Technical Memorandum

TO: Ranil Dhammapala and Clint Bowman, Washington State Department of Ecology

FROM: Christel Olsen and Mark Brunner

DATE: February 25, 2016

RE: **Air Dispersion Modeling Protocol**
Vantage Data Center
Quincy, Washington

Introduction

This technical memorandum presents our proposed air dispersion modeling approach to support a Notice of Construction (NOC) air permit application for Vantage Data Centers' (Vantage) facility in Quincy, Washington. The NOC application—to be submitted to the Washington State Department of Ecology (Ecology)—will propose a modification to Approval Order No. 12AQ-E450 (Approval Order). This protocol establishes the modeling techniques and other factors that may affect the results of the ambient air dispersion impact analysis. We would appreciate Ecology's review of this protocol and any feedback on the methods proposed.

Source Characteristics

Vantage is permitted to build a data center complex located at 2101 M Street NE in Quincy, Washington. At full build-out, the facility would be composed of five buildings (one office building and four buildings to house the server equipment) and 17 diesel-powered emergency backup generators. Each generator will include a diesel-powered engine that drives an alternator section to produce electricity. The alternator section does not emit any air pollutants, so the overall emissions from a diesel generator are produced only from the diesel engine. The terms "generator" and "engine" are used interchangeably in this report. State and federal air quality regulations apply only to the emissions from the diesel engines. The generators are permitted to provide backup power to the facility in the event of disruption to the Grant County Public Utility District (PUD) electrical power service, which has an average total outage time per year of only 152 minutes (from 2008 to 2014) for customers who experienced an outage throughout PUD's service area (Grant County PUD 2015). Construction of the data center complex will be completed in phases. The first phase of construction, which has been completed, comprises a computer server building and a building that houses five emergency generators. Future expansion plans may include two additional emergency generators in the existing building that houses generators, and up to four additional computer server buildings that would be served by 10 additional emergency generators.

The original proposal was for 17 3.0-megawatt (MW) generators to be equipped with US Environmental Protection Agency (EPA) Tier 4-certified emission controls, including a catalyzed diesel particulate filter, a urea-injection selective catalytic reduction system, and a diesel oxidation catalyst. The latest compliance tests performed on the engines in April 2015 indicate that particulate matter (PM) emissions are higher with the Tier 4 controls installed than they would be without the Tier 4 controls (i.e., engines that comply with EPA Tier 2 emission standards)[1]. Multiple attempts to repair and/or optimize the Tier 4 emissions controls have failed; therefore, Vantage has elected to request a permit modification to allow for removal of the controls on the existing engines and future engines to be installed would be certified to comply with EPA Tier 2 standards. This protocol is intended to describe the air dispersion modeling methods that will be used to demonstrate compliance with National Ambient Air Quality Standards (NAAQS) and Washington air toxics regulations (Washington Administrative Code [WAC] 173-460).

Table 1 summarizes generator runtime activities and the assumptions that will be used for estimating emissions and the modeling setup. Note, the number of runtime hours associated with each runtime activity may change based on preliminary emission estimates and air dispersion modeling results.

On an annual basis, the applicant will request a regulatory limitation to operate the generators a certain number of hours per year and will request that compliance with per-generator runtime limits be demonstrated by summing total actual operating hours for all generators in service and comparing that to the total number of permitted hours for all generators in service. Additionally, the applicant will request that compliance with the annual fuel usage and hour limitations be based on a 3-year period using monthly rolling totals. For example, total fuel and operating hours will be summed for the 3-year period and an annual average for that period will be calculated and compared to the annual fuel and hour limits. These permit considerations will be addressed accordingly in the emission estimates and modeling setup.

Air Pollutant Emission Estimates

Air pollutant emission rates will be estimated for the generators per the requirements of WAC 173-400-103 and WAC 173-460-050. Emission rates will be calculated for criteria pollutants and toxic air pollutants (TAPs) based on peak hourly (worst-case maximum) and long-term (annual-average) operating scenarios. For comparison of emission rate standards of short-term durations, such as 1-hour, 8-hour, or 24-hour averaging periods, the peak hourly rate will be multiplied by the corresponding number of hours (i.e., the maximum duration of a particular runtime activity).

