DEPARTMENT OF
ECOLOGY
State of Washington

# Technical Support Document for Second Tier Review

## Dell Data Center
## Quincy, Washington

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# 1. EXECUTIVE SUMMARY

## 1.1. Proposal Summary

Dell Marketing, LP (Dell) proposes to build a new data center located in Quincy, Grant County, Washington. The project will consist of two main buildings to house server equipment and three smaller buildings to house a total of 28 diesel-powered backup generator sets each rated at 3,000 electrical kilowatts (kWe).

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

The Washington State Department of Ecology (Ecology) determined that a community-wide approach to permitting data centers was warranted for the Quincy urban growth area (UGA) because of the relatively close geographic proximity of existing and planned large data centers in Quincy. As part of the community-wide approach, Ecology considered the cumulative impacts of DEEP from existing permitted data centers and other nearby sources of diesel engine emissions.

## 1.2. Health Impacts Evaluation

Dell retained ICF International (ICF) to prepare a Health Impact Assessment (HIA) to evaluate the potential health risks attributable to operation of the diesel-powered generators from Dell's data center project. The HIA demonstrated that emissions of DEEP from the proposed project could result in an increased cancer risk of up to five in one million ($5 \times 10^{-6}$) at the maximally impacted residential location, which is an undeveloped residentially zoned property immediately to the east of Dell. Because the increase in cancer risk attributable to the new data center alone is less than the maximum risk allowed by a second tier review, which is 10 in one million, the project could be approvable under WAC 173-460-090.

## 1.3. Cumulative Health Risks

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

Ecology estimates the maximum potential cumulative cancer risk posed by DEEP emitted from Dell and other nearby sources to be approximately 49 in one million ($49 \times 10^{-6}$) at a location directly adjacent to Microsoft Columbia Data Center's northern boundary and Dell's southeast boundary. This parcel is currently not developed, and parcel information from Grant County reports this parcel's current land use as "General Trade-Merchandise." Quincy's zoning and planning map indicates that the parcel is zoned "multi-family residential."

### 1.4. Conclusions and Recommendation

Ecology recommends approval of the proposed project because project-related health risks are permissible under WAC 173-460-090, and the cumulative risk from DEEP emissions in Quincy is less than the cumulative risk goal established by Ecology for permitting data centers in Quincy (100 per million or 100 x $10^{-6}$). Ecology recommends that Dell be required to communicate health risks posed by Dell's emissions to current residents near Dell, and potential new homeowners at undeveloped parcels adjacent to Dell, or to the local regulatory agency responsible for zoning and development in the affected area.

The remainder of this document describes the technical review performed by Ecology.

## 2. DELL QUINCY DATA CENTER PROJECT

Dell proposes to build a new data center complex in Quincy, Washington. The Dell Data Center is located directly north of the Microsoft Columbia Data Center and will be utilized by Dell to store data and run software applications. The project will be located in the northeastern portion of Quincy's UGA (Figure 1), and include two main buildings to house server equipment and twenty-eight (28) backup generators. The primary air contaminant sources at the facility consist of the twenty-eight (28) electric generators each powered by 3,298 mechanical kilowatts (kWm) (i.e., 4,423 brake horse power (bhp)) Caterpillar C175-16 diesel engines. Each generator has the capacity to produce 3,000 electrical kilowatts (kWe) and provide emergency backup power to the facility during infrequent disruption of Grant County Public Utility District's (PUD) electrical power service. At full buildout, the generators will have a combined power capacity of up to 84 megawatts electrical (MWe). The project will be phased in over several years depending on demand.

The Dell Data Center consists of phased construction of three buildings, i.e., Phase 1, Phase 2, and Phase 3. Phase 1 construction of 100,866 square feet ($ft^2$) will commence during 2011, and includes fourteen (14) 3.0 MWe generators powered by 4,423 bhp Caterpillar C175-16 engines. Phase 2 and 3 construction will be 56,659 $ft^2$ and 57,508 $ft^2$ of space each, respectively, and each phase will include seven (7) 3.0 Megawatts (MWe) electric generators powered by 4423 brake horse power Caterpillar C175-16 engines. The 14 engines that are part of Phase 2 and Phase 3 will be installed at an undetermined date.

Three generator buildings near the western edge of the proposed facility boundary will house the engines (Figure 2). Exhaust from each engine will be routed through vertical stacks that extend to 58 feet above grade through the roof of the generator buildings.

