Revised – Final Second Tier Risk Analysis

Technical Support Document (Increased DEEP Emission Limit at 10% Load)

Vantage Data Center
Quincy, Washington

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List of Acronyms and Abbreviations

ASIL	Acceptable Source Impact Level
BACT	Best Available Control Technology
CO	Carbon monoxide
DEEP	Diesel engine exhaust particulate
DPF	Diesel particulate filter
Ecology	Washington Department of Ecology
EPA	Environmental Protection Agency
HI	Hazard Index
HIA	Health Impact Assessment
kWe	Kilowatt (electrical)
kWm	Kilowatt (mechanical)
LAER	Lowest Achievable Emission Rate
MIBR	Maximally Impacted Boundary Receptor
MIBR	Maximally Impacted Commercial Receptor
MIBR	Maximally Impacted Residential Receptor
NAAQS	National Ambient Air Quality Standard
NO2	Nitrogen dioxide
NOx	Oxides of nitrogen
NOC	Notice of Construction
PAH	Polycyclic aromatic hydrocarbon
PM2.5	Fine particulate matter with a diameter less than 2.5 microns
PM10	Particulate matter with a diameter less than 10 microns
RACT	Reasonably Available Control Technology
RBC	Risk-based concentration
SO2	Sulfur dioxide
SQER	Small Quantity Emission Rate
tBACT	Toxics Best Available Control Technology
TAP	Toxic air pollutant
TEF	Toxic equivalency factor
TWA	Time-weighted average
VOC	Volatile organic compound
WAC	Washington Administrative Code

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1 Executive Summary

1.1 Proposal Summary

This revised risk assessment (dated November 2012) replaces the previous May 2012 version ICF 2012a). This revised version accounts for increased diesel engine exhaust particulate (DEEP) emission rates resulting from Vantage Data Centers (Vantage)'s request to increase the allowable DEEP emission limit at 10% generator load (ICF 2012b). The DEEP emission limit at 10% load specified in the Washington State Department of Ecology (Ecology)'s earlier public review Draft Preliminary Determination was 0.194 pounds per hour (lbs/hr). Vantage Data Centers now requests that limit at 10% load should be increased to 0.40 lbs/hr.

Vantage proposes to build a new data center located in Quincy, Grant County, Washington. The project will consist of four main buildings to house server equipment and three smaller buildings to house a total of 17 diesel-powered backup generator sets each rated at 3,000 electrical kilowatts (kWe). Every generator will be equipped with EPA Tier-4 certified emission controls.

Potential emissions of DEEP from the proposed backup engines exceed regulatory trigger levels called Acceptable Source Impact Levels (ASILs). Therefore, Vantage is required to submit a second tier petition per Chapter 173-460 Washington Administrative Code (WAC).

Ecology determined that a community-wide approach to permitting data centers was warranted for the Quincy urban growth area because of the relatively close geographic proximity of existing and planned large data centers in Quincy. As part of the community-wide approach, this risk assessment report considers the cumulative impacts of DEEP from existing permitted data centers and other nearby sources of diesel engine emissions.

1.2 Health Impacts Evaluation

Vantage retained ICF International (ICF) to prepare a Health Impact Assessment (HIA) to evaluate the potential health risks attributable to operation of the diesel-powered generators from its data center project. The HIA demonstrates that emissions of DEEP from the proposed project could result in an increased cancer risk of up to 9 in one million (9×10^{-6}) at the maximally impacted residential location—specifically at the property line of the closest existing house on industrially-zoned property bordering the southwestern property line of the Vantage Data Center. Because the increase in cancer risk attributable to the new data center alone is less than the maximum risk allowed by a second tier review, which is 10 in one million, the project could be approvable under WAC 173-460-090.

1.3 Cumulative Health Risks

ICF and Ecology also evaluated emissions from other nearby emission sources to determine the cumulative long-term health impacts associated with DEEP.

Based on the cumulative maximum DEEP concentration at a residential location near the Vantage Data Center, the estimated maximum potential cumulative cancer risk posed by DEEP emitted from all sources within the area is approximately 30.3 in one million (30.3×10^{-6}) at an existing house on industrially zoned property located to the southwest of the Vantage Data Center. Vantage Data Center emissions account for approximately ¼ of this cumulative risk.

1.4 Conclusions

Project-related health risks are consistent with those permissible under WAC 173-460-090, and the cumulative risk from DEEP emissions in Quincy is less than the cumulative risk goal established by Ecology for permitting data centers in Quincy (100 per million or 100×10^{-6}). Upon approval of the project, Vantage will communicate any health risks posed by their emissions to current residents near the Vantage Data Center, and potential buyers of undeveloped parcels adjacent to the data center, or to the local regulatory agency responsible for zoning and development in the affected area.

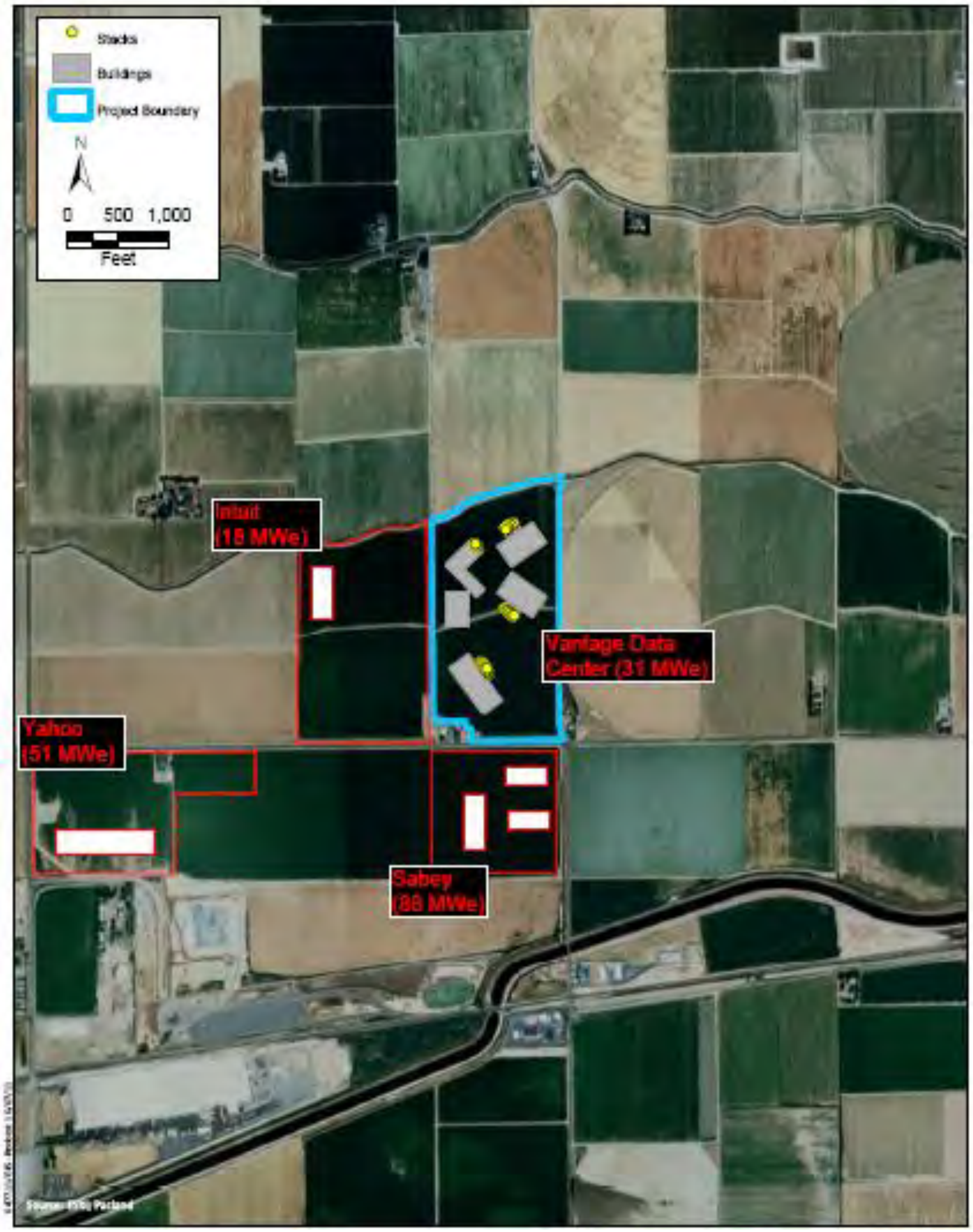
2 Vantage Data Center Project

Vantage proposes to build a new data center complex in Quincy, Washington. The Vantage Data Center will be located directly north of the Sabey Data Center and will be utilized by Vantage to store data and run software applications. The project will be located in the northeastern portion of Quincy's urban growth area (Figure 2-1) and will include a total of five buildings, one office building and four buildings to house server equipment and seventeen (17) backup generators. The primary air contaminant sources at the facility consist of the seventeen (17) electric generators. The proposed generators for the facility are MTU emergency diesel generators, rated at 3,000kWe. Each generator will be equipped with U.S. Environmental Protection Agency (EPA) Tier-4 certified emission controls including a catalyzed diesel particulate filter, to control DEEP, CO, and VOC, and a urea-injection selective catalytic reduction system for NO_x control, and a diesel oxidation catalyst for control of carbon monoxide and VOCs. Each generator has the capacity to produce 3,000 electrical kilowatts (kWe) and provide emergency backup power to the facility during infrequent disruption of Grant County Public Utility District's (PUD) electrical power service. At full buildout, the generators will have a combined power capacity of up to 51 megawatts electrical (MWe). The project will be phased in over several years depending on demand.

The layout for the proposed Vantage Data Center is shown in Figure 2-2. The Vantage Data Center will consist of phased construction of four primary data center buildings, three adjoining generator buildings, and an office building. Phase 1 construction is expected to be completed in late 2012. The start dates for three additional phases are to be determined. Phase 1 construction of 148,800 square feet (ft^2) will commence during 2012. It consists of Building 1 plus the adjoining generator building and includes seven (7) (five primary and two reserve) 3000 kWe generators powered by 4680 brake horse power MTU engines. Phases 2 and 3 (Buildings 2 and 3) will consist of 120,750 ft^2 of space each, and each phase will include a data center building and an adjoining generator building with four (4) (three primary and one reserve) 3000 kWe (MWe) electric generators. Phase 4 (Building ETC and the office building) will consist of 89,700 ft^2 of space and will include two (2) (one primary and one reserve) 3000 kWe (MWe) electric generators. The 10 generators that are part of Phases 2, 3 and 4 will be installed at an undetermined date.

At full buildout for all phases combined, the data center will include seventeen (17) 3000 kWe generators (consisting of 12 primary generators and 5 reserve generators). The locations of the generator buildings are shown in Figure 2-2. Exhaust from each engine will be routed through vertical stacks that extend to 41 feet above grade through the roof of the generator buildings.

Figure 2-1. Land Use and Location of Other Data Centers in the Vicinity of the Vantage Data Center



Note: listed MWe values at each data center indicate the total installed power for permitted emergency backup generators.

Figure 2-2. Site Layout for the Vantage Data Center

Source: ESRI; Facland

Table 2-1 provides a summary of the proposed operating durations for the emergency generators for the Vantage Data Center. The generators will operate for varying durations and loads depending on the type of test. The only time all 17 engines would operate simultaneously is during a complete power outage. The Notice of Construction (NOC) application proposes a facility-wide fuel usage limit of 169,500 gallons per year of ultra-low sulfur (less than 0.0015 wt%), EPA on-road specification No. 2 distillate fuel oil. In order to minimize air quality impacts from the proposed project, Vantage proposes to limit the duration of engine testing, maintenance, and unplanned outage. The 17 engines will operate for a maximum of 82 hours per year. These forecast engine runtime regimes are equivalent to a maximum annual runtime of 32.5 hours per year per generator of scheduled testing, 16 hours of maintenance, an additional 24 hours per year per generator of combined unplanned power outages plus storm avoidance, and 9.5 hours of cool down time for each generator.