The proposed generators will be guaranteed by the manufacturer to meet EPA Tier 2 emission standards for non-road diesel engines. The manufacturer-reported “not to exceed” generator emission rates for carbon monoxide (CO), nitrogen oxides (NO_x), and PM will be used to estimate these criteria pollutant emissions. Additionally, the manufacturer-provided hydrocarbon emission rate will be used as the emission rate for total volatile organic compounds (VOCs).

[1] Based on MTU factory test data for the same engine model certified to comply with EPA Tier 2 emission standards.

During any event for which the emergency engines will supply power to the server system, the generators will activate at less than or equal to 100 percent load ("full-variable load"). The applicant is requesting the flexibility to operate at any load when power is being supplied to the server system, which will be set based on electrical demand. Therefore, considering that not all pollutant emission rates are maximum under the same operating load and because the applicant is requesting flexibility to operate at any load, the pollutant-specific maximum emission rate, under any load less than or equal to 100 percent, will be assumed for calculating the worst-case emission rates. These emission rates will be used in all operating scenarios that require full-variable load.

It will be conservatively assumed that the emission factors for diesel engine exhaust particulate matter (DEEP) are equal to the reported emission rates provided by the manufacturers' not-to-exceed (NTE) emission value for PM. For predicting annually averaged impacts, the modeling setup will assume total annual emissions released over the entire year; that is, a constant year-round emission rate AERMOD[2] input equal to the total maximum annual emissions (based on the number of hours requested as the operating limit) divided by the number of hours in a year (8,760 hours).

Emissions of PM with an aerodynamic diameter less than or equal to 10 microns (PM_{10}) and diameter less than or equal to 2.5 microns ($PM_{2.5}$) will be assumed equal. PM emission rate estimates will account for both "front-half" (filterable PM) and "back-half" (condensable PM) emissions for all modeling scenarios. This front- and back-half wash is expected to condense VOCs; therefore, the manufacturers' reported NTE emission values for PM (front-half emissions) will be scaled up by summing those with the reported NTE values for hydrocarbons. All remaining pollutant emission rate estimates will be calculated using emission factors from the EPA's AP-42, Volume I, Chapter 3.4, which provides emission factors for hazardous air pollutants (HAPs) from large internal combustion diesel engines (EPA 1995).

Emission estimates for criteria pollutants (PM, CO, NO_x, and total VOCs) and volatile TAPs associated with cold startup will be scaled up using a "black-puff" emission factor in order to account for slightly higher cold-start emissions during the first minute of each scheduled cold start. These "black-puff" factors are based on short-term concentration trends for VOC, CO, and NO_x emissions immediately following cold start by a large diesel backup generator that were measured by the California Energy Commission in its document entitled, "Air Quality Implications of Backup Generators in California" (Miller and Lents 2005).

Air Dispersion Modeling – Model Setup and Assumptions

Air dispersion models will be used to predict ambient impacts caused by emissions from the proposed emergency generators. The AERMOD modeling system will be used in accordance with the EPA's

[2] American Meteorological Society (AMS)/EPA regulatory model.

Guideline on Air Quality Models (Federal Register 2005) to estimate ambient pollutant concentrations beyond the project property boundary, assumed to be the fenceline for the purposes of this analysis.

Ambient air dispersion modeling will be conducted for all criteria pollutants and TAPs for which compliance is not demonstrated via emissions threshold screening. The Industrial Source Complex (ISC)-AERMOD View version 9.1.0 interface provided by Lakes Environmental will be used for all air dispersion modeling (Lakes Environmental 1995-2015).

This version of the Lakes Environmental software incorporates the most recent version of AERMOD (version 15181). AERMOD incorporates the data from a variety of pre-processors (described below) to process meteorological parameters, building downwash parameters, and terrain heights along with emission estimates and physical emission point characteristics to predict ambient impacts beyond the fenceline. The model will be used to estimate ambient concentrations based on various averaging times (e.g., 1 hour, 24 hours, annual, etc.) to demonstrate compliance with air quality standards for a network of receptors.