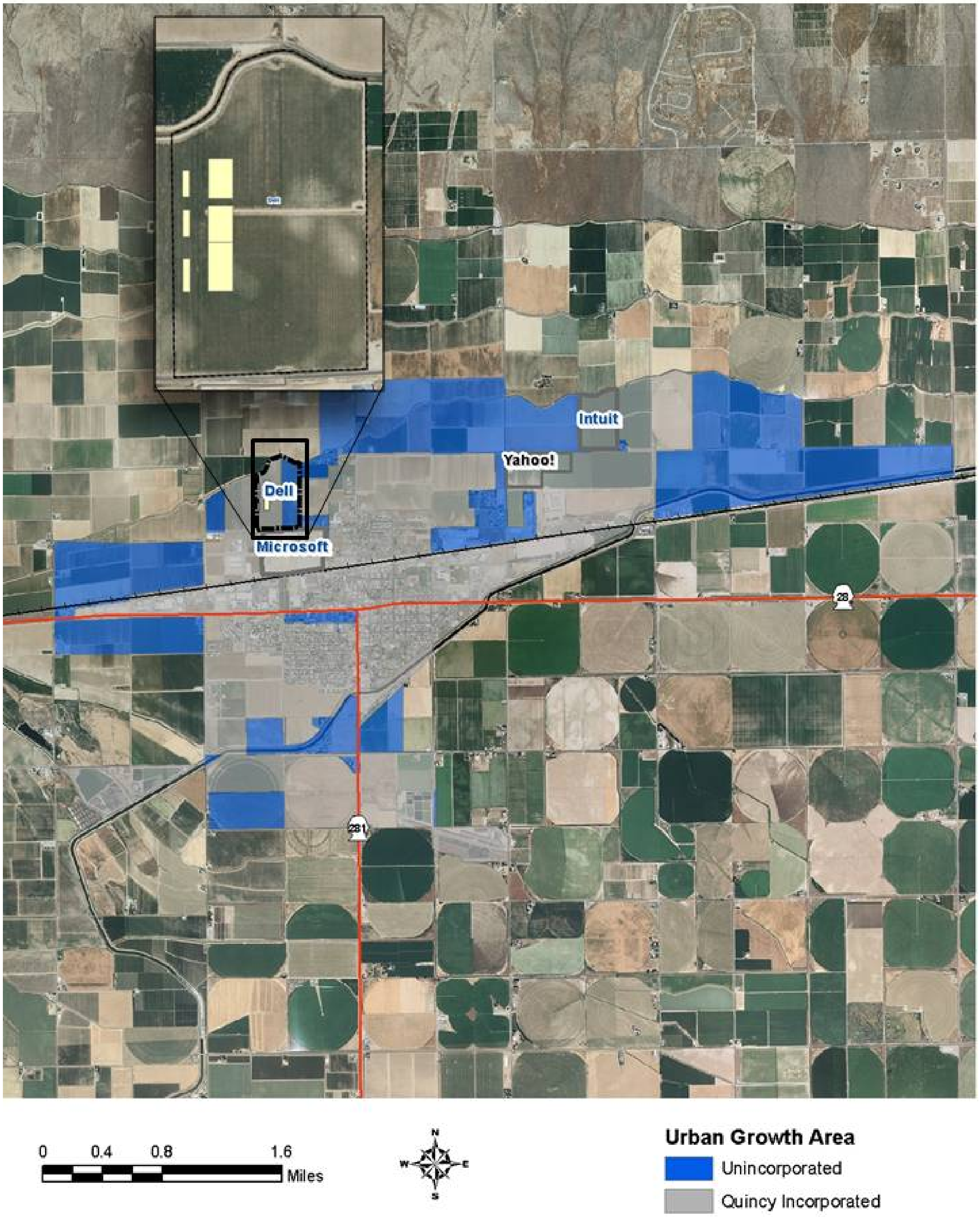


**Figure 1**. Dell Data Center location within Quincy, WA's UGA

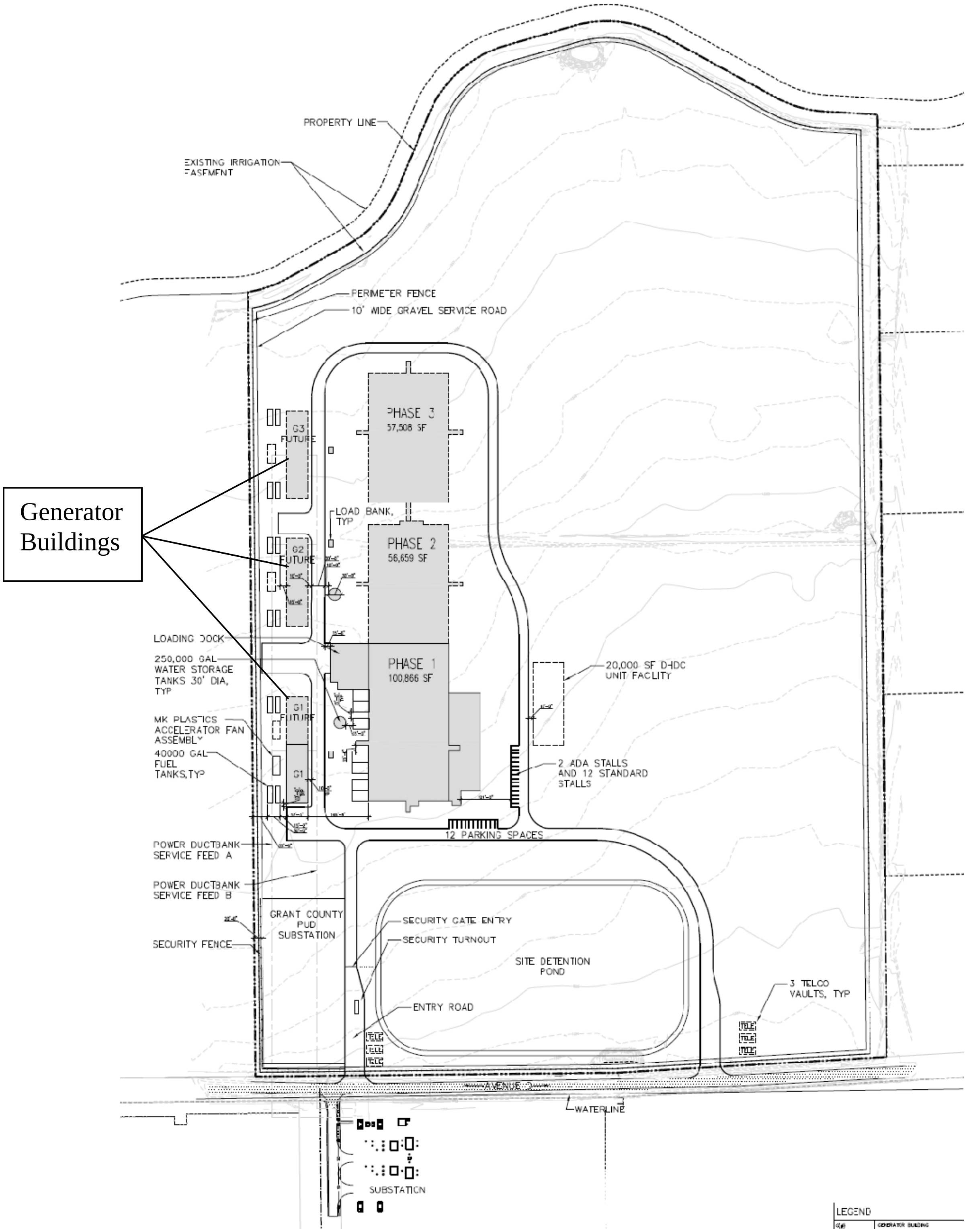


**Figure 2.** Site plan drawing showing general location of air emission units (ICF, 2011a)

In order to minimize air quality impacts from the proposed project, Dell proposes to limit the duration of engine testing, maintenance, and other usage. The 28 engines will operate for an average of 53.5 hours per year (averaged over three years). Engines will operate for varying durations and loads depending on the type of test being ran. The only time all 28 engines would operate simultaneously is during a complete power outage. The May 19, 2011, draft Notice of Construction (NOC) approval order imposes a facility-wide fuel usage limit of 175,031 gallons per year of ultra-low sulfur (less than 0.0015 wt percent), EPA on-road specification No. 2 distillate fuel oil. Total annual fuel consumption by the facility may be averaged over a three-(3) year period using monthly rolling totals. Table 1 provides a summary of Dell's proposed operating durations (ICF 2011a).

**Table 1. Operating Time Limits for Dell's Proposed Data Center Diesel Engines**

| Scenario | Engine Load | Hours per Test | Tests per Year | Average Hours per Year per Engine* | Maximum # of Engines Tested per Day | # of Engines Operating Concurrently |
|---|---|---|---|---|---|---|
| Weekly Testing | 10% | 0.5 | 40 | 20 | 14 | 1 |
| Monthly Testing | 70% | 1.25 | 10 | 12.5 | 8 | 1 |
| Semi-Annual Testing | 70% | 1.5 | 1 | 1.5 | 8 | Engines run one at a time for 1hr of the test, then simultaneously for the last ½ hour of the test time |
| Annual Testing | 100% | 4 | 1 | 4 | 2 | 1 |
| | 70% | 0.75 | 1 | 0.75 | 8 | 8 |
| Maintenance | 70% | As needed | As needed | 8 | 1 | 1 |
| Power Outage | 70% | As needed | As needed | 8 | All | 19 |
| | Reserves @ idle (10%) | | | 4 | | 9 |

∗ The 5/19/2011 draft NOC approval order allows 3-year averaging of average hours of operation.

## 2.1. Dell Data Center Power Reliability and Infrastructure

Dell designed the first phase of their proposed data center to achieve a tier 4 data center industry classification. To attain this classification, Dell must ensure that their electrical supply is stable and can be maintained almost continuously. For this reason, Dell will have several backup generators and redundant backup generators.

The design calls for a dual-feed electrical supply system that can receive power from two independent substations. These substations will receive power from two separate supply lines (A-feed and B-feed) (ICF, 2011b). If Grant County PUD suffers a complete loss of power to either A-feed or B-feed, then Dell's electrical system will instantly and automatically switch to the other intact feed. This automatic feed switch will not activate any of Dell's backup generators. Therefore, a total loss of Grant County PUD's line power to either A-feed or B-feed would not result in any generator emissions. In the unlikely event that Grant County PUD suffers a loss of power to its entire Quincy transmission system from its two independent transmission lines, Dell's backup generators would automatically activate. This is the only type of event in which a loss of Grant County PUD line power would cause every generator at Dell to activate simultaneously.

Dell's redundant power supply means that generators will not need to operate when transformers within the Dell buildings are taken off-line for scheduled maintenance. Dell will be able to manually switch power from one feed line to the other without engaging backup generators.

### 2.2. Land Use

Dell's property is located in an industrial-zoned area along the northeastern portion of Quincy city boundary (Figure 3). Several nearby parcels are currently used as agricultural parcels (Figure 4), but the Quincy area zoning map (Figure 3) shows that these areas are planned for residential use in the future. Table 2 describes current and planned land uses in properties surrounding the Dell facility (Grant County, 2011; City of Quincy, 2011).

**Table 2. General Land Use Zone Near Dell Data Center in Quincy, WA**

| Direction From Dell | Current Land Use (from Tax Parcel Information) | Planned Zoning (from Quincy map) | Notable Development |
|---|---|---|---|
| North | Agriculture | Open | |
| Northeast | Agriculture<br>Residential | Residential | |
| East<br>Southeast | Agriculture<br>Residential | Residential | Mountain View Elementary School |
| South | Industrial | Industrial | Microsoft Data Center |
| Southwest | Industrial | Industrial | |
| West | Agriculture | Industrial | |
| Northwest | Agriculture | Open | |