Table 2-1. Generator Runtime Regimes for Vantage Data Center Diesel Engines

Phase	Generator Type	# of Gens	Scheduled Testing							
			Weekly				Monthly			
			% Load	Hrs/ test	Tests/ yr	Hrs/ yr	% Load	Hrs/ test	Tests/ yr	Hrs/ yr
1	Primary	5	10	0.5	40	20	10	0.5	6	3
	Reserve	2	10	0.5	40	20	10	0.5	6	3
	Cooldown	7	0	0	0	0	10	0	0	0
2	Primary	3	10	0.5	40	20	10	0.5	6	3
	Reserve	1	10	0.5	40	20	10	0.5	6	3
	Cooldown	4	0	0	0	0	10	0	0	0
3	Primary	3	10	0.5	40	20	10	0.5	6	3
	Reserve	1	10	0.5	40	20	10	0.5	6	3
	Cooldown	4	0	0	0	0	10	0	0	
ETC	Primary	1	10	0.5	40	20	10	0.5	6	3
	Reserve	1	10	0.5	40	20	10	0.5	6	3
	Cooldown	2	0	0	0	0	10	0	0	0

Table 2-1. Generator Runtime Regimes (Continued)

Phase	Generator Type	# of Gens	Scheduled Testing (continued)							
			Quarterly				Annual Fall Building			
			% Load	Hrs/ test	Tests/ yr	Hrs/ yr	% Load	Hrs/ test	Tests/ yr	Hrs/ yr
1	Primary	5	81.3	0.75	4	3	81.3	6	1	6
	Reserve	2	10	0.75	4	3	10	6	1	6
	Cooldown	7	10	0.5	4	2	10	0.5	1	0.5
2	Primary	3	90.0	0.75	4	3	90.0	6	1	6
	Reserve	1	10	0.75	4	3	10	6	1	6
	Cooldown	4	10	0.5	4	2	10	0.5	1	0.5
3	Primary	3	90.0	0.75	4	3	90.0	6	1	6
	Reserve	1	10	0.75	4	3	10	6	1	6
	Cooldown	4	10	0.5	4	2	10	0.5	1	0.5
ETC	Primary	1	93.3	0.5	4	3	93.3	6	1	6
	Reserve	1	10	0.5	4	3	10	6	1	6
	Cooldown	2	10	0.5	4	2	10	0.5	1	0.5

Table 2-1. Generator Runtime Regimes (Continued)

Phase	Generator Type	# of Gens	Scheduled Testing (Continued)				
			Annual-Step Testing				Total Scheduled Testing
			% Load	Hrs/test	Tests/yr	Hrs/yr	Hrs/yr
1	Primary	5	100	0.5	1	0.5	32.5
	Reserve	2	100	0.5	1	0.5	32.5
	Cooldown	7	10	0.5	1	0.5	3
2	Primary	3	100	0.5	1	0.5	32.5
	Reserve	1	100	0.5	1	0.5	32.5
	Cooldown	4	10	0.5	1	0.5	3
3	Primary	3	100	0.5	1	0.5	32.5
	Reserve	1	100	0.5	1	0.5	32.5
	Cooldown	4	10	0.5	1	0.5	3
ETC	Primary	1	100	0.5	1	0.5	32.5
	Reserve	1	100	0.5	1	0.5	32.5
	Cooldown	2	10	0.5	1	0.5	3

Table 2-1. Generator Runtime Regimes (Concluded)

Bldg	Generator Type	# of Gens	Unscheduled Maintenance					Power Outage and Storm Avoidance			Total Generator Usage	
			Corrective Generator Maintenance		De-energized Building Transformer Maintenance				Storm Avoid-ance	Outage	Total Discre-tionary	Facility Total
			% Load	H/ yr	% Load	Hrs/ yr	Total Maint. Hrs/ yr	% Load	Hrs/ yr	Hrs/ yr	Hrs/ yr	Hrs/ yr
1	Primary	5	100	8	81.3%	8	16	81.3	16	8	64.5	72.5
	Reserve	2	100	8	10%	8	16	10	16	8	64.5	72.5
	Cooldown	7	10	1	10%	0.5	1.5	10%	4	1	8.5	9.5
2	Primary	3	10	8	90%	8	16	90%	16	8	64.5	72.5
	Reserve	1	100	8	10%	8	16	10%	16	8	64.5	72.5
	Cooldown	4	10	1	10%	0.5	1.5	10%	4	1	8.5	9.5
3	Primary	3	100	8	90%	8	16	90%	16	8	64.5	72.5
	Reserve	1	100	8	10%	8	16	10%	16	8	64.5	72.5
	Cooldown	4	10	1	10%	0.5	1.5	10%	4	1	8.5	9.5
ETC	Primary	1	100	8	93.3%	8	16	93.3%	16	8	64.5	72.5
	Reserve	1	100	8	10%	8	16	10%	16	8	64.5	72.5
	Cooldown	2	10	1	10%	0.5	1.5	10%	4	1	8.5	9.5

2.1 DEEP Emissions From Routine Permitted Operations, Initial Generator Commissioning Testing and Triennial Compliance Stack Testing

The Vantage-only DEEP impacts described in this report include the routine operational emissions after full buildout, storm avoidance plus power outages, first-year commissioning testing that will be conducted on each generator, and triennial compliance stack testing that will be required for each generator. For purposes of estimating maximum-annual emissions, it was assumed the final 5 generators would be commissioned early in the year then the full-buildout facility would immediately commence operation, and the commissioning emissions were added to the routine operational emissions plus the maximum annual stack testing emissions.

For purposes of calculating long-term cancer risks, the 70-year average DEEP impacts were calculated by annualizing the initial commissioning emissions from the combined 17 generators over the assumed 70-year exposure period. Similarly, the annual average emissions from triennial stack testing were calculating by annualizing each stack test over a 3-year averaging period. The overall 70-year average emissions are the sum of the routine operational emissions, storm avoidance plus outages, annualized commissioning emissions, and the annualized compliance stack testing emissions.

Table 2-2 summarizes the forecast facility-wide emission rates including routine operations, power outages, initial commissioning, and compliance stack testing.

Table 2-2 lists ammonia as one of the toxic air pollutants that will be emitted from the generators. The generators themselves do not emit ammonia. Instead, small amounts of ammonia are emitted from the selective catalytic reduction (SCR) system used to control NOx. Ammonia is injected into the flue gas upstream of the SCR catalyst, and some is emitted as "ammonia slip" as a result of a fraction of the injected ammonia not reacting with the nitrogen compounds. The issue of ammonia slip is a well-understood issue with SCR control systems. Vantage will operate the SCR system to maintain the concentration of ammonia gas below 15 parts per million by volume (ppmv) at a reference oxygen concentration of 15%.

Table 2-2. Backup Generator Emission Rates Including Annual Stack Testing and Initial Commissioning Testing

Pollutant	Annual Emissions (tons/year) from Routine Operations (Excluding Commissioning and Compliance Stack Testing)	Annualized 70-Year Emissions (Tons/year) Used for Cancer Risk Assessment	Maximum Annual Emissions (Tons/Year) Used for Annual NAAQS, Annual ASIL Compliance, and Annual Chronic Non-Cancer Risk Assessment
NO_X	5.93	6.49	7.59
PM (DEEP)	0.289	0.306	0.348
CO	1.22	1.27	1.46
VOC	0.36	0.37	0.40
SO_2	1.78E-02	1.9E-02	2.3E-02
Primary Nitrogen Dioxide (NO_2)	0.667	0.707	0.844
Ammonia	Maximum of 209 lbs/day during a 24-hour power outage (15 ppmv at 15% O_2)		
Benzene	1.89-03	1.93E-03	2.09E-03
Toluene	6.85-04	7.01E-04	7.58E-04
Xylene	4.71E-04	4.82E-04	5.21E-04
1,3-Butadiene	4.77E-05	4.88E-05	5.28E-05
Formaldehyde	1.92E-04	1.96E-04	2.12E-04
Acetaldehyde	6.14E-05	6.28E-05	6.79E-05
Acrolein	1.92E-04	1.96E-04	2.12E-04

Pollutant	Annual Emissions (tons/year) from Routine Operations (Excluding Commissioning and Compliance Stack Testing)	Annualized 70-Year Emissions (Tons/year) Used for Cancer Risk Assessment	Maximum Annual Emissions (Tons/Year) Used for Annual NAAQS, Annual ASIL Compliance, and Annual Chronic Non-Cancer Risk Assessment
Benzo(a)Pyrene	2.98E-07	3.20E-07	3.77E-07
Benzo(a)anthracene	1.44R-06	1.54E-06	1.82E-06
Chrysene	3.55E-05	3.81E-05	4.49E-05
Benzo(b)fluoranthene	2.58E-06	2.77E-06	3.26E-06
Benzo(k)fluoranthene	2.53E-07	2.71E-07	3.20E-07
Dibenz(a,h)anthracene	4.02E-07	4.31E-07	5.09E-07
Ideno(1,2,3-cd)pyrene	4.81E-07	5.16E-07	6.09E-07
Naphthalene	3.17E-04	3.40E-04	4.01E-04
Propylene	6.80E-03	7.30E-03	8.60E-03
Total PAHs (simple sum, no TEFs)	**9.01E-06**	**9.67E-06**	**1.14E-05**
Total PAHs (applying TEFs)	**1.16E-06**	**1.24E-06**	**1.47E-06**

Notes: NO_X= nitrogen oxide, $PM_{2.5}$ = particulate matter less than 2.5 microns in size, DEEP=diesel engine exhaust particulate, CO= carbon monoxide, VOC=volatile organic compound, SO_2=sulfur dioxide, NO_2=nitrogen dioxide, PAH=polycyclic aromatic hydrocarbon, TEF=toxic equivalency factor.

2.2 Vantage Data Center Power Reliability and Infrastructure

Grant County PUD publishes its system-wide reliability. Their latest report indicated that, on average, each customer has historically experienced only 2.3 hours per year of power outage.

Vantage designed the proposed data center to achieve a “Tier 4 data reliability” data center industry classification according to the rating system developed by the Telecommunications Industry Association and ANSI (American National Standards Institute). This is the highest rating for data center reliability. To attain this classification, Vantage must ensure that their electrical supply is stable and can be maintained continuously. For this reason, Vantage will have several backup generators and reserve backup generators.

2.3 Land Use and Zoning

Figure 2-1 (presented earlier) shows land use as well as the locations of other data center facilities near the Vantage data center site. The project site is flat ground and zoned for industrial use. It is surrounded by agricultural land, industrial-zoned land, commercial businesses, schools, and residential neighborhoods.

Detailed zoning information for the Quincy area is displayed in Figure 2-3. The data center will be located within Quincy's urban growth boundary. The agricultural fields to the east, south and west of the proposed facility are zoned for industrial development and are also within the urban growth boundary. From a health impacts standpoint, two existing farm houses located on industrially-zoned agricultural land at the southwest and southeast corners of the data center (see Figure 2-1 and Figure 2-2) are of primary interest.

Figure 2-3. Detailed Zoning Information for the Quincy Area.