A receptor grid will consist of Cartesian flagpole receptor grids placed at a height of 1.5 meters (m) above ground to approximate the human breathing zone. The grid spacing will vary with distance from the facility, as listed below:

- 12.5-m spacing from the property boundary to 150 m from the nearest emission source
- 25-m spacing from 150 m to 400 m
- 50-m spacing from 400 m to 900 m
- 100-m spacing from 900 m to 2,000 m
- 300-m spacing between 2,000 m and 4,500 m
- 600-m spacing beyond 4,500 m (to 6,000 m maximum extent).

Meteorological Pre-Processing

AERMET (version 15181) is the meteorological pre-processor model that estimates boundary layer parameters for use in AERMOD. AERMET processes three types of meteorological input data in three stages and generates two input files for the AERMOD model. The two AERMOD input files produced by AERMET are the Surface File with hourly boundary layer parameter estimates, and the Profile File with multi-level observations of wind speed, wind direction, temperature, and standard deviations of fluctuating wind components. The three types of meteorological data that will be used by AERMET are described below.

- National Weather Service (NWS) hourly surface observations from the Grant County International Airport in Moses Lake, Washington located approximately 24 miles from the Vantage site. Five years (January 1, 2001 through December 31, 2005) of hourly surface data will be processed in AERMET.

- NWS twice-daily upper air soundings from Spokane, Washington. Five years (January 1, 2001 through December 31, 2005) of upper air data will be processed in AERMET.
- The site-specific data required for AERMET are Albedo, Bowen ratio, and surface roughness. Albedo is a measure of the solar radiation reflected back from earth into space. The Bowen ratio is an evaporation-related measurement and is defined as the ratio of sensible heat to latent heat. The surface roughness length is the theoretical height above ground where the wind speed becomes zero. The Vantage site does not have an instrumentation tower to record these site-specific parameters for use in AERMET; therefore, site-specific data will be approximated based on surface data from the meteorological tower at the Grant County International Airport. AERSURFACE will be used to approximate the Albedo, Bowen ratio, and surface roughness within 12 equal sectors of a circle that has a 1-kilometer radius and is centered on the surface station tower. Looking at each sector individually, AERSURFACE will determine the percentage of land-use type within each sector. Land cover data from the US Geological Survey (USGS) National Land Cover Data 1992 archives will be used as an input to AERSURFACE (USGS 1992). Default seasonal categories will be used in AERSURFACE to represent the four seasonal categories as follows: 1) midsummer with lush vegetation; 2) autumn with unharvested cropland; 3) late autumn after frost and harvest, or winter with no continuous snow; and 4) transitional spring with partial green coverage or short annuals.

Building Downwash Pre-Processing

Building downwash occurs when the aerodynamic turbulence induced by nearby buildings causes a pollutant emitted from an elevated source to be mixed rapidly toward the ground (downwash), resulting in higher ground-level pollutant concentrations. The software program Building Profile Input Program (BPIP)-PRIME will be used to determine if exhaust from emission units would be affected by nearby building structures. In general, these determinations are made if a stack's height is less than the height defined by the EPA's Good Engineering Practice (GEP) stack height.

GEP stack height is defined as the height of the nearby structure(s) measured from the ground-level elevation at the base of the stack plus 1.5 times the lesser dimension, height, or projected width of the nearby structure(s). For regulatory applications, a building is considered sufficiently close to a stack to cause wake effects when the distance between the stack and the nearest part of the building is less than or equal to 5 times the lesser of the building height (BH) or the projected width of the building (PBW). BPIP-PRIME considers building downwash for point sources that are within the GEP 5L Area of Influence of a structure. Four types of structures considered are:

- Low simple structures
- Tall simple structures
- Multi-tiered structures
- Groups of structures.