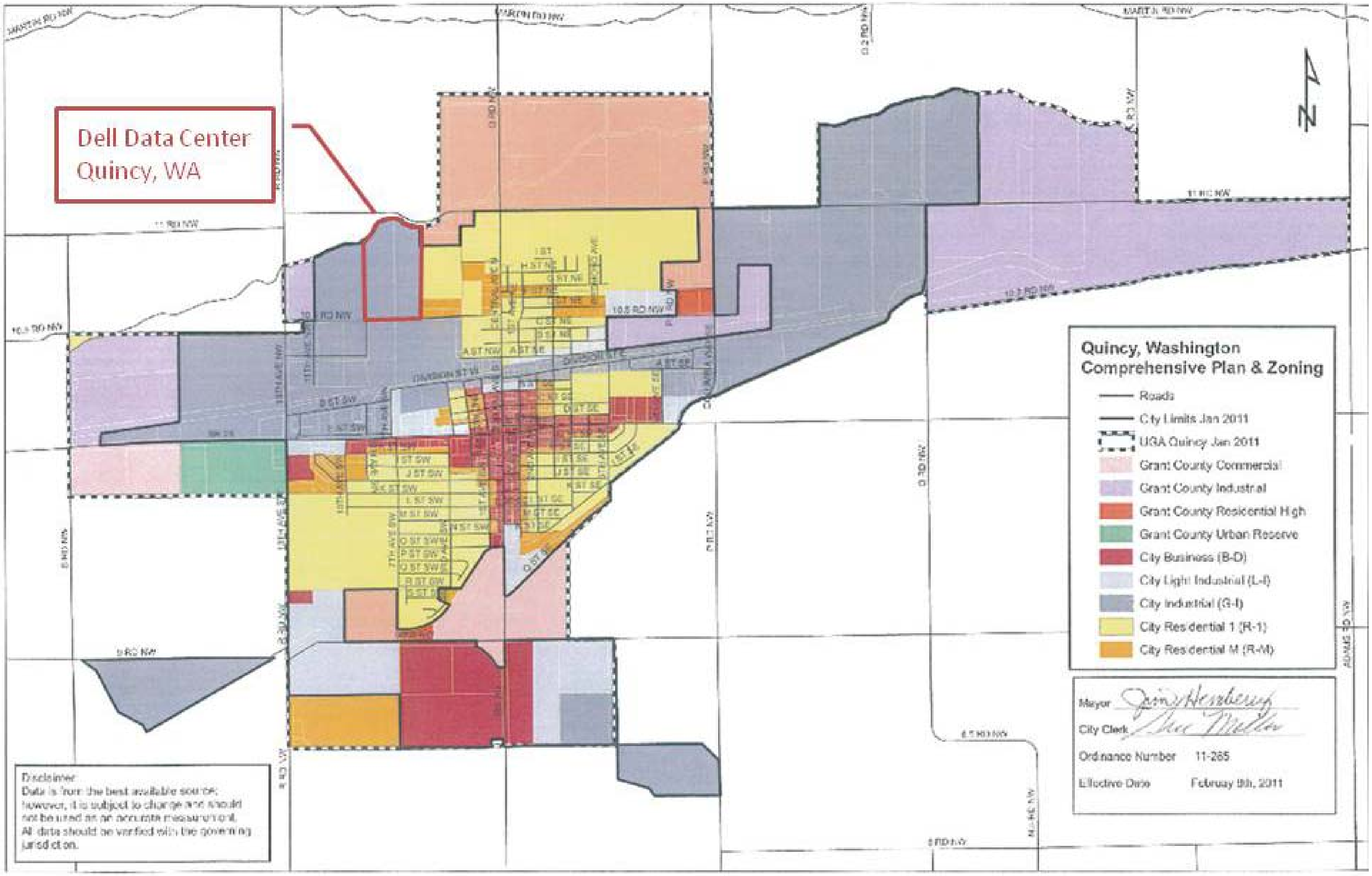


**Figure 3.** Land use planning and zoning map
(ICF, 2011b; City of Quincy, 2011)

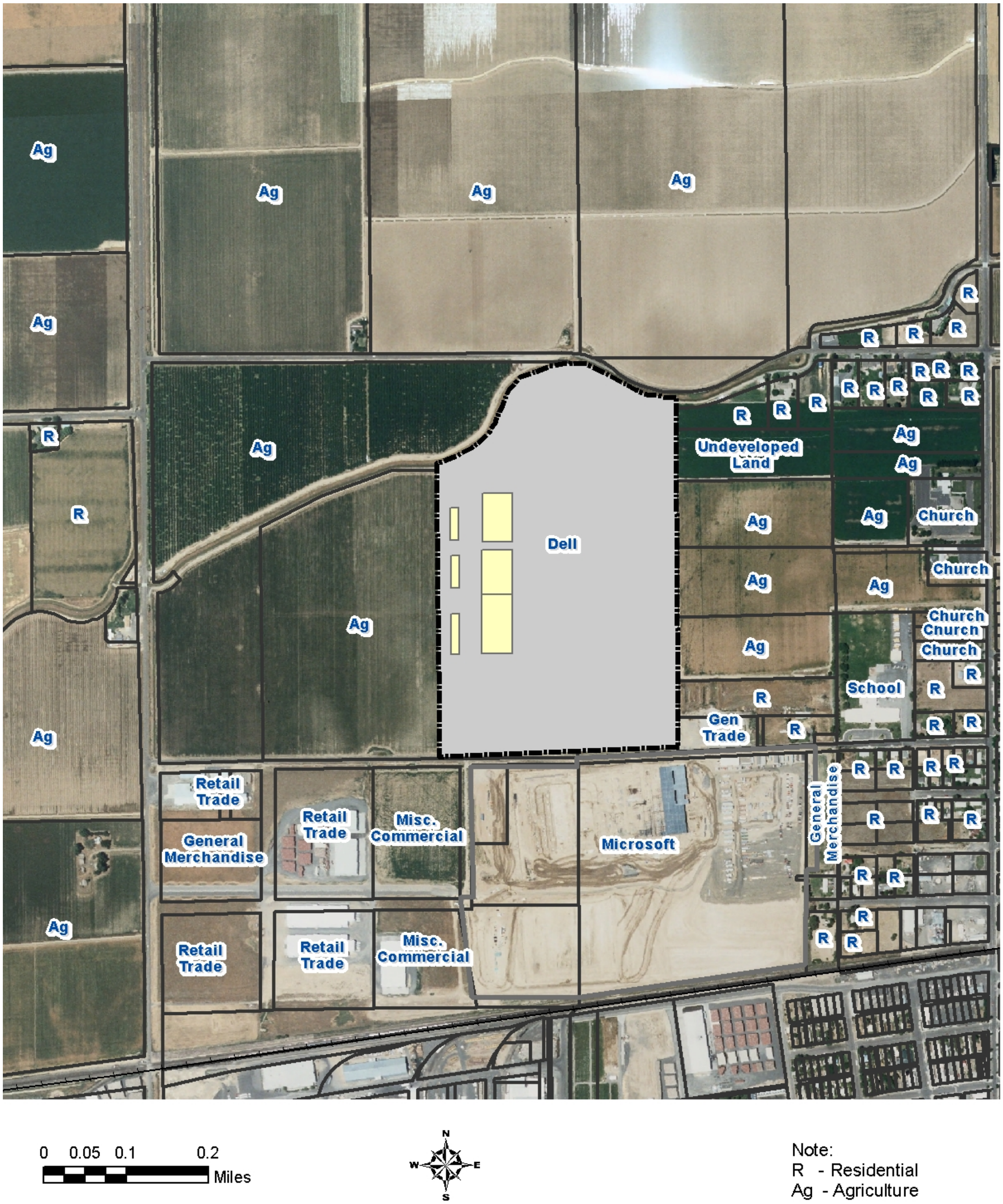


**Figure 4.** Current land use designation according to Grant County Parcel Information (Grant County, 2011)

## 3. PERMITTING REQUIREMENTS FOR NEW SOURCES OF TOXIC AIR POLLUTANTS

### 3.1. Overview of the Regulatory Process

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

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

All projects with emissions exceeding the de minimis levels are required to undergo a toxics screening (first tier review) as required by WAC 173-460-080. The objective of the toxics screening is to establish the systematic control of new sources emitting TAPs in order to prevent air pollution, reduce emissions to the extent reasonably possible, and maintain such levels of air quality to protect human health and safety. If modeled emissions exceed the trigger levels called acceptable source impact levels (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 health impacts assessment (HIA). The objective of a HIA is to quantify the increase in lifetime cancer risk for persons exposed to the increased concentration of any carcinogen, and to quantify the increased health hazard from any noncarcinogen that would result from the proposed project. Once quantified, the cancer risk is compared to the maximum risk allowed by a second tier review, which is 10 in one million, and the concentration of any noncarcinogen that would result from the proposed project is compared to its effect threshold concentration.

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

A third tier review is a risk management decision in which Ecology makes a decision that the risk of the project is acceptable based on a determination that emissions will be maximally reduced through available preventive measures, assessment of environmental benefit, disclosure of risk at a public hearing, and related factors associated with the facility and the surrounding community.

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

### 3.2. BACT and tBACT for the Dell Data Center Project

Ecology is responsible for establishing BACT and tBACT for controlling criteria and TAPs emitted from the new diesel generators. The proposed generators will use EPA Tier 2 combustion controls to reduce emissions of particulate matter, oxides of nitrogen ($NO_X$), including nitrogen dioxide ($NO_2$), unburned hydrocarbons, and other pollutants. Ecology's BACT and tBACT determinations are summarized in Tables 3 and 4, respectively (Ecology, 2011a).

**Table 3. Summary of BACT Determination**

| Pollutant(s) | BACT Determination |
|---|---|
| Particulate matter (PM), carbon monoxide, and volatile organic compounds | a. Use of good combustion practices;<br>b. Use of EPA Tier 2 certified engines if the engines are installed and operated as emergency engines, as defined at 40 CFR§60.4219; or applicable emission standards found in 40 CFR Part 89.112 Table 1 and 40 CFR Part 1039.102 Tables 6 and 7 if Model Year 2011 or later engines are installed and operated as nonemergency engines; and<br>c. Compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart IIII. |
| Nitrogen oxides ($NO_X$) | a. Use of good combustion practices;<br>b. Use of an engine design that incorporates fuel injection timing retard, turbocharger and a low-temperature aftercooler;<br>c. Use of EPA Tier 2 certified engines if the engines are installed and operated as emergency engines, as defined at 40 CFR§60.4219; or applicable emission standards found in 40 CFR Part 89.112 Table 1 and 40 CFR Part 1039.102 Tables 6 and 7 if Model Year 2011 or later engines are installed and operated as nonemergency engines;<br>d. Compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart IIII; and<br>e. Installation of a two-stage oxidation catalyst system (i.e., 3-way catalysts) that is guaranteed by the catalyst manufacturer to remove 35% of nitrogen oxides, and capable of reducing at least 50% each of carbon monoxide, volatile organic compounds, and particulate matter from the exhaust stream. |
| Sulfur dioxide | Use of ultra-low sulfur diesel fuel containing no more than 15 parts per million by weight of sulfur. |

**Table 4. tBACT for Air Toxics Emitted by Dell's Diesel Engines**

| Toxic Air Pollutant(s) | tBACT Determination |
|---|---|
| Acetaldehyde, carbon monoxide, acrolein, benzene, benzo(a)pyrene, 1,3-butadiene, diesel engine exhaust particulate, formaldehyde, propylene, toluene, total PAHs, xylenes | Compliance with the VOC BACT requirement |
| Nitrogen dioxide | Compliance with the $NO_X$ BACT requirement |
| Sulfur dioxide | Compliance with the $SO_2$ BACT requirement |

Additional restrictions proposed by Ecology in the May 19, 2011, draft preliminary approval order include:

- Limiting DEEP emissions from the 28 new engines (combined) to 0.71 tons per year.
- Limiting $NO_2$ emissions from the 28 new engines (combined) to 76 pounds per hour.
- Limits on $NO_X$ and $NO_2$ emissions from each of the 28 new engines.
- Limiting $NO_2$ emissions from each of the 28 new engines to the following emission rates at the stated loads, based on emission factors provided by the engine manufacturer.

| Operating Scenario | Operating Load | Emissions Limit per engine in g/kWm-hr | Emissions Limit per engine in lb/hr |
|---|---|---|---|
| Weekly Testing | 10% (idle) | 0.612 | 0.615 |
| Monthly Testing | 70% | 0.716 | 3.712 |
| Semi-Annual Testing | 70% | 0.716 | 3.712 |
| Annual Testing | 95% | 0.823 | 5.700 |
| Maintenance | 70% | 0.716 | 3.712 |
| Power Outages | 70% | 0.716 | 3.712 |

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

The project review team for the second tier review concurs with this tBACT determination.

### 3.3. First Tier Review Toxics Screening for the Dell Data Center Project

Dell's consultant, ICF, used a combination of EPA emission factors, EPA Tier 2 engine emission limits, and manufacturer test data to estimate emission rates of TAPs from Dell's diesel-powered generators (ICF, 2011a).

**Table 5. Comparison of Emission Rates to SQER**

| Pollutant | Averaging Period | Total Emissions | SQER | Emissions Above SQER |
|---|---|---|---|---|
| | | **See Averaging Period for Units** | **See Averaging Period for Units** | **Yes or No** |
| Acetaldehyde | lb/yr | 0.6043 | 71 | No |
| Acrolein | lb/24-hr | 0.027 | 0.00789 | **Yes** |
| Benzene | lb/yr | 18.6 | 6.62 | **Yes** |
| Benzo(a)pyrene (TEQ*) | lb/yr | 0.0119 | 0.174 | No |
| Benz(a)anthracene | lb/yr | 0.0149 | 1.74 | No |
| Benzo(a)pyrene | lb/yr | 0.0031 | 0.174 | No |
| Benzo(b)fluoranthene | lb/yr | 0.0226 | 1.74 | No |
| Benzo(k)fluoranthene | lb/yr | 0.0026 | 1.74 | No |
| Chrysene | lb/yr | 0.0367 | 17.4 | No |
| Dibenz(a,h)anthracene | lb/yr | 0.0041 | 0.16 | No |
| Indeno(1,2,3-cd)pyrene | lb/yr | 0.005 | 1.74 | No |
| 1,3-Butadiene | lb/yr | 0.4688 | 1.13 | No |
| Carbon Monoxide | lb/hr | 401 | 50.4 | **Yes** |
| DEEP | lb/yr | 1418 | 0.639 | **Yes** |
| Formaldehyde | lb/yr | 1.89 | 32 | No |
| Naphthalene | lb/yr | 3.12 | 5.64 | No |
| Nitrogen Dioxide | lb/hr | 76 | 1.03 | **Yes** |
| Propylene | lb/24-hr | 9.7 | 394 | No |
| Sulfur dioxide | lb/hr | 0.7 | 1.45 | No |
| Toluene | lb/24-hr | 0.977 | 657 | No |
| Xylenes | lb/24-hr | 0.672 | 29 | No |
| ∗ TEQ – toxic equivalent (sum of relative toxicity of several polycyclic aromatic hydrocarbons similar to benzo(a)pyrene) | | | | |

Table 5 shows each TAP's proposed emissions compared to its respective small quantity emission rate (SQER).[2] DEEP, nitrogen dioxide, carbon monoxide, benzene, and acrolein emission rates exceed their respective SQER.

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

ICF used refined dispersion modeling (briefly described in Section 4.2.2) to model ambient concentrations of those TAPs that exceed their SQER. Table 6 shows a comparison of the modeled concentrations of pollutants that exceeded SQERs to their respective ASILs. Only DEEP levels exceeded the ASIL, therefore, Dell was required to prepare a HIA that evaluates potential risks from exposure to Dell's DEEP emissions.

**Table 6. Comparison of Modeled Off-Site TAP Concentrations to ASILs**

| Pollutant | CAS# | Averaging Time | Highest Modeled Off-Site Concentration (μg/m$^3$) | ASIL (μg/m$^3$) | Exceeds ASIL |
|---|---|---|---|---|---|
| Acrolein | 107-02-8 | 24-hr | 0.0025 | 0.06 | No |
| Benzene | 71-43-2 | Annual | 0.00081 | 0.0345 | No |
| Carbon monoxide | 630-08-0 | 1-hr | 1,760 | 23,000 | No |
| DEEP | -- | Annual | 0.0062 | 0.00333 | **Yes** |
| Nitrogen dioxide | 10102-44-0 | 1-hr | 468 | 470 | No |

Although $NO_2$ is not predicted to exceed its ASIL, and therefore not subject to a second tier review, our analysis also discusses potential impacts of exposure to $NO_2$ emissions from Dell (see Section 6.2).

### 3.4. The Community-Wide Approach

Between 2006 and 2008, Ecology permitted the construction of three data centers in Quincy, WA. Each data center installed multiple large backup diesel-powered generators to be used during power failures. In total, the three existing data centers currently operate a total of 46 diesel-powered generators each rated at 2.0 MWe electrical generating capacity or higher. Microsoft and Yahoo!'s recent expansion permits increased the total permitted diesel-powered emergency engines at Quincy area data centers to 69.

When Ecology permitted these facilities in 2006-2007, DEEP was not regulated as a TAP under Chapter 173-460 WAC, Controls for Toxic Air Pollutants. In June 2009 Ecology revised Chapter 173-460 WAC, and began regulating DEEP as a TAP, along with a number of other new pollutants. The revised rule established an ambient trigger level or ASIL for DEEP of 0.00333 μg/m$^3$, annual average, above which predicted ambient concentrations of DEEP are subject to second tier review. Primarily because DEEP was not previously regulated, data centers were permitted more hours of operation and fuel use than would likely be permitted under this revised rule.

On March 25, 2010, the governor signed into law a bill (ESSB 6789)[3] passed by the Washington State Legislature to promote the development of additional data centers in rural Washington.

[3] http://apps.leg.wa.gov/documents/WSLdocs/2009-10/Pdf/Bills/Session%20Law%202010/6789-S.SL.pdf

The final law gives anyone who starts constructing a data center between April 1, 2010 and July 1, 2011, an exemption from the sales tax for server equipment and power infrastructure. Among other requirements, eligible data centers have to be located in a rural county, cover at least 20,000 square feet dedicated to servers, and completed by April 1, 2018.

The passage of this *Computer Data Centers–Sales and Use Tax Exemption* Act of 2010 prompted much interest from companies wanting to build new data centers in Quincy and other parts of central and eastern Washington. To date, four companies have submitted proposals to Ecology to build or expand their Quincy data centers, including Microsoft Corporation; Yahoo!, Inc.; Dell Marketing, LP; and Sabey Corporation.

Given the interest in building several more data centers clustered within the Quincy UGA, and the potential for overlapping DEEP plumes, Ecology's Air Quality Program (AQP) recognized the need to consider the cumulative impacts of new and existing data centers on a community-wide basis (Ecology, 2010).

Under the community-wide risk evaluation approach, Ecology estimated background DEEP concentrations by modeling contributions from:

- The existing data centers assuming each of the data centers was operating at their allowed maximum rate; and
- Other known sources of DEEP in the Quincy area.

Section 4 of this document summarizes Ecology's review of Dell's HIA and presents results of our evaluation of cumulative DEEP concentrations in Quincy.

### 3.5. Second Tier Review Processing Requirements

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

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

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

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

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

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

Ecology provided comments to ICF's HIA protocol (item (c)) on December 21, 2010. These comments were addressed as part of the submittal of the final HIA (item (e)) received by Ecology on April 28, 2011. The project review team found the refined modeling conducted by Dell to be acceptable.

Acting as the "permitting authority" for this project, Ecology's Eastern Regional Office (ERO) satisfied items (a) and (b) above on May 19, 2011. The applicant has therefore satisfied all of the five requirements above.

### 3.6. Second Tier Review Approval Criteria

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

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

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

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

The remainder of this document discusses the HIA review performed by Ecology.

## 4. HEALTH IMPACT ASSESSMENT

The HIA reviewed by Ecology was conducted according to the requirements of WAC 173-460-100. It addressed the public health risk associated with exposure to DEEP from Dell's proposed diesel-powered emergency generators and existing sources of DEEP in Quincy, WA. Dell's consultant (ICF) prepared the HIA (ICF, 2011b).

While the HIA is not a complete risk assessment, it loosely follows the four steps of the standard health risk assessment approach proposed by the National Academy of Sciences (NAS, 1983, 1994). These four steps are: (1) hazard identification, (2) exposure assessment, (3) dose-response assessment, and (4) risk characterization.

### 4.1. Hazard Identification

Hazard identification involves gathering and evaluating toxicity data on the types of health injury or disease that may be produced by a chemical, and on the conditions of exposure under which injury or disease is produced. It may also involve characterization of the behavior of a chemical within the body and the interactions it undergoes with organs, cells, or even parts of cells. This information may be of value in determining whether the forms of toxicity known to be produced by a chemical agent in one population group or in experimental settings are also likely to be produced in human population groups of interest. Note that risk is not assessed at this stage.

Hazard identification is conducted to determine whether and to what degree it is scientifically correct to infer that toxic effects observed in one setting will occur in other settings (e.g., are chemicals found to be carcinogenic or teratogenic in experimental animals also likely to be so in adequately exposed humans?).

#### 4.1.1. Overview of DEEP Toxicity

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

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

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

- Inflammation and irritation of the respiratory tract
- Eye, nose, and throat irritation along with coughing, labored breathing, chest tightness, and wheezing
- Decreased lung function
- Worsening of allergic reactions to inhaled allergens
- Asthma attacks and worsening of asthma symptoms
- Heart attack and stroke in people with existing heart disease
- Lung cancer and other forms of cancer
- Increased likelihood of respiratory infections
- Male infertility
- Birth defects
- Impaired lung growth in children

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

### 4.2. Exposure Assessment

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

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

### 4.2.1. Identifying Routes of Potential Exposure

Humans can be exposed to chemicals in the environment through inhalation, ingestion, or dermal contact. The primary route of exposure to most air pollutants is inhalation; however, some air pollutants may also be absorbed through ingestion or dermal contact. Ecology uses guidance provided in California's Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments to determine which routes and pathways of exposure to assess for chemicals emitted from a facility (CalEPA, 2003). Table 7 shows a table of chemicals for which Ecology assesses multiple routes and pathway of exposure. It's possible that 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 near Dell. However, given the very low amounts of PAHs and other multi-exposure route-type TAPs that will be emitted from Dell, 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. In the case of Dell's backup engine emissions, Ecology will evaluate only inhalation exposure to DEEP.

**Table 7. California's Air Toxics Hotspots Risk Assessment Guidance on Specific Pathways to be Analyzed for Each Multi-Pathway Substance**

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

### 4.2.2. Estimating Pollutant Concentrations

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

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

- American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) with Plume Rise Model Enhancements (PRIME) algorithm for building downwash.
- Five years sequential hourly meteorological data from Moses Lake Airport (2004-2008).
- Twice-daily upper air data from Spokane (2004-2008) to define mixing heights.
- Quincy area digital elevation model (DEM) files (which describe local topography and terrain).
- Quincy area digital land classification files (which describe surface characteristics).
- Each engine's emissions were modeled with a stack height of 58 feet above local ground level and a stack inside diameter of 20 inches (0.508 meters). Engine-specific exhaust gas temperature and velocity were used.
- The data center building dimensions were included to account for building downwash.
- The receptor grid for the AERMOD modeling domain was established using a 10-meter grid spacing along the facility boundary extending to a distance of 350 meters from each of the stacks. A grid spacing of 25 meters was used for distances 350 to 800 meters from the stacks. Grid spacing of 50 meters was used for distances 800 to 2000 meters from the stacks.
- Plume Volume Molar Ratio Method (PVMRM) option, which is used to model the conversion of nitrogen oxides ($NO_X$) to $NO_2$. One-hour $NO_2$ concentrations were modeled using PVMRM module, with default concentrations of 40 parts per billion (ppb) of ozone, and an equilibrium $NO_2/NO_X$ ambient ratio of 90 percent. For purposes of modeling $NO_2$ impacts, the primary $NO_X$ emissions were assumed to be 10 percent $NO_2$ and 90 percent nitric oxide (NO) by mass.

ICF modeled both short- and long-term impacts to demonstrate compliance with National Ambient Air Quality Standards (NAAQS) and derive DEEP concentrations for the HIA. Because Dell's emissions are intermittent, several operating scenarios were assumed when estimating ambient impacts. For the purpose of estimating maximum annual DEEP concentrations, ICF used the sum of emissions from each operating scenario shown in Table 1. Because maximum 1-hour $NO_2$ concentrations would occur in a power outage, ICF assumed all 28 generators were operating for the purpose of estimating maximum 1-hour $NO_2$ concentrations. Details of the ambient impacts analysis conducted by ICF are found in the NOC application materials received by Ecology on January 25, 2011 and April 27, 2011.

#### 4.2.3. Identifying Potentially Exposed Receptors

As described in Section 2.3, the proposed Dell facility is located among commercial/industrial-zoned properties, but several different land uses are located within the vicinity of Dell's property. ICF identified locations where people could be exposed to project-related emissions. Typically, Ecology considers exposures occurring at maximally exposed boundary, residential, and commercial areas to capture worst-case exposure scenarios. In this case, ICF identified these locations and the most impacted school.

##### 4.2.3.1. Receptors Maximally Exposed to DEEP

Table 8 shows maximally exposed receptors of different types and the direction and distance from Dell's proposed data center. These receptors represent locations of various land uses that are most impacted by Dell's DEEP emissions. This table also shows the estimated average exposure concentration at each maximally exposed receptor.

**Table 8. Maximally Exposed Receptors–Annual Average DEEP**

| Receptor Type | Direction From Nearest Project-Specific DEEP Emission Source | Estimated Distance From Nearest Project-Specific DEEP Emission Source | | Estimated Project-Related Increase in Average Annual DEEP Concentration (μg/m$^3$) at Receptor Location |
|---|---|---|---|---|
| | | Feet | Meters | |
| Point of Maximum Impact [a] | W | 130 | 40 | 0.062 |
| Maximum Impacted Residence (existing) | NW | 1,200 | 366 | 0.014 |
| Maximum Impacted Residential Land Use (currently undeveloped)[b] | E | 1,400 | 427 | 0.018 |
| Maximum Impacted Business/Office | S | 1,300 | 396 | 0.011 |
| Maximum Impacted School | SE | 2,500 | 762 | 0.003 |

a. Occurs at property fence line.
b. Location identified by Ecology as the maximum impacted residential land use (undeveloped) differs from that identified in the HIA.

Figure 5 shows a color-coded map of estimated annual average off-site DEEP concentrations attributable to Dell's DEEP emissions relative to the ASIL. This figure represents the ambient impacts of Dell's project and each of the maximally exposed receptors representing different land uses. Each modeled DEEP concentration shown in the figure has been divided by the ASIL. Areas outside the shaded area in Figure 5 are those with an estimated impact below the ASIL. Ecology estimates that Dell's emissions impact 30 to 40 residentially zoned parcels (including developed and undeveloped parcels) at a level exceeding the ASIL.

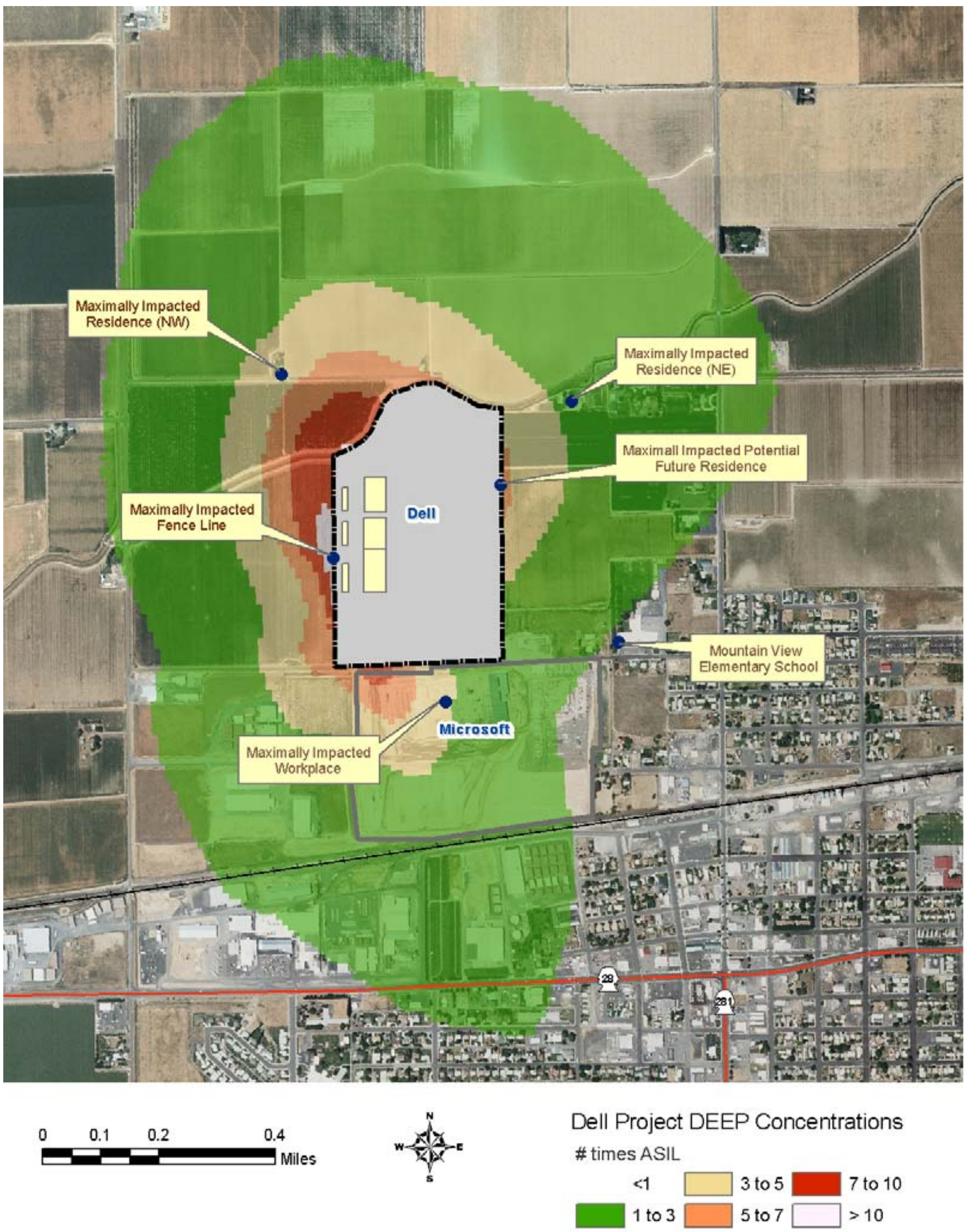


**Figure 5.** Dell Project DEEP Concentrations

### 4.2.4. Exposure Frequency and Duration

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

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

Ecology typically makes simplified assumptions about receptors' exposure frequency and duration. Ecology assumes people located at residential receptors are potentially continuously exposed, meaning they never leave their property. Ecology recognizes that these behaviors are not typical; however, these assumptions are intended to avoid underestimating exposure so that public health protection is ensured. Workplace and other nonresidential exposures are also considered, but adjustments are often made because the amount of time that people spend at these locations is more predictable than time that people could spend at their homes. These adjustments are presented in Section 4.4.2 of this document 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."[4] The word "background" is often used to describe exposures to chemicals that come from existing sources, or sources other than those being assessed.

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

#### 4.2.5.1. Cumulative Exposure to DEEP in Quincy

Ecology used an EPA-recommended dispersion model, AERMOD, to estimate concentrations of DEEP in Quincy emitted from locomotives traveling on the Burlington Northern–Santa FE (BNSF) rail line, trucks on State Route 281 and State Route 28, and the permitted emissions from existing data centers: Yahoo!, Microsoft, and Intuit. Data center emissions were derived from existing permits from Microsoft (2010), Yahoo! (2011), and Intuit (2007). The rail and highway emissions were taken from 2005 emissions inventories.

[4] http://apps.leg.wa.gov/WAC/default.aspx?cite=173-460-090

Table 9 and Figure 6 shows the calculated cumulative concentrations (presented as the number of times greater than the ASIL of 0.0033 µg/m$^3$) near Dell based on allowable emissions from all existing permits, proposed Dell emissions, rail, and highway emissions. The maximum cumulative concentration at a residentially zoned parcel near Dell and Microsoft is about 50 times the DEEP ASIL. It is important to note that the ambient levels of DEEP estimated by Ecology are based on allowable (permitted) emissions instead of actual emissions. Actual emissions are likely to be much lower than what Ecology assumed, but Ecology calculated worst-case emissions to avoid underestimating cumulative DEEP exposure concentrations.

**Table 9. Maximally Exposed Receptors–Cumulative Annual DEEP**

| Attributable To: | Annual DEEP Concentration (µg/m$^3$) at Various Receptor Locations–Dell | | | | | | Annual DEEP Concentration at Maximum Cumulatively Impacted Residentially Zoned Location Near Dell |
|---|---|---|---|---|---|---|---|
| | **Fence Line Receptor** | **Current Residence (NW)** | **Current Residence (NE)** | **Possible Future Residence** | **Workplace** | **Students/ Teachers** | |
| **Dell** | **0.062** | **0.014** | **0.009** | **0.018** | **0.011** | **0.003** | **0.0059** |
| Yahoo | 0.00073 | 0.00092 | 0.0011 | 0.00089 | 0.00067 | 0.00079 | 0.00071 |
| Intuit | 0.00064 | 0.00070 | 0.00078 | 0.00072 | 0.00062 | 0.00062 | 0.00062 |
| Microsoft | 0.032 | 0.010 | 0.016 | 0.029 | 0.083 | 0.035 | 0.138 |
| BNSF | 0.013 | 0.008 | 0.010 | 0.012 | 0.022 | 0.023 | 0.0230 |
| Highways | 0.00016 | 0.00013 | 0.00016 | 0.00018 | 0.00021 | 0.00027 | 0.00023 |
| Proposed Sabey[a] | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 |
| Cumulative (post-project) | 0.109 | 0.034 | 0.037 | 0.061 | 0.12 | 0.063 | 0.168 |

a. Proposed Sabey data center is located approximately 2 miles east of Dell. Sabey's modeling grid did not extend into the area near Dell. The value shown is the maximum concentration at the western most edge of Sabey's modeling grid (closest to Dell). Sabey's contribution to cumulative DEEP near Dell is likely to be lower than the value shown.

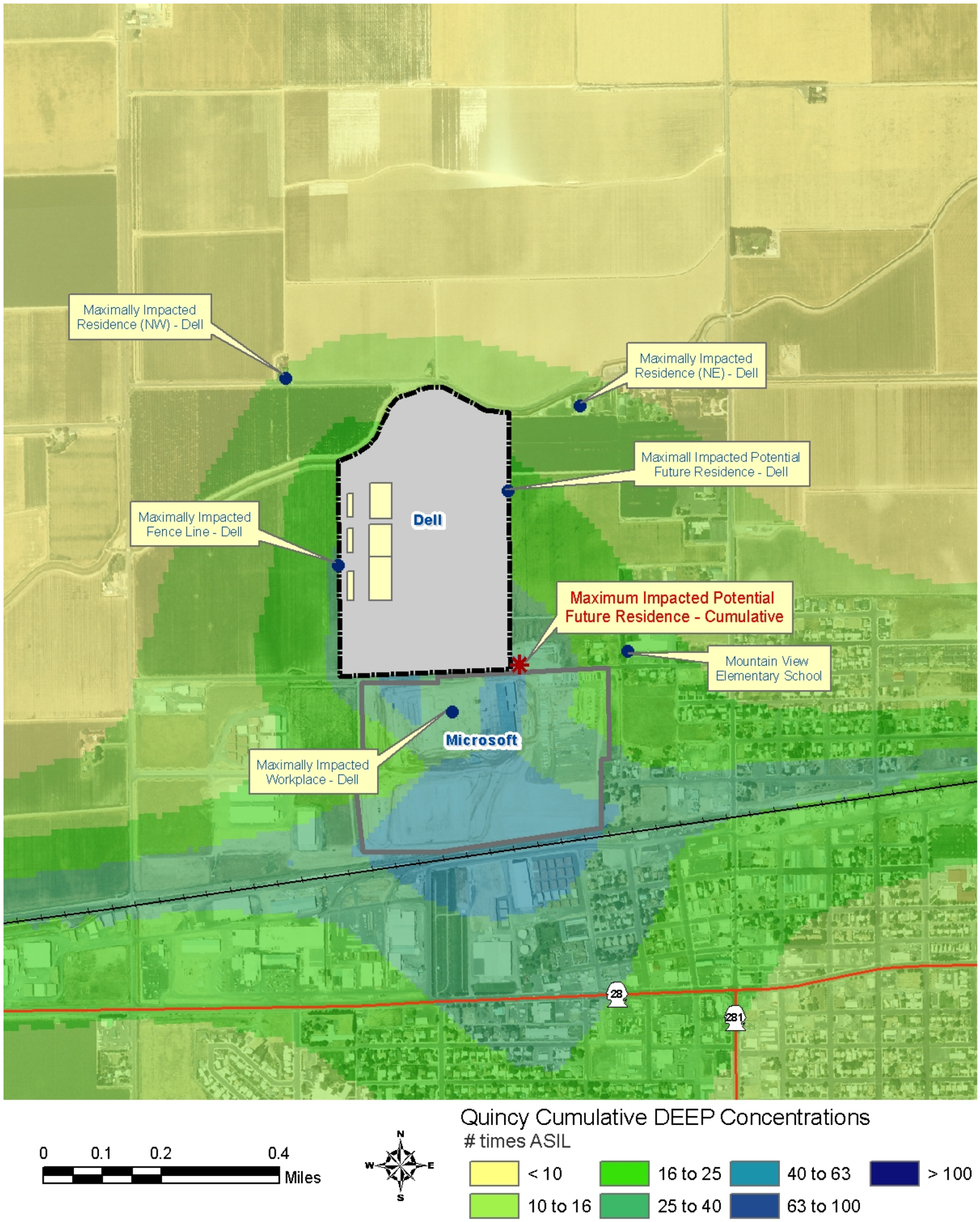


**Figure 6.** Cumulative DEEP concentrations near Dell (magnitude of ASIL exceedance)

### 4.3. Dose-Response Assessment

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

#### 4.3.1. Dose-Response Assessment–DEEP

The U.S. Environmental Protection Agency (EPA) and California Office of Environmental Health Hazard Assessment (OEHHA) developed toxicological values for DEEP evaluated in this project (EPA, 2002; EPA, 2003; CalEPA, 1998). These toxicological values are derived from studies of animals that were exposed to a known amount (concentration) of DEEP, or from epidemiological studies of exposed humans, and are intended to represent a level at or below which adverse noncancer health effects are not expected, and a metric by which to quantify increased risk from exposure to a carcinogen. Table 10 shows DEEP noncancer and cancer toxicity values.

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

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

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

**Table 10. Toxicity Values Used to Assess and Quantify Noncancer Hazard and Cancer Risk**

| Pollutant | Agency | Noncancer | Cancer |
|---|---|---|---|
| DEEP | U.S. Environmental Protection Agency | RfC = 5 µg/m3 | NA[a] |
| | California EPA–Office of Environmental Health Hazard Assessment | Chronic REL = 5 $\mu g/m^3$ | URF = 0.0003 per $\mu g/m^3$ |

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

### 4.4. Risk Characterization

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

#### 4.4.1. Evaluating Noncancer Hazards

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

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

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

##### 4.4.1.1. Hazard Quotient–DEEP

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

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

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

Table 11 shows chronic HQs at the maximally exposed receptors near Dell attributable to DEEP exposure from all sources. HQs are several-fold lower than unity for all receptors' cumulative exposure to DEEP. This indicates adverse noncancer effects are not likely to result from chronic exposure to DEEP emitted from Dell and other local sources.

**Table 11. Chronic Noncancer Hazards for Residential, Student, and Occupational Scenarios**

| Attributable To: | Chronic Hazard Quotient at Various Receptor Locations | | | | | | Maximum Cumulative Impacted Residentially Zoned Location Near Dell |
|---|---|---|---|---|---|---|---|
| | Fence Line Receptor | Current Residence (NW) | Current Residence (NE) | Possible Future Residence | Workplace | Students/ Teachers | |
| **Dell** | **0.012** | **0.003** | **0.002** | **0.004** | **0.002** | **0.001** | **0.001** |
| Yahoo | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Intuit | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Microsoft | 0.006 | 0.002 | 0.003 | 0.006 | 0.017 | 0.007 | 0.028 |
| BNSF | 0.003 | 0.002 | 0.002 | 0.002 | 0.004 | 0.005 | 0.005 |
| Highways | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Proposed Sabey | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Cumulative (post-project) | 0.022 | 0.007 | 0.007 | 0.012 | 0.024 | 0.013 | 0.033 |

### 4.4.2. Quantifying an Individual's Increased Cancer Risk

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

The formula used to determine cancer risk is as follows:

$$\text{Risk} = \frac{\text{CAir} \times \text{URF} \times EF_1 \times EF_2 \times \text{ED}}{\text{AT}}$$

Where:

| Parameter | Description | Value Based on Receptor Type | | | | | Units |
|---|---|---|---|---|---|---|---|
| | | Residential | Worker | School-Staff | School-Student | Boundary | |
| CAir | Concentration in air at the receptor | See Table 9 | | | | | $\mu g/m^3$ |
| URF | Unit Risk Factor | 0.0003 | | | | | $(\mu g/m^3)^{-1}$ |
| $EF_1$ | Exposure Frequency | 365 | 250 | 200 | 180 | 250 | days/year |
| $EF_2$ | Exposure Frequency | 24 | 8 | 8 | 8 | 2 | hours/day |
| ED | Exposure Duration | 70 | 40 | 40 | | | years |
| AT | Averaging Time | 25550 | | | | | days |

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

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

The following table (Table 12) shows ranges of estimated worst-case residential (current and potential future), off-site worker, school staff, students, and fence line receptor's increased cancer risks attributable to DEEP exposure near the proposed Dell facility. As shown in Table 12, cancer risks attributable to the data center project are less than one in one hundred thousand ($1 \times 10^{-5}$). The highest risk occurs at undeveloped residential parcels to the east of the Dell facility ($5.4 \times 10^{-6}$). This area is currently undeveloped, so the estimated risks would apply if this parcel were indeed developed in the future. Under Chapter 173-460 WAC, Ecology may recommend approval of a project if the applicant demonstrates that the increase in emissions of TAPs is not likely to result in an increased cancer risk of more than one in one hundred thousand ($1 \times 10^{-5}$).

As part of the community-wide approach in Quincy, Ecology also considers the cumulative impacts of DEEP emissions in the Quincy UGA. Ecology established a cumulative risk management goal of 100 excess cancer cases in one million people exposed ($1 \times 10^{-4}$) representing the cumulative level of concern for Quincy residents (also called an "ample margin of safety")[5] above which a new source of DEEP would not be approved to locate in Quincy, without requiring offsets or other mitigation. It therefore represents a limit on permissible DEEP-associated cancer risk to the community. Note that Chapter 173-460 WAC **does not** currently contain a numerical limit on allowable cumulative cancer risks.

As shown in Table 12, the maximum cumulative cancer risk for the maximally impacted current residential receptor near Dell is 11 in one million. This risk occurs at the existing residence to

[5] "Ample margin of safety" is the phrase used in the federal clean air act to describe the goal of National Emission Standards for Hazardous Air Pollutants.

the northeast of the Dell facility. This residence is more impacted by allowable DEEP emissions from the existing Microsoft Data Center and locomotives on the BNSF rail line than by emissions from Dell. In the event residential parcels to the west of Dell are developed, maximum cumulative risks approach 49 in one million. Occupational, near boundary, and student receptors' cumulative risks from DEEP exposure are much lower than 10 in one million.

Because these cumulative risks are less than 100 in one million, the cumulative risks attributable to Dell's project are permissible pending public comment.

**Table 12. Estimated Increased Cancer Risk for Residential, Occupations, and Student Scenarios**

| Attributable To: | Risk Per Million From DEEP Exposure at Various Receptor Locations | | | | | | | Maximum Cumulative Impacted Residentially Zoned Location Near Dell |
|---|---|---|---|---|---|---|---|---|
| | Fence Line Receptor | Current Residence (NW) | Current Residence (NE) | Possible Future Residence | Workplace | Students | Teachers | |
| **Dell** | **0.6** | **4.2** | **2.7** | **5.4** | **0.4** | **0.01** | **0.1** | **1.7** |
| Yahoo | 0.01 | 0.3 | 0.3 | 0.3 | 0.03 | 0.004 | 0.02 | 0.2 |
| Intuit | 0.01 | 0.2 | 0.2 | 0.2 | 0.02 | 0.003 | 0.02 | 0.2 |
| Microsoft | 0.3 | 3.0 | 4.8 | 8.7 | 3.2 | 0.2 | 1.1 | 41.4 |
| BNSF | 0.1 | 2.4 | 3.0 | 3.6 | 0.9 | 0.1 | 0.7 | 6.9 |
| Highways | 0.002 | 0.04 | 0.05 | 0.05 | 0.01 | 0.001 | 0.008 | 0.07 |
| Proposed Sabey | <0.01 | <0.3 | <0.3 | <0.3 | <0.04 | <0.005 | <0.03 | <0.3 |
| Cumulative (post-project) | 1.1 | 10.2 | 11.1 | 18.3 | 4.7 | 0.3 | 2.0 | 49.2 |

## 5. UNCERTAINTY CHARACTERIZATION

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

### 5.1. Exposure Uncertainty

It is difficult to characterize the amount of time that people can be exposed to Dell's DEEP emissions. For simplicity, Dell and Ecology assumed a residential receptor is at one location for 24 hours per day, 365 days per year for 70 years. These assumptions tend to overestimate exposure.

The duration and frequency of power outages is also uncertain. Dell estimates that they will use the generators during emergency outages for no more than eight hours per year. Since 2003 the average outage for all Grant County PUD power customers has been about 2.5 hours per year.

While this small amount of power outage provides some comfort that power service is relatively stable, Dell cannot predict future outages with any degree of certainty. Dell accepted a limit of emergency operation for eight hours per year and estimated that this limit should be more than sufficient to meet their emergency demands.

### 5.2. Emissions Uncertainty

The exact amount of DEEP emitted from Dell's diesel-powered generators is uncertain. Dell applied both engine-specific and EPA's Tier 2 emission factors to describe the emission rates from the diesel engines. The most conservative (i.e., highest) emission rate was used in dispersion modeling to ensure that ambient impacts are not underestimated.

### 5.3. Air Dispersion Modeling Uncertainty

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

### 5.4. Toxicity Uncertainty

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

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

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

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

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

- Lack of knowledge about the underlying mechanisms of DEEP toxicity.
- The question of whether toxicity studies of DEEP based on older engines is relevant to current diesel engines.

Table 13 presents a summary of how the uncertainty affects the quantitative estimate of risks or hazards.

**Table 13. Qualitative Summary of how the Uncertainty Affects the Quantitative Estimate of Risks or Hazards**

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

## 6. OTHER CONSIDERATIONS

### 6.1. Short-Term Exposures to DEEP

As discussed previously, exposure to DEEP can cause both acute and chronic health effects. However, as discussed in Section 4.3.1, reference toxicological values specifically for DEEP exposure at short-term or intermediate intervals do not currently exist. Therefore, Ecology did not quantify short-term risks from DEEP exposure. By not quantifying short-term health risks in this document, Ecology does not imply that they have not been considered. Instead, we have assumed that compliance with the 24-hour $PM_{2.5}$ NAAQS is an indicator of acceptable short-term health effects from DEEP exposure. In our analysis, we assumed all DEEP emissions to be $PM_{2.5}$. The May 19, 2011, Technical Support Document (TSD) for the draft preliminary NOC approval prepared by Ecology concludes that Dell's emissions are not expected to cause or contribute to an exceedance of any NAAQS.

Relevant to Dell's DEEP emissions, the 24-hour $PM_{2.5}$ NAAQS was set by EPA to protect people from short-term exposure to small particles (which include DEEP). Ecology determined that Dell adequately demonstrated compliance with the $PM_{2.5}$ NAAQS. Therefore, short-term impacts from DEEP exposure were considered and found to be acceptable.

### 6.2. Short-Term Exposures to $NO_2$

In the event of a system-wide power outage in Quincy, dozens of backup diesel engines could run simultaneously resulting in higher short-term emission rates of nitrogen dioxide ($NO_2$) and other TAPs. The impacts of higher short-term emission rates from the existing unmodified engines have not been evaluated in this document because only DEEP emissions from the project exceeded the ASIL. Because emissions of $NO_2$ and other TAPs from the project were below the ASIL, no further review was required for those pollutants. Emissions below the ASIL suggest that increased health risks from these pollutants are acceptable.

The short-term $NO_2$ impacts were evaluated as part of the Yahoo! expansion project (Ecology, 2011b). Ecology considered the infrequent meteorological conditions required to cause a high $NO_2$ impact coincident with the infrequent occurrence of emergency outages to determine the probability and frequency with which receptors could be impacted at levels of concern. This analysis also included proposed emissions from Dell and showed that the likelihood of an event causing a $NO_2$ level of concern could happen about one hour every 100 years or so in the vicinity of Dell (Figure 7). The analysis demonstrates that individual receptors are not likely to be frequently and repeatedly exposed to short-term $NO_2$ levels above 470-$\mu g/m^3$.

## 7. SUMMARY OF HEALTH RISKS, CONCLUSIONS, AND SECOND TIER REVIEW RECOMMENDATIONS

### 7.1. Project Summary

Dell proposes to build a new data center in Quincy, Grant County, Washington. The project will consist of two buildings to house server equipment and 28 diesel-powered backup engine-generator sets each rated at 3,000 kWe. The engines will be housed in three buildings.

Potential emissions of DEEP from the proposed backup engines exceeded regulatory trigger levels called ASILs. Therefore, the proponent was required to submit a second tier petition per Chapter 173-460 WAC.

Due to the relatively close geographic proximity of existing and planned large data centers in Quincy, Ecology determined that a community-wide approach for permitting data centers is warranted for the Quincy UGA. The community-wide approach considers the cumulative impacts of DEEP which includes consideration of background emissions from existing permitted data centers and other sources of DEEP.

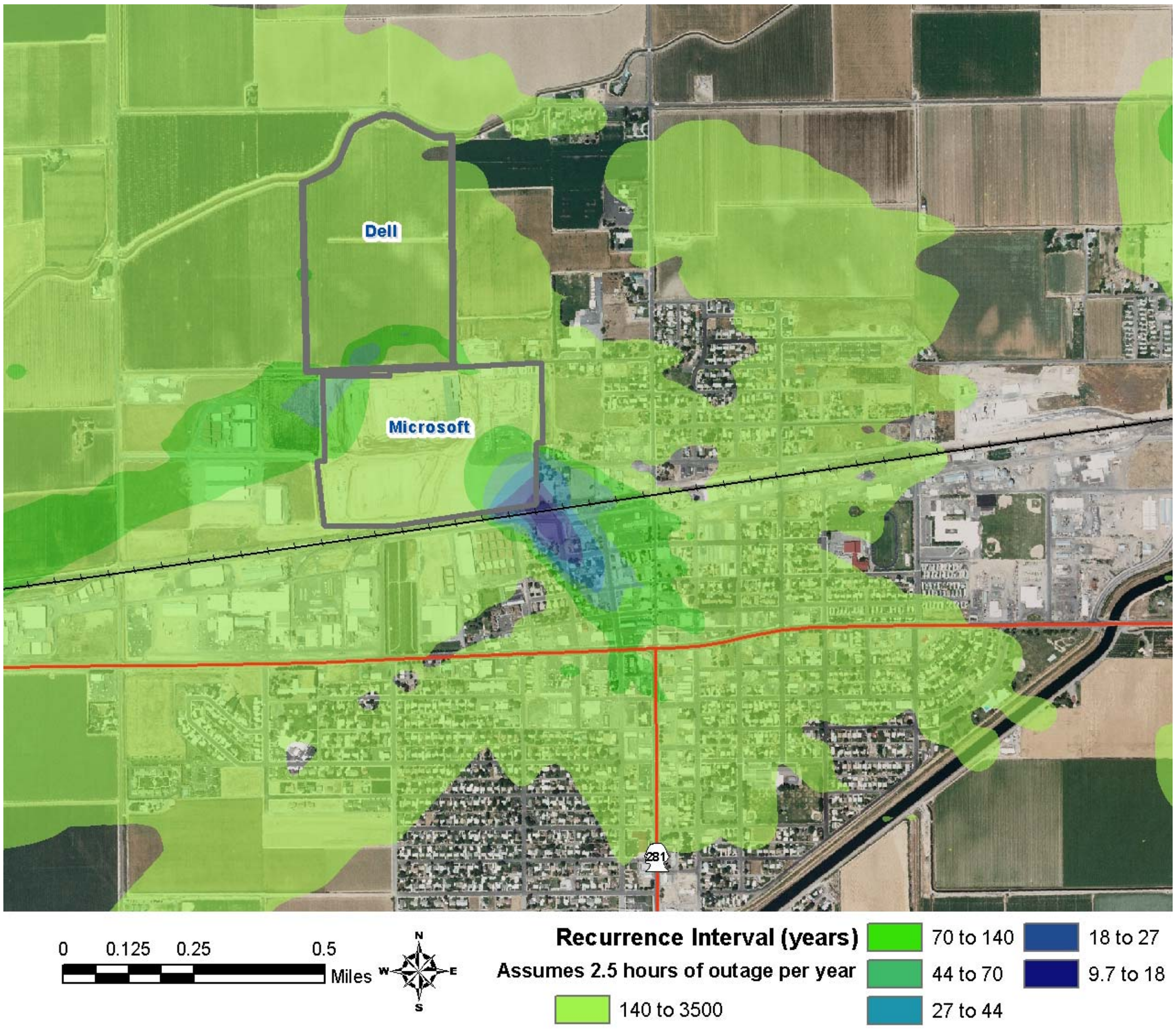


**Figure 7.** Frequency with which 1-hour $NO_2$ concentrations could exceed 441 µg/m$^3$ assuming continuous power outage emissions from all existing and proposed Quincy data centers (presented as a recurrence interval in years)

### 7.2. Potential Health Risks

Dell retained ICF International (ICF) to prepare a HIA to evaluate the potential health risks attributable to operation of the diesel-powered generators from the data center project. The HIA demonstrated that emissions of DEEP from the proposed data center alone could result in an increased cancer risk of up to 5 in one million ($5 \times 10^{-6}$) at an undeveloped residentially zoned property located to the east of Dell.

While Dell's proposed project alone results in increased health risks within the range that Ecology may approve for proposed new sources of TAPs under the second tier review provisions of WAC 173-460-090(7), Ecology also considered the cumulative impact of long-term onroad, nonroad, and existing data center emissions of DEEP.

The maximum cumulative cancer risk at an existing residence northeast of Dell is 11 per million ($1.1 \times 10^{-5}$). The maximum cumulative risk at any residentially zoned area near Dell is approximately 49 per million ($4.9 \times 10^{-5}$). This occurs at a location directly adjacent to Microsoft's northern boundary and Dell's southeast property boundary. This parcel is currently undeveloped, but parcel information from Grant County states that this parcel's land use is "General Trade-Merchandise." Quincy's zoning and planning map indicates that the parcel is zoned "multi-family residential."

### 7.3. Second Tier Review Criteria

Section 3.5 lists the minimum approval criteria for a second tier review. The criteria are restated below followed by a brief summary of how Dell satisfied each approval criterion for a second tier review:

(a) Proposed emission controls represent at least tBACT.

ERO determined that tBACT for DEEP is restricted operation of the EPA Tier 2 certified engines and compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart IIII. Ecology verifies that in this case, the technology described represents at least tBACT.

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

The maximum increased cancer risk attributable to Dell's emissions is one half the new source risk limit of one in one hundred thousand. This risk occurs at an undeveloped residentially zoned parcel to the east of Dell. Ecology also evaluated the cumulative risk from exposure to all known sources of DEEP in Quincy and found that risks are approximately one half the cumulative risk goal established as part of the community-wide approach to permitting data centers in Quincy.

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

The HQs describing the noncancer hazard are less than one. This means that adverse noncancer health effects from long-term exposure to DEEP are unlikely to occur.

### 7.4. Conclusions and Recommendations

Assuming that Dell does not exceed the emission rates relied upon for modeling ambient impacts, the overall increased cancer risk impact from the proposed project and other sources of DEEP is acceptable because it is within a range considered by Ecology to reflect an "ample margin of safety." Ecology concludes that cancer and noncancer risks from the proposed engines are acceptable under Chapter 173-460 WAC.

Ecology recommends that Dell communicate their potential impacts to:

- Current residents near Dell;
- Potential new homeowners at undeveloped parcels adjacent to Dell or the local agency responsible for zoning and development in the affected area.

## 8. LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AERMOD | American Meteorological Society/Environmental Protection Agency Regulatory Model |
| AQP | Department of Ecology, Air Quality Program |
| ASIL | Acceptable Source Impact Level |
| AT | Averaging Time (days) |
| BACT | Best Available Control Technology |
| BNSF | Burlington Northern Santa Fe |
| CAir | Concentration in air |
| CalEPA | California Environmental Protection Agency |
| CAS # | Chemical Abstracts Service Number |
| DEEP | Diesel engine exhaust particulate |
| Dell | Dell Marketing, LP |
| DEM | Digital Elevation Model |
| Ecology | Washington State Department of Ecology, Headquarters Office |
| ED | Exposure Duration (years) |
| EF | Exposure Frequency |
| $EF_1$ | Exposure Frequency (days per year) |
| $EF_2$ | Exposure Frequency (hours per day) |
| EPA | United States Environmental Protection Agency |
| ERO | Washington State Department of Ecology, Eastern Regional Office |
| ESSB 6789 | Engrossed Substitute Senate Bill 6789 – Computer Data Centers – Sales and Use Tax Exemption |
| HIA | Health Impact Assessment |
| HQ | Hazard Quotient |
| hr | Hour(s) |
| ICF | ICF International |
| kW | kilowatt |
| kWe | kilowatt, electrical |
| kWm | kilowatt, mechanical |

| | |
|---|---|
| μg/m$^3$ | Micrograms per cubic meter |
| μm | Micron or micrometer |
| NAAQS | National Ambient Air Quality Standards |
| NAS | National Academies of Science |
| NO | Nitric oxide |
| $NO_2$ | Nitrogen dioxide |
| NOC | Notice of Construction Order of Approval |
| $NO_X$ | Oxides of nitrogen |
| OEHHA | California Environmental Protection Agency’s Office of Environmental Health Hazard Assessment |
| PAHs | Polycyclic Aromatic Hydrocarbons |
| PM | Particulate matter |
| $PM_{2.5}$ | Particulate matter less than 2.5 micrometers in diameter |
| ppb | parts per billion |
| PRIME | Plume Rise Model Enhancements |
| PUD | Public Utility District |
| PVMRM | Plume Volume Molar Ratio Method |
| REL | OEHHA Reference Exposure Level |
| RfC | Reference Concentration |
| SQER | Small Quantity Emission Rate |
| TAP | Toxic Air Pollutant |
| tBACT | Best Available Control Technology for Toxics |
| TEQ | Toxic Equivalent |
| UGA | Urban Growth Area |
| URF | Unit Risk Factor |
| WAC | Washington Administrative Code |

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