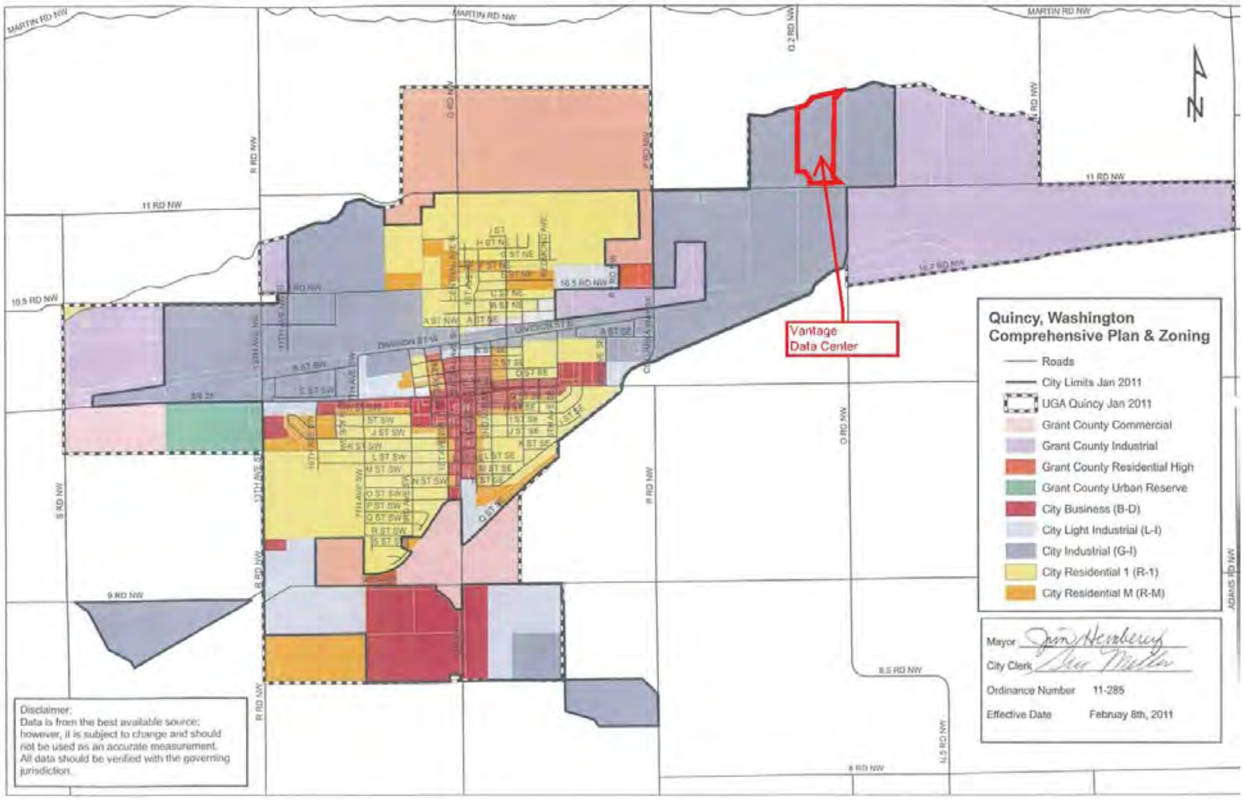


Table 2-3 describes current and planned land use for properties surrounding the Vantage facility (Grant County 2011; City of Quincy 2011).

Table 2-3. General Land Use Zones near the Vantage Data Center in Quincy Washington

Direction From Vantage Data Center	Current Land Use (from Tax Parcel Information)	Planned Zoning (from Quincy map)	Notable Development
North	Agricultural	Open	
South	Commercial/Industrial	Industrial	Sabey Data Center
East	Agricultural	Industrial	
West	Commercial/Industrial	Industrial	Intuit Data Center
Southwest (Corner)	Agricultural/Residential	Industrial	Home on industrially-zoned parcel 14990 NW Road 11
Southwest (Across Road 11)	Commercial/Industrial	Industrial	Yahoo! Data Center
Southeast (Corner)	Agricultural/Residential	Industrial	Home on industrially-zoned parcel 14994 NW Road 11

2.4 Sensitive Receptors near Vantage Data Center

The following sensitive receptors are in the vicinity of the Vantage Data Center:

- The closest school is Quincy High School, which is 1.4 miles southwest of the data center.
- The closest daycare facility is RealMe Daycare, roughly 1 mile east of the Vantage data center.
- The closest health care facility is Grant Medical Healthcare, roughly 2.1 miles west-southwest of the data center.
- The closest assisted living facility is Cambridge House, roughly 2.5 miles west-southwest of the data center.

All of the receptor locations are well outside area where modeled concentrations exceed 0.0033 µg/m3, the concentration that corresponds to the ASIL for DEEP.

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3 Permitting Requirements for New Sources of Toxic Air Pollutants

3.1 Overview of the Regulatory Process

The requirements for performing a toxics screening are established in Chapter 173-460 WAC. This rule requires a review of any non-de minimis[1] increase in toxic air pollutant (TAP) emissions for all new or modified stationary sources in the State of Washington. Sources subject to review under this rule must apply best available control technology for toxics (tBACT) to control emissions of all TAPs subject to review.

There are three levels of review when processing a NOC application for a new or modified emissions unit emitting TAPs in excess of the de minimis levels: (1) first tier (toxic screening), (2) second tier (health impacts assessment), and (3) third tier (risk management decision).

All projects with emissions exceeding the de minimis levels are required to undergo a toxics screening (first tier review) as required by WAC 173-460-080. The objective of the toxics screening is to establish the systematic control of new sources emitting TAPs in order to prevent air pollution, reduce emissions to the extent reasonably possible, and maintain such levels of air quality to protect human health and safety. If modeled emissions exceed the trigger levels called ASILs, a second tier review is required.

As part of a second tier petition, described in WAC 173-460-090, the applicant submits a site-specific HIA. The objective of a HIA is to quantify the increase in lifetime cancer risk for persons exposed to the increased concentration of any carcinogen, and to quantify the increased health hazard from any non-carcinogen that would result from the proposed project. Once quantified, the cancer risk is compared to the maximum risk allowed by a second tier review, which is 10 in one million, and the concentration of any non-carcinogen that would result from the proposed project is compared to its effect threshold concentration.

In evaluating a second tier petition, background concentrations of the applicable pollutants must be considered. If the emissions of a TAP result in an increased cancer risk of greater than 10 in one million (equivalent to one in one hundred thousand), then an applicant may request Ecology perform a third tier review. For non-carcinogens, a similar path exists, but there is no bright line associated with when a third tier review is triggered.

If an applicant is unable to demonstrate compliance with the Second Tier conditions, then they can request approval under Third Tier review. A third tier review (which is not required for the Vantage Data Center) is a risk management decision in which Ecology makes a decision that the risk of the project is acceptable based on a determination that emissions will be maximally reduced through available preventive measures, assessment of environmental benefit, disclosure of risk at a public hearing, and related factors associated with the facility and the surrounding community.

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[1] If the estimated increase of emissions of a TAP or TAPs from a new or modified project is below the de minimis emissions threshold(s) found in WAC 173-460-150, the project is exempt from review under Chapter 173-460 WAC.

3.2 BACT and tBACT for the Vantage Data Center Project

Ecology is responsible for establishing BACT and tBACT for controlling criteria and TAPs emitted from the new diesel generators. Ecology's BACT and tBACT determinations are summarized in Tables 3-1 and 3-2, respectively.

Table 3-1. Summary of BACT Determination

Pollutant(s)	BACT Determination
Particulate matter (PM)	• Use of good combustion practices; • Use of a catalyzed, diesel particulate filter (DPF) on each engine; and • Compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart IIII.
Nitrogen oxides (NOX)	• Use of good combustion practices; • Use of a urea selective catalytic reduction (SCR) scrubber on each engine; and • Compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart IIII.
Carbon monoxide (CO) and volatile organic compounds (VOC)	• Use of good combustion practices; • Use of a catalyzed diesel particulate filter on each engine; and • Compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart IIII.
Sulfur dioxide	• Use of ultra-low sulfur diesel fuel containing no more than 15 parts per million by weight of sulfur.

Table 3-2. Summary of tBACT Determination for Air Toxics

Toxic Air Pollutant(s)	tBACT Determination
DEEP	Compliance with the PM BACT requirement
Acetaldehyde, carbon monoxide, acrolein, benzene, benzo(a)pyrene, 1,3-butadiene, formaldehyde, propylene, toluene, total PAHs, xylenes	Compliance with the VOC BACT requirement
Nitrogen dioxide	Compliance with the NOX BACT requirement
Sulfur dioxide	Compliance with the SO2 BACT requirement

For the Vantage Data Center project, all generators will be equipped with diesel particulate filters (DPFs), SCR systems for control of emissions of NO_x, and diesel oxidation catalysts for control of emissions of CO and VOC using the AirClarity™ 3000 Emissions Control System for 3000-XC6DT2 engines. The controlled emissions are expected to be lower than uncontrolled emissions by more than 87% for PM, and by more than 90% for NO_x, CO, and VOC. This proposed equipment for the Vantage Data Center is more costly and provides better emission control than is required for BACT for the proposed generators. Additional detail is provided in the NOC document.

3.3 First Tier Review Toxics Screening for the Vantage Data Center Project

ICF used a combination of EPA emission factors, EPA manufacturer emission guarantees, and manufacturer test data to estimate emission rates of TAPs from Vantage's diesel-powered generators (ICF 2012). Table 3-3 shows each TAP's proposed emissions compared to its respective small quantity emission rate (SQER).[2] Because each generator will be equipped with emission controls, only a small number of pollutants (DEEP, nitrogen dioxide, and acrolein) have emission rates exceeding their respective SQER. Note: use of EPA's published emission factors likely over-estimated the actual emission rates for toxic air pollutants other than DEEP, NO_2, and ammonia.

The 1st-highest maximum-annual emission rates used for AERMOD modeling to evaluate compliance with the ASILs accounts for a combination of commissioning testing, routine operation, power outages, and triennial stack emission testing all occurring in a 12-month period. The maximum-annual emission rates listed in Table 3-3 are higher than the routine annual emission rates (caused only by routine operation plus storm avoidance plus outages) by the following factors: DEEP = 1.27, VOC = 1.11. ICF originally used AERMOD to model the annual-average ambient impacts caused only routine annual emissions. The 1st-highest maximum-annual ambient impacts listed in Table 3-4 were calculated by manually scaling the original AERMOD values by the scale factor of 1.27 for DEEP and PAHs, and scaling the gaseous pollutants by the 1.11 scale factor. For the First-Tier screening it was assumed the 1.27 annual factor for the emission rates also results in a 1.27 factor for the annual concentrations. That assumption results in conservatively high ambient impacts. In reality, the emissions from commissioning and startup testing will be restricted to daytime hours (7 am to 7 pm) when dispersion conditions are more favorable. Therefore, the ambient impact factor should be less than the 1.27 value assumed for this screening analysis.

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[2] An SQER is an emission rate that is not expected to result in an off-site concentration that exceeds an ASIL.