Each structure type produces an area of wake effect influence that extends out to a distance of 5 times L directly downwind from the trailing edge of the structure, where L is the lesser of the BH and PBW. As the wind rotates full circle, each direction-specific area of influence changes and is integrated into one overall area of influence termed the GEP 5L Area of Influence. A line drawn around the limit of the overall GEP 5L Area of Influence is termed the GEP 5L limit line. Any stack that is on or within the limit line is affected by GEP wake effects for some wind directions or range of wind directions.

Wakes from two structures, which are closer than the greater of either structure's L, are considered to be "sufficiently close" to one another that their wakes act as one wake. Therefore, when the projected widths of the structures do not completely overlie each other, the structures are combined and the gap between the two structures is treated as if the gap had been filled with a structure equal in height to the lower structure. Otherwise, the two structures are processed separately.

BPIP-PRIME creates a gap-filling structure (GFS) by connecting each pair of structures on a corner-to-corner basis and/or corner-perpendicular-to-the-other-side basis. In some cases, the GFS can be just two dimensions, height and width. The most outward parts of the lines form the perimeter of the GFS. The GFS perimeter is used together with the perimeters of the connected structures to determine the GEP 5L Area of Influence. Flags are also placed to identify which stacks are being influenced by which structures. To identify which stacks are in the GEP 5L Area of Influence, a system was devised that identifies each structure and its tiers, locates these in a coordinate system, and then processes the structure and tier data to calculate:

- GEP stack heights
- Building heights
- Projected building widths
- Projected building lengths
- The along-flow distance from the stack to the center of the upwind face of the projected building
- The across-flow distance from the stack to the center of the upwind face of the projected building.

Information in this section was obtained from the EPA, Electric Power Research Institute (EPRI), and Lakes Environmental guidance documents.

Terrain Height Pre-Processing

To model complex terrain, AERMOD requires information about the surrounding terrain. This information includes a height scale and a base elevation for each receptor. The AMS/EPA Regulatory Model Terrain Pre-processor (AERMAP) was used to obtain a height scale and the base elevation for a receptor, and to develop receptor grids with terrain effects.

Digital topographical data for the analysis region were obtained from the Web GIS website (www.webgis.com) and processed for use in AERMOD. The Shuttle Radar Topography Mission data used for this project have a resolution of approximately 30 m (1 arc-second).

AERMAP produces a receptor output file (*.rou) containing the calculated terrain elevations and scale height for each receptor. The .rou file will be used as an input runstream file (AERMOD input file) for the receptor pathway in the terrain options page of the control pathway. AERMAP also produces a source output file (*.sou). This file contains the calculated base elevations for all sources.

Modeling Methodology

The maximum ambient air quality impacts will be estimated using AERMOD. The assumptions and methodologies listed below will be used in the ambient air dispersion modeling setup to predict the worst-case project-related emission impacts based on various engine operating scenarios. Generators will be operated as part of the following runtime activities:

- **Monthly Maintenance Testing**: Routine operation and maintenance on the emergency generators will be conducted on a monthly basis. This runtime activity will be conducted on one emergency generator at a time; therefore, multiple generators will not be run concurrently for this operating scenario. Monthly runtime for maintenance operations would take up to 1 hour per generator. However, on rare occasions when a problem is identified and a generator requires diagnosis and repair, it may be necessary to operate it longer than 1 hour per month.
- **Annual Load Bank Testing**: A load bank test will be conducted on each generator once per year. The load bank test will be conducted under full-variable load for up to 4 hours on one generator at a time. Multiple generators will not be run concurrently during load bank testing.
- **Unplanned Power Outage**: During a power outage at the site, all installed generators will activate in order to supplement power to the server system and the administrative building. At full build-out, all 17 generators will be concurrently operated at full-variable load.
- **Electrical Bypass**: Generator operation during an electrical bypass event may be necessary during computer server maintenance at the data center. Electrical bypass events may require operation of up to seven generators concurrently at full-variable load. Electrical bypass events would typically require generator operation for 2 hours or less. Electrical bypass events would typically occur five times per year or less.
- **Generator Startup and Commissioning**: After a new generator installation, that generator will require commissioning, which includes up to 30 hours of individual operation under a range of loads followed by a 10-hour site integrated test (SIT), which requires operation of all the generators that service a single computer server building. If there are multiple phases of generator installations in a single building, it may be necessary to complete a second 10-hour SIT on the generators that were installed in the first phase for that building. For example, for the existing building at the facility, five generators have already been installed and a SIT test has been completed. However, once the remaining two generators are installed at that building, a SIT must be completed for all seven generators in that building. It is assumed that

one cold-startup event (per engine) will occur during the individual engine commissioning and another cold-startup will occur for the SIT test.

