Prepared for:

Sierra Pacific Industries, Inc.
Anderson, California

Prepared by:

Ramboll US Consulting, Inc.
Lynnwood, Washington

Date:

November 2020

Project Number:

1690015834

HEALTH IMPACT ASSESSMENT REPORT - REVISED

LUMBER DRY KILN REDEVELOPMENT ABERDEEN, WASHINGTON

RAMBOLL Bright ideas. Sustainable change.

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1. INTRODUCTION

Sierra Pacific Industries, Inc. (SPI) owns and operates a lumber manufacturing facility in located in Aberdeen, Washington, which is in Grays Harbor County (hereafter, "the facility"). SPI proposes to replace the existing lumber dry kilns at the Aberdeen facility with new, more efficient, and slightly larger capacity kilns (hereafter, "the project"). As a result of the project, SPI expects the dried lumber production capacity of the Aberdeen facility to increase from the currently permitted 315 million board feet per year (MMbf/yr) to approximately 415 MMBf/yr.

The facility is within the jurisdiction of the Olympic Region Clean Air Agency (ORCAA), so the proposed project must comply with regulations adopted by that agency, as applicable. Because the proposed new kilns will emit regulated air pollutants, a Notice of Construction (NOC) must be filed with ORCAA, and installation of new kilns cannot commence until ORCAA issues an Order of Approval (OA).

Toxic air pollutant (TAP) emission rate increases calculated using representative emission factors and maximum potential operating schedules were provided in the NOC application submitted to ORCAA. Three TAPs were determined to have the potential to exceed the Small Quantity Emission Rates (SQERs) provided in WAC 173-460-150: acetaldehyde, acrolein, and formaldehyde. A dispersion modeling analysis, using the AERMOD modeling system, was employed to predict ambient concentrations attributable to these SQER-exceeding TAP emission increases. The modeling analysis indicated that emission increases of two of the modeled TAPs (i.e., acetaldehyde and formaldehyde) have the potential to exceed the Acceptable Source Impact Levels (ASILs) provided in WAC 173-460-150. In cases where a modeling analysis predicts concentration increases that exceed one or more ASILs, WAC 173-460-090 provides a second-tier review process to determine a means of compliance with the ambient impact requirement. Ramboll US Consulting, Inc. (Ramboll) submitted a Health Impact Assessment (HIA) Protocol to the Washington State Department of Ecology (Ecology) on behalf of SPI on October 22, 2020, and Ecology notified Ramboll via email on October 28, 2020 that it had been reviewed and approved for use in developing an HIA.

The remainder of this document describes the methodology and results of the HIA, which includes descriptions of the project and project location, identification of

exposed populations, a discussion of the toxicity of the TAPs of concern, an outline of the air dispersion modeling methodology used to estimate exposure, and a description of the calculations used to quantify increased hazards and risk attributable to the project, as well as the results of those calculations, all of which conforms with the HIA Protocol, which was approved by Ecology via email on October 28, 2020.

2. PROJECT DESCRIPTION

2.1 Project Location

The facility is located at 301 Hagara Street in Aberdeen, Washington, which is located in Grays Harbor County. The demographics of Grays Harbor County, as well as the city of Aberdeen, are summarized in Table 2-1. All data were obtained from the U.S. Census Bureau and represent data from the 2010 census.

Table 2-1. Demographics of Pertinent Jurisdictions

Metric	Washington	Grays Harbor County	Aberdeen
Population, 2010	6,724,540	72,797	16,896
Fraction of persons under 5 years, 2010	6.5%	5.85%	7.47%
Fraction of persons under 18 years, 2010	23.5%	21.60%	24.89%
Fraction of persons 65 years and over, 2010	12.3%	16.28%	12.87%

The areas surrounding the facility are zoned light industrial. A zoning map is provided in Appendix A, and Figure 2-1 shows the location of the facility property boundary.

2.2 Emission Units

SPI proposes to install new lumber dry kilns that will be slightly larger and more efficient than the existing kilns, which will be removed to make room for the new kilns. The existing sawmill, planer mill, and natural gas-fired package boiler will continue to operate as in the past and will not be affected by the project.

Following implementation of the project, there will be 8 new double-track kilns at the facility which will be used to dry the majority of the lumber produced at the facility (i.e., up to 415 MMbf). Other than the increased annual throughput, the new kilns will operate in essentially the same manner as the existing kilns: all of the lumber dried in the kilns will be Douglas fir or hemlock; depending on market demand, the kilns may operate continuously as a group throughout the year; and the kilns will be heated by steam from the existing wood-fired boiler located at the adjacent cogeneration facility, unless it is non-operational for some reason, in which case the kilns will be heated using the on-site natural gas-fired boiler.

The proposed and existing facility layouts are presented in Figures 2-1 and 2-2, respectively. The figures show the locations of emission units included in the analysis as well as the structures with the potential to influence emissions from those emission units. Figure 2-2 shows the existing dry kilns, which will be removed.

Figure 2-1. Proposed Facility Layout

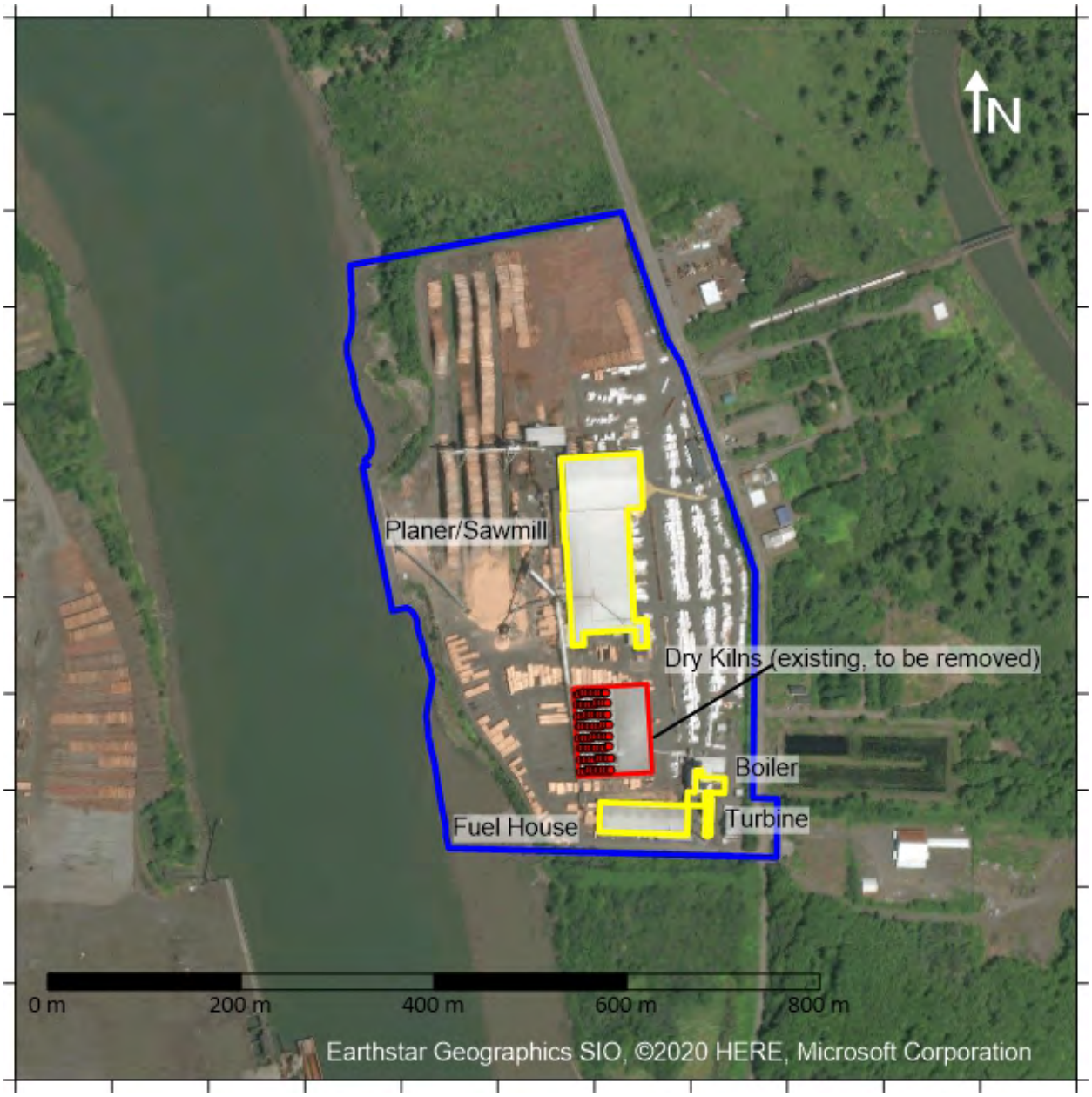

Figure 2-2. Existing Facility layout

2.3 Emission Rate Calculations

The new lumber dry kilns are the only emission units associated with the project that will increase TAP emissions at the facility, and, as such, represent the only TAP emissions to be considered by the compliance demonstration, per WAC 173-460-040.

2.3.1 Proposed New Lumber Dry Kilns

The 8 new double-track dry kilns will be used to dry up to a maximum of 415 MMbf/yr of lumber composed entirely of Douglas fir and hemlock. Based on

SPI's experience at other lumber manufacturing facilities in western Washington, average drying times are between 32 and 36 hours for Douglas fir and 51 to 55 hours for hemlock.

As wood dries, it releases VOCs naturally contained in the wood which pass to the atmosphere through vents in the roof of the kilns. Some of these VOCs have been designated as TAPs and are listed in WAC 173-460-150. Emission factors used to calculate emission rates for proposed new kilns were obtained from the most recent information provided by U.S. Environmental Protection Agency (EPA) Region 10 are summarized in Tables 2-2. These emission factors reflect a maximum kiln temperature set point of 200 °F.

The lumber dry kilns will operate as near to continuously as possible to maximize production. To achieve the proposed maximum dry lumber production (415 MMbf/year) using the 8 proposed lumber dry kilns, the kilns must be charged and operating as close to 24 hours per day, seven days per week as possible. The drying schedule of each individual kiln varies depending upon the dimensions of the lumber, the wood species, and the season (i.e., lumber tends to be drier in the summer, and wetter in the winter), and non-operational periods (i.e., loading, unloading, maintenance, etc.) must be accommodated.

Table 2-2. Maximum Potential Toxic Air Pollutant Emissions for Proposed New Lumber Dry Kilns (≤200°F)

Pollutant	CAS #	Emission Factor[1] (lb/Mbf)			Maximum Emission Factor Species
		Western Hemlock	Douglas Fir	Maximum	
Acetaldehyde	75-07-0	0.0677	0.0275	0.0677	Hemlock
Acrolein	107-02-8	0.00120	0.000500	0.00120	Hemlock
Formaldehyde	50-00-0	0.00436	0.00180	0.00436	Hemlock
Methanol	67-56-1	0.196	0.0671	0.196	Hemlock
Propionaldehyde	123-38-6	0.000400	0.000300	0.000400	Hemlock

1. TAP emission factors are from "EPA Region 10 HAP and VOC Emission Factors for Lumber Drying, November 2019" issued by EPA Region 10. Acetaldehyde, formaldehyde, and methanol emission factors were calculated using a maximum kiln temperature of 200 °F.

Because emission factors for lumber dry kilns are based on the quantity of lumber dried, rather than the time the lumber spends in the kilns, it is impossible to calculate exact emission rates over a 24-hour period. As a result, the quantity of

lumber dried, as well as the resulting emissions, are totaled over a longer period of time, typically a year. The consistency and overlapping nature of kiln operations and emissions means the long-term average is representative of the short-term average, and the short-term average is no different from the short-term worst-case scenario. When a representative quantity of lumber dried, or pollutant emitted, is required for a shorter period of time, an average based on the annual total is used.

The approach described above for determining kiln emission rates over various averaging periods has been applied to every project in Washington involving lumber dry kilns of which we are aware, including Sierra Pacific Industries' (SPI) lumber manufacturing facility projects in Aberdeen (ORCAA, when originally permitted in 2002), Burlington (Northwest Clean Air Agency (NWCAA)), Centralia (Southwest Clean Air Agency (SWCAA)), Frederickson (Puget Sound Clean Air Agency (PSCAA), which was never built), and Shelton (ORCAA), as well as the kiln throughput increase at Vaagen Brothers Lumber, in Colville, Washington (Washington Department of Ecology's Eastern Region Office (ERO)), the Teal-Jones facility in Sumas, Washington (NWCAA), and the Skagit River Reman facility in Sedro Wooley, Washington (NWCAA). Moreover, HIA modeling protocols approved by Washington Department of Ecology (Ecology) for SPI's Frederickson facility in 2014, SPI's Shelton facility in 2015, Teal-Jones's facility in 2018, and Skagit River Reman in 2019 use this same approach for determining short-term emissions to represent lumber dry kilns in dispersion modeling analyses.

