



DEPARTMENT OF
ECOLOGY
State of Washington

Health Impact Assessment Recommendation Document for

*Microsoft MWH Data Center
Phases 03/04/05/06
Quincy, Washington*

July 2018

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**Health Impact Assessment
Recommendation Document for**

*Microsoft MWH Data Center
Phases 03/04/05/06
Quincy, Washington*

Air Quality Program

Washington State Department of Ecology

Olympia, Washington

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Executive Summary

This health impact assessment review evaluates and summarizes the health risks from air pollutants emitted by seventy-two (72) new diesel-powered generators at Microsoft MWH Data Center – Phases 03/04/05/06 (MWH-03/04/05/06) in Quincy, WA. In general, toxic air pollutant impacts in the area near MWH will not result in excessive risk or cause serious short- or long-term health effects. Ecology concludes that the health risk is acceptable and recommends approval of the project.

Microsoft proposes to expand their MWH data center in Quincy, WA. The expansion will include:

- Sixty-eight (68) 3.0 megawatt diesel-powered emergency generators,
- Four diesel-powered emergency generators less than or equal to 1.5 megawatts.

While the proposed engines will operate infrequently (facility average of up to 86 hours per year per engine) and use diesel particulate filters and selective catalytic reduction to control pollutants, the engines may emit two toxic air pollutants – diesel engine exhaust particles and nitrogen dioxide – at rates requiring a health impact assessment. A health impact assessment describes the increased health risks from exposure to toxic air pollutants emitted by a new source of toxic air pollutants.

Microsoft hired Landau Associates to prepare a health impact assessment. Landau Associates estimated increased health risks associated with Microsoft’s diesel particles and other toxic air pollutant emissions. Because several data centers with many large diesel engines are located in Quincy, Landau Associates also evaluated emissions from other nearby sources to determine the short-term and long-term health risks associated with cumulative exposure to diesel engine emissions.

Conclusions

- Short term:
 - Nitrogen dioxide emitted from MWH-03/04/05/06 and other west Quincy data center diesel-powered engines that operate during a power outage could rise to levels of short-term concern for people with respiratory problems.
 - On less frequent occasions, nitrogen dioxide levels could also become high enough to be a concern for healthy people.
 - NO₂ concentrations could potentially exceed an Acute Exposure Guidance Level. For short-term exposures above this level, the general population, including susceptible individuals, could experience effects such as headaches, burning eyes, and chest tightness or difficulty breathing. The effects are considered to be “not disabling” and reversible upon cessation of exposure.
 - The wind and weather conditions conducive to producing higher NO₂ impacts would need to coincide with high emissions during power outages to result in high

concentrations. Power outages affecting data centers are not expected to occur frequently, therefore concentrations responsible for these hazards are not expected to occur frequently or be sustained for long periods of time.

- Long term:
 - Proposed MWH-03/04/05/06 diesel particle emissions result in an increased lifetime cancer risk of up to three in one million. The maximum risk was estimated at a residential location approximately 400 meters northeast of MWH.
 - Generally, cancer risks estimated in the HIA represent worst-case scenarios in that Ecology assumes continuous lifetime exposure in assessing cancer risks from residents' exposure to project-related DEEP.
 - The maximum cumulative cancer risk to a person who lives near MWH is about 91 in one million. Most of the exposure to diesel particles at this location comes from on-road heavy-duty vehicles and locomotives. Cancer risk can be expressed as the number of cancers that might occur in addition to those normally expected in a population of one million people. The reported DEEP-related cancer risk estimates represent increases above a baseline lifetime cancer risk of about 40 percent in the United States.
 - Exposure to diesel particles in the area is not likely to result in long-term non-cancer health effects.

Ecology's recommendations

Ecology recommends:

- Approval of the project because:
 - The cancer risk from MWH's project-related toxic air pollutant emissions is less than the maximum risk (10 in one million) allowed by a Second Tier review.
 - The estimated cumulative risks to residents living near MWH are below the cumulative risk threshold established by Ecology as a goal for minimizing data center emission impacts in Quincy (100 per million or 100×10^{-6}).
 - The likelihood of power outage occurrences is low based on the reported reliability of the Grant County Public Utilities District power system.
- Periodic follow-up into the frequency of power outages impacting Quincy data centers. This will help to determine if assumptions used to characterize nitrogen dioxide hazards continue to be appropriate.
- Engaging local emergency planners and data center operators to discuss strategies for reducing potential impacts during a prolonged power outage.
- Developing a strategy for addressing potential impacts from continued data center growth in Quincy.

Second Tier Review Processing and Approval Criteria

The health impact assessment (HIA) for Microsoft submitted by Landau Associates is part of the second tier toxics review process under WAC 173-460 (Landau Associates, 2018a). Ecology is responsible for processing and reviewing second tier review petitions statewide.

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 (NOC) have been met, and has issued a preliminary approval order.
- (b) Emission controls contained in the preliminary NOC approval order represent at least best available control technology for toxics (tBACT).
- (c) The applicant has developed an HIA protocol that has been approved by Ecology.
- (d) The ambient impact of the emissions increase of each toxic air pollutant (TAP) that exceed ASILs has been quantified using refined air dispersion modeling techniques as approved in the HIA protocol.
- (e) The second tier review petition contains an HIA conducted in accordance with the approved HIA protocol.

Acting as the “permitting authority” for this project, Ecology’s project permit engineer satisfied item (a) and verified item (b) above on June 7, 2018 ((Ecology, 2018a; Ecology, 2018b). Ecology approved an HIA protocol (item (c)), and the final HIA (item (e)) was received by Ecology on June 6, 2018. Ecology’s modeler confirmed that refined modeling (item (d)) was conducted appropriately.¹

All five processing requirements above are satisfied.

Second tier review approval criteria

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

- (a) Determines that the emission controls for the new and modified emission units represent tBACT.
- (b) The applicant demonstrates that the increase in emissions of TAPs is not likely to result in an increased cancer risk of more than one in one hundred thousand.
- (c) Ecology determines that the non-cancer hazard is acceptable.

¹ Tesfamichael Ghidey, “Modeling Review Checklist.docx” email attachment, 7/13/2018.

tBACT determination

Ecology's permit engineer determined that Microsoft's proposed pollution control equipment satisfies the BACT and tBACT requirement for diesel engines powering backup generators (Ecology 2018a). Generally tBACT was determined to be met through restricted operation of EPA Tier-2 certified engines operated as emergency engines as defined in 40 CFR §60.4219, and compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart III. In addition, the source must have written verification from the engine manufacturer that each engine of the same make, model, and rated capacity installed at the facility uses the same electronic Programmable System Parameters, i.e., configuration parameters, in the electronic engine control unit.

While the BACT and tBACT emission limitation is EPA's Tier 2 standards, Microsoft will voluntarily equip the generators with a selective catalytic reduction (SCR) and catalyzed diesel particulate filter (DPF) controls to meet EPA Tier 4 emission standards. Emission limitations in the draft permit reflect the use of these additional pollution controls.

Health Impact Assessment Review

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

For the proposed MWH-03/04/05/06, the HIA focused on health risks attributable to DEEP and nitrogen dioxide exposure because the modeled ambient air concentrations exceeded respective ASILs. Landau briefly described emissions and exposure to other TAPs (ammonia, carbon monoxide (CO), sulfur dioxide, benzene, 1-3 butadiene, acrolein, chromium, formaldehyde, dibenz(a,h)anthracene, and naphthalene) because these pollutants exceeded a small quantity emission rate (SQER), and Ecology requested that health hazards from exposure to these pollutants be quantified.

Health effects summary

The HIA prepared by Landau Associates quantifies the non-cancer hazards and increased cancer risks attributable to Microsoft's TAP emissions. The health impact assessment focused on potential exposure to diesel particles and nitrogen dioxide, as these were the two TAPs with emissions causing an exceedance of an ASIL.

DEEP health effects summary

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

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

Nitrogen dioxide health effects summary

NO_2 is present in diesel exhaust. It forms when nitrogen, present in diesel fuel and as a major component of air, combines with oxygen to produce oxides of nitrogen.

NO_2 and other oxides of nitrogen are of concern for ambient air quality because they are part of a complex chain of reactions responsible for the formation of ground-level ozone. Additionally, exposure to NO_2 can cause both long-term (chronic) and short-term (acute) health effects.

Long-term exposure to NO_2 can lead to chronic respiratory illness such as bronchitis and increase the frequency of respiratory illness due to respiratory infections.

