Revised Second-Tier Risk Analysis for Diesel Engine Exhaust Particulate Matter and Nitrogen Dioxide
Project Genesis
Quincy, Washington

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Prepared for

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TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

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LIST OF ABBREVIATIONS AND ACRONYMS

µg/m^3	Microgram per Cubic Meter
µm	Micrometer
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µm	Micrometer
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	U.S. Environmental Protection Agency
ft	Feet
G-I	City of Quincy City Industrial
GCA	Grant County Agriculture
g/kWm-hr	Grams per Mechanical Kilowatt-Hour
g/m^3	Grams per Cubic Meter
HI	Hazard Index
HIA	Health Impact Assessment
HQ	Hazard Quotient
m	Meter
MIBR	Maximally Impacted Boundary Receptor
MICR	Maximally Impacted Commercial Receptor
MIRR	Maximally Impacted Residential Receptor
MRL	Minimal Risk Level
MW	Megawatt
NAAQS	National Ambient Air Quality Standards
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
RBC	Risk-Based Concentration
REL	Reference Exposure Level
RfC	Reference Concentration
SCR	Selective Catalytic Reduction
SQER	Small-Quantity Emission Rate
SR	State Route
TAP	Toxic Air Pollutant
tBACT	Best Available Control Technology for Toxics
URF	Unit Risk Factor
VOC	Volatile Organic Compound
WAC	Washington Administrative Code

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1.0 EXECUTIVE SUMMARY

1.1 PROPOSED PROJECT

Yahoo! Inc. (Yahoo!) has proposed to develop the Project Genesis data center building complex in Quincy, Washington. The proposed data center project will include the installation of 20 2.0-megawatt (MW) emergency diesel engine generators and five 2.75-MW generators. All of the engines will be U.S. Environmental Protection Agency (EPA) Tier 2-certified.

The construction of Project Genesis is expected to begin in the fall of 2015. Construction for the emergency backup generators would begin in February 2016 and installation and startup of the generators would begin in March 2016.

Yahoo! evaluated air quality impacts associated with the proposed project in a Notice of Construction (NOC) application and supporting documentation submitted to the Washington State Department of Ecology (Ecology) Eastern Regional Office (Landau Associates 2015). As documented in the NOC application, potential emissions of diesel engine exhaust particulate matter (DEEP) and nitrogen dioxide (NO_2) from the 25 emergency diesel engine generators may cause ambient air impacts that exceed the Washington State acceptable source impact levels (ASILs). Based on the modeled exceedances, Yahoo! 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 and the adjacent 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 25 proposed emergency diesel engine generators could cause an increased cancer risk of up to 7.3 in 1 million (4.1×10^{-6}) at the maximally impacted residence. Because the increase in cancer risk attributable to the proposed 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) location near the Project Genesis site, the estimated maximum potential cumulative cancer risk posed by DEEP emitted from the proposed project and background sources within the area would be approximately 42 in 1 million (42×10^{-6}) at the MIRR location. Most of the DEEP cancer risk at that location would be caused by the Intuit Data Center.

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 receptors (HQs of 1.2 and 1.3, 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 49 and 103 years at the receptors maximally impacted by the project. Additionally, due to the inconsistency with which adverse health effects have been observed as a result of exposures to 900 micrograms per cubic meter ($\mu g/m^3$) or less, it is anticipated that no significant adverse health impacts will occur as a result of NO_2 emissions from diesel generators at the Project Genesis site.

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 PROJECT GENESIS DATA CENTER PROJECT

2.1 DESCRIPTION OF PROPOSED DEVELOPMENT OF PROJECT GENESIS

Yahoo! is proposing to develop the Project Genesis data center complex in Quincy, Washington (Figure 2-1). The proposed data center project will include the installation of 20 2.0-MW emergency diesel engine generators and five 2.75-MW generators. Installation of the emergency generators will occur in two phases. The first phase will involve construction for the proposed generators starting in February 2016 and installation and startup of six 2.0-MW generators and two 2.75-MW generators in late March 2016. The remaining 14 2.0-MW and three 2.75-MW generators will be installed at least one year after the first phase. Each backup diesel engine generator will be housed within its own acoustical enclosure. During a power outage, the 20 2.0-MW emergency generators will be used to provide electricity to the data center, four 2.75-MW emergency generators will serve as reserve generators, and one 2.75-MW generator will support the administration building.

The Project Genesis site layout and the proposed location of the backup diesel generators are shown on Figure 2-2. Each diesel engine generator will have its own 42-foot-tall vertical exhaust stack.

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 (Landau Associates 2015). The emission estimates presented in this report are based on the operating modes for the proposed 25 emergency diesel engine generators summarized in Table 2-1. The emission estimates presented in this report have been calculated for generators that meet EPA Tier 2 emission limits. Table 2-2 summarizes the facility-wide calculated emission rates for the proposed generators. Load-specific emission rates were developed from generator manufacturer estimates of "Not to Exceed" and "Potential Site Variation" emissions data for nitrogen oxides (NO_x), particulate matter (PM), carbon monoxide (CO), and total volatile organic compounds (VOCs). 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 the TAPs other than DEEP, emission factors from the EPA's Compilation of Air Pollutant Emission Factors (AP-42), Sections 3.3 and 3.4 were used (EPA 1995).

Our emission calculations and AERMOD[1] modeling account for cold-start operating conditions. We have accounted for the 60-second "black puff" that occurs during each cold start 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* (CEC 2005)].

2.3 LAND USE AND ZONING

Land uses in the vicinity of the proposed Project Genesis site are presented on Figure 2-3 and receptors of interest are summarized in Table 2-3. The topography in the vicinity of the Project Genesis site is relatively flat with elevations ranging between approximately 1,300 and 1,400 feet (ft) above sea level. The zoning designation for the site is City of Quincy City Industrial (G-I). Zoning designations on adjacent lands include G-I to the northeast and east, southeast and south, Grant County Agriculture (GCA) to the northwest and north, and Grant County Urban Residential to the southwest and west of the site.

Detailed zoning information for the area surrounding the proposed Project Genesis site is shown on Figure 2-3 (Grant County website 2015; City of Quincy 2011). From a health impacts standpoint, an existing single-family residence located to the northeast (R-3) of the Project Genesis Data Center on land zoned GCA is of primary interest (see Figure 2-3).

2.4 SENSITIVE RECEPTORS

The following sensitive receptors are near the proposed Project Genesis site:

- The nearest school is Quincy Junior High and High Schools (I-1), approximately 0.6 miles southwest of the Project Genesis site.
- The nearest daycare or pre-school is a private home-based facility, approximately 0.8 miles southwest of the Project Genesis site.
- The nearest church is located approximately 1 mile west of the Project Genesis site.
- The nearest medical facility is Quincy Valley Medical Center, approximately 1.25 miles southwest of the Project Genesis site.
- The nearest convalescent home is The Cambridge, approximately 1.5 miles southwest of the Project Genesis site.

[1] American Meteorological Society/EPA Regulatory Model.

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*[2] 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 in order to prevent air pollution, reduce emissions to the extent reasonably possible, and maintain such levels of air quality to protect human health and safety. If modeled 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 proposed project. 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 the proposed project 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).

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

3.2 BACT AND TBACT FOR PROJECT GENESIS

Ecology is responsible for determining BACT and tBACT for controlling criteria pollutants and TAPs emitted from the proposed project. Yahoo! has committed to using diesel engine generators that meet EPA Tier 2 emission limits.

Yahoo! conducted a BACT and tBACT analysis as presented in the NOC Supporting Information report (Landau Associates 2015). The BACT/tBACT analysis concluded that all of the add-on control technology options [the selective catalytic reduction (SCR)/catalyzed diesel particulate filter (DPF) 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 limitations 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 non-methane hydrocarbons. The proposed BACT and tBACT determinations are summarized in Tables 3-1 and 3-2, respectively.

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.

3.3 FIRST-TIER TOXICS SCREENING REVIEW FOR PROJECT GENESIS

The first-tier TAP assessment compares the forecast emission rates for Project Genesis to the small-quantity emission rates (SQERs) and compares the maximum ambient air impacts at any sensitive receptor to the ASILs.

Table 2-2 shows the calculated emission rates for each TAP emitted from the proposed project, 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. Table 2-2 lists the "SQER Ratio" of the emission rate for the proposed project compared to the SQER. The maximum emission rates for DEEP, benzene, 1,3-butadiene, naphthalene, CO, NO_2, and acrolein 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 whose emissions exceed 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, then compare the modeled values to the ASILs (WAC 173-460-080). For this analysis, annual-average impacts were modeled based on a worst-case operational scenario of 24 hours per day for 365 days per year for 5 years, with the American Meteorological Society/EPA Regulatory Model (AERMOD).

Table 3-3 presents the first-tier ambient air concentration screening analysis for each TAP whose emission rate exceeds its SQER. Details on the methodologies for the modeling are provided in the NOC Supporting Information report (Landau Associates 2015). All of the modeled maximum impacts occur at the unoccupied facility boundary (i.e., locations where there are no current buildings). The maximum annual average DEEP impact from Project Genesis at the unoccupied facility boundary exceeds its ASIL and the maximum 1-hour average NO_2 impact from Project Genesis exceeds its ASIL, while 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 contained 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 ASILs has been quantified using refined air dispersion modeling techniques as approved in the HIA protocol.

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

Ecology provided comments to Landau Associates' HIA protocol [item (c) above]. Ecology's comments were addressed as part of this HIA.

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 Landau Associates.

4.0 HEALTH IMPACT ASSESSMENT

This HIA was conducted according to the requirements of WAC 173-460-090 and guidance provided by Ecology. The HIA addresses the public health risk associated with exposure to DEEP and NO_2 from Yahoo!'s proposed emergency diesel engine generators and existing sources of DEEP and NO_2 in the vicinity. 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 (NAS 1983, 1994). These four steps are: 1) hazard identification; 2) exposure assessment; 3) dose-response assessment; and 4) risk characterization. As described later in this document, the HIA did not consider exposure pathways other than inhalation.

4.1 HAZARD IDENTIFICATION

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

- 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 Yahoo!'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_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 grams per cubic meter (g/m^3)] of NO_2 may result in serious effects including death (NAC AEGL Committee 2008). Moderate levels (~30,000 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 g/m^3), such as that experienced near major roadways, or perhaps downwind from stationary sources of NO_2, may cause increased bronchial reactivity in some asthmatics, decreased lung function in patients with chronic obstructive pulmonary disease, and increased risk of respiratory infections, especially in young children (CalEPA 2008). For this project, the maximum short-term ambient NO_2 concentration has been estimated to be 859 $\mu g/m^3$ (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, naphthalene, CO, and acrolein.

- Benzene: The reference exposure level for benzene considers toxic effects for reproductive development, the immune system, and the hematologic system (OEHHA website 2007), not the respiratory system; however, the ambient air impacts associated with benzene emissions have been conservatively included in the project-specific hazard index calculated in this HIA.
- 1,3-Butadiene: The reference concentration for 1,3-butadiene considers toxic effects for both the respiratory system and peripheral systems (EPA website 2015); therefore, the ambient air impacts associated with 1,3-butadiene emissions are included in the project-specific hazard index calculated in this HIA.
- Naphthalene: The reference exposure level for naphthalene considers toxic effects for the respiratory system (OEHHA website 2007); therefore, the ambient air impacts associated with naphthalene emissions are included in the project-specific index calculated in this HIA.
- Carbon monoxide: The reference exposure level for CO considers toxic effects for the cardiovascular system (OEHHA website 2007), not the respiratory system; however, the ambient air impacts associated with CO emissions have been conservatively included in the project-specific hazard index calculated in this HIA.
- Acrolein: The reference exposure level for acrolein considers toxic effects for the eyes and respiratory system (OEHHA website 2007); therefore the ambient air impacts associated with acrolein emissions are included in the project-specific index 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 receptors
- Estimating the duration and frequency of receptors' exposure.

4.2.1 IDENTIFYING ROUTES OF POTENTIAL EXPOSURE

Humans can be exposed to chemicals in the environment through inhalation, ingestion, or dermal contact. The primary route of exposure to most air pollutants is inhalation; however, some air pollutants may also be absorbed through ingestion or dermal contact. Ecology uses guidance provided in California's *Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments* (CalEPA 2003) 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 presented 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 Project Genesis site. 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 Project Genesis site. 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 atmosphere substances (ATSDR 2002).

In both outdoor and indoor conditions, NO_2 exists in gaseous form; therefore inhalation is the major 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, Adamkiewicz, Heroux et al. 2010).

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

4.2.2 ESTIMATING PARTICULATE CONCENTRATIONS

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

Each of the proposed Project Genesis emergency generators was modeled as an individual discharge point. Additionally, local background DEEP and NO_2 contributions were modeled, including existing generators at Yahoo!'s existing data center buildings, the Intuit Data Center, the Sabey Data Center, the Vantage Data Center, diesel truck exhaust along SR 28, and emissions from the Celite Corporation (Celite) facility (NO_2). DEEP impacts from diesel locomotive emissions along the railroad line were estimated based on impacts presented in Ecology's 2011 Technical Support Document for the Sabey Data Center (Ecology 2011). Emission rates for the Intuit Data Center, Sabey Data Center, Vantage Data Center, and Yahoo!'s existing data center were calculated based on the maximum permitted emission rates provided in the Ecology approval orders for those facilities. NO_2 emission rates for the Celite facility and DEEP emission rates for SR 28 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. 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 (2001 to 2005).
- Twice-daily upper air data from Spokane, Washington (2001 to 2005) 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 42 ft. Existing engines at Yahoo!'s data center were modeled at their permitted height of 20 or 29 ft above grade.
- The dimensions of the existing and proposed buildings at the Project Genesis site 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).

4.2.3 IDENTIFYING POTENTIALLY EXPOSED RECEPTORS

There are several different land use types within the general vicinity of the Project Genesis site. Residential, commercial, and institutional locations where people could be exposed to project-related emissions are identified on Figure 2-3. The residential, business, and institutional receptors 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 school, which is Quincy High and Quincy Junior High schools located to the southwest of the Project Genesis site.

4.2.3.1 Receptors Maximally Exposed to DEEP

Maximally exposed receptors of different use types, the direction and distance of those receptors from the project, and the predicted project-related DEEP impacts at those receptors 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 proposed Project Genesis. Figure 4-1 shows the ambient air impacts of Project Genesis at each of the maximally exposed receptors representing different land uses. The concentrations at the maximally impacted boundary receptor (MIBR), maximally impacted residential receptor (MIRR), and maximally impacted commercial receptor (MICR) are presented. The modeling indicates that emissions from the proposed Project Genesis will reach multiple existing residences at a level exceeding the ASIL. The blue contour line (0.00333 $\mu g/m^3$) 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 Receptors Maximally Exposed to NO_2

Maximally exposed receptors of different use types, the direction and distance of those receptors from the project, and the predicted project-related NO_2 impacts at those receptors are summarized in Table 4-2. Figure 4-2 shows a color-coded map of estimated 1-hour average NO_2 concentrations attributable solely to emissions from the proposed Project Genesis, including project-related impacts at each of the maximally exposed receptors representing different land uses. The concentrations at the MIBR, MIRR, and MICR are presented. Note, the MIRR for NO_2 is different from the MIRR for DEEP. The modeling indicates that emissions from the proposed Project Genesis will reach multiple existing residences to the northeast, southwest, and south at levels exceeding the ASIL. The green contour line (470 $\mu g/m^3$) represents the ASIL. Receptors at all locations outside the green 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 in Appendix A.

4.2.4 Exposure Frequency and Duration

The likelihood that someone would be exposed to DEEP and NO_2 from Project Genesis depends on local wind patterns, the frequency of engine testing, 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 Project Genesis site.

This analysis considers the land use surrounding the proposed project 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 located at residential receptors are potentially continuously exposed, meaning they never leave their property. These behaviors are not typical; however, these assumptions are intended to avoid underestimating exposure so that public health protection is ensured. Workplace and other 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, the railroad line, and the Intuit, Sabey, and Vantage data centers were evaluated using the methodology described in Section 4.2.2. Regional background DEEP and NO_2 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 4-3 shows the calculated cumulative DEEP concentrations near the Project Genesis site 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 0.21 $\mu g/m^3$ (approximately 63 times greater than the DEEP ASIL). This is modeled to occur approximately 0.8 miles south of the proposed project. However, at that location, most of the DEEP exposure is due to emissions from trucks traveling on nearby SR 28 and locomotives traveling on the railroad tracks, and only a fraction of the DEEP exposure is due to emissions from the Project Genesis 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 4-4 shows the calculated cumulative NO_2 concentrations near the Project Genesis site based on allowable emissions from the proposed project, other permitted sources of NO_2 in the area, and nearby highways and the railroad line.

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

- Simultaneous outage emissions for all data center engines for the hour of maximum impact at the receptors that are maximally impacted by the project
- Engine operation at loads specified in permits
- Potential emissions from the nearby Celite facility.

Table 4-4 shows the maximum 1-hour NO_2 concentrations at various receptors attributable to Project Genesis 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 Project Genesis site 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 4-5 shows exposure assumptions and risk factors used to calculate lifetime cancer risk, and Table 4-6 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 (EPA 2002; EPA website 2015; CalEPA 1998). These toxicological values are derived from studies of animals that were exposed to a known amount (concentration) of DEEP, or from epidemiological studies of exposed humans, and are intended to represent a level at or below which 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 lung from rat inhalation studies. Each agency established a level of 5 $\mu g/m^3$ as the concentration of DEEP in air at which long-term exposure is not expected to cause 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 reference exposure level for NO_2 based on inhalation studies of asthmatics exposed to NO_2. These studies found that some asthmatics exposed to about 0.25 ppm (i.e., 470 $\mu g/m^3$) 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 4-6 lists the non-cancer toxicological values that were used for this assessment. If a concentration exceeds the RfC, minimal risk level (MRL), 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 of 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 µg/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).

Tables 4-3 and 4-7 show chronic HQs at the maximally exposed receptors near the project site attributable to DEEP exposure from Project Genesis 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 Project Genesis site.

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 µg/m^3). The acute HQ for NO_2 exposure was calculated using the following equation:

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

Tables 4-4 and 4-8 show acute HQs at the maximally exposed receptors near the project site attributable to NO_2 exposure from Project Genesis and all background sources. Hazard quotients exceed 1 at all maximally impacted receptors.

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 reference exposure level 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 Whose Emission Rates Exceed SQER

The non-cancer health impacts were evaluated based on the conservatively high emission rates. Seven TAPs (DEEP, benzene, 1,3-butadiene, naphthalene, CO, NO_2, and acrolein) to be emitted by Project Genesis have emission rates that exceed their respective SQERs and, therefore, are subject to further evaluation. The receptor locations of concern are the MIBR, MICR, MIRR, and the nearest school (I-1) to the project site. Tables 4-7 and 4-8 show modeled concentrations, risk-based concentrations (RBCs), and HQs for each receptor point. All modeled concentrations and RBCs are reported in $\mu g/m^3$. The annual chronic combined hazard index (HI) for each location is the sum of all HQs for DEEP, benzene, 1,3-butadiene, acrolein, and naphthalene (the only TAPs with an emission rate above the SQER with a chronic RBC). 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, and acrolein. Table 4-8 shows the acute combined HI including and not including NO_2.

The information in Table 4-7 indicates that chronic non-cancer health effects are unlikely to occur even under worst-case conditions at the maximally impacted 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, and naphthalene are modeled to be less than 1. If the HQ or HI is less than 1, then the risk is considered acceptable.

The information in Table 4-8 indicates that acute health effects from CO, benzene, 1,3-butadiene, and acrolein are unlikely to occur even under worst-case conditions at maximally impacted locations. When NO_2 is included in the acute combined HI, the HIs for all maximally impacted locations exceed 1. Section 4.4.1.5 discusses the probability of the worst-case scenario exceedances.

4.4.1.5 Probability Analysis of NO_2 ASIL Exceedances

Landau Associates analyzed the frequency (number of hours) that meteorological conditions could result in a NO_2 concentration greater than 454 $\mu g/m^3$ across the Quincy modeling domain. Although the NO_2 level of interest is 470 $\mu g/m^3$, concentrations that exceed 454 $\mu g/m^3$ are noteworthy because Ecology estimates that a prevailing NO_2 concentration of 16 $\mu g/m^3$ could exist in Quincy at any given time (WSU website 2015). Figure 4-4 displays these results graphically by showing the number of hours per year that project-related NO_2 concentrations could exceed 454 $\mu g/m^3$ assuming Project Genesis data center engines operate continuously throughout the year. In reality, Project Genesis would be permitted to operate for only up to 84 hours per year under emergency outage conditions. According to the Grant County Public Utility District (PUD), the average total outage time per year, from 2008 to 2014, for customers who experienced an outage throughout PUD's service area was only about 152 minutes (Grant County PUD 2015).

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

- Number of AERMOD modeled hours: 43,825
- Number of hours in 5 years exceeding 454 µg/m^3: 20
- Number of events with 2 sequential hours of NO_2 > 454 µg/m^3: 1
- Number of events with 3 sequential hours of NO_2 > 454 µg/m^3 0

This statistical analysis confirms that ASIL exceedances would very rarely last for more than 1 hour, even if the generators are assumed to operate continuously for 5 years.

To account for infrequent intermittent emergency outages, Landau Associates 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 assigned loads, based on a conservatively high assumption of 84 hours of power outage every year. The results were examined in detail for four receptors: MIBR, MICR, MIRR, and I-1. 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 with exceptionally poor atmospheric dispersion.

To calculate the frequency of occurrence, Landau Associates 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 the 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 152 minutes of outage per year based on PUD data from 2008 to 2014, and an upper-bound case of 84 hours of outage every year based on the requested potential-to-emit.
- 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 4-9.

Figure 4-5 shows the spatial distribution of AERMOD-derived NO_2 concentrations for the hour of maximum NO_2 impact at the MIBR during the 5-year simulation period, assuming that a system-wide power failure occurs at the same time as the worst-case meteorological conditions. For the hour of maximum impact, the plume of high concentrations extends east from the facility. Exceedance concentrations are limited to industrial and agricultural land that is normally unoccupied.

Figure 4-6 shows the spatial distribution of AERMOD-derived NO_2 concentrations for the hour of maximum NO_2 impact at the MICR during the 5-year simulation period, assuming that a system-wide power failure occurs at the same time as the worst-case meteorological conditions. For the hour of maximum impact, the plume of high concentrations extends to the northeast from the facility. Exceedance concentrations are limited to industrial and agricultural land that is normally unoccupied.

Figure 4-7 shows the spatial distribution of AERMOD-derived NO_2 concentrations for the hour of maximum NO_2 impact at the MIRR during the 5-year simulation period, assuming that a system-wide power failure occurs at the same time as the worst-case meteorological conditions. For the hour of maximum impact, the plume of high concentrations extends to the southwest from the facility. Exceedance concentrations are present throughout many land use types.

Table 4-9 summarizes the probability that the modeled values exceed the selected thresholds for the worst-case assumption of 84 hours/year of power outage and the average-case assumption of 152 minutes/year of power outage. Table 4-9 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 fraction of total hours 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 (p_{hr}), the overall probability that the threshold will be exceeded in a given year (p_{1yr}), and the estimated recurrence interval. Overall annual probability, p, is calculated as: $p = 1 - (1- p_{hr})^n$, 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 9, 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:

- MIBR = 74 years
- MIRR = 49 years
- MICR = 20 years
- School (I-1) = 103 years.

This evaluation demonstrates that the probability of a receptor being exposed to NO_2 concentrations above the acute REL 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 a continuous exposure over a 70-year lifetime, exposure duration and exposure frequency are important considerations.

The formula used to determine cancer risk is as follows:

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

The exposure frequencies for each receptor type are shown below and provided in Table 4-5, based on Ecology's judgment from review of published risk evaluation guidelines.

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	See Table 4-3						µg/m^3
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 4-3 shows the estimated cancer risks associated with predicted project-related DEEP concentrations and the URFs (Table 4-5). Although the highest annual average DEEP concentration was predicted to occur at the MIBR, the greatest cancer risk estimate is located at the MIRR. This is due to considerations of duration and frequency of potential exposure incorporated in the corrected unit risk factors. The calculated lifetime cancer risk at the MIRR is 7.3 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 indicated in Table 4-3 are the cumulative cancer risks for each maximally impacted receptor. This accounts for currently permitted DEEP emissions from neighboring data centers, railroad and roadway diesel traffic emissions, and project-related emissions from Project Genesis. The maximum cumulative (project-related and background emissions) cancer risk impact at the MIRR is estimated to be 42 per million. The maximum cumulative cancer risk at the school (I-1) is estimated to be 4.7 per million. The maximum cumulative impacted residence in the Quincy modeling domain is 62 per million; however, the contribution to the cancer risk associated with impacts from the project accounts for only 6 percent of the total cancer risk. Most of the cancer risk at this receptor is from truck traffic on SR 28 and locomotives traveling on the railroad tracks.

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 4-10. As indicated in Table 4-10, the cancer risk associated with DEEP alone at the MIRR (R-3, the northeast residence) is 7.3×10^{-6}. The other recognized carcinogenic compounds contribute negligibly to the overall cancer risk (i.e., 2.1×10^{-8}). The combined cancer risk caused by all constituents is 7.3×10^{-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 U.S. Department of Health and Human Services, the International Agency for Research on Cancer, or the EPA (ASTDR website 2014; EPA website 2015).

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 comprised 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 Project Genesis. 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, Yahoo! conservatively estimated that it would use the generators during emergency outages for no more than 84 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 over 99.99 percent each year (2008 to 2014) and a Customer Average Interruption Duration Index (or average duration of power interruption per customer) of 76 to 300 minutes (1.3 to 5 hours) over the same period (Grant County PUD 2015). While this high level of historical reliability provides some assurance that electrical service is relatively stable, Yahoo! cannot predict future outages with any degree of certainty. Yahoo! accepted a limit of 84 hours per year for emergency operations, and estimated that this limit should be more than sufficient to meet its emergency demands. It is expected that estimates 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, but 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 Genesis 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 $\mu g/m^3$. OEHHA's DEEP URF (3×10^{-4} per $\mu g/m^3$) falls within this range. Regarding the range of URFs, 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 their 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 (OEHHA 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.

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

As discussed previously, exposure to DEEP can cause both acute and chronic health effects. However, as discussed in Section 4.3.1, reference toxicological values specifically for DEEP exposure at short-term or intermediate intervals (e.g., 24-hour values) do not currently exist. Therefore, short-term risks from DEEP exposure are not quantified in 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 (Landau Associates 2015) concludes that emissions from the proposed project are not expected to cause or contribute to an exceedance of any NAAQS.

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 Project Genesis 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, and acrolein. The long-term uncontrolled cancer risks at the nearby residences, businesses, and sensitive receptor locations range from 1.1 to 7.3 per million for DEEP and are much lower for the other TAPs considered in this analysis. The overall cancer risk at any of the maximally exposed residential, business, and sensitive receptors, 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 Project Genesis site near the railroad tracks 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:

Project Genesis-only cancer risk (R-3 NE residence):	7.3 per million
Background DEEP cancer risk:	34.6 per million
Cumulative DEEP cancer risk:	41.9 per million
Project Genesis-only cancer risk (C-2 Intuit Data Center):	3.4 per million
Background DEEP cancer risk:	5.5 per million
Cumulative DEEP cancer risk:	8.9 per million
Project Genesis-only cancer risk (I-1 School):	1.1 per million
Background DEEP cancer risk:	3.6 per million
Cumulative DEEP cancer risk:	4.7 per million

Note, as presented above, the increased cancer risk associated with DEEP emissions from the proposed Project Genesis is approximately 17 percent of the total cumulative DEEP cancer risk at receptor R-3.

7.3 NON-CANCER RISK HAZARD QUOTIENTS

As described previously, the maximum HQ related to project-only and cumulative annual average DEEP at any maximally impacted receptor is 0.06. The maximum chronic HI for impacts caused by emissions of DEEP, benzene, 1,3-butadiene, naphthalene, and acrolein is only 0.08.

The maximum HQ related to project-only and cumulative 1-hour average NO_2 at any maximally impacted receptor is 2.2. The maximum acute HI for impacts caused by emissions of NO_2, CO, benzene, 1,3-butadiene, and acrolein is 2.4. 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 with exceptionally poor atmospheric dispersion. An evaluation of the recurrence interval of HQs greater than 1 concluded that the estimated recurrence interval ranges from 20 years (MICR) to 103 years (school) 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., increased bronchial reactivity in some asthmatics).

8.0 SIGNATURES

This document has been prepared under the supervision and direction of the following key staff.

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MWB/CPH/ccy

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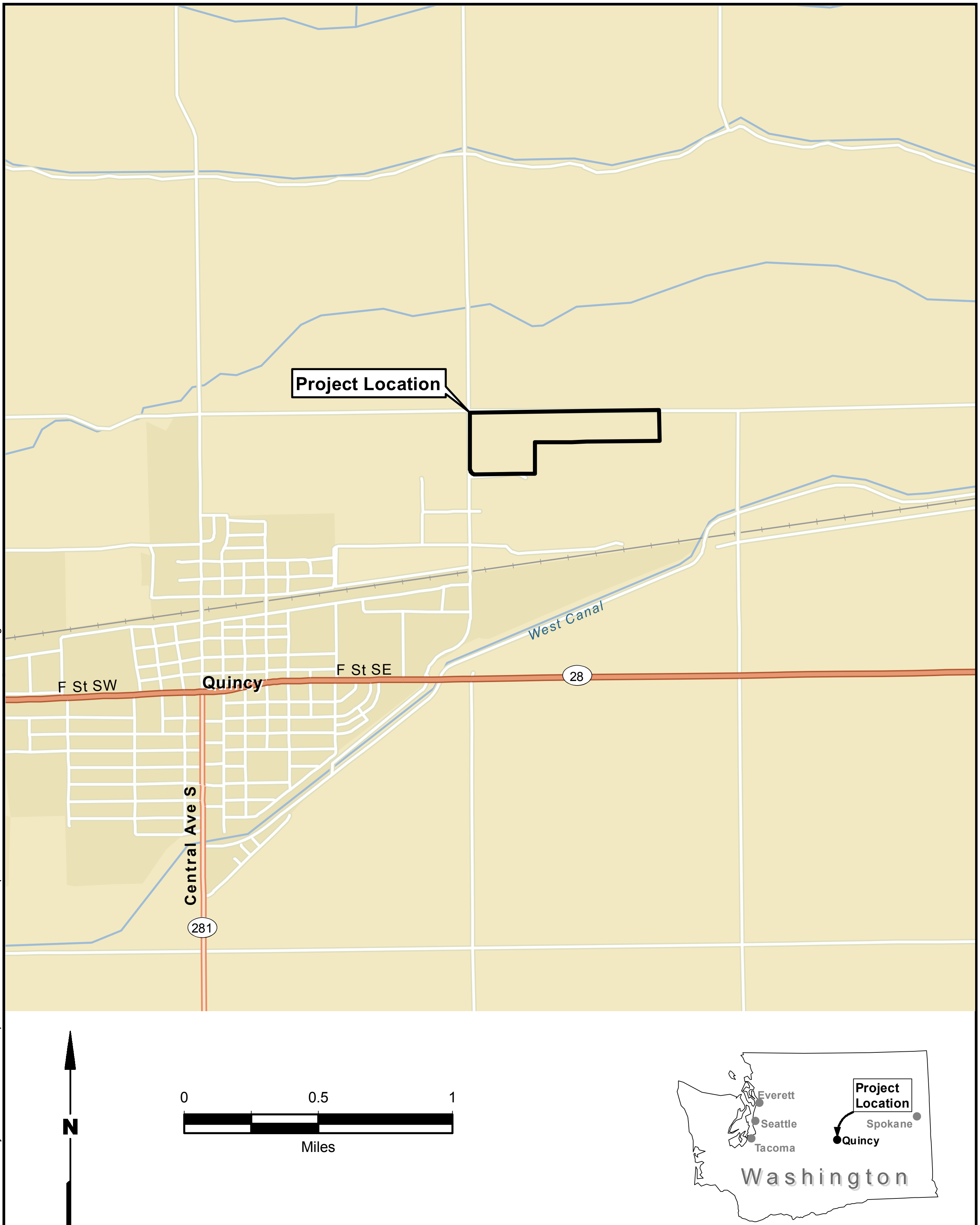
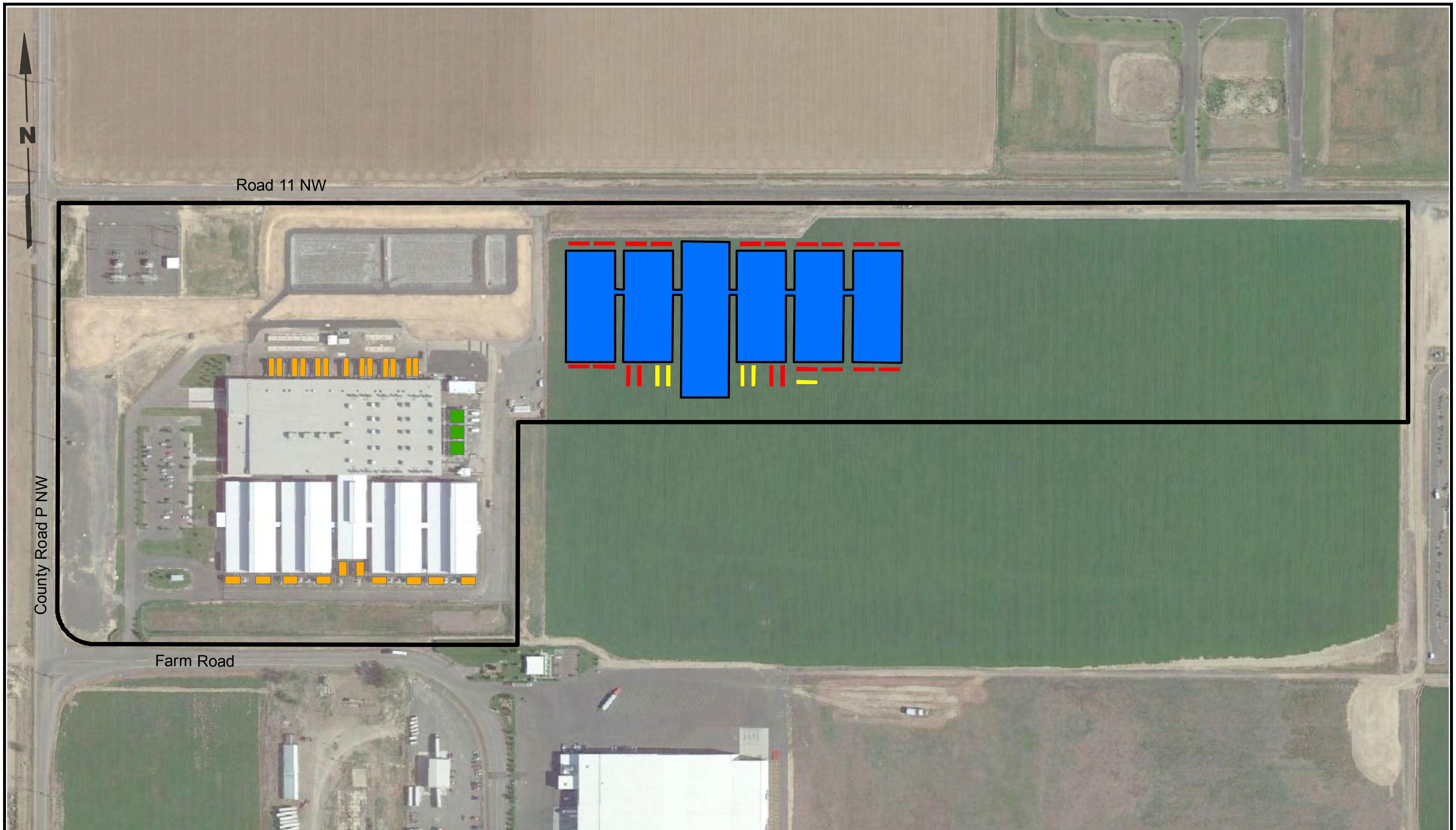


Data Source: Esri 2012.

Landau Associates	Project Genesis Quincy, Washington	**Vicinity Map**	Figure 2-1

G:\Projects\967\009\010\Project Genesis\Health Impact Assessment\F022 SitePlan.mxd 10/19/2015 NAD 1983 UTM Zone 11N



Legend

- Property Boundary
- Permitted Emergency Diesel Engine
- Permitted Cooling Tower
- Proposed 2.0-MW Emergency Engine
- Proposed 2.75-MW Emergency Engine
- Proposed Building

0 400 800

Scale in Feet

Data Source: © Google Earth Pro 2015; EKI Solutions Group 2015

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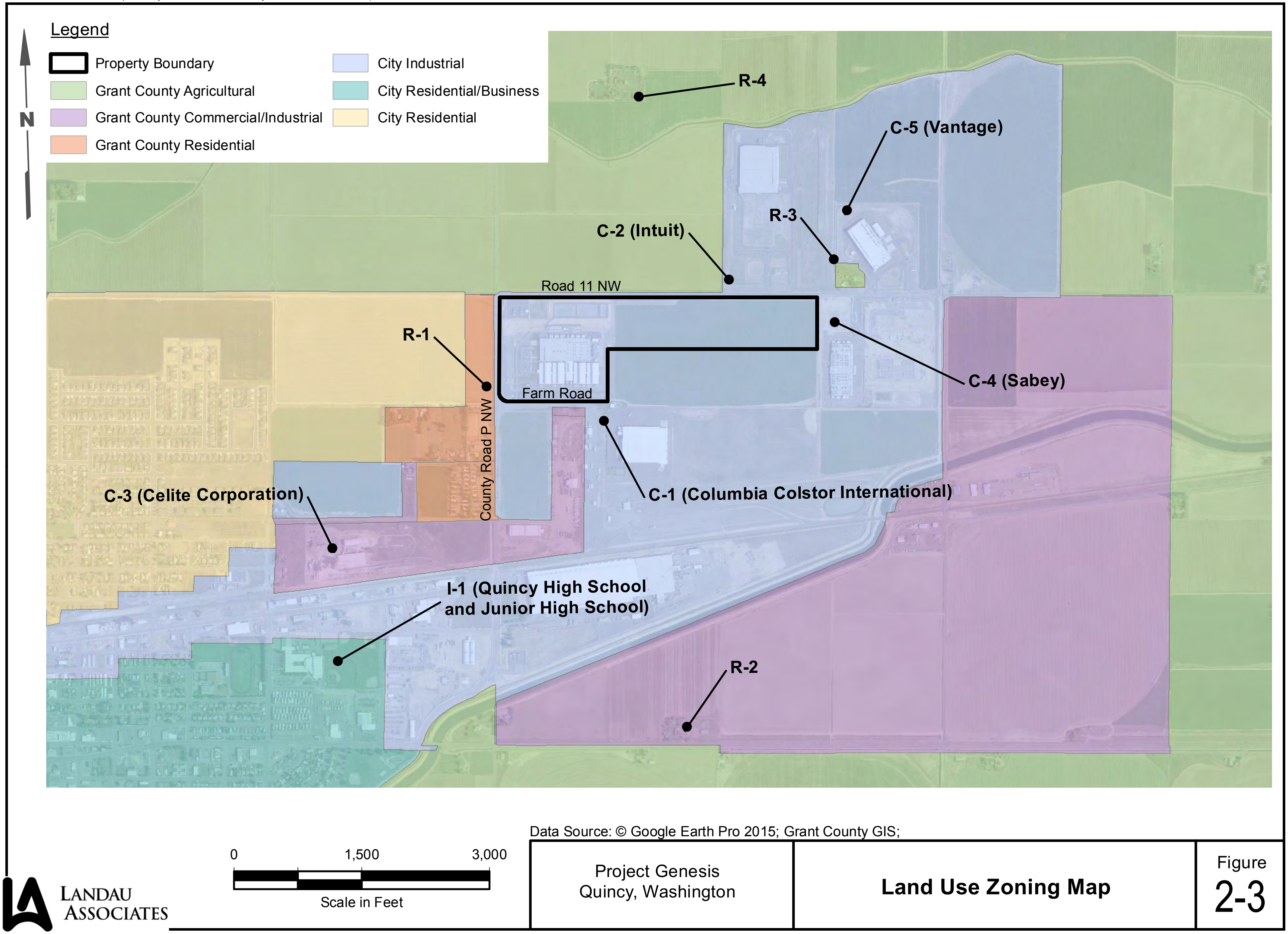
Project Genesis Quincy, Washington	**Site Map**	Figure 2-2



Data Source: © Google Earth Pro 2015; Grant County GIS;

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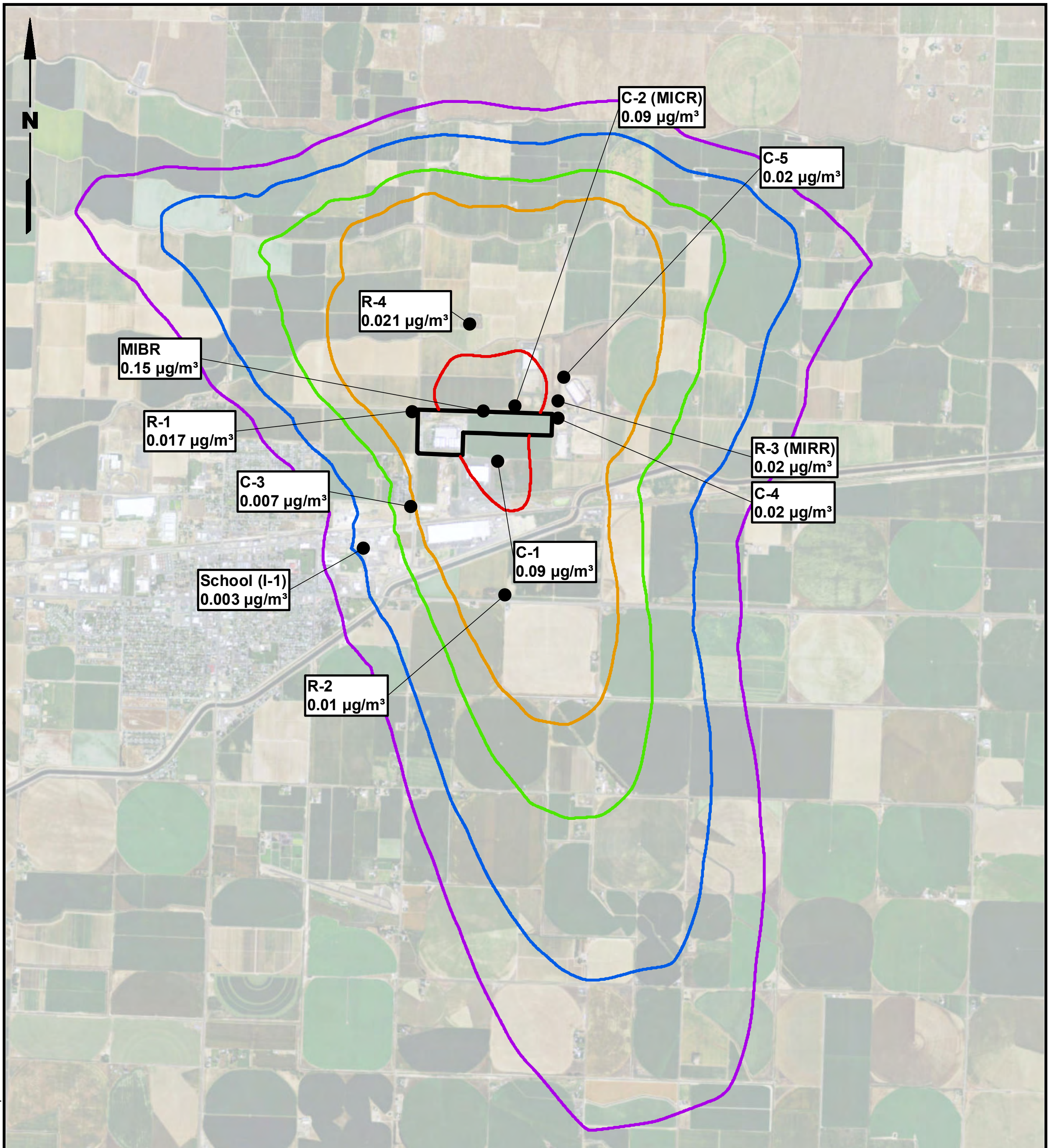
Project Genesis Quincy, Washington	**Land Use Zoning Map**	Figure 2-3



G:\Projects\967\009\010\Project Genesis\Health Impact Assessment\F041 DEEP.mxd 10/19/2015 NAD 1983 UTM Zone 11N

Legend

Property Boundary

DEEP Concentrations

- 0.0025 µg/m³
- 0.0033 µg/m³
- 0.005 µg/m³
- 0.007 µg/m³
- 0.033 µg/m³

Note

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

0 4,000 8,000

Scale in Feet

Data Source: Esri World Imagery.

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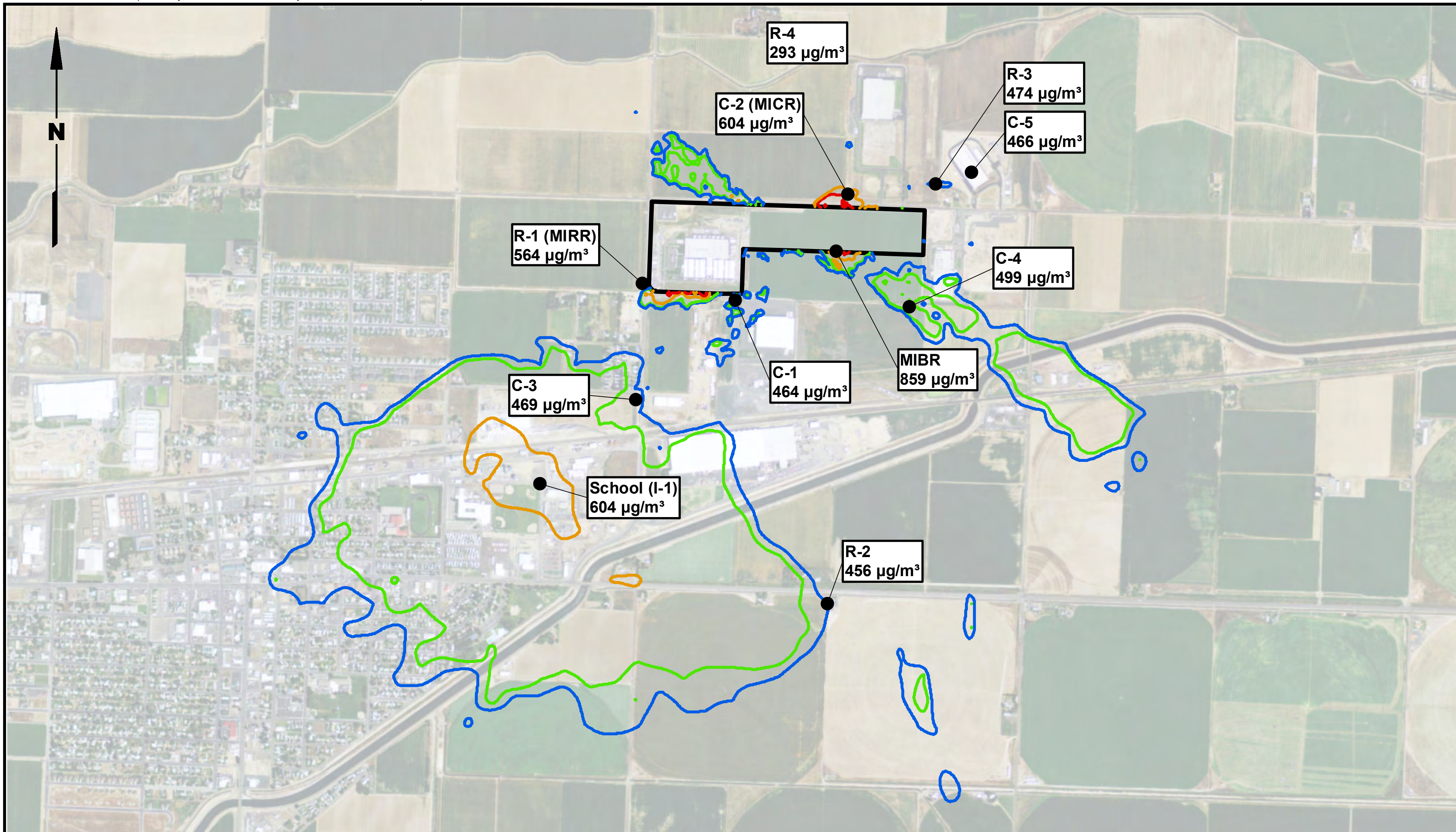
Project Genesis Quincy, Washington	**Project-Only DEEP Concentration Contour Map**	Figure 4-1

Landau Associates, Inc. | G:\Projects\967\009\010\Project Genesis\Health Impact Assessment\F042 NO2.mxd



Legend

Property Boundary

NO_2 Concentrations

454 µg/m³

470 µg/m³

550 µg/m³

625 µg/m³

0 2,000 4,000

Scale in Feet

Data Source: Esri World Imagery.

Note

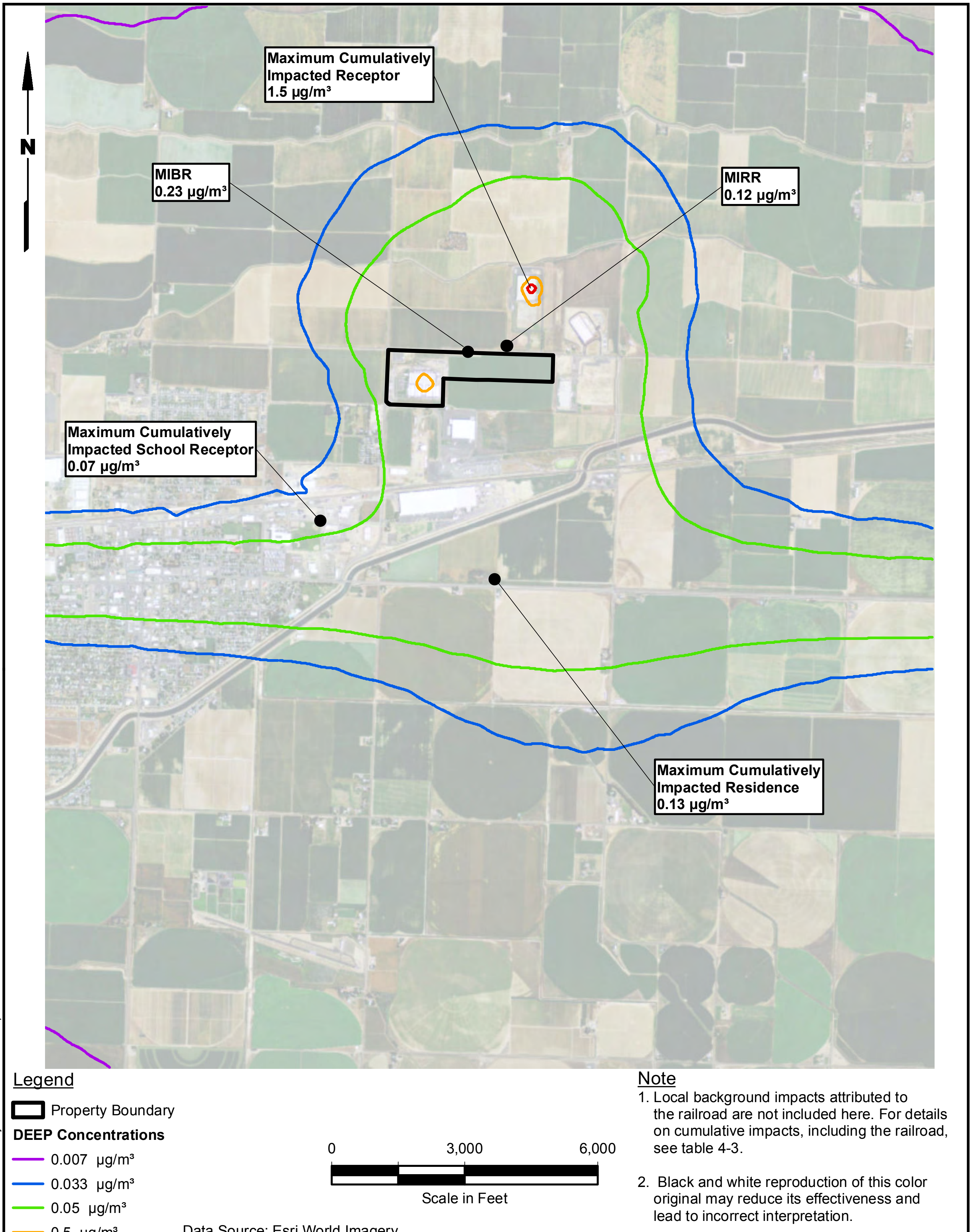
1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Landau Associates

Project Genesis
Quincy, Washington

Project-Only NO_2 Concentration Contour Map

Figure 4-2



G:\Projects\967\009\010\Project Genesis\Health Impact Assessment\F043 Cummulative DEEP.mxd 10/19/2015 NAD 1983 UTM Zone 11N

Note

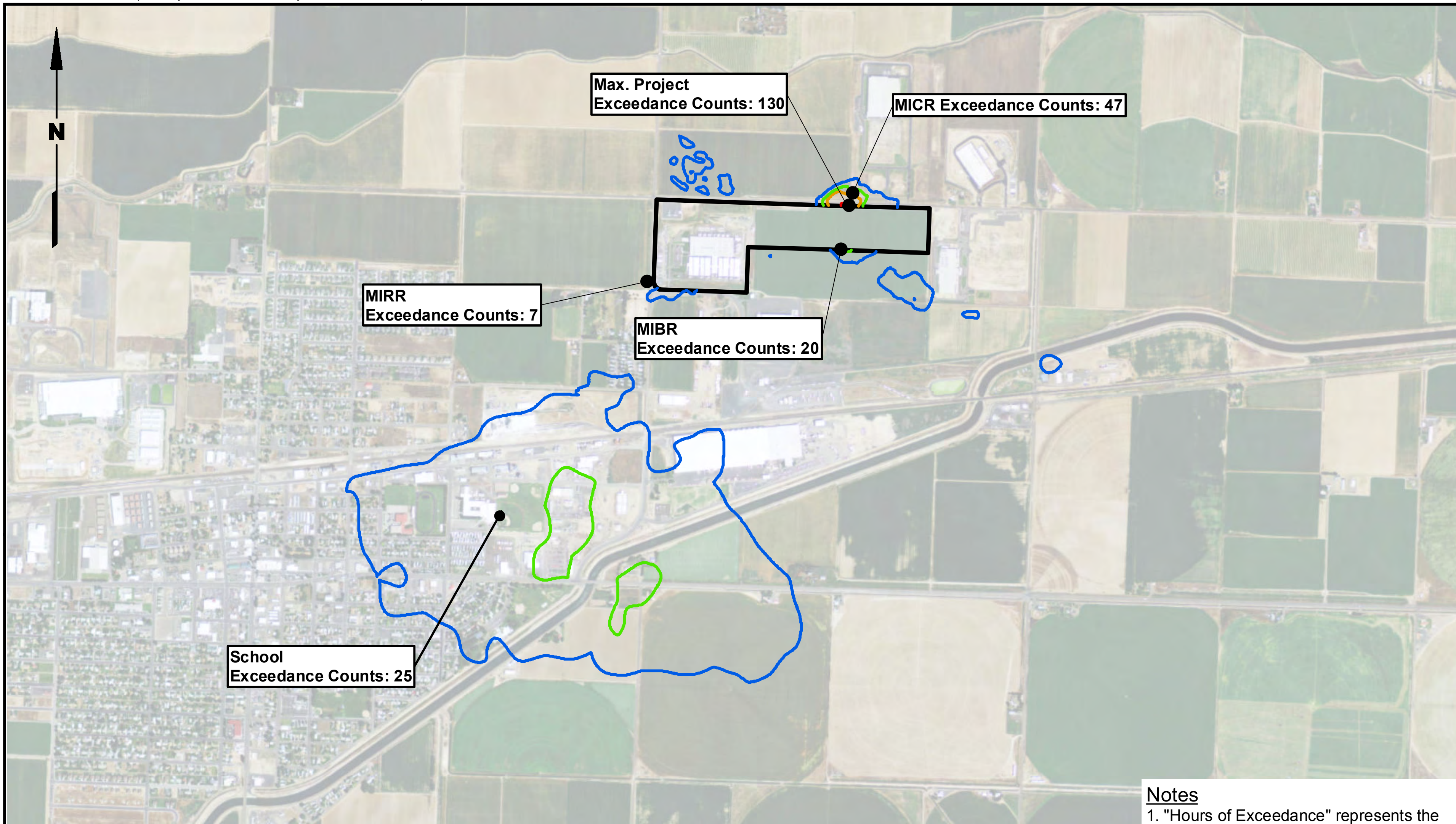
1. Local background impacts attributed to the railroad are not included here. For details on cumulative impacts, including the railroad, see table 4-3.

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

Data Source: Esri World Imagery.

LANDAU ASSOCIATES

Project Genesis Quincy, Washington	**Cumulative DEEP Concentration Contour Map**	Figure 4-3



Notes
1. "Hours of Exceedance" represents the number of 1-hour NO_2 concentrations exceeding 454 µg/m³, if the generators were to operate continuously (power outage scenario) for 5 years.
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Legend
Property Boundary
Hours Exceeding the ASIL Limit (454 µg/m³)
- 5
- 25
- 50
- 100

0 2,000 4,000
Scale in Feet

Data Source: Esri World Imagery.

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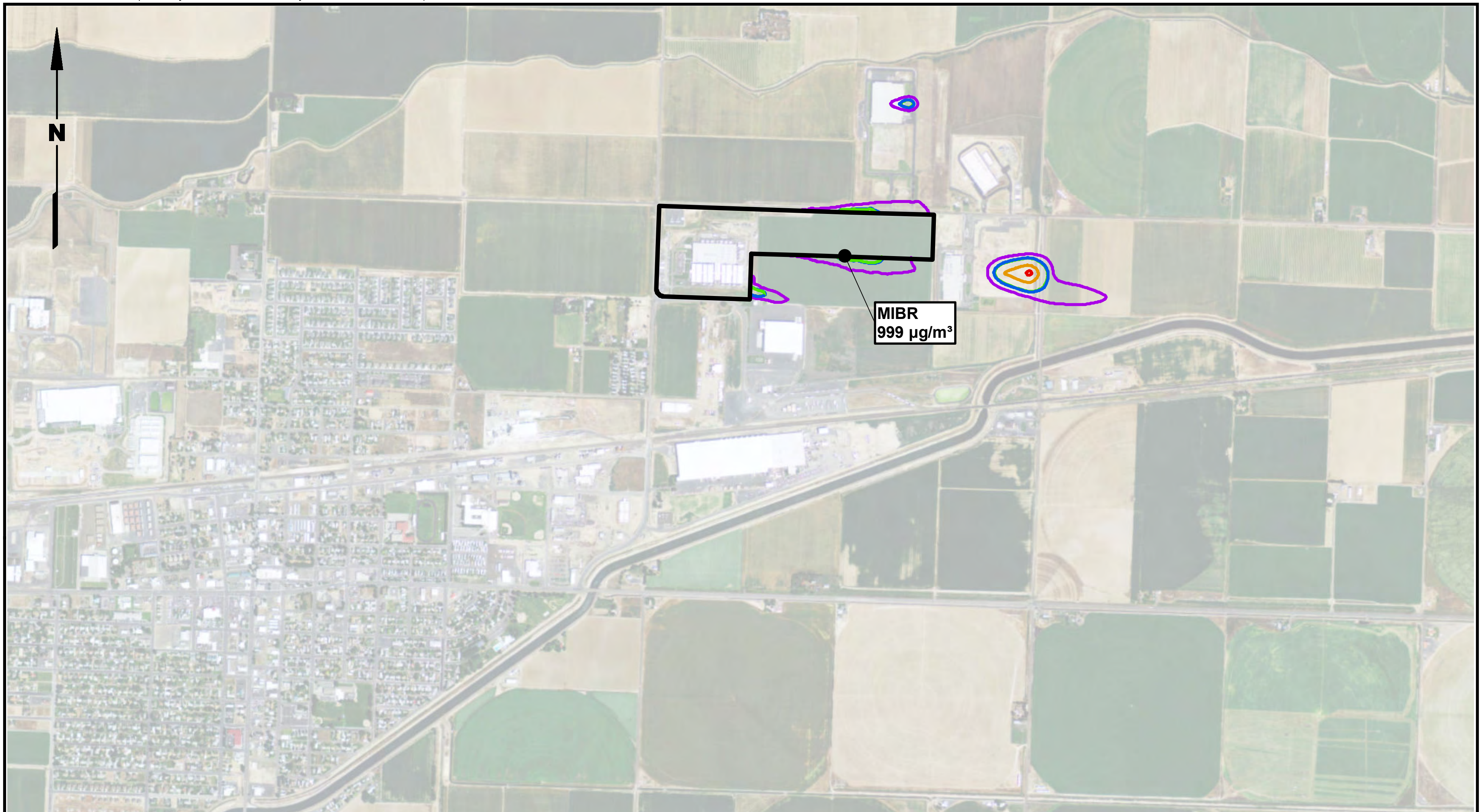
Project Genesis
Quincy, Washington

Number of "Hours of Exceedance" for 1-hour NO_2 Concentration > 454 µg/m³

Figure 4-4



Legend

Property Boundary

300 µg/m³

454 µg/m³

470 µg/m³

750 µg/m³

1,000 µg/m³

0 2,000 4,000

Scale in Feet

Data Source: Esri World Imagery.

Notes

1. Regional background not included; see Table 4-4.

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

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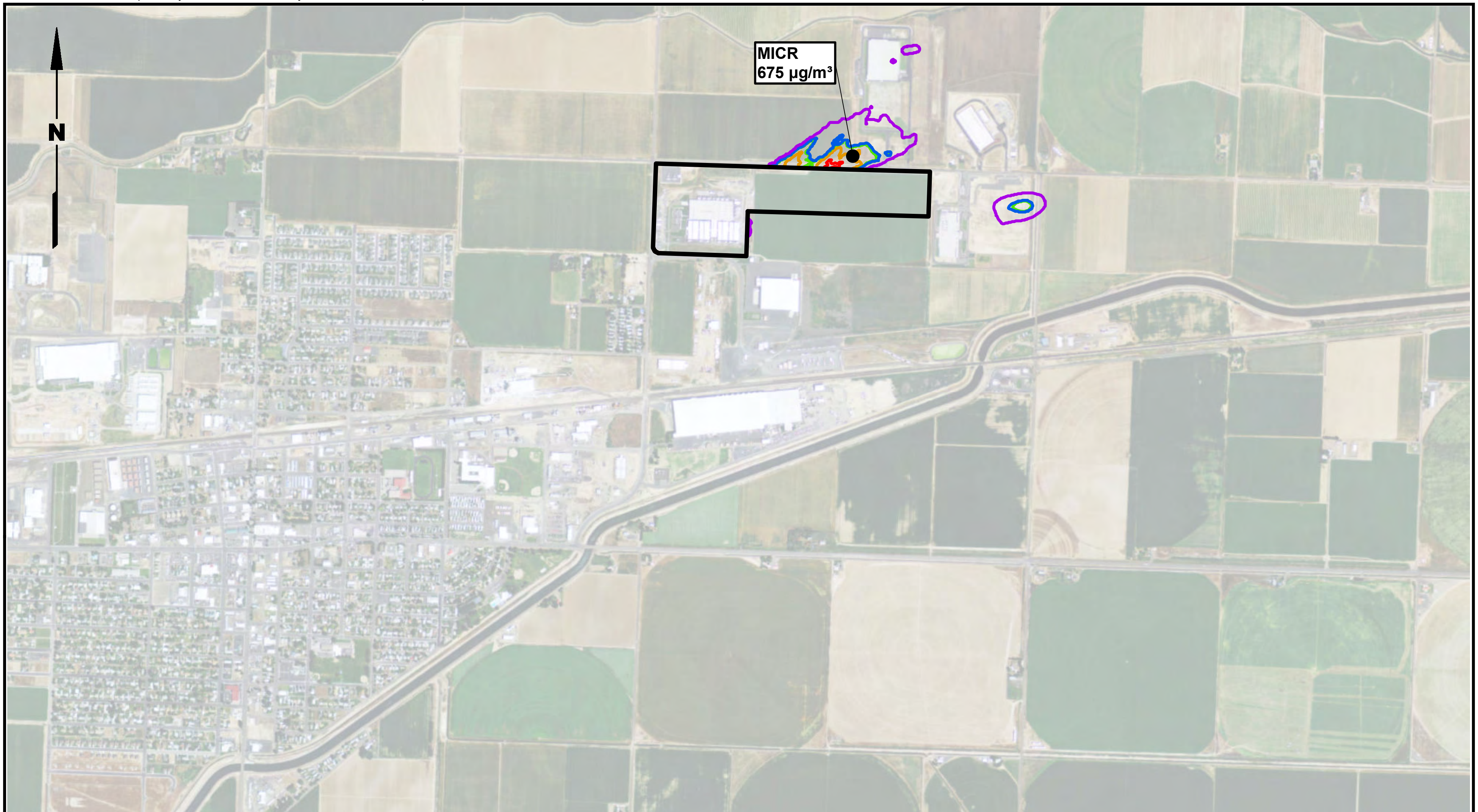
Project Genesis
Quincy, Washington

Maximum Cumulative 1-hour NO_2 Impact at the MIBR

Figure 4-5

Landau Associates, Inc. | G:\Projects\967\009\010\Project Genesis\Health Impact Assessment\F046 MICR.mxd



Legend

- Property Boundary
- 300 µg/m³
- 454 µg/m³
- 470 µg/m³
- 600 µg/m³
- 750 µg/m³

0 2,000 4,000
Scale in Feet

Data Source: Esri World Imagery.

Notes

1. Regional background not included; see Table 4-4.
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

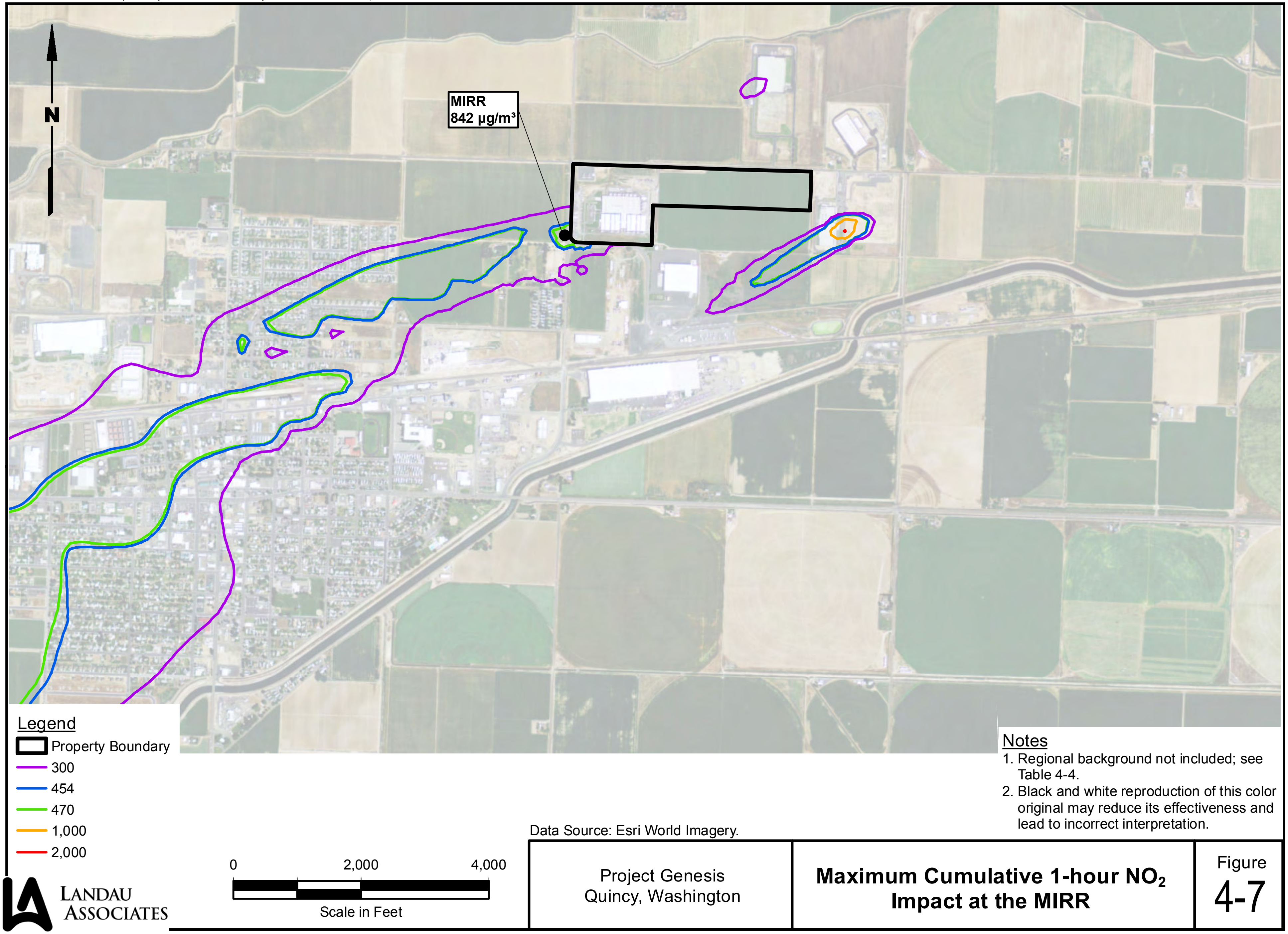
LANDAU ASSOCIATES

Project Genesis
Quincy, Washington

Maximum Cumulative 1-hour NO_2 Impact at the MICR

Figure
4-6

Landau Associates, Inc. | G:\Projects\967\009\010\Project Genesis\Health Impact Assessment\F047 MIRR.mxd



Notes
1. Regional background not included; see Table 4-4.
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Data Source: Esri World Imagery.

LANDAU ASSOCIATES

Project Genesis
Quincy, Washington

Maximum Cumulative 1-hour NO_2 Impact at the MIRR

Figure 4-7

TABLE 2-1
SUMMARY OF OPERATING SCENARIOS
PROJECT GENESIS
QUINCY, WASHINGTON

Activity	Operating Load	Max. No. Generators to Operate Concurrently	Max. Annual Operating Hours (per generator)
Emergency Power Outage	≤100%	25	84
Monthly Maintenance Testing	≤100%	1	12
Annual Load Testing	≤100%	1	4

TABLE 2-2
ESTIMATED TOXIC AIR POLLUTANT EMISSION RATES
PROJECT GENESIS
QUINCY, WASHINGTON

Pollutant	CAS#	Project Emissions	SQER Value	SQER Ratio	SQER Exceeded?
DEEP	--	2,243 lbs/yr	0.639 lbs/yr	3,510	Yes
CO	82115-62-3	195 lbs/hour	50.2 lbs/hour	3.9E+00	Yes
NO_2	10102-44-0	1.3E+03 lbs/hour	1.03 lbs/hour	1.2E+03	Yes
SO_2	7446-09-5	0.9 lbs/hour	1.45 lbs/hour	0.61	No
Benzene	71-43-2	43.1 lbs/yr	6.62 lbs/yr	6.5	Yes
Toluene	108-88-3	15.6 lbs/yr	657 lbs/yr	2.4E-02	No
Xylenes	95-47-6	10.7 lbs/yr	58 lbs/yr	0.18	No
1,3-Butadiene	106-99-0	2.2 lbs/yr	1.13 lbs/yr	1.9	Yes
Formaldehyde	50-00-0	4.4 lbs/yr	32 lbs/yr	0.14	No
Acetaldehyde	75-07-0	1.4 lbs/yr	71 lbs/yr	2.0E-02	No
Acrolein	107-02-8	0.10 lbs/day	0.00789 lbs/day	13	Yes
Benzo(a)pyrene	50-32-8	1.43E-02 lbs/yr	0.174 lbs/yr	0.08	No
Benzo(a)anthracene	56-55-3	3.45E-02 lbs/yr	1.74 lbs/yr	2.0E-02	No
Chrysene	218-01-9	8.50E-02 lbs/yr	17.4 lbs/yr	4.9E-03	No
Benzo(b)fluoranthene	205-99-2	6.16E-02 lbs/yr	1.74 lbs/yr	3.5E-02	No
Benzo(k)fluoranthene	207-08-9	1.21E-02 lbs/yr	1.74 lbs/yr	7.0E-03	No
Dibenz(a,h)anthracene	53-70-3	1.92E-02 lbs/yr	0.16 lbs/yr	0.12	No
Ideno(1,2,3-cd)pyrene	193-39-5	2.30E-02 lbs/yr	1.74 lbs/yr	1.3E-02	No
Naphthalene	91-20-3	7.2 lbs/yr	5.64 lbs/yr	1.3	Yes
Propylene	115-07-1	36.9 lbs/day	394 lbs/day	0.09	No

Notes:
Highlighting indicates exceedance of the SQER.
Source: Landau Associates 2015

TABLE 2-3
LAND USES IN THE PROJECT VICINITY
PROJECT GENESIS
QUINCY, WASHINGTON

Direction from Project Site	City/County Zoning	Notable Development
West	City/County Residential	Residence (R-1)
Southwest	County Commercial/Industrial	Celite Corporation (C-3)
Southwest	City Residential/Business	Quincy High School (I-1)
South	City Industrial	Columbia Colstor Intl. (C-1)
South	County Commercial/Industrial	Residence (R-2)
East	City Industrial	Sabey Data Center (C-4)
Northeast	County Agricultural	Residence (R-3)
Northeast	City Industrial	Vantage Data Center (C-5)
North	City Industrial	Intuit Data Center (C-2)
North	County Agricultural	Residence (R-4)

TABLE 3-1
SUMMARY OF BACT DETERMINATION FOR DIESEL ENGINE GENERATORS
PROJECT GENESIS
QUINCY, WASHINGTON

Pollutant(s)	BACT Determination
Particulate matter (PM)	Use of good combustion practices;
	Use of EPA Tier 2-certified engines; and
	Compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart IIII
Nitrogen oxides (NO_x)	Use of good combustion practices;
	Use of EPA Tier 2-certified engines; and
	Compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart IIII
Carbon monoxide (CO) and volatile organic compounds (VOCs)	Use of good combustion practices;
	Use of EPA Tier 2-certified engines; and
	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

TABLE 3-2
SUMMARY OF TBACT DETERMINATION FOR DIESEL ENGINE GENERATORS
PROJECT GENESIS
QUINCY, WASHINGTON

Toxic Air Pollutant(s)	tBACT Determination
DEEP	Compliance with the PM BACT requirement
Carbon monoxide (CO), benzene, 1,3-butadiene, acrolein, and naphthalene	Compliance with the VOC BACT requirement
Nitrogen dioxide (NO_2)	Compliance with the NO_x BACT requirement

TABLE 3-3
FIRST-TIER AMBIENT IMPACT ASSESSMENT FOR TOXIC AIR POLLUTANTS
PROJECT GENESIS
QUINCY, WASHINGTON

Toxic Air Pollutant	Averaging Period	ASIL ($\mu g/m^3$)	Predicted Max. Ambient Impact (ug/m3)
DEEP	Annual	0.00333	0.15
CO	1-hour	23,000	637
NO_2	1-hour	470	859
Benzene	Annual	0.0345	2.9E-03
1,3-Butadiene	Annual	0.00588	1.5E-04
Acrolein	24-hour	0.06	6.7E-03
Naphthalene	Annual	0.0294	4.8E-04

TABLE 4-1
CHEMICALS ASSESSED FOR MULTIPLE EXPOSURE PATHWAYS
PROJECT GENESIS
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

TABLE 4-2
RISK RECEPTOR DISTANCES FROM PROJECT SITE AND MAXIMUM IMPACTS
PROJECT GENESIS
QUINCY, WASHINGTON

Receptor Type	ID	UTM		Direction From Project Site	Estimated Distance From Nearest Project-Generator		DEEP annual Impact ($\mu g/m^3$)	NO_2 1-hour Impact ($\mu g/m^3$)
		E (m)	N (m)		Feet	Meters		
MIBR-DEEP	-	286,258	5,236,648	North	--	--	1.5E-01	--
MIBR-NO_2	-	286,474	5,236,455	South	--	--	--	859
MICR (a)	C-2	286,524	5,236,692	North	160	49	0.09	604
MIRR-DEEP	R-3	286,890	5,236,736	Northeast	380	116	2.4E-02	474
MIRR-NO_2	R-1	285,679	5,236,275	West	121	37	8.8E-03	564
School-DEEP	I-1 (b)	285,240	5,235,486	Southwest	3,412	1,040	3.5E-03	--
School-NO_2		285,140	5,235,486		3,652	1,113	--	604

Notes:

(a) The workplace receptor identified as C-2 (Intuit Data Center) represents the MICR for both DEEP and NO_2 exposure.

(b) The maximum project related impacts on school property, for DEEP and NO_2 , are predicted to occur at two different locations within the same school gr

TABLE 4-3
PREDICTED DEEP IMPACTS AT EACH RISK RECEPTOR LOCATION
PROJECT GENESIS
QUINCY, WASHINGTON

Source	Annual DEEP Impact (µg/m^3)				
	MIBR	MIRR	MICR	School	Max Cumulative Impacted Residence
Project Genesis-Only	0.15	2.4E-02	8.9E-02	3.5E-02	1.3E-02
Existing Yahoo! Data Center	5.8E-02	1.2E-02	2.5E-02	5.6E-03	1.5E-02
Intuit Data Center	8.8E-03	5.2E-02	2.4E-02	1.4E-03	3.7E-03
Sabey Data Center	5.1E-03	2.3E-02	9.0E-03	7.9E-04	2.5E-03
Vantage Data Center	7.3E-04	3.8E-03	1.1E-03	2.3E-04	5.6E-04
State Route 28	1.0E-02	9.8E-03	9.9E-03	3.3E-02	9.9E-02
Railroad (a)	7.5E-02	1.5E-02	7.5E-02	7.53E-02	7.5E-02
Cumulative (including local background) Impacts	0.31	0.14	0.23	0.15	0.21

5 = DEEP REL (µg/m^3)	DEEP - Chronic Hazard Quotient				
	MIBR	MIRR	MICR	School	Max Cumulative Impacted Residence
Project Genesis-Only	3.0E-02	4.8E-03	1.8E-02	7.0E-03	2.5E-03
Cumulative (including local background) HQ	6.2E-02	2.8E-02	4.7E-02	3.0E-02	4.2E-02

	MIBR	MIRR	MICR	School	Max Cumulative Impacted Residence
DEEP Cancer Risk Unit Risk Factor (µg/m^3)$^{-1}$	7.3	300	38.0	31	300
	Lifetime Cancer Risk per Million Population				
Project (only) Risk	1.1	7.3	3.4	1.1	3.8
Existing Yahoo! Data Center	0.4	3.5	0.9	0.2	4.5
Intuit Data Center	0.1	15.6	0.9	0.0	1.1
Sabey Data Center	0.0	7.0	0.3	0.0	0.8
Vantage Data Center	0.0	1.1	0.0	0.0	0.2
State Route 28	0.1	2.9	0.4	1.0	29.6
Railroad	0.5	4.4	2.9	2.3	22.5
Cumulative (including local background) Risk	2.2	41.9	8.9	4.7	62

Notes:

(a) Railroad impacts were derived from Ecology's *Technical Support Document for Second Tier Review, Sabey Data Center* (2011). The MIRR for Project Genesis is the same as the residence referred to in the Sabey report as "residence located northwest of Sabey." For all other Project Genesis RME receptors, it was conservatively assumed the impact from the railroad line was equal to the DEEP impact at the MICR in the 2011 Sabey report.

HQ = Hazard Quotient.
MIBR = Maximally impacted boundary receptor.
MIRR = Maximally impacted residential receptor.
MICR = Maximally impacted commercial receptor.
µg/m^3 = micrograms per cubic meter.

TABLE 4-4
PREDICTED NO_2 IMPACTS AT EACH RISK RECEPTOR LOCATION
PROJECT GENESIS
QUINCY, WASHINGTON

	1-hour NO_2 Impact ($\mu g/m^3$)			
	MIBR	**MIRR**	**MICR**	**School**
Project (only) impacts	859	564	604	604
Project + Local Point Sources	999	842	675	1,029
Approximate Regional Background (a)	16			
Cumulative (post-project) Impacts	1,015	857	691	1,045

470 = NO_2 REL ($\mu g/m^3$)	Acute (1-hour) NO_2 Hazard Quotient			
	MIBR	**MIRR**	**MICR**	**School**
Project (only) HQ	1.8	1.2	1.3	1.3
Project + Local Point Sources HQ	2.1	1.8	1.4	2.2
Approximate Regional Background HQ	0.03			
Cumulative (post-project) HQ	2.2	1.8	1.5	2.2

Notes:
(a) Regional background values obtained from WSU website 2015.

HQ = Hazard Quotient.
MIBR = Maximally impacted boundary receptor.
MIRR = Maximally impacted residential receptor.
MICR = Maximally impacted commercial receptor.

TABLE 4-5
EXPOSURE ASSUMPTIONS AND UNIT RISK FACTORS USED FOR LIFETIME CANCER RISK ASSESSMENT
PROJECT GENESIS
QUINCY, WASHINGTON

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

TABLE 4-6
TOXICITY VALUES USED TO ASSESS AND QUANTIFY NON-CANCER HAZARD AND CANCER RISK
PROJECT GENESIS
QUINCY, WASHINGTON

Pollutant	Agency	Non-Cancer REL ($\mu g/m^3$)	Carcinogenic URF $(\mu g/m^3)^{-1}$
DEEP	Acute (1-hr average)	N/A	$3.0x10^{-4}$
	Chronic (12-month average)	5	
CO	Acute (1-hr average)	23,000	N/A
	Chronic (12-month average)	N/A	
NO_2	Acute (1-hr average)	470	N/A
	Chronic (12-month average)	N/A	
Benzene	Acute (1-hr average)	27	$2.9x10^{-5}$
	Chronic (12-month average)	3	
1,3-Butadiene	Acute (1-hr average)	660	$1.7x10^{-4}$
	Chronic (12-month average)	2	
Acrolein	Acute (1-hr average)	2.5	N/A
	Chronic (12-month average)	0.35	
Naphthalene	Acute (1-hr average)	N/A	$3.4x10^{-5}$
	Chronic (12-month average)	9	

Notes:
Source: California Office of Environmental Health Hazard Assessment
N/A = Not applicable to this toxic air pollutant

TABLE 4-7
ANNUAL CHRONIC (NON-CANCER) HEALTH IMPACT ASSESSMENT FOR TOXIC AIR POLLUTANTS
PROJECT GENESIS
QUINCY, WASHINGTON

Annual Average Hazard Index (a)		MIBR (b)	MIRR	MICR	School
DEEP	Ambient Impact (µg/m^3)	0.31	0.14	0.23	0.15
	Risk-Based Toxic Threshold Value (µg/m^3)	5			
	Hazard Quotient	6.2E-02	2.8E-02	4.7E-02	3.0E-02
Benzene (c)	Ambient Impact (µg/m^3)	5.9E-03	2.7E-03	4.5E-03	2.9E-03
	Risk-Based Toxic Threshold Value (µg/m^3)	3			
	Hazard Quotient	2.0E-03	8.9E-04	1.5E-03	9.7E-04
1,3-Butadiene (c)	Ambient Impact (µg/m^3)	3.0E-04	1.4E-04	2.3E-04	1.5E-04
	Risk-Based Toxic Threshold Value (µg/m^3)	2			
	Hazard Quotient	1.5E-04	6.8E-05	1.1E-04	7.3E-05
Acrolein (c)	Ambient Impact (µg/m^3)	5.2E-03	2.4E-03	4.0E-03	2.6E-03
	Risk-Based Toxic Threshold Value (µg/m^3)	0.35			
	Hazard Quotient	1.5E-02	6.8E-03	1.1E-02	7.3E-03
Naphthalene (c)	Ambient Impact (µg/m^3)	9.9E-04	4.5E-04	7.5E-04	4.9E-04
	Risk-Based Toxic Threshold Value (µg/m^3)	9			
	Hazard Quotient	1.1E-04	5.0E-05	8.3E-05	5.4E-05
	Combined Hazard Index (HI)	**7.9E-02**	**3.6E-02**	**6.0E-02**	**3.9E-02**

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) Predicted impacts based on dispersion factors.

TABLE 4-8
1-HOUR ACUTE (NON-CANCER) HEALTH IMPACT ASSESSMENT FOR TOXIC AIR POLLUTANTS
PROJECT GENESIS
QUINCY, WASHINGTON

1-hour Acute Hazard Index (a)(b)		MIBR	MIRR	MICR	School
CO	Ambient Impact (µg/m^3)	529	494	481	209
	Risk-Based Toxic Threshold Value (µg/m^3)	23,000			
	Hazard Quotient	2.3E-02	2.1E-02	2.1E-02	9.1E-03
NO_2	Ambient Impact (µg/m^3)	1015	857	691	1045
	Risk-Based Toxic Threshold Value (µg/m^3)	470			
	Hazard Quotient	2.2E+00	1.8E+00	1.5E+00	2.2E+00
Benzene (c)	Ambient Impact (µg/m^3)	1.95	1.95	1.50	1
	Risk-Based Toxic Threshold Value (µg/m^3)	11			
	Hazard Quotient	1.8E-01	1.8E-01	1.4E-01	8.0E-02
1,3-Butadiene (c)	Ambient Impact (µg/m^3)	0.10	0.10	0.08	0.04
	Risk-Based Toxic Threshold Value (µg/m^3)	660			
	Hazard Quotient	1.5E-04	1.5E-04	1.1E-04	6.7E-05
Acrolein (c)	Ambient Impact (µg/m^3)	0.02	0.02	0.02	0.01
	Risk-Based Toxic Threshold Value (µg/m^3)	3			
	Hazard Quotient	7.9E-03	7.9E-03	6.1E-03	3.6E-03

Combined Hazard Index (HI)	2.4	2.0	1.6	2.3
Combined HI (not including NO_2)	**0.21**	**0.21**	**0.16**	**9.3E-02**

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.

TABLE 4-9
JOINT PROBABILITY OF NO_2 ASIL EXCEEDANCES
PROJECT GENESIS
QUINCY, WASHINGTON

Exceedance Threshold Value (µg/m^3)	454			
Max. Project Impact	859			
Project Genesis --> MIBR	**Assumed Power Outage Occurrence**		**Historical Occurrence: Grant County PUD (a)**	
Hours of Power Outage per Year	**84**		**2.5**	
Contributing Source	Genesis	ALL	Genesis	ALL
Total #No. of Hrs > Threshold (in 5 Yrs)	20	236	20	236
Average No. of Hrs > Threshold Per Year	4	47	4	47
Hourly Probability of Poor Wind Dispersion	4.57E-04	5.39E-03	4.57E-04	5.39E-03
Hourly Probability of a Power Outage	9.59E-03	9.59E-03	2.89E-04	2.89E-04
Joint Probablility (per Hr) of Exceeding the Threshold During a Power Outage	4.38E-06	5.17E-05	1.32E-07	1.56E-06
Overall Probability in 1 Yr	3.76E-02	3.64E-01	1.16E-03	1.36E-02
Recurrence Interval (yrs)	27	2.7	865	74

Max. Project Impact	564			
Project Genesis --> MIRR	**Assumed Power Outage Occurrence**		**Historical Occurrence: Grant County PUD (a)**	
Hours of Power Outage per Year	**84**		**2.5**	
Contributing Source	Genesis	ALL	Genesis	ALL
Total #No. of Hrs > Threshold (in 5 Yrs)	7	356	7	356
Average No. of Hrs > Threshold Per Year	1	71	1	71
Hourly Probability of Poor Wind Dispersion	1.60E-04	8.13E-03	1.60E-04	8.13E-03
Hourly Probability of a Power Outage	9.59E-03	9.59E-03	2.89E-04	2.89E-04
Joint Probablility (per Hr) of Exceeding the Threshold During a Power Outage	1.53E-06	7.79E-05	4.62E-08	2.35E-06
Overall Probability in 1 Yr	1.33E-02	4.95E-01	4.05E-04	2.04E-02
Recurrence Interval (yrs)	75	2.0	2470	49

Max. Project Impact	604			
Project Genesis --> MICR	**Assumed Power Outage Occurrence**		**Historical Occurrence: Grant County PUD (a)**	
Hours of Power Outage per Year	**84**		**2.5**	
Contributing Source	Genesis	ALL	Genesis	ALL
Total #No. of Hrs > Threshold (in 5 Yrs)	47	889	47	889
Average No. of Hrs > Threshold Per Year	9	178	9	178
Hourly Probability of Poor Wind Dispersion	1.07E-03	2.03E-02	1.07E-03	2.03E-02
Hourly Probability of a Power Outage	9.59E-03	9.59E-03	2.89E-04	2.89E-04
Joint Probablility (per Hr) of Exceeding the Threshold During a Power Outage	1.03E-05	1.95E-04	3.10E-07	5.87E-06
Overall Probability in 1 Yr	8.62E-02	8.18E-01	2.71E-03	5.01E-02
Recurrence Interval (yrs)	12	1.2	368	20

TABLE 4-9
JOINT PROBABILITY OF NO_2 ASIL EXCEEDANCES
PROJECT GENESIS
QUINCY, WASHINGTON

Max. Project Impact	604			
Project Genesis --> School	**Assumed Power Outage Occurrence**		**Historical Occurrence: Grant County PUD (a)**	
Hours of Power Outage per Year	**84**		**2.5**	
Contributing Source	Genesis	ALL	Genesis	ALL
Total #No. of Hrs > Threshold (in 5 Yrs)	25	169	25	169
Average No. of Hrs > Threshold Per Year	5	34	5	34
Hourly Probability of Poor Wind Dispersion	5.71E-04	3.86E-03	5.71E-04	3.86E-03
Hourly Probability of a Power Outage	9.59E-03	9.59E-03	2.89E-04	2.89E-04
Joint Probablility (per Hr) of Exceeding the Threshold During a Power Outage	5.47E-06	3.70E-05	1.65E-07	1.12E-06
Overall Probability in 1 Yr	4.68E-02	2.77E-01	1.44E-03	9.73E-03
Recurrence Interval (yrs)	21	3.6	692	103

Notes:

TABLE 4-10
LIFETIME CANCER RISK CAUSED BY PROJECT-RELATED EMISSIONS OF CARCINOGENIC COMPOUNDS
PROJECT GENESIS
QUINCY, WASHINGTON

Carcinogen	Annual Emissions (Tons per Year)	ASIL (µg/m^3)	Lifetime Cancer Risk at Key Receptors (per Million)		
			MIBR	MIRR	MICR
DEEP	1.1E+00	0.0033	1.1	7.3	3.4
Benzene	2.2E-02	0.0345	2.0E-03	1.35E-02	6.3E-03
Toluene	7.8E-03	5,000	5.1E-09	3.37E-08	1.6E-08
Xylenes	5.4E-03	221	7.9E-08	5.23E-07	2.4E-07
1,3-Butadiene	1.1E-03	0.0059	6.0E-04	3.98E-03	1.9E-03
Formaldehyde	2.2E-03	1.7E-01	4.2E-05	2.78E-04	1.3E-04
Acetaldehyde	7.0E-04	3.7E-01	6.1E-06	4.08E-05	1.9E-05
Benzo(a)pyrene	7.1E-06	9.1E-04	2.5E-05	1.69E-04	7.9E-05
Benzo(a)anthracene	1.7E-05	9.1E-03	6.2E-06	4.09E-05	1.9E-05
Chrysene	4.2E-05	9.1E-02	1.5E-06	1.01E-05	4.7E-06
Benzo(b)fluoranthene	3.1E-05	9.1E-03	1.1E-05	7.30E-05	3.4E-05
Benzo(k)fluoranthene	6.1E-06	9.1E-03	2.2E-06	1.43E-05	6.7E-06
Dibenz(a,h)anthracene	9.6E-06	9.1E-04	3.4E-05	2.28E-04	1.1E-04
Ideno(1,2,3-cd)pyrene	1.1E-05	9.1E-03	4.1E-06	2.72E-05	1.3E-05
Naphthalene	3.6E-03	0.0294	4.0E-04	2.65E-03	1.2E-03
Total Lifetime Cancer Risk	**--**	**--**	**1.1**	**7.3**	**3.4**

TABLE 5-1
QUALITATIVE SUMMARY OF THE EFFECTS OF UNCERTAINTY ON QUANTITATIVE ESTIMATES OF HEALTH RISK
PROJECT GENESIS
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 concentration
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

APPENDIX A

Electronic Files

(on DVD)