could be supervised by BAAQMD staff.

4. The ROA Inappropriately Models Ship and Tug Maneuvering Emissions

The ROA models ship and tug maneuvering emissions using volume sources with elevated release heights. For example, ship maneuvering is modeled with a volume source release height of 50 meters, and some tugs are modeled with a volume source release height of 32.79 meters.

In air dispersion modeling, a volume source is essentially a cube from which the emissions are released. And as with the auxiliary generator stack, over-estimating the height of the volume emission release point will under-estimate the resulting ground-level air pollutant concentrations. The volume source release heights assumed in the ROA are much higher than I would expect them to be and are based on flawed methodologies.

The ROA methodology for estimating volume source height uses overly-simple and antiquated methods, including a screening approach no longer in use (DEIR, p. 52). The ROA calculations are further compromised by not incorporating building downwash into the volume source release height estimates. There is a straight-forward solution to this problem: The ROA and DEIR should be revised to model all marine vessel, tug, and barge emission sources as a series of point sources, employing appropriate stack and building downwash parameters.

5. The ROA Fails to Include Building Downwash Effects for all Point Sources

As discussed above, building downwash should be included when modeling point sources which can be affected by structural wake effects. The ROA only assessed building downwash for some of the modeled point sources, and importantly, failed to assess downwash for some of the largest TAC emission sources.

The ROA modeled several point sources with building downwash, including rail idling, the main onshore stack, the silos, and truck loading. Other point sources which were not modeled with building downwash, but should have been, include:

- Ship auxiliary generator during hoteling
- Ship boiler during hoteling
- Ship maneuvering
- Tug maneuvering
- Mobile hoppers
- Conveyors

The ROA and DEIR air modeling should be revised to include building downwash for all applicable point sources.

6. The ROA Relies on Unrepresentative Meteorological Data

Meteorological data are used in air dispersion modeling to predict where, and to what degree, air pollution emissions will impact surrounding communities. It is essential that meteorological data reliably represent the wind speeds, directions, and dispersion characteristics of the area where the emission sources are modeled.

The ROA relies on air dispersion modeling using meteorological data from the Conoco-Phillips Rodeo Refinery, augmented with data from the Napa County Airport. While these data may be of high quality, the Rodeo location may not actually be representative of the proposed VMT/Orcem project site. The project site is sheltered from prevailing winds by a peninsula with 150-foot terrain, whereas the Rodeo location is directly exposed to the bay.

The San Francisco Bay area has complex wind fields, caused by a wide-variety of terrain configurations and land-ocean interactions. Also, pressure gradients between the cool ocean surface and warm interior locations can cause winds to vary widely over a relatively short distance. Exhibit D, which includes wind roses from Conoco-Phillips Rodeo Refinery and the Napa County Airport, demonstrates this concern.

The project applicant should be required to collect at least one-year of on-site meteorological data, consistent with current USEPA guidelines on air quality modeling. The applicant has had ample time to collect these data, but has neglected to do so. These data should be used in revised ROA and DEIR air quality impact analyses and health risk assessments.

7. The ROA Fails to Assess a Reliable Cumulative Impact Scenario

The DEIR HRA relies on BAAQMD cumulative impact screening methods, which are limited to sources within one-half mile of the proposed project site. This methodology does not account for significant marine vessel activities in the nearby waters, high-density on-road vehicle traffic (e.g., I-80 and I-780, which are within a mile of the proposed facility), or other large non-point source TAC emissions. Conspicuously, local refineries and other major sources are excluded from the DEIR cumulative impact analysis.

The DEIR cumulative impact assessment is limited to three small sources. From the DEIR:

> As recommended by the BAAQMD (BAAQMD, 2012), to assist in evaluating cumulative risks, permitted stationary sources of TACs near the Project Site were identified using BAAQMD's *Stationary Source Risk and Hazard Analysis Tool* for sources in Napa-Solano counties. This mapping tool uses Google Earth to identify the location of stationary sources and their estimated screening level cancer risk and hazard impacts. Three stationary sources within a 0.5-mile radius of the Project site were identified:
>
> • Plant G10729 is the Discount Gas Grocery & Liquor located at 605 Magazine Street, approximately 1,300 feet northeast of the Project boundary. This gas station has a cancer risk value of 4.02, a hazard value of 0.004, and no $PM_{2.5}$ value associated with it.
>
> • Plant 16677 is Original Display Fixtures located at 206 Lemon Street, about 600 feet northwest of the Project boundary. There are no cancer risk, hazard or $PM_{2.5}$ values associated with this source.
>
> • Plant 17907 is the Sousa Solano Auto Body & Paint shop located at 407 Lemon Street, about 970 feet north of the Project boundary. There are no cancer risk, hazard or $PM_{2.5}$ values associated with this source.
>
> It is assumed that both Plants 16677 and 17907 would not contribute to cumulative risks or hazards. For Plant G10729 it is highly unlikely that the gas station will significantly contribute to any significant cumulative cancer risk or hazard when combined with the Project's cancer risks and hazards since the BAAQMD Thresholds for significant cumulative risk are a cancer risk of greater than 100 in a million and a hazard index of greater than 10.0 for all local sources combined. Based on the above, the project would not exceed the adopted BAAQMD Thresholds with respect to cumulative community risk caused during project operation since single-source and cumulative and cancer risk and hazard index would all be less than the BAAQMD Thresholds. Therefore, the Project and ROA impacts are found to be less-than-significant (DEIR, p. 113).

The DEIR cumulative impact assessment should be revised and expanded to include local refineries, freeways, marine vessels, and area sources.

8. Ambient Air Monitoring Should be Required as a Permit Condition

The ROA and the preceding DEIR rely on a number of difficult to verify emission rates, load factors, control measures, and model input parameters. While the BAAQMD may be able to confirm some of these assumptions during the authority to construct and operating permit approval process, ambient air monitoring should be required to ensure that the ROA and DEIR assumptions have merit. The EIR lead agency is in a strong position to require such monitoring as a permit condition.

The City of Vallejo should require monitoring of particulate matter, in the form of $PM_{2.5}$ and PM_{10}. This monitoring is particularly important since the DEIR failed to include any quality impact analyses for verifying compliance with the applicable California and National ambient air quality standards. These monitoring activities should:

- Be continuous;
- Be in place for both construction and operation;
- Include at least four sites;
- Be placed on downwind facility boundary and nearby residential areas.
- Measure on-site meteorological data, including 10-meter wind speed, wind direction, and sigma-theta (standard deviation of horizontal wind direction fluctuations);
- Be in place for the life of the project.

The BAAQMD could assist the City of Vallejo in developing the specific monitoring requirements, siting of the monitoring systems, and data collection methods.

9. Concluding Remarks

As discussed above, the VMT/Orcem ROA and DEIR employ technical assumptions that tend to result in under-stated air pollution impacts and associated health risks. The ROA and DEIR should be revised to address these concerns, and the public should have the opportunity to review and comment on these revisions.

Due to the extensive amount of technical materials to review, my comments on the ROA and DEIR should not be considered as a complete list of flaws in these documents. Additional concerns may be identified with further review.

Exhibit A:

Curriculum Vitae

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Summary

I have over 35 years of regulatory and private-sector experience in air quality impact analyses, health risk assessments, meteorological monitoring, and geographic information systems. I specialize in litigation support; I have successfully provided testimony in numerous cases, both as an individual consultant and as part of a team of experts.

Education

- M.S., Atmospheric Science, University of California, Davis, 1980.
- B.S., Atmospheric Science, University of California, Davis, 1978.