- **Stack Testing**: It is anticipated that Ecology will require exhaust stack emission testing of a single generator once every 5 years in order to demonstrate continued compliance with air quality standards. Such a stack test can take up to 16 hours and involve several engine startup and shutdown events. The worst-case scenario would be if the stack test failed, requiring a second, follow-up test in the same year. The worst-case runtime that could occur in a single year from stack testing would be operation of two 3.0-MW generators for 16 hours each. It is assumed that two cold-start events will occur per test.

Generator runtime activities are summarized in Table 1. The following sections provide information on which generator operating scenarios will be assumed in the modeling to demonstrate compliance with all applicable NAAQS and the Washington State acceptable source impact levels (ASILs). The input stack parameters for each model run will be pollutant-specific to correspond with the flow rate and temperature reported for the worst-case operating load for that particular pollutant. A summary of these standards and modeling setups is shown in Table 2.

Annually Averaged Modeling Setup

An annual-average (70-year lifetime) scenario will assume up to 3 days of power outages, five electrical bypass occurrences, 12 hours per year of monthly maintenance testing, and 4 hours of annual load bank testing per engine; this expected annual runtime schedule is summarized in Table 1.

The calculated annual pounds of pollutant to be emitted (per engine) from operation will include estimated emissions from cold-start events and the total will be divided by 8,760 hours (total number of hours in a year). This pounds-per-hour emission rate will be input to the annual-average modeling setup. This annual AERMOD setup will include evaluations for:

- $PM_{2.5}$ annual NAAQS, which is based on a 3-year rolling average
- Nitrogen dioxide (NO_2) annual NAAQS
- Any applicable TAP with an annual averaging period (i.e., DEEP ASIL).

To allow for the annual fuel usage and hour limitations to be based on a 3-year period using monthly rolling totals—as described above—we will demonstrate compliance with the NO_2 annual NAAQS by assuming a conservative worst-case scenario that the engines will operate 3 times the annual operating hour limit in a single year. We understand a similar type of evaluation (i.e., assuming 3 years' worth of operation in a single year) will not be required to demonstrate compliance with any other NAAQS or ASIL because 1) the $PM_{2.5}$ annual NAAQS standard is based on a 3-year average and 2) the DEEP ASIL was developed based on a 70-year lifetime exposure.

Worst-Case 1-Hour Modeling Setup

To determine the worst-case ambient impacts for CO and sulfur dioxide (SO_2), each with a 1-hour averaging period, the modeling setup will assume an emergency power outage. Seventeen generators will be modeled as if operating 24 hours per day, 365 days per year, which will address the conservative consideration that an outage could occur at any time of day or night and at any time of year. The hourly emission rate input into the model will conservatively assume a cold start. This modeling setup will include:

- CO 1st-highest 1-hour NAAQS
- SO_2 1st-highest 1-hour NAAQS
- SO_2 1st-highest 1-hour ASIL
- Any applicable TAP with a 1-hour averaging period (i.e., NO_2 ASIL).

Worst-Case 3-Hour, 8-Hour, or 24-Hour Modeling Setup

To estimate worst-case ambient impacts for pollutants regulated on a short-term average (i.e., 3 hours, 8 hours, or 24 hours), the worst-case unplanned power outage scenario will be modeled. The air dispersion models will be set up for all 17 generators to operate 24 hours per day, 365 days per year. A single cold-start event for each engine will be assumed to occur once during each simulation. This modeling setup will include:

- CO 1st-highest 8-hour NAAQS
- SO_2 1st-highest 3-hour NAAQS
- PM_{10} 4th-highest 24-hour NAAQS
- Any applicable TAP with a 24-hour averaging period (i.e., acrolein).

$PM_{2.5}$ 24-Hour NAAQS Modeling Setup

The $PM_{2.5}$ 24-hour NAAQS is based on the 98th percentile of ambient impacts during a 3-year rolling average period. The above-discussed worst-case generator runtime scenarios are conservative maxima that are not expected to occur often, if at all. However, due to the variable operating regimes that might occur on any given day (including arrangement of operating engines, weather conditions, the various generator operating scenarios, and the likelihood of all worst-case conditions happening at the same time), it is difficult to determine which actual generator operation scenario might trigger an exceedance of the NAAQS at any given location and time.

For a screening-level approach, several combinations of scenarios have been characterized and ranked based on worst-case daily emissions output. The 8th-highest ranked runtime scenario (based on the maximum approximate daily $PM_{2.5}$ emissions) will be chosen as the most probable operating condition that may trigger an exceedance (within the 98th percentile) and will be modeled in AERMOD to screen the possibility of project-related emissions contributing to an exceedance of the NAAQS.

Table 3 lists and ranks each of the daily operating regimes for $PM_{2.5}$ emissions from Vantage. The list is based on the number of days each operating scenario is expected to occur (referencing annual runtime listed in Table 1). The ranked 8th-highest day would be during a monthly maintenance or load testing scenario. The worst-case modeling setup for this testing scenario will be one engine operating up to 8 hours per day or up to 8 separate engines operating up to 1 hour per day. Eight cold-start events will be assumed to occur during the simulation event. Since testing will generally occur from 7 a.m. to 7 p.m. (during daylight hours), the total $PM_{2.5}$ emissions estimated for that daily period will be divided by 12 hours per day to identify the per-hour emission rate input in AERMOD.

NO_2 1-Hour NAAQS Modeling Setup

The NO_2 1-hour NAAQS is also based on the 98th percentile of maximum daily ambient impacts during a 3-year rolling average period. The same screening level approach as described for evaluation of the $PM_{2.5}$ 24-hour NAAQS will therefore be used to evaluate the NO_2 1-hour NAAQS. Table 3 lists and ranks each of the daily runtime operating scenarios for NO_2 emissions from Vantage. The ranked 8th-highest day would also be during a monthly maintenance testing scenario when only one engine is operated at a time. Emissions from a single cold-start event for each engine will be included in the input emission rates and the air dispersion model will be set up as if operating 24 hours per day, 365 days per year. In the event that AERMOD predicts that the 8th-highest day (based on the maximum 1-hour average impact for that day) could contribute to an exceedance of the NAAQS, the probability of occurrence will be evaluated using Ecology's Monte Carlo simulation technique.

Additional details for the modeling setup for evaluating all NO_2 emission impacts models include:

- The ambient NO_2 concentrations will be modeled using the plume volume molar ratio method option to demonstrate compliance with the 1-hour and annual NAAQS for NO_2 and ASIL. This AERMOD option will calculate ambient NO_2 concentrations surrounding the site by applying a default NO_2/NO_x equilibrium ratio of 0.90 and an NO_2/NO_x in-stack ratio of 0.1.
- The estimated ambient ozone concentration of 49 micrograms per cubic meter ($\mu g/m^3$) will be the AERMOD input level for all corresponding NO_2 modeling setups. This value was taken from the NW AIRQUEST 2009-2011 design value of criteria pollutants website, provided by Washington State University's Northwest International Air Quality Environmental Science and Technology Consortium, for the Quincy, Washington area (WSU website 2016).

Monte Carlo Simulation

In the event that AERMOD predicts the 8th-highest ranked runtime scenario (in the screening-level analysis for evaluating the NO_2 1-hour NAAQS) could contribute to an exceedance, the probability of occurrence will be evaluated using Ecology's Monte Carlo simulation technique. This technique evaluates the probable ambient impact by post-processing AERMOD output files. These AERMOD runs will be set up for a combination of various operating scenarios.