Short-term exposure to extremely high concentrations (> 180,000 $\mu\text{g}/\text{m}^3$) of NO_2 may result in serious effects including death (National Research Council, 2012). Moderate levels (~ 30,000 $\mu\text{g}/\text{m}^3$) may severely irritate the eyes, nose, throat, and respiratory tract, and cause shortness of

breath and extreme discomfort. Lower level NO₂ exposure (< 1,000 µg/m³), such as that experienced near major roadways, or perhaps downwind from stationary sources of NO₂, 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 NO₂ concentration, 877 µg/m³, 1-hour average, occurs about three miles NNW of the proposed MWH property boundary during a power outage scenario that lasts for at least one hour.

Power outage emissions present the greatest potential for producing high enough short-term concentrations of NO₂ to be of concern for respiratory health effects. Landau and Ecology calculated numerical estimates of exposure and hazard reported later in this document. The likelihood or frequency of exposure is also discussed.

Toxicity reference values

Agencies develop toxicity reference values for use in evaluating and characterizing exposures to chemicals in the environment. As part of the HIA, Landau Associates identified appropriate toxicity values for DEEP and NO₂.

DEEP toxicity values

Landau identified toxicity values for DEEP from two agencies: the U.S. Environmental Protection Agency (EPA) (EPA, 2002; EPA, 2003), and California EPA's Office of Environmental Health Hazard Assessment (OEHHA) (CalEPA, 1998). These toxicity values are derived from studies of animals that were exposed to a known amount (concentration) of DEEP, or from epidemiological studies of exposed humans. They are intended to represent a level at or below which adverse non-cancer health effects are not expected, and a metric by which to quantify increased risk from exposure to a carcinogen. Table 1 shows the appropriate DEEP non-cancer and cancer toxicity values identified by Landau Associates.

EPA's reference concentration (RfC) and OEHHA's reference exposure level (REL) for diesel engine exhaust (measured as DEEP) was derived from dose-response data on inflammation and changes in the lung from rat inhalation studies. Each agency established a level of 5 µg/m³ as the concentration of DEEP in air at which long-term exposure is not expected to cause adverse non-cancer health effects.

National Ambient Air Quality Standards (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. In these studies, DEEP exposure was estimated from measurements of elemental carbon and respirable particulate representing fresh diesel exhaust.

Therefore, DEEP is defined as the filterable fraction of particulate emitted by diesel engines.² The URF is 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 ($1 \mu\text{g}/\text{m}^3$), and are expressed in units of inverse concentration [i.e., $(\mu\text{g}/\text{m}^3)^{-1}$]. OEHHA's URF for DEEP is 0.0003 per $\mu\text{g}/\text{m}^3$ meaning that a lifetime of exposure to $1 \mu\text{g}/\text{m}^3$ 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.

Nitrogen dioxide toxicity values

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., $470 \mu\text{g}/\text{m}^3$) experienced increased airway reactivity following inhalation exposure to NO_2 (CalEPA, 2008). Not all exposed 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 less likely to experience effects at NO_2 levels at or below the REL. OEHHA intended for acute RELs to be "for infrequent one hour exposures that occur no more than once every two weeks in a given year" (CalEPA, 2015).

Acute Exposure Guidance Levels (AEGs) developed by the National Research Council (NRC), are also relevant to acute NO_2 exposures. AEGs are intended for use by emergency planners and responders as guidance in dealing with rare releases of chemicals into the air. AEGs are expressed as specific concentrations of airborne chemicals at which health effects, ranging from non-disabling to severe, may occur. The varying AEG levels (1, 2, or 3) are dictated by the severity of the toxic effects caused by the exposure, with Level 1 being the least and Level 3 being the most severe. They are designed to protect the elderly and children, and other individuals who may be susceptible. The AEG1 (non-disabling effects) for NO_2 is $940 \mu\text{g}/\text{m}^3$ (NRC, 2012). Potential effects include slight burning of the eyes, headache, and chest tightness or labored breathing with exercise in people with asthma.

Although not intended for protection of the public, the Washington State Department of Labor and Industries has established a permissible exposure level – short-term exposure level for NO_2 of 1 ppm or $1880 \mu\text{g}/\text{m}^3$ (WAC 296-841-20025).

EPA developed an annual and 1-hr NAAQS for nitrogen dioxide. Compliance with these NAAQS was demonstrated as part of the NOC application process (Ecology 2018b).

² Condensable particulate is not considered to represent DEEP for the purposes assessing health risks from DEEP exposure, however, both the filterable and condensable fractions of PM are considered when determining compliance with NAAQS for the purposes of the NOC application.

Table 1: Toxicity Values or Comparison Values Considered in Assessing and Quantifying Non-cancer Hazard and Cancer Risk

Pollutant	Agency	Non-cancer	Cancer
DEEP	U.S. Environmental Protection Agency	RfC = 5 µg/m ³	NA ¹
	California EPA—Office of Environmental Health Hazard Assessment	Chronic REL = 5 µg/m ³	URF = 0.0003 per µg/m ³
Nitrogen Dioxide	California EPA—Office of Environmental Health Hazard Assessment	Acute REL = 470 µg/m ³	NA
	National Research Council – Committee on Acute Exposure Guideline Levels.	AEGL – 1 = 940 µg/m ³	NA
	Washington State Department of Labor and Industries (L&I)	PEL-STEEL = 1,880 µg/m ³	NA
¹ EPA considers DEEP to be a probable human carcinogen, but has not established a cancer slope factor or unit risk factor. Notes: <ul style="list-style-type: none"> • RfC – Reference Concentration • REL- Reference Exposure Level • URF – Unit Risk Factor • AEGL – Acute Exposure Guidance Level • PEL – STEEL – Permissible Exposure Level – Short-term exposure limit 			

Community/receptors

While MWH-03/04/05/06 is proposed to be built in an industrially zoned area surrounded largely by agricultural land uses, air dispersion modeling indicated that proposed DEEP emissions could result in long-term concentrations in excess of the ASIL at about 82 parcels with residential land use codes (Figure 1) [Ecology 2018c].³ U.S. Census data show that approximately 270 people live in the Census Blocks intersected by the area in which DEEP concentrations are estimated to exceed the ASIL (U.S. Census Bureau, 2010). Relevant to short-term impacts, levels of NO₂ could exceed the ASIL at about 25 residential parcels (Figure 2).

For the purposes of assessing increased cancer risk and non-cancer hazards, Landau Associates identified receptor locations where the highest exposure to project-related air pollutants could occur: at the project boundary, nearby residences, and nearby commercial locations (Figures 3 and 4). Landau Associates also evaluated exposures that occur at Monument Elementary School and Quincy Valley Medical Center.

Ecology's review of the HIA found that Landau identified appropriate receptors to capture the highest MWH-project attributable exposures for residential, commercial, and other potentially susceptible receptors.

³ For the purpose of defining residential land uses with potential long-term occupancy, Ecology identified those parcels with two-digit land use codes 11, 12, 13, 14, 15, 17, and 18 as defined in WAC 458-53-030(5).

Increased cancer risk

Landau Associates assessed the increased risk of cancer from lifetime exposure to DEEP emitted from MWH's engines. Cumulative risks posed by other sources of DEEP in the area were also evaluated. Cancer risk was estimated in a manner consistent with EPA guidance for inhalation risk assessment (EPA, 2009). Risks were quantified using the following equations:

$$\text{Risk} = \text{IUR} \times \text{EC}$$

Where: IUR ($\mu\text{g}/\text{m}^3$)⁻¹ = Inhalation Unit Risk (i.e., Unit Risk Factor); and
EC ($\mu\text{g}/\text{m}^3$) = exposure concentration

$$\text{EC} = (\text{CA} \times \text{ET} \times \text{EF} \times \text{ED}) / \text{AT}$$

Where: EC ($\mu\text{g}/\text{m}^3$) = exposure concentration;
CA ($\mu\text{g}/\text{m}^3$) = contaminant concentration in air;
ET (hours/day) = exposure time;
EF (days/year) = exposure frequency;
ED (years) = exposure duration; and
AT (ED in years of a lifetime [i.e., 70 years] x 365 days/year x 24 hours/day) = averaging time

Cancer risk attributable to MWH-03/04/05/06 DEEP and other TAP emissions

Table 2, adapted from the HIA, shows the estimated MWH-03/04/05/06 related cancer risk per million for residential, commercial, and school receptors. Figure 3 shows the location of these receptors relative to MWH. The highest increase in risks attributable to MWH's emissions is 2.7 per million⁴ at a residential location northeast of MWH. Landau also calculated risks posed by other carcinogenic TAPs emitted by diesel engines (i.e., acetaldehyde, benzene, formaldehyde, 1,3-butadiene, and carcinogenic polycyclic aromatic hydrocarbons) and metals emitted by cooling towers. They estimated a negligible increased risk attributable to these other TAPs of ~ 0.06 per million at the MIRR.