Table 3-3. Comparison of Emission Rates to SQER

Pollutant	CAS Number	SQER		Facility Emissions		SQER Exceeded?
Diesel Exhaust Particulate	None	0.639	lbs/yr	696	lbs/yr	Yes
CO	630-08-0	50.2	lbs/1-hour	31.5	lbs/1-hour	No
SO2		1.45	lbs/1-hour	0.6	lbs/1-hour	No
Primary Nitrogen Dioxide (NO2)	10102-44-0	1.03	lbs/1-hour	18.1	lbs/1-hour	Yes
Ammonia	7664-41-7	9.3	Lbs/day	209	Lbs/day	Yes
Benzene	71-43-2	6.62	lbs/yr	3.87	lbs/yr	No
Toluene	108-88-3	657	lbs/day	0.523	lbs/day	No
Xylenes	95-47-6	58	lbs/day	0.360	lbs/day	No
1,3-Butadiene	106-99-0	1.13	lbs/yr	0.0976	lbs/yr	No
Formaldehyde	50-00-0	32	lbs/yr	0.3927	lbs/yr	No
Acetaldehyde	75-07-0	71	lbs/yr	0.1256	lbs/yr	No
Acrolein	107-02-8	0.00789	lbs/day	0.015	lbs/day	Yes
Benzo(a)Pyrene	50-32-8	0.174	lbs/yr	0.0006	lbs/yr	No
Benzo(a)anthracene	56-55-3	1.74	lbs/yr	0.0031	lbs/yr	No
Chrysene	218-01-9	17.4	lbs/yr	0.0762	lbs/yr	No
Benzo(b)fluoranthene	205-99-2	1.74	lbs/yr	0.0055	lbs/yr	No
Benzo(k)fluoranthene	207-08-9	1.74	lbs/yr	0.0005	lbs/yr	No
Dibenz(a,h)anthracene	53-70-3	0.16	lbs/yr	0.0009	lbs/yr	No
Ideno(1,2,3-cd)pyrene	193-39-5	1.74	lbs/yr	0.0010	lbs/yr	No
Napthalene	91-20-3	5.65	lbs/yr	0.6802	lbs/yr	No
Propylene	115-07-1	394	lbs/day	5.198	lbs/day	No
Combined PAHs (TEF)	N/A	0.174	lbs/yr	0.0025	lbs/yr	No

ICF used refined AERMOD dispersion modeling (briefly described in Section 4.2.2) to model ambient concentrations of those TAPs that exceed their SQER. Table 3-4 shows a comparison of the modeled concentrations of pollutants that exceeded SQERs to their respective ASILs. Only DEEP levels exceeded the ASIL, therefore, Vantage was required to prepare a HIA that evaluates potential risks from exposure to Vantage's DEEP emissions.

Table 3-4. Comparison of Modeled Off-Site TAP Concentrations to ASILs.

Pollutant	CAS#	Averaging Time	Highest Modeled Off-Site Concentration (µg/m3)	ASIL (µg/m3)	Exceeds ASIL
Acrolein	107-02-8	24-hr	0.0016	0.06	No
Ammonia	7664-41-7	24-hr	23	70.8	No
DEEP	—	Annual	0.053	0.0033	Yes
NO2	10102-44-0	1-hr	345	470	No

NO_2 is not predicted to exceed its ASIL and is, therefore, not subject to a second tier review.

3.4 The Community-Wide Approach

Between 2006 and 2011, Ecology permitted the construction of five data centers in Quincy, Washington. Each data center installed multiple large backup diesel-powered generators to be used during power failures. In total, the five existing data centers currently operate a total of 144 diesel-powered generators each rated at 2.0 MWe to 3.0 MWe electrical generating capacity.

When Ecology permitted these original facilities in 2006-2007 (Microsoft, Yahoo, and Intuit), DEEP was not regulated as a TAP under Chapter 173-460 WAC, Controls for Toxic Air Pollutants. In June 2009 Ecology revised Chapter 173-460 WAC, and began regulating DEEP as a TAP, along with a number of other new pollutants. The revised rule established an ambient trigger level or ASIL for DEEP of 0.00333 µg/m3, annual average, above which predicted ambient concentrations of DEEP are subject to second tier review. Primarily because DEEP was not previously regulated, data centers were permitted more hours of operation and fuel use than would likely be permitted under this revised rule.

On March 25, 2010, the governor signed into law a bill (ESSB 6789) passed by the Washington State Legislature to promote the development of additional data centers in rural Washington. The final law gives anyone who starts constructing a data center between April 1, 2010 and July 1, 2011, an exemption from the sales tax for server equipment and power infrastructure. Among other requirements, eligible data centers have to be located in a rural county, cover at least 20,000 square feet dedicated to servers, and completed by April 1, 2018. The passage of this Computer Data Centers–Sales and Use Tax Exemption Act of 2010 prompted much interest from companies wanting to build new data centers in Quincy and other parts of central and eastern Washington.

The second round of data centers built in Quincy (the Microsoft and Yahoo expansions, and the Dell and Sabey Data Centers) requested much lower operating hours than did the original data centers, largely because those new data centers were required to comply with the DEEP risk assessment requirements under the revised Ecology regulation.

Given the interest in building several more data centers clustered within the Quincy UGA, and the potential for overlapping DEEP plumes, Ecology's Air Quality Program (AQP) recognized the need to consider the cumulative impacts of new and existing data centers on a community-wide basis (Ecology, 2010). Under the community-wide risk evaluation approach, Ecology estimated background DEEP concentrations by modeling contributions from:

- The existing data centers assuming each of the data centers was operating at their allowed maximum rate; and
- Other known sources of DEEP in the Quincy area (i.e., existing rail lines and state highways).

Section 4 of this document presents Vantage's HIA and includes an evaluation of cumulative DEEP concentrations in Quincy.

3.5 Second Tier Review Processing Requirements

In order for Ecology to review the second tier petition, each of the following regulatory requirements under Chapter 173-460-090 must be satisfied:

(a) The permitting authority has determined that other conditions for processing the NOC Order of Approval have been met, and has issued a preliminary approval order.

(b) Emission controls contained in the preliminary NOC approval order represent at least tBACT.

(c) The applicant has developed a HIA protocol that has been approved by Ecology.

(d) The ambient impact of the emissions increase of each TAP that exceeds ASILs has been quantified using refined air dispersion modeling techniques as approved in the HIA protocol.

(e) The second tier review petition contains a HIA conducted in accordance with the approved HIA protocol.

Ecology provided comments to ICF's HIA protocol (item (c)) on November 22, 2011. These comments were addressed as part of this HIA.

3.6 Second Tier Review Approval Criteria

As specified in WAC 173-460-090(7), Ecology may recommend approval of a project that is likely to cause an exceedance of ASILs for one or more TAPs only if it:

(f) Determines that the emission controls for the new and modified emission units represent tBACT;

(g) The applicant demonstrates that the increase in emissions of TAPs is not likely to result in an increased cancer risk of more than one in one hundred thousand; and

(h) Ecology determines that the non-cancer hazard is acceptable.

The remainder of this document discusses the HIA performed by ICF.

4 Health Impact Assessment

The HIA was conducted according to the requirements of WAC 173-460-090 and guidance provided by Ecology. It addresses the public health risk associated with exposure to DEEP from Vantage's proposed diesel-powered emergency generators and existing sources of DEEP in Quincy, Washington. While the HIA is not a complete risk assessment, it loosely follows the four steps of the standard health risk assessment approach proposed by the National Academy of Sciences (NAS, 1983, 1994). These four steps are: (1) hazard identification, (2) exposure assessment, (3) dose-response assessment, and (4) risk characterization. As described later in this document, the HIA did not consider exposure pathways other than inhalation.

4.1 Hazard Identification

Hazard identification involves gathering and evaluating toxicity data on the types of health injury or disease that may be produced by a chemical, and on the conditions of exposure under which injury or disease is produced. It may also involve characterization of the behavior of a chemical within the body and the interactions it undergoes with organs, cells, or even parts of cells. This information may be of value in determining whether the forms of toxicity known to be produced by a chemical agent in one population group or in experimental settings are also likely to be produced in human population groups of interest. Note that risk is not assessed at this stage. Hazard identification is conducted to determine whether and to what degree it is scientifically correct to infer that toxic effects observed in one setting will occur in other settings (e.g., are chemicals found to be carcinogenic or teratogenic in experimental animals also likely to be so in adequately exposed humans?).

4.1.1 Overview of DEEP Toxicity

Diesel engines emit very small fine (<2.5 micrometers [µm]) and ultrafine (<0.1 µm) particles. These particles can easily enter deep into the lung when inhaled. Mounting evidence indicates that inhaling fine particles can cause numerous adverse health effects.

Studies of humans and animals specifically exposed to DEEP show that diesel particles can cause both acute and chronic health effects including cancer. Ecology has summarized these health effects in Concerns about Adverse Health Effects of Diesel Engine Emissions available at http://www.ecy.wa.gov/pubs/0802032.pdf.

The following health effects have been associated with exposure to diesel particles:

- Inflammation and irritation of the respiratory tract.
- Eye, nose, and throat irritation along with coughing, labored breathing, chest tightness, and wheezing.
- Decreased lung function.
- Worsening of allergic reactions to inhaled allergens.
- Asthma attacks and worsening of asthma symptoms.

- Heart attack and stroke in people with existing heart disease.
- Lung cancer and other forms of cancer.
- Increased likelihood of respiratory infections.
- Male infertility.
- Birth defects.
- Impaired lung growth in children.

It is important to note that the estimated levels of Vantage Data Center related DEEP emissions that will potentially impact people will be much lower than levels associated with many of the health effects listed above. For the purpose of determining whether or not Vantage's project-related and community-wide DEEP impacts are acceptable, non-cancer hazards and cancer risks are quantified and presented in the remaining sections of this document.

4.2 Exposure Assessment

Exposure assessment involves estimating the extent that the public is exposed to a chemical substance emitted from a facility. This includes:

- Identifying routes of exposure.
- Estimating long- and/or short-term off-site pollutant concentrations.
- Identifying exposed receptors.
- Estimating the duration and frequency of receptors' exposure.

4.2.1 Identifying Routes of Potential Exposure

Humans can be exposed to chemicals in the environment through inhalation, ingestion, or dermal contact. The primary route of exposure to most air pollutants is inhalation; however, some air pollutants may also be absorbed through ingestion or dermal contact. Ecology uses guidance provided in California's Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments to determine which routes and pathways of exposure to assess for chemicals emitted from a facility (CalEPA, 2003). Table 4-1 shows a table of chemicals for which Ecology assesses multiple routes and pathway of exposure.

DEEP consists of ultra-fine particles (roughly 0.1 to 1 micron in size) that behave like a gas and do not settle out of the downwind plume by gravity. DEEP particles will eventually be removed from the atmosphere and deposit onto the ground by either molecular diffusion or by being incorporated into rain droplets, but that deposition process is slow and will likely occur many miles downwind of the data center. At those far downwind distances the resulting DEEP concentrations in the surface soil will likely be indistinguishable from regional background values.

It’s possible that very low levels of polycyclic aromatic hydrocarbons (PAHs) and the few other persistent chemicals in DEEP will build up in food crops, soil, and drinking water sources downwind the proposed Vantage Data Center. However, given the very low amounts of PAHs and other multi-exposure route-type TAPs that will be emitted from the data center, quantifying exposures via pathways other than inhalation is very unlikely to yield significant concerns. Further, inhalation is the only route of exposure to DEEP that has received sufficient scientific study to be useful in human health risk assessment. Therefore, in the case of Vantage’s backup engine emissions, only inhalation exposure to DEEP is evaluated.

Table 4-1. California’s Air Toxics Hotspots Risk Assessment Guidance on Specific Pathways to be Analyzed for Each Multi-Pathway Substance SIL Compliance at Facility Boundary

Substance	Ingestion Pathway									
	Soil	Dermal	Meat, Milk & Egg	Fish	Exposed Veg.	Leafy Veg.	Protected Veg.	Root Veg.	Water	Breast Milk
4,4’-Methylene dianiline	X	X		X	X	X	X	X	X	
Creosotes	X	X	X	X	X	X			X	
Diethylhexylphthalate	X	X		X	X	X	X	X	X	
Hexachlorocyclohexanes	X	X		X	X	X			X	
PAHs	X	X	X	X	X	X			X	
PCBs	X	X	X	X	X	X	X	X	X	X
Cadmium & compounds	X	X	X	X	X	X	X	X	X	
Chromium VI & compounds	X	X	X	X	X	X	X	X	X	
Inorganic arsenic & compounds	X	X	X	X	X	X	X	X	X	
Beryllium & compounds	X	X	X	X	X	X	X	X	X	
Lead & compounds	X	X	X	X	X	X	X	X	X	
Mercury & compounds	X	X		X	X	X	X	X	X	
Nickel	X	X	X		X	X	X	X	X	
Fluorides (including hydrogen fluoride)	To be determined									
Dioxins & furans	X	X	X	X	X	X	X		X	X

Notes: veg = vegetable

4.2.2 Estimating Pollutant Concentrations

DEEP emissions may be carried by the wind and may impact people living and working in the immediate area. The level of these pollutants in off-site air depends in part on how much is emitted, wind direction, and other weather-related variables at the time the pollutants are emitted. To estimate where pollutants will disperse after they are emitted from the Vantage Data Center, ICF conducted air dispersion modeling. Air dispersion modeling incorporates emissions, meteorological, geographical, and terrain information to estimate pollutant concentrations downwind from a source.