The Monte Carlo script will process the AERMOD output files by randomizing results from the generator runtime regimes, wind directions, and wind speeds to estimate the probability of exceedance of the corresponding regulatory standard at any given receptor location. The Monte Carlo simulation will assume the following:

- AERMOD runs for the Monte Carlo simulation will be set up for a single “worst-year” of meteorological data observed during 2001 to 2005. This “worst-year” will be determined by identifying the year in which the maximum impact would occur when the generators are modeled as if operated continuously under the worst-case power outage operating scenario for the entire 5 years of meteorological data.
- Impacts associated with the local background source from the Celite facility will be included in the Monte Carlo simulation. Local background modeling input parameters have been provided by Ecology from information used in its most recent community-wide emissions analysis (Dhammapala 2015).
- The generator runtime scenarios to be used in the analysis will be determined at a later date, once it is determined that the Monte Carlo simulation is necessary and final runtime hour limitations are identified. Landau Associates assumes that the requirements for statistical evaluation will be equivalent and consistent with Monte Carlo simulations required for other recent data center permit applications.

Background Modeling

This evaluation will include “regional background” values contributed by existing regional emission sources in the project vicinity (e.g., permitted sources, highway vehicles, area sources) and “local background” values contributed by the other data centers and an industrial facility in the vicinity. Project coordinate-specific regional background values will be obtained from the Washington State University NW Airquest website (WSU website 2016) for:

- PM_{10} (24-hour average)
- $PM_{2.5}$ (annual average)
- $PM_{2.5}$ (24-hour average)
- NO_2 (1-hour average).

Local background values for PM_{10} will consist of the ambient impacts at Vantage’s maximum impact location caused by emissions from the nearby emergency generators and industrial emission sources at the existing Yahoo! Data Center, Sabey Data Center, Intuit Data Center, and the Celite facility. Local background values for $PM_{2.5}$ and NO_2 will consist of the ambient impacts at Vantage’s maximum impact location, caused by emissions from the Celite facility. It is assumed that emissions from each of these facilities will be equal to their respective permit limits. After the location and date of the maximum impact caused by Vantage’s generators are determined, AERMOD will be used to model the local background ambient impacts at that same location and date caused by simultaneous activity at each of the adjacent data centers and industrial facility. The modeled local background values will be evaluated based on the following assumptions:

- 24-Hour $PM_{2.5}$ and 1-Hour NO_2 (Monthly Testing). Because data centers coordinate maintenance testing activities to prevent multiple facilities from testing on the same day, it is assumed that generators at other nearby data centers will not be operating concurrently during Vantage's monthly maintenance testing. It is assumed that the Celite facility will emit at its permitted rate.
- 24-hour PM_{10} (Power Outage). It is assumed that each nearby data center will operate at its permitted rate during a power outage, electrical bypass, or monthly maintenance testing on the same day that Vantage operates during a power outage, electrical bypass, or monthly maintenance testing; while the Celite facility will emit at its permitted rate.

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This technical memorandum presents the air dispersion modeling protocol to support the NOC application for the Vantage Data Center in Quincy, Washington. If you have any questions regarding this protocol, please contact Mark Brunner at (206) 631-8695 or via email at mbrunner@landauinc.com.

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Attachments

Table 1: Potential Annual Runtimes
Table 2: AERMOD Setup Plan
Table 3: Emissions Ranking for 24-hour $PM_{2.5}$ and 1-hour NO_2 NAAQS Compliance

TABLE 1
POTENTIAL ANNUAL RUNTIMES
VANTAGE DATA CENTER
QUINCY, WASHINGTON

Activity	Max. Annual Operating Hours (per generator)	Operating Load	Max. No. Generators to Operate Concurrently
Monthly Maintenance Testing	12	≤100%	1
Annual Load Testing	4	≤100%	1
Electrical Bypass/ Emergency Power Outage	50	≤100%	17
Commissioning Generator Testing	30	≤100%	1
Commissioning SIT Testing	20	≤100%	7
Stack Testing	16	≤100%	1

Notes:
SIT = Site Integration Test

TABLE 2
AERMOD SETUP PLAN
VANTAGE DATA CENTER
QUINCY, WASHINGTON

Regulatory Standard	Assumed Operating Scenario	Model Setup (a)	Averaging period
CO 1-hour NAAQS	24x7 Power Outage, 1 cold-start event	1st highest 1-hr impact	Averaged over 5 years of met. data
SO_2 1-hour NAAQS and SO_2 ASIL	24x7 Power Outage, 1 cold-start event	1st highest 1-hr impact	Averaged over 5 years of met. data
NO_2 ASIL	24x7 Power Outage, 1 cold-start event	1st highest 1-hr average	Averaged over 5 years of met. data, PVMRM
NO_2 1-hour NAAQS (b)	24x7 Operation of 8th Highest Day	1st highest 1-hr impact	3-year rolling average of 5 years PVMRM
SO_2 3-hour NAAQS	24x7 Power Outage, 1 cold-start event	1st highest 3-hr impact	Averaged over 5 years of met. data
CO 8-hour NAAQS	24x7 Power Outage, 1 cold-start event	1st highest 8-hr impact	Averaged over 5 years of met. data
SO_2 24-hour NAAQS	24x7 Power Outage, 1 cold-start event	1st highest 24-hr impact	Averaged over 5 years of met. data
$PM_{2.5}$ 24-hour NAAQS (b)	8th Highest Day	1st highest 24-hr impact	3-year rolling average of 5 years of met. data
Acrolein ASIL	24x7 Power Outage, 1 cold-start event	1st highest 24-hr average	Averaged over 5 years of met. data
PM_{10} 24-hour NAAQS	24x7 Power Outage, 1 cold-start event	4th highest 24-hr average	Averaged over 5 years of met. data
$PM_{2.5}$ Annual NAAQS (b)	Annual Runtime Limit	Annual average	Averaged over 5 years of met. data
SO_2 Annual NAAQS	Annual Runtime Limit	Annual average	Averaged over 5 years of met. data
NO_2 Annual NAAQS (c)	3x the Annual Runtime Limit	Annual average	Averaged over 5 years of met. data
DEEP ASIL	Annual Runtime Limit	Annual average	Averaged over 5 years of met. data
Benzene ASIL	Annual Runtime Limit	Annual average	Averaged over 5 years of met. data

(a) Pollutants with the same modeling setup and averaging period may reference one model and the dispersion factors generated from that model run
(b) Standard is based on a 3-year average.
(c) Standard is based on the annual mean.

CO = Carbon monoxide
SO_2 = Sulfur dioxide
PM_{10} = Particulate matter with an aerodynamic diameter of less than or equal to 10 microns
$PM_{2.5}$ = Particulate matter with an aerodynamic diameter of less than or equal to 2.5 microns
NO_2 = Nitrogen dioxide
DEEP = Diesel engine exhaust particulate matter
PVMRM = Plume volume molar ratio method
NAAQS = National Ambient Air Quality Standards
ASIL = Acceptable source impact level

TABLE 3
EMISSIONS RANKING FOR 24-HOUR $PM_{2.5}$ AND 1-HOUR NO_2 NAAQS COMPLIANCE
VANTAGE DATA CENTER
QUINCY, WASHINGTON

Day	Runtime Scenario	Duration (hours)	Maximum Generators Concurrently Operating	Operating Load
1	Emergency Power Outage	24	17	≤100%
2	Emergency Power Outage	24	17	≤100%
3	Emergency Power Outage/Electrical Bypass	24	17	≤100%
4	Electrical Bypass	2	7	≤100%
5	Electrical Bypass	2	7	≤100%
6	Electrical Bypass	2	7	≤100%
7	Electrical Bypass	2	7	≤100%
8	Monthly Maintenance or Load Testing	8	0	≤100%

Notes: Boxed row represents 8th-highest operating scenario (i.e., equivalent to 98 percentile).