For commercial exposure scenarios, the maximally impacted residential receptor (MICR) may have increased risks of about 2.2 per million.

⁴ Number per million represents an upper-bound theoretical estimate of the number of excess cancers that might result in an exposed population of one million people compared to an unexposed population of one million people. Alternatively, an individual's increase in risk of one in one million means a person's chance of getting cancer in their lifetime increases by one in one-million or 0.0001 percent.

Table 2: Estimated Increased Cancer Risk for Residential, Commercial, and School Receptors Attributable to MWH-03/04/05/06 DEEP Emissions

Attributable to:	Risk Per Million from DEEP Exposure at Various Receptor Locations			
	Northeast Residence - Property (MIRR) ¹	On-site tenant (MICR) ²	School-Student ³	School – Teacher ⁴
Proposed MWH-03/04/05/06	2.7	2.2	<0.1	<0.1
¹ Residential scenarios assume continuous lifetime exposure. ² Workplace scenario assumes exposure occurs 250 days per year, eight hours per day for 40 years. ³ Student scenario assumes exposure occurs 180 days per year, eight hours per day for 13 years. ⁴ Teacher scenario assumes exposure occurs 200 days per year, eight hours per day for 40 years.				

Cancer risk attributable to cumulative DEEP emissions

As part of the health impact assessment, Landau Associates conducted an analysis of cumulative exposure to DEEP in Quincy.⁵ In total, the cumulative analysis includes allowable emissions estimates from:

- Microsoft Columbia Data Center
- Existing Microsoft MWH Data Center
- Proposed Microsoft MWH-03/04/05/06 Data Center
- NTT Data Center (formerly Dell)
- Proposed CyrusOne Data Center⁶

The cumulative analysis also includes 2014 annual DEEP emissions estimates from:

- State Route 28
- State Route 281
- Locomotives on BNSF rail line

The cumulative cancer risk from all known sources of DEEP emissions in the vicinity⁷ of MWH (Table 3) is highest for a residential location along SR28. This parcel is about ¼ mile southeast of the MWH Data Center property boundary (Figure 3). The cumulative DEEP risk at this location is about 91 per million, and the majority (~88%) of estimated DEEP exposure is attributable to emissions from heavy-duty vehicles and locomotives. The cumulative risk at the residential location most impacted by MWH (i.e., the MIRR) is about 32 in one million with

⁵ Landau Associates reported the concentrations obtained from the model, which used five years of meteorological data, and reported cumulative risks associated with DEEP exposure in the area near CyrusOne.

⁶ CyrusOne Data Center has been proposed but has not received a permit. Ambient impacts estimated from CyrusOne for the cumulative analysis are based on proposed emissions and facility configuration.

⁷ For the purposes of this analysis, the “vicinity” of MWH encompasses the area in which MWH’s estimated impact exceeds the DEEP ASIL.

approximately 1/3 of the risk attributable to MWH 01/02 (existing) and proposed MWH-03/04/05/06.

Table 3: Estimated Cumulative Increased Cancer Risk for Residential Receptors Exposure to DEEP Emissions

Source	Residence Maximally Impacted by MWH-03/04/05/06 (MIRR)	Maximum Cumulatively Impacted Residence (interpolated)
Proposed MWH-03/04/05/06 ¹	2.7	1.3
Existing Microsoft MWH ¹	7.5	2.4
Microsoft Columbia ¹	1.8	2.5
NTT Data (Formerly Dell) ¹	0.3	0.5
Proposed CyrusOne ²	3.8	4.8
SR 28 ³	9.3	63.5
Rail ³	3.6	10.2
SR 281 ³	2.8	6.0
Cumulative	31.8	90.9
¹ Estimates of ambient impact are based on allowable emissions ² Estimates of ambient impact are based on proposed emissions. This facility does not currently have a permit. ³ Estimates of ambient impact are based on 2014 emissions estimates.		

Non-cancer hazard

Landau Associates assessed the acute and chronic non-cancer hazards from exposure to nitrogen dioxide and DEEP emissions from MWH and other local sources. Non-cancer hazard was characterized consistent with EPA guidance for inhalation risk assessment (EPA, 2009). Hazards were quantified using the following equations:

$$\text{HQ} = \text{EC}/\text{Toxicity Value}$$

Where: HQ (unitless) = hazard quotient;

EC ($\mu\text{g}/\text{m}^3$) = exposure concentration;

Toxicity Value ($\mu\text{g}/\text{m}^3$) = Inhalation toxicity value (e.g., RfC, REL) that is appropriate for the exposure scenario (acute, subchronic, or chronic).

EC = CA

Where: EC ($\mu\text{g}/\text{m}^3$) = exposure concentration;

CA ($\mu\text{g}/\text{m}^3$) = contaminant concentration in air.

Landau Associates evaluated short-term (acute) exposures to NO_2 emitted during power outage scenarios from MWH and other nearby permitted and proposed data center engines and determined hazard quotients could exceed unity at several locations. This indicates that there is potential for short-term respiratory hazards from exposure to NO_2 . Section 4.2 further discusses the frequency of these potential occurrences.

Landau Associates also evaluated chronic non-cancer hazards associated with long-term exposure to DEEP emitted from MWH and other local sources. Table 4 shows that hazard quotients associated with all receptors' exposure to MWH project-related and cumulative DEEP are much lower than unity (one). This indicates that chronic non-cancer hazards are not likely to occur because of exposure to DEEP near MWH.

Table 4: Estimated Short-term NO_2 and Long-term DEEP Non-cancer Hazards Attributable to MWH and [Cumulative] Emissions at Locations near West Quincy Data Centers

Receptors	Acute (short-term)			Chronic (long-term)		
	Maximum 1-hr NO_2 ($\mu\text{g}/\text{m}^3$)	NO_2 Acute REL ($\mu\text{g}/\text{m}^3$)	HQ	Theoretical Maximum Annual Average DEEP ($\mu\text{g}/\text{m}^3$)	DEEP Chronic REL ($\mu\text{g}/\text{m}^3$)	HQ
MIBR - MWH	877 [2355]	470	1.9 [5.0]	0.06 [0.44]	5	0.01 [0.09]
MICR - MWH	798 [1012]		1.7 [2.2]			
MIRR - MWH	535 [850]		1.1 [1.8]			
Monument School	454 [593]		1.0 [1.3]			
Hospital	477 [610]		1.0 [1.3]			

Note: Landau Associates also evaluated acute and chronic hazards related to other TAPs with emission rates in excess of SQER. Generally, these pollutants contributed only a small amount to potential acute and chronic hazards.

Other Considerations

Short-term exposures to DEEP

Exposure to DEEP can cause both acute and chronic health effects. However, as discussed previously, reference toxicity values specifically for DEEP exposure at short-term or intermediate intervals do not currently exist. Therefore, Landau Associates did not quantify short-term risks or hazards from DEEP exposure. Generally, Ecology assumes that compliance with the 24-hour PM_{2.5} NAAQS is an indicator of acceptable short-term health effects from DEEP exposure. Ecology's Technical Support Document (TSD) for the draft preliminary NOC approval concludes that MWH's emissions are not expected to cause or contribute to an exceedance of any NAAQS (Ecology 2018b). DEEP exposure during power outages may contribute somewhat to potential respiratory effects experienced during power outage scenarios discussed in Section 4.2 below.

Frequency of short-term NO₂ hazards

Landau Associates evaluated short-term MWH-03/04/05/06 project and cumulative NO_x emissions as part of the second tier review. This analysis incorporated potential NO_x emission rates from each of the proposed and permitted engines at all west Quincy⁸ data centers during a power outage. The analysis showed that while NO₂ levels could indeed rise to levels of concern⁹ during a localized and system-wide outage, the outage would have to occur at a time when the dispersion conditions were optimal for concentrating NO₂ at a given location.

Landau Associates and Ecology estimated the combined probability of ambient impact of concern from emissions occurring during an MWH-03/04/05/06 outage coinciding with unfavorable meteorology. Table 5 and Figure 7 shows the recurrence interval of concentrations exceeding the ASIL (470 µg/m³) at each key receptor location. Generally, outage emissions coming from MWH-03/04/05/06 alone are not likely to cause impacts of concern.

