Second-Tier Health Impact Assessment for Diesel Engine Exhaust Particulate Matter and Nitrogen Dioxide MWH-03/04/05/06 Data Center Quincy, Washington

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Prepared for

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LIST OF ABBREVIATIONS AND ACRONYMS

µg/m³	microgram per cubic meter
µm	micrometer
AEGL 1	Acute Exposure Guideline Level 1
AERMOD	American Meteorological Society/EPA Regulatory Model
ASIL	acceptable source impact level
BACT	best available control technology
CFR	Code of Federal Regulations
CO	carbon monoxide
DEEP	diesel engine exhaust particulate matter
DPF	diesel particulate filter
Ecology	Washington State Department of Ecology
EPA	US Environmental Protection Agency
Facility	Microsoft Data Center complex
g/kWm-hr	grams per mechanical kilowatt-hour
HI	hazard index
HIA	health impact assessment
HQ	hazard quotient
LAI	Landau Associates, Inc.
m	meter
McIRR	maximum cumulative impacted residential receptor location
MIBR	maximally impacted boundary receptor location
MICR	maximally impacted commercial receptor location
Microsoft	The Microsoft Corporation
MIIR	maximally impacted institutional receptor location
MIRR	maximally impacted residential receptor location
MWe	megawatts electrical
NAAQS	National Ambient Air Quality Standards
NO	nitric oxide
NO_2	nitrogen dioxide
NOC	Notice of Construction
NO_x	nitrogen oxides
OEHHA	California Office of Environmental Health Hazard Assessment
PAH	polycyclic aromatic hydrocarbon
PM	particulate matter
$PM_{2.5}$	particulate matter with an aerodynamic diameter less than or equal to 2.5 microns
ppm	parts per million
PUD	public utility district
RBC	risk-based concentration

LIST OF ABBREVIATIONS AND ACRONYMS (Continued)

REL .... reference exposure level
RfC .... reference concentration
SCR .... selective catalytic reduction
SO_2 .... sulfur dioxide
SQER .... small-quantity emission rate
SR .... State Route
TAP .... toxic air pollutant
tBACT .... best available control technology for toxic air pollutants
URF .... unit risk factor
VOC .... volatile organic compound
WAC .... Washington Administrative Code

1.0 EXECUTIVE SUMMARY

1.1 Proposed Project

The Microsoft Corporation (Microsoft) proposes to expand the existing MWH Data Center complex in Quincy, Washington (Facility). Microsoft has submitted a Notice of Construction (NOC) application for installation and operation of new emergency generators and evaporative fluid coolers, under air quality regulations promulgated by the Washington State Department of Ecology (Ecology). The MWH Data Center complex is located on Grant County Parcel No. 313769000, at 1515 NW Port Industrial Parkway, in Quincy, Washington.

The data center expansion will be completed in four phases, MWH-03 through MWH-06, and will include the installation of 4 emergency generators that are 1.5 megawatts electrical (MWe) or less, 68 3.0-MWe emergency generators, and 136 evaporative fluid coolers or cooling towers.

Landau Associates, Inc. (LAI), on behalf of Microsoft, evaluated air quality impacts associated with the proposed project in an NOC application and supporting documentation, which were submitted to the Ecology Eastern Regional Office (LAI 2018). The NOC application, once approved by Ecology, will allow Microsoft to expand and operate the proposed data center complex.

As documented in the NOC application, potential emissions of diesel engine exhaust particulate matter (DEEP) and nitrogen dioxide (NO_2) from the 72 emergency diesel engine generators may cause ambient air impacts that exceed the Washington State acceptable source impact levels (ASILs). Based on the modeled exceedances, Microsoft is required to submit a second-tier petition per Chapter 173-460 of the Washington Administrative Code (WAC).

Ecology has implemented a community-wide approach to evaluating health impacts from Quincy data centers because the engines are within close proximity to other background sources of DEEP and NO_2. As part of the community-wide approach, this second-tier health impact assessment (HIA) considers the cumulative impacts of DEEP and NO_2 from the proposed generators, nearby existing permitted sources, and other background sources including State Route (SR) 28, SR 281, and the nearby railroad line.

1.2 Health Impacts Evaluation

This HIA demonstrates that the ambient cancer risks caused by emissions of DEEP are less than Ecology's approval limits. Under worst-case exposure assumptions involving residents standing outside their homes for 70 continuous years, DEEP from the 72 proposed emergency diesel engine generators could cause an increased cancer risk of up to 2.7 in 1 million (2.7×10^{-6}) at the maximally impacted residence. Because the increase in cancer risk attributable to the project alone would be less than the maximum risk allowed by a second-tier review, which is 10 in 1 million (10×10^{-6}), the project is approvable under WAC 173-460-090. NO_2 is not classified as a carcinogen; therefore, there is no cancer toxicity value associated with NO_2.

Based on the cumulative maximum DEEP concentration at the maximally impacted residential receptor (MIRR, R-4) location near the Facility, the estimated maximum potential cumulative cancer risk posed by DEEP emitted from the proposed project and background sources within the area would be approximately 46 in 1 million (46×10^{-6}) at the MIRR location.

The non-cancer risk assessment concluded that all receptors exposed to ambient DEEP concentrations would encounter acceptable levels of non-cancer risk as quantified by hazard quotients (HQs) less than 1. Potential project-related NO_2 concentrations correspond to HQs of more than 1 at the maximally impacted residential and workplace receptor locations (HQs of 1.1 and 1.7, respectively). However, based on the very good electrical grid reliability in Grant County, the recurrence interval for human exposure to cumulative NO_2 concentrations (project + local background) above the acute reference exposure level (REL) ranges between 35 and 772 years at the receptor locations maximally impacted by the project. Additionally, because maximum modeled project-related NO_2 concentrations are below the level at which nearly all individuals could be exposed for up to 1 hour without experiencing more than mild, transient adverse health effects, it is anticipated that no significant adverse health impacts would occur as a result of NO_2 emissions from diesel generators.

1.3 Conclusions

Project-related health risks are less than the limits permissible under WAC 173-460-090. Therefore, the project is approvable under WAC 173-460-090.

2.0 PROPOSED PROJECT

2.1 Description of Facility Buildout Plans

Microsoft is proposing to expand the existing MWH Data Center complex in Quincy, Washington (Figure 2-1).

The data center expansion will include:

- MWH-03: (8) 3-MWe emergency generators, (1) emergency generator that is 1.5 MWe or less, and 16 fluid coolers
- MWH-04: (20) 3-MWe emergency generators, (1) 1.5-MWe emergency generator, and 40 fluid coolers
- MWH-05: (20) 3-MWe emergency generators, (1) 1.5-MWe emergency generator, and 40 fluid coolers
- MWH-06: (20) 3-MWe emergency generators, (1) 1.5-MWe emergency generator, and 40 fluid coolers.

The Facility layout and the location of the backup diesel generators and fluid coolers are shown on Figure 2-2.

2.2 Forecast Emission Rates

Air pollutant emission rates were calculated for the sources identified in Section 2.1 in accordance with WAC 173-460-050. Emission rates were quantified for criteria pollutants and toxic air pollutants (TAPs). For a detailed description of the methods used to calculate project emission rates, see the NOC Supporting Information Report (LAI 2018). The emission estimates presented in this report are based on a request to operate the 72 proposed emergency diesel engine generators in accordance with the following proposed permit conditions:

1. The following runtime limits:
    a. 86 hours per year, per generator for the proposed 3.0-MWe generators.
    b. 86 hours per year, per generator for the proposed generators with a power rating of 1.5 MWe or less.
    c. Compliance with the operating hour limits in Conditions 1.a and 1.b is based on a 3-year rolling average of 12-month runtime totals, averaged over all generators in service.
2. Operation of more than five generators for more than 18 hours per generator in any 24-hour period shall not occur more than three times in any 3-calendar-year period.
3. The operation of more than five generators, operating concurrently at any one time, shall not occur on more than 18 calendar days in any 3-calendar-year period.

4. The operation of between three and five generators operating concurrently at any one time, shall not occur on more than 24 calendar days in any 3-calendar-year period. Operation during this scenario is limited to daytime hours only (7:00 a.m. to 7:00 p.m.).
5. The operation of two generators operating concurrently at any one time, shall not occur on more than 144 calendar days in any 3-calendar-year period. Operation during this scenario is limited to daytime hours only (7:00 a.m. to 7:00 p.m.).
6. There is no limit on the number of days that operation of one generator at a time can occur, but operation under this scenario is limited to daytime hours only (7:00 a.m. to 7:00 p.m.).
7. Concurrent operation of generators occurs when multiple generators operate at exactly the same moment. Generators are considered to operate concurrently even on occasions when the operational overlap occurs for just a short period of time (e.g., one minute or less). Sequential operation of generators is not considered concurrent operation even if multiple generators operate in the same minute, hour, or day.
8. Compliance with annual generator fuel use limitations will be based on a 3-year rolling average of 12-month fuel usage totals, averaged over all generators in service.
9. The Approval Order conditions will not assign specific fuel or runtime limits to each individual runtime activity (e.g., unplanned power outages).

The emission estimates presented in this report have been calculated for generators that are US Environmental Protection Agency (EPA) Tier 2 certified and that will be equipped with a catalyzed diesel particulate filter and urea-based selective catalytic reduction to meet EPA Tier 4 emission standards. Table 2-1 summarizes the calculated emission rates for the proposed generators. Load-specific emission rates were developed from generator manufacturer estimates of "not-to-exceed" emissions data for nitrogen oxides (NO_x), particulate matter (PM), carbon monoxide (CO), ammonia, and total volatile organic compounds (VOCs). Because generators could be operated at any load, the emission rates used for this evaluation were based on emission factors for the highest emitting load for each pollutant. An estimate of the "back-half" condensable fraction of the emitted PM was used for evaluating compliance with the National Ambient Air Quality Standards (NAAQS). The emission factor for DEEP is composed of the front-half fraction (i.e., filterable particulates) only. For sulfur dioxide (SO_2), the emission rate was calculated using a mass-balance approach based on the maximum sulfur content in the fuel and the maximum expected fuel usage. For the TAPs other than DEEP and SO_2, emission factors from the EPA's Compilation of Air Pollutant Emission Factors (AP-42), Sections 3.3 and 3.4 were used (EPA 1995).

The emission calculations and AERMOD[1] modeling account for startup operating conditions by factoring in the 60-second "black puff" that occurs during each startup. Startup emissions were estimated using the same methodology that was used for previous data center permit applications; the factor is based on measurements taken by the California Energy Commission as described in its 2005 document, Implications of Backup Emergency Generators in California (Lents et al. 2005).

[1] American Meteorological Society/EPA Regulatory Model (AERMOD).

2.3 Land Use and Zoning

Land uses in the vicinity of the Facility are shown on Figure 2-3 and receptor locations of interest are summarized in Table 2-2. The topography in the vicinity of the Facility is relatively flat with elevations ranging between approximately 1,325 and 1,350 feet above sea level. The zoning designation for the site is City of Quincy Industrial. Zoning designations on adjacent lands include City of Quincy Industrial to the east, west, and south and Grant County Agricultural to the north and west.

Detailed zoning information for the area surrounding the Facility is shown on Figure 2-3 (Grant County; accessed January 4, 2018). From a health impacts standpoint, three existing single-family residences located to the north (R-1), northeast (R-4), and southwest (R-7) of the Facility on land zoned Grant County Agricultural, a City Residential/Business zone located south and southeast (R-2), and a City Residential zone located east (R-3) of the Facility are of primary interest (see Figure 2-3).

2.4 Sensitive Receptor Locations

The following sensitive receptor locations are near the Facility:

- The nearest school is Monument Elementary School, approximately 0.8 miles south of the Facility.
- The nearest daycare or pre-school is a private home-based facility, approximately 0.5 miles southeast of the Facility.
- The nearest church is located approximately 0.6 miles southeast of the Facility.
- The nearest medical facility is Quincy Valley Hospital, approximately 0.5 miles southeast of the Facility.
- The nearest convalescent home is The Cambridge, approximately 0.9 miles southeast of the Facility.

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3.0 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* increase in TAP emissions for all new or modified stationary sources in Washington State. Sources subject to review under this rule must apply best available control technology (BACT) for toxics (tBACT) to control emissions of all TAPs subject to review.

There are three levels of review when processing an NOC application for a new or modified 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 must 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 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 project 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 an 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 operations of the Facility. Once quantified, the cancer risk is compared to the maximum risk allowed by a second-tier review, which is 10 in 1 million, and the concentration of any non-carcinogen that would result from project operations is compared to its effect threshold concentration. If the emissions of a TAP result in an increased cancer risk of greater than 10 in 1 million (equivalent to 1 in 100,000), then an applicant may request that Ecology conduct a third-tier review. For non-carcinogens, a similar path exists, but there is no specified numerical criterion to indicate when a third-tier review is triggered.

In evaluating a second-tier petition, background concentrations of the applicable TAPs must be considered. Ecology sets no numerical limit on cumulative impacts (project + background).

3.2 BACT and tBACT for the Project

Ecology is responsible for determining BACT and tBACT for controlling criteria pollutants and TAPs emitted from the Facility. Microsoft conducted a BACT and tBACT analysis as presented in the NOC Supporting Information Report (LAI 2018). The BACT/tBACT analysis concluded that all of the add-on control technology options (the selective catalytic reduction [SCR]/catalyzed diesel particulate filter [DPF] Tier 4 Integrated Control Package, urea-SCR, catalyzed DPF, and diesel oxidation catalyst-alone) are technically feasible, but each of them failed the BACT cost-effectiveness evaluation. Therefore, the emission controls inherent to EPA Tier 2-certified diesel engines should be required as BACT. The proposed BACT for PM, NO_x, CO, and VOCs is based on compliance with the EPA's Tier 2 emission standards for non-road diesel engines: 0.20 grams per mechanical kilowatt-hour (g/kWm-hr) for PM, 3.5 g/kWm-hr for CO, and 6.4 g/kWm-hr for combined NO_x plus VOCs. The proposed BACT and tBACT determinations are summarized in Tables 3-1 and 3-2, respectively. However, please note that while the recommendation for the BACT and tBACT emission limitations is certification with the EPA's Tier 2 emission standards, Microsoft will voluntarily equip the generators with an SCR and catalyzed DPF controls to meet EPA Tier 4 emission standards.

Additional restrictions proposed in the NOC application include:

- Limits on the total number of hours that the emergency diesel engines operate
- Use of ultra-low sulfur diesel fuel (15 parts per million [ppm] sulfur content)
- Compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart IIII.

Evaporative fluid coolers or cooling towers will be equipped with high-efficiency drift eliminators certified to reduce the drift droplet rate to at most 0.0005 percent of the recirculation water flow rate within each cooling unit. EVAPCO and Baltimore Air Coil have stated that this reduction is the greatest reduction in drift emissions the manufacturer is able to certify (Baltimore Air Coil 2017; Shank 2017). Therefore, the high-efficiency drift eliminators (0.0005 percent) are proposed as BACT.

3.3 First-Tier Toxics Screening Review for the Project

The first-tier TAP assessment compares the forecast emission rates for the 72 proposed generators and 136 evaporative fluid coolers to the small-quantity emission rates (SQERs) and compares the maximum ambient air impacts at any offsite receptor location to the ASILs.

Table 2-1 shows the calculated project-related emission rates for each TAP emitted from the Facility, and compares the emission rates to the SQERs. The SQERs are emission thresholds, below which Ecology does not require an air quality impact assessment for the listed TAP. The maximum emission rates for DEEP, benzene, 1,3-butadiene, formaldehyde, dibenz(a,h)anthracene, naphthalene, CO, NO_2, SO_2, acrolein, ammonia, and chromium exceed their respective SQERs, so an ambient air impact assessment based on atmospheric dispersion modeling was required for those TAPs.

Ecology requires facilities to conduct a first-tier screening analysis for each TAP with an emission rate that exceeds its SQER by modeling the 1st-highest 1-hour, 1st-highest 24-hour, or annual impacts (based on the averaging period listed for each TAP in WAC 173-460-150) at or beyond the project boundary or where public receptors could be exposed, then compare the modeled values to the ASILs (WAC 173-460-080).

Table 3-3 presents the first-tier ambient air concentration screening analysis for each TAP with an emission rate that exceeds its SQER. Details on the methodologies for the modeling are provided in the NOC Supporting Information Report (LAI 2018). All of the modeled maximum impacts occur at the unoccupied Facility boundary or at a location where there are no current buildings or an offsite receptor location. The maximum annual-average DEEP impact from the project at an offsite receptor location exceeds its ASIL. Additionally, the maximum 1-hour average NO_2 impact from the project at the maximally impacted receptor location exceeds its ASIL. The impacts for all TAPs other than DEEP and NO_2 are less than their respective ASILs. Therefore, DEEP and NO_2 are the only TAPs that trigger a requirement for a second-tier HIA.

3.4 Second-Tier Review Processing Requirements

In order for Ecology to review the second-tier petition, each of the following regulatory requirements under WAC 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 in the preliminary NOC Approval Order represent at least 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 exceeds its ASIL 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.

Ecology indicated approval of Microsoft's HIA protocol (item [c] above) (Palcisko 2017).

3.5 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:

- Ecology determines that the emission controls for the new and modified emission units represent tBACT
- The applicant demonstrates that the increase in emissions of TAPs is not likely to result in an increased cancer risk of more than 1 in 100,000
- Ecology determines that the non-cancer hazard is acceptable.

The remainder of this document discusses the HIA conducted by LAI.

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4.0 HEALTH IMPACT ASSESSMENT

This HIA was conducted according to the requirements of WAC 173-460-090 and guidance provided by Ecology. This HIA addresses the public health risk associated with exposure to DEEP and NO_2 from the proposed emergency diesel engine generators and existing sources of DEEP and NO_2 in the vicinity of the project. While the HIA is not a complete risk assessment, it generally follows the four steps of the standard health risk assessment approach proposed by the National Academy of Sciences (NRC 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, this 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., whether chemicals found to be carcinogenic or teratogenic in experimental animals also would likely be so in adequately exposed humans).

Although the second-tier HIA is triggered solely by potential ambient air impacts of DEEP and NO_2, the toxicity of other TAPs with emission rates exceeding the SQERs was also reviewed to consider whether additive toxicological effects should be considered in the HIA.

4.1.1 Overview of DEEP Toxicity

Diesel engines emit very small, fine (smaller than 2.5 micrometers [µm]) and ultrafine (smaller than 0.1 µm) particles. These particles can easily enter deep into the lungs 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 a document titled Concerns about Adverse Health Effects of Diesel Engine Emissions (Ecology 2008).

The health effects listed below have been associated with exposure to very high concentrations of diesel particles, primarily in industrial workplace settings (e.g., underground mines that use diesel equipment) with concentrations much higher than the ambient levels that will be caused by the project:

- 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 DEEP emissions from the proposed project 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 the Facility's project-related and cumulative DEEP impacts are acceptable, non-cancer hazards and cancer risks are quantified and presented in the remaining sections of this document.

4.1.2 Overview of NO_2 Toxicity

NO_2 is a red-brown gas that is present in diesel exhaust. It forms when nitrogen, present in diesel fuel and a major component of air, combines with oxygen to produce oxides of nitrogen (NO_x). 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 micrograms per cubic meter [$\mu g/m^3$]) of NO_2 may result in serious effects including death (NAC AEGL Committee 2008). Moderate levels (~30,000 $\mu g/m^3$) 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 $\mu g/m^3$), such as that experienced near major roadways, or perhaps downwind from stationary sources of NO_2, may cause sporadic 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). The EPA's Acute Exposure Guideline Level 1 (AEGL 1) for NO_2 is 0.5 ppm (940 $\mu g/m^3$). The AEGL 1 is defined as the level at which notable discomfort, irritation, or certain asymptomatic non-sensory effects may occur, but the effects are not disabling and are transient and reversible upon cessation of exposure. For this project, the maximum short-term ambient NO_2 concentration has been estimated to be 877 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 susceptible individuals, such as people with asthma.

4.1.3 Overview of Toxicity for Other Toxic Air Pollutants

Other TAPs with emission rates exceeding the SQERs are benzene, 1,3-butadiene, formaldehyde, dibenz(a,h)anthracene, naphthalene, CO, acrolein, ammonia, SO_2, and chromium, as described below.

- Benzene: The reference exposure level (REL) for benzene considers toxic effects for reproductive development, the immune system, and the hematologic system (CalEPA 2016; accessed January 3, 2018), not the respiratory system; however, to conservatively overestimate health risks, the ambient air impacts associated with benzene emissions have been included in the project-specific hazard index (HI) calculated in this HIA.
- 1,3-Butadiene: The REL for 1,3-butadiene considers toxic effects for both the respiratory system and peripheral systems (EPA; accessed January 3, 2018); therefore, the ambient air impacts associated with 1,3-butadiene emissions are included in the project-specific HI calculated in this HIA.
- Formaldehyde: The REL for formaldehyde considers toxic effects for the eyes, urinary, gastrointestinal, and respiratory systems (EPA; accessed January 3, 2018; CalEPA 2016; accessed January 3, 2018); therefore, the ambient air impacts associated with formaldehyde emissions are included in the project-specific HI calculated in this HIA.
- Dibenz(a,h)anthracene: The REL for dibenz(a,h)anthracene considers carcinogenic effects based on dermal and subdermal exposure, not toxic effects for the respiratory system (EPA; accessed January 3, 2018); however, to conservatively overestimate health risks, the ambient air impacts associated with dibenz(a,h)anthracene have been included in the project-specific HI calculated in this HIA.
- Naphthalene: The REL for naphthalene considers toxic effects for the respiratory system (CalEPA 2016; accessed January 3, 2018); therefore, the ambient air impacts associated with naphthalene emissions are included in the project-specific HI calculated in this HIA.
- Carbon monoxide: The REL for CO considers toxic effects for the cardiovascular system (CalEPA 2016; accessed August 23, 2016), not the respiratory system; however, to conservatively overestimate health risks, the ambient air impacts associated with CO emissions have been included in the project-specific HI calculated in this HIA.
- Acrolein: The REL for acrolein considers toxic effects for the eyes and respiratory system (CalEPA 2016; accessed August 23, 2016); therefore, the ambient air impacts associated with acrolein emissions are included in the project-specific HI calculated in this HIA.
- Ammonia: The REL for ammonia considers toxic effects for the eyes and respiratory system (CalEPA 2016; accessed May 23, 2018); therefore, the ambient air impacts associated with ammonia emissions are included in the project-specific HI calculated in this HIA.

- Sulfur dioxide: The REL for sulfur dioxide considers toxic effects for the respiratory system (CalEPA 2016; accessed February 16, 2018); therefore, the ambient air impacts associated with sulfur dioxide emissions are included in the project-specific HI calculated in this HIA.
- Chromium: The REL for chromium considers toxic effects for the respiratory and hematologic systems (CalEPA 2016; accessed January 3, 2018); therefore, the ambient air impacts associated with chromium emissions are included in the project-specific HI calculated in this HIA.

4.2 Exposure Assessment

An 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 offsite pollutant concentrations
- Identifying exposed receptor locations
- 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. Chemicals for which Ecology assesses multiple routes and pathways of exposure are provided in Table 4-1.

DEEP consists of ultra-fine particles (approximately 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 can be slowly deposited onto the ground surface 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 Facility. At those far downwind distances, the resulting DEEP concentrations in the surface soil will likely be indistinguishable from regional background values.

It is 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 of the Facility. However, given the very low levels of PAHs and other multi-exposure route-type TAPs that will be emitted from the proposed project, 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.

NO_2 is formed by nitrogen and oxygen combining at high temperatures during the combustion process. Though both nitric oxide (NO) and NO_2 are produced during the combustion process, NO is oxidized quickly in ambient air, by oxygen, ozone, and VOCs, to form NO_2. NO_2 is then broken down through reactions with sunlight and other substances in the atmosphere (ATSDR 2002).

In both outdoor and indoor conditions, NO_2 exists in gaseous form; therefore, inhalation is the primary route of exposure. High concentrations of NO_2 can cause eye irritation; however, such high concentrations are associated with industrial settings, not ambient air (Jarvis et al. 2010).

In the case of project emissions, only inhalation exposure to DEEP and NO_2 is evaluated.

4.2.2 Estimating DEEP and NO_2 Concentrations

To estimate where pollutants will disperse after they are emitted from the project, LAI conducted air dispersion modeling, which incorporates emissions, meteorological, geographical, and terrain information to estimate pollutant concentrations downwind from a source.

Each of the existing and proposed Facility emergency generators was modeled as an individual discharge point. Additionally, local background DEEP and NO_2 contributions were modeled, including on-road diesel trucks (DEEP) traveling on SR 28 and SR 281, which are south of the MWH Data Center, diesel locomotives (DEEP) on the rail line that is about ⅓ mile south of the Facility, currently permitted diesel generators (DEEP and NO_2) at the MWH-01/02 Data Center, currently permitted diesel generators (DEEP and NO_2) at the Microsoft Columbia and NTT-Data Data Centers, planned diesel generators at the CyrusOne Data Center (permit pending), and the currently permitted Con Agra industrial facility (NO_2). Emission rates for the Microsoft Columbia Data Center, MWH-01/02, and NTT-Data Data Centers were calculated based on the maximum permitted emission rates provided in the Ecology approval orders for those facilities. Emission rates for the CyrusOne Data Center were calculated based on the maximum permitted emission rates provided in the NOC application submitted to Ecology in 2017. DEEP emission rates for SR 28, SR 281, and the rail line were provided by Ecology (Dhammapala 2015). Ecology developed highway emissions data using the EPA model MOVES, which incorporates Grant County-wide on-road diesel emissions exhaust data and highway-specific vehicle miles traveled. Additionally, Ecology determined emissions from locomotives using Grant County locomotive emissions data in conjunction with the ratio of active track feet in Quincy compared to Grant County. LAI updated Ecology's railroad emissions information—using a method that was reviewed and approved by Ecology—to account for reduced DEEP emissions from locomotive engines over the last 10 years (Dhammapala 2016). DEEP and NO_2 ambient air impacts from the proposed project and local background sources were modeled using the following air dispersion model inputs:

- The EPA's plume rise model enhancement algorithm for building downwash.
- Five years of sequential hourly meteorological data from Grant County International Airport at Moses Lake (2012 to 2016).

- Twice-daily upper air data from Spokane, Washington (2012 to 2016) to define mixing heights.
- Digital topographical data for the analysis region were obtained from Web GIS website (www.webgis.com) and processed for use in AERMOD.
- The emissions for each proposed diesel engine were modeled with stack heights of 72 feet above grade.
- The dimensions of the existing and proposed buildings at the Facility were included to account for building downwash.
- The receptor grid for the AERMOD modeling domain at or beyond the Facility boundary was established using a variable Cartesian grid:
  - 12.5-meter (m) spacing from the property boundary to 150 m from the nearest emission source
  - 25-m spacing from 150 m to 400 m
  - 50-m spacing from 400 m to 900 m
  - 100-m spacing from 900 m to 2,000 m
  - 300-m spacing between 2,000 m and 4,500 m
  - 600-m spacing beyond 4500 m (to 6,000 m maximum extent).

A project coordinate-specific regional background concentration for NO_2 was obtained from the Washington State University NW Airquest website (WSU; accessed January 3, 2018).

4.2.3 Identifying Potentially Exposed Receptor Locations

There are several different land-use types within the general vicinity of the Facility. Residential, commercial, institutional, and agricultural locations where people could be exposed to project-related emissions are identified on Figure 2-3. The residential, business, and institutional receptor locations are modeled for exposure to project-related emissions. Typically, Ecology considers exposures occurring at maximally exposed boundary, residential, and business/commercial areas to capture worst-case exposure scenarios. In addition, this evaluation also considered exposures occurring at the maximally impacted institutional receptor (MIIR) location.

4.2.3.1 Receptors Maximally Exposed to DEEP

Maximally exposed receptor locations of different use types, the direction and distance of those receptor locations from the Facility, and the predicted project-related DEEP impacts at those receptor locations are summarized in Table 4-2.

Figure 4-1 shows a color-coded map of estimated annual-average DEEP concentrations attributable solely to DEEP emissions from the project. Figure 4-1 shows the project-related ambient air impacts at each of the maximally exposed receptor locations representing different land uses. The concentrations at the maximally impacted boundary receptor (MIBR, C-2) location, MIRR location (R-4), and maximally impacted commercial receptor (MICR, C-2) location are presented. The modeling indicates that emissions from the proposed project will reach multiple existing residences at a level exceeding the ASIL. The blue contour line (0.00333 μg/m^3) represents the ASIL. Receptors at all locations outside the blue contour are forecast to be exposed to concentrations less than the ASIL.

4.2.3.2 Receptor Locations Maximally Exposed to NO_2

Maximally exposed receptor locations of different use types, the direction and distance of those receptors from the Facility, and the predicted project-related NO_2 impacts at those receptor locations are summarized in Table 4-3. Figure 4-2 shows a color-coded map of estimated 1-hour average NO_2 concentrations attributable solely to emissions from the project, including project-related impacts at each of the maximally exposed receptor locations representing different land uses. The concentrations at the MIBR (C-5), MICR (C-4), and MIRR (R-7) locations are shown. The modeling indicates that project-related emissions from the Facility will reach residences to the south at levels exceeding the ASIL. The blue contour line (470 μg/m^3) represents the ASIL. Receptors at all locations outside the blue contour are forecast to be exposed to concentrations less than the ASIL. An AERMOD isopleth showing the full extent of project-related impacts exceeding the ASIL is provided on DVD in Appendix A.

4.2.4 Exposure Frequency and Duration

The likelihood that someone would be exposed to DEEP and NO_2 from the Facility depends on local wind patterns, the frequency of engine testing and power outages, and how much time people spend in the immediate area. As discussed previously, the air dispersion model uses emission and meteorological information (and other assumptions) to determine ambient DEEP and NO_2 concentrations in the vicinity of the Facility.

This analysis considers the land use surrounding the proposed project site 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 at industrial or commercial properties in the area are likely to be exposed to project-related emissions only 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 at residential receptor locations 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 non-residential 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 described in Section 4.4.2 when quantifying cancer risk from intermittent exposure to DEEP.

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.

To estimate DEEP and NO_2 background concentrations, ambient air impacts from SR 28, SR 281, the railroad line, the Microsoft Columbia, MWH-01/02, NTT-Data and CyrusOne data centers and the Con Agra industrial facility were evaluated using the methodology described in Section 4.2.2. Regional background DEEP concentrations from the EPA's National Air Toxics Assessment database were not used because Ecology has concluded that site-specific evaluation of the local highways and railroad lines provides a more realistic spatial determination of regional background concentrations.

4.2.6 Cumulative Exposure to DEEP in Quincy

Table 4-4 shows the calculated cumulative DEEP concentrations near the Facility based on allowable emissions from the proposed project, other permitted sources of DEEP in the area, and nearby highways and the railroad line. Figure 4-3 presents cumulative DEEP contours within the modeling domain. The maximum 70-year cumulative concentration at a residence near the project is estimated at 0.15 µg/m^3 (approximately 45 times greater than the DEEP ASIL). This is modeled to occur approximately 0.5 miles northeast of the Facility. It is important to note that the estimated ambient levels of DEEP are based on allowable (permitted) emissions instead of actual emissions. Actual emissions are likely to be lower than what the facilities are permitted for, but worst-case emissions were used to avoid underestimating cumulative DEEP exposure concentrations.

4.2.7 Cumulative Exposure to NO_2 in Quincy

A similar methodology as described in Section 4.2.6 above was used to estimate the cumulative short-term NO_2 impact assuming a system-wide power outage. The purpose of this effort was to identify worst-case exposure scenarios in the event of a system-wide power outage in Quincy. Table 4-5 and Figure 4-4 show the calculated cumulative NO_2 concentrations near the Facility based on allowable emissions from the proposed project, other permitted sources of NO_2 in the area, and nearby regional background sources (e.g., highways and the railroad line).

NO_2 emissions during a simultaneous power outage from nearby existing data centers were modeled. This model assumed:

- Simultaneous power outage emissions for all data center engines
- Engine operation at loads specified in permits
- Potential emissions from the nearby Con Agra facility.

Table 4-5 shows the maximum 1-hour NO_2 concentrations at various receptor locations attributable to Facility emissions and cumulative emissions from all sources.

Worst-case scenarios could result in concentrations greater than the NO_2 acute REL at locations near the Facility and other data centers in Quincy. The frequency with which these impacts could occur is discussed further in Section 4.4.1.5.

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. Table 4-6 shows exposure assumptions and risk factors used to calculate lifetime cancer risk, and Table 4-7 shows non-cancer and cancer toxicity values for all pollutants with maximum emissions exceeding their respective SQERs.

4.3.1 Dose-Response Assessment for DEEP

The EPA and California Office of Environmental Health Hazard Assessment (OEHHA) developed toxicological values for DEEP evaluated in this project (CalEPA 1998; EPA; accessed January 3, 2018; 2002). 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 non-cancer health effects are not expected, and a metric by which to quantify increased risk from exposure to emissions.

The EPA's reference concentration (RfC) and OEHHA's REL for diesel engine exhaust (measured as DEEP) was derived from dose-response data on inflammation and changes in the lungs 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 non-cancer health effects.

National Ambient Air Quality Standards (NAAQS) and other regulatory toxicological values for short- and intermediate-term exposure to PM 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 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 percent or a population risk of 300 excess cancer cases per million people exposed.

4.3.2 Dose Response Assessment for NO_2

OEHHA developed an acute REL 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 $\mu g/m^3$) experienced increased airway reactivity following inhalation exposure to NO_2 (CalEPA 1998). 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 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.

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 health effects associated with a chemical under its known or anticipated conditions of exposure.

4.4.1 Evaluating Non-Cancer Hazards

The non-cancer health impacts were evaluated based on the conservatively high 1-hour and annual-average emission rates. In order to evaluate the potential for non-cancer health effects that may result from exposure to TAPs, exposure concentrations at each receptor location were compared to relevant non-cancer toxicological values (i.e., RfC, REL). Table 4-7 lists the non-cancer toxicological values that were used for this assessment. If a concentration exceeds the RfC, minimal risk level, or REL, this indicates only the potential for 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:

$$HQ = \frac{Concentration\ of\ pollutant\ in\ air\ (\mu g/m^3)}{RfC, MRL, or\ REL}$$

An HQ of 1 or less indicates that the exposure to a substance is not likely to result in non-cancer health effects. As the HQ increases above 1, the potential for adverse human health effects increases by an undefined amount. However, it should be noted that an HQ above 1 would not necessarily result in health impacts due to the application of uncertainty factors in deriving toxicological reference values (e.g., RfC and REL).

4.4.1.1 Hazard Quotient – DEEP

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

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

HQs were calculated for the maximally exposed residential, workplace, and sensitive receptors. Because chronic toxicity values (RfCs and RELs) are based on a continuous exposure, an adjustment is sometimes necessary or appropriate to account for shorter receptor exposure periods (i.e., people working at business/commercial properties who are exposed for only 8 hours per day, 5 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 4-8 shows chronic HQs at the maximally exposed receptor locations near the project site attributable to DEEP exposure from the Facility and all background sources. HQs are significantly lower than 1 for all receptors' cumulative exposure to DEEP. This indicates that non-cancer effects are not likely to result from chronic exposure to DEEP in the vicinity of the Facility.

4.4.1.2 Hazard Quotient – NO_2

To evaluate possible non-cancer effects from exposure to NO_2, modeled concentrations at receptor locations were compared to their respective non-cancer toxicological values. In this case, maximum-modeled 1-hour NO_2 concentrations were compared to the acute REL (470 $\mu g/m^3$). The acute HQ for NO_2 exposure was calculated using the following equation:

$$Acute\ HQ\ = \frac{maximum\ 1\ hr\ NO_2\ concentration}{470\ \mu g/m^3}$$

Table 4-5 shows acute HQs at the maximally exposed receptor locations near the project site attributable to NO_2 exposure from the project and all background sources. Hazard quotients exceed 1 at all maximally impacted receptor locations.

Given that the acute REL for NO_2 does not provide any additional buffer between the derived value and the exposure concentration at which effects have been observed in sensitive populations, someone with asthma or other respiratory illness present at these locations when both meteorological conditions and engine use during a power outage occurred could experience increased airway reactivity and respiratory symptoms. However, the extremity of exposure symptoms associated with NO_2 exposure at levels contributed by the proposed project are not considered significant.

4.4.1.3 Discussion of Acute Hazard Quotients Greater Than 1

NO_2 HQs may exceed 1 at certain times when unfavorable air dispersion conditions coincide with electrical grid transmission failure. If the HQ is less than 1, then the risk is generally considered acceptable. The more the HQ increases above 1, the more likely it is that adverse health effects will occur by some undefined amount (due in part to how the risk-based concentration is derived).

OEHHA developed an acute REL for NO_2 based on inhalation studies of people with asthma. These studies found that some subjects exposed to about 0.25 ppm (470 µg/m^3) experienced increased airway reactivity following exposure (CalEPA 2008). Not all subjects experienced apparent effects. Like NO_2, DEEP may interact with airways in the respiratory tract. Simultaneous exposure to NO_2 and DEEP components of diesel engine exhaust probably results in a higher risk of adverse respiratory effects than exposure to the NO_2 component alone.

4.4.1.4 Combined Hazard Quotient for All Pollutants with Emission Rates that Exceed the SQERs

The non-cancer health impacts were evaluated based on the conservatively high emission rates. Eleven TAPs (DEEP, benzene, 1,3-butadiene, formaldehyde, dibenz[a,h]anthracene, naphthalene, CO, NO_2, acrolein, ammonia, chromium, and SO_2) to be emitted by the Facility have emission rates that exceed their respective SQERs and, therefore, are subject to further evaluation. The receptor locations of concern are the MIBR/MICR (C-2, C-5, or C-4), MIRR (R-4 or R-7), and the nearest hospital (I-2) and the nearest school (I-4) to the project site. Tables 4-9 and 4-10 show modeled concentrations, risk-based concentrations (RBCs), and HQs for each receptor point. All modeled concentrations and RBCs are reported in µg/m^3. The acute combined HI for each location is the sum of the 1-hour time-weighted average HQs for NO_2, benzene, 1,3-butadiene, CO, acrolein, ammonia, SO_2 and formaldehyde. Table 4-9 shows the acute combined HI including and not including NO_2. The annual chronic combined HI for each location is the sum of all HQs for DEEP, benzene, 1,3-butadiene, acrolein, ammonia, naphthalene, formaldehyde, and chromium (the only TAPs with an emission rate above the SQER with a chronic RBC).

The information in Table 4-9 indicates that acute health effects from CO, benzene, 1,3-butadiene, SO_2, ammonia, formaldehyde, and acrolein are unlikely to occur even under worst-case conditions at maximally impacted receptor locations. When NO_2 is included in the acute combined HI, the HIs for all maximally impacted receptor locations exceed 1. Section 4.4.1.5 discusses the probability of worst-case scenario exceedances.

The information in Table 4-10 indicates that chronic non-cancer health effects are unlikely to occur even under worst-case conditions at the maximally impacted receptor locations. At times when unfavorable air dispersion conditions occur coincident with a maximum operating scenario, the chronic combined HIs from DEEP, benzene, 1,3-butadiene, acrolein, chromium, ammonia, formaldehyde, and naphthalene are modeled to be less than 1. If the HQ or HI is less than 1, then the risk is considered acceptable.

4.4.1.5 Probability Analysis of NO_2 ASIL Exceedances

LAI analyzed the frequency (number of hours) that meteorological conditions could result in a NO_2 concentration greater than 454 µg/m^3 across the Quincy modeling domain. Although the NO_2 level of interest is 470 µg/m^3, concentrations that exceed 454 µg/m^3 are noteworthy because Ecology estimates that a prevailing NO_2 concentration of 16 µg/m^3 could exist in Quincy at any given time (WSU; accessed October 30, 2017). Figure 4-5 displays these results graphically by showing the exceedance interval, or number of years between each theoretical occurrence of project-related NO_2 concentrations exceeding 454 µg/m^3, based on an average power outage duration for Grant County Public Utility District (PUD) customers of 142 minutes (Grant County PUD 2017).

LAI conducted an analysis of the duration of each event exceeding 454 µg/m^3 at the MIBR (C-5), and the time intervals between those exceedance events. The results were as follows:

- Number of AERMOD modeled hours: 43,800
- Number of hours in 5 years exceeding 454 µg/m^3: 4
- Number of events with 2 sequential hours of NO_2 > 454 µg/m^3: 0

This statistical analysis confirms that ASIL exceedances would occur very rarely, even if the generators are assumed to operate continuously for 5 years.

To account for infrequent intermittent emergency outages, LAI further evaluated the modeling data to consider the frequency of occurrence of the modeled ASIL exceedances caused by a power outage when all of the generators activate at their highest emitting load, based on a conservatively high assumption of 42 hours of power outage every year. The results were examined in detail for four receptor locations—MIBR (C-5), MICR (C-4), MIRR (R-7), MIIR (I-4)—and the receptor with the maximum ASIL exceedance counts due to project impacts. As described above, AERMOD modeling showed that the maximum 1-hour NO_2 concentration at or beyond the Facility boundary could theoretically exceed the ASIL; however, that could happen only if two infrequent, independent events occurred simultaneously: a full power outage and winds blowing directly toward the receptor location with exceptionally poor atmospheric dispersion.

To calculate the frequency of occurrence, LAI used the following steps for each maximally impacted receptor:

- Calculate the hourly probability of occurrence of “poor dispersion conditions” defined as the fraction of hours in the 5-year modeling period when AERMOD predicts a 1-hour NO_2 concentration exceeding the threshold, assuming a power outage occurs continuously during the 5-year period.
- Calculate the hourly probability of occurrence of a power outage based on an “average case” of 142 minutes of outage per year based on PUD data from 2009 to 2016, and an upper-bound case of 42 hours of outage every year.
- Calculate the joint probability of those two independent events happening simultaneously and convert the joint probability to an annual recurrence interval.

The results of these calculations are shown in Table 4-11.

Figure 4-4 shows cumulative NO_2 impacts at the MIBR, MICR, MIRR, and school during the 5-year simulation period, assuming that a system-wide power failure occurs at the same time as the worst-case meteorological conditions. Exceedance concentrations are present throughout multiple land-use types.

Table 4-11 summarizes the probability that the modeled values exceed the selected thresholds for the worst-case assumption of 42 hours/year of power outage and the average-case assumption of 142 minutes/year of power outage. Table 4-11 presents the number of hours that the threshold is exceeded during the 5-year period, the average number of hours per year that the threshold is exceeded, the probability that a power outage will occur for any given hour, the probability of exceeding the threshold during a power outage for any given hour (phr), the overall probability that the threshold will be exceeded in a given year (p1yr), and the estimated recurrence interval. Overall annual probability, p, is calculated as: p = 1 - (1- phr)n, where n is the total number of hours (e.g., 8,760 hours in 1 year). The annual recurrence interval is the inverse of the overall annual probability, and represents the average number of years between exceedances.

As shown in Table 4-11, when taking into account historical Grant County PUD electrical grid reliability, the recurrence interval of cumulative NO_2 impacts above the ASIL (project + local background sources) was calculated as follows:

- MICR (C-4) = 35 years
- MIRR (R-7) = 386 years
- MIIR (I-4) = 186 years.

This evaluation demonstrates that the probability of a receptor location being exposed to NO_2 concentrations above the acute REL is very low.

4.4.1.6 Probability Analysis of NO_2 AEGL Exceedances

LAI also analyzed the frequency (number of hours) that meteorological conditions could result in a NO_2 concentration greater than the AEGL 1. Although the NO_2 AEGL is 940 µg/m^3, concentrations that exceed 924 µg/m^3 are noteworthy because Ecology estimates that a prevailing NO_2 concentration of 16 µg/m^3 could exist in Quincy at any given time.

Table 4-12 summarizes the probability that the modeled values exceed the AEGL threshold for the worst-case assumption of 24 hours/year of power outage and the average-case assumption of 142 minutes/year of power outage. Modeling did not indicate any project-related AEGL 1 exceedance. Table 4-12 presents the number of hours that the threshold is exceeded during the 5-year period based on cumulative impacts, the average number of hours per year that the threshold is exceeded, the probability that a power outage will occur for any given hour, the probability of exceeding the threshold during a power outage for any given hour, the overall probability that the threshold will be exceeded in a given year, and the estimated recurrence interval.

As shown in Table 4-12, when taking into account historical Grant County PUD electrical grid reliability, the recurrence interval of cumulative NO_2 impacts above the AEGL 1 (project + local background sources) was calculated as follows:

- MIBR (C-5) = 18,508 years
- MICR (C-4) = 712 years

This evaluation demonstrates that the probability of a receptor location being exposed to NO_2 concentrations above the AEGL 1 is very low.

4.4.2 Quantifying an Individual's Increased Cancer Risk

4.4.2.1 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 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:

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

The exposure frequencies for each receptor type are shown below and provided in Table 4-6, based on Ecology's judgment from review of published risk evaluation guidelines.

DEEP Exposure Frequencies for Each Receptor Type

Parameter	Description	Value Based on Receptor Type						Units
		Residential	Worker	School-Staff	School-Student	Hospital	Boundary	
C_{Air}	Concentration in air at the receptor location	See Table 4-4						µg/m³
URF	Unit Risk Factor	0.0003						$(µg/m^3)^{-1}$
EF1	Exposure Frequency	365	250	200	180	365	250	Days/Year
EF2	Exposure Frequency	24	8	8	8	24	2	Hours/Day
ED	Exposure Duration	70	40	40	7 (Elem) 4 (HS & College)	1	30	Years
AT	Averaging Time	613,200						Hours

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 the EPA reflect the potential that thresholds for some carcinogenesis exist. However, the 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 million people are exposed to a carcinogen, one excess cancer might occur, or a person's chance of getting cancer in their lifetime increases by 1 in 1 million or 0.0001 percent. 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.

Table 4-4 shows the estimated cancer risks associated with predicted project-related DEEP concentrations and the URFs (Table 4-6). The location with the greatest increased cancer risk associated with project-related DEEP concentrations is the MIRR location. The calculated lifetime cancer risk at the MIRR is 2.7 per million. This is less than 10 per million, which is the recommended permissible limit for second-tier review under Chapter 176-460 WAC.

As part of the second-tier risk evaluation, Ecology will consider all the cumulative impacts of DEEP emissions in the project vicinity. Note that Chapter 173-460 WAC does not currently have a numerical limit on allowable cumulative cancer risks. However, Ecology has indicated that new sources of DEEP may not be approved to locate in Quincy if the resulting cumulative cancer risk is above 100 per million (100×10^{-6}).

Also shown in Table 4-4 are the cumulative cancer risks for each maximally impacted receptor location. This accounts for currently permitted DEEP emissions from neighboring data centers, railroad and roadway diesel traffic emissions, and project-related emissions from the Facility. The maximum cumulative (project-related and background emissions) cancer risk impact at the MIRR location (R-4) is estimated to be 32 per million. The maximum cumulative cancer risk at the MICR is estimated to be 11 per million. The maximum cumulative cancer risk at the hospital (I-2) and school (I-4) is estimated to be 1.26 per million and 0.55 per million, respectively. The maximum cumulative impacted residential receptor (McIRR) location in the Quincy modeling domain is R-2 with a cumulative cancer risk estimated at 94.7 per million; however, the contribution to the cancer risk associated with impacts from the project accounts for only 1.3 percent of the total cancer risk. Most of the cancer risk at this receptor location is from truck traffic on SR 28.

4.4.2.2 Cancer Risk from Exposure to All Pollutants

An evaluation was completed to estimate the increased cancer risk from exposure to all potentially carcinogenic compounds from the proposed project alone. The emission rate for every carcinogenic constituent was considered in this evaluation, which is shown in Table 4-13. As indicated in Table 4-13, the cancer risk associated with DEEP alone at the MIRR location (R-4) is 2.7×10^{-6}. The other recognized carcinogenic compounds contribute negligibly to the overall cancer risk (i.e., 6×10^{-8}). The combined cancer risk caused by all constituents is 2.8×10^{-6}.

4.4.2.3 Cancer Risk from Exposure to NO_2

Cancer health risk was not evaluated for NO_2 because NO_2 is not considered carcinogenic by the US Department of Health and Human Services, the International Agency for Research on Cancer, or the EPA (ATSDR 2011; EPA; accessed January 3, 2018).

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5.0 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 and NO_2 emissions from the proposed project and "background" sources of DEEP and NO_2. The assumptions used in the face of uncertainty may tend to overestimate 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 TAPs emitted by diesel engines. The forecast emission rates for PM used for this analysis were based on the upper range of vendor estimates for engines meeting Tier 2 emission criteria. The forecast emission rates for NO_2 were based on the conservatively high assumption that NO_2 makes up 10 percent of the emitted NO_x. The emission rates for the other TAPs were based on published emission factor data from the EPA, which 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 will be exposed to DEEP and NO_2 emissions from the proposed Facility. For simplicity, this analysis assumed that 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. For this permit application, Microsoft conservatively estimated that it would use the generators during emergency outages for no more than 42 hours per year. Grant County PUD reports an Average Service Availability Index (or percent of time that a customer has power provided during the year) of more than 99.99 percent each year (2009 to 2016) and a Customer Average Interruption Duration Index (or average duration of power interruption per customer) of 77 to 300 minutes (1.3 to 5 hours) over the same period (Grant County PUD 2017). While this high level of historical reliability provides some assurance that electrical service is relatively stable, Microsoft cannot predict future outages with any degree of certainty. Microsoft proposes a limit of 86 hours average per generator per year for all Facility emergency generator operations (including maintenance, testing, and power outages), and estimates that this limit should be sufficient to meet its emergency demands. It is expected that calculations of cancer risk will be significantly overestimated by assuming the generators will operate annually at the maximum permitted level for 70 consecutive years.

5.2 Air Dispersion Modeling Uncertainty

The transport of pollutants through the air is a complex process. Regulatory air dispersion models have been 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, and are developed 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 project analysis will likely slightly overestimate the short-term (24-hour average) impacts and somewhat underestimate the annual pollutant 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), the EPA and other agencies apply "uncertainty" factors to doses or concentrations that were observed to cause non-cancer effects in animals or humans. The EPA applies these uncertainty factors so that it derives a toxicity value that is considered protective of humans including susceptible populations.

5.3.1 DEEP Toxicity Uncertainty

In the case of the DEEP RfC, the 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 the EPA classifies DEEP as probably carcinogenic to humans, it has not established a URF for quantifying cancer risk. In its health assessment document, the EPA determined that "human exposure-response data are too uncertain to derive a confident quantitative estimate of cancer unit risk based on existing studies" (EPA 2002). However, the 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, the EPA states in its 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 the 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.

5.3.2 NO_2 Toxicity Uncertainty

Similar to DEEP, uncertainty exists surrounding NO_2 toxicity. In a 2009 review of more than 50 experimental studies regarding human exposure to NO_2, Hesterberg et al. (2009) found that “the reporting of statistically significant changes in lung function and bronchial sensitivity did not show a consistent trend with increasing NO_2 concentrations.” Hesterberg et al. (2009) also reported:

> The NO_2 epidemiology remains inconsistent and uncertain due to the potential for exposure misclassification, residual confounding, and co-pollutant effects, whereas animal toxicology findings using high levels of NO_2 exposure require extrapolation to humans exposed at low ambient NO_2 levels.

In OEHHA’s Acute Toxicity Summary, describing the factors contributing to its determination of an acute REL for NO_2, OEHHA reported uncertainty in NO_2 effects on pulmonary function due to the lack of accidental human exposure data available. High uncertainty factors were used when extrapolating animal test results to humans due to interspecies differences. “Species-specific susceptibility comparisons of experimental animals suggest that humans are less sensitive to the toxic effects of NO_2 than smaller experimental animal species.” OEHHA found that exposure levels that resulted in compromised lung function in experimental animal species failed to produce even symptoms of mild irritation in humans with asthma (CalEPA 1999).

It is likely that the mixture of pollutants emitted by new-technology diesel engines (such as those proposed for this project) is different from older-technology engines. Table 5-1 presents a summary of how the uncertainty affects the quantitative estimate of risks or hazards.

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6.0 SHORT-TERM EXPOSURE TO DEEP AND $PM_{2.5}$

As discussed previously, exposure to DEEP can cause both acute and chronic adverse 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 this 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 NAAQS for particulate matter with an aerodynamic diameter less than or equal to 2.5 microns ($PM_{2.5}$) is an indicator of acceptable short-term health effects from DEEP exposure. The NOC Supporting Information Report (LAI 2018) concludes that emissions from the proposed project are not expected to cause or contribute to an exceedance of any NAAQS.

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7.0 DISCUSSION OF ACCEPTABILITY OF RISK WITH REGARD TO SECOND-TIER REVIEW GUIDELINES

7.1 Project-Only Cancer Risks are Lower than 10-per-million

As noted above, the modeled worst-case TAP concentrations at the Facility boundary caused solely by emissions from the proposed Facility are less than the ASIL values established by Ecology for all pollutants, with the exception of DEEP and NO_2. The worst-case emission rates are less than the SQERs for most pollutants, with the exception of DEEP, benzene, 1,3-butadiene, naphthalene, CO, NO_2, SO_2, formaldehyde, acrolein, ammonia, dibenz(a,h)anthracene, and chromium. The long-term uncontrolled cancer risks at the nearby residences, businesses, and sensitive receptor locations range from 0.016 to 2.7 per million for DEEP and are much lower for the other TAPs considered in this analysis (Table 4-13). The overall cancer risk at any of the maximally exposed residential, business, and sensitive receptor locations, caused solely by emissions from the proposed project, 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

The residences and businesses that will be exposed to the highest cumulative cancer risk are located south of the Facility near the railroad tracks, SR 281, and SR 28, in locations where most of the cancer risk is attributable to trucks and trains unrelated to the project. The total average cumulative DEEP cancer risks for the maximally exposed home, business, and sensitive receptors are as follows:

Facility-only cancer risk (McIRR at R-2 SE residence):	1.3 per million
Background DEEP cancer risk:	93.4 per million
Cumulative DEEP cancer risk:	94.7 per million
Facility-only cancer risk (MICR at C-2 Facility):	2.1 per million
Background DEEP cancer risk:	14.5 per million
Cumulative DEEP cancer risk:	16.6 per million
Facility-only cancer risk (MIIR at I-4 School):	0.016 per million
Background DEEP cancer risk:	0.59 per million
Cumulative DEEP cancer risk:	0.61 per million
Facility-only cancer risk (I-2 Hospital):	0.016 per million
Background DEEP cancer risk:	1.30 per million
Cumulative DEEP cancer risk:	1.32 per million

Note, as presented above, the increased cancer risk associated with DEEP emissions from the proposed Facility is approximately 1.3 percent of the total cumulative DEEP cancer risk at the maximum cumulatively impacted residential receptor location R-2.

7.3 Non-Cancer Risk Hazard Quotients

The maximum HQ related to project-only and cumulative annual-average DEEP at any maximally impacted receptor location is 0.011 and 0.088, respectively. The maximum chronic HI for impacts caused by emissions of DEEP, benzene, 1,3-butadiene, naphthalene, formaldehyde, acrolein, ammonia, and chromium is 0.027.

The maximum HQ related to project-only and cumulative 1-hour average NO_2 at any maximally impacted receptor location is 1.9 and 5.0, respectively. The maximum acute HI for impacts caused by emissions of NO_2, CO, SO_2, benzene, 1,3-butadiene, formaldehyde, ammonia, and acrolein is 2.1. As described above, 1-hour NO_2 acute REL exceedances—that would result in an HQ or HI greater than 1—could theoretically occur; however, it would require two infrequent, independent events occurring simultaneously: a full power outage and winds blowing directly toward the receptor location with exceptionally poor atmospheric dispersion. An evaluation of the recurrence interval of HQs greater than 1 concluded that the estimated recurrence interval ranges from 35 years (MICR) to 386 years (MIRR) considering historical power grid reliability in Grant County.

This evaluation demonstrates that the probability that this project could cause non-cancer health impacts is very low. Additionally, the extremity of potential exposure symptoms associated with NO_2 exposure at levels evaluated for this project are not considered significant (e.g., mild, transient adverse health effects).

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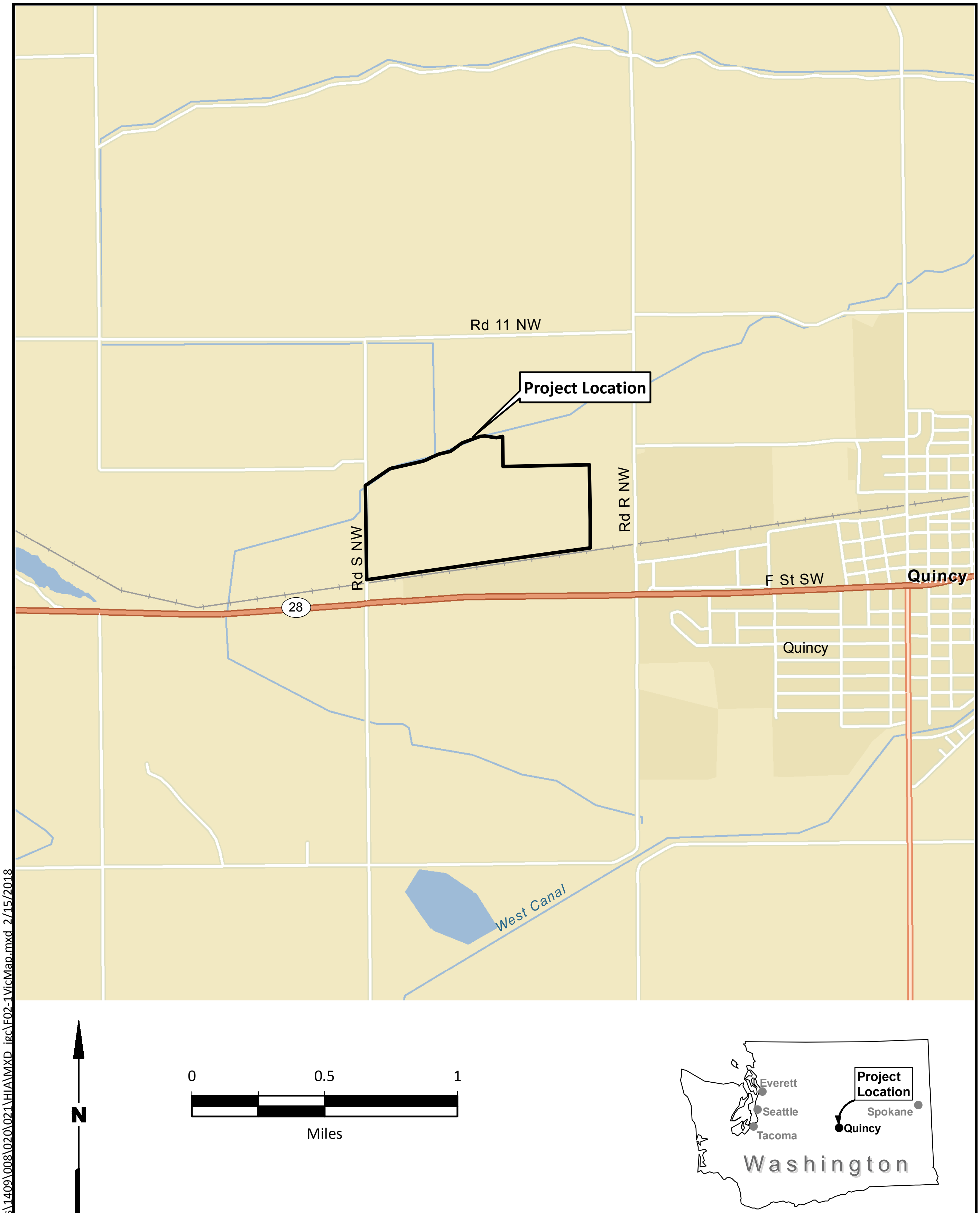

Data Source: Esri 2012.

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Microsoft MWH Data Center Health Impact Assessment Quincy, Washington	**Vicinity Map**	Figure 2-1

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Legend

- Cooling Towers
- 3,000 kW Generator
- 1,500 kW Generator
- Subject Property
- Proposed Buildings
- Existing Buildings

0 670 1,340

Scale in Feet

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Data Sources: Grant County GIS; Google Earth Imagery.

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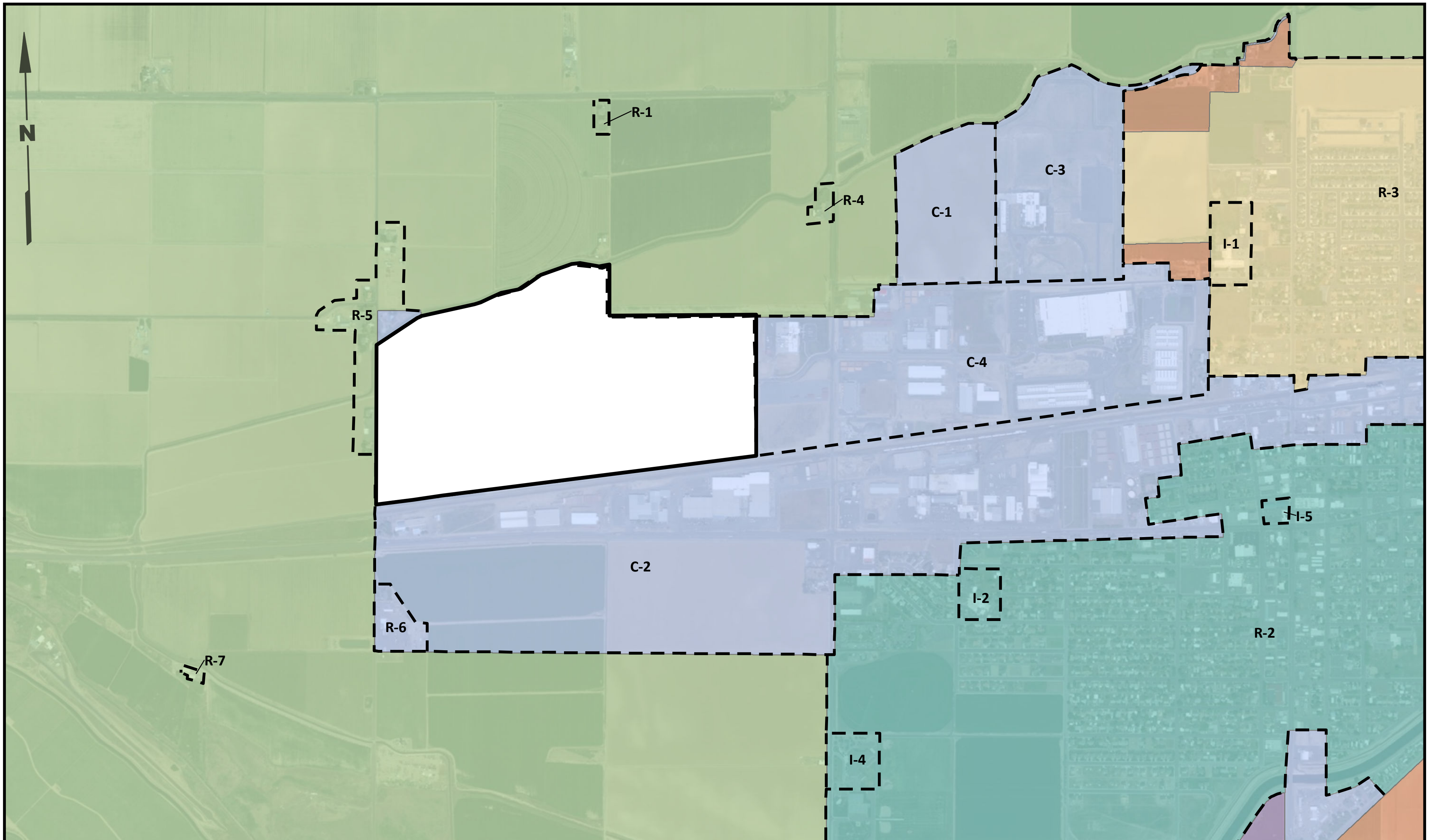
Health Impact Assessment
Quincy, Washington

Site Map

Figure
2-2

Landau Associates, Inc. | G:\Projects\1409\008\020\021\HIA\MXD_jgc\F02-3Zone.mxd



Legend

- Grant County Agricultural
- Grant County Commercial/Industrial
- Grant County Residential
- City Industrial
- City Residential/Business
- City Residential

0 1,700 3,400

Scale in Feet

Data Sources: Grant County GIS; Esri World Imagery.

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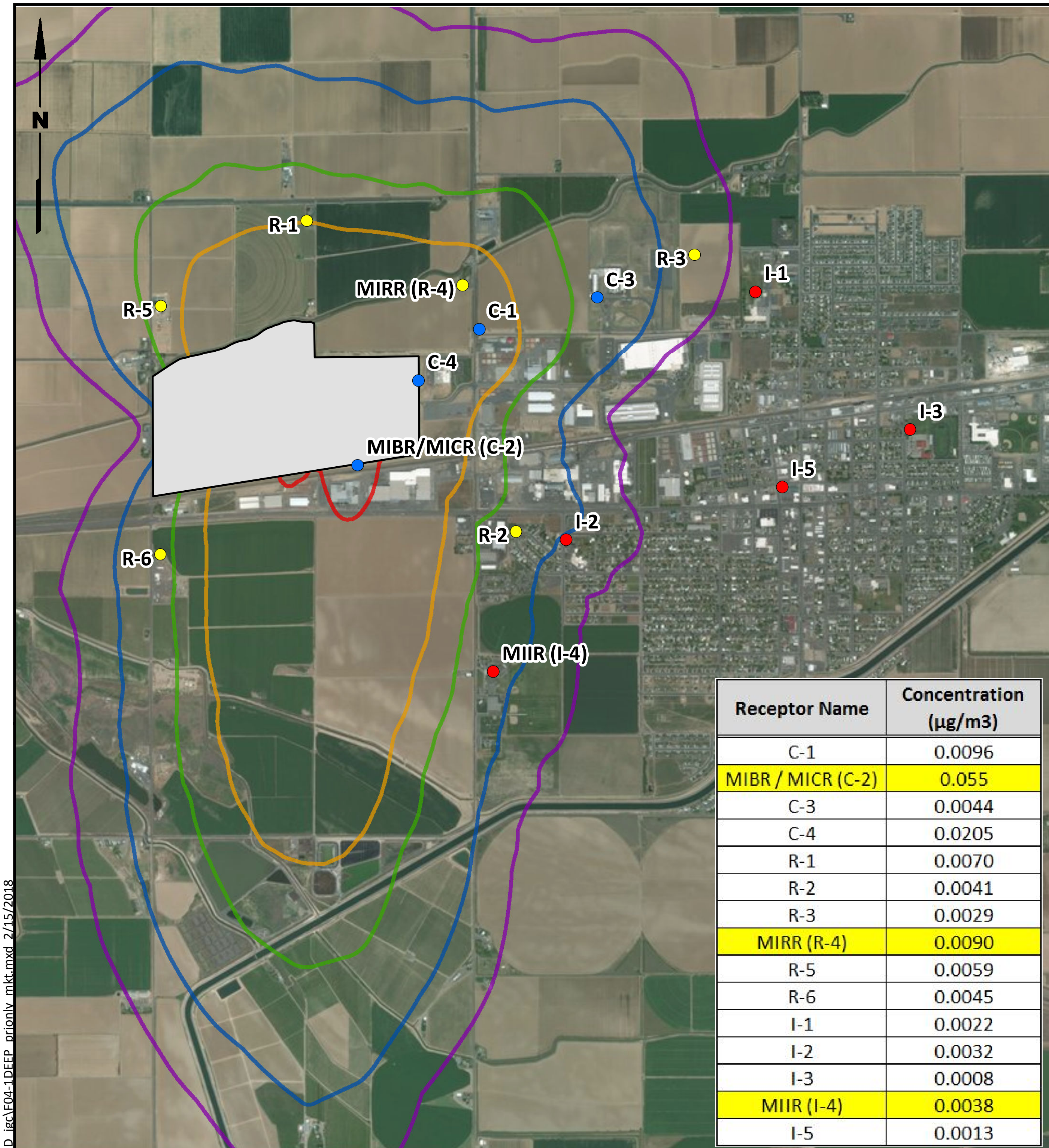
Microsoft MWH Data Center Health Impact Assessment Quincy, Washington	**Land Use Zoning Map**	Figure 2-3



Receptor Name	Concentration (µg/m3)
C-1	0.0096
MIBR / MICR (C-2)	0.055
C-3	0.0044
C-4	0.0205
R-1	0.0070
R-2	0.0041
R-3	0.0029
MIRR (R-4)	0.0090
R-5	0.0059
R-6	0.0045
I-1	0.0022
I-2	0.0032
I-3	0.0008
MIIR (I-4)	0.0038
I-5	0.0013

DEEP Concentrations

- 0.0025 µg/m^3
- 0.00333 µg/m^3 (ASIL)
- 0.005 µg/m^3
- 0.007 µg/m^3
- 0.033 µg/m^3

Legend

- Commercial Receptors
- Residential Receptors
- Institutional Receptors

Data Source: T4caDPM122017
Base Map Source: ESRI World Imagery

Note
1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 3,200 6,400
Scale in Feet

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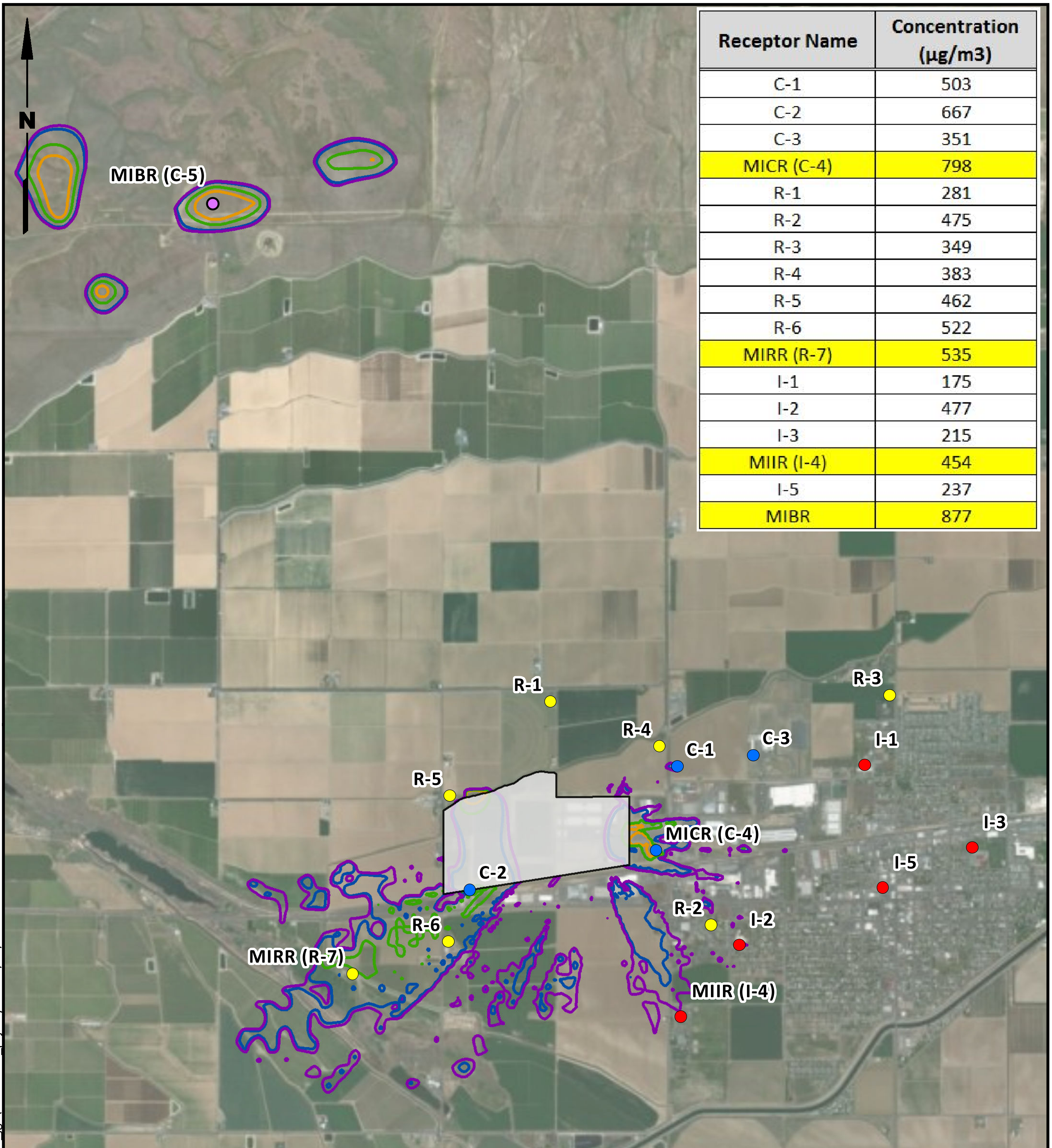
Health Impact Assessment
Quincy, Washington

Project-Only DEEP Concentration Contour Map

Figure
4-1



Receptor Name	Concentration (µg/m3)
C-1	503
C-2	667
C-3	351
MICR (C-4)	798
R-1	281
R-2	475
R-3	349
R-4	383
R-5	462
R-6	522
MIRR (R-7)	535
I-1	175
I-2	477
I-3	215
MIIR (I-4)	454
I-5	237
MIBR	877

NO_2 Contours

- 454 µg/m^3
- 470 µg/m^3
- 550 µg/m^3
- 625 µg/m^3
- 871 µg/m^3

Legend

- Boundary Receptor
- Residential Receptor
- Institutional Receptors
- Commercial Receptors

Data Source: T4no2_122117(a-b)
Base Map Source: ESRI World Imagery

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 4,500 9,000
Scale in Feet

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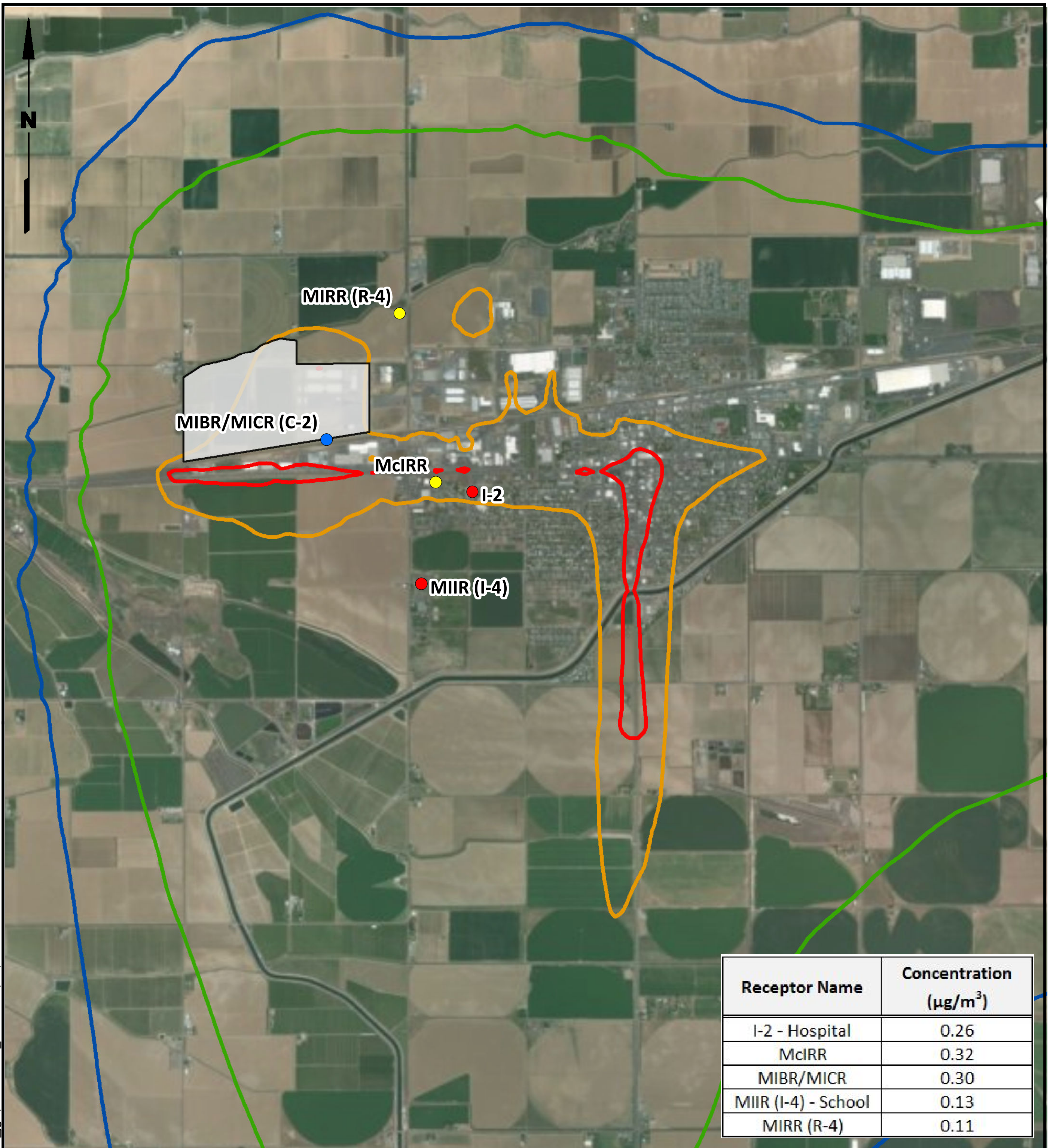
Health Impact Assessment
Quincy, Washington

Project-Only NO_2 1-hour Concentration Contour Map

Figure 4-2



Receptor Name	Concentration ($\mu g/m^3$)
I-2 - Hospital	0.26
McIRR	0.32
MIBR/MICR	0.30
MIIR (I-4) - School	0.13
MIRR (R-4)	0.11

Legend

- Institutional Receptor
- Residential Receptor
- Commercial Receptor

DEEP Concentrations

- 0.033 $\mu g/m^3$
- 0.05 $\mu g/m^3$
- 0.25 $\mu g/m^3$
- 0.5 $\mu g/m^3$

Data Source: T4caDPM122017
Base Map Source: ESRI World Imagery

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 4,500 9,000
Scale in Feet

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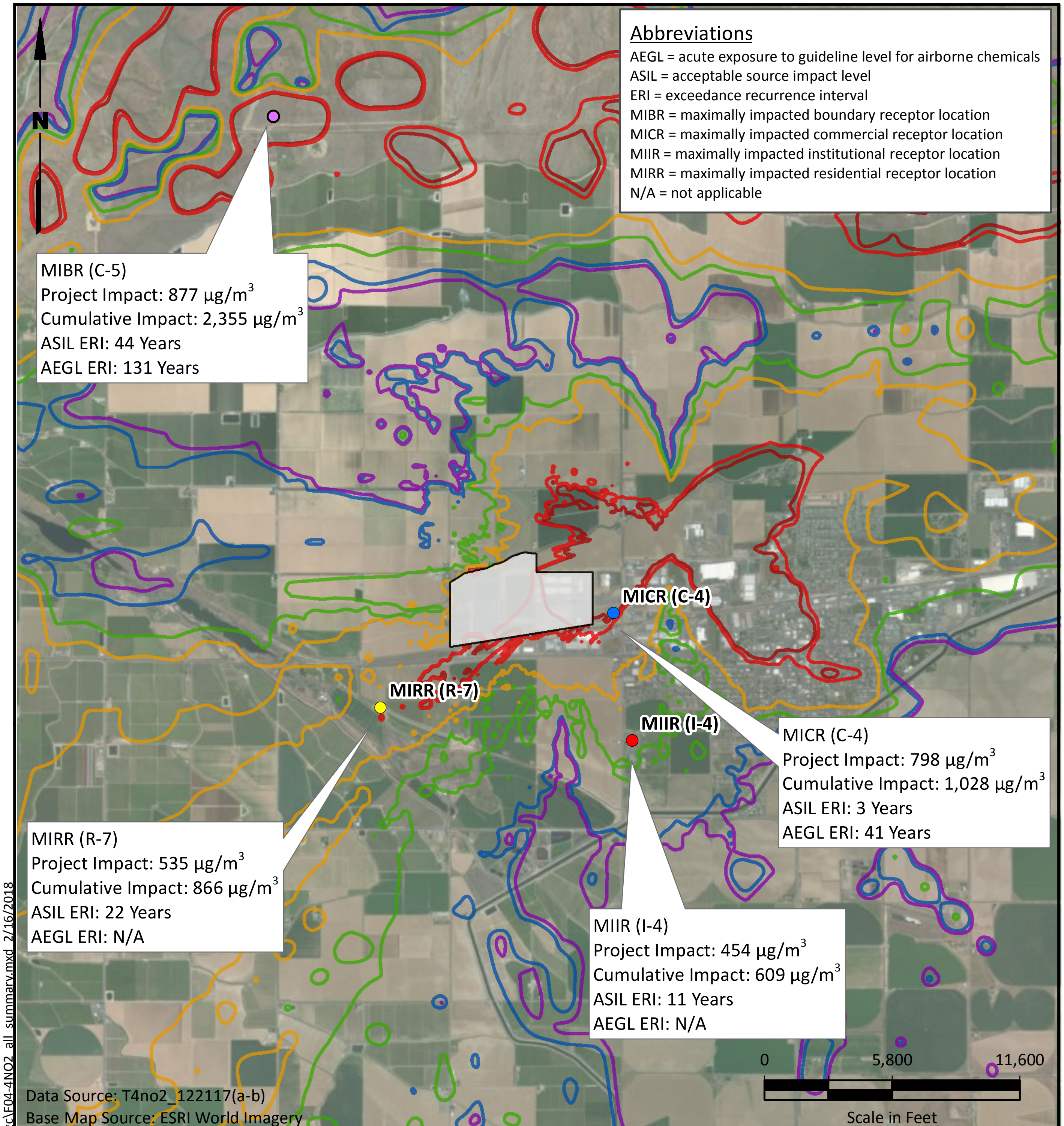
Health Impact Assessment
Quincy, WA

Cumulative DEEP Concentration Contour Map

Figure
4-3



NO_2 Contour

- 454 µg/m^3
- 470 µg/m^3
- 550 µg/m^3
- 625 µg/m^3
- 924 µg/m^3
- 970 µg/m^3

Legend

- Boundary Receptor
- Residential Receptor
- Institutional Receptor
- Commercial Receptor

Note

1. The reported ERIs are based on the conservatively assumed power outage duration of 42 hours per year. Observed power outage by Grant County customers was 142 minutes per year between 2009 to 2016 (Grant County PUD 2017).
2. ASIL exceedances represent impact concentrations greater than 454 µg/m^3, including regional background effects.
3. AEGL exceedances represent impact concentrations greater than 924 µg/m^3, including regional background effects.
4. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

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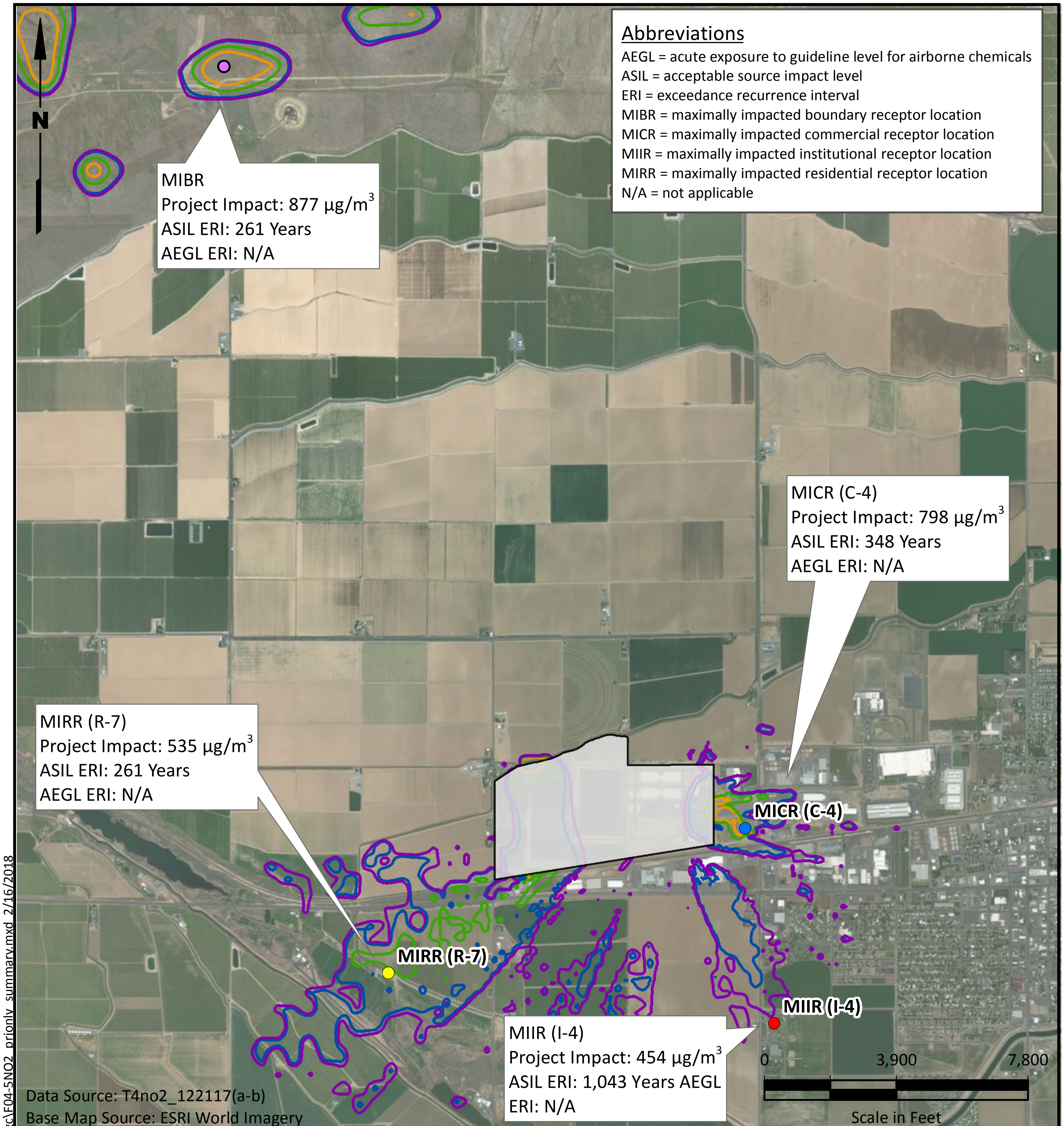
Health Impact Assessment
Quincy, Washington

Cumulative NO_2 1-Hour Impacts Summary

Figure
4-4



NO_2 Contour

- 454 µg/m³
- 470 µg/m³
- 550 µg/m³
- 625 µg/m³
- 924 µg/m³
- 970 µg/m³

Legend

- Residential Receptor
- Institutional Receptor
- Commercial Receptor
- Boundary Receptor

Note

1. The reported ERIs are based on the conservatively assumed power outage duration of 42 hours per year. Observed power outage by Grant County customers was 142 minutes per year between 2009 to 2016 (Grant County PUD 2017).
2. ASIL exceedances represent impact concentrations greater than 454 µg/m³, including regional background effects.
3. AEGL exceedances represent impact concentrations greater than 924 µg/m³, including regional background effects.
4. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

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Microsoft MWH Data Center Health Impact Assessment Quincy, Washington	**Project-Only NO_2 1-Hour Impacts Summary**	Figure 4-5

Table 2-1
Project Emissions Compared to Small-Quantity Emission Rates
MWH-03/04/05/06 Data Center
Quincy, Washington

Pollutant	CAS Number	Averaging Period	Project-wide Emission Rate	*De Minimis*	SQER	Required Action
			(pounds per averaging period)			
Diesel Engine Generator Emissions						
NO_2	10102-44-0	1-hr	59	0.457	1.03	Model
DEEP	--	year	3,359	0.032	0.639	Model
SO_2	7446-09-5	1-hr	3.2	0.457	1.45	Model
Carbon monoxide (CO)	630-08-0	1-hr	138	1.14	50.4	Model
Benzene	71-43-2	year	432	0.331	6.62	Model
Toluene	108-88-3	24-hr	14	32.9	657	
Xylenes	95-47-6	24-hr	9.5	1.45	29	Report
1,3-Butadiene	106-99-0	year	22	0.0564	1.13	Model
Formaldehyde	50-00-0	year	44	1.6	32	Model
Acetaldehyde	75-07-0	year	14	3.55	71	Report
Acrolein	107-02-8	24-hr	0.39	3.94E-04	0.00789	Model
Benzo(a)pyrene	50-32-8	year	0.14	0.00872	0.174	Report
Benzo(a)anthracene	56-55-3	year	0.35	0.0872	1.74	Report
Chrysene	218-01-9	year	0.85	0.872	17.4	
Benzo(b)fluoranthene	205-99-2	year	0.62	0.0872	1.74	Report
Benzo(k)fluoranthene	207-08-9	year	0.12	0.0872	1.74	Report
Dibenz(a,h)anthracene	53-70-3	year	0.19	0.00799	0.16	Model
Ideno(1,2,3-cd)pyrene	193-39-5	year	0.23	0.0872	1.74	Report
Naphthalene	91-20-3	year	72	0.282	5.64	Model
Propylene	115-07-1	24-hr	137	19.7	394	Report
Cooling Unit Emissions						
Arsenic (As)	7440-38-2	year	*3.88E-02*	0.00291	0.058	Report
Beryllium (Be)	7440-41-7	year	*3.88E-02*	0.004	0.080	Report
Cadmium (Cd)	7440-43-9	year	*1.94E-02*	0.00228	0.046	Report
Chromium (Cr)	--	year	*3.88E-02*	6.40E-05	1.28E-03	Model
Copper (Cu)	--	1-hr	*5.53E-04*	0.011	0.22	
Lead (Pb)	7439-92-1	year	*3.88E-02*	10	16	
Manganese (Mn)	7439-96-5	24-hr	**1.59E-03**	2.63E-04	5.26E-03	Report
Mercury (Hg)	7439-97-6	24-hr	*1.06E-02*	5.91E-04	0.0118	Report
Selenium (Se)	7782-49-2	24-hr	*1.06E-04*	0.131	2.63	
Vanadium (V)	7440-62-2	24-hr	**1.80E-03**	0.00131	0.026	Report
Total Cyanide	74-90-8	24-hr	*5.31E-04*	0.0591	1.18	
Total Phosphorus	7723-14-0	24-hr	**1.9E-01**	0.131	2.63	Report
Combined (Diesel Engine Generator + Cooling Unit) Emissions						
Ammonia	7664-41-7	24-hr	1593	0.465	9.310	Model

Notes:

Highlighted cells indicate pollutants that require ambient air dispersion model analysis

italic = not detected above reporting limit; emissions reflect reporting limit

bold and shaded = detected; emissions reflect actual detected concentrations

Abbreviations and Acronyms:

µg/m^3 = micrograms per cubic meter
CAS = Chemical Abstract Service
DEEP = diesel engine exhaust particulate matter
hr = hour
NO_2 = nitrogen dioxide
SO_2 = sulfur dioxide
SQER = small-quantity emission rate

Table 2-2
Land Uses in the Project Vicinity
MWH-03/04/05/06 Data Center
Quincy, Washington

	Notable Development	Direction from Project Site	City / County Zoning	HIA Zoning ID
Commercial	CyrusOne Data Center	Northeast	City Industrial	C-1
	Commercial Zone	Southeast and adjacent South	City Industrial	C-2
	NTT DATA Data Center	East	City Industrial	C-3
	Columbia Data Center	Adjacent East	City Industrial	C-4
	Vacant Land	North	County Agricultural	C-5
Residential	Residence	North	County Agricultural	R-1
	Residential Zone	Southeast	City Residential/Business	R-2
	Residential Zone	East	County / City Residential	R-3
	Residence	Northeast	County Agricultural	R-4
	Residences	Adjacent north and Northwest	County Agricultural	R-5
	Residence	Southwest	County Agricultural	R-6
	Residence	Southwest	County Agricultural	R-7
Institutional	Mountain View Elementary School	Northeast	County / City Residential	I-1
	Quincy Valley Hospital	Southeast	City Residential/Business	I-2
	Quincy High School & Junior High School	East	City Residential/Business	I-3
	Monument Elementary School	Southeast	City Residential/Business	I-4
	Quincy High Tech High School	East	City Residential/Business	I-5

Table 3-1
Summary of BACT Determination for Diesel Engine Generators
MWH-03/04/05/06 Data Center
Quincy, Washington

Pollutant(s)	BACT Determination
Particulate matter (PM), carbon monoxide (CO), volatile organic compounds (VOC), and nitrogen oxides (NO_x)	a. Use of EPA Tier 2-certified engines when installed and operated as emergency engines, as defined by 40 CFR 60.4219. b. Compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart IIII.
Sulfur dioxide (SO_2)	Use of ultra-low sulfur diesel fuel containing no more than 15 parts per million by weight of sulfur.

Abbreviations and Acronyms:
BACT = Best available control technology
CFR = Code of Federal Regulations
CO = Carbon monoxide
EPA = US Environmental Protection Agency
NO_x = Nitrogen oxides
PM = Particulate matter
SO_2 = Sulfur dioxide
VOCs = Volatile organic compounds

Table 3-2
Summary of tBACT Determination for Diesel Engine Generators
MWH-03/04/05/06 Data Center
Quincy, Washington

Toxic Air Pollutant(s)	tBACT Determination
Particulate matter (PM), carbon monoxide (CO), volatile organic compounds (VOC), and nitrogen oxides (NO_x)	Use of EPA Tier 2-certified engines when installed and operated as emergency engines, as defined by 40 CFR 60.4219. Compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart III.
Sulfur dioxide (SO_2)	Use of ultra-low sulfur diesel fuel containing no more than 15 parts per million by weight of sulfur.
Toxic air pollutants, including CO, acrolein, acetaldehyde, benzene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)anthracene, chrysene, indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, naphthalene, propylene, 1,3 butadiene, diesel engine exhaust particulate matter (DEEP), formaldehyde, xylenes, nitrogen dioxide (NO_2) and SO_2.	Compliance with the proposed BACT requirements for PM, CO, VOCs, NO_x, and SO_2.

Abbreviations and Acronyms:

BACT = best available control technology
CFR = Code of Federal Regulations
CO = carbon monoxide
DEEP = diesel engine exhaust particulate matter
EPA = US Environmental Protection Agency
NO_2 = nitrogen dioxide
NO_x = nitrogen oxides
PM = particulate matter
SO_2 = sulfur dioxide
tBACT = best available control technology for toxic air pollutants
VOC = volatile organic compound

Table 3-3
Estimated Project Impacts Compared to Acceptable Source Impact Levels
MWH-03/04/05/06 Data Center
Quincy, Washington

Pollutant	CAS Number	Averaging Period	AERMOD Filename	Facility-wide Emission Rate (lbs/avg. period)	Modeled Max. Project-Impact (µg/m^3)	ASIL (µg/m^3)
1,3-Butadiene	106-99-0	year	[a,b]	25	0.00132	0.00588
Acrolein		24-hr	T4acrolein_122117	0.39	0.015	0.06
Benzene	71-43-2	year	T4benzene_020218[b]	495	0.0263	0.0345
Carbon monoxide (CO)	630-08-0	1-hr	T4co_122117	138	473	23,000
Chromium	--	year	T4cr_011218[b]	3.9E-02	4.5E-06	6.67E-06
DEEP	--	year	T4ncDPM_010318[b]	3,359	0.18	0.00333
Dibenz(a,h)anthracene	53-70-3	year	T4dbz_011318[b]	50	1.2E-05	8.33E-04
Formaldehyde	50-00-0	year	[a,b]	0.22	1.2E-05	1.67E-01
Naphthalene	91-20-3	year	[a,b]	83	0.0044	0.029
Nitrogen dioxide (NO_2)	10102-44-0	1-hr	T4no2_122117a	59	877	470
Sulfur Dioxide (SO_2)	7446-09-5	1-hr	T4so2_122117	3.2	10	660
Ammonia	7664-41-7	24-hr	[c]	1,593	61	70.8

Notes:

[a] Predicted impacts were approximated using a dispersion factor derived from the T4benzene_020218 model.

[b] Predicted maximum impacts are based on emissions for the theoretical maximum year.

[c] Predicted impacts were approximated using a dispersion factor derived from the T4acrolein_122117 model.

Highlighted cells indicate pollutants that require a human health impact assessment

Abbreviations and Acronyms:

µg/m^3 = micrograms per cubic meter
AERMOD = American Meteorological Society (AMS)/US Environmental Protection Agency (EPA) Regulatory Model
ASIL = acceptable source impact level
avg = averaging
CAS = Chemical Abstract Service
CO = carbon monoxide
DEEP = diesel engine exhaust particulate matter
hr = hour
lbs = pounds
NO_2 = nitrogen dioxide
SO_2 = sulfur dioxide

Table 4-1
Chemicals Assessed for Multiple Exposure Pathways
MWH-03/04/05/06 Data Center
Quincy, Washington

Chemical	Breast Milk	Dermal	Exposed Vegetable	Fish	Leafy Vegetable	Meat, Milk & Eggs	Protected Vegetable	Root Vegetable	Soil	Water
4,4’-Methylene dianiline		X	X	X	X		X	X	X	X
Beryllium & compounds		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
Creosotes		X	X	X	X	X			X	X
Diethylhexylphthalate		X	X	X	X		X	X	X	X
Dioxins & furans	X	X	X	X	X	X	X	X	X	X
Fluorides (including hydrogen fluoride)	To be determined									
Hexachlorocyclohexanes		X	X	X	X				X	X
Inorganic arsenic & 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
Polycyclic aromatic hydrocarbons (PAHs)		X	X	X	X	X			X	X
Polychlorinated biphenyls (PCBs)	X	X	X	X	X	X	X	X	X	X

Source: CalEPA. 2015. Air Toxics Hot Spots Program Risk Assessment Guidelines: Guidance Manual for Preparation of Health Risk Assessments. Air, Community, anc Environmental Research Branch, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency. February.

Table 4-2
Summary of Project Impacts from Emissions of DEEP
MWH-03/04/05/06 Data Center
Quincy, Washington

Receptor Type	UTM		ID	Direction From Project Site	Approximate Distance From Nearest Project-Generator		DEEP Annual Impact ($\mu g/m^3$)
	E (m)	N (m)			Feet	Meters	
MIBR/MICR	281,796.74	5,235,338.05	C-2	South	429	131	0.055
MIRR	282,360.00	5,236,225.00	R-4	Northeast	2,459	749	0.0090
MIIR (School)	282,441.75	5,234,275.00	I-4	Southeast	4,320	1,317	0.0038
Hospital	282,835.00	5,234,925.00	I-2	Southeast	3,610	1,100	0.0032
Max. Cumulatively Impacted Residential Receptor Location[a]	282,574.30	5,235,001.60	R-2	Southeast	2,748	838	0.32[b]

Notes:

[a] Maximum cumulative impacts were evaluated for receptors only within ASIL domain.

[b] This value was established by interpolation between receptors encompassing the residence, in order to estimate the maximum impact at the residence

Abbreviations and Acronyms:

$\mu g/m^3$ = micrograms per cubic meter
DEEP = diesel engine exhaust particulate matter
E = east
m = meter
MIBR = maximally impacted boundary receptor location
MICR = maximally impacted commercial receptor location
MIIR = maximally impacted institutional receptor location
MIRR = maximally impacted residential receptor location
N = north
UTM = Universal Transverse Mercator

Table 4-3
Summary of Project Impacts from Emissions of Nitrogen Dioxide
MWH-03/04/05/06 Data Center
Quincy, Washington

Receptor Type	UTM		ID	Direction From Project Site	Approximate Distance From Nearest Project-Generator		NO_2 Project Impacts ($\mu g/m^3$)	Project Exceedance Counts (5 years)	
	E (m)	N (m)			Feet	Meters		ASIL	AEGL
MIBR	279,285.00	5,240,247.00	C-5	Northwest	24,475	7,460	877	4	0
MICR	282,310.00	5,235,475.00	C-4	East	1,426	435	798	3	0
MIRR	280,085.00	5,234,671.00	R-7	Southwest	4,981	1,518	535	4	0
MIIR	282,441.75	5,234,275.00	I-4	Southeast	4,320	1,317	454	1	0
Hospital	282,885.00	5,234,775.00	I-2	Southeast	4,009	1,222	477	1	0
Receptor with Max. ASIL Exceedance Counts (due to Project impacts)	282,115.36	5,235,642.95	C-4	East	763	245	656	143	0

Abbreviations and Acronyms:

$\mu g/m^3$ = micrograms per cubic meter
AEGL = acute exposure guideline
ASIL = acceptable source impact level
E = east
N = north
m = meter
MIBR = maximally impacted boundary receptor location
MICR = maximally impacted commercial receptor location
MIIR = maximally impacted institutional receptor location
MIRR = maximally impacted residential receptor location
NO_2 = nitrogen dioxide
UTM = Universal Transverse Mercator

Table 4-4
Predicted DEEP Impacts and Associated Cumulative Increased Cancer Risk Summary
MWH-03/04/05/06 Data Center
Quincy, Washington

Source	Annual DEEP Impact (µg/m^3)				
	MIBR/MICR	MIRR	MIIR	Hospital	Max Cumulative Impacted Residence
Project Only	0.055	0.0090	0.0038	0.0032	0.0042
NTT DATA Data Center	0.0005	0.001	0.00073	0.0018	0.0018
Microsoft-Columbia Data Center	0.0027	0.0061	0.0058	0.017	0.0087
Microsoft-MWH Data Center [a]	0.07	0.024	0.007	0.006	0.008
CyrusOne Data Center	0.0066	0.013	0.008	0.015	0.016
State Route 28	0.12	0.032	0.067	0.16	0.22
State Route 281	0.010	0.0094	0.021	0.026	0.020
Railroad	0.051	0.012	0.019	0.032	0.03
Cumulative (including local background) Impacts [a]	0.30	0.11	0.13	0.26	0.32

	MIBR	MICR	MIRR	MIIR	Hospital	Max Cumulative Impacted Residence
DEEP Cancer Risk Unit Risk Factor (µg/m^3)$^{-1}$	7.3	38	300	4.3	4.9	300
	Lifetime Cancer Risk per Million Population					
Project (only) Risk	0.4	2.1	2.7	0.016	0.016	1.3
NTT DATA Data Center	0.004	0.02	0.3	0.003	0.009	0.53
Microsoft-Columbia Data Center	0.02	0.10	1.8	0.025	0.08	2.6
Microsoft-MWH Data Center [a]	0.493	2.57	7.2	0.029	0.028	2.28
CyrusOne Data Center	0.048	0.25	4.0	0.036	0.076	4.84
State Route 28	0.850	4.43	9.5	0.29	0.787	67
State Route 281	0.073	0.38	2.8	0.088	0.125	6
Railroad	0.376	1.96	3.7	0.082	0.155	10.4
Cumulative (including local background) Risk [a]	2.2	11	32	0.55	1.26	94.7

Abbreviations and Acronyms:

µg/m^3 = micrograms per cubic meter
DEEP = diesel engine exhaust particulate matter
MIBR = maximally impacted boundary receptor location
MICR = maximally impacted commercial receptor location
MIIR = maximally impacted institutional receptor location
MIRR = maximally impacted residential receptor location

Table 4-5
Predicted Nitrogen Dioxide Impacts and Acute Hazard Quotients Summary
MWH-03/04/05/06 Data Center
Quincy, Washington

	1-hour NO_2 Impact (µg/m^3)				
	MIBR	MICR	MIRR	MIIR	Hospital
Project (only) impacts	877	798	535	454	477
Project + Local Point Sources	2,355	1,012	850	593	610
Approximate Regional Background[a]	16				
Cumulative (post-project) Impacts	2,371	1,028	866	609	626

470 = NO_2 REL (µg/m^3)	Acute (1-hour) NO_2 Hazard Quotient				
	MIBR	MICR	MIRR	MIIR	Hospital
Project (only) HQ	1.9	1.7	1.1	1.0	1.0
Project + Local Point Sources HQ	5.0	2.2	1.8	1.3	1.3
Approximate Regional Background HQ	0.034				
Cumulative (post-project) HQ	5.0	2.2	1.8	1.3	1.3

Note:

[a] Regional background values obtained from WSU. "NW Airquest: Lookup 2009-2011 Design Values of Criteria Pollutants." Northwest International Air Quality Environmental Science and Technology Consortium, Washington State University. http://lar.wsu.edu/nw-airquest/lookup.html. Accessed January 3, 2018.

Abbreviations and Acronyms:

µg/m^3 = micrograms per cubic meter
HQ = hazard quotient
MIBR = maximally impacted boundary receptor location
MICR = maximally impacted commercial receptor location
MIIR = maximally impacted institutional receptor location
MIRR = maximally impacted residential receptor location
NO_2 = nitrogen dioxide
REL = reference exposure level

Table 4-6
Exposure Assumptions and Unit Risk Factors Used for Lifetime Cancer Risk Assessment
MWH-03/04/05/06 Data Center
Quincy, Washington

Receptor Type	Annual Exposure	Exposure Duration	Unit Risk Factor (URF)
Unoccupied Land	2 hours/day 250 days/year	30 years	7.3 -per-million cancer risk per µg/m^3 DEEP
Residences	24 hours/day 365 days/year	70 years	300 -per-million cancer risk per µg/m^3 DEEP
Schools (College Students)	36 hours/week 40 week/year	4 years	2.8 -per-million cancer risk per µg/m^3 DEEP
Schools (High School Students)	36 hours/week 40 week/year	4 years	2.8 -per-million cancer risk per µg/m^3 DEEP
Schools (Elementary School Students)	36 hours/week 40 week/year	7 years	4.9 -per-million cancer risk per µg/m^3 DEEP
Schools (All Teachers)	40 hours/week 40 week/year	40 years	31 -per-million cancer risk per µg/m^3 DEEP
Churches	2 hours/week 52 week/year	40 years	2 -per-million cancer risk per µg/m^3 DEEP
Business	8 hours/day 250 days/year	40 years	38 -per-million cancer risk per µg/m^3 DEEP
Hospital	24 hours/week 365 week/year	1 year	4.3 -per-million cancer risk per µg/m^3 DEEP

Abbreviations and Acronyms:

µg/m^3 = Micrograms per cubic meter
DEEP = Diesel engine exhaust particulate matter

Table 4-7
Toxicity Values Used to Assess and Quantify Non-Cancer Hazard and Cancer Risk
MWH-03/04/05/06 Data Center
Quincy, Washington

Pollutant	Agency	Non-Cancer REL ($\mu g/m^3$)	Carcinogenic URF $(\mu g/m^3)^{-1}$
1,3-Butadiene	Acute (1-hr average)	660	1.7×10^{-4}
	Chronic (12-month average)	2	
Acrolein	Acute (1-hr average)	2.5	N/A
	Chronic (12-month average)	0.35	
Ammonia	Acute (1-hr average)	3,200	N/A
	Chronic (12-month average)	200	
Benzene	Acute (1-hr average)	27	2.9×10^{-5}
	Chronic (12-month average)	3	
Chromium	Acute (1-hr average)	N/A	1.5×10^{-1}
	Chronic (12-month average)	0.2	
Carbon monoxide (CO)	Acute (1-hr average)	23,000	N/A
	Chronic (12-month average)	N/A	
DEEP	Acute (1-hr average)	N/A	3.0×10^{-4}
	Chronic (12-month average)	5	
Dibenz(a,h)anthracene	Acute (1-hr average)	N/A	1.2×10^{-3}
	Chronic (12-month average)	N/A	
Formaldehyde	Acute (1-hr average)	55	6.0×10^{-6}
	Chronic (12-month average)	9	
Naphthalene	Acute (1-hr average)	N/A	3.4×10^{-5}
	Chronic (12-month average)	9	
NO_2	Acute (1-hr average)	470	N/A
	Chronic (12-month average)	N/A	
SO_2	Acute (1-hr average)	660	N/A
	Chronic (12-month average)	N/A	

Source: California Office of Environmental Health Hazard Assessment (OEHHA)

Abbreviations and Acronyms:

$\mu g/m^3$ = micrograms per cubic meter
CO = carbon monoxide
DEEP = diesel engine exhaust particulate matter
hr = hour
N/A = not applicable to this toxic air pollutant
NO_2 = nitrogen dioxide
REL = reference exposure level
SO_2 = sulfur dioxide
URF = unit risk factor

Table 4-8
Predicted DEEP Impacts and Chronic Hazard Quotients Summary
MWH-03/04/05/06 Data Center
Quincy, Washington

	Theoretical Maximum DEEP Impact (µg/m^3)			
	MIBR/MICR	MIRR	MIIR	Hospital
Project (only) impacts	0.055	0.0090	0.0038	0.0032
Cumulative (post-project) Impacts	0.44	0.15	0.14	0.27

5 = DEEP REL (µg/m^3)	DEEP - Chronic Hazard Quotient			
	MIBR/MICR	MIRR	MIIR	Hospital
Project (only) HQ	0.011	0.0018	0.00076	0.00064
Cumulative (post-project) HQ	0.088	0.031	0.028	0.054

Abbreviations and Acronyms:

µg/m^3 = micrograms per cubic meter
DEEP = diesel engine exhaust particulate matter
HQ = hazard quotient
MIBR = maximally impacted boundary receptor location
MICR = maximally impacted commercial receptor location
MIIR = maximally impacted institutional receptor location
MIRR = maximally impacted residential receptor location
REL = reference exposure level

Table 4-9
Acute (1-hour) Combined Hazard Index for Toxic Air Pollutants
MWH-03/04/05/06 Data Center
Quincy, Washington

1-hour Acute Hazard Index[a, b]		MIBR	MICR	MIRR	MIIR
Nitrogen dioxide (NO_2)	Ambient Impact (µg/m^3)	8.8E+02	8.0E+02	5.3E+02	4.5E+02
	Risk-Based Toxic Threshold Value (µg/m^3)	470			
	Hazard Quotient	1.9E+00	1.7E+00	1.1E+00	9.7E-01
Carbon Monoxide (CO)	Ambient Impact (µg/m^3)	3.9E-02	3.3E-02	2.8E-02	1.9E-02
	Risk-Based Toxic Threshold Value (µg/m^3)	23,000			
	Hazard Quotient	1.7E-06	1.4E-06	1.2E-06	8.2E-07
Sulfur Dioxide (SO_2)	Ambient Impact (µg/m^3)	7.60E+00	6.50E+00	5.43E+00	3.68E+00
	Risk-Based Toxic Threshold Value (µg/m^3)	660			
	Hazard Quotient	1.2E-02	9.8E-03	8.2E-03	5.6E-03
Benzene[c]	Ambient Impact (µg/m^3)	3.8E+00	3.3E+00	2.7E+00	1.8E+00
	Risk-Based Toxic Threshold Value (µg/m^3)	27			
	Hazard Quotient	1.4E-01	1.2E-01	1.0E-01	6.8E-02
1,3-Butadiene[c]	Ambient Impact (µg/m^3)	1.9E-01	1.6E-01	1.4E-01	9.3E-02
	Risk-Based Toxic Threshold Value (µg/m^3)	660			
	Hazard Quotient	2.9E-04	2.5E-04	2.1E-04	1.4E-04
Formaldehyde[c]	Ambient Impact (µg/m^3)	3.9E-01	3.3E-01	2.8E-01	1.9E-01
	Risk-Based Toxic Threshold Value (µg/m^3)	55			
	Hazard Quotient	7.0E-03	6.0E-03	5.0E-03	3.4E-03
Acrolein	Ambient Impact (µg/m^3)	3.9E-02	3.3E-02	2.8E-02	1.9E-02
	Risk-Based Toxic Threshold Value (µg/m^3)	3			
	Hazard Quotient	1.5E-02	1.3E-02	1.1E-02	7.5E-03
Ammonia[c]	Ambient Impact (µg/m^3)	1.5E+02	1.3E+02	1.1E+02	7.3E+01
	Risk-Based Toxic Threshold Value (µg/m^3)	3,200			
	Hazard Quotient	4.7E-02	4.0E-02	3.4E-02	2.3E-02
	Combined Hazard Index (HI)	2.1	1.9	1.3	1.1
	Combined HI (not including NO_2)	**0.21**	**0.18**	**0.15**	**0.10**

Notes:

[a] The hazard quotients for DEEP and naphthalene are not applicable to this exposure scenario.

[b] The MIBR, MICR, and MIRR are the maximally impacted receptors for NO_2.

[c] Predicted impacts based on dispersion factors.

Abbreviations and Acronyms:

µg/m^3 = micrograms per cubic meter
CO = carbon monoxide
DEEP = diesel engine exhaust particulate matter
HI = hazard index
NO_2 = nitrogen dioxide
MIBR = maximally impacted boundary receptor location
MICR = maximally impacted commercial receptor location
MIIR = maximally impacted institutional receptor location
MIRR = maximally impacted residential receptor location
SO_2 = sulfur dioxide

Table 4-10
Annual Chronic (Non-Cancer) Combined Hazard Index for Toxic Air Pollutants
MWH-03/04/05/06 Data Center
Quincy, Washington

Annual Hazard Index[a, b]		MIBR/MICR[c]	MIRR	MIIR
1,3-Butadiene[e]	Ambient Impact (µg/m^3)	1.3E-03	2.2E-04	8.7E-05
	Risk-Based Toxic Threshold Value (µg/m^3)		2	
	Hazard Quotient	6.6E-04	1.1E-04	4.4E-05
Acrolein[e]	Ambient Impact (µg/m^3)	2.7E-04	4.3E-05	1.8E-05
	Risk-Based Toxic Threshold Value (µg/m^3)		0.35	
	Hazard Quotient	7.6E-04	1.2E-04	5.0E-05
Ammonia[e]	Ambient Impact (µg/m^3)	1.1E+00	1.8E-01	7.1E-02
	Risk-Based Toxic Threshold Value (µg/m^3)		200	
	Hazard Quotient	5.4E-03	8.8E-04	3.6E-04
Benzene[e]	Ambient Impact (µg/m^3)	2.6E-02	4.3E-03	1.7E-03
	Risk-Based Toxic Threshold Value (µg/m^3)		3	
	Hazard Quotient	8.8E-03	1.4E-03	5.8E-04
Chromium	Ambient Impact (µg/m^3)	4.5E-06	5.8E-07	2.6E-07
	Risk-Based Toxic Threshold Value (µg/m^3)		0.2	
	Hazard Quotient	2.3E-05	2.9E-06	1.3E-06
DEEP[d]	Ambient Impact (µg/m^3)	0.055	0.0090	0.0038
	Risk-Based Toxic Threshold Value (µg/m^3)		5	
	Hazard Quotient	1.1E-02	1.8E-03	7.6E-04
Formaldehyde[e]	Ambient Impact (µg/m^3)	2.7E-03	4.4E-04	1.8E-04
	Risk-Based Toxic Threshold Value (µg/m^3)		9	
	Hazard Quotient	3.0E-04	4.8E-05	2.0E-05
Naphthalene[e]	Ambient Impact (µg/m^3)	4.4E-03	7.2E-04	2.9E-04
	Risk-Based Toxic Threshold Value (µg/m^3)		9	
	Hazard Quotient	4.9E-04	8.0E-05	3.2E-05
	Combined Hazard Index (HI)	**0.027**	**0.0045**	**0.0018**

Notes:

[a] The hazard quotients for NO_2 and CO are not applicable to this exposure scenario.

[b] The MIBR, MICR, and MIRR are the maximally impacted receptors for DEEP.

[c] The DEEP impacted MIBR and MICR were at the same receptor location.

[d] This chronic (non-cancer) evaluation is based on the theoretical maximum impacts, assuming 3 years of permitted runtime could be released in a single year

[e] Predicted impacts based on dispersion factors.

Abbreviations and Acronyms:

µg/m^3 = micrograms per cubic meter
CO = carbon monoxide
DEEP = diesel engine exhaust particulate matter
HI = hazard index
MIBR = maximally impacted boundary receptor location
MICR = maximally impacted commercial receptor location
MIIR = maximally impacted institutional receptor location
MIRR = maximally impacted residential receptor location
NO_2 = nitrogen dioxide

Table 4-11
Joint Probability of NO_2 ASIL Exceedances
MWH-03/04/05/06 Data Center
Quincy, Washington

Exceedance Threshold Value (μg/m^3): 454

Risk Receptor Location: MIBR

Evaluation Detail	Assumed Power Outage Occurrence		Historical Occurrence: Grant County PUD[a]	
Hours of Power Outage per Year	**42**		**2.4**	
Contributing Source	Project-only	ALL	Project-only	ALL
Total No. of Hrs > Threshold (in 5 Yrs)	4	24	4	24
Average No. of Hrs > Threshold Per Year	1	5	1	5
Hourly Probability of Poor Wind Dispersion	9.1E-05	5.5E-04	9.1E-05	5.5E-04
Hourly Probability of a Power Outage	4.8E-03	4.8E-03	2.7E-04	2.7E-04
Joint Probablility (per Hr) of Exceeding the Threshold During a Power Outage	4.4E-07	2.6E-06	2.5E-08	1.5E-07
Overall Probability in 1 Year	3.8E-03	2.3E-02	2.2E-04	1.3E-03
Recurrence Interval (yrs)	**261**	**44**	**4,627**	**772**

Risk Receptor Location: MICR

Evaluation Detail	Assumed Power Outage Occurrence		Historical Occurrence: Grant County PUD[a]	
Hours of Power Outage per Year	**42**		**2.4**	
Contributing Source	Project-only	ALL	Project-only	ALL
Total No. of Hrs > Threshold (in 5 Yrs)	3	532	3	532
Average No. of Hrs > Threshold Per Year	1	106	1	106
Hourly Probability of Poor Wind Dispersion	6.8E-05	1.2E-02	6.8E-05	1.2E-02
Hourly Probability of a Power Outage	4.8E-03	4.8E-03	2.7E-04	2.7E-04
Joint Probablility (per Hr) of Exceeding the Threshold During a Power Outage	3.3E-07	5.8E-05	1.9E-08	3.3E-06
Overall Probability in 1 Year	2.9E-03	4.0E-01	1.6E-04	2.8E-02
Recurrence Interval (yrs)	**348**	**3**	**6,170**	**35**

Risk Receptor Location: MIRR

Evaluation Detail	Assumed Power Outage Occurrence		Historical Occurrence: Grant County PUD[a]	
Hours of Power Outage per Year	**42**		**2.4**	
Contributing Source	Project-only	ALL	Project-only	ALL
Total No. of Hrs > Threshold (in 5 Yrs)	4	48	4	48
Average No. of Hrs > Threshold Per Year	1	10	1	10
Hourly Probability of Poor Wind Dispersion	9.1E-05	1.1E-03	9.1E-05	1.1E-03
Hourly Probability of a Power Outage	4.8E-03	4.8E-03	2.7E-04	2.7E-04
Joint Probablility (per Hr) of Exceeding the Threshold During a Power Outage	4.4E-07	5.3E-06	2.5E-08	3.0E-07
Overall Probability in 1 Year	3.8E-03	4.5E-02	2.2E-04	2.6E-03
Recurrence Interval (yrs)	**261**	**22**	**4,627**	**386**

Risk Receptor Location: MIIR

Evaluation Detail	Assumed Power Outage Occurrence		Historical Occurrence: Grant County PUD[a]	
Hours of Power Outage per Year	**42**		**2.4**	
Contributing Source	Project-only	ALL	Project-only	ALL
Total No. of Hrs > Threshold (in 5 Yrs)	1	100	1	100
Average No. of Hrs > Threshold Per Year	0	20	0	20
Hourly Probability of Poor Wind Dispersion	2.3E-05	2.3E-03	2.3E-05	2.3E-03
Hourly Probability of a Power Outage	4.8E-03	4.8E-03	2.7E-04	2.7E-04
Joint Probablility (per Hr) of Exceeding the Threshold During a Power Outage	1.1E-07	1.1E-05	6.2E-09	6.2E-07
Overall Probability in 1 Year	9.6E-04	9.1E-02	5.4E-05	5.4E-03
Recurrence Interval (yrs)	**1,043**	**11**	**18,508**	**186**

Risk Receptor Location: Maximum project-only ASIL Exceedance Counts

Evaluation Detail	Assumed Power Outage Occurrence		Historical Occurrence: Grant County PUD[a]	
Hours of Power Outage per Year	**42**		**2.4**	
Contributing Source	Project-only	ALL	Project-only	ALL
Total No. of Hrs > Threshold (in 5 Yrs)	143	455	143	455
Average No. of Hrs > Threshold Per Year	29	91	29	91
Hourly Probability of Poor Wind Dispersion	3.3E-03	1.0E-02	3.3E-03	1.0E-02
Hourly Probability of a Power Outage	4.8E-03	4.8E-03	2.7E-04	2.7E-04
Joint Probablility (per Hr) of Exceeding the Threshold During a Power Outage	1.6E-05	5.0E-05	8.8E-07	2.8E-06
Overall Probability in 1 Year	1.3E-01	3.5E-01	7.7E-03	2.4E-02
Recurrence Interval (yrs)	**8**	**3**	**130**	**41**

Note:

[a] The average power outage duration for Grant County PUD customers between 2009 and 2016 was 142 minutes per year (Grant County PUD. 2017. Grant County PUD System Reliability Indices Numbers. Grant County Public Utility District.

Abbreviations and Acronyms:

μg/m^3 = micrograms per cubic meter
ASIL = acceptable source impact level
Hr = hour
MIBR = maximally impacted boundary receptor location
MICR = maximally impacted commercial receptor location
MIIR - maximally impacted institutional receptor location
MIRR = maximally impacted residential receptor location
NO_2 = nitrogen dioxide
PUD = Public Utility District
Yr = year

Table 4-12
Joint Probability of NO_2 AEGL 1 Exceedances
MWH-03/04/05/06 Data Center
Quincy, Washington

Exceedance Threshold Value (μg/m^3): 924

Risk Receptor Location: MIBR

Evaluation Detail	Assumed Power Outage Occurrence		Historical Occurrence: Grant County PUD[a]	
Hours of Power Outage per Year	42		2.4	
Contributing Source	Project-only	ALL	Project-only	ALL
Total No. of Hrs > Threshold (in 5 Yrs)	0	8	0	8
Average No. of Hrs > Threshold Per Year	0	2	0	2
Hourly Probability of Poor Wind Dispersion	0.0E+00	1.8E-04	0.0E+00	1.8E-04
Hourly Probability of a Power Outage	4.8E-03	4.8E-03	2.7E-04	2.7E-04
Joint Probablility (per Hr) of Exceeding the Threshold During a Power Outage	0.0E+00	8.8E-07	0.0E+00	4.9E-08
Overall Probability in 1 Year	0.0E+00	7.6E-03	0.0E+00	4.3E-04
Recurrence Interval (yrs)	**-**	**131**	**-**	**2,314**

Risk Receptor Location: MICR

Evaluation Detail	Assumed Power Outage Occurrence		Historical Occurrence: Grant County PUD[a]	
Hours of Power Outage per Year	42		2.4	
Contributing Source	Project-only	ALL	Project-only	ALL
Total No. of Hrs > Threshold (in 5 Yrs)	0	26	0	26
Average No. of Hrs > Threshold Per Year	0	5	0	5
Hourly Probability of Poor Wind Dispersion	0.0E+00	5.9E-04	0.0E+00	5.9E-04
Hourly Probability of a Power Outage	4.8E-03	4.8E-03	2.7E-04	2.7E-04
Joint Probablility (per Hr) of Exceeding the Threshold During a Power Outage	0.0E+00	2.8E-06	0.0E+00	1.6E-07
Overall Probability in 1 Year	0.0E+00	2.5E-02	0.0E+00	1.4E-03
Recurrence Interval (yrs)	**-**	**41**	**-**	**712**

Risk Receptor Location: Maximum project-only ASIL Exceedance Counts

Evaluation Detail	Assumed Power Outage Occurrence		Historical Occurrence: Grant County PUD[a]	
Hours of Power Outage per Year	42		2.4	
Contributing Source	Project-only	ALL	Project-only	ALL
Total No. of Hrs > Threshold (in 5 Yrs)	0	59	0	59
Average No. of Hrs > Threshold Per Year	0	12	0	12
Hourly Probability of Poor Wind Dispersion	0.0E+00	1.3E-03	0.0E+00	1.3E-03
Hourly Probability of a Power Outage	4.8E-03	4.8E-03	2.7E-04	2.7E-04
Joint Probablility (per Hr) of Exceeding the Threshold During a Power Outage	0.0E+00	6.5E-06	0.0E+00	3.6E-07
Overall Probability in 1 Year	0.0E+00	5.5E-02	0.0E+00	3.2E-03
Recurrence Interval (yrs)	**-**	**18**	**-**	**314**

Note:

[a] The average power outage duration for Grant County PUD customers between 2009 and 2016 was 142 minutes per year (Grant County PUD. 2017. Grant County PUD System Reliability Indices Numbers. Grant County Public Utility District.

Abbreviations and Acronyms:

μg/m^3 = micrograms per cubic meter
AEGL 1 = Acute Exposure Guideline Level 1
ASIL = acceptable source impact level
Hr = hour
MIBR = maximally impacted boundary receptor location
MICR = maximally impacted commercial receptor location
NO_2 = nitrogen dioxide
PUD = Public Utility District
Yr = year

Table 4-13
Lifetime Cancer Risk Associated with
Project-Related Emissions of Carcinogenic Compounds
MWH-03/04/05/06 Data Center
Quincy, Washington

Carcinogen	Annual Emissions (TPY)	ASIL (µg/m^3)	Estimated Increased Cancer Risk at Key Risk Receptor Locations (per Million)			
			MIBR	MICR	MIRR	MIIR
Diesel Engine Emissions						
DEEP	0.47	0.00333	0.40	2.09	2.71	0.016
Benzene	0.070	0.0345	0.006	0.03	0.04	2.3E-04
Toluene	0.025	5,000	1.4E-08	7.5E-08	9.7E-08	5.8E-10
Xylenes	0.017	221	2.2E-07	1.2E-06	1.5E-06	9.1E-09
Formaldehyde	7.1E-03	0.17	1.2E-04	6.2E-04	8.0E-04	4.8E-06
Acetaldehyde	2.3E-03	0.37	1.7E-05	9.1E-05	1.2E-04	7.1E-07
1,3-Butadiene	3.5E-03	0.00588	1.7E-03	0.009	0.011	6.9E-05
Naphthalene	0.012	0.0294	1.1E-03	0.006	0.008	4.6E-05
Benz(a)anthracene	5.6E-05	0.0091	1.7E-05	9.1E-05	1.2E-04	7.1E-07
Chrysene	1.4E-04	0.091	4.3E-06	2.2E-05	2.9E-05	1.7E-07
Benzo(b)fluoranthene	1.0E-04	0.0091	3.1E-05	1.6E-04	2.1E-04	1.3E-06
Benzo(k)fluoranthene	2.0E-05	0.0091	6.1E-06	3.2E-05	4.1E-05	2.5E-07
Benzo(a)pyrene	2.3E-05	0.00091	7.2E-05	3.8E-04	4.9E-04	2.9E-06
Indeno(1,2,3-cd)pyrene	3.7E-05	0.0091	1.2E-05	6.0E-05	7.8E-05	4.7E-07
Dibenz(a,h)anthracene	3.1E-05	0.00091	9.7E-05	5.1E-04	6.5E-04	3.9E-06
Cooling Tower Emissions						
Arsenic	1.9E-05	0.000303	1.5E-08	7.8E-08	7.8E-08	5.0E-10
Beryllium	1.9E-05	0.000417	1.1E-08	5.7E-08	5.7E-08	3.6E-10
Cadmium	9.7E-06	0.000238	9.5E-09	5.0E-08	5.0E-08	3.2E-10
Chromium[a]	1.9E-05	0.00000667	6.8E-07	3.5E-06	3.6E-06	2.3E-08
Copper	2.4E-03	100	5.7E-12	3.0E-11	3.0E-11	1.9E-13
Lead	1.9E-05	0.0833	5.5E-11	2.8E-10	2.9E-10	1.8E-12
Manganese	2.9E-04	0.04	1.7E-09	8.9E-09	8.9E-09	5.7E-11
Mercury	1.9E-03	0.09	5.0E-09	2.6E-08	2.6E-08	1.7E-10
Selenium	4.4E-06	20	5.2E-14	2.7E-13	2.7E-13	1.7E-15
Cyanide	2.2E-05	9	5.8E-13	3.0E-12	3.0E-12	1.9E-14
Combined Increased Cancer Risk			**0.4**	**2.14**	**2.77**	**0.017**

Abbreviations and Acronyms:

µg/m^3 = micrograms per cubic meter
ASIL = acceptable source impact level
DEEP = diesel engine exhaust particulate matter
MIBR = maximally impacted boundary receptor location
MICR = maximally impacted commercial receptor location
MIIR = maximally impacted institutional receptor location
MIRR = maximally impacted residential receptor location
TPY = tons per year

Table 5-1
Qualitative Summary of the Effects of Uncertainty on Quantitative Estimates of Health Risk
MWH-03/04/05/06 Data Center
Quincy, Washington

Source of Uncertainty	How Does It Affect Estimated Risk from This Project?
Exposure assumptions	Likely overestimate of exposure
Emissions estimates	Possible overestimate of emissions
AERMOD air modeling methods	Possible underestimate of average long-term ambient air concentrations and overestimate of short-term ambient air concentrations
Toxicity of DEEP at low concentrations	Possible overestimate of cancer risk, possible underestimate of non-cancer hazard for sensitive individuals
Toxicity of NO_2 at low concentrations	Possible overestimate of non-cancer hazard for sensitive individuals

Abbreviations and Acronyms:

AERMOD = American Meteorological Society (AMS)/US Environmental Protection Agency (EPA) regulatory model

DEEP = Diesel engine exhaust particulate matter

NO_2 = Nitrogen dioxide

APPENDIX A

Electronic Files

(on DVD)