Each of Vantage's backup engines was modeled as individual discharge points. ICF used the following model inputs to estimate ambient impacts:

- American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) with Plume Rise Model Enhancements (PRIME) algorithm for building downwash.
- Five years sequential hourly meteorological data from Moses Lake Airport (2004-2008).
- Twice-daily upper air data from Spokane (2004-2008) to define mixing heights.
- Quincy area digital elevation model (DEM) files (which describe local topography and terrain).
- Quincy area digital land classification files (which describe surface characteristics).
- Each engine's emissions were modeled with a stack height of 41 feet above local ground level and a stack inside diameter of 26 inches. Engine-specific exhaust gas temperature and velocity were used.
- The data center building dimensions were included to account for building downwash.
- Two sets of receptors were considered in the AERMOD modeling:
- The receptor grid for the AERMOD modeling domain at or beyond the facility boundary was established using a 10-meter grid spacing along the facility boundary extending to a distance of 350 meters from each of the stacks. A grid spacing of 25 meters was used for distances 350 to 800 meters from the stacks. Grid spacing of 50 meters was used for distances 800 to 2000 meters from the stacks.
- Additional modeling receptors were placed on the rooftops of each building within the Vantage property that is expected to be leased by tenants. These receptors are considered to be "ambient air" receptors and were placed at the air intake systems that feed outside air into occupied office space.
- Plume Volume Molar Ratio Method (PVMRM) option, which is used to model the conversion of NO_X to NO_2. One-hour NO_2 concentrations were modeled using PVMRM module, with default concentrations of 40 parts per billion (ppb) of ozone, and an equilibrium NO_2/NO_X ambient ratio of 90%. For purposes of modeling NO_2 impacts, the primary NO_X emissions at each generator load were adjusted to assume a distinct "primary NO_2 ratio" based on the permitted emission limits at each load. The percent of NO_2 by mass was approximately 32% for a 10% load, and 7.6, 7.3 and 7.1%, respectively, for 81, 90 and 93% loads.

- The maximum-annual emission rates used to evaluate ASIL compliance and chronic (non-cancer) risk assume the facility will conduct commissioning testing, routine operations, storm avoidance and outages, and triennial stack emission testing within a 12-month period. The “maximum-annual” emission rates are 1.27 times higher than the “routine annual” emission rates caused solely by routine operations plus storm avoidance plus outages. Therefore, the “maximum annual” ambient impacts were calculated by scaling the “routine annual” AERMOD results by the 1.27 scale factor.
- The 70-year average DEEP emission rate used to assess the 70-year average DEEP cancer risk was calculated by annualizing the initial commissioning testing over the 70-year period, then adding the “routine annual” emissions, then adding the annualized triennial stack emission testing emissions over a 3-year period. The 70-year annual average emissions from these activities were distributed evenly across every generator at the facility. The AERMOD modeling for all non-emergency testing done at the facility was restricted to 7:00 a.m. to 7:00 p.m.

ICF modeled both short- and long-term impacts to demonstrate compliance with National Ambient Air Quality Standards (NAAQS) and derive DEEP concentrations for the HIA. Because the Vantage Data Center’s emissions are intermittent, several operating scenarios were assumed when estimating ambient impacts.

For the purpose of estimating maximum annual DEEP concentrations, ICF used the sum of emissions from each operating scenario shown in Table 2-1. For various testing modes, as well as for the outage scenario, modeling at idle load was included to account for cool-down of the generators after operation. Cool-down is assumed to be at 10% idle.

Because maximum 1-hour NO_2 concentrations would likely occur during a power outage, ICF assumed all 17 generators were operating for the purpose of estimating maximum 1-hour NO_2 concentrations. Details of the ambient impacts analysis conducted by ICF are found in the NOC application materials (ICF 2012).

4.2.3 Identifying Potentially Exposed Receptors

As described in Section 2.2, the proposed Vantage facility is located among other commercial/industrial-zoned properties, but several different land uses are located within the vicinity of Vantage’s property. Most importantly, two existing farm houses are on industrially zoned land adjacent to the data center. ICF identified locations where people could be exposed to project-related emissions. Typically, Ecology considers exposures occurring at maximally exposed boundary, residential, and commercial areas to capture worst-case exposure scenarios.

Receptors Maximally Exposed to DEEP

Table 4-2 shows maximally exposed receptors of different types and the direction and distance from the proposed data center. These receptors represent locations of various land uses that are most impacted by DEEP emissions from the facility. This table also shows the estimated 70-year average exposure concentration at each maximally exposed receptor. Note that because these are 70-year average values, they have not been multiplied by the factor of 1.27.

Table 4-2. Maximally Exposed Receptors–70-Year Average DEEP

Receptor Type	Direction From Nearest Project-Specific DEEP Emission Source	Estimated Distance From Nearest Project-Specific DEEP Emission Source		Estimated Vantage-Only Increase in 70-Year Average DEEP Concentration (µg/m^3) at Receptor Location
		Feet	Meters	
Point of Maximum Off-Site Impact[a]	East (unoccupied farm land at eastern facility boundary)	656	200	0.042
Maximum Impacted Residence - Closest Property Line (Existing)[b]	South-southwest	590	180	0.031
Maximum Impacted Residence - Structure (Existing)[b]	South-southwest	766	234	0.018
Maximum Off-Site Impacted Business/Office (Sabey Data Center)	South	902	275	0.026
Maximum On-Site Tenant Rooftop Impact (Bldg 1)	Rooftop of Building 1			0.047

[a] *East fenceline, approximately 440 meters north of the southern property line.*
[b] *Near the southwest corner of the Vantage property.*

Figure 4-1 shows a color-coded map of estimated annual average off-site DEEP concentrations attributable solely to Vantage's DEEP emissions. This figure represents the ambient impacts of Vantage's project and each of the maximally exposed receptors representing different land uses. The concentrations at the Maximally Impacted Boundary Receptor (MIBR), Maximally Impacted Residential Receptor (MIRR), and Maximally Impacted Commercial Receptor (MICR) are highlighted. The modeling indicates that Vantage's emissions impact two existing residences (the existing homes at the southwest and southeast corners of the data center) at a level exceeding the ASIL. The blue contour line (0.003 ug/m^3) represents the ASIL. The DEEP impacts at all locations outside the blue contour are forecast to be exposed to concentrations less than the ASIL.

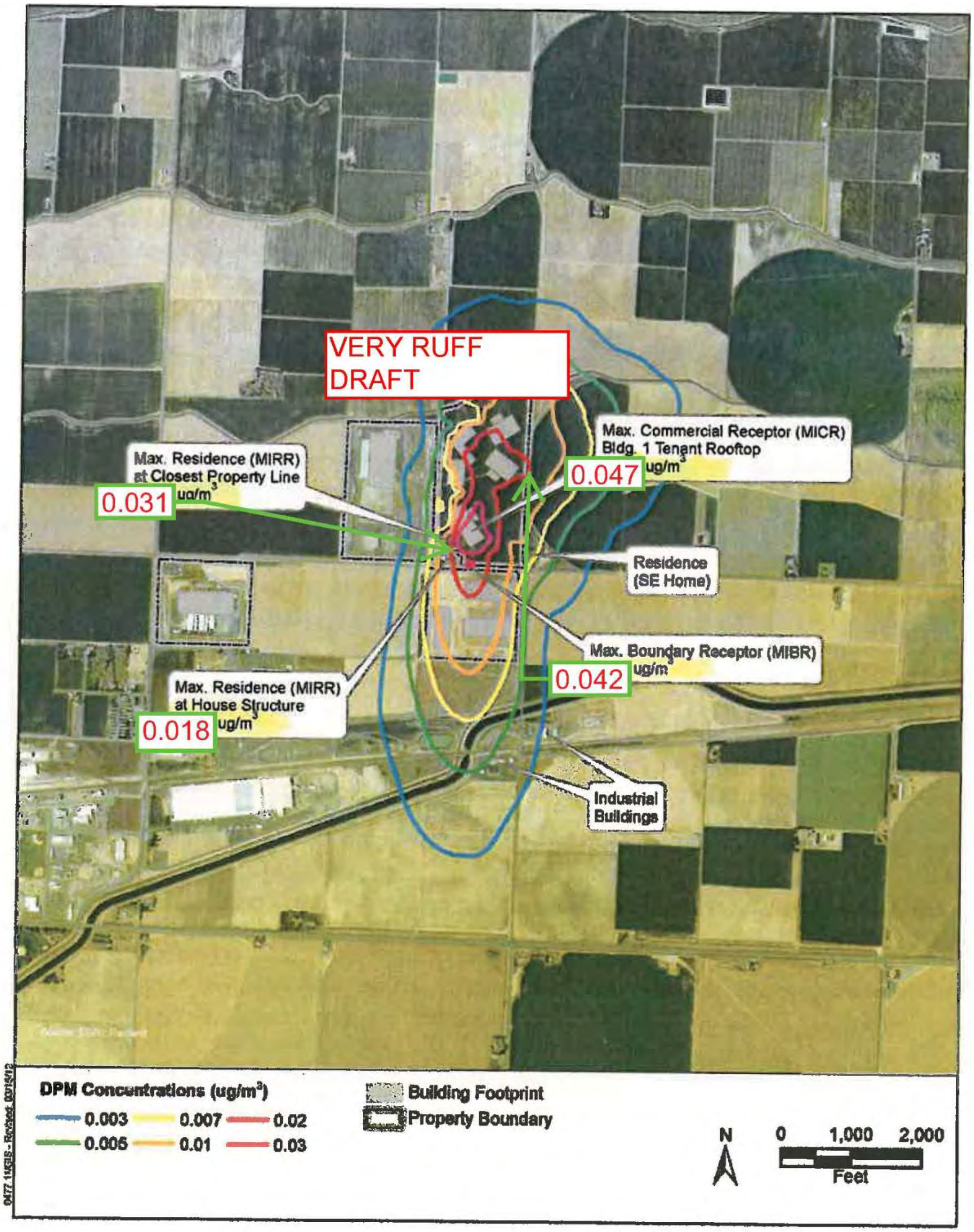
4.2.4 Exposure Frequency and Duration

The likelihood that someone is exposed to DEEP from Vantage's backup diesel engines depends on local wind patterns (meteorology), how frequently engines operate, and how much time people spend in the immediate area. As discussed previously, the air dispersion model uses emissions and meteorology information (and other assumptions) to determine ambient DEEP concentrations in the vicinity of the proposed Vantage Data Center.

This analysis considers the land use surrounding the Vantage facility to estimate the amount of time a given receptor could be exposed. For example, people are more likely to be exposed frequently and for a longer duration if the source impacts residential locations because people spend much of their time at home. People working in offices or commercial buildings in the area are likely only exposed to data center related emissions during the hours that they spend working near the facility.

This analysis uses simplified assumptions about receptors' exposure frequency and duration and assumes that people located at residential receptors are potentially continuously exposed, meaning they never leave their property. These behaviors are not typical; however, these assumptions are intended to avoid underestimating exposure so that public health protection is ensured. Workplace and other nonresidential exposures are also considered, but adjustments are often made because the amount of time that people spend at these locations is more predictable than time spent at their homes. These adjustments are presented in Section 4.4.2 of this document when quantifying cancer risk from intermittent exposure to DEEP.

Figure 4-1. DEEP Concentrations Caused Solely by Vantage Data Center Emissions.



4.2.5 Background Exposure to Pollutants of Concern

WAC 173-460-090 states, “Background concentrations of TAPs will be considered as part of a second tier review.” The word “background” is often used to describe exposures to chemicals that come from existing sources, or sources other than those being assessed.

Given the renewed interest in building data centers within the Quincy UGA, Ecology has determined that the cumulative risk of all sources of DEEP (including existing and proposed data centers’ emissions) should be considered during the permitting process.

To support this analysis, Ecology used an EPA-recommended dispersion model, AERMOD, to estimate concentrations of DEEP in Quincy emitted from all known sources in the City (Bowman, 2012). These sources include the Vantage Data Center and all other existing data centers, locomotives traveling on the Burlington Northern–Santa Fe (BNSF) rail line, trucks on State Routes 281 and 28, and the permitted emissions from existing data centers: Yahoo!, Microsoft, Intuit, Dell, and Sabey. Data center emissions were derived from existing permits from Microsoft (2010), Yahoo! (2011), Intuit (2007), Dell (2011) and Sabey (2011). The rail and highway emissions were taken from 2008 emissions inventories.

4.2.6 Cumulative Exposure to DEEP in Quincy

Table 4-3 (Bowman, 2012) shows the calculated cumulative DEEP concentrations near the location of the proposed Vantage Data Center based on allowable emissions from all existing permits, proposed Vantage emissions, rail, and highway emissions. As shown in Figure 4-1, Vantage’s DEEP contribution disperses to negligible values within roughly 0.50 mile of the data center.

The maximum cumulative concentration at a residentially zoned parcel near the Vantage Data Center is 0.101 $\mu g/m^3$ (about 31 times the DEEP ASIL). This is at the SW home, at the property line closest to the data center. It is important to note that the ambient levels of DEEP estimated by Ecology are based on allowable (permitted) emissions instead of actual emissions. Actual emissions are likely to be much lower than what the facilities are permitted, but worst-case emissions were used to avoid underestimating cumulative DEEP exposure concentrations.

Table 4-3. Maximally Exposed Receptors–70-Year Average Cumulative Annual DEEP

Attributable To	Annual DEEP Concentration (µg/m^3) at Various Receptor Locations – Vantage Receptors					
	Fence Line Receptor	Current Home (SW) at Structure	Current Home (SW) at Property Boundary	Current Home (SE)	Off-Site Workplace (Sabey Data Center)	Vantage Tenants Within Vantage Facility
Vantage (70-year average including initial commissioning testing plus triennial stack compliance testing)	0.042	0.018	0.031	0.009	0.026	0.047
Railroads, highways, and existing data centers (Sabey, Yahoo!, Intuit, Dell, Microsoft)	0.082	0.079	0.070	0.055	0.078	0.066
Cumulative (Post-project)	0.124	0.097	0.101	0.064	0.104	0.113

4.3 Dose-Response Assessment

Dose-response assessment describes the quantitative relationship between the amounts of exposure to a substance (the dose) and the incidence or occurrence of injury (the response). The process often involves establishing a toxicity value or criterion to use in assessing potential health risk.

4.3.1 Dose-Response Assessment for DEEP

EPA and California Office of Environmental Health Hazard Assessment (OEHHA) developed toxicological values for DEEP evaluated in this project (EPA 2002; EPA 2003; CalEPA 1998). These toxicological values are derived from studies of animals that were exposed to a known amount (concentration) of DEEP, or from epidemiological studies of exposed humans, and are intended to represent a level at or below which adverse non-cancer health effects are not expected, and a metric by which to quantify increased risk from exposure to a carcinogen. Table 4-4 shows DEEP non-cancer and cancer toxicity values.

EPA's reference concentration (RfC) and OEHHA's reference exposure level (REL) for diesel engine exhaust (measured as DEEP) was derived from dose-response data on inflammation and changes in the lung from rat inhalation studies. Each agency established a level of 5 µg/m^3 as the concentration of DEEP in air at which long-term exposure is not expected to cause adverse non-cancer health effects.

NAAQS and other regulatory toxicological values for short- and intermediate-term exposure to particulate matter have been promulgated, but values specifically for DEEP exposure at these intervals do not currently exist.

OEHHA derived a unit risk factor (URF) for estimating cancer risk from exposure to DEEP. The URF is based on a meta-analysis of several epidemiological studies of humans occupationally exposed to DEEP. URFs are expressed as the upper-bound probability of developing cancer, assuming continuous lifetime exposure to a substance at a concentration of one microgram per cubic meter (1 $\mu g/m^3$), and are expressed in units of inverse concentration i.e., $(\mu g/m^3)^{-1}$. OEHHA's URF for DEEP is 0.0003 $(\mu g/m^3)^{-1}$ meaning that a lifetime of exposure to 1 $\mu g/m^3$ of DEEP results in an increased individual cancer risk of 0.03% or a population cancer risk of 300 excess cancer cases per million people exposed.

Table 4-4. Toxicity Values Used to Assess and Quantify Non-Cancer Hazard and Cancer Risk

Pollutant	Agency	Non-Cancer	Cancer
DEEP	U.S. Environmental Protection Agency	RfC = 5 µg/m3	NAa
	California EPA–Office of Environmental Health Hazard Assessment	Chronic REL = 5 µg/m3	URF = 0.0003 per µg/m3

[a] *EPA considers DEEP to be a probable human carcinogen, but has not established a cancer slope factor or unit risk factor.*

4.4 Risk Characterization

Risk characterization involves the integration of data analyses from each step of the HIA to determine the likelihood that the human population in question will experience any of the various forms of toxicity associated with a chemical under its known or anticipated conditions of exposure.

4.4.1 Evaluating Non-cancer Hazards

In order to evaluate the potential for non-cancer adverse health effects that may result from exposure to air pollutants, exposure concentrations at each receptor location are compared to relevant non-cancer toxicological values (i.e., RfC, REL). If a concentration exceeds the RfC or REL, this indicates only the potential for adverse health effects. The magnitude of this potential can be inferred from the degree to which this value is exceeded. This comparison is known as a hazard quotient (HQ) and is given by the equation below:

$$HQ = \frac{\text{concentration of pollutant in air } (\mu g/m3)}{\text{RfC or REL}}$$

A HQ of one or less indicates that the exposure to a substance is not likely to result in adverse non-cancer health effects. As the HQ increases above one, the probability of human health effects increases by an undefined amount. However, it should be noted that a HQ above one is not necessarily indicative of health impacts due to the application of uncertainty factors in deriving toxicological reference values (e.g., RfC and REL).

Hazard Quotient–DEEP

The chronic HQ for DEEP exposure is calculated using the following equation:

$$\text{Chronic HQ} = \frac{\underline{\text{annual average DEEP concentration } (\mu g/m^3)}}{5\ \mu g/m^3}$$

HQs were calculated for the maximally exposed residential and workplace receptors. Because chronic toxicity values (RfCs and RELs) are based on a continuous exposure, an adjustment is sometimes necessary or appropriate to account for people working at commercial properties who are exposed for only eight hours per day, five days per week. While EPA risk assessment guidance recommends adjusting to account for periodic instead of continuous exposure, OEHHA does not employ this practice. For the purpose of this evaluation, an RfC or REL of 5 $\mu g/m^3$ was used as the chronic risk-based concentration for all scenarios where receptors could be exposed frequently (e.g., residences, work places, or schools).

Table 4-5 shows chronic HQs at the maximally exposed receptors near the Vantage Data Center attributable to DEEP exposure from all sources. HQs are several-fold lower than unity for all receptors' cumulative exposure to DEEP. This indicates adverse non-cancer effects are not likely to result from chronic exposure to DEEP emitted from the Vantage Data Center and other local sources.

Note: the Vantage-only annual DEEP values are the "maximum-annual" impacts that assume Vantage will conduct routine operations, storm avoidance plus outages, generator commissioning, and triennial stack emission testing during the same 12-month period.

Table 4-5. Chronic Non-Cancer Hazards for Residential and Occupational Scenarios (Maximum Year).

Attributable To:	Chronic Hazard Quotient at Various Receptor Locations					
	Fence Line Receptor	Current Home (SW) at Structure	Current Home (SW) at Property Boundary	Current Home (SE)	Off-Site Workplace	Vantage Tenants Within Vantage Facility
Vantage (highest annual average including initial commissioning testing plus triennial stack compliance testing)	0.0106	0.0046	0.0078	0.0023	0.0066	0.0119
Railroads, highways, and existing data centers (Sabey, Yahoo!, Intuit, Dell, Microsoft)	0.0164	0.0158	0.0140	0.0110	0.0156	0.0132
Cumulative (Post-project)	0.0270	0.0204	0.0218	0.0133	0.0222	0.0251

Combined Hazard Quotient for All Pollutants Whose Emission Rates Exceed SQER

Three toxic air pollutants emitted by the Vantage Data Center have the potential to cause acute or chronic non-cancer inhalation health risks: DEEP, NO_2, and acrolein. The receptor locations of concern are the maximally impacted boundary receptor (MIBR), the on-site tenant rooftop locations or maximally impacted commercial receptors (MICR), and the property line of the adjacent residential location or maximally impacted residential receptor (MIRR). Tables 4-6 through 4-8 show modeled concentrations, risk-based concentrations (RBCs), and HQs at each receptor point. All modeled concentrations and RBCs are in µg/m3. The hazard index (HI) for each location is the sum of 1-hour time-weighted average (TWA) HQs for NO_2, ammonia, acrolein, and the chronic HQ of DEEP.

Table 4-6 shows the impacts at the MIBR for $NO_{2,}$ ammonia, and acrolein during a facility-wide power outage. The MICR location for these pollutants occurs in unoccupied cropland, roughly 100 meters north of the northern facility boundary. As listed in Table 4-6, the acute HI of approximately 0.7 and the chronic HQ of approximately 0.011 are much lower than 1.0. This indicates that the MIBR is not likely to experience either acute or chronic non-cancer adverse health effects attributable to emissions from Vantage.

Table 4-6. Non-cancer Hazards of Vantage Emissions at the Maximally-Exposed Location at or Beyond the Facility Boundary (MIBR)

<table>
<tr><th colspan="4">NO_2</th></tr>
<tr><td>NO_2 Concentration</td><td>345 (Max 1-hr TWA)</td><td colspan="2" rowspan="3"></td></tr>
<tr><td>RBC</td><td>REL = 470</td></tr>
<tr><td>HQ</td><td>0.734</td></tr>
<tr><th colspan="4">DEEP</th></tr>
<tr><td>DEEP Concentration</td><td rowspan="3"></td><td colspan="2">0.053 (Max annual TWA)</td></tr>
<tr><td>RBC</td><td>RfC = 5</td><td>REL = 5</td></tr>
<tr><td>HQ</td><td>0.0106</td><td>0.0106</td></tr>
<tr><th colspan="4">Acrolein</th></tr>
<tr><td>Acrolein Concentration</td><td>0.0037 (Max 1-hr TWA)</td><td colspan="2" rowspan="3"></td></tr>
<tr><td>RBC</td><td>REL = 2.5</td></tr>
<tr><td>HQ</td><td>0.0015</td></tr>
<tr><th colspan="4">Ammonia</th></tr>
<tr><td>Ammonia Concentration</td><td>56.2 (Max 1-hr TWA)</td><td colspan="2" rowspan="3"></td></tr>
<tr><td>RBC</td><td>REL = 3,200</td></tr>
<tr><td>HQ</td><td>0.018</td></tr>
<tr><th colspan="4">Combined Pollutants</th></tr>
<tr><td rowspan="2">Combined Pollutant Hazard Index</td><td>Max 1-hr Acute Hazard</td><td colspan="2">Max Chronic Hazard</td></tr>
<tr><td>0.734</td><td colspan="2">0.0106</td></tr>
</table>

Table 4-7 shows the HIs at the rooftop of Building 1, which is the MICR and the location of the maximum impact for annual DEEP. As listed in Table 4-7, the acute HI of approximately 0.5 and the chronic HQ of 0.012 are both lower than 1.0. This indicates that the MICR is not likely to experience either acute or chronic non-cancer adverse health effects attributable to emissions from Vantage.

Table 4-7. Non-cancer Hazards of Vantage Emissions at the at the On-Site Tenant Rooftops (MICR)

<table>
<tr><th colspan="4">NO_2</th></tr>
<tr><td>NO_2 Concentration</td><td>236 (Max 1-hr TWA)</td><td colspan="2"></td></tr>
<tr><td>RBC</td><td>REL = 470</td><td colspan="2"></td></tr>
<tr><td>HQ</td><td>0.501</td><td colspan="2"></td></tr>
<tr><th colspan="4">DEEP</th></tr>
<tr><td>DEEP Concentration</td><td></td><td colspan="2">0.060 (Max annual TWA)</td></tr>
<tr><td>RBC</td><td></td><td>RfC = 5</td><td>REL = 5</td></tr>
<tr><td>HQ</td><td></td><td>0.012</td><td>0.012</td></tr>
<tr><th colspan="4">Acrolein</th></tr>
<tr><td>Acrolein Concentration</td><td>0.0035 (Max 1-hr TWA)</td><td colspan="2"></td></tr>
<tr><td>RBC</td><td>REL = 2.5</td><td colspan="2"></td></tr>
<tr><td>HQ</td><td>0.0014</td><td colspan="2"></td></tr>
<tr><th colspan="4">Ammonia</th></tr>
<tr><td>Ammonia Concentration</td><td>53.2 (Max 1-hr TWA)</td><td colspan="2"></td></tr>
<tr><td>RBC</td><td>REL = 3,200</td><td colspan="2"></td></tr>
<tr><td>HQ</td><td>0.017</td><td colspan="2"></td></tr>
<tr><th colspan="4">Combined Pollutants</th></tr>
<tr><td rowspan="2">Combined Pollutant Hazard Index</td><td>Max 1-hr Acute Hazard</td><td colspan="2">Max Chronic Hazard</td></tr>
<tr><td>0.501</td><td colspan="2">0.012</td></tr>
</table>

Table 4-8, the acute HI of approximately 0.6 and the chronic HQ of 0.007 are both lower than 1.0. This indicates that the MIRR is not likely to experience either acute or chronic non-cancer adverse health effects attributable to emissions from Vantage.

Table 4-8. Non-cancer Hazards of Vantage Emissions at the at Property Line of the Maximally-Exposed Residential Receptor (MIRR)

NO_2			
NO_2 Concentration	291 (Max 1-hr TWA)		
RBC	REL = 470		
HQ	0.62		
DEEP			
DEEP Concentration		0.039 (Max annual TWA)	
RBC		RfC = 5	REL = 5
HQ		0.0078	0.0078
Acrolein			
Acrolein Concentration	0.0037 (Max 1-hr TWA)		
RBC	REL = 2.5		
HQ	0.0015		
Ammonia			
Ammonia Concentration	53.2 (Max 1-hr TWA)		
RBC	REL = 3,200		
HQ	0.017		
Combined Pollutants			
Combined Pollutant Hazard Index	Max 1-hr Acute Hazard	Max Chronic Hazard	
	0.62	0.0078	

This information suggests that both chronic and acute health effects are unlikely to occur even under worst-case conditions at the maximally impacted locations. The primary hazard is from acute exposure to NO_2. At times when unfavorable air dispersion conditions occur coincident with electrical grid transmission failure to Vantage, the combined HQs (i.e., the hazard index) from NO_2, ammonia, and acrolein are modeled to be less than one (1). If the HI is less than one, then the risk is generally considered acceptable.

4.4.2 Quantifying an Individual's Increased Cancer Risk

Cancer Risk from Exposure to DEEP

Cancer risk is estimated by determining the concentration of DEEP at each receptor point and multiplying it by its respective URF. Because URFs are based on a continuous exposure over a 70-year lifetime, exposure duration and exposure frequency are important considerations.

The formula used to determine cancer risk is as follows:

$$\text{Risk} = \frac{C_{Air} \text{ x URF x EF1 x EF2 x ED}}{\text{AT}}$$

Where:

Parameter	Description	Value Based on Receptor Type					Units
		Residential	Worker	School-Staff	School-Student	Boundary	
CAir	Concentration in air at the receptor	See Table 4-3					µg/m3
URF	Unit Risk Factor	0.0003					(µg/m3)-1
EF1	Exposure Frequency	365	250	200	180	250	days/year
EF2	Exposure Frequency	24	8	8	8	2	hours/day
ED	Exposure Duration	70	40	40	7 (Elem) 4 (HS & College)	30	years
AT	Averaging Time	25550					days

Based on the factors listed above, Table 4-9 shows the resulting Unit Risk Factor for each exposure scenario.

Table 4-9. Exposure Assumptions and Unit Risk Factors for Diesel Particulate Matter Risk Assessment.

Receptor Type	Annual Exposure	Exposure Duration	Diesel Particulate Matter Cancer Unit Risk Factor (risk per million, per annual µg/m3 DEEP)
Unoccupied Land	2 hours/day 250 days/year	30 years	7.3-per-million cancer risk per µg/m3 DEEP
Residences	24 hours/day 365 days/year	70 years	300-per-million cancer risk per µg/m3 DEEP
Schools (College Students)	36 hours/week 40 weeks/year	4 years	2.8-per million risk per µg/m3 DEEP
Schools (High School Students)	36 hours/week 40 weeks/year	4 years	2.8-per-million risk per µg/m3 DEEP
Schools (Elementary School Students)	36 hours/week 40 weeks/year	7 years	4.9-per-million risk per µg/m3 DEEP
Schools (All Teachers)	40 hours/week 40 weeks/year	40 years	31-per-million risk per µg/m3 DEEP
Churches	2 hours/week 52 weeks/year	40 years	2-per-million risk per µg/m3 DEEP
Business	8 hours/day 250 days/year	40 years	38-per-million risk per µg/m3 DEEP

Current regulatory practice assumes that a very small dose of a carcinogen will give a very small cancer risk. Cancer risk estimates are, therefore, not yes or no answers but measures of chance (probability). Such measures, however uncertain, are useful in determining the magnitude of a cancer threat because any level of a carcinogenic contaminant carries an associated risk. The validity of this approach for all cancer-causing chemicals is not clear. Some evidence suggests that certain chemicals considered carcinogenic must exceed a threshold of tolerance before initiating cancer. For such chemicals, risk estimates are not appropriate. Guidelines on cancer risk from EPA reflect the potential that thresholds for some carcinogenesis exist. However, EPA still assumes no threshold unless sufficient data indicate otherwise.

In this document, cancer risks are reported using scientific notation to quantify the increased cancer risk of an exposed person, or the number of excess cancers that might result in an exposed population. For example, a cancer risk of 1×10^{-6} means that if 1,000,000 people are exposed to a carcinogen, one excess cancer might occur, or a person's chance of getting cancer in their lifetime increases by one in one million or 0.0001%. The reader should note that these estimates are for excess cancers that might result in addition to those normally expected in an unexposed population. Cancer risks quantified in this document are upper-bound theoretical estimates. In other words, each is the estimate of the plausible upper limit, or highest likely true value of the quantity of risk.

The following table (Table 4-10) shows ranges of estimated worst-case residential, business, and fence line receptor increased cancer risks attributable to DEEP exposure near the proposed Vantage facility. Cancer risks attributable to the data center project are less than one in one hundred thousand (1×10^{-5}). The highest risk occurs at the closest property line of the existing dwelling located to the southwest of the proposed facility (9.2×10^{-6}). The maximum cancer risk at the house itself, which is located well inside the property line, is much lower at only 5.4×10^{-6}. Under Chapter 173-460 WAC, Ecology may recommend approval of a project if the applicant demonstrates that the increase in emissions of TAPs is not likely to result in an increased cancer risk of more than one in one hundred thousand (1×10^{-5}).

As part of the community-wide approach in Quincy, Ecology also considers the cumulative impacts of DEEP emissions in the Quincy UGA. Ecology established a cumulative risk management goal of 100 excess cancer cases in one million people exposed (1×10^{-4}) representing the cumulative level of concern for Quincy residents (also called an “ample margin of safety”) above which a new source of DEEP would not be approved to locate in Quincy, without requiring offsets or other mitigation. It therefore represents a limit on permissible DEEP-associated cancer risk to the community. Note that Chapter 173-460 WAC does not currently contain a numerical limit on allowable cumulative cancer risks.

Bowman (2012) modeled the cumulative DEEP concentrations for Vantage and the other existing data centers. The cumulative modeling also included emissions from the railways and state highways in Quincy. The results, as shown in Table 4-10, indicate that the cumulative cancer risk for the maximally impacted current residential receptor near the Vantage Data Center is approximately 30 in one million. This is also the maximum value for east Quincy. This risk occurs at existing residence to the southwest of the facility. This residence is more impacted by allowable DEEP emissions from the combined data centers in the northeastern industrial area of Quincy and by the local railroads and highways. The maximum cumulative cancer risk at existing commercial business near the Vantage Data Center, including the tenants leasing data center space within the facility, are much lower than 10 in one million.

Because these cumulative risks are less than 100 in one million, the cumulative risks attributable to Vantages’ project are permissible under Ecology’s city-wide risk policy.

Note, the Vantage-only 70-year average DEEP values account for all of Vantage’s operating modes: routine testing, power outages, generator commissioning annualized over 70 years, and triennial stack emission testing annualized over 3 years.

Table 4-10. Estimated Increased Cancer Risk for Residential, Occupations, and Student Scenarios

Attributable To:	Risk Per Million From DEEP Exposure at Various Receptor Locations					
	Fence Line Receptor	Current Home (SW) at Structure	Current Home (SW) at Property Boundary	Current Home (SE)	Off-Site Workplace	Vantage Tenants Within Vantage Facility
Vantage	0.3	5.4	9.3	2.7	1.0	1.8
Railroads, highways, and existing data centers (Sabey, Yahoo!, Intuit, Dell, Microsoft)	0.6	23.7	21.0	16.5	3.0	2.5
Cumulative (Post-project)	0.9	29.1	30.3	19.2	4.0	4.3

Based on the estimated emissions of all potentially carcinogenic compounds from the proposed data center alone, the emission rates for most of the carcinogenic constituents are less than Ecology's small quantity emission rates (SQERs) except for DEEP. The SQERs are Ecology's screening threshold emission rates below which the WAC 173-460 regulation indicates there is negligible potential for ambient air quality impacts. The maximum permitted emission rates for most toxic pollutants emitted at the Vantage Data Center are less than their respective SQERs. Regardless of the SQER comparison, the emission rate for every carcinogenic constituent was considered in the cumulative cancer analysis, which is shown in Table 4-11.

Table 4-11. Cancer Risk Caused by All Emitted Carcinogens at the SW Home RME Receptor (at the Property Boundary)

Carcinogen	Annual Emissions (tons/year)	SQER (tons/year)	Emissions/SQER Ratio	Concentration at SW Home Receptor (µg/m3)	ASIL ($\mu g/m^3$)	Cancer Risk (per Million)
DEEP	474	0.639	742.1	3.00E-02	3.33E-03	9.3
Benzene	3.87	6.62	0.5840	2.45E-04	3.45E-02	7.09E-03
1,3-Butadiene	0.0976	1.13	0.0863	6.17E-06	5.88E-03	1.05E-03
Formaldehyde	0.3927	32	0.0123	2.48E-05	1.67E-01	1.49E-04
Acetaldehyde	0.1256	71	0.0018	7.95E-06	3.70E-01	2.15E-05
Benzo(a)Pyrene	0.0006	0.174	0.0037	4.05E-08	9.09E-04	4.45E-05
Benzo(a)anthracene	0.0031	1.74	0.0018	1.95E-07	9.09E-03	2.15E-05
Chrysene	0.0762	17.4	0.0044	4.82E-06	9.09E-02	5.30E-05
Benzo(b)fluoranthene	0.0055	1.74	0.0032	3.50E-07	9.09E-03	3.85E-05
Benzo(k)fluoranthene	0.0005	1.74	0.0003	3.43E-08	9.09E-03	3.78E-06
Dibenz(a,h)anthracene	0.0009	0.16	0.0054	5.46E-08	9.09E-04	6.00E-05
Ideno(1,2,3-cd)pyrene	0.0010	1.74	0.0006	6.53E-08	9.09E-03	7.18E-06
Combined Cancer Risk From All Constituents						9.3

As indicated in Table 4-11, the cancer risk associated with DEEP alone at the SW home is 9.3 per million. The other recognized carcinogenic compounds contribute negligibly to the overall cancer risk (i.e., less than 0.008 per million). The combined cancer risk caused by all constituents is 9.3 per million.

5 Uncertainty Characterization

Many factors of the HIA are prone to uncertainty. Uncertainty relates to the lack of exact knowledge regarding many of the assumptions used to estimate the human health impacts of DEEP emissions from Vantage's backup generators and "background" sources of DEEP in Quincy. The assumptions used in the face of uncertainty may tend to over- or underestimate the health risks estimated in the HIA.

5.1 Emission Factor and Exposure Uncertainty

One of the major uncertainties is the emission factors for toxic air pollutants emitted by diesel generators. The forecast emission rates for particulate matter used for this analysis was based on emission test data conducted by the applicant on the same type of engines proposed for the Quincy facility. For this analysis it was conservatively assumed that all of the particulate matter emitted from diesel generators is DEEP, with the highest level of cancer potency. The forecast emission rates for NO_2 were also based on emission testing data for the same model generator. The forecast emission rate for ammonia is based on a conservatively high estimate of ammonia slip concentrations. However, the emission rates for the other toxic air pollutants were based on published emission factor data from EPA. Those EPA emission factors are believed to be conservatively high because they were developed based on historical testing of older-technology engines.

It is difficult to characterize the amount of time that people can be exposed to DEEP emissions from the proposed Vantage Data Center. For simplicity, this analysis assumed a residential receptor is at one location for 24 hours per day, 365 days per year for 70 years. These assumptions tend to overestimate exposure.

The duration and frequency of power outages is also uncertain. Vantage estimates that they will use the generators during emergency outages or storm avoidance for no more than 24 hours per year. Since 2003 the average outage for all Grant County PUD power customers has been about 2.5 hours per year. While this small amount of power outage provides some comfort that power service is relatively stable, Vantage cannot predict future outages with any degree of certainty. Vantage accepted a limit of 24 hours per year for combined emergency operations and storm avoidance and estimated that this limit should be more than sufficient to meet their emergency demands.

5.2 Air Dispersion Modeling Uncertainty

The transport of pollutants through the air is a complex process. Regulatory air dispersion models are developed to estimate the transport and dispersion of pollutants as they travel through the air. The models are frequently updated as techniques that are more accurate become known but are written to avoid underestimating the modeled impacts. Even if all of the numerous input parameters to an air dispersion model are known, random effects found in the real atmosphere will introduce uncertainty. Typical of the class of modern steady-state Gaussian dispersion models, the AERMOD model used for the Vantage Data Center analysis will likely slightly overestimate the short-term (24-hour average) impacts and somewhat underestimate the annual concentrations. The expected magnitude of the uncertainty is probably similar to the emissions uncertainty and much lower than the toxicity uncertainty.

5.3 Toxicity Uncertainty

One of the largest sources of uncertainty in any risk evaluation is associated with the scientific community's limited understanding of the toxicity of most chemicals in humans following exposure to the low concentrations generally encountered in the environment. To account for uncertainty when developing toxicity values (e.g., RfCs), EPA and other agencies apply "uncertainty" factors to doses or concentrations that were observed to cause adverse non-cancer effects in animals or humans. EPA applies these uncertainty factors so that they derive a toxicity value that is considered protective of humans including susceptible populations. In the case of EPA's DEEP RfC, EPA acknowledges (EPA, 2002):

> *".. the actual spectrum of the population that may have a greater susceptibility to diesel exhaust (DE) is unknown and cannot be better characterized until more information is available regarding the adverse effects of diesel particulate matter (DPM) in humans*."

Quantifying DEEP cancer risk is also uncertain. Although EPA classifies DEEP as probably carcinogenic to humans, they have not established a URF for quantifying cancer risk. In their health assessment document, EPA determined that "human exposure-response data are too uncertain to derive a confident quantitative estimate of cancer unit risk based on existing studies." However, EPA suggested that a URF based on existing DEEP toxicity studies would range from 1×10^{-5} to 1×10^{-3} per µg/m^3. OEHHA's DEEP URF (3×10^{-4} per µg/m^3) falls within this range. Regarding the range of URFs, EPA states in their health assessment document for diesel exhaust (EPA, 2002):

> "*Lower risks are possible and one cannot rule out zero risk. The risks could be zero because (a) some individuals within the population may have a high tolerance to exposure from [diesel exhaust] and therefore not be susceptible to the cancer risk from environmental exposure, and (b) although evidence of this has not been seen, there could be a threshold of exposure below which there is no cancer risk*."

Other sources of uncertainty cited in EPA's health assessment document for diesel exhaust are:

- Lack of knowledge about the underlying mechanisms of DEEP toxicity.
- The question of whether historical toxicity studies of DEEP based on older engines is relevant to current diesel engines. It is likely that the mixture of pollutants emitted by new technology diesel engines (such as those proposed by Vantage) is different than that of older technology engines.

Table 5-1 presents a summary of how the uncertainty affects the quantitative estimate of risks or hazards.

Table 5-1. Qualitative Summary of the Effects of Uncertainty on Quantitative Estimates of Risks or Hazards

Source of Uncertainty	How Does it Affect Estimated Risk From This Project?
Exposure assumptions	Likely overestimate of exposure
Emissions estimates	Possible overestimate of emissions concentrations
AERMOD air modeling methods	Possible underestimate of average long-term ambient concentrations and overestimate of short-term ambient concentration
Toxicity of DEEP at low concentrations	Possible overestimate of cancer risk, possible underestimate of non-cancer hazard for sensitive individuals

6 Other Considerations

6.1 Short-Term Exposure to DEEP

As discussed previously, exposure to DEEP can cause both acute and chronic health effects. However, as discussed in Section 4.3.1, reference toxicological values specifically for DEEP exposure at short-term or intermediate intervals (e.g., 24-hour values) do not currently exist. Therefore, short-term risks from DEEP exposure are not quantified in the assessment. Regardless, not quantifying short-term health risks in this document does not imply that they have not been considered. Instead, it is assumed that compliance with the 24-hour $PM_{2.5}$ NAAQS is an indicator of acceptable short-term health effects from DEEP exposure. In our analysis, we assumed all DEEP emissions to be $PM_{2.5}$. The NOC Permit Application Support Document (ICF 2012) concludes that emissions from the proposed Vantage Data Center are not expected to cause or contribute to an exceedance of any NAAQS.

The 24-hour $PM_{2.5}$ NAAQS was set by EPA to protect people from short-term exposure to small particles (which include DEEP) and compliance with the $PM_{2.5}$ NAAQS is demonstrated in the NOC Application (ICF 2012).

6.2 Short-Term Exposure to NO_2

The impacts of higher short-term NO_2 emission rates from the existing unmodified engines at the Vantage Data Center have not been evaluated in detail in this document because only DEEP emissions from the project exceeded the ASIL. Because emissions of NO_2 and other TAPs from the project were below the ASIL, no further review was required for those pollutants. Emissions below the ASIL suggest that increased health risks from these pollutants are acceptable. The maximum 1-hour NO_2 concentrations at the nearby receptor locations are presented in Table 6-1.

Table 6-1. Maximally Exposed Receptors–Vantage Only NO_2 Concentrations

Attributable To:	Maximum 1-Hour NO2 Concentration (µg/m3) at Various Receptor Locations – Vantage Receptors					
	Fence Line Receptor	Current Home (SW) at Structure	Current Home (SW) at Property Boundary	Current Home (SE)	Off-Site Workplace (Sabey Data Center)	Vantage Tenants Within Vantage Facility
Vantage	345	190	291	165	230	236

Note: ASIL = 470 ug/m^3

Ecology will be conducting additional analyses to determine cumulative NO_2 concentrations during a hypothetical city-wide power outage when every data center activates its emergency generators. As part of that analysis Ecology will also evaluate the combined probability that a city-wide power outage will occur coincident with unfavorable dispersion conditions.

7 Discussion of Acceptability of Risk with Regard to Second Tier Review Guidelines

7.1 Vantage-Only Cancer Risks Are Lower Than 10-Per-Million

As noted above, the modeled worst-case toxic air pollutant concentrations at the facility boundary caused solely by emissions from the proposed data center are less than the ASIL values established by Ecology for all pollutants, with the exception of DEEP. The worst-case emissions rates are less than the SQER for most pollutants, with the exception of DEEP, NO_2, acrolein and ammonia. The long-term uncontrolled cancer risks at the nearby homes and businesses range from 0.2 to 9.3 per-million for DEEP and are much lower for the other toxic pollutants considered in this analysis. The overall cancer risk at any the maximally exposed home, caused solely by Vantage Data Center emissions, is estimated to be less than the 10-per-million threshold that has been established by Ecology under its Second Tier Review criteria.

7.2 Cumulative Cancer Risk is Less Than Ecology's 100-Per-Million Target Level

Vantage and ICF recognize that Ecology has committed to maintaining the cumulative DEEP cancer risk caused by all sources (new and existing) in Quincy below a target level of 100-per-million. The DEEP emissions from the Vantage facility easily satisfy Ecology's commitment. The total cumulative DEEP cancer risks for the maximally exposed home both at the structure and at the property line are as follows:

Vantage-only cancer risk (SW home at the structure):	5.4 per-million
Ecology local background DEEP cancer risk:	23.7 per-million
Cumulative DEEP cancer risk:	29.1 per-million

Vantage-only cancer risk (SW home at the property line):	9.3 per-million
Ecology local background DEEP cancer risk:	21.0 per-million
Cumulative DEEP cancer risk:	30.3 per-million

On a city-wide cumulative basis, the SW home is the maximum impacted home in eastern Quincy. The total cumulative DEEP risk at the maximally exposed home is well below the 100 per million target that Ecology has established for the City of Quincy, and the majority of the cumulative impact is caused by background sources.

7.3 Non-Cancer Risk Hazard Quotient HQ <<1.0

As described previously, the maximum hazard quotient (HQ) related to Vantage-only annual-average DEEP impacts at any maximum impacted receptor is 0.012. The maximum HQ for cumulative impacts is only 0.025. This confirms that DEEP emissions are unlikely to cause non-cancer impacts.

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