If power outages affect more than one data facility at the same time, then diesel exhaust impacts of concern may occur more frequently. Assuming eight hours of simultaneous west Quincy data center power outage emissions per year, the most frequent occurrence of NO₂ reaching a level of concern at residential location [MFIRR(1) in Table 6 and Figure 8] would be once every seven years at a residence north of MWH.¹⁰ The most frequently impacted location (MIBR/MICR cumulative) would occur within the boundary of the proposed CyrusOne data center. Assuming eight hours of simultaneous outage per year, NO₂ levels above the ASIL would probably occur yearly on the proposed CyrusOne property (Table 6 and Figure 8). This area would be largely

⁸ According to Grant County PUD, power is served to Quincy by separate feeder lines making it far less likely for both sides of Quincy to be without power at the same time. West Quincy data centers include Microsoft Columbia, Microsoft MWH, NTT, and proposed CyrusOne.

⁹ The level of concern in this case is 454 µg/m³. This represents California OEHHA's acute reference exposure level of 470 µg/m³ minus an estimated regional background concentration of 16 µg/m³.

¹⁰ NO₂ impacts at this residential location are largely influenced by estimated emissions from the proposed CyrusOne Data Center.

impacted by emissions from CyrusOne Data Center, which has applied for a notice of construction approval order, but no order has been issued as of July 2018. Levels above the AEGL could occur about once every three years on the proposed CyrusOne property (Table 6 and Figure 9). Although possible, these higher short-term levels are less likely to occur at residential, school, or hospital locations on the west side of Quincy. Generally, recurrence becomes much less frequent with distance from the data centers.

If outages were to occur more frequently than assumed, then the potential for exposure to NO₂ levels of concern could occur more frequently. Table 6 shows that if west Quincy data centers experience 24 hours of simultaneous outage each year, then occurrences above the ASIL at the most frequently impacted residential receptor [MFIRR(1)] would occur once every three years, and impacts at levels above the AEGL could occur once every 14 years (at the [MFIRR(2)]). It should be noted that existing power reliability information suggests that recurring simultaneous power outage emissions scenarios are uncommon.

Exposures at levels above the ASIL are of most concern for people with existing respiratory problems. At levels above the AEGL, people may experience effects such as slight burning of the eyes, headache, and chest tightness or labored breathing with exercise in people with asthma. These effects are reversible once cleaner air returns.

Table 5: Recurrence Intervals (years) of MWH-03/04/05/06 NO₂ Outage Emissions Potentially Causing Impacts > ASIL Depending on 2.3, 8, or 24 Hours of Emergency Power Outage Emission

Receptor Type	Receptor	Hours per 5-Year Period > ASIL	Recurrence (Years) Based on # Hours of Outage Emissions per Year		
			2.3 hr	8 hr	24 hr
Residential	MIRR	4	4727	1369	457
	MFIRR	8	2364	685	229
Commercial or Other	MIBR	4	4727	1369	457
	MICR	3	6303	1825	609
Healthcare	Hospital	1	18907	5475	1825
School	Monument Elementary	1	18907	5475	1825
MIRR – Maximally impacted residential receptor MFIRR – Most frequently impacted (at levels > ASIL) residential receptor MIBR – Maximally impacted boundary receptor MICR – Maximally impacted commercial receptor					

Table 6: Recurrence Intervals (Years) of Cumulative NO₂ Levels > ASIL or > AEGL at Various Receptor Locations Depending on 2.3, 8, or 24 Hours of Cumulative West Quincy Data Center Power Outage Emissions

Cumulative West Quincy Data Center Outage Emissions Potentially Causing Impacts > ASIL						Cumulative West Quincy Data Center Outage Emissions Potentially Causing Impacts > AEGL			
Receptor Type	Receptor	Hours per 5-Year Period > ASIL	Recurrence (Years) Based on # Hours of Outage Emissions Per Year			Hour per 5-Year Period >AEGL	Recurrence (Years) Based on # Hours of Outage Emissions per Year		
			2.3 hr	8 hr	24 hr		2.3 hr	8 hr	24 hr
Residential	MIRR - MWH	48	394	115	39	0	NA	NA	NA
	MIRR - Cumulative	630	31	9	3	116	163	48	16
	MFIRR - MWH	247	77	23	8	0	NA	NA	NA
	MFIRR(1) - Cumulative	796	24	7	3	0	NA	NA	NA
	MFIRR(2) - Cumulative	634	30	9	3	139	137	40	14
Commercial or Other	MIBR - MWH	24	788	229	77	8	2364	685	229
	MIBR/MICR - Cumulative	4731	5	2	1	1645	12	4	2
	MICR - MWH	532	36	11	4	26	728	211	71
Healthcare	Hospital	100	190	55	19	0	NA	NA	NA
School	Monument Elementary	100	190	55	19	0	NA	NA	NA
MIRR – Maximally impacted residential receptor MFIRR(1) – Most frequently impacted (at levels > ASIL) residential receptor MFIRR(2) – Most frequently impacted (at levels > AEGL) residential receptor MIBR – Maximally impacted boundary receptor MICR – Maximally impacted commercial receptor									

Uncertainty

Many factors of the HIA are prone to uncertainty. Uncertainty relates to the lack of exact knowledge regarding many of the assumptions used to estimate the human health impacts of MWH's emissions. The assumptions used in the face of uncertainty may tend to over- or underestimate the health risks estimated in the HIA. Key aspects of uncertainty in the HIA for the Microsoft's proposed data center project are exposure assumptions, emissions estimates, air dispersion modeling, and toxicity of DEEP.

Exposure uncertainty

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

Emissions uncertainty

The exact amount of DEEP emitted from MWH's diesel-powered generators is uncertain. Landau Associates estimated emissions assuming engines would operate at loads that produce the highest amount of DEEP, and that engines would operate for the full extent of hours allowed in the draft permit. In reality, the engines will operate at a variety of loads in which emissions may be lower than assumed, and they may be used less frequently than allowed in the draft permit. Landau Associates also attempted to account for higher emissions that would occur during initial start-up. The resulting values are considered an appropriate estimate of potential DEEP emissions.

Landau Associates also determined cumulative NO_x emissions analyzed as part of a simultaneous power outage scenario are likely overestimated by at least 12 percent (Landau Associates 2018b). This is because several redundant engines will operate at only idle or low loads during an outage, and engine load during an outage is likely to be much lower than assumed because most of the data centers are not designed to use their engines at the highest possible loads.

Forecasting the amount of time MWH and other Quincy data center engines are used under emergency conditions is also uncertain. Furthermore, forecasting events that might affect each of the data centers simultaneously is difficult. While future outages cannot be predicted, past outages affecting data centers in Quincy appear to be infrequent (Ecology 2014), and information reported to Landau Associates for the years 2006 through 2016 by Grant County PUD shows that the average time customers were without power was about 139 minutes per year.¹¹

¹¹ Based on the average SAIDI from 2006 through 2016. SAIDI is the system average interruption duration index = total duration of interruptions for a group of customers divided by the total number of customers.

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

Toxicity uncertainty

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

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

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

MWH will use emission controls that will reduce the overall emissions of DEEP and other pollutants. Some studies suggest that the toxicity of the pollutant mixture emitted by newer technology diesel engines may be less than older technology diesel engines (HEI, 2015). Since OEHHA derived the URF for diesel particulate based on studies where people were exposed to older technology diesel engine emissions, the applicability of the URF to newer technology exhaust is uncertain. California OEHHA, however, determined that when assessing risks to diesel exhaust, the NTE exhaust should not be “considered to be fundamentally different” than older technology diesel exhaust (CalEPA, 2012).

Conclusions and Recommendation

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

- (a) The TAP emissions estimates presented by Landau Associates represent a reasonable estimate of the project's future emissions.
- (b) Emission controls for the new and modified emission units meet the tBACT requirement.
- (c) The ambient impact of the emissions increase of each TAP that exceeds ASILs has been quantified using appropriate refined air dispersion modeling techniques.
- (d) The HIA submitted by Landau Associates on behalf of Microsoft adequately assesses project-related increased health risk attributable to TAP emissions.

In the HIA, Landau Associates estimated lifetime increased cancer risks attributable to MWH-03/04/05/06 DEEP and other toxic air pollutant emissions. DEEP emissions resulted in an increase cancer risk of about three in one million at the maximally impacted residential receptor.

Landau Associates also assessed chronic and acute non-cancer hazards attributable to the project's emissions and those from other nearby sources and determined that long-term adverse non-cancer health effects from exposure to DEEP are not likely to occur. Acute respiratory hazards, however, are possible from exposure to NO₂ during power outage scenarios that occur during periods of unfavorable pollutant dispersion. If they do happen, these impacts could occur for short periods at commercial and residential locations near MWH and other data centers. These impacts may affect sensitive individuals with existing respiratory conditions such as asthma resulting in chest tightness or labored breathing with exercise. In some cases, healthy people may also experience adverse effects such as headaches and stinging eyes. Symptoms related to these high exposure episodes would be expected to improve once cleaner air conditions resume. Because power outages affecting several data centers at the same time are not expected to occur frequently, the concentrations responsible for these hazards are not expected to occur frequently or be sustained for long periods of time.

Finally, Landau Associates and Ecology assessed the cumulative health risk by adding estimated concentrations attributable to MWH emissions to an estimated background DEEP concentration. The maximum cumulative cancer risk from exposure to DEEP near MWH is approximately **91 in one million**. Most of the exposure to diesel particulate at this location comes from heavy-duty vehicles and locomotives.

The project review team concludes that the HIA represents an appropriate estimate of potential increased health risks posed by MWH-03/04/05/06 TAP emissions. The risk manager may recommend approval of the permit because:

- The cancer risk from MWH-03/04/05/06 toxic air pollutant emissions is less than the maximum risk (10 in one million) allowed by a Second Tier review.
- The cumulative risks to residents living near MWH are below the cumulative risk threshold established by Ecology as a goal for minimizing data center emission impacts in Quincy (100 per million or 100×10^{-6}).

- The likelihood of power outage occurrences is low based on the reported reliability of the Grant County PUD power system.

Recommendations include:

- Periodic follow-ups by Ecology into the frequency of power outages impacting Quincy data centers. This will help to determine if assumptions used to characterize nitrogen dioxide hazards continue to be appropriate.
- Engaging local emergency planners and data center operators to discuss strategies for reducing potential impacts during a prolonged power outage.
- Develop a strategy for addressing potential impacts from continued data center growth in Quincy.

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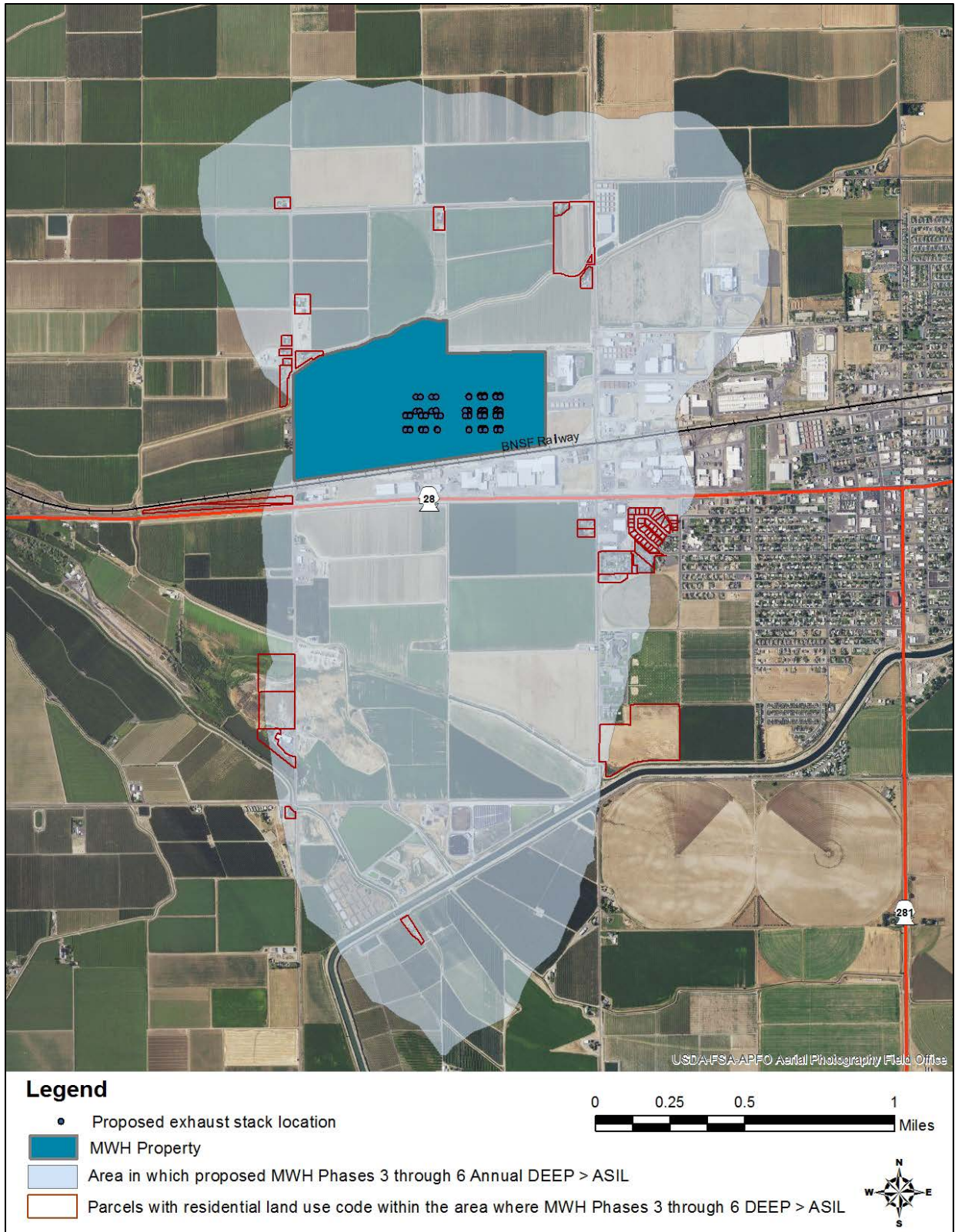


Figure 1: Residential parcels in the area where proposed MWH-03/04/05/06 DEEP emissions may cause impacts that exceed the ASIL

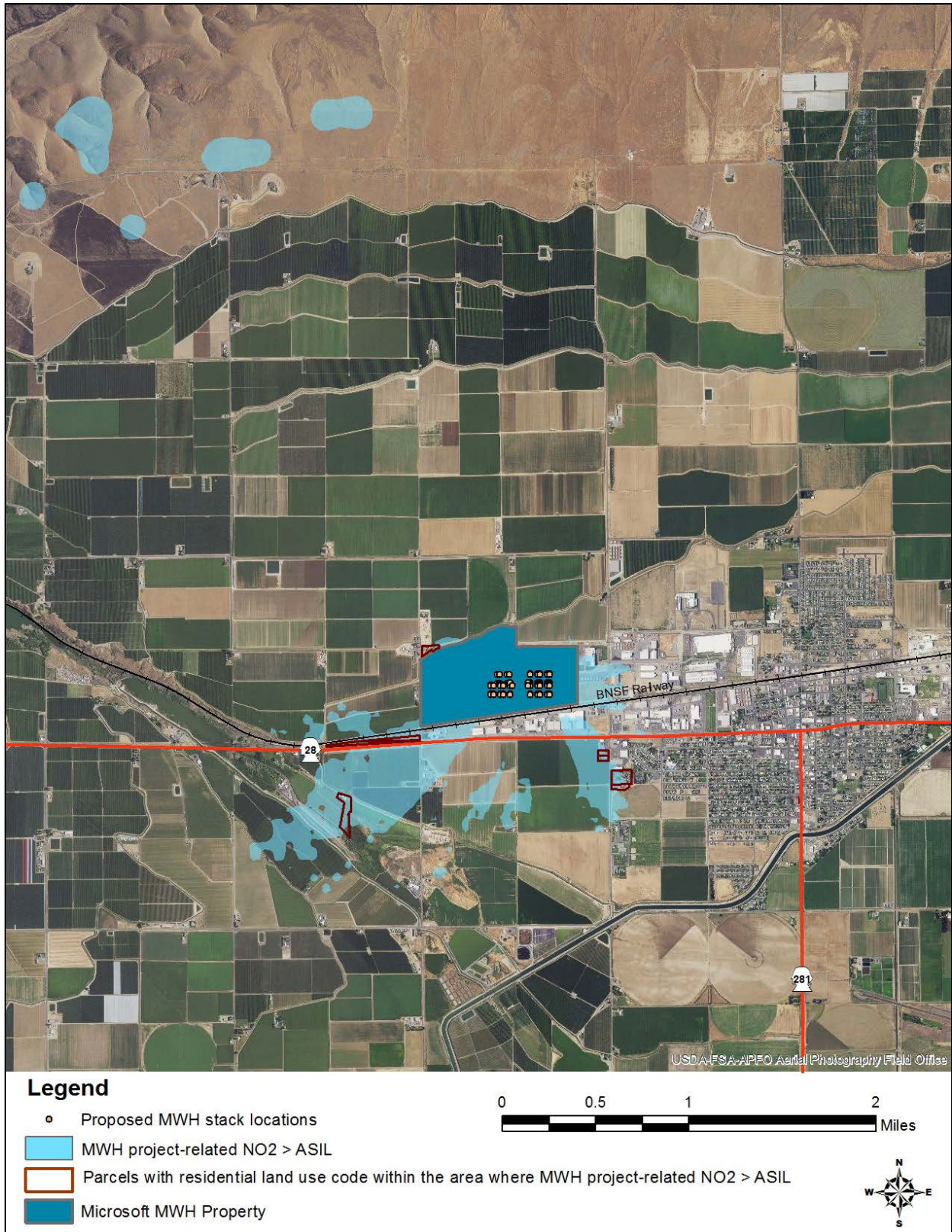


Figure 2: Residential parcels within the area where proposed MWH-03/04/05/06 power outage related NO₂ concentrations could exceed the ASIL

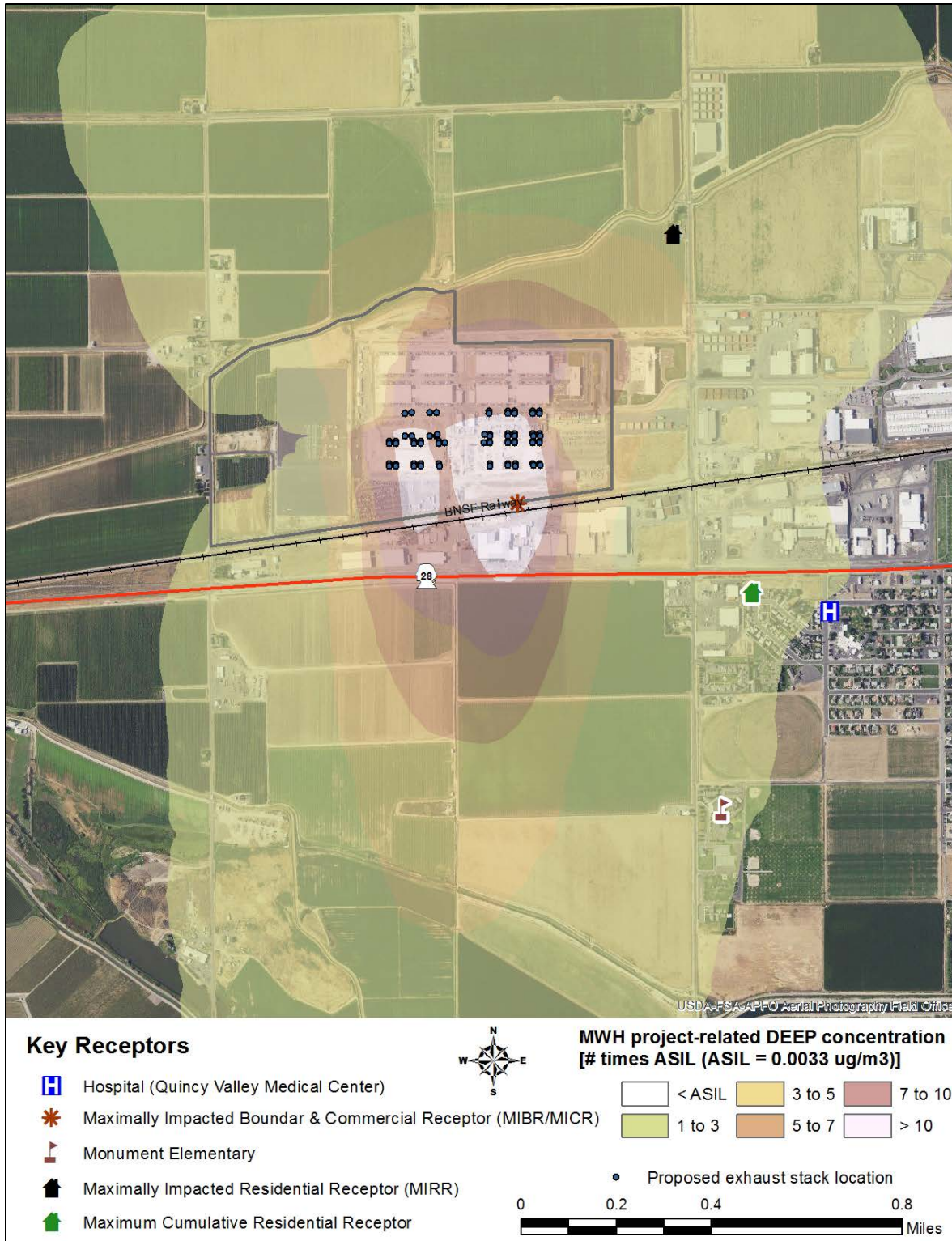


Figure 3: DEEP concentrations attributable to MWH’s 03/04/05/06 engines and key receptor locations evaluated in the HIA. Concentrations reported as the number of times greater than the ASIL.

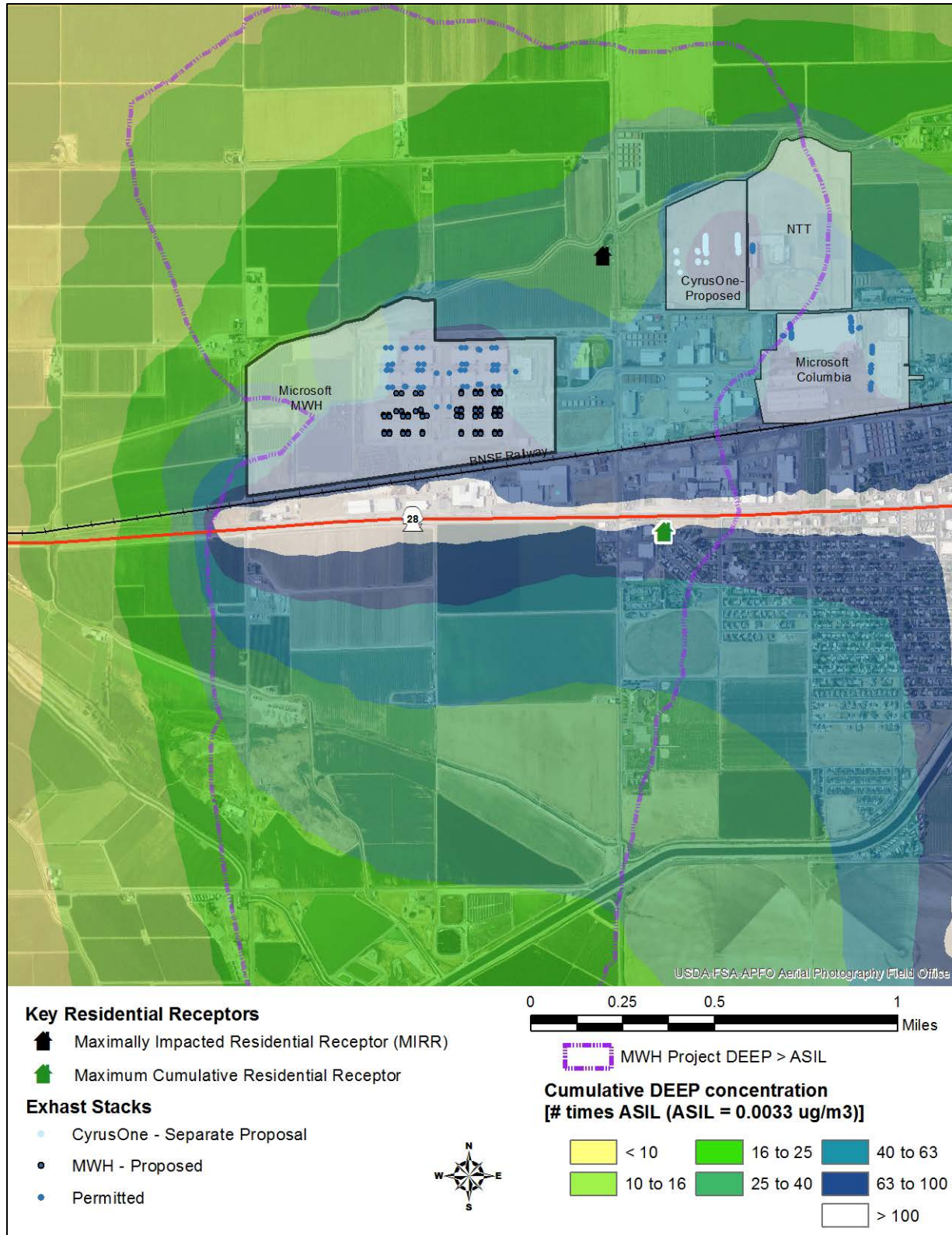


Figure 4: Cumulative DEEP concentrations near MWH. Concentrations reported as the number of times higher than the ASIL.

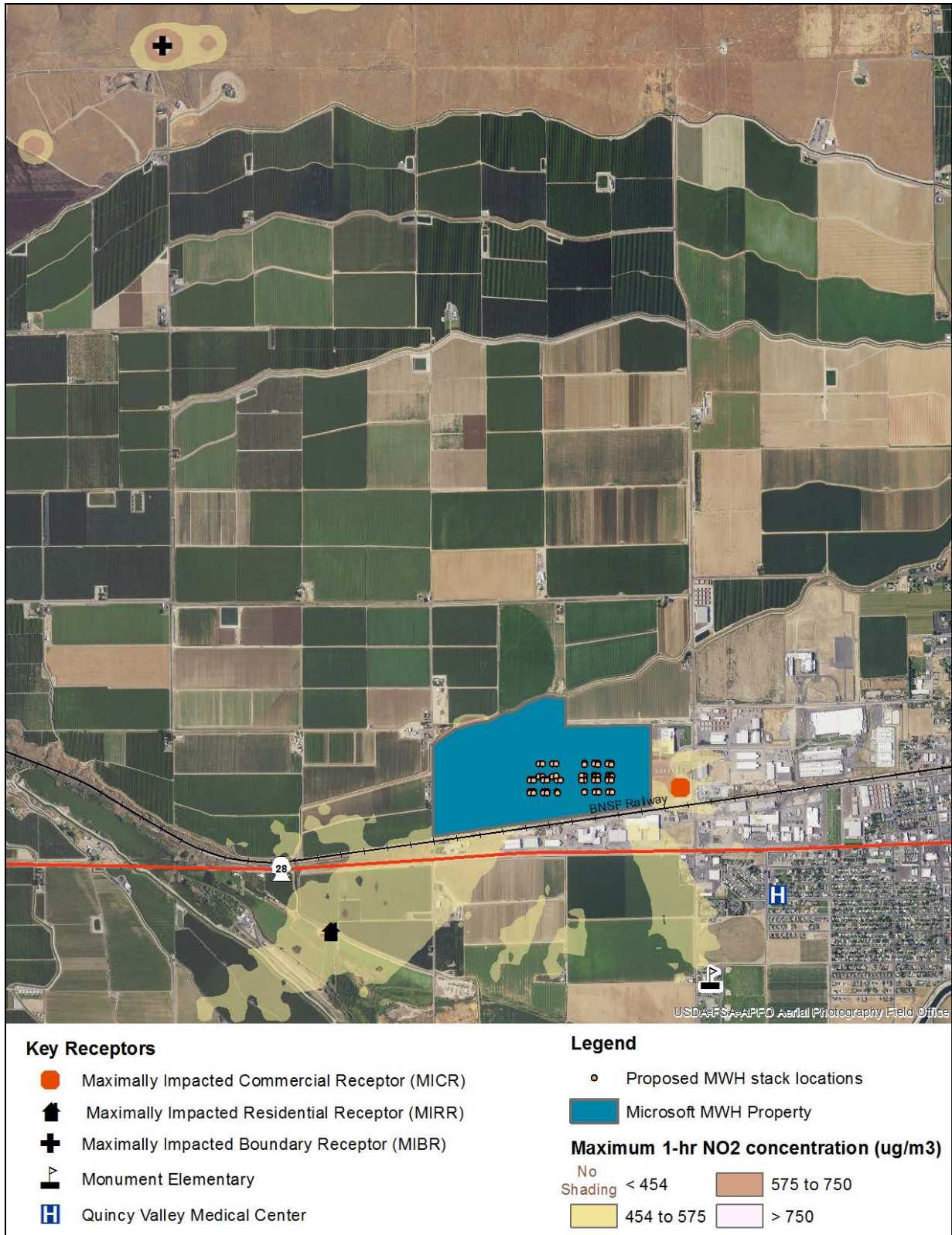


Figure 5: Maximum NO₂ concentrations attributable to MWH-03/04/05/06 outage emissions and key receptor locations evaluated in the HIA

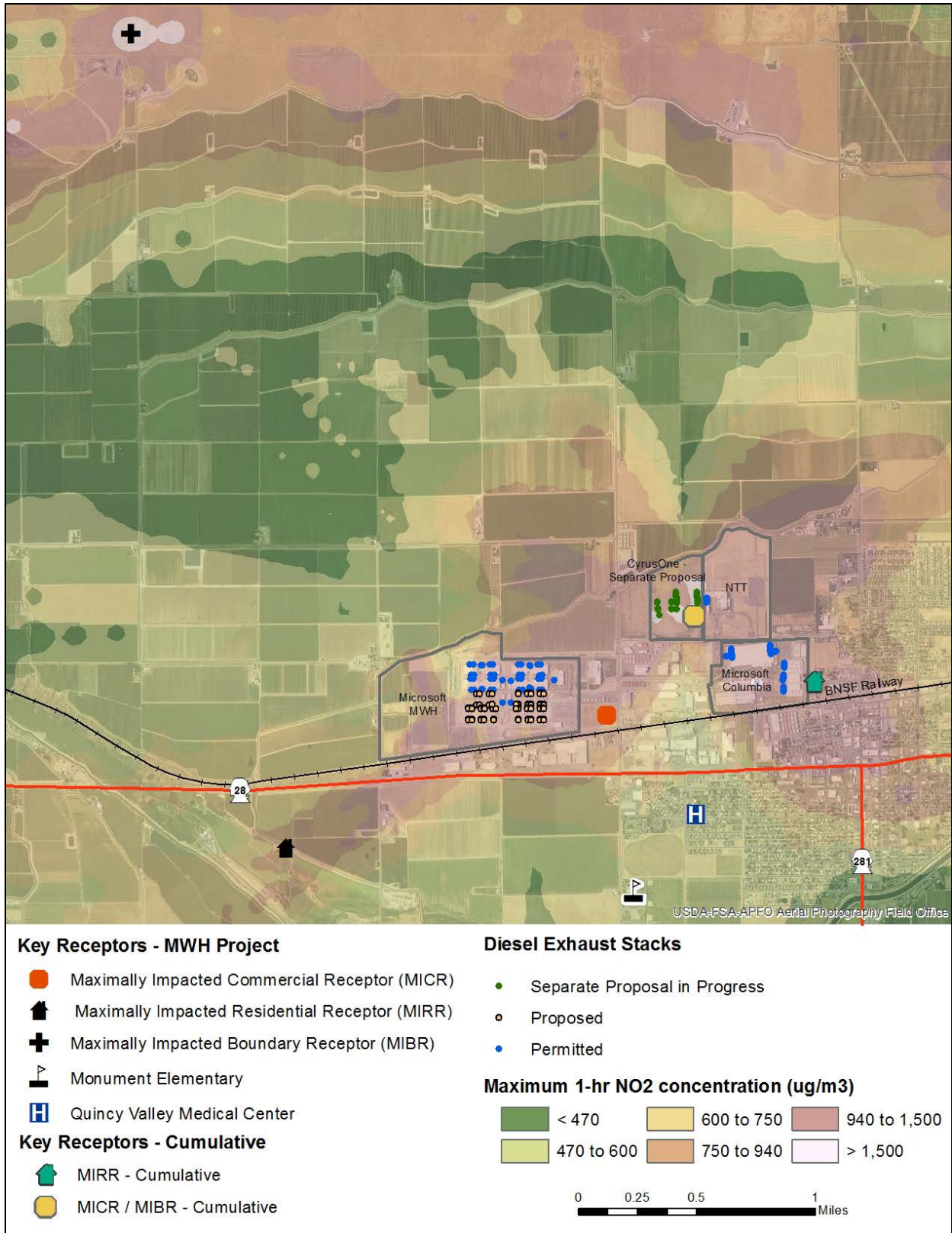


Figure 6: Maximum NO₂ concentrations attributable to simultaneous west side Quincy data center power outage emissions and key receptor locations evaluated in the HIA