Maximum potential emission rates for the proposed new kilns were calculated using the emission factors in Table 2-2 and a maximum annual throughput of 415 MMbf/yr. Maximum potential annual TAP emissions calculated for the proposed new kilns are summarized in Table 2-3.

Table 2-3. Proposed Lumber Dry Kiln Maximum Potential Toxic Air Pollutant Emissions

Pollutant	Emission Rate[1]		
	(lb/day)	(lb/yr)	(tpy)
Acetaldehyde	--	28,100	14.0
Acrolein	1.36	--	0.249
Formaldehyde	--	1,810	0.905
Methanol	223	--	40.8
Propionaldehyde	0.455	--	0.0830

1. The maximum potential annual emission rates are based on 415,000 Mbf/yr throughput of the worst-case wood species for each pollutant. The annual average emission rates are assumed to be representative of worst-case daily emission rates based on the overlapping batch-wise nature of drying lumber in kilns, and uniform, year-round operation, as discussed in Section 2.3.1.

2.3.2 Existing Lumber Dry Kilns to Be Removed

Past actual TAP emission rates for the existing kilns were calculated using the emission factors in Table 2-2 and past actual kiln throughputs averaged over two consecutive years in which facility production was representative of normal operating conditions. To identify production rates during these years, annual emission reports from the 2009 through 2019 were examined. The reported quantities of lumber dried in the existing kilns from 2009 through 2019, by species are presented in Table 2-4.

Table 2-4. Lumber Dried in Existing Kilns by Species, 2009 – 2019

Year	Lumber Species (Mbf/yr)		
	Douglas Fir	Hemlock	Total
2009	77,400	183,900	261,300
2010	129,900	174,600	304,500
2011	113,700	158,400	272,100
2012	106,800	163,200	270,000
2013	104,400	173,100	277,500
2014	132,900	139,800	272,700
2015	163,500	134,400	297,900
2016	186,322	113,678	300,000
2017	167,669	104,336	272,005
2018	160,200	152,700	312,900
2019	182,400	129,900	312,300

Two-year average emissions of criteria pollutants and TAPs, calculated using the emission factors in Table 2-2 and the lumber throughputs in Table 2-4, are summarized in Table 2-5. The maximum emission rate for each TAP is shaded.

Table 2-5. Existing Lumber Dry Kilns Past Actual TAP Emission Rates

Years	Two-Year Average Emission Rate (tpy)				
	Acetal-dehyde	Acrolein	Formal-dehyde	Methanol	Propion-aldehyde
2009-2010	7.49	0.133	0.484	21.1	0.0514
2010-2011	7.31	0.130	0.473	20.4	0.0516
2011-2012	6.96	0.124	0.450	19.5	0.0487
2012-2013	7.14	0.127	0.462	20.1	0.0495
2013-2014	6.93	0.124	0.448	19.3	0.0491
2014-2015	6.68	0.119	0.432	18.4	0.0497
2015-2016	6.60	0.118	0.428	18.0	0.0510
2016-2017	6.12	0.110	0.397	16.6	0.0484
2017-2018	6.60	0.118	0.428	18.1	0.0503
2018-2019	7.14	0.128	0.462	19.6	0.0540

Past actual hourly, daily, and annual TAP emissions calculated for the existing kilns that are to be removed from the facility are summarized in Table 2-6.

Table 2-6. Maximum Two-Year Average Past Actual Toxic Air Pollutant Emissions from Existing Lumber Dry Kilns

Toxic Air Pollutant	Emission Rate[1]		
	(lb/day)	(lb/yr)	(tpy)
Acetaldehyde	--	15,000	7.49
Acrolein	0.731	--	0.133
Formaldehyde	--	1,000	0.484
Methanol	116	--	21.1
Propionaldehyde	0.296	--	0.0540

1. The annual average emission rates are assumed to be representative of worst-case daily emission rates based on the overlapping batch-wise nature of drying lumber in kilns, and uniform, year-round operation, as discussed in Section 2.3.1.

Table 2-7. Project Potential Toxic Air Pollutant Emissions

Pollutant	CAS #	HAP?	Avg. Period[1]	Emission Rate[2] (lb/averaging period)				Over SQER?
				Proposed Kilns[2]	Existing Kilns[3]	Net Increase[4]	SQER	
Acetaldehyde	75-07-0	Yes	Year	28,100	-15,000	13,100	60	**Yes**
Acrolein	107-02-8	Yes	24-Hr	1.36	-0.731	0.633	0.026	**Yes**
Formaldehyde	50-00-0	Yes	Year	1,810	-970	841	27	**Yes**
Methanol	67-56-1	Yes	24-Hr	223	-116	108	1,500	No
Propionaldehyde	123-38-6	Yes	24-Hr	0.455	-0.296	0.159	0.59	No

1. The averaging period basis and SQER for each TAP are assigned in WAC 173-460-150.
2. Proposed kiln emission rates from Table 2-3.
3. Existing kiln emission rates from Table 2-6.
4. "Net Increase" is the proposed new kiln emission rate minus the existing kiln emission rate.

2.4 Control Technology

2.4.1 Best Available Control Technology for Toxics

Per WAC 173-460-060, new or modified sources that increase TAP emission rates must employ Best Available Control Technology for toxics (tBACT). In the NOC application submitted to ORCAA, SPI proposed that tBACT for the lumber dry kilns is use of a computerized kiln management system and limiting the maximum kiln temperature set point to less than or equal to 200 °F. SPI proposes to keep records to demonstrate compliance.

2.4.2 National Emissions Standards for Hazardous Air Pollutants

Although the facility does not, and will not, manufacture plywood or composite wood products, 40 CFR Part 63, Subpart DDDD applies to lumber dry kilns located at any facility. According to 40 CFR 63.2252, the only requirement in Subpart DDDD that applies to lumber kilns is the initial notification requirement in 40 CFR 63.9(b). Pursuant to 40 CFR 63.9(b)(iii), the NOC application submitted to ORCAA will serve as the initial notification for the new lumber dry kilns.

3. HAZARD IDENTIFICATION

As noted above, the maximum potential emission rates of three TAPs are expected to exceed the assigned SQERs, and acetaldehyde and formaldehyde are predicted by the dispersion modeling to exceed the assigned ASIL. The TAPs which exceeded the ASILs, as well as those that exceeded the SQERs but did not exceed the ASILs, will also be included in the second-tier analysis. This section presents the physical properties, environmental fate and transport, and general health effects associated with acetaldehyde, acrolein, and formaldehyde exposure in humans. Principal sources of this information include the Integrated Risk Information System (IRIS), Agency for Toxic Substances and Diseases Registry (ATSDR), and California Office of Environmental Health Hazard Assessment (OEHHA) toxic air contaminant databases. A summary of the potential effects of each emitted TAP that is expected to exceed the assigned SQER is presented in Table 3-1.

Table 3-1. Summary of Potential Effects of Chemicals that Exceed the SQER

Toxic Air Pollutant	CAS #	Potential Health Effects
Acetaldehyde	75-07-0	Sensory irritation, redness, and swelling of the eye; broncoconstriction; degenerative, inflammatory, and hyperplastic changes of the nasal mucosa; nasal and laryngeal tumors and cancer by hyperplasia mechanism Hazard index targets: nose and throat (nasopharyx), eye, and bronchus
Acrolein	107-02-8	Hazard index targets: eye and entire respiratory tract
Formaldehyde	50-00-0	Irritation of mucous membranes of eyes, nose, and throat; inflammation; epithelial degeneration; respiratory epithelial hypertrophy; and squamous metaplasia. Acute high exposure may lead to eye, nose, throat, and respiratory tract irritation, nasal obstruction, pulmonary edema, and dyspnea. Prolonged or repeated exposures are associated with allergic sensitization, cough, wheeze, dyspnea, histopathological changes in respiratory epithelium, and decrements in lung function. Chronic exposure in children, especially those with asthma, is more likely to induce symptoms and impair pulmonary functioning than in adults. Nasopharyngeal and respiratory tract cancer; possibly brain cancer and leukemia. Hazard quotient targets: nasopharynx, respiratory tract

3.1 Potential Effects of Chemicals that Exceed the ASIL

Depending on exposure levels, the three TAPs that exceed the SQERs, i.e., acetaldehyde, acrolein, and formaldehyde, can adversely affect the nose and throat (nasopharyx), the eyes, and the entire respiratory tract, including the bronchi. Additionally, acetaldehyde exposure may cause nasal and laryngeal cancer. The primary acute effects of human exposure to acetaldehyde in air consist of irritation to the eyes, skin, and respiratory tract.[1] Asthmatics exposed to acetaldehyde may experience a decrease in lung function due to bronchoconstriction.

There is little information regarding health outcomes in humans related to long-term exposure to acetaldehyde. In animals, chronic inhalation exposure to acetaldehyde has produced changes in the mucus membranes of the nose and trachea, growth retardation, slight anemia, and increased kidney weight. EPA derived a reference concentration based on the degeneration of a layer of cells lining the tissue responsible for smell in the noses (olfactory epithelium) of rats.[2] There is currently insufficient human data regarding the carcinogenic effects of acetaldehyde. Animal studies involving inhalation of acetaldehyde have shown an increased rate of nasal tumors in rats and laryngeal tumors in hamsters. EPA has classified acetaldehyde as a Group B2, probable human carcinogen.

Low levels of formaldehyde can cause irritation of the eyes, nose, throat, and skin. It is possible that people with asthma exposed to formaldehyde can experience respiratory symptoms such as wheezing, shortness of breath, and reduced pulmonary function consistent with bronchoconstriction.[3] At concentrations that typically occur in ambient air, effects occur in tissues where formaldehyde enters the body (i.e., nose or mouth). At higher levels, coughing, wheezing, bronchitis, nasal obstruction, pulmonary edema, choking, dyspnea, and chest tightness may occur.

People chronically exposed to formaldehyde by inhalation have experienced respiratory symptoms and eye, nose, and throat irritation. Animal studies have reported effects on the nasal respiratory epithelium and lesions in the respiratory system from chronic inhalation exposure to formaldehyde. Some studies of people exposed to formaldehyde in workplace air found more cases of cancer of the nose and throat than expected, but these workers may have been exposed to multiple

[1] http://www.arb.ca.gov/toxics/id/summary/acetaldehyde_b.pdf
[2] http://www.epa.gov/ncea/iris/subst/0290.htm
[3] http://www.oehha.ca.gov/air/toxic_contaminants/pdf_zip/formaldehyde_112508.pdf

different chemicals, so it is not clear if formaldehyde was the chemical that caused this increased rate. In animal studies, rats exposed to high levels of formaldehyde in air developed cancer in a type of epithelial cell in the nose (nasal squamous cell carcinoma). The United States Department of Health and Human Services has determined that formaldehyde may reasonably be anticipated to be a carcinogen.[4] EPA has classified formaldehyde as a Group B1, probable human carcinogen.

Acrolein is an irritant to skin and mucous membranes. Effects of acrolein typically occur at the point of exposure (i.e., nasal passages, eyes) and upper respiratory tract. Short-term exposure to acrolein can cause eye and nasal irritation at relatively low concentrations (< 1ppm [≤ 2.3 mg/m_3]) in air.[5] Higher concentrations may also irritate the entire respiratory tract. Water soluble fine particulates may potentiate the irritancy of acrolein. Accidental exposures to extremely high levels of acrolein result in high fever, dyspnea, coughing, foam expectoration, cyanosis, pulmonary edema, and death.[6] Animals exposed to higher acrolein concentrations showed signs of lesions in the respiratory tract and respiratory distress. These effects became more severe with increasing concentrations. At higher levels, respiratory distress resulted in death.

There are no available studies of humans exposed to acrolein over long periods. Longer-term studies in laboratory animals at higher concentrations have demonstrated severe nasal lesions as well as pronounced adverse effects on lung function leading to lethality. Studies indicated that rats were the most sensitive species. The potential carcinogenicity of acrolein cannot be determined because the existing data are inadequate for an assessment of human carcinogenic potential for either the oral or the inhalation route of exposure.