Air Dispersion Modeling

- I am experienced in applying many different air dispersion models, including programs still in the development phase. I have prepared well over 1,000 air dispersion modeling analyses requiring the use of on-site or site-specific meteorological data. These runs were made with the USEPA ISC, OCD, MESOPUFF, INPUFF, CALPUFF, ISC-PRIME, AERMOD, COMPLEX-I, MPTER, and other air dispersion models.
- I prepared and submitted technical comments to the USEPA on beta-testing versions of AERMOD; these comments are being addressed and will be incorporated into the model and instructions when it is ready for regulatory application.
- I am experienced in performing air dispersion modeling for virtually every emission source type imaginable. I have modeled:
  Refineries and associated activities;
  Mobile sources, including cars, trains, airplanes, trucks, and ships;
  Power plants, including natural gas and coal-fired;
  Smelting operations;
  Area sources, such as housing tracts, biocides from agricultural operations, landfills, highways, fugitive dust sources, airports, oil and gas seeps, and ponds;
  Volume sources, including fugitive emissions from buildings and diesel construction combustion emissions;
  Small sources, including dry cleaners, gas stations, surface coating operations, plating facilities, medical device manufacturers, coffee roasters, ethylene oxide sterilizers, degreasing operations, foundries, and printing companies;
  Cooling towers and gas compressors;
  Diatomaceous earth, rock and gravel plants, and other mining operations;
  Offshore oil platforms, drilling rigs, and processing activities;
  Onshore oil and gas exploration, storage, processing, and transport facilities;
  Fugitive dust emissions from roads, wind erosion, and farming activities;
  Radionuclide emissions from actual and potential releases.
- I have extensive experience in modeling plume depletion and deposition from air releases of particulate emissions.
- As a senior scientist, I developed the Santa Barbara County Air Pollution Control District (SBAPCD) protocol on air quality modeling. I developed extensive modeling capabilities for the SBAPCD on VAX 8600 and Intel I-860 computer systems; I acted as systems analyst for the SBAPCD air quality modeling system; I served as director of air quality analyses for numerous major energy projects; I performed air quality impact analyses using inert and photochemical models, including EPA, ARB and private-sector models; I performed technical review and evaluating air quality and wind field models; I developed software to prepare model inputs consistent with the SBAPCD protocol on air quality modeling for OCD, OCDCPM, MPTER, COMPLEX-I/II and ISC.
- I provided detailed review and comments on the development of the Minerals Management Service OCD model. I developed the technical requirements for and

supervised the development of the OCDCPM model, a hybrid of the OCD, COMPLEX-I and MPTER models.

- I prepared the "Modeling Exposures of Hazardous Materials Released During Transportation Incidents" report for the California Office of Environmental Health Hazard Assessment (OEHHA). This report examines and rates the ADAM, ALOHA, ARCHIE, CASRAM, DEGADIS, HGSYSTEM, SLAB, and TSCREEN models for transportation accident consequence analyses of a priority list of 50 chemicals chosen by OEHHA. The report includes a model selection guide for adequacy of assessing priority chemicals, averaging time capabilities, isopleth generating capabilities, model limitations and concerns, and model advantages.
- I am experienced in assessing uncertainty in emission rate calculations, source release, and dispersion modeling. I have developed numerous probability distributions for input to Monte Carlo simulations, and I was a member of the External Advisory Group for the California EPA *Air Toxics Hot Spots Program Risk Assessment Guidelines, Part IV, Technical Support Document for Exposure Assessment and Stochastic Analysis*.

Health Risk Assessment

- I have prepared more than 300 health risk assessments of major air toxics sources. These assessments were prepared for AB 2588 (the Air Toxics "Hot Spots" Information and Assessment Act of 1987), Proposition 65, and other exposure analysis activities. More than 150 of these exposure assessments were prepared for Proposition 65 compliance verification in a litigation support setting.
- I reviewed approximately 300 other health risk assessments of toxic air pollution sources in California. The regulatory programs in this review include AB 2588, Proposition 65, the California Environmental Quality Act, and other exposure analysis activities. My clients include the California Attorney General's Office, the Los Angeles County District Attorney's Office, the SBAPCD, the South Coast Air Quality Management District, numerous environmental and community groups, and several plaintiff law firms.
- I am experienced in assessing public health risk from continuous, intermittent, and accidental releases of toxic emissions. I am experienced in generating graphical presentations of risk results, and characterizing risks from carcinogenic and acute and chronic noncarcinogenic pollutants.
- I am experienced in communicating adverse health risks discovered through the Proposition 65 and AB 2588 processes. I have presented risk assessment results in many public settings -- to industry, media, and the affected public.
- For four years, I was the Air Toxics Program Coordinator for the SBAPCD. My duties included: developing and managing the District air toxics program; supervising District staff assigned to the air toxics program; developing District air toxics rules, regulations, policies and procedures; management of all District air toxics efforts, including AB 2588, Proposition 65, and federal activities; developing and tracking the SBAPCD air toxics budget.
- I have prepared numerous calculations of exposures from indoor air pollutants. A few examples include: diesel PM_{10} inside school buses, formaldehyde inside temporary school buildings, lead from disturbed paint, phenyl mercuric acetate from water-based paints and drywall mud, and tetrachloroethene from recently dry-cleaned clothes.

Litigation Support

- I have prepared numerous analyses in support of litigation, both in Federal and State Courts. I am experienced in preparing F.R.C.P. Rule 26(a)(2) expert reports and providing deposition and trial testimony (I have prepared eight Rule 26 reports). Much of my work is focused on human dose and risk reconstruction resulting from multiple air emission sources (lifetime and specific events).

- I am experienced in preparing declarations (many dozens) and providing expert testimony in depositions and trials (see my testimony history).
- I am experienced in providing support for legal staff. I have assisted in preparing numerous interrogatories, questions for depositions, deposition reviews, various briefs and motions, and general consulting.
- Recent examples of my work include:
  DTSC v. Interstate Non-Ferrous; United States District Court, Eastern District of California (2002).
  In this case I performed air dispersion modeling, downwind soil deposition calculations, and resultant soil concentrations of dioxins (TCDD TEQ) from historical fires at a smelting facility. I prepared several Rule 26 Reports in my role of assisting the California Attorney General's Office in trying this matter.
  Akee v. Dow et al.; United States District Court, District of Hawaii (2003-2004).
  In this case I performed air dispersion modeling used to quantify air concentrations and reconstruct intake, dose, excess cancer risk, and noncancer chronic hazard indices resulting from soil fumigation activities on the island of Oahu, Hawaii. I modeled 319 separate AREAPOLY pineapple fields for the following chemicals: DBCP, EDB, 1,3-trichloropropene, 1,2-dichloropropane, and epichlorohydrin. I calculated chemical flux rates and modeled the emissions from these fumigants for years 1946 through 2001 (56 years) for 34 test plaintiffs and 97 distinct home, school, and work addresses. I prepared a Rule 26 Expert Report, successfully defended against Daubert challenges, and testified in trial.
  Lawrence O'Connor v. Boeing North America, Inc., United States District Court, Central District of California, Western Division (2004-2005).
  In this case I performed air dispersion modeling, quantified air concentrations, and reconstructed individual intake, dose, and excess cancer risks resulting from approximately 150 air toxics sources in Los Angeles and Ventura Counties, California. I prepared these analyses for years 1950 through 2000 (51 years) for 173 plaintiffs and 741 distinct home, school, and work addresses. I prepared several Rule 26 Reports, and the case settled on the eve of trial in September, 2005. Defendants did not attempt a Daubert challenge of my work.
- I have prepared scores of individual and region-wide health risk assessments in support of litigation. These analyses include specific sub-tasks, including: calculating emission rates, choosing proper meteorological data inputs, performing air dispersion modeling, and quantifying intake, dose, excess cancer risk, and acute/chronic noncancer health effects.
- I have prepared over 150 exposure assessments for Proposition 65 litigation support. In these analyses, my tasks include: reviewing AB 2588 risk assessments and other documents to assist in verifying compliance with Proposition 65; preparing exposure assessments consistent with Proposition 65 Regulations for carcinogens and reproductive toxicants; using a geographic information system (Atlas GIS) to prepare exposure maps that display areas of required warnings; calculating the number of residents and workers exposed to levels of risk requiring warnings (using the GIS); preparing declarations, providing staff support, and other expert services as required. I have also reviewed scores of other assessments for verifying compliance with Proposition 65. My proposition 65 litigation clients include the California Attorney General's Office, the Los Angeles County District Attorney's Office, As You Sow, California Community Health Advocates, Center for Environmental Health, California Earth Corps, Communities for a Better Environment, Environmental Defense Fund, Environmental Law Foundation, and People United for a Better Oakland.

Geographic Information Systems

- ArcGIS: I am experienced in preparing presentation and testimony maps using ArcView versions 3 through 9.3. I developed methods to convert AutoCAD DXF files to ArcView polygon theme shape files for use in map overlays.

- I have created many presentation maps with ArcView using MrSID DOQQ and other aerial photos as a base and then overlaying exposure regions. This provides a detailed view (down to the house level) of where air concentrations and health risks are projected to occur.
- Using ArcView, I have created numerous presentations using USGS Topographic maps (as TIFF files) as the base on to which exposure regions are overlaid.
- MapInfo for Windows: I prepared numerous presentation maps including exposure isopleths, streets and highways, and sensitive receptors, labels. I developed procedures for importing Surfer isopleths in AutoCAD DXF format as a layer into MapInfo.
- Atlas GIS: I am experienced in preparing presentation maps with both the Windows and DOS versions of Atlas GIS. In addition to preparing maps, I use Atlas GIS to aggregate census data (at the block group level) within exposure isopleths to determine the number of individuals living and working within exposure zones. I am also experienced in geocoding large numbers of addresses and performing statistical analyses of exposed populations.
- I am experienced in preparing large-scale graphical displays, both in hard-copy and for PowerPoint presentations. These displays are used in trial testimony, public meetings, and other litigation support.
- I developed a Fortran program to modify AutoCAD DXF files, including batch-mode coordinate shifting for aligning overlays to different base maps.

Ozone and Long-Range Transport

- I developed emission reduction strategies and identified appropriate offset sources to mitigate project emissions liability. For VOC offsets, I developed and implemented procedures to account for reactivity of organic compound species for ozone impact mitigation. I wrote Fortran programs and developed a chemical database to calculate ozone formation potential using hydroxyl radical rate constants and an alkane/non-alkane reactive organic compound method.
- I provided technical support to the Joint Interagency Modeling Study and South Central Coast Cooperative Aerometric Monitoring Program. With the SBAPCD, I provided technical comments on analyses performed with the EKMA, AIRSHED, and PARIS models. I was responsible for developing emissions inventory for input into regional air quality planning models.
- I was the CEQA project manager for the Santa Barbara County Air Quality Attainment Plan Environmental Impact Report (EIR). My duties included: preparing initial study; preparation and release of the EIR Notice of Preparation; conducting public scoping hearings to obtain comments on the initial study; managing contractor efforts to prepare the draft EIR.
- I modified, tested, and compiled the Fortran code to the MESOPUFF model (the precursor to CALPUFF) to incorporate critical dividing streamline height algorithms. The model was then applied as part of a PSD analysis for a large copper-smelting facility.
- I am experienced in developing and analyzing wind fields for use in long-range transport and dispersion modeling.
- I have run CALPUFF numerous times. I use CALPUFF to assess visibility effects and both near-field and mesoscale air concentrations from various emission sources, including power plants.

Emission Rate Calculations

- I developed methods to estimate and verify source emission rates using air pollution measurements collected downwind of the emitting facility, local meteorological data, and dispersion models. This technique is useful in determining whether reported source emission rates are reasonable, and based on monitored and modeled air concentrations, revised emission rates can be created.

- I am experienced in developing emission inventories of hundreds of criteria and toxic air pollutant sources. I developed procedures and programs for quantifying emissions from many air emission sources, including: landfills, diesel exhaust sources, natural gas combustion activities, fugitive hydrocarbons from oil and gas facilities, dry cleaners, auto body shops, and ethylene oxide sterilizers.
- I have calculated flux rates (and modeled air concentrations) from hundreds of biocide applications to agricultural fields. Emission sources include aerial spraying, boom applications, and soil injection of fumigants.
- I am experienced in calculating emission rates using emission factors, source-test results, mass-balance equations, and other emission estimating techniques.
- I have been qualified in Federal court to provide opinions on calculating emission rates from fugitive sources of particulate matter.

Software Development

- I am skilled in computer operation and programming, with an emphasis on Fortran 95.
- I am experienced with numerous USEPA dispersion models, modifying them for system-specific input and output, and compiling the code for personal use and distribution. I own and am experienced in using the following Fortran compilers: Lahey Fortran 95, Lahey Fortran 90 DOS-Extended; Lahey F77L-EM32 DOS-Extended; Microsoft PowerStation 32-bit DOS-Extended; and Microsoft 16-bit.
- I configured and operated an Intel I-860 based workstation for the SBAPCD toxics program. I created control files and recoded programs to run dispersion models and risk assessments in the 64-bit I-860 environment (using Portland Group Fortran).
- Using Microsoft Fortran PowerStation, I wrote programs to extract terrain elevations from both 10-meter and 30-meter USGS DEM files. Using a file of discrete x,y coordinates, these programs extract elevations within a user-chosen distance for each x,y pair. The code I wrote can be run in steps or batch mode, allowing numerous DEM files to be processed at once.
- I have written many hundreds of utilities to facilitate data processing, entry, and quality assurance. These utility programs are a “tool chest” from which I can draw upon to expedite my work.
- While at the SBAPCD, I designed the ACE2588 model - the first public domain multi-source, multi-pathway, multi-pollutant risk assessment model. I co-developed the structure of the ACE2588 input and output files, supervised the coding of the model, tested the model for quality assurance, and for over 10 years I provided technical support to about 200 users of the model. I was responsible for updating the model each year and ensuring that it is consistent with California Air Pollution Control Officer’s Association (CAPCOA) Risk Assessment Guidelines.
- I developed and coded the ISC2ACE and ACE2 programs for distribution by CAPCOA. These programs were widely used in California for preparing AB 2588 and other program health risk assessments. ISC2ACE and ACE2 contain "compression" algorithms to reduce the hard drive and RAM requirements compared to ISCST2/ACE2588. I also developed ISC3ACE/ACE3 to incorporate the revised ISCST3 dispersion model requirements.
- I developed and coded the "HotSpot" system - a series of Fortran programs to expedite the review of air toxics emissions data, to prepare air quality modeling and risk assessment inputs, and to prepare graphical risk presentations.
- I customized ACE2588 and developed a mapping system for the SBAPCD. I modified the ACE2588 Fortran code to run on an Intel I-860 RISC workstation; I updated programs that allow SBAPCD staff to continue to use the "HotSpot" system – a series of programs that streamline preparing AB 2588 risk assessments; I developed a risk assessment mapping system based on MapInfo for Windows which linked the MapInfo mapping package to the "HotSpot" system.
- I developed software for electronic submittal of all AB 2588 reporting requirements for the SBAPCD. As an update to the "HotSpot" system software, I created software that

allows facilities to submit all AB 2588 reporting data, including that needed for risk prioritization, exposure assessment, and presentation mapping. The data submitted by the facility is then reformatted to both ATDIF and ATEDS formats for transmittal to the California Air Resources Board.

- I developed and coded Fortran programs for AB 2588 risk prioritization; both batch and interactive versions of the program were created. These programs were used by several air pollution control districts in California.

Air Quality and Meteorological Monitoring

- I was responsible for the design, review, and evaluation of an offshore source tracer gas study. This project used both inert tracer gas and a visible release to track the onshore trajectory and terrain impaction of offshore-released buoyant plumes.
- I developed the technical requirements for the Santa Barbara County Air Quality/Meteorological Monitoring Protocol. I developed and implemented the protocol for siting pre- and post-construction air quality and meteorological PSD monitoring systems. I determined the instrumentation requirements, and designed and sited over 30 such PSD monitoring systems. Meteorological parameters measured included ambient temperature, wind speed, wind direction, sigma-theta (standard deviation of horizontal wind direction fluctuations), sigma-phi (standard deviation of vertical wind direction fluctuations), sigma-v (standard deviation of horizontal wind speed fluctuations), and sigma-w (standard deviation of vertical wind speed fluctuations). Air pollutants measured included PM_{10}, SO_2, NO, NO_x, NO_2, CO, O_3, and H_2S.
- I was responsible for data acquisition and quality assurance for an offshore meteorological monitoring station. Parameters measured included ambient temperature (and delta-T), wind speed, wind direction, and sigma-theta.
- In coordination with consultants performing air monitoring for verifying compliance with Proposition 65 and other regulatory programs, I wrote software to convert raw meteorological data to hourly-averaged values formatted for dispersion modeling input.
- Assisting the Ventura Unified School District, I collected air, soil, and surface samples and had them analyzed for chlorpyrifos contamination (caused by spray drift from a nearby citrus orchard). I also coordinated the analysis of the samples, and presented the results in a public meeting.
- Using summa canisters, I collected numerous VOC samples to characterize background and initial conditions for use in Santa Barbara County ozone attainment modeling. I also collected samples of air toxics (such as xylenes downwind of a medical device manufacturer) to assist in enforcement actions.
- For the California Attorney General's Office, I purchased, calibrated, and operated a carbon monoxide monitoring system. I measured and reported CO air concentrations resulting from numerous types of candles, gas appliances, and charcoal briquettes.

Support, Training, and Instruction

- For 10 years, I provided ACE2588 risk assessment model support for CAPCOA. My tasks included: updating the ACE2588 risk assessment model Fortran code to increase user efficiency and to maintain consistency with the CAPCOA Risk Assessment Guidelines; modifying the Fortran code to the EPA ISC model to interface with ACE2588; writing utility programs to assist ACE2588 users; updating toxicity data files to maintain consistency with the CAPCOA Risk Assessment Guidelines; developing the distribution and installation package for ACE2588 and associated programs; providing technical support for all users of ACE2588.
- I instructed approximately 20 University Professors through the National Science Foundation Faculty Enhancement Program. Instruction topics included: dispersion modeling, meteorological data, environmental fate analysis, toxicology of air pollutants, and air toxics risk assessment; professors were also trained on the use of the ISC2ACE dispersion model and the ACE2 exposure assessment model.

- I was the instructor of the Air Pollution and Toxic Chemicals course for the University of California, Santa Barbara, Extension certificate program in Hazardous Materials Management. Topics covered in this course include: detailed review of criteria and noncriteria air pollutants; air toxics legislation and regulations; quantifying toxic air contaminant emissions; criteria and noncriteria pollutant monitoring; air quality modeling; health risk assessment procedures; health risk management; control/mitigating air pollutants; characteristics and modeling of spills and other short-term releases of air pollutants; acid deposition, precipitation and fog; indoor/occupational air pollution; the effect of chlorofluorocarbons on the stratospheric ozone layer. I taught this course for five years.
- I have trained numerous regulatory staff on the mechanics of dispersion modeling, health risk assessments, emission rate calculations, and presentation mapping. I provided detailed training to SBAPCD staff in using the HARP program, and in comparing and contrasting ACE2588 analyses to HARP.
- Through UCSB Extension, I taught a three-day course on dispersion modeling, preparing health risk assessments, and presentation mapping with Atlas GIS and MapInfo.
- I hold a lifetime California Community College Instructor Credential (Certificate No. 14571); Subject Matter Area: Physics.
- I have presented numerous guest lectures – at universities, public libraries, farm groups, and business organizations.

Indoor Air Quality

- I prepared mercury exposure assessments caused by applying indoor latex paints containing phenylmercuric acetate as a biocide.
- Using a carbon monoxide monitor, I examined CO concentrations inside rooms of varying sizes and with a range of ventilation rates. Indoor sources of CO emissions included gas appliances and candles. I also examined CO concentrations within parking garages.
- I calculated air concentrations of tetrachloroethene inside homes and cars from offgassing dry-cleaned clothes.
- I examined air concentrations of formaldehyde inside manufactured homes and school buildings. I also calculated formaldehyde exposures from carpet emissions within homes.
- I assessed lead air exposures and surface deposition from deteriorating lead-based paint applications within apartments. I also calculated lead air concentrations and associated exposures resulting from milling of brass pipes and fittings.
- While employed by the SBAPCD, I assisted with exposure assessment and awareness activities for Santa Barbara County high-exposure radon areas.
- I calculated BTEX air concentrations and health risks inside homes from leaking underground fuel tanks and resultant contaminated soil plumes. I also assessed indoor VOC exposures and remediation options with the AERIS model.
- I have assessed indoor air concentrations from numerous volatile organic compound sources, including printing operations, microprocessor manufacturing, and solvent degreasing activities.
- I calculated indoor emission flux rates and air concentrations of elemental mercury for plaintiff litigation support purposes. This analysis included an exposure reconstruction (home, school, workplace, outside, and other locations) for 16 plaintiffs who had collected spilled mercury in their village. The study required room volume calculations, air exchange rates, exposure history reconstruction, mercury quantity and droplet size estimation, elemental mercury flux rate calculations (including decay with time), and resultant air concentration calculations. I calculated both peak acute (two-hour) and 24-hour average concentrations.
- I calculated emission rates of lead from disturbed paint surfaces. I then calculated indoor air concentrations of lead for plaintiff litigation support purposes.

Publications

- To establish a legal record and to assist in environmental review, I prepared and submitted dozens of detailed comment letters to regulatory and decision-making bodies.
- I have contributed to over 100 Environmental Impact Statements/Reports and other technical documents required for regulatory decision-making.
- I prepared two software review columns for the *Journal of the Air and Waste Management Association*.
- Correlations of total, diffuse, and direct solar radiation with the percentage of possible sunshine for Davis, California. Solar Energy, 27(4):357-360 (1981).

Employment History

• Self-Employed Air Quality Consultant	1992 to 2018
• Santa Barbara County APCD, Senior Scientist	1988 to 1992
• URS Consultants, Senior Scientist	1987 to 1988
• Santa Barbara County APCD, Air Quality Engineer	1983 to 1987
• Dames and Moore, Meteorologist	1982 to 1983
• UC Davis, Research Associate	1980 to 1981

Testimony History

- People of the State of California v. McGhan Medical, Inc.
  Deposition: Two dates: June - July 1990
- People of the State of California v. Santa Maria Chili
  Deposition: Two dates: August 1990
- California Earth Corps v. Johnson Controls, Inc.
  Deposition: October 26, 1995
- Larry Dale Anderson v. Pacific Gas & Electric
  Deposition: January 4, 1996
  Arbitration: January 17, 1996
- Adams v. Shell Oil Company
  Deposition: July 3, 1996
  Trial: August 21, 1996
  Trial: August 22, 1996
- California Earth Corps v. Teledyne Battery Products
  Deposition: January 17, 1997
- Marlene Hook v. Lockheed Martin Corporation
  Deposition: December 15, 1997
- Lawrence O’Connor v. Boeing North America, Inc.
  Deposition: May 8, 1998
- Bristow v. Tri Cal
  Deposition: June 15, 1998
- Abeyta v. Pacific Refining Co.
  Deposition: January 16, 1999
  Arbitration: January 25, 1999
- Danny Aguayo v. Betz Laboratories, Inc.
  Deposition: July 10, 2000
  Deposition: July 11, 2000
- Marlene Hook v. Lockheed Martin Corporation
  Deposition: September 18, 2000
  Deposition: September 19, 2000
- Tressa Haddad v. Texaco
  Deposition: March 9, 2001

- California DTSC v. Interstate Non-Ferrous
  United States District Court, Eastern District of California,
  Case No. CV-F-97 50160 OWW LJO
  - Deposition: April 18, 2002
- Akee v. Dow et al.
  United States District Court, District of Hawaii,
  Case No. CV 00 00382 BMK
  - Deposition: April 16, 2003
  - Deposition: April 17, 2003
  - Deposition: January 7, 2004
  - Trial: January 17, 2004
  - Trial: January 20, 2004
- Center for Environmental Health v. Virginia Cleaners
  Superior Court of the State of California
  County of Alameda, Case No. 2002 07 6091
  - Deposition: March 4, 2004
- Application for Certification for Small Power Plant Exemption – Riverside Energy Resource Center. Docket No. 04-SPPE-01.
  - Evidentiary Hearing Testimony before the California Energy Resource Conservation And Development Commission: August 31, 2004
- Lawrence O'Connor v. Boeing North America, Inc.
  United States District Court, Central District of California,
  Western Division. Case No. CV 97-1554 DT (RCx)
  - Deposition: March 1, 2005
  - Deposition: March 2, 2005
  - Deposition: March 3, 2005
  - Deposition: March 15, 2005
  - Deposition: April 25, 2005
- Clemente Alvarez, et al, v. Western Farm Service, Inc.
  Superior Court of the State of California
  County of Kern, Metropolitan Division. Case No. 250 621 AEW
  - Deposition: April 11, 2005
- Gary June et al. v. Union Carbide Corporation & UMETCO Minerals Corporation
  United States District Court, District of Colorado,
  Case No. 04-CV-00123 MSK-MJW
  - Deposition: January 9, 2007
- Alberto Achas Castillo, et al. v. Newmont Mining Corporation, et al.
  District Court, Denver County, Colorado,
  Case No. 01-CV-4453
  - Deposition: February 19, 2007
  - Deposition: February 20, 2007
  - Arbitration: March 6, 2007
  - Arbitration: March 7, 2007
- Jacobs Farm/Del Cabo Inc. v. Western Farm Service, Inc.
  Superior Court of the State of California
  County of Santa Cruz, Case No. CV 157041
  - Deposition: May 8, 2008
  - Deposition: August 26, 2008
  - Trial: September 18, 2008
  - Trial: September 24, 2008

- Environmental Law Foundation et al. v. Laidlaw Transit Inc. et al.
  Superior Court of the State of California
  County of San Francisco, Case No. CGC-06-451832
  Deposition: July 8, 2008
- Application of NRG Texas Power, LLC for State Air Quality Permit No. 79188
  and Prevention of Significant Deterioration Air Quality Permit PSD-TX-1072.
  State Office of Administrative Hearings Docket No. 582-08-0861;
  TCEQ Docket No. 2007-1820-AIR.
  Deposition: February 12, 2009
  Hearing: February 24, 2009
- Application of IPA Coleto Creek, LLC for State Air Quality Permit No. 83778
  and Prevention of Significant Deterioration Air Quality Permit PSD-TX-1118 and for Hazardous Air Pollutant Major Source [FCAA § 112(G)] Permit HAP-14.
  State Office of Administrative Hearings Docket No. 582-09-2045;
  TCEQ Docket No. 2009-0032-AIR.
  Deposition: September 21, 2009
  Hearing: October 16, 2009
- Application of Las Brisas Energy Center, LLC for State Air Quality Permit No. 85013
  and Prevention of Significant Deterioration Air Quality Permit PSD-TX-1138 and for Hazardous Air Pollutant Major Source [FCAA § 112(G)] Permit HAP-48 and Plantwide Applicability Permit PAL41.
  State Office of Administrative Hearings Docket No. 582-09-2005;
  TCEQ Docket No. 2009-0033-AIR.
  Deposition: October 9, 2009
  Hearing: November 5, 2009
  Hearing: November 6, 2009
- Abarca, Raul Valencia, et al. v. Merck & Co., Inc., et al.
  United States District Court, Eastern District of California,
  Case No. 1:07-CV-00388-OWW-DLB
  Phase 1 Deposition: April 13, 2010
  Daubert Hearing: October 7, 2010
  Daubert Hearing: October 13, 2010
  Daubert Hearing: October 14, 2010
  Rule 706 Expert Hearing: December 2, 2010
  Phase 1 Trial: February 10, 2011
  Phase 2 Deposition: September 19, 2012
- Commonwealth of Kentucky, Energy and Environment Cabinet, File No. DAQ-41109-048. Sierra Club, Kentucky Environmental Foundation, and Kentuckians for the Commonwealth v. Energy and Environment Cabinet, Division for Air Quality, and East Kentucky Power Cooperative, Inc.
  Deposition: August 31, 2010
- Dorsey, Michael J., et al. v. Mid-Pacific Country Club
  First District Court, State of Hawaii
  Case No. 12-1-0158-01
  Deposition: November 17, 2013
- Global Community Monitor, et al. v. Lumber Liquidators, Inc. et al.
  Superior Court of the State of California
  County of Alameda. Case No. RG14733979
  Deposition: January 8, 2016
  Deposition: March 1, 2016

- Scott D. McClurg, et al. v. Mallinckrodt, Inc., et al.
  United States District Court, Eastern District of Missouri, Eastern Division
  Case No. 4:12-CV-00361-AGF
    Deposition: July 12, 2017
    Deposition: July 13, 2017
    Deposition: September 27, 2017

Exhibit B:

Diesel Particulate Matter Health Risk Assessment
Emission Rate Inputs and Risk Calculations

9-Year Excess Cancer Risk
From Exposure to 1.0 ug/m^3 DPM
First 9-Years of Life

DPM	3rd Trimester	0<2 years	2<9 years	2<16 years	16<30 years	16<70 years
Mean inh (m^3/kg-day)	0.225	0.658	0.535	0.452	0.210	0.185
95% inh (m^3/kg-day)	0.361	1.090	0.861	0.745	0.335	0.290
Age Sensitivity Factor	10.0	10.0	3.0	3.0	1.0	1.0
Duration (years)	0.25	2.0	7.0	14.0	14.0	54.0
FAH (% at home)	1.00	1.00	1.00	1.00	0.73	0.73
CPF ((mg/(kg-day))$^{-1}$	1.1					
URV (µg/m^3)$^{-1}$	3.00E-04					
chi (µg/m^3)	1.00E+00					
ECR	3.00E-04					

Year	ECR for year
1	1.71E-04
2	1.71E-04
3	4.06E-05
4	4.06E-05
5	4.06E-05
6	4.06E-05
7	4.06E-05
8	4.06E-05
9	4.06E-05
9-yr total:	6.27E-04

95% tile inh	3rd Trimester	0<2 years	2<9 years	2<16 years	16<30 years	16<70 years	ECR
Dose-air (mg/(kg-day))	3.61E-04	1.09E-03	8.61E-04	7.45E-04	2.45E-04	2.12E-04	
ECR - AB2588 9-yr	1.42E-05	3.43E-04	2.84E-04				6.41E-04
ECR - AB2588 30-yr	1.42E-05	3.43E-04		4.92E-04	5.38E-05		9.02E-04
ECR - AB2588 70-yr	1.42E-05	3.43E-04		4.92E-04		1.80E-04	1.03E-03
Adult ECR - no ASF	8.32E-07	6.65E-06		4.66E-05		1.80E-04	2.34E-04

Hoteling Aux Gen DPM Emissions
and Excess Cancer Risk Post-Processing Inputs

SRCGRP	SRCRNG	NSRC	DPM (lb/yr)	DPM (g/s) per source	9-yr risk sum from 1.0 µg/m^3 DPM:	Total multiplier for 9-yr per million ECR Output
All	SHPHTAX1-SHPHTAX2	2	511.344	3.67747E-03	6.27E-04	2.306
	SHPHTAX1	1	511.344	7.35495E-03	6.27E-04	4.612

Exhibit C:

AERMOD Input Files
BPIP Input and Output Files

```
CO STARTING
CO TITLEONE VMT/Orcem Hotel Aux DPM, Per chioq, dpm-aux.inp, cms, 10/16/2018
CO TITLETWO 2007-2012 CP Rodeo met
CO MODELOPT DFAULT  CONC
CO RUNORNOT RUN
CO AVERTIME 1 period
CO POLLUTID PM
CO FLAGPOLE 1.5
CO FINISHED

SO STARTING
SO ELEVUNIT meters
** Hotelling aux only
SO INCLUDED ogv-aux.src
SO SRCGROUP all
SO FINISHED

RE STARTING
RE ELEVUNIT meters
** ROA receptors
RE INCLUDED receptors.rec
RE FINISHED

ME STARTING
** ROA met
ME SURFFILE CPRODEO_2007_12.SFC
ME PROFFILE CPRODEO_2007_12.PFL
ME SURFDATA 23254 2007 CPR
ME UAIRDATA 23230 2007
ME SITEDATA 2771  2007
ME PROFBASE 10.7  METERS
ME FINISHED

OU STARTING
OU FILEFORM EXP
OU RECTABLE allave first
OU PLOTFILE period all dpm-aux.plt  31
OU FINISHED
```

```
CO STARTING
CO TITLEONE VMT/Orcem Hotel Aux DPM, Per chioq, dpm-aux1.inp, cms, 10/16/2018
CO TITLETWO 2007-2012 CP Rodeo met
** VS = 7.5 m/s (ROA = 25 m/s)
CO MODELOPT DFAULT  CONC
CO RUNORNOT RUN
CO AVERTIME 1 period
CO POLLUTID PM
CO FLAGPOLE 1.5
CO FINISHED

SO STARTING
SO ELEVUNIT meters
** Hotelling aux only
SO INCLUDED ogv-aux1.src
SO SRCGROUP all
SO FINISHED

RE STARTING
RE ELEVUNIT meters
** ROA receptors
RE INCLUDED receptors.rec
RE FINISHED

ME STARTING
** ROA met
ME SURFFILE CPRODEO_2007_12.SFC
ME PROFFILE CPRODEO_2007_12.PFL
ME SURFDATA 23254 2007 CPR
ME UAIRDATA 23230 2007
ME SITEDATA 2771  2007
ME PROFBASE 10.7  METERS
ME FINISHED

OU STARTING
OU FILEFORM EXP
OU RECTABLE allave first
OU PLOTFILE period all dpm-aux1.plt  31
OU FINISHED
```

```
CO STARTING
CO TITLEONE VMT/Orcem Hotel Aux DPM, Per chioq, dpm-aux2.inp, cms, 10/17/2018
CO TITLETWO 2007-2012 CP Rodeo met
** VS = 7.5 m/s (ROA = 25 m/s); with DW
CO MODELOPT DFAULT  CONC
CO RUNORNOT RUN
CO AVERTIME 1 period
CO POLLUTID PM
CO FLAGPOLE 1.5
CO FINISHED

SO STARTING
SO ELEVUNIT meters
** Hotelling SHPHTAX1 only
SO INCLUDED ogv-aux2.src
SO INCLUDED handymax1.dw
SO SRCGROUP all
SO FINISHED

RE STARTING
RE ELEVUNIT meters
** ROA receptors
RE INCLUDED receptors.rec
RE FINISHED

ME STARTING
** ROA met
ME SURFFILE CPRODEO_2007_12.SFC
ME PROFFILE CPRODEO_2007_12.PFL
ME SURFDATA 23254 2007 CPR
ME UAIRDATA 23230 2007
ME SITEDATA 2771  2007
ME PROFBASE 10.7  METERS
ME FINISHED

OU STARTING
OU FILEFORM EXP
OU RECTABLE allave first
OU PLOTFILE period all dpm-aux2.plt  31
OU FINISHED
```

```
CO STARTING
CO TITLEONE VMT/Orcem Hotel Aux DPM, Per chioq, dpm-aux3.inp, cms, 10/17/2018
CO TITLETWO 2007-2012 CP Rodeo met
** VS = 7.5 m/s (ROA = 25 m/s); with DW; both SHPHTAX orientations
CO MODELOPT DFAULT  CONC
CO RUNORNOT RUN
CO AVERTIME 1 period
CO POLLUTID PM
CO FLAGPOLE 1.5
CO FINISHED

SO STARTING
SO ELEVUNIT meters
** Hotelling SHPHTAX1 and SHPHTAX2 orientations
SO INCLUDED ogv-aux1.src
SO INCLUDED handymax1.dw
SO INCLUDED handymax2.dw
SO SRCGROUP all
SO FINISHED

RE STARTING
RE ELEVUNIT meters
** ROA receptors
RE INCLUDED receptors.rec
RE FINISHED

ME STARTING
** ROA met
ME SURFFILE CPRODEO_2007_12.SFC
ME PROFFILE CPRODEO_2007_12.PFL
ME SURFDATA 23254 2007 CPR
ME UAIRDATA 23230 2007
ME SITEDATA 2771  2007
ME PROFBASE 10.7  METERS
ME FINISHED

OU STARTING
OU FILEFORM EXP
OU RECTABLE allave first
OU PLOTFILE period all dpm-aux3.plt  31
OU FINISHED
```

ogv-aux.src:

```
SO LOCATION  SHPHTAX1  POINT     566130.4  4214886  0
** SRCDESCR  ship auxiliary engine1
SO LOCATION  SHPHTAX2  POINT     566033.9  4215026  0
** SRCDESCR  ship auxiliary engine 2

SO SRCPARAM  SHPHTAX1  1.000  25.0  555.15  25.0  0.8
SO SRCPARAM  SHPHTAX2  1.000  25.0  555.15  25.0  0.8
```

ogv-aux1.src:

```
SO LOCATION  SHPHTAX1  POINT     566130.4  4214886  0
** SRCDESCR  ship auxiliary engine1
SO LOCATION  SHPHTAX2  POINT     566033.9  4215026  0
** SRCDESCR  ship auxiliary engine 2

SO SRCPARAM  SHPHTAX1  1.000  25.0  555.15  7.5  0.8
SO SRCPARAM  SHPHTAX2  1.000  25.0  555.15  7.5  0.8
```

ogv-aux2.src:

```
SO LOCATION  SHPHTAX1  POINT     566130.4  4214886  0
** SRCDESCR  ship auxiliary engine1
**SO LOCATION  SHPHTAX2  POINT     566033.9  4215026  0
** SRCDESCR  ship auxiliary engine 2

SO SRCPARAM  SHPHTAX1  1.000  25.0  555.15  7.5  0.8
**SO SRCPARAM  SHPHTAX2  1.000  25.0  555.15  7.5  0.8
```

handymax1.inp:

```
'Handymax stack 1 orientation; cms 10/17/2018'
'p'
'METERS' 1.0
'UTMY' 0.00
1
'BLDG1'      2        0.0
 4       14.0
566118.1    4214863.5
566144.5    4214879.9
566037.9    4215038.1
566010.8    4215021.0
 4       20.0
566118.1    4214863.5
566144.5    4214879.9
566128.3    4214907.5
566102.6    4214889.5
 1
'SHPHTAX1'     0.0  25.00  566130.4  4214886.0
 0
```

handymax1.dw:

```
SO BUILDHGT SHPHTAX1   20.00   20.00   20.00   20.00   20.00   20.00
SO BUILDHGT SHPHTAX1   20.00   20.00   20.00   20.00   20.00   20.00
SO BUILDHGT SHPHTAX1   20.00   20.00   20.00   20.00   20.00   20.00
SO BUILDHGT SHPHTAX1   20.00   20.00   20.00   20.00   20.00   20.00
SO BUILDHGT SHPHTAX1   20.00   20.00   20.00   20.00   20.00   20.00
SO BUILDHGT SHPHTAX1   20.00   20.00   20.00   20.00   20.00   20.00
SO BUILDWID SHPHTAX1   42.93   42.66   41.09   38.27   34.29   33.01
SO BUILDWID SHPHTAX1   37.86   41.56   44.00   45.10   44.84   43.21
SO BUILDWID SHPHTAX1   40.26   36.10   31.49   36.09   39.60   41.90
SO BUILDWID SHPHTAX1   42.93   42.66   41.09   38.27   34.29   33.01
SO BUILDWID SHPHTAX1   37.86   41.56   44.00   45.10   44.84   43.21
SO BUILDWID SHPHTAX1   40.26   36.10   31.49   36.09   39.60   41.90
SO BUILDLEN SHPHTAX1   45.10   44.84   43.21   40.26   36.10   31.49
SO BUILDLEN SHPHTAX1   36.09   39.60   41.90   42.93   42.66   41.09
SO BUILDLEN SHPHTAX1   38.27   34.29   33.01   37.86   41.56   44.00
SO BUILDLEN SHPHTAX1   45.10   44.84   43.21   40.26   36.10   31.49
SO BUILDLEN SHPHTAX1   36.09   39.60   41.90   42.93   42.66   41.09
SO BUILDLEN SHPHTAX1   38.27   34.29   33.01   37.86   41.56   44.00
SO XBADJ    SHPHTAX1  -24.29  -25.35  -25.64  -25.14  -23.89  -22.33
SO XBADJ    SHPHTAX1  -24.93  -26.77  -27.80  -27.99  -27.32  -25.83
SO XBADJ    SHPHTAX1  -23.55  -20.55  -19.67  -20.92  -21.54  -21.50
SO XBADJ    SHPHTAX1  -20.81  -19.49  -17.57  -15.12  -12.21   -9.16
SO XBADJ    SHPHTAX1  -11.16  -12.83  -14.10  -14.95  -15.34  -15.26
SO XBADJ    SHPHTAX1  -14.72  -13.74  -13.34  -16.94  -20.02  -22.50
SO YBADJ    SHPHTAX1    6.52    5.99    5.28    4.41    3.41    3.17
SO YBADJ    SHPHTAX1    1.99    0.76   -0.50   -1.74   -2.93   -4.03
SO YBADJ    SHPHTAX1   -5.01   -5.84   -6.58   -6.88   -6.97   -6.85
SO YBADJ    SHPHTAX1   -6.52   -5.99   -5.28   -4.41   -3.41   -3.17
SO YBADJ    SHPHTAX1   -1.99   -0.76    0.50    1.74    2.93    4.03
SO YBADJ    SHPHTAX1    5.01    5.84    6.58    6.88    6.97    6.85
```

handymax2.inp:

```
'Handymax stack 2 orientation; cms 10/17/2018'
'p'
'METERS' 1.0
'UTMY' 0.00
1
'BLDG1'      2        0.0
 4       14.0
566118.1    4214863.5
566144.5    4214879.9
566037.9    4215038.1
566010.8    4215021.0
 4       20.0
566028.6    4214996.3
566056.1    4215012.7
566037.9    4215038.1
566010.8    4215021.0
 1
'SHPHTAX2'     0.0  25.00  566033.9  4215026.0
 0
```

handymax2.dw:

```
SO BUILDHGT SHPHTAX2   20.00   20.00   20.00   20.00   20.00   20.00
SO BUILDHGT SHPHTAX2   20.00   20.00   20.00   20.00   20.00   20.00
SO BUILDHGT SHPHTAX2   20.00   20.00   20.00   20.00   20.00   20.00
SO BUILDHGT SHPHTAX2   20.00   20.00   20.00   20.00   20.00   20.00
SO BUILDHGT SHPHTAX2   20.00   20.00   20.00   20.00   20.00   20.00
SO BUILDHGT SHPHTAX2   20.00   20.00   20.00   20.00   20.00   20.00
SO BUILDWID SHPHTAX2   46.05   45.41   43.38   40.04   35.48   31.55
SO BUILDWID SHPHTAX2   36.10   39.55   41.80   42.78   42.46   40.85
SO BUILDWID SHPHTAX2   38.00   33.99   35.08   39.73   43.17   45.30
SO BUILDWID SHPHTAX2   46.05   45.41   43.38   40.04   35.48   31.55
SO BUILDWID SHPHTAX2   36.10   39.55   41.80   42.78   42.46   40.85
SO BUILDWID SHPHTAX2   38.00   33.99   35.08   39.73   43.17   45.30
SO BUILDLEN SHPHTAX2   42.78   42.46   40.85   38.00   33.99   35.08
SO BUILDLEN SHPHTAX2   39.73   43.17   45.30   46.05   45.41   43.38
SO BUILDLEN SHPHTAX2   40.04   35.48   31.55   36.10   39.55   41.80
SO BUILDLEN SHPHTAX2   42.78   42.46   40.85   38.00   33.99   35.08
SO BUILDLEN SHPHTAX2   39.73   43.17   45.30   46.05   45.41   43.38
SO BUILDLEN SHPHTAX2   40.04   35.48   31.55   36.10   39.55   41.80
SO XBADJ    SHPHTAX2  -30.17  -29.72  -28.37  -26.16  -23.15  -22.51
SO XBADJ    SHPHTAX2  -23.42  -23.62  -23.10  -21.88  -20.00  -17.51
SO XBADJ    SHPHTAX2  -14.48  -11.02   -8.48  -10.00  -11.22  -12.10
SO XBADJ    SHPHTAX2  -12.61  -12.74  -12.48  -11.84  -10.84  -12.58
SO XBADJ    SHPHTAX2  -16.31  -19.55  -22.20  -24.17  -25.41  -25.88
SO XBADJ    SHPHTAX2  -25.56  -24.46  -23.07  -26.10  -28.33  -29.70
SO YBADJ    SHPHTAX2   -1.15   -2.71   -4.19   -5.54   -6.72   -7.30
SO YBADJ    SHPHTAX2   -8.05   -8.55   -8.80   -8.78   -8.49   -7.95
SO YBADJ    SHPHTAX2   -7.16   -6.15   -4.96   -3.55   -2.03   -0.45
SO YBADJ    SHPHTAX2    1.15    2.71    4.19    5.54    6.72    7.30
SO YBADJ    SHPHTAX2    8.05    8.55    8.80    8.78    8.49    7.95
SO YBADJ    SHPHTAX2    7.16    6.15    4.96    3.55    2.03    0.45
```

Exhibit D:

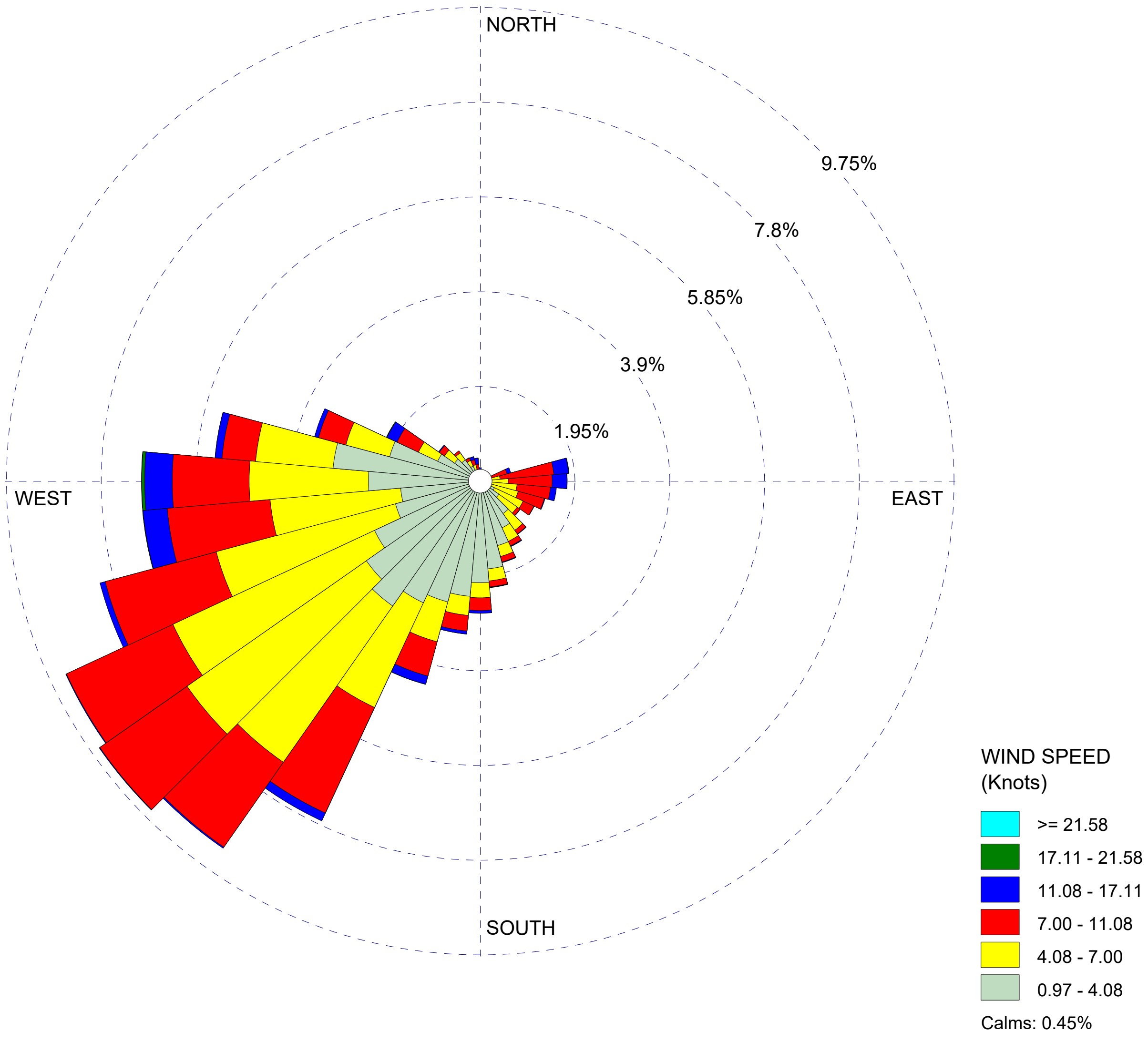
Meteorological Data Wind Roses

WIND ROSE PLOT:

Surface met: Conoco Phillips Rodeo Refinery
Upper air: KOAK (Oakland, CA)

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:

AERMET 14134

DATA PERIOD:

Start Date: 1/1/2007 - 00:00
End Date: 12/31/2012 - 23:59

COMPANY NAME:

MODELER:

CALM WINDS:

0.45%

TOTAL COUNT:

43824 hrs.

AVG. WIND SPEED:

5.27 Knots

DATE:

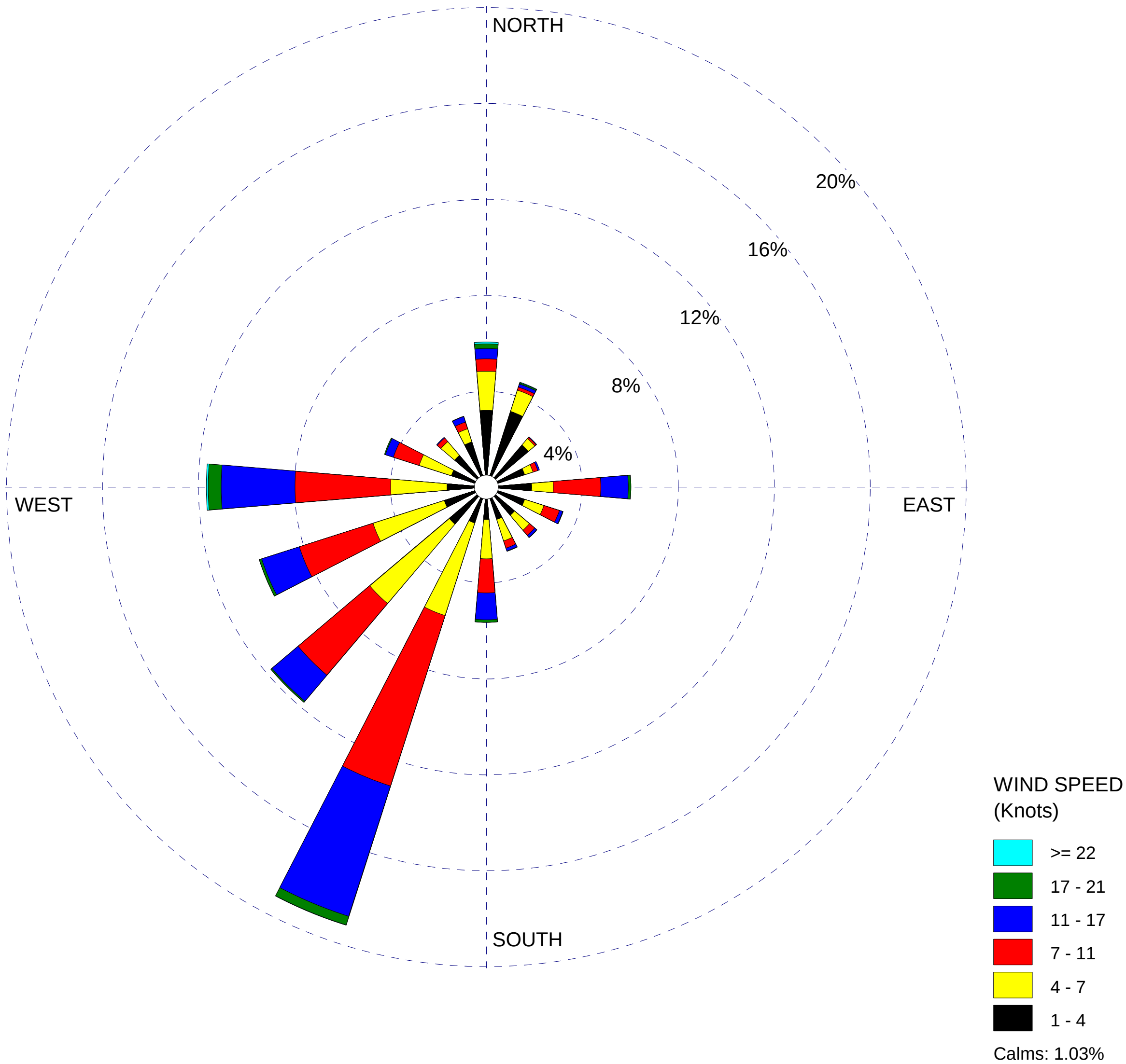
10/24/2018

PROJECT NO.:

WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:

Surface met: KAPC (Napa County Airport)
Upper air: KOAK (Oakland, CA)



COMMENTS:	DATA PERIOD:		
AERMET v. 15181; AERMINUTE v. 14337	**2010-2014** **Jan 1 - Dec 31** **00:00 - 23:00**		
	CALM WINDS: **1.03%**	TOTAL COUNT: **43745 hrs.**	
	AVG. WIND SPEED: **6.95 Knots**		PROJECT NO.:

WRPLOT View - Lakes Environmental Software