Figure 7: Estimated time interval (years) between occurrences of 1-hr NO₂ concentrations greater than 454 µg/m³ assuming eight hours of MWH-03/04/05/06 data center emergency engine outage emissions per year

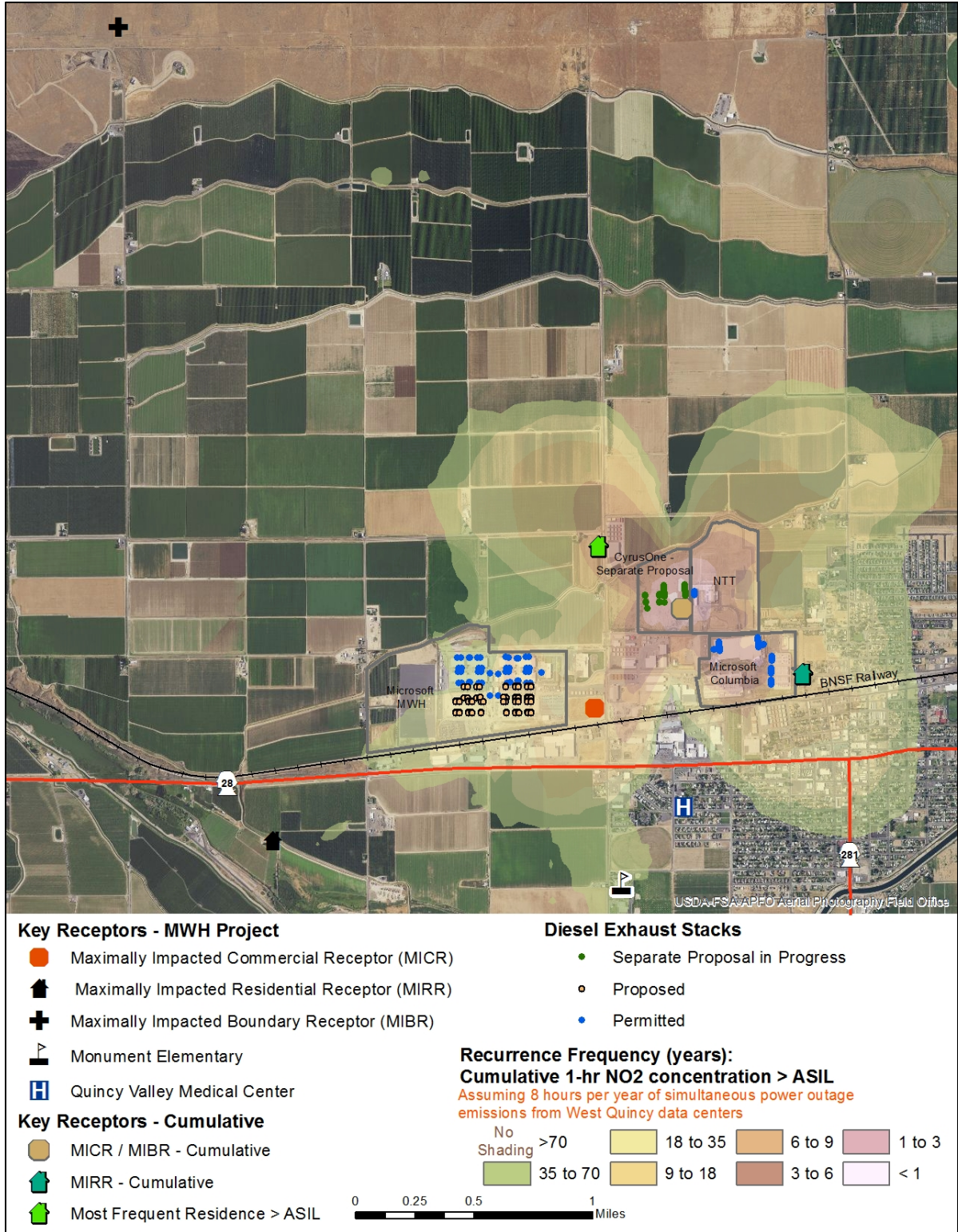


Figure 8: Estimated time interval (years) between occurrences of 1-hr NO₂ concentrations greater than 454 µg/m³ assuming eight hours of simultaneous west side data center emergency engine outage emissions per year

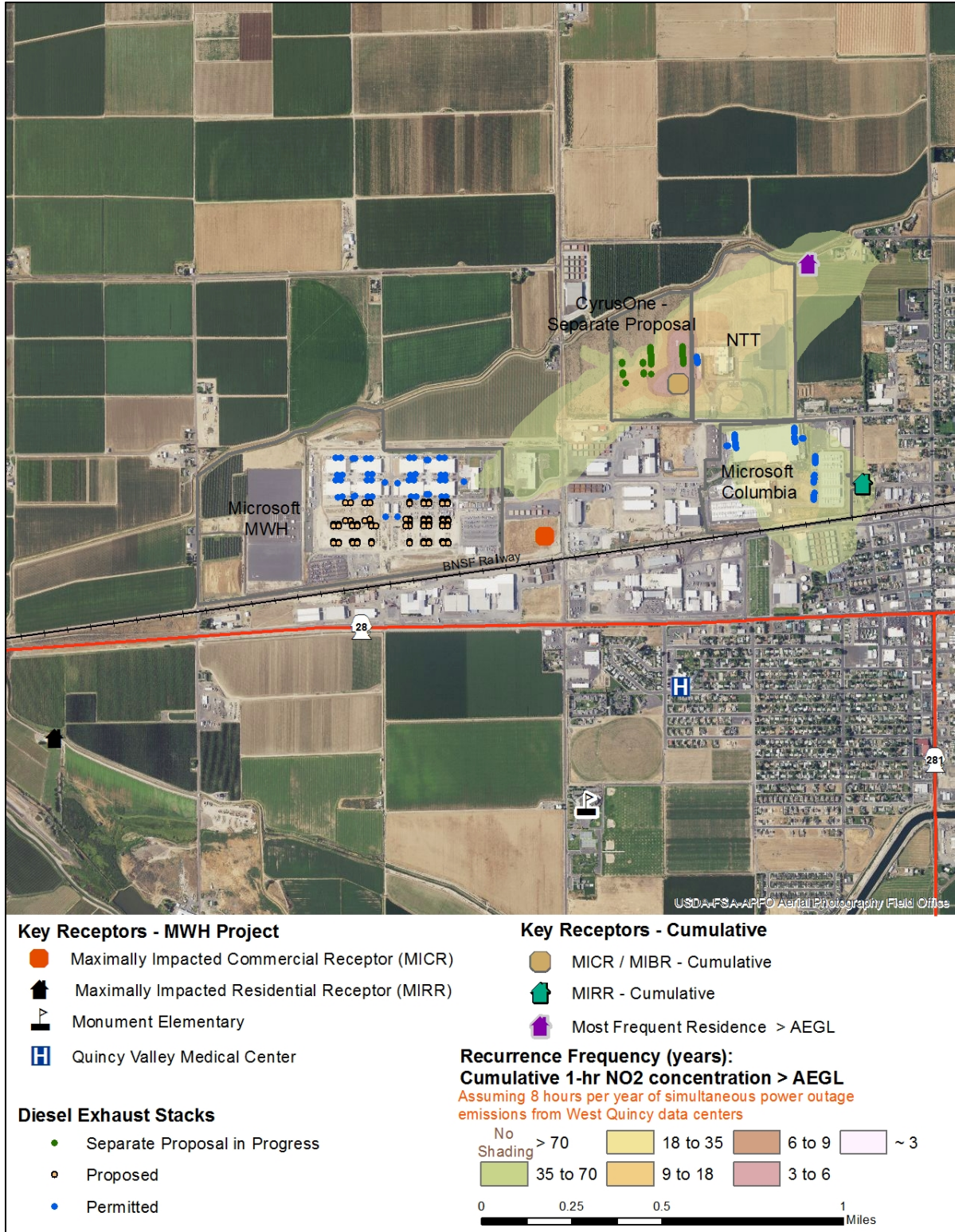


Figure 9: Estimated time interval (years) between occurrences of 1-hr NO₂ concentrations greater than 940 µg/m³ (AEGL) assuming eight hours of simultaneous west side data center emergency engine outage emissions per year