3.2 Environmental Fate of Chemicals that Exceed the SQER

3.2.1 Terrestrial Fate

Acetaldehyde will volatilize rapidly in near surface and surface soils.[7] Formaldehyde is biodegraded in soil in a relatively short time.[8] Acrolein can be mobile in soil, but a large portion is expected to volatilize or be broken down by microorganisms or

[4] http://www.atsdr.cdc.gov/tfacts111.html#bookmark06
[5] http://www.oehha.ca.gov/air/toxic_contaminants/pdf_zip/acrolein_112508.pdf
[6] http://www.atsdr.cdc.gov/toxprofiles/tp124.html
[7] http://www.inchem.org/documents/ehc/ehc/ehc167.htm
[8] http://www.atsdr.cdc.gov/toxprofiles/tp111-c5.pdf

other reactive processes.[9] Therefore, none of these chemicals are likely to build up in soil as a result of the relatively small quantities SPI proposes to emit.

3.3 Aquatic Fate

Acetaldehyde dissolves in water but does not reside long in surface water as it either will volatilize or be broken down by microbes. A degradation half-life of 9.3 hours has been reported as typical for rivers.[10] Formaldehyde dissolves easily in water, but it does not reside long in water and is not commonly found in drinking water supplies. Acrolein dissolves readily in water but levels are reduced through volatilization, aerobic biodegradation, and hydration to other chemicals that subsequently biodegrade. Degradation half-lives are less than 1 to 3 days for small amounts of acrolein in surface water. As emitted from the project, these chemicals are unlikely to build up in aquatic environments.

3.4 Atmospheric Fate

Generally, acetaldehyde and acrolein do not persist in air. They react with other chemicals in air (mainly sunlight-derived radicals). The estimated half-life for the reaction of acetaldehyde with the hydroxyl radical produced by ultraviolet light is 6.2 hours. Most formaldehyde in the air also breaks down during the day. The breakdown products of formaldehyde in air include formic acid and carbon monoxide. In air, acrolein is broken down by chemicals generated in sunlight producing carbon monoxide, formaldehyde, and glycolaldehyde. Acrolein also reacts with nitrogen oxides to form peroxynitrate and nitric acid. The half-life for the reaction of acrolein with the hydroxyl radical is 15 to 20 hours.[11]

[9] http://www.atsdr.cdc.gov/toxprofiles/tp124-c6.pdf
[10] http://www.epa.gov/chemfact/s_acetal.txt
[11] http://www.atsdr.cdc.gov/toxprofiles/tp124-c6.pdf

4. POLLUTANT CONCENTRATION CALULATIONS

4.1 Modeling Methodology

Air dispersion modeling is frequently used to estimate ambient air concentrations for calculating inhalation exposure to airborne toxic compounds. This section provides the methodology used to calculate ambient concentrations, and the results of the modeling analysis.

4.1.1 Model Selection

Regulatory modeling techniques were reviewed to select the most appropriate air quality dispersion model to simulate dispersion of the air pollutant emissions of concern. AERMOD, the preferred model in the EPA's "Guideline on Air Quality Models" (codified as Appendix W to 40 CFR Part 51, hereafter referred to as "the Guideline"), was selected for the modeling analysis primarily because it is the most up-to-date dispersion model currently available, and is recommended for use in Ecology's 2nd Tier guidance document.[12]

4.1.2 Modeling Procedures

AERMOD was applied using regulatory defaults, and the options and data discussed in this section.

4.1.2.1 Setup and Application

The most up-to-date version of AERMOD (Version 19191) available was applied using the default options for dispersion that depend on local meteorological data, regional upper air data, and the local physical characteristics of land use surrounding the facility. The facility was categorized as rural, as opposed to urban, for modeling purposes, and rural dispersion coefficients were used.

4.1.2.2 Averaging Periods

The TAPs listed in WAC 173-460-150 have assigned averaging periods: 1-hour, 24-hour, or annual. Of the three TAPs expected to exceed the assigned SQERs, acetaldehyde and formaldehyde are assigned an annual averaging period, and acrolein is assigned a 24-hour averaging period. AERMOD was executed to provide ambient concentrations averaged over those periods. However, based on the different characteristics of potentially exposed receptors and the possibility for acute and chronic effects, AERMOD was also configured to provide concentrations

[12] Department of Ecology, "Guidance Document: First, Second, and Third Tier Review of Toxic Air Pollution Sources (Chapter 173-460 WAC)." Publication Number 08-02-025, revised August 2015.

averaged over periods that can be used to estimate acute effects (i.e., 1-hour and 8-hour) and chronic effects (i.e., annual) results for all three TAPs.

4.1.3 Terrain Elevation Data and Receptor Network

Receptor terrain elevation data were obtained using 1/3rd arc-second elevation data from the National Elevation Dataset (NED), which is a product of the United States Geological Survey (USGS). The NED is a seamless elevation dataset covering the continental United States, Alaska, and Hawaii. The elevation dataset for the modeling demonstration was downloaded from the USGS National Map Viewer[13]. These data have a horizontal spatial resolution of approximately 10 meters (m).

For the dispersion model analyses, receptors spacing was determined based Ecology's 2nd Tier guidance document. Nested grids of receptors with 12.5-m, 25-m, 50-m, 100-m, 300-m, and 600-m spacing were located within 150 m, 400 m, 900 m, 2 km, 4.5 km, and 5 km areas, respectively. All receptor grids were centered on the facility. Receptors were also located at 10-m intervals along the ambient air boundary of the facility. The flagpole receptor option was used to set the height of each receptor at 1.5-m above ground level. The final receptor locations are shown in Figure 4-1. The base elevation and hill height scale for each receptor were determined using the EPA's terrain processor AERMAP (Version 11103), which generates the receptor output files that are read by AERMOD. All receptor locations are in Universal Transverse Mercator (UTM), Zone 10 coordinates using the spatial reference of NAD 83.

[13] http://viewer.nationalmap.gov/viewer/

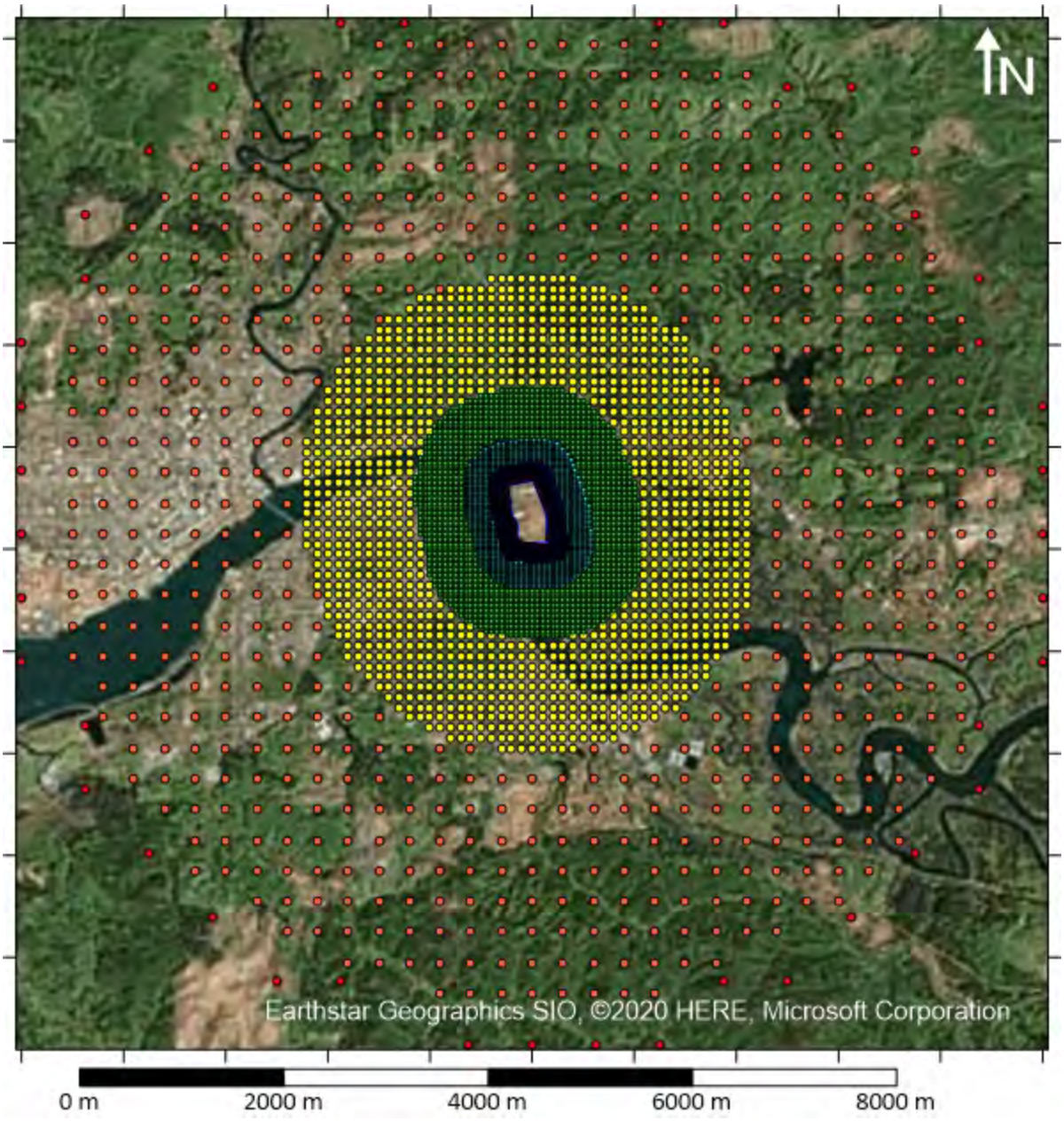

Figure 4-1. Receptor Locations

4.1.4 Meteorological Data

Ramboll conducted a survey of available meteorological data for use in the modeling simulations. A representative five-year data set was prepared using available surface and upper air data for the period 2015 through 2019. Surface meteorology data from National Weather Service (NWS) observations at Bowerman Airport (KHQM) in Hoquiam, Washington, and upper air data collected at the NWS station in Quillayute, Washington were used. A windrose summarizing the KHQM wind speed and wind direction data is provided in Figure 4-2.

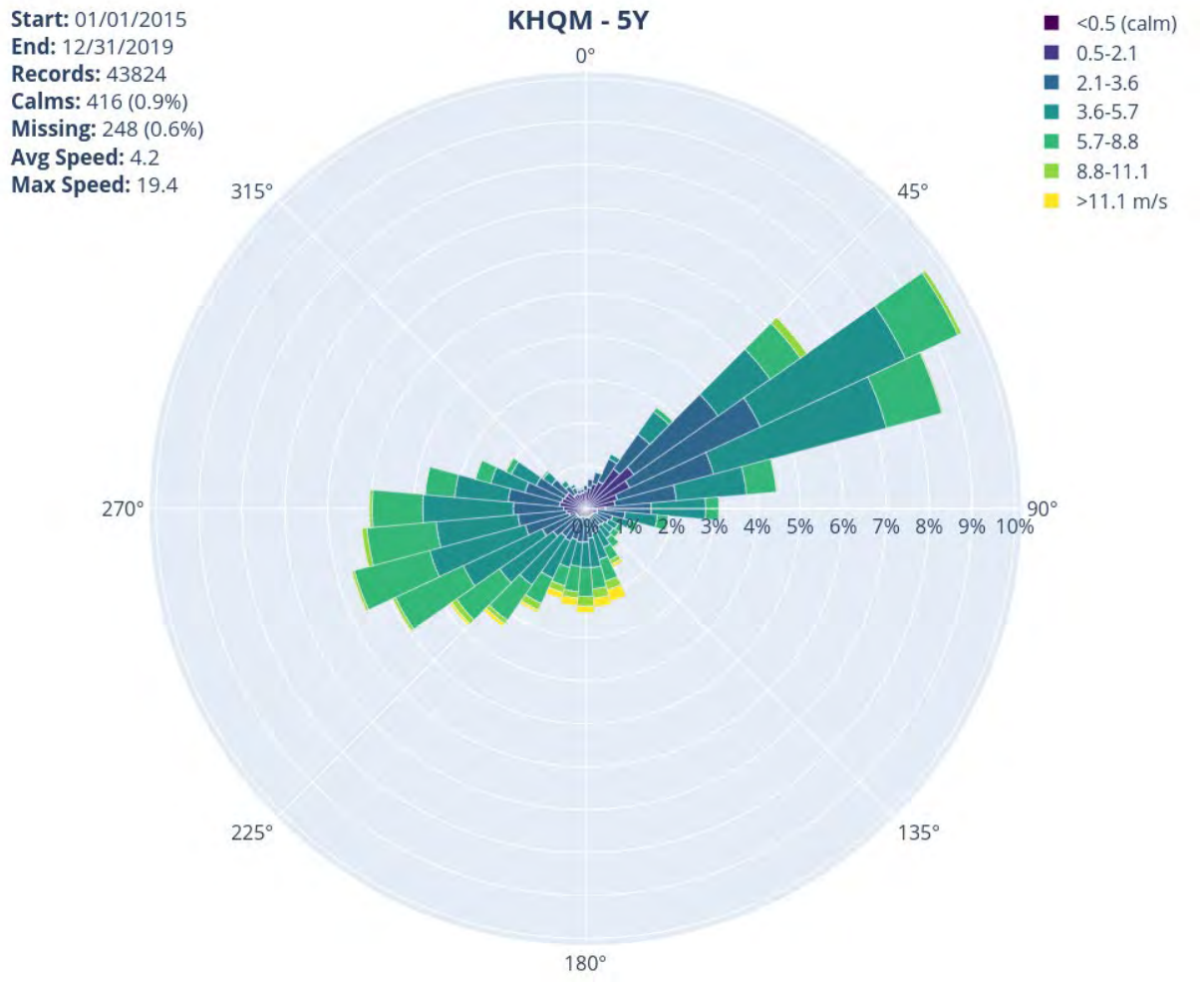

Figure 4-2. KHQM Windrose (2015-2019)

Additional meteorological variables and geophysical parameters are required for use in the AERMOD dispersion modeling analysis to estimate the surface energy fluxes and construct boundary layer profiles. Surface characteristics including albedo, Bowen ratio, and surface roughness length were determined for the area surrounding the KHQM meteorological station using the AERMET surface characteristic pre-processor, AERSURFACE (Version 20060), the 2016 National Land Cover (NLCD16) land use data set, the USGS 2016 Impervious surface data set

(MPRV2016), and the USGS tree canopy data set (CNPY2016).[14] Seasonal surface parameters were determined using AERSURFACE according to the EPA's guidance.[15]

Seasonal albedo and Bowen ratio values were based on averaging over a 10-km by 10-km region centered on the KHQM meteorological station. An unweighted arithmetic average was used for calculating seasonal albedo; and an unweighted geometric average was used for calculating seasonal Bowen ratio. Seasonal surface roughness values were calculated for twelve 30-degree sectors within 1 km of the Bowerman Airport meteorological station. An inverse-distance weighted geometric average was used to calculate seasonal surface roughness length values for each of the 12 sectors.

The EPA meteorological program AERMET (Version 19191) was used to combine the surface meteorological observations collected by the KHQM meteorological station with the twice-daily upper air soundings from Quillayute, Washington and to calculate the meteorological variables and profiles required by AERMOD. One-minute wind speed and wind direction data from KHQM were used to resolve calm and variable wind conditions using the current version of AERMINUTE (Version 15272) pre-processor, which will accept five-minute data when one-minute data is not available.

4.1.5 Emission Unit Characterization

Figures 2-1 and 2-2 shows the locations of emission units at the facility as well as significant structures that could potentially influence emissions. It should be noted that the modified facility will include both new buildings and existing buildings that remain. Table 4-1 provides a summary of the parameters used to represent exhaust from the proposed lumber dry kiln vents, as well as the existing lumber dry kiln vents, which were used only for modeling TAP emission decreases.

Each of the 8 proposed lumber dry kilns will have 22 vents, 11 on each side of the roof peak, and each of the 8 existing lumber dry kilns have 24 vents, 12 on each side of the roof peak. Because kilns exhaust through vents on one side of the roof peak at any given time, the kiln vents were represented in the model by half the

[14] THE USGS landuse data sets are described and can be accessed at: https://www.mrlc.gov/
[15] The AERMOD Implementation Guide (EPA, 2009) and the AERSURFACE User's Guide (EPA-454/B-08-001, January 2008).

total number of vents, located along the roof peak of each kiln (i.e., 11 vents on each kiln for the proposed kilns, and 12 vents on each kiln for the existing kilns).

Table 4-1. Release Parameters

Emission Unit	No. of Vents[1]	Source Elev. (m)	Height (m)	Temp. (K)	Exit Velocity (m/s)	Inside Dia.[2] (m)
Proposed Lumber Dry Kilns	88	4.0	7.62	366	1.52	0.688
Existing Lumber Dry Kilns	96	4.0	5.49	366	1.52	0.688

1. There are 8 existing kilns and 8 proposed kilns. Each existing kiln has 24 vents per kiln and each proposed kiln will have 11 vents per kiln, but only half vent at any given time, so half the total number of vents were included in the modeling to represent the kilns.
2. Equivalent diameter; each existing and proposed kiln vent is a square measuring 24 in. by 24 in.

In addition to the release parameters discussed above, the dimensions and configuration of structures at the facility were provided to AERMOD to assess potential downwash effects. Wind direction-specific building profiles were prepared for the modeling using EPA's Building Profile Input Program including the PRIME algorithm (BPIP PRIME). The facility layout and heights of proposed new (green) and retained (yellow) existing structures, as shown in Figures 2-1 and 2-2 and Table 4-2, were used to prepare data for BPIP PRIME, which calculates the necessary input data for AERMOD.

Emissions from the existing lumber dry kilns, which were included in the TAPs modeling to account for the decrease in TAP emissions that will result from their removal, are influenced by the current facility configuration rather than the post-project facility configuration. To account for that difference, wind direction-specific building profiles were also prepared for the existing kilns using BPIP PRIME, the existing facility layout, shown in red in Figure 2-2, and the heights for existing structures in Table 4-2.

Table 4-2. Significant Onsite Structure Heights

Structure Name	New or Existing Structure	Height Above Grade (m)
Proposed Lumber Dry Kilns	New	7.6
Existing Lumber Dry Kilns	Existing, will be removed	5.5
Sawmill	Existing, will be retained	17.3
Fuelhouse	Existing, will be retained	12.2
Boiler	Existing, will be retained	18.3
Turbine	Existing, will be retained	13.7

For the TAPs modeling, positive maximum potential emission rates attributable to the proposed lumber dry kilns and negative actual emission rates attributable to the existing lumber dry kilns were provided to AERMOD along with building profile information unique to each group of kilns. Using those inputs, AERMOD calculates the net concentrations for comparison to the ASILs.

4.2 Modeling Results

To evaluate ambient concentrations (i.e., impacts on air quality) attributable to the project for each TAP with the potential to exceed its assigned SQER, the emission rates and source release parameters described in the previous sections were applied using the modeling methodology outlined above. The maximum predicted concentrations for the three TAPs with the potential to exceed the assigned SQERs are presented in Table 4-3.

Table 4-3. Maximum Predicted Project Toxic Air Pollutant Concentrations

Toxic Air Pollutant	Averaging Period	Maximum Concentration (µg/m³)	ASIL (µg/m³)
Acetaldehyde	1-Hour	29.7	--
	8-Hour	18.4	--
	24-Hour	12.0	--
	Annual	2.79	0.37
Acrolein	1-Hour	0.521	--
	8-Hour	0.324	--
	24-Hour	0.212	0.35
	Annual	0.0491	--
Formaldehyde	1-Hour	1.90	--
	8-Hour	1.18	--
	24-Hour	0.770	--
	Annual	0.179	0.17

The maximum concentration receptors, for all TAPs and averaging periods of interest, are located on the facility property boundary. Contour plots showing the spatial variation of the 1-hour average, 8-hour average, and annual average acetaldehyde, acrolein, and formaldehyde concentrations throughout the modeling domain are provided in Figures 4-3 through 4-11.

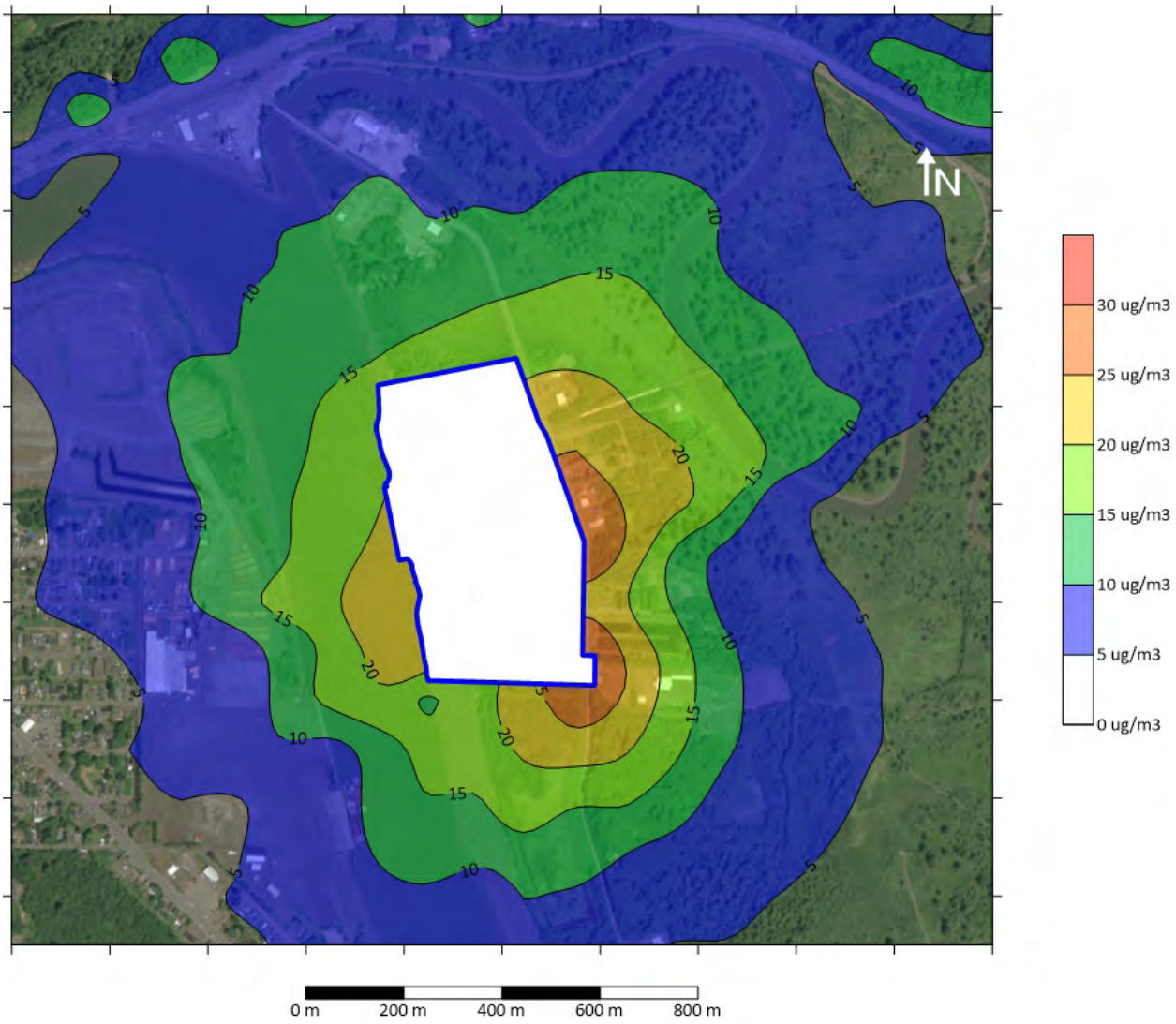

Figure 4-3. Spatial Variation of 1-Hour Average Acetaldehyde Concentrations

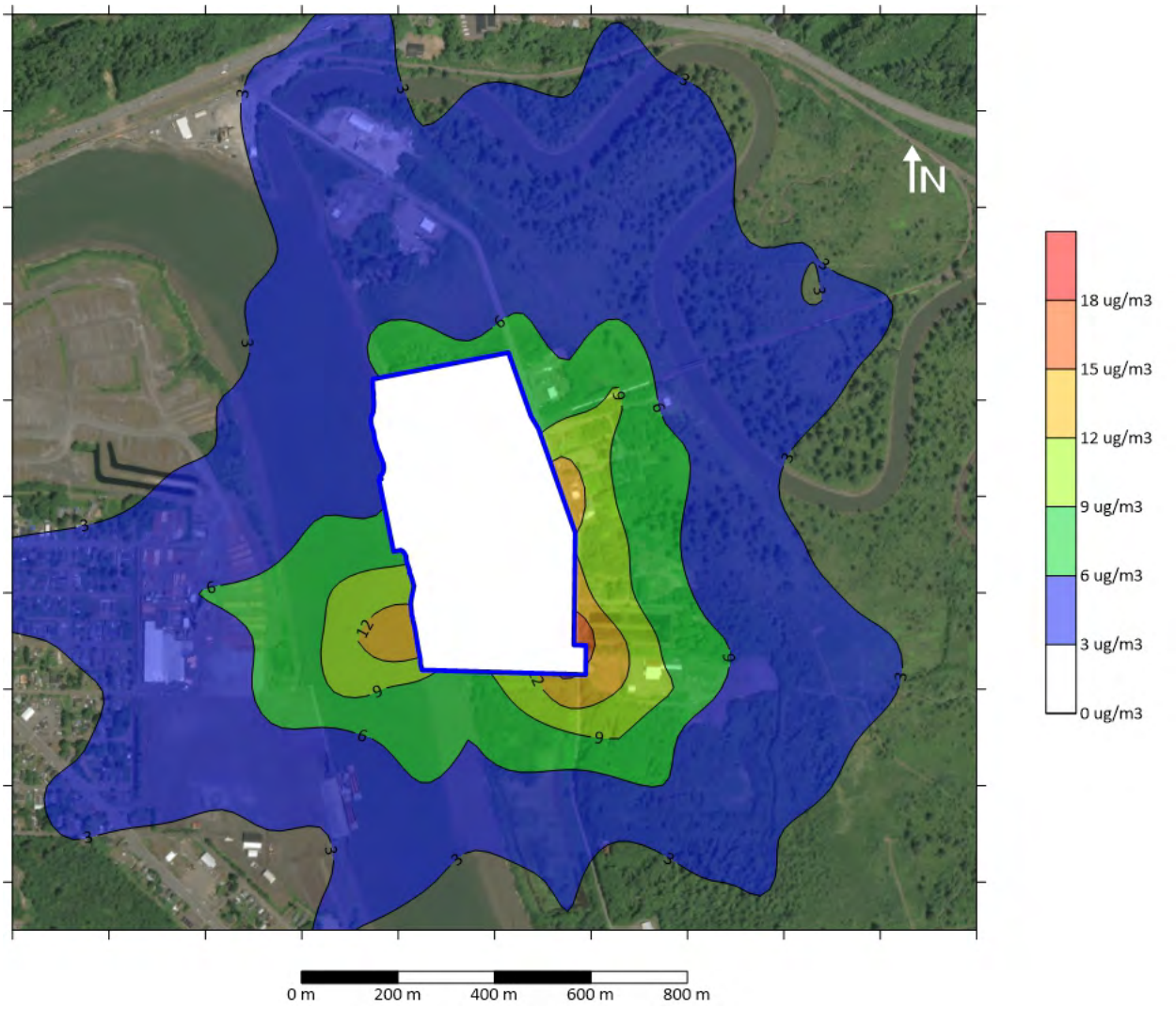

Figure 4-4. Spatial Variation of 8-Hour Average Acetaldehyde Concentrations

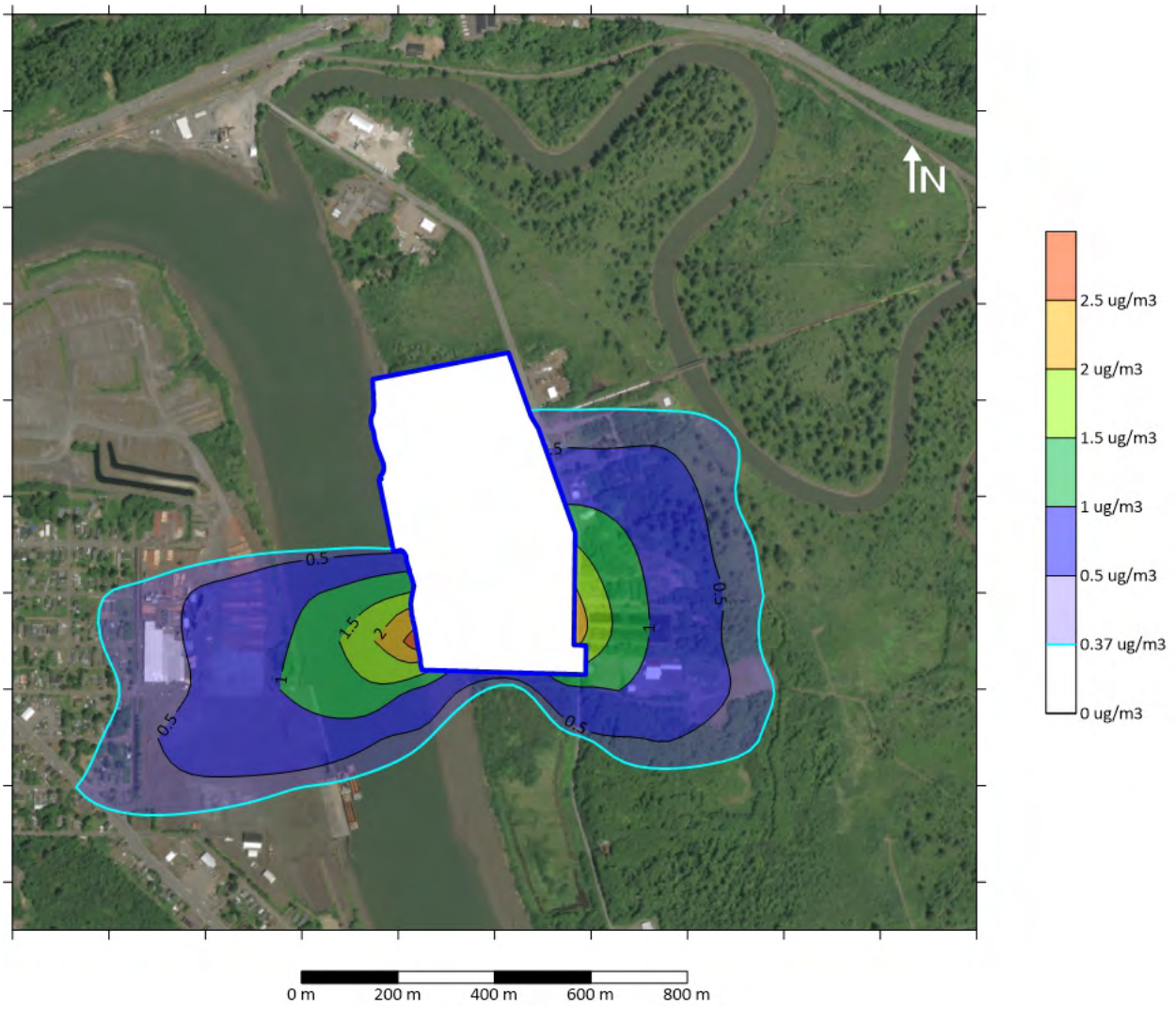

Figure 4-5. Spatial Variation of Annual Average Acetaldehyde Concentrations

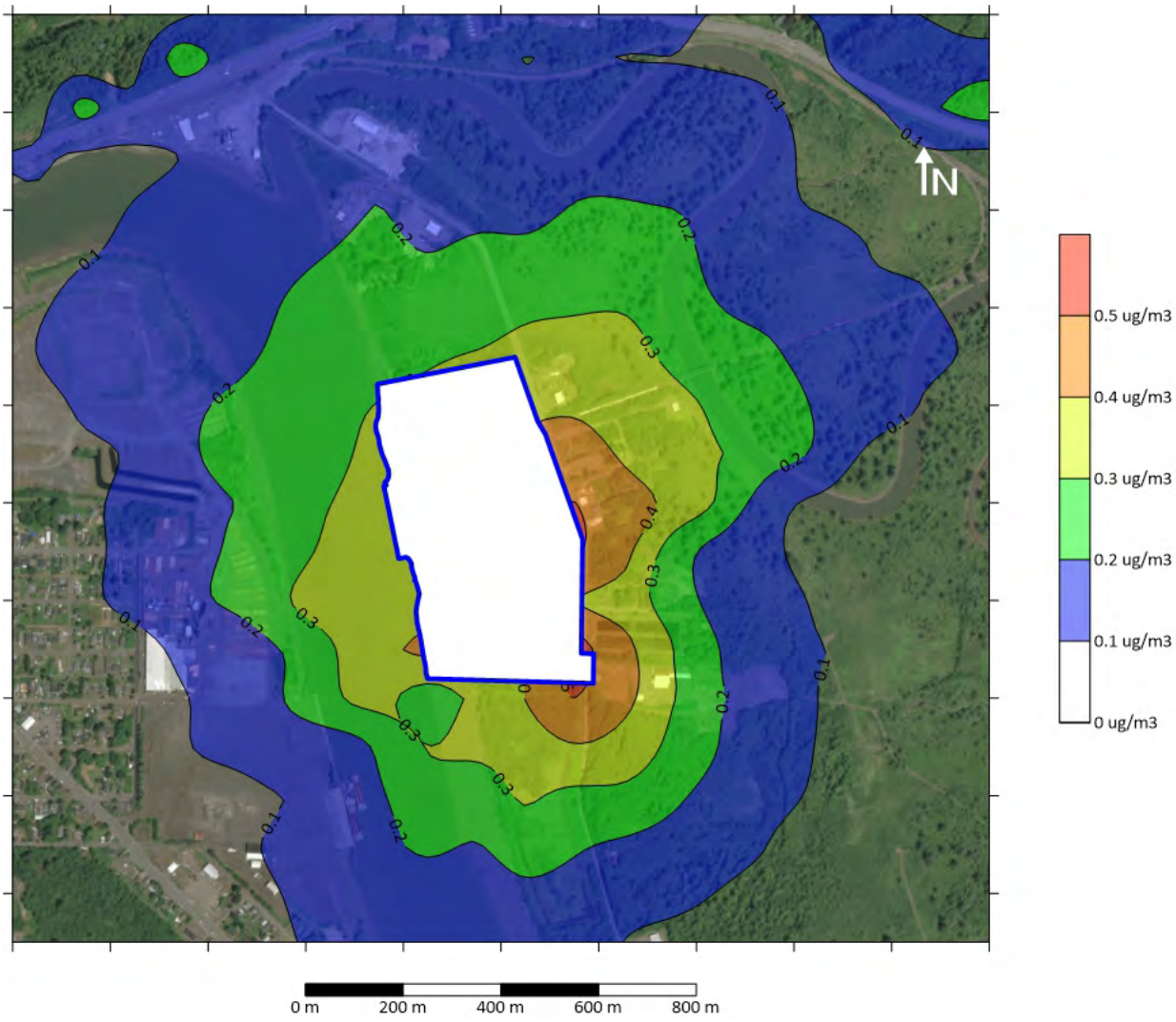

Figure 4-6. Spatial Variation of 1-Hour Average Acrolein Concentrations

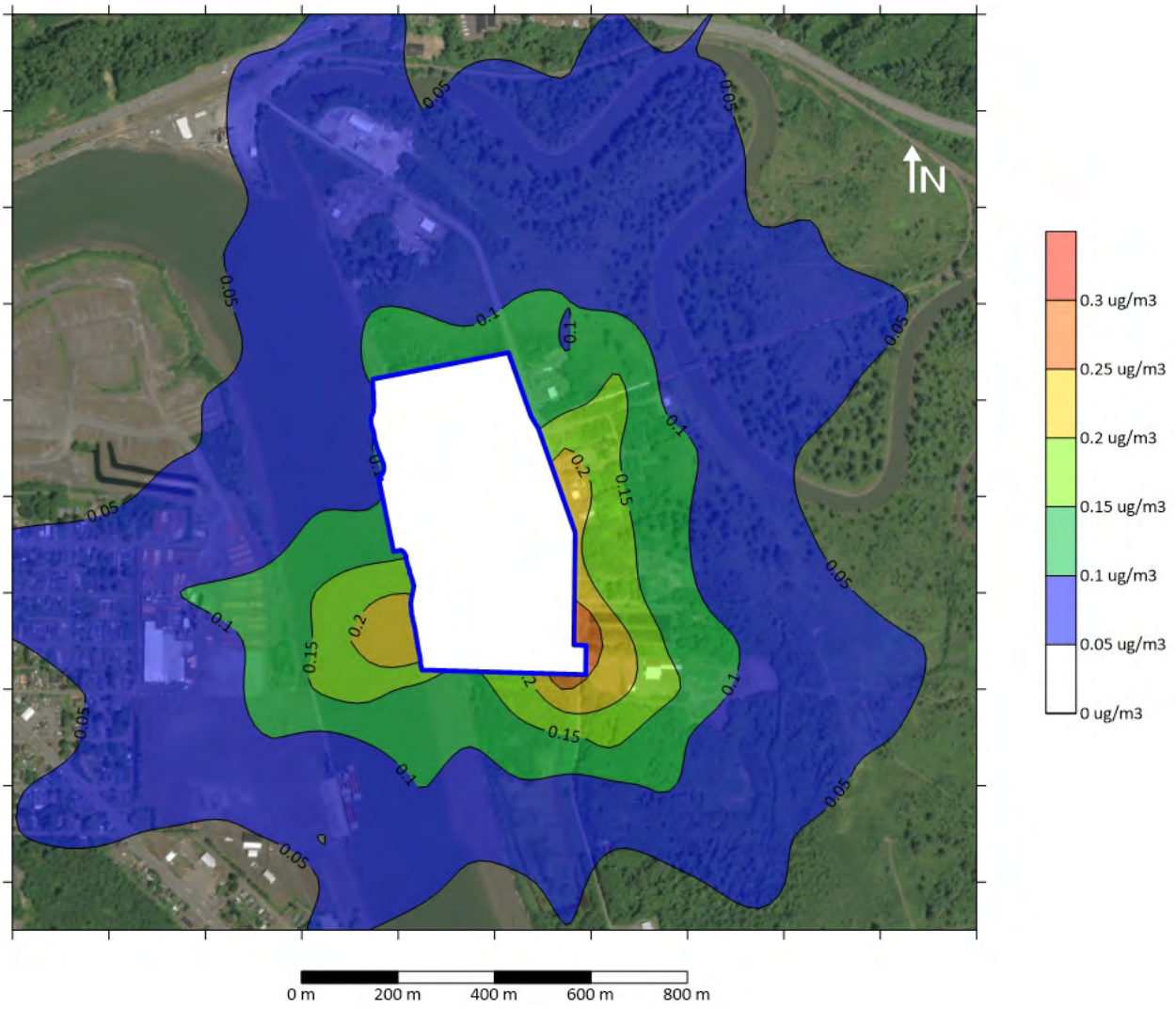

Figure 4-7. Spatial Variation of 8-Hour Average Acrolein Concentrations

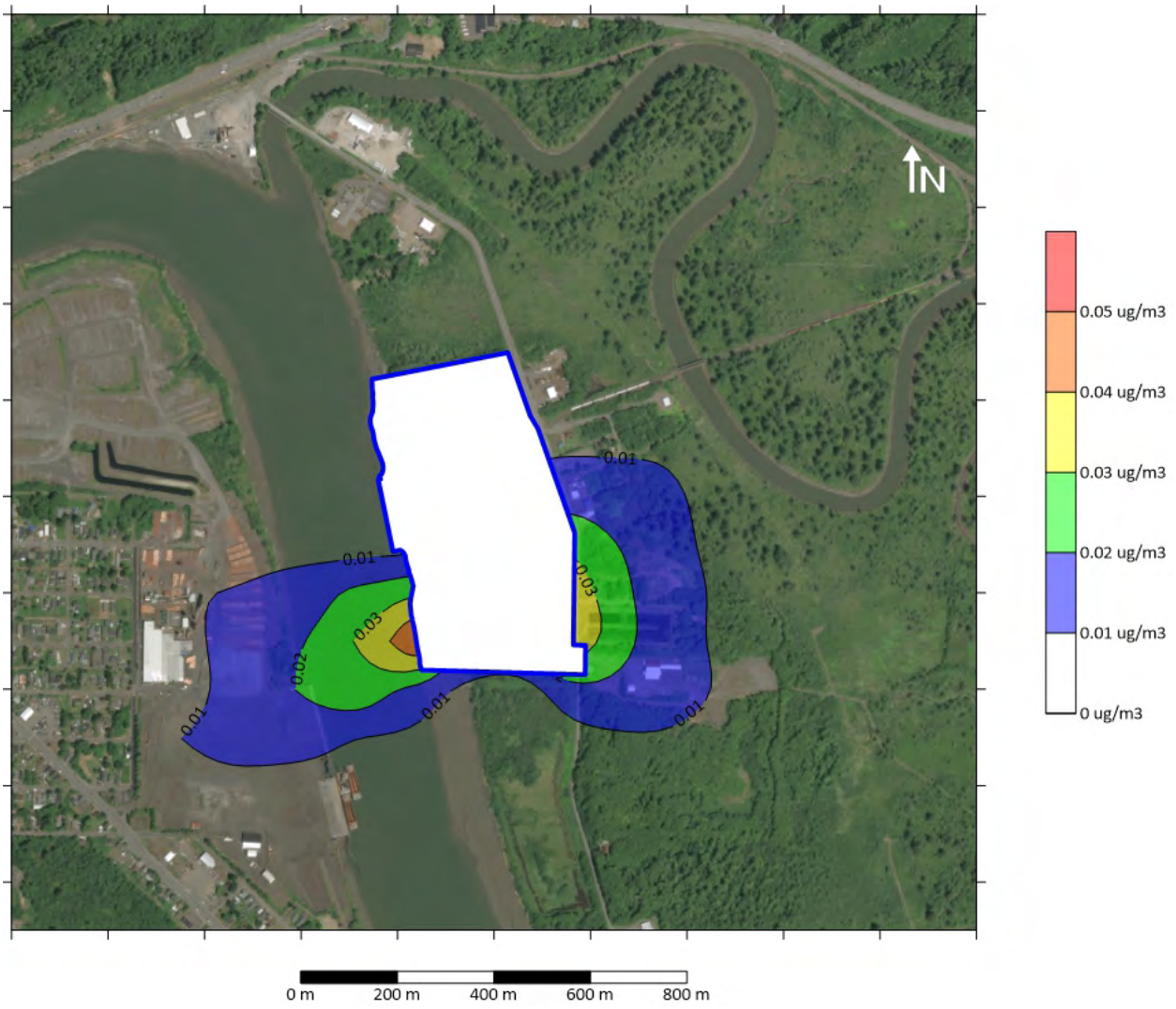

Figure 4-8. Spatial Variation of Annual Average Acrolein Concentrations

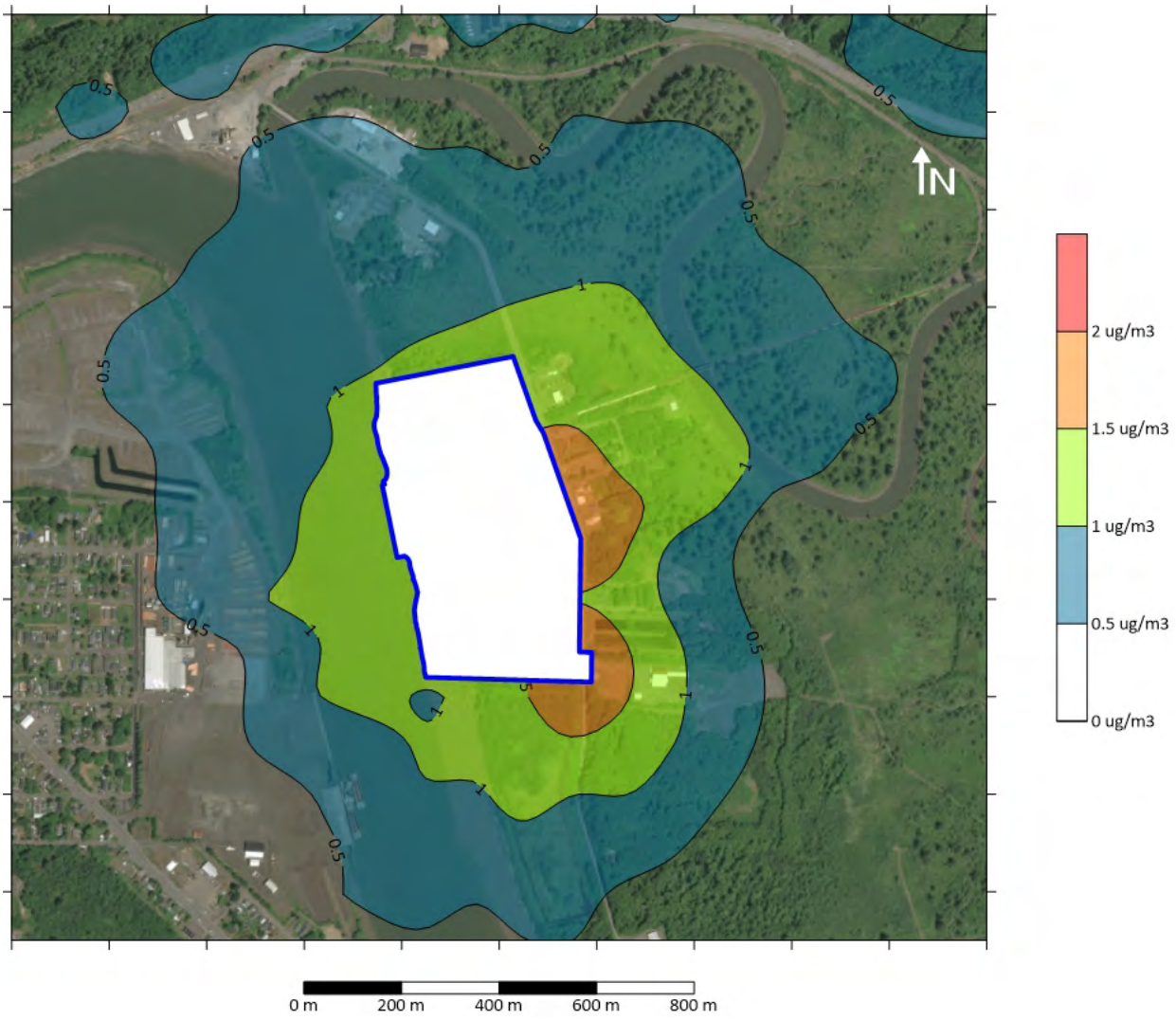

Figure 4-9. Spatial Variation of 1-Hour Average Formaldehyde Concentrations

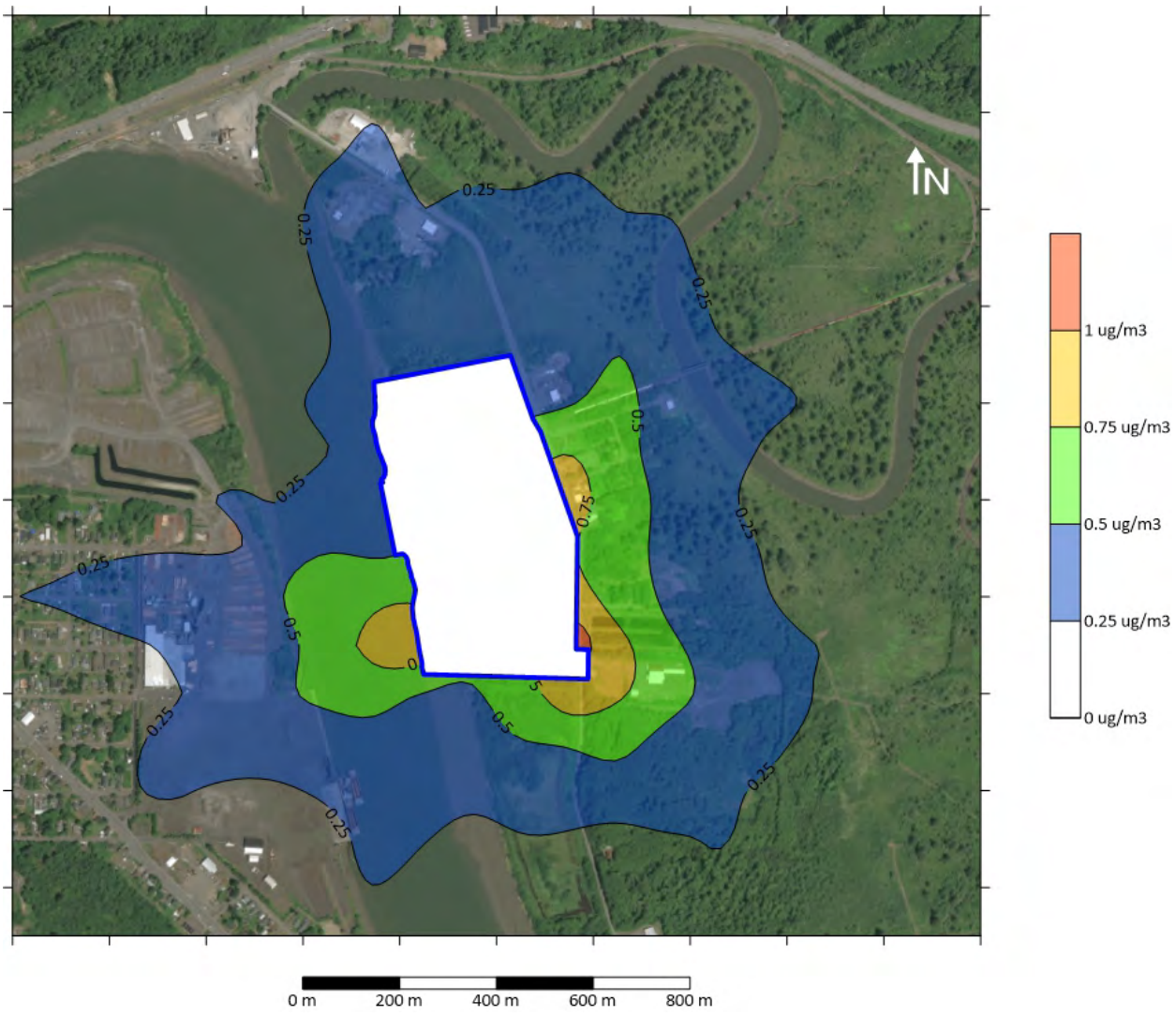

Figure 4-10. Spatial Variation of 8-Hour Average Formaldehyde Concentrations

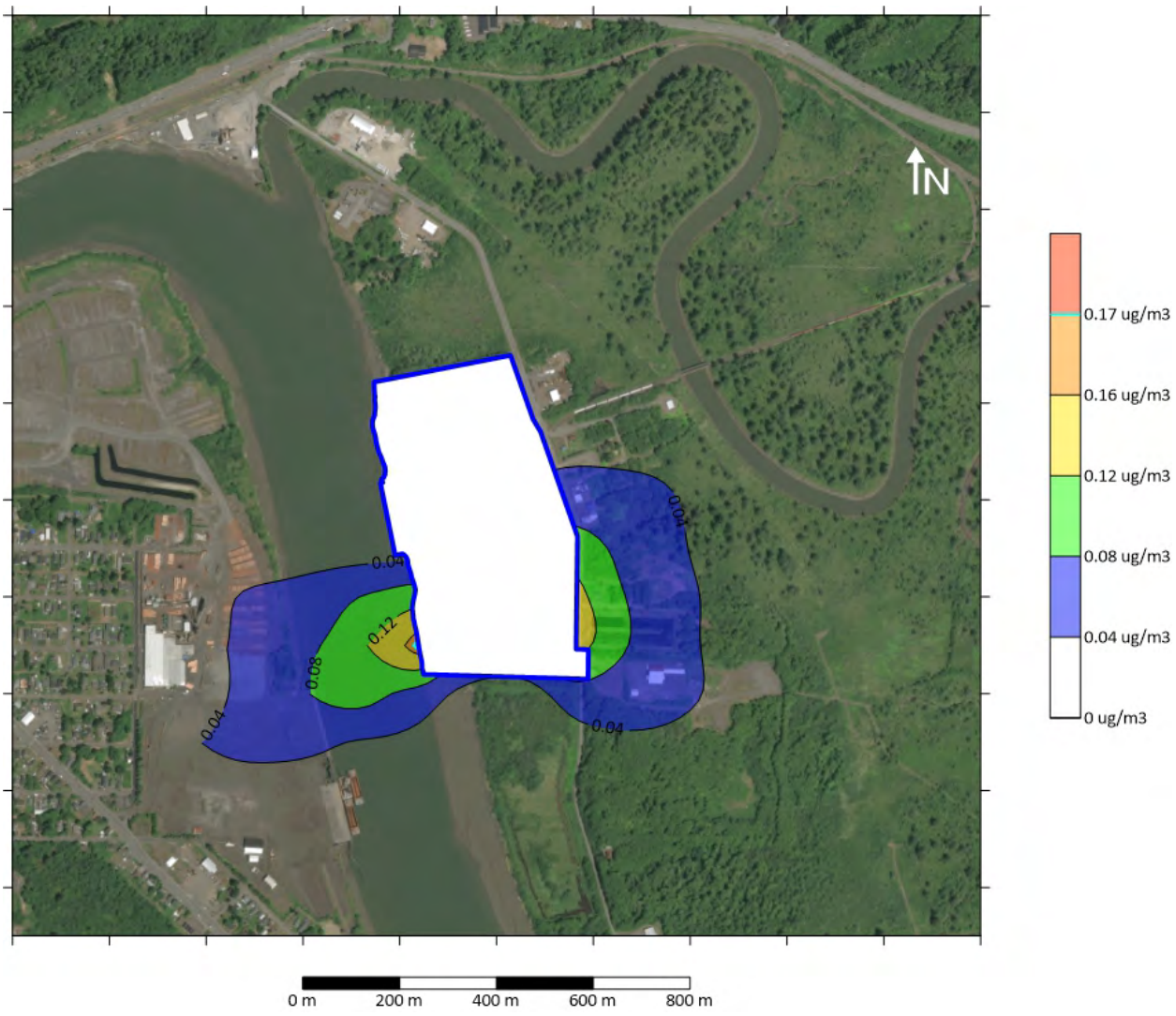

Figure 4-11. Spatial Variation of Annual Average Formaldehyde Concentrations

4.3 Background Concentration

EPA has developed, and periodically updates, the National-Scale Air Toxics Assessment (NATA) to identify and prioritize air toxics, sources, and locations of concern. The most recently issued NATA was for 2014, and the total modeled acetaldehyde, acrolein, and formaldehyde concentrations in the three tracts in which the facility and the town of Aberdeen are located, are presented in Table 4-4. The maximum of the three concentrations will be included in the risk analysis.

Table 4-4. NATA 2014 Predicted Toxic Air Pollutant Concentrations

Toxic Air Pollutant	Census Tract	Annual Average Concentration (µg/m³)
Acetaldehyde	53027000800	0.872
	53027000900	0.837
	53027001000	0.845
	Max	0.872
Acrolein	53027000800	0.0239
	53027000900	0.0243
	53027001000	0.0230
	Max	0.0243
Formaldehyde	53027000800	0.817
	53027000900	0.795
	53027001000	0.818
	Max	0.818

SPI is unaware of any ambient monitoring studies involving acetaldehyde and formaldehyde that have been conducted in the immediate vicinity of the facility location. Monitored acrolein concentrations are typically not available because the data are considered unreliable. Acrolein is highly reactive, making it one of the most difficult chemicals to measure, and an EPA study has raised questions concerning the consistency and reliability of acrolein monitoring results that have not been resolved. In the absence of site-specific monitoring data, Ecology typically concurs that use of NATA 2014 estimates to quantify background concentrations is appropriate for this analysis

Monitored acrolein concentration data are considered unreliable and are typically not relied upon for any decision-making. Acrolein is highly reactive, making it one of the most difficult-to-measure chemicals. An EPA study has raised questions concerning the consistency and reliability of acrolein monitoring results that have not been resolved. The most recent NATA estimates were used as the source of acrolein background concentration for this analysis.

5. IDENTIFICATION OF POTENTIALLY EXPOSED POPULATIONS

The HIA evaluates potential airborne exposure to modeled acetaldehyde, acrolein, and formaldehyde concentrations attributable to the project. Potentially exposed populations within the simulation domain are identified in this section. Various population groups include residents and workers as well as sensitive subpopulations.

5.1 Receptors of Concern

The primary populations potentially exposed to project emissions include residents and workers in the vicinity of the facility. The maximally impacted residential receptor (MIRR) and maximally impacted commercial receptor (MICR) existing locations will be identified and hazards will be quantified at these receptor locations.

The location of the maximally impacted boundary receptor (MIBR) was also identified; these receptors, which are along the facility perimeter that serves as the boundary for publicly accessible land, typically experience concentrations greater than those of more distant receptors, but for lesser periods than residents in homes or workers in a workplace. Potential populations that may periodically be present around the perimeter of the facility include employees or customers of the facility, or those of adjacent businesses.

Exposures at the MIRR, MICR, and MIBR were estimated using averaging periods of one hour, eight hours, and one year.

5.2 Sensitive Populations

For the purpose of this HIA, sensitive populations are identified as children, the infirm, and elderly persons. These subpopulations may have immune systems that are more sensitive to the effects of TAPs. The nearest identified sensitive receptors are listed in Table 5-1, and the locations relative to the facility are presented in Figure 5-1. As shown in Figure 5-1, the sensitive receptors closest to the facility are quite distant, and evaluating exposures at the maximally impacted locations (i.e., the MIRR, MICR, and MIBR), which are closer (see Figure 5-2), and, therefore, have greater exposure than the sensitive receptors, is expected to adequately address the lesser exposures that might occur at sensitive receptor locations.

Table 5-1. Nearest Sensitive Receptors

Type of Receptor	Name	Address	Distance (km / mi)
Daycare/Preschool	Rise & Shine	117 E Scott St Aberdeen, WA 98520	1.2 / 0.75
	Aunt Suzie's Daycare	1023 W Marion St Aberdeen, WA 98520	2.5 / 1.6
Medical Facility	Grays Harbor Community Hospital – East Campus	1008 N H St Aberdeen, WA 98520	3.6 / 2.2
School	Stevens Elementary School	301 S Farragut St Aberdeen, WA 98520	1.3 / 0.81
	Miller Junior High School	100 East Lindstrom Aberdeen, WA 98520	1.6 / 1.0

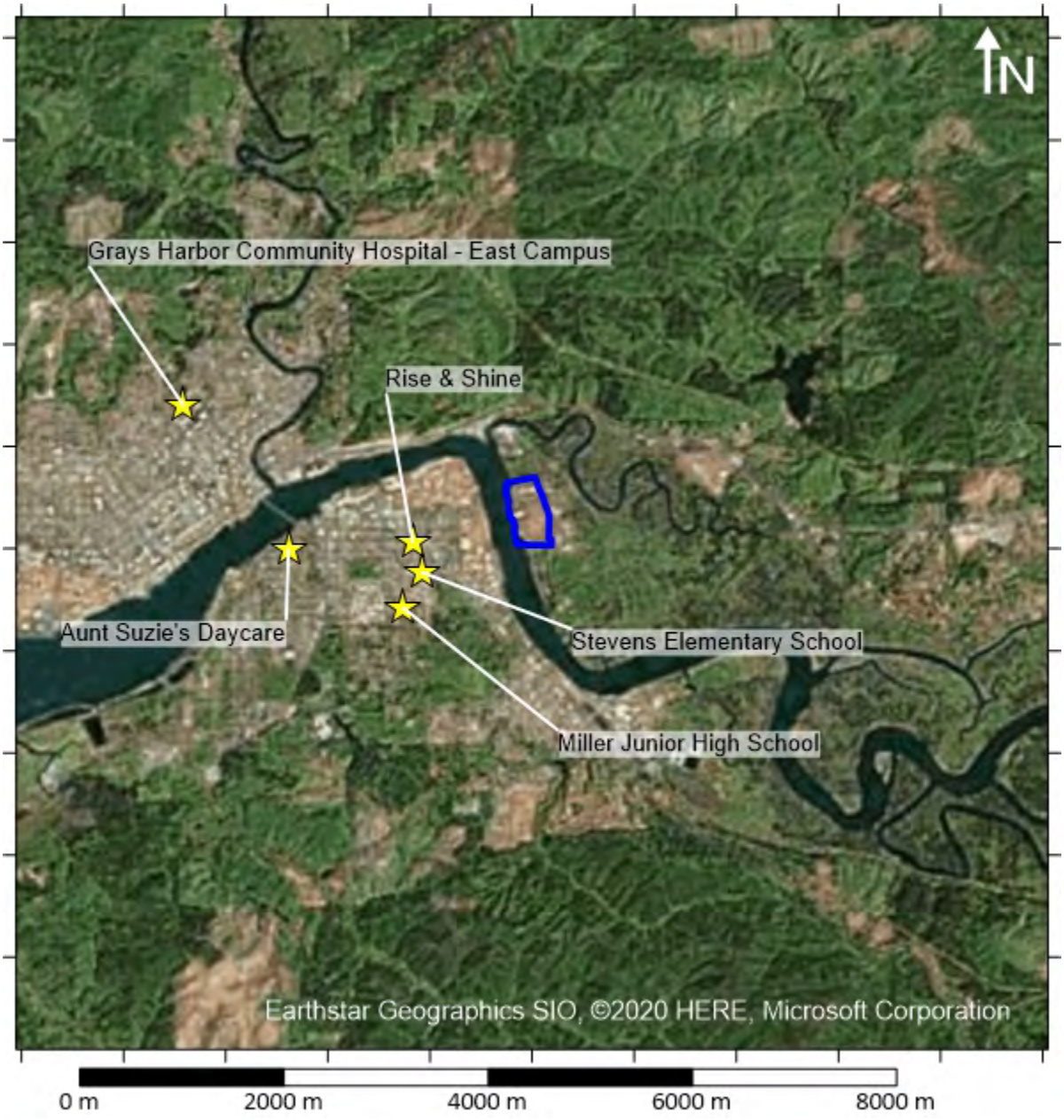

Figure 5-1. Locations of Sensitive Receptors

6. EXPOSURE ASSESSMENT

This section describes the routes and manner by which population groups identified in the previous section may be exposed to new sources of acetaldehyde, acrolein, and formaldehyde proposed by the project. Concentrations to which receptor populations may be exposed and key exposure assumptions also are described.

6.1 Identification of Exposure Pathways

The types of receptors discussed in the previous section, which include residents, workers, and sensitive subpopulations, may be exposed to chemicals present in the environment. Specifically, contact with emissions from the project may occur primarily through direct inhalation. Contact with emissions attributable to the project may also occur indirectly, through incidental ingestion and skin contact with emissions deposited on surface soils. However, for the TAPs assessed in this HIA, indirect exposures through ingestion and skin contact pathways are not considered significant in comparison with the direct inhalation pathway.

Ecology's 2nd Tier guidance document[16] references California Air Toxic Hot Spots Program guidance[17] for assessing whether indirect exposure pathways should be considered in addition to consideration of inhalation exposure. Acetaldehyde, acrolein, and formaldehyde are not chemicals for which the California Air Toxic Hot Spots Program recommends consideration of multiple exposure pathways. Typically, chemicals considered for alternate ingestion pathways (e.g., soil, produce, breast milk, livestock/game, etc.) are those that are persistent and bioaccumulative. Acetaldehyde, acrolein, and formaldehyde do not bioaccumulate, and are, therefore, not prioritized for multi-pathway evaluation. Based on Ecology and California Air Toxic Hot Spots Program guidance, inhalation was the only exposure pathway assessed in the HIA.

6.2 Exposure Concentrations

The maximum airborne exposure concentrations (ECs) estimated for acetaldehyde, acrolein, and formaldehyde are provided in Table 4-3. The maximum concentration

[16] Department of Ecology, "Guidance Document: First, Second, and Third Tier Review of Toxic Air Pollution Sources (Chapter 173-460 WAC)." Publication Number 08-02-025, revised September 2013.

[17] Office of Environmental Health Hazard Assessment (OEHHA), California Environmental Protection Agency, "Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments." February 2015. http://www.oehha.ca.gov/air/hot_spots/2015/2015GuidanceManaual.pdf

receptors are all predicted to occur at the property boundary; therefore, these receptors represent both the MIR and the MIBR, which are presented in Table 6-1. The MICR and MIRR concentrations are presented in Tables 6-2 and 6-3, respectively. The locations of the MIR/MIBR, MIRR, and MICR are shown in Figure 6-1.

Table 6-1. MIBR and MIR Concentrations and Receptors

Chemical	MIBR/MIR		
	Period	Concentration (µg/m³)	Coordinates[1]
Acetaldehyde	1-Hour	29.7	441165, 5202092
	8-Hour	18.4	441165, 5202092
	Annual	2.79	440839, 5202094
Acrolein	1-Hour	0.521	441165, 5202092
	8-Hour	0.324	441165, 5202092
	Annual	0.0491	440839, 5202094
Formaldehyde	1-Hour	1.90	441165, 5202092
	8-Hour	1.18	441165, 5202092
	Annual	0.179	440839, 5202094

1. Universal Transverse Mercator (UTM) coordinates in Zone 10 using the NAD 83 datum system.

Table 6-2. MIRR Concentrations and Coordinates

Chemical	MIRR		
	Period	Concentration (µg/m³)	Coordinates[1]
Acetaldehyde	1-hr	20.6	441212, 5202213
	8-hr	12.0	441212, 5202213
	Annual	1.57	441212, 5202200
Acrolein	1-hr	0.361	441212, 5202213
	8-hr	0.211	441212, 5202213
	Annual	0.0276	441212, 5202200
Formaldehyde	1-hr	1.32	441212, 5202213
	8-hr	0.768	441212, 5202213
	Annual	0.101	441212, 5202200

1. Universal Transverse Mercator (UTM) coordinates in Zone 10 using the NAD 83 datum system.

Table 6-3. MICR Concentrations and Coordinates

Chemical	MICR		
	Period	Concentration ($\mu g/m^3$)	Coordinates[1]
Acetaldehyde	1-hr	28.0	441100, 5202025
	8-hr	14.9	441125, 5202025
	Annual	1.23	441175, 5202025
Acrolein	1-hr	0.492	441100, 5202025
	8-hr	0.263	441175, 5202025
	Annual	0.0216	441175, 5202025
Formaldehyde	1-hr	1.79	441100, 5202025
	8-hr	0.96	441175, 5202025
	Annual	0.0788	441175, 5202025

1. Universal Transverse Mercator (UTM) coordinates in Zone 10 using the NAD 83 datum system.

Figure 6-1. Locations of MIBR, MIRR, and MICR

6.2.1 Calculating ECs

For noncancer hazards, acute exposures were calculated using the model-predicted maximum 1-hour and 8-hour average concentrations at the maximally impacted receptors, and the maximum annual average concentrations were used to calculate chronic exposures.

It is important to note that EPA and OEHHA offer slightly different guidance for assessing chronic hazards to offsite workers. EPA recommends adjusting the long-term exposure concentration to account for the fact that workers may not be present in the vicinity of a facility on a continuous basis.[18] In the absence of an 8-hour reference exposure level (REL), OEHHA recommends using the chronic REL and the annual average air concentration at maximally-impacted commercial receptors without adjustments to estimate chronic hazards at nearby workplace. OEHHA guidance also notes that if available, "the 8-hour RELs can be used to evaluate the potential for health impacts (including effects of repeated exposures) in offsite workers, and to children and teachers exposed during school hours."[19] In this case, 8-hour RELs are available for acetaldehyde, acrolein, and formaldehyde and will be used to estimate the potential for health impacts at the MICR.

ECs for increased cancer risk will be based on the maximum annual modeled air concentration, modified by a representative exposure time (ET), exposure frequency (EF), exposure duration (ED), and averaging time (AT), as shown in the following equation:

EC ($\mu g/m^3$) = [modeled air concentration ($\mu g/m^3$) x ET x EF x ED] / AT

Exposure parameter values used to calculate the increased cancer risk ECs are presented in Table 6-4.

[18] United States Environmental Protection Agency (EPA), "Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment) Final," January 2009. http://www2.epa.gov/risk/risk-assessment-guidance-superfund-rags-part-f

[19] Office of Environmental Health Hazard Assessment (OEHHA), California Environmental Protection Agency, "Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments." February 2015. http://www.oehha.ca.gov/air/hot_spots/2015/2015GuidanceManaual.pdf

Table 6-4. Exposure Parameters Used to Calculate ECs for Increased Cancer Risk

Exposure Parameter	Resident	Commercial / Industrial Worker	Boundary Receptor
ET (hours per day)	24	8	2
EF (days per year)	350[1]	250	250
ED (years)	70	40	30
AT (hours; 70 years x 365 days/year x 24 hr/day)	613,200	613,200	613,200
Fraction of 70-Year Continuous Exposure	0.9589	0.1305	0.02446

1 350 days of annual exposure was assumed for residential receptors per OEHHA guidance (see Table I.2 on page of Appendix I to Air Toxics Hot Spots Program Risk Assessment Guidelines: The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments, August 2003) https://oehha.ca.gov/media/downloads/crnr/hraguidefinal.pdf

6.2.2 Background ECs

The second tier review outlined in WAC 173-460-090 includes a requirement, in WAC 173-460-090(5), that TAP background concentration be considered as part of the second tier review, but does not describe the form or method of this consideration. To satisfy this requirement, ambient background concentrations were estimated for the area in which the facility is located using the latest NATA data, as described in Section 4.3. These background concentrations were combined with calculated cancer risk increases attributable to proposed project. It should be noted that calculated cancer risk increases combined with background concentrations are not intended for compared with the regulatory project approval threshold for increased cancer risk provided in WAC 173-460-090(7).

7. TOXICITY ASSESSMENT

This section contains information regarding the toxicity of the TAPs of concern, which, in this case, are acetaldehyde, acrolein, and formaldehyde. Included are descriptions of toxic effects and the general levels of exposure associated with those effects, which can be used to evaluate the risk of those effects occurring. Additionally, a brief summary of the toxicokinetics of exposure via inhalation is provided. Risk-based concentrations from EPA (i.e., IRIS), ATSDR, and OEHHA were compiled and used to determine quantitative estimates of acute and chronic toxicity, as well as cancer risk. Table 7-1 summarizes the non-cancer values for each chemical of interest and Table 7-2 provides the cancer unit risk values.

Table 7-1. Non-Cancer, Risk-Based Concentrations

Toxic Air Pollutant	Source	Type[1]	Value ($\mu g/m^3$)
Acetaldehyde	EPA	Chronic RfC	9
	OEHHA	Acute REL	470
		8-Hour REL	300
		Chronic REL	140
Acrolein	EPA	Chronic RfC	0.02
	OEHHA	Acute REL	2.5
		8-Hour REL	0.7
		Chronic REL	0.35
	ATSDR	Acute MRL	7
		Intermediate MRL	0.09
Formaldehyde	OEHHA	Acute REL	55
		8-Hour REL	9
		Chronic REL	9
	ATSDR	Acute MRL	50
		Intermediate MRL	37
		Chronic MRL	10

1 RfC = reference concentration, REL = reference exposure level, MRL = minimal risk level

Table 7-2. Cancer Inhalation Unit Risk Values

Toxic Air Pollutant	Source	Inhalation Unit Risk (per µg/m³)
Acetaldehyde	EPA	2.2E-06
	OEHHA	2.7E-06
Acrolein	--	--[1]
Formaldehyde	EPA	1.3E-05
	OEHHA	6.6E-06

1. Data inadequate for assessment of carcinogenic potential

7.1 Acetaldehyde

As described in the hazard identification (Section 3), acetaldehyde inhalation may cause a variety of respiratory effects at certain concentrations. The EPA reference concentration (RfC), developed in 1991, is based on two short-term rat exposure studies. In the first, effects on the olfactory epithelium (such as decreases in cell density and viability and histopathological changes in the nasal cavity) were seen at 500 ppm[20]. In this study, no effects were seen at 150 ppm over the 4-week exposure period. The no-observable-adverse-effect level (NOAEL) adjusted for human exposure is 8.7 mg/m^3. In the second study, slight to severe degeneration of the nasal olfactory epithelium was seen at 400 ppm[21], the concentration designated to be the lowest-observable-adverse-effect level (LOAEL), adjusted for human equivalency to a concentration of 16.9 mg/m^3. Uncertainty factors were applied to the NOAEL: 10 for sensitive human populations, 10 for incomplete data and interspecies extrapolation, and 10 for subchronic to chronic exposure. This resulted in the RfC of 9 µg/m^3, which was given a designation of "low confidence" by EPA due to the use of limited, subchronic data.

OEHHA provides acute, 8-hour, and chronic RELs developed in 2008. The 8-hour REL and chronic REL are both based on the same two studies as the EPA RfC. OEHHA generated a benchmark concentration of 178 mg/m^3 from the data. These results were then adjusted for the appropriate duration and uncertainty factors for an 8-hour REL of 300 µg/m^3 and a chronic REL of 140 µg/m^3.

[20] Appleman, L.M., R.A. Woutersen, V.J. Feron, R.N. Hooftman and W.R.F. Notten. 1986. Effect of variable versus fixed exposure levels on the toxicity of acetaldehyde in rats. J. Appl. Toxicol. 6(5): 331-336.

[21] Appleman, L.M., R.A. Woutersen, and V.J. Feron. 1982. Inhalation toxicity of acetaldehyde in rats. I. Acute and subacute studies. Toxicology. 23: 293-297.

The range of chronic toxicity values is 9 to 140 µg/m^3, with the EPA RfC at the low end of the range and the OEHHA REL at the high end. The EPA RfC is falls within the range for normal human breath, with acetaldehyde concentrations of 0.7 to 11 µg/m^3[22]. The OEHHA chronic REL is a more appropriate value for estimating hazards associated with inhalation of acetaldehyde as it represents an updated analysis, performed in 2008 using the same critical studies but the more advanced benchmark dose modeling methodology. Ultimately the use of a benchmark concentration, as well as a more realistic dosimetric adjustment factor (from a 2008 PBPK model[23]), and smaller uncertainty factors result in a more technically sound estimate of acetaldehyde toxicity.

The acute acetaldehyde REL is based on a short-term study of human asthmatics exposed to aerosolized acetaldehyde solutions. The study determined the concentration at which the subjects experienced a 20 percent decrease in forced expiratory volume in one second[24]. The 95 percent lower confidence interval of the mean concentration for this endpoint was chosen to be the LOAEL, at 142 mg/m^3. Uncertainty factors totