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DEPARTMENT OF
ECOLOGY
State of Washington

Revised Health Impact Assessment Review Document for

Vantage Data Center
Quincy, Washington

Prepared by

Air Quality Program
Olympia, Washington

May 11, 2017

1. Executive Summary

This document presents Ecology's review and summary of the health risks from air pollutants emitted by 17 diesel engines at the Vantage Data Center in Quincy. This document updates a previous review to reflect changes to the operation, emission controls, and exhaust stacks of previously permitted engines. In general, toxic air pollutant impacts in the area near Vantage Data Center fall below levels that are likely to cause serious long- or short-term health effects. Ecology concluded health risks are acceptable and recommends approval of the project.

In 2013, Ecology issued an air permit which allowed Vantage to install and operate 17 diesel-powered generators (rated at 3.0 electrical megawatts) that emit pollutants into the air at their data center facility in Quincy, WA. After conducting performance tests on a set of engines at the facility, Vantage determined that the emission controls did not function as designed, and they could not meet emission limits specified in their permit. In August 2016, Vantage resubmitted application materials to reflect changes in emissions resulting from the removal of add-on emission controls on five existing engines and the elimination of the requirement to install the controls on the remaining 12 engines originally permitted in 2013. Vantage also requested flexibility in how they operate their engines, and proposed increased stack heights on the 12 engines that have not yet been installed.

Because the new proposal requests to operate engines under substantially altered permit conditions Ecology required Vantage to revise the health impact assessment (HIA) to evaluate the health risks from exposure to pollutants with impacts in excess of screening levels.

Vantage hired Landau Associates to revise the HIA (Landau Associates, 2016). In this assessment, Landau Associates estimated lifetime increased cancer risks and non-cancer hazards associated with Vantage's diesel particles, nitrogen dioxide, and other toxic air pollutant (TAP) emissions. Landau Associates also assessed the cumulative health hazard and risk by adding estimated concentrations associated with Vantage's emissions to an estimated background concentration.

Conclusions:

- The revised diesel particle emissions resulted in an increase lifetime cancer risk from the previous estimate of about 9.3 in one million to a new estimate of about 9.9 in one million. The maximum risk was estimated along the southwest boundary that Vantage Data Center shares with a residential parcel. Ecology identified a lower risk of approximately four in one million at the location of the house on the same parcel. This risk assumes that a person is exposed to Vantage's emissions continuously during their entire lifetime. Ecology allows an increased risk of up to 10 in one million from new sources of air pollutants. The risk can also be expressed as the number of cancers that might occur in addition to those normally expected in a population of one million people. The cancer risk estimates reported here are for increases above a baseline lifetime risk of cancer of about 40 percent in the United States.

- The maximum cumulative cancer risk to a person who lives near Vantage is about 39 in one million. Much of the estimated exposure to diesel particles at this location comes from potential emissions from nearby Intuit, Sabey, Vantage, and Yahoo! data centers. It is important to note that data centers in Quincy typically operate their engines much less than they are allowed.

- Chronic respiratory or other non-cancer health effects associated with the Vantage's and other local source's diesel particle emissions are not likely to occur.

- Acute (short-term) hazards, however, are possible during a power outage affecting Vantage, Sabey, Intuit, and Yahoo! data centers. Vantage's and other east Quincy data center's nitrogen oxides emissions during a power outage could cause NO_2 to rise to levels that may cause respiratory symptoms for people with asthma or other respiratory issues. These situations would occur if a power outage coincided with unfavorable weather conditions. Based on the limited frequency of weather conditions with unfavorable pollutant dispersion and a presumed infrequency of power outage, the occurrence of short-term nitrogen dioxide impacts of concern is expected to be infrequent.

Ecology's Recommendation:

Ecology recommends approval of the project because the increase in cancer risk associated with the new data center alone is less than the maximum risk allowed under Ecology's rules (10 in one million), and the noncancer hazard is low. Furthermore, the cumulative risks to residents living near Vantage Data Center are below the cumulative risk threshold established by Ecology for permitting data centers in Quincy (100 per million or 100×10^{-6}). With regard to short-term exposures to diesel engine exhaust, Ecology will need annual reports of power outage from Quincy data centers to ensure the assumptions used in the short-term NO_2 impact analysis remain appropriate.

This summary document presents Ecology's review of Vantage Data Center's revised HIA and other requirements under WAC 173-460.

2. Second Tier Review Processing and Approval Criteria

2.1. 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 best available control technology for toxics (tBACT).

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

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

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

Acting as the "permitting authority" for this project, Ecology's project permit engineer satisfied items (a) and (b) above on April 26, 2017 (Ecology, 2017). Landau Associates submitted an HIA protocol (item (c)) on March 7, 2016, and the revised final HIA (item (e)) on November 16, 2016. Ecology's air dispersion modeler determined that the revised refined air dispersion modeling for short-term NO_2 and annual DEEP emissions (item (d)) was conducted appropriately.[1] Therefore, all five processing requirements above are satisfied.

2.2. 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:

(a) Determines that the emission controls for the new and modified emission units represent tBACT.

(b) 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.

(c) Ecology determines that the noncancer hazard is acceptable.

2.2.1. tBACT determination

Ecology's permit engineer determined that Vantage's proposed pollution control equipment satisfies the BACT and tBACT requirement for diesel engines powering backup generators at Vantage Data Center (Ecology, 2017).[2]

3. HIA Review

As described above, the applicant is responsible for preparing the HIA under WAC 173-460-090. Ecology's project team consisting of an engineer, a toxicologist, and a modeler review the HIA to determine if the methods and assumptions are appropriate for assessing and quantifying the surrounding community's risk from a new project.

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[1] NOC and HIA Modeling Review Checklist completed 11/28/16.

[2] BACT was determined to be met through the use of EPA Tier 2 certified engines if the engines are installed and operated as emergency engines, as defined at 40 CFR §60.4219; compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart IIII; and use of ultra-low sulfur diesel fuel containing no more than 15 parts per million by weight of sulfur.

For the Vantage project, the HIA focused on health risks attributable to DEEP and nitrogen dioxide exposure as these were the only TAPs with a modeled concentration in ambient air that exceeded respective ASILs. Landau Associates briefly described emissions and exposure to other TAPs (benzene, 1,3-butadiene, naphthalene, carbon monoxide (CO), and acrolein) because these pollutants exceeded a small quantity emission rate (SQER), and Ecology requested that health hazards from exposure to these pollutants be quantified.

3.1. DEEP health effects summary

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 or contribute to 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>.

3.2. NO_2 health effects summary

NO_2 forms when nitrogen, present in diesel fuel and as a major component of air, combines with oxygen to produce oxides of nitrogen. NO_2 and other oxides of nitrogen are of concern for ambient air quality because they are part of a complex chain of reactions responsible for the formation of ground-level ozone. Additionally, exposure to NO_2 can cause both long-term (chronic) and short-term (acute) health effects.

Long-term exposure to NO_2 can lead to chronic respiratory illness such as bronchitis and increase the frequency of respiratory illness due to respiratory infections. Short-term exposure to extremely high concentrations (> 180,000 µg/m^3) of NO_2 may result in serious effects including death (NRC, 2012). Moderate levels (~30,000 µg/m^3) may severely irritate the eyes, nose, throat, and respiratory tract, and cause shortness of breath and extreme discomfort. Lower level NO_2 exposure (< 1,000 µg/m^{3}may cause increased bronchial reactivity in some asthmatics, decreased lung function in patients with chronic obstructive pulmonary disease, and increased risk of respiratory infections, especially in young children (CalEPA, 2008). For the Vantage project, the maximum short-term ambient NO_2 concentration has been estimated to be 1,411 µg/m^3, 1-hour average.

Power outage emissions present the greatest potential for producing high enough short-term concentrations of NO_2 to be of concern for the general public and susceptible individuals, such as people with asthma.

3.3. Toxicity reference values

Agencies develop toxicity reference values for use in evaluating and characterizing exposures to chemicals in the environment. As part of the HIA, Landau Associates identified appropriate toxicity values for DEEP and NO_2.

3.3.1. DEEP toxicity reference values

To quantify noncancer hazards and cancer risk from exposure to DEEP, quantitative toxicity values must be identified. Landau Associates identified toxicity values for DEEP from two agencies: the U.S. Environmental Protection Agency (EPA) (EPA, 2002; EPA, 2003), and California EPA's Office of Environmental Health Hazard Assessment (OEHHA) (CalEPA, 1998). These toxicity 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 noncancer health effects are not expected, and a metric by which to quantify increased risk from exposure to a carcinogen. Table 1 shows the appropriate DEEP noncancer and cancer toxicity values identified by Landau Associates.

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 $\mu g/m^3$ as the concentration of DEEP in air at which long-term exposure is not expected to cause adverse noncancer health effects.

National Ambient Air Quality Standards (NAAQS) and other regulatory toxicological values for short- and intermediate-term exposure to particulate matter have been established, 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. In these studies, DEEP exposure was estimated from measurements of elemental carbon and respirable particulate representing fresh diesel exhaust. The URF is expressed as the estimate of the plausible upper limit (i.e., the 95th percentile upper confidence interval) of cancer risk, assuming continuous lifetime exposure to a substance at a concentration of one microgram per cubic meter (1 $\mu g/m^3$). It is 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 percent or a population cancer risk of 300 excess cancer cases per million people exposed.

3.3.2. NO_2 toxicity reference value

OEHHA developed an acute reference exposure level for NO_2 based on inhalation studies of asthmatics exposed to NO_2. These studies found that some asthmatics exposed to about 0.25 ppm (i.e., 470 µg/m^3) experienced increased airway reactivity following inhalation exposure to NO_2 (CalEPA, 2008). Not all asthmatic subjects experienced an effect.

The acute REL derived for NO_2 does not contain any uncertainty factor adjustment, and therefore does not provide any additional buffer between the derived value and the exposure concentration at which effects have been observed in sensitive populations. This implies that exposure to NO_2 at levels equivalent to the acute REL (which is also the same value as Ecology's ASIL) could result in increased airway reactivity in a subset of asthmatics. People without asthma or other respiratory disease are not likely to experience effects at NO_2 levels at or below the REL. OEHHA intended for acute RELs to be "for infrequent 1 hour exposures that occur no more than once every two weeks in a given year" (CalEPA, 2015).

EPA developed an annual and 1-hour NAAQS for NO_2. Compliance with these NAAQS was demonstrated as part of the Notice of Construction (NOC) application process (Ecology, 2017).

Finally, National Research Council developed an acute exposure guidance level (AEGL) of 940 ug/m^3 at which the general population could experience irritating, non-disabling short-term effects (NRC, 2012). These effects are considered to be reversible once exposure is diminished. AEGLs are used to inform emergency managers about the severity of public health threats from exposure to chemicals during emergency situations.

Table 1. Toxicity Values Used to Assess and Quantify Noncancer Hazard and Cancer Risk

Pollutant	Agency	Noncancer	Cancer
DEEP	U.S. Environmental Protection Agency	RfC = 5 µg/m3	N/A[1]
	California EPA–Office of Environmental Health Hazard Assessment	Chronic REL = 5 µg/m^3	URF = 0.0003 per µg/m^3
NO_2	California EPA–Office of Environmental Health Hazard Assessment	Acute REL = 470 µg/m^3	N/A

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

3.4. Affected community/receptors

While Vantage Data Center is located in an industrially zoned area and surrounded largely by agricultural land uses, air dispersion modeling indicated that proposed DEEP emissions could result in concentrations in excess of the ASIL at roughly 4 parcels with residential land use codes (Figure 1) [Ecology, 2015; Grant County, 2015]. U.S. Census data show that approximately 12 people live in the area in which DEEP concentrations are estimated to exceed the ASIL (U.S. Census Bureau, 2010).[3]

[3] Number of people estimated by taking the fraction of a census block area intersected by the area in which the ASIL is exceeded times the number of people in the census block based on the 2010 census.

For the purposes of assessing increased cancer risk and noncancer hazards, Landau Associates identified receptor locations where the highest exposure to project-related air pollutants could occur: at the project boundary, a nearby residence, and tenant occupied areas within the Vantage Data Center property boundary. They also identified and evaluated exposures at other areas with sensitive populations such as schools. Landau Associates calculated both noncancer hazards and cancer risks for each of these receptors, and estimated long-term cumulative risks attributable to other known sources of DEEP.[4]

Ecology's review of the HIA found that Landau Associates identified appropriate receptors to capture the highest exposures for residential, commercial, and fence line receptors (Figures 2 and Figure 3). Landau Associates also identified other potential sensitive receptor areas such as students at Quincy High School. These receptors are located outside the area in which Vantage-specific TAP impacts exceed ASILs.

3.5. Increased cancer risk

3.5.1. Cancer risk attributable to Vantage's DEEP and other TAP emissions

Table 2, adapted from the HIA, shows the estimated Vantage Data Center-specific and cumulative cancer risk per million at each of the receptors evaluated. The highest increase in risks attributable to Vantage Data Center's emissions is 9.9 per million[5] and occurs along the southwest boundary that Vantage shares with a residential property. Landau Associates also calculated risks posed by other carcinogenic TAPs (i.e., acetaldehyde, benzene, formaldehyde, 1,3-butadiene, and carcinogenic polycyclic aromatic hydrocarbons). They estimated a negligible increased risk attributable to these other TAPs of about 0.06 per million at the MIRR.

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[4] Landau Associates modeled cumulative emissions from existing data centers, railway, and highways. Results were incorporated into the review of proposed emissions from Vantage Data Center.

[5] Number per million represents an upper-bound theoretical estimate of the number of excess cancers that might result in an exposed population of one million people compared to an unexposed population of one million people. Alternatively, an individual's increase in risk of one in one million means a person's chance of getting cancer in their lifetime increases by one in one-million or 0.0001 percent.

Table 2. Estimated Increased Cancer Risk for Residential, Occupational, and Student Scenarios Attributable to Vantage's DEEP Emissions

Attributable to:	Risk Per Million from DEEP Exposure at Various Receptor Locations					
	Fence Line Receptor (MIBR)[1]	Southwest Residence Parcel Boundary (MIRR)[2]	Southwest Residence Home Location	Tenant Building (MICR)[3]	School	
					Students[4]	Teachers[5]
Vantage	0.4	9.9	3.8	2.3	<0.01	0.01

MIBR – Maximally Impacted Boundary Receptor

MIRR – Maximally Impacted Residential Receptor

MICR – Maximally Impacted Commercial Receptor

[1] Fence line scenario assumes intermittent exposure 250 days per year, two hours per day for 30 years.

[2] Residential scenarios assume continuous lifetime exposure.

[3] Workplace scenarios assume exposure occurs 250 days per year, eight hours per day for 40 years.

[4] Student scenario assumes exposure occurs 180 days per year, eight hours per day for seven years.

[5] Teacher scenario assumes exposure occurs 200 days per year, eight hours per day for 40 years.

Note: Landau Associates also calculated risks posed by other carcinogenic TAPs (i.e., acetaldehyde, benzene, formaldehyde, 1,3-butadiene, and carcinogenic polycyclic aromatic hydrocarbons). They estimated a negligible increased risk attributable to these TAPs of about 0.06 per million at the MIRR.

3.5.2. Cancer risk attributable to cumulative DEEP emissions

Landau Associates conducted a separate analysis of cumulative exposure to DEEP in Quincy. The cumulative risk of all known sources of DEEP emissions in the vicinity of Vantage Data Center (Table 3 and Figure 4) is highest for the residence adjacent to Vantage's southwest property boundary. The cumulative DEEP risk at this home is about 39 per million.[6] The majority (~79 percent) of estimated DEEP exposure at this location is attributable to allowable emissions from emergency engines at nearby data centers. Landau Associates also identified a home within the modeling domain approached 100 per million near the center of town. It is important to note that the tax parcel information defines this location with a land use code "53" (General Merchandise Retail), but street view photographs indicate that a residence may exist. Regardless, Vantage's contribution to diesel PM at this location is insignificant.

[6] Note that residential receptors tend to be the most exposed (e.g., longest exposure duration and exposure frequency). Therefore, their risks tend to be higher than other types of receptors. For regulatory decision-making purposes, Ecology assumes that a resident is continuously exposed at their residence for their entire lifetime.

Table 3. Estimated Cumulative Cancer Risk at Residential Locations near Vantage Data Center		
	Risk Per Million from DEEP Exposure at Various Residential Receptor Locations[1]	
Attributable to:	Vantage MIRR (which is also the maximum cumulatively exposed residence within the area > ASIL)	Maximum cumulatively exposed residence within the Quincy modeling domain identified by Landau Associates[2]
Vantage[3]	9.9	0.05
Intuit[3]	5.7	0.09
Sabey	8.3	0.08
Yahoo!	7.3	0.87
SR 28[4]	3.1	75.9
Rail[5]	4.0	16.4
SR 281[4]	0.7	6.6
Cumulative	39.0	99.8

[1] Residential scenarios assume continuous lifetime exposure.

[2] Tax parcel information defines this location with a land use code 53 (General Merchandise Retail), but street view photographs indicate that a residence may exist at this location.

[3] Based on allowable emissions or requested emission limits. Actual emissions likely to be lower.

[4] Based on 2011 emissions estimates.

[5] Based on 2005 emissions (approximate 2-fold higher emission rate than 2011 emissions).

3.6. Noncancer hazard

Landau Associates evaluated chronic noncancer hazards associated with long-term exposure to DEEP emitted from Vantage Data Center and other local sources (Table 4). Hazard quotients were much lower than unity (one) for all receptors' exposure to Vantage Data Center-related and cumulative DEEP. In addition, Landau Associates evaluated combined long-term exposure to DEEP, benzene, 1,3-butadiene, acrolein, and naphthalene emitted from Vantage and determined the hazard indices were much lower than unity for all receptors' exposure to Vantage Data Center-related pollutants.[7] This indicates that chronic noncancer hazards are not likely to occur as a result of exposure to DEEP and other project-related TAPs in the vicinity of Vantage Data Center.

Landau Associates also evaluated acute hazards associated with short-term exposure to NO_2 and other TAPs (Table 4).[7] Landau Associates evaluated scenarios where Vantage Data Center and other nearby data center engines was operating under full power outage mode because this is the time period when short-term emissions would be greatest. Hazard quotients for the receptors near

[7] Acute hazard quotients attributable to other TAPs (carbon monoxide, benzene, 1,3-butadiene, and acrolein) were extremely low and are not presented in Table 4.

Vantage were above one indicating that acute adverse health effects may occur in people occupying areas near Vantage's property boundary during a power outage. The frequency of these potential occurrences is further discussed in Section 4.2.

Table 4. Estimated Maximum Short-term NO_2 and Long-term DEEP Noncancer Hazards Attributable to Vantage and (Cumulative) Emissions at Locations near Vantage Data Center

Receptors	Acute (short-term)			Chronic (long-term)		
	Max. 1-hr NO_2 ($\mu g/m^3$)	NO_2 Acute REL ($\mu g/m^3$)	HQ	Maximum Annual Avg. DEEP ($\mu g/m^3$)	DEEP Chronic REL ($\mu g/m^3$)	HQ
MIBR	1,411 (Same)	470	3.0	0.24 (0.30)	5	0.05 (0.06)
MICR	1,381 (Same)		2.9	0.24 (0.30)		0.05 (0.06)
MIRR	827 (Same)		1.8	0.13 (0.23)		0.03 (0.05)
School	96 (467)		0.2 (1.0)	0.001 (0.09)		0.0002 (0.02)

4. Other Considerations

4.1. Short-term exposures to DEEP

Exposure to DEEP can cause both acute and chronic health effects. However, as discussed previously, reference toxicity values specifically for DEEP exposure at short-term or intermediate intervals do not currently exist. Therefore, Landau Associates did not quantify short-term risks from DEEP exposure. Generally, Ecology assumes that compliance with the 24-hour $PM_{2.5}$ NAAQS is an indicator of acceptable short-term health effects from DEEP exposure. Ecology's Technical Support Document (TSD) for the draft preliminary NOC approval concludes that Vantage's emissions are not expected to cause or contribute to an exceedance of any NAAQS (Ecology, 2017).

4.2. Cumulative short-term NO_2 hazard

Ecology recognizes that it is possible that cumulative impacts of multiple data center's emissions during a system-wide outage could potentially cause NO_2 levels to be a health concern. Landau Associates evaluated the short-term NO_2 impacts that could result from emergency engine operation during a system-wide power outage affecting:

- Intuit Data Center
- Yahoo! Data Center
- Sabey Data Center
- Vantage Data Center

While NO_2 levels could indeed rise to levels of concern[8] at various locations across the east side of Quincy, the outage would have to occur at a time when the dispersion conditions were optimal for concentrating NO_2 at a given location.

Landau Associates estimated the combined probability of an east side Quincy system-wide outage coinciding with unfavorable dispersion conditions and found the likelihood of this occurrence to be relatively low.

To conduct this analysis, Landau Associates modeled emissions of:

- Simultaneous outage emissions of NO_X for all east side permitted (i.e., Intuit, Yahoo!, and Sabey) and proposed Vantage Data Center engines, during all meteorological conditions experienced throughout a five-year period.
- Potential emissions from other NO_X sources on the east side of Quincy like Celite, State Route 28, State Route 281, and the BNSF railroad line.

Table 4 shows the maximum 1-hour NO_2 concentrations that could occur at key receptor locations near Vantage if all east side data centers' engines operated simultaneously under emergency conditions.

Additionally, Landau Associates analyzed the frequency (# of hours per year) meteorological conditions could result in a NO_2 concentration greater than 454 $\mu g/m^3$ at each key receptor point within the east side Quincy modeling domain. If all east Quincy engines were run continuously during the course of a year, the areas near the MICR could achieve concentrations of health concern for as often as 416 hours per year. In reality, these data centers were not permitted to continuously operate their engines. The engines are not expected to be used frequently under outage scenarios as the Grant County Public Utilities District (PUD) reported that from 2003 to 2009, the average total outage time for customers that experience an outage throughout Grant County PUD's service area is about 143 minutes per year (Coe, 2010).

Figures 5a -5c shows the number of years between occurrences in which the NO_2 levels could exceed a level of concern at the MIBR, MICR, and MIRR assuming each east side data center operates each engine at outage load during one to 45 hours of simultaneous outage per year. Generally, the occurrences of elevated NO_2 levels will be infrequent if the frequency and duration of power outages remains low. Assuming 2.5 hours of simultaneous power outage per year, NO_2 levels could exceed a level of concern about once every 9, 10, and 23 years at the MICR, MIBR, and MIRR respectively.

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[8] The level of concern in this case is 454 $\mu g/m^3$. This represents California OEHHA's acute reference exposure level of 470 $\mu g/m^3$ minus an estimated regional background concentration of 16 $\mu g/m^3$. The regional background was estimated by using the Northwest International Air Quality Environmental Science and Technology Consortium tool to lookup 2009-2011 design values of criteria pollutants. Available at: <http://lar.wsu.edu/nw-airquest/lookup.html>.

5. Uncertainty

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 Vantage's emissions. The assumptions used in the face of uncertainty may tend to over- or underestimate the health risks estimated in the HIA. Key aspects of uncertainty in the HIA for Vantage Data Center are exposure assumptions, emissions estimates, air dispersion modeling, and toxicity of DEEP.

5.1. Exposure

It is difficult to characterize the amount of time that people can be exposed to Vantage's DEEP emissions. For simplicity, Landau Associates and Ecology 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. From 2003 to 2009, the average outage for all Grant County PUD power customers was about 2.5 hours per year. While this small amount of power outage provides some evidence that power service is relatively stable, we cannot predict future outages with any degree of certainty.

5.2. Emissions

The exact amount of DEEP emitted from Vantage's diesel-powered generators is uncertain. Landau Associates estimated emissions assuming that each engine operates at a load resulting in the highest emissions regardless of actual intended operational load. Landau Associates also attempted to account for higher emissions that would occur during initial start-up and before control equipment was fully warmed up.

5.3. Air modeling

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 analysis may slightly overestimate the short-term (1-hour average) impacts and somewhat underestimate the annual concentrations.

5.4. Toxicity

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 noncancer effects in animals or humans. Agencies apply these uncertainty factors so that they derive a toxicity value that is considered protective of humans including susceptible populations. In the case of DEEP exposure, the noncancer reference values used in this assessment were generally derived from animal studies. These reference values are probably protective of the majority of the population including sensitive individuals, but 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 $1x10^{-5}$ to 1×10^{-3} per $\mu g/m^3$. OEHHA's DEEP URF (3×10^{-4} per $\mu g/m^3$) 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 toxicity studies of DEEP based on older engines is relevant to current diesel engines.

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

Table 5. Qualitative Summary of How the Uncertainty Affects the Quantitative Estimate 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

Table 5. Qualitative Summary of How the Uncertainty Affects the Quantitative Estimate of Risks or Hazards	
Source of Uncertainty	**How Does it Affect Estimated Risk from this Project?**
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 noncancer hazard for sensitive individuals

6. Conclusions and Recommendation

The project review team has reviewed the HIA and determined that:

(a) The TAP emissions estimates presented by Landau Associates represent a reasonable estimate of the project's future emissions.

(b) Emission controls for the new and modified emission units meet the tBACT requirement.

(c) 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.

(d) The HIA submitted by Landau Associates on behalf of Vantage Data Center adequately assesses project-related increased health risk attributable to TAP emissions.

In the HIA, Landau Associates estimated lifetime increased cancer risks attributable to Vantage's DEEP emissions. The maximum of risk 9.9 in one million was estimated at a residential location southwest of Vantage Data Center's property.

Landau Associates also assessed chronic and acute noncancer hazards attributable to the project's emissions and determined that Vantage's emissions by themselves are not likely to result in adverse noncancer health effects.

Finally, Landau Associates and Ecology assessed the cumulative health risk by adding estimated concentrations attributable to Vantage's emissions to an estimated background DEEP concentration. The maximum cumulative cancer risk from resident's exposure to DEEP in the vicinity of Vantage is approximately 39 in one million. Much of the estimated exposure to diesel particulate at this location comes from allowable emissions from Intuit, Yahoo!, Sabey, and Vantage data centers. Additionally, exposure to DEEP in the area is not likely to result in noncancer health effects.

The project review team concludes that the HIA represents an appropriate estimate of potential increased health risks posed by Vantage Data Center's TAP emissions. The risk manager may recommend approval of the revised permit because total project-related health risks are permissible under WAC 173-460-090 and the cumulative risk from DEEP emissions in Quincy is less than the cumulative additional cancer risk threshold established by Ecology for permitting data centers in Quincy (100 per million or 100 x 10^{-6}) [Ecology, 2010].

Additionally, Ecology's analysis of short-term impacts from simultaneous outage emissions determined a very low likelihood of east side Quincy system-wide power outage coinciding with unfavorable pollutant dispersion. While existing power outage reports from each of the data centers do not indicate power outages have simultaneously affected all Quincy data centers, Ecology should track outage reports from the data centers to ensure that assumptions used in the analysis remain plausible.

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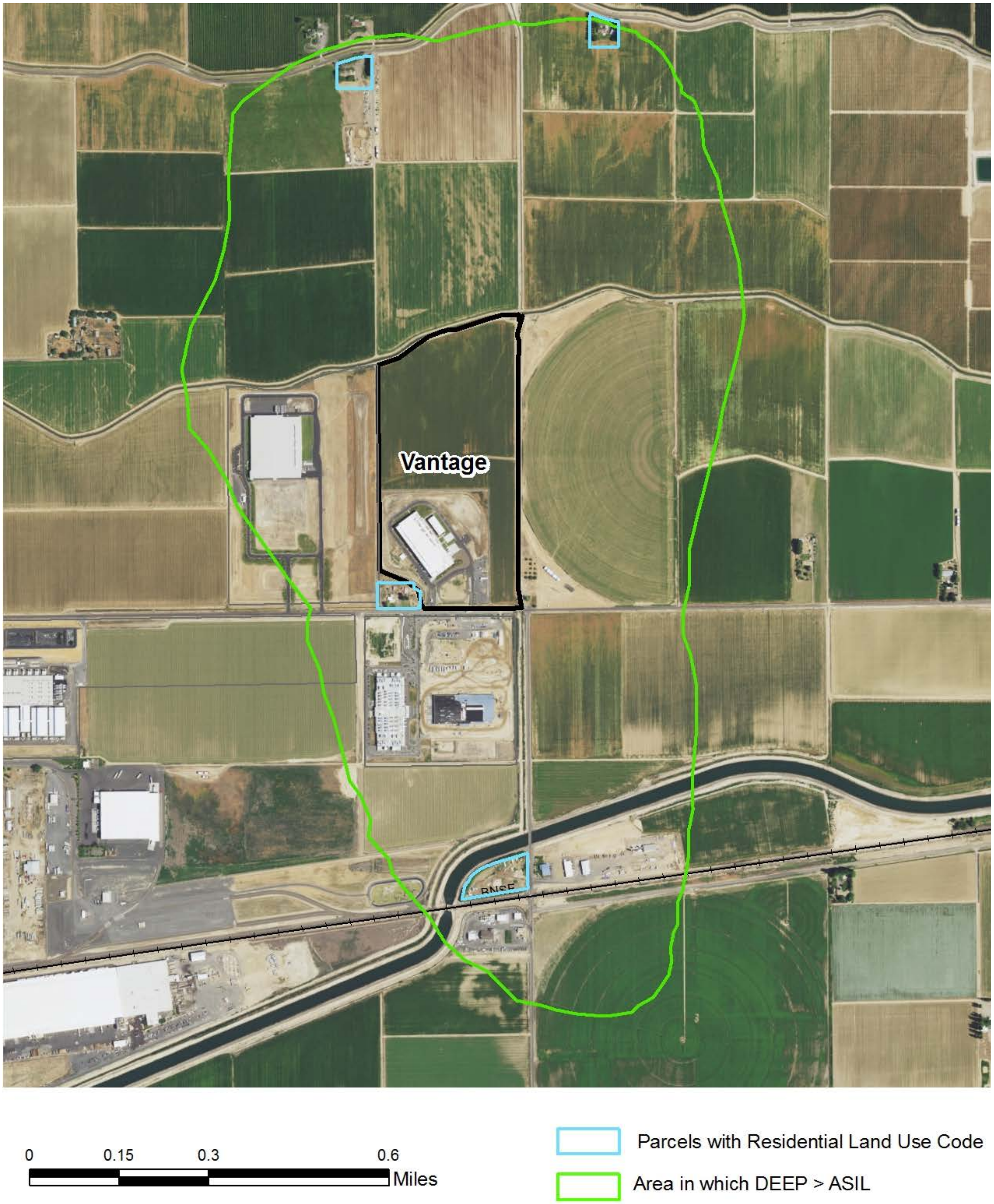

Figure 1. Residential parcels in the area where the average annual DEEP concentrations could exceed the ASIL

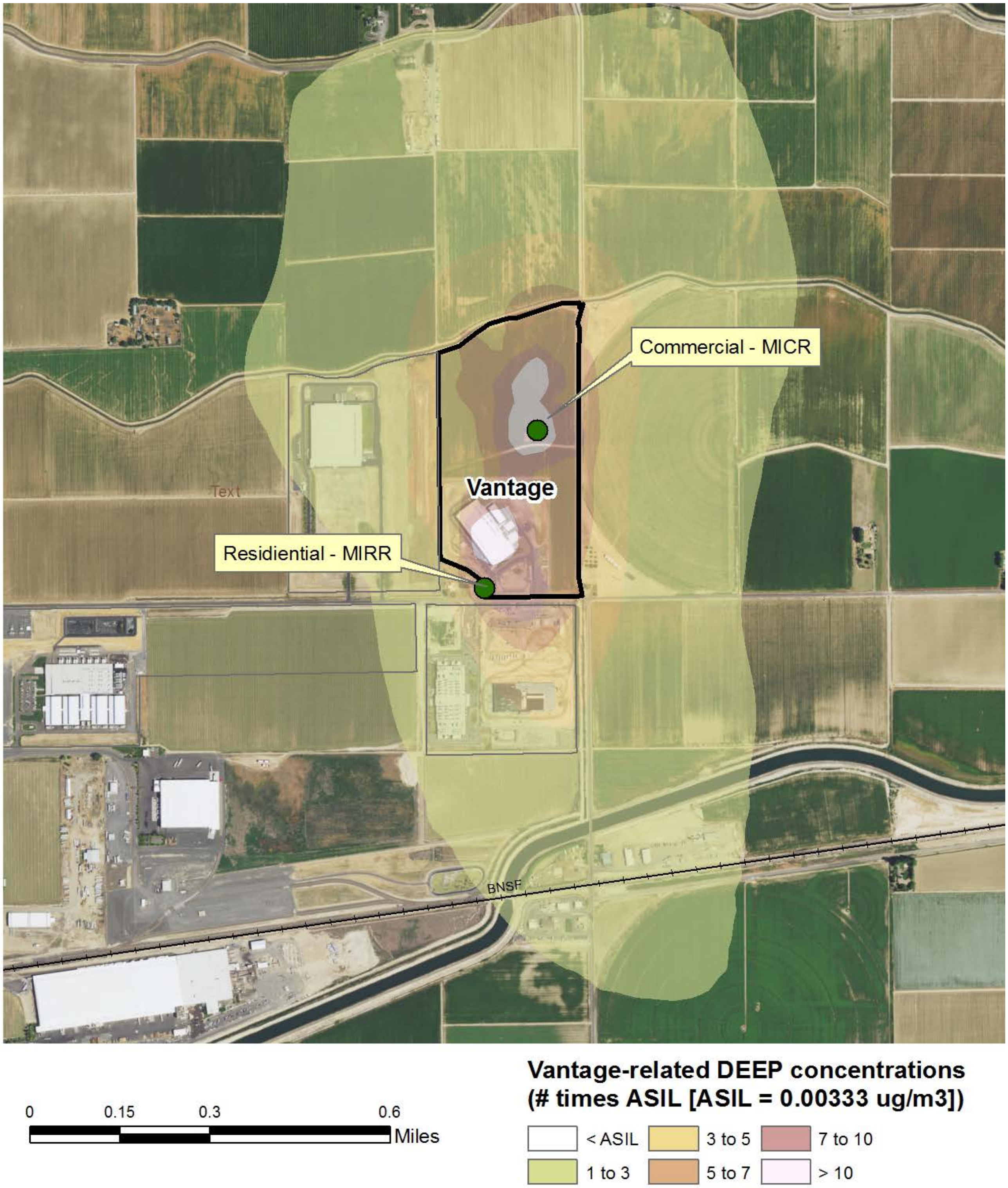

Figure 2. Receptor locations evaluated in the HIA in relation to estimated average annual DEEP concentrations. Concentrations are reported as the number of times higher than the ASIL.

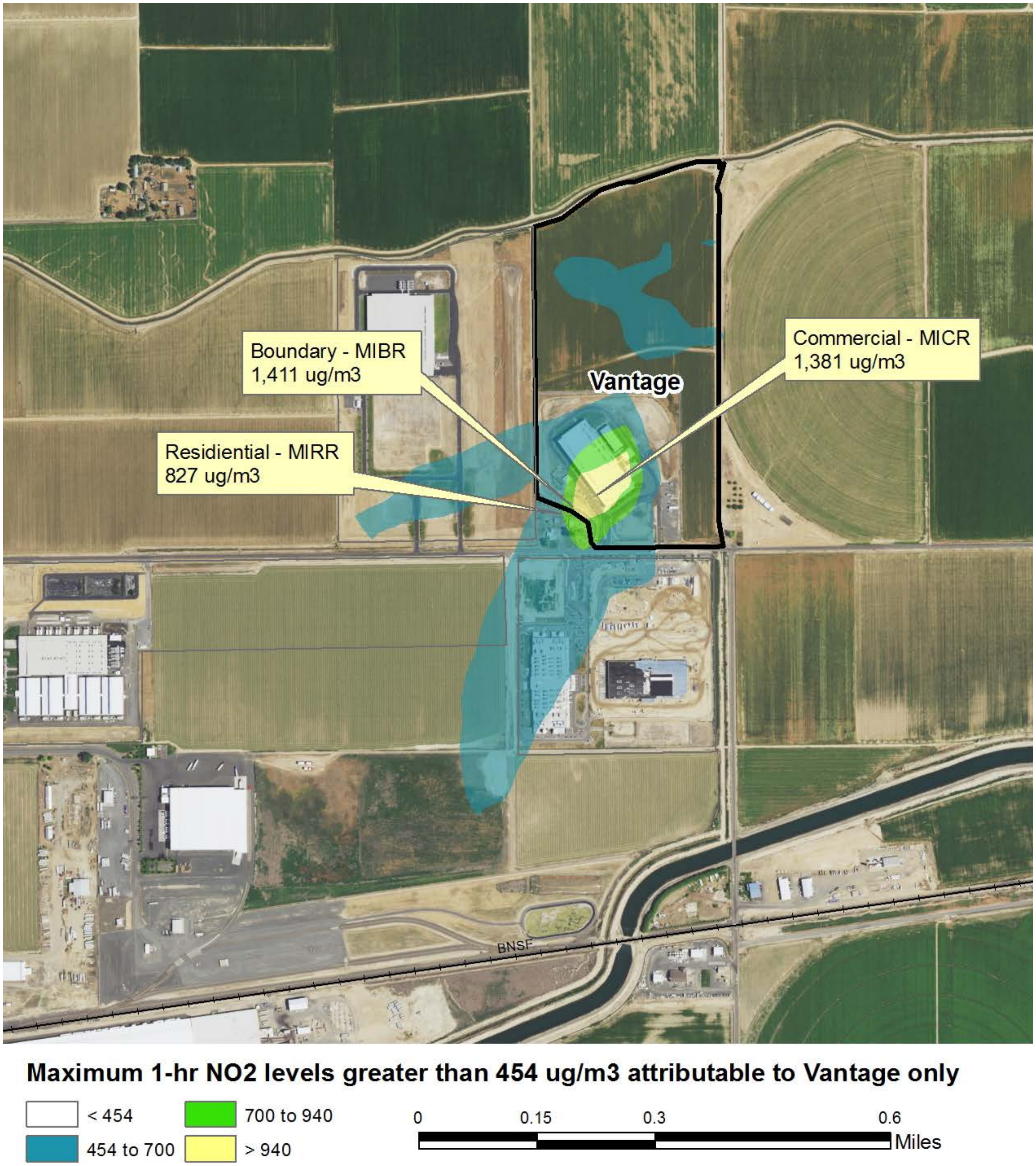

Figure 3. Receptor locations in relation to estimated maximum 1-hour NO_2 concentrations

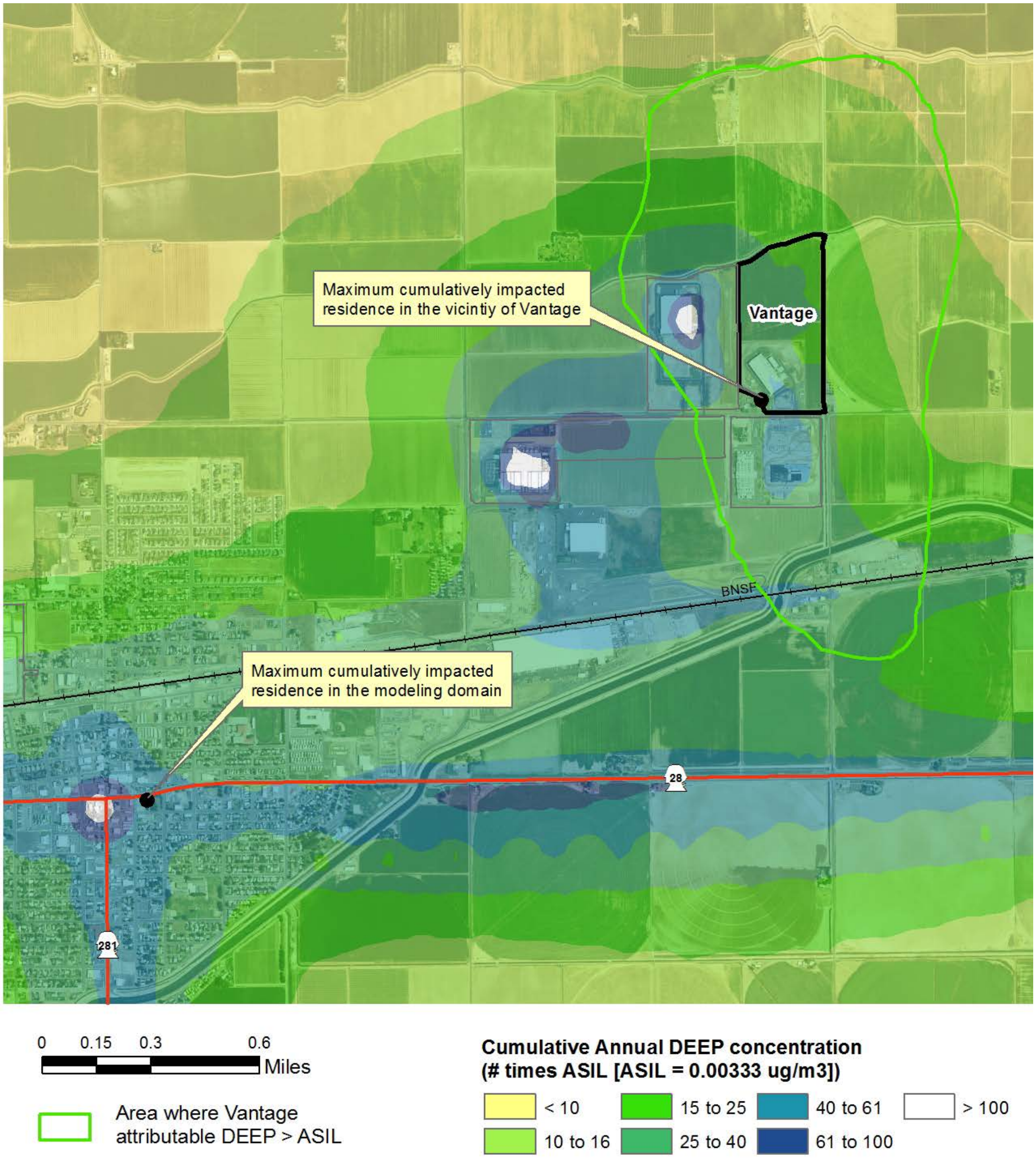

Figure 4. Cumulative DEEP concentrations (estimated by Landau Associates) in the Vantage Data Center vicinity. Concentrations are reported as the number of times higher than the ASIL.

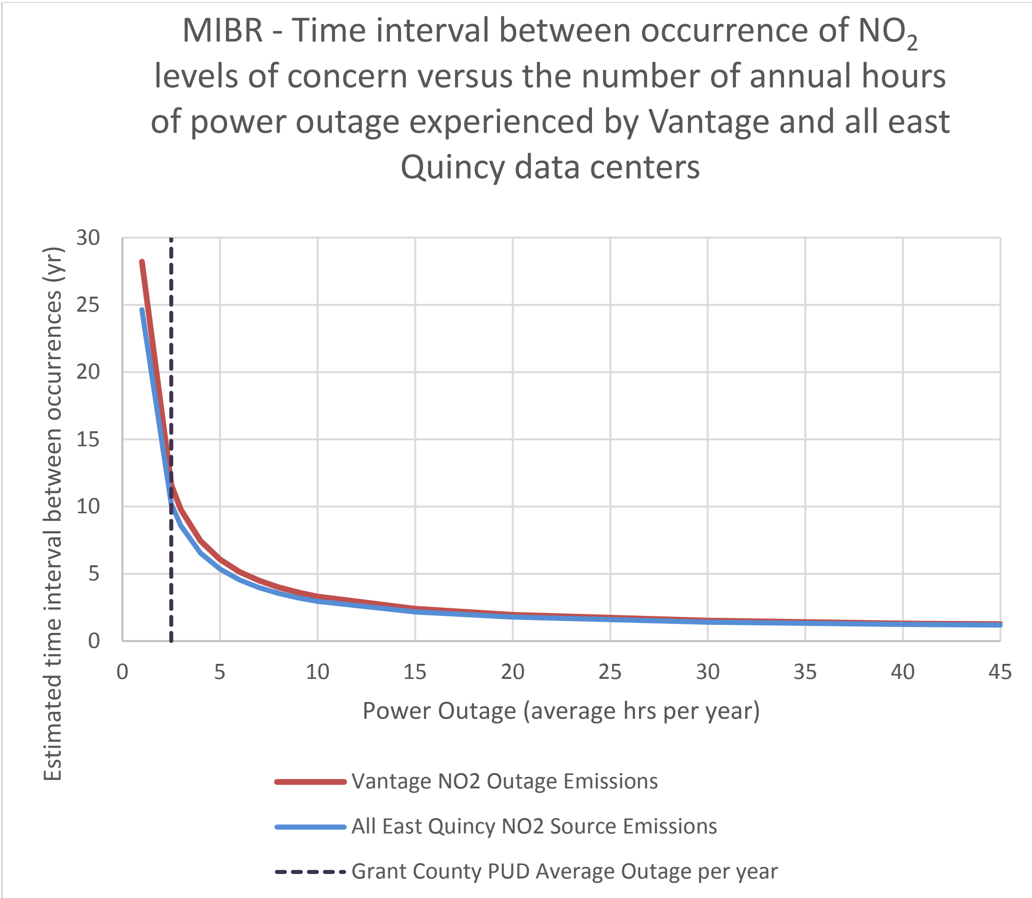

Figure 5a. Estimated time interval between occurrences of NO_2 levels of concern at the MIBR depending on the number of hours of power outage experienced by Vantage and other east Quincy Data Centers assuming all permitted engines operate at outage loads.

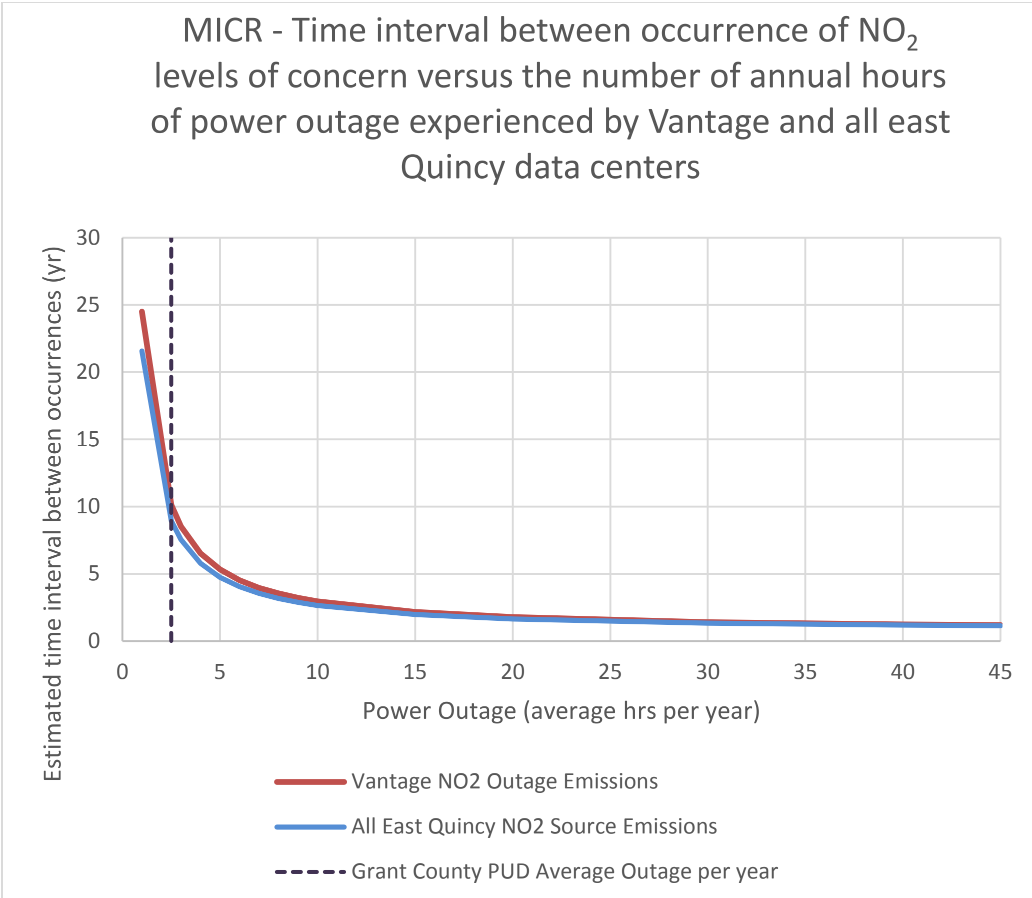

Figure 5b. Estimated time interval between occurrences of NO_2 levels of concern at the MICR depending on the number of hours of power outage experienced by Vantage and other east Quincy Data Centers assuming all permitted engines operate at outage loads.

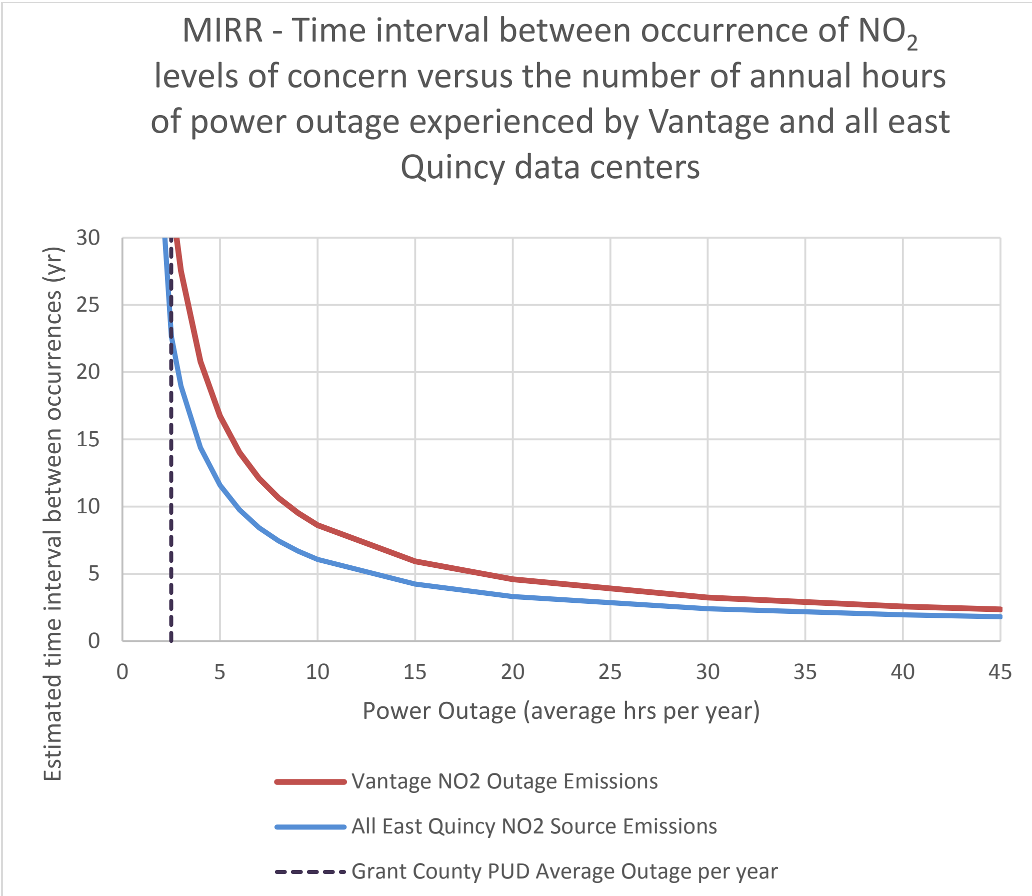

Figure 5c. Estimated time interval between occurrences of NO_2 levels of concern at the MIRR depending on the number of hours of power outage experienced by Vantage and other east Quincy Data Centers assuming all permitted engines operate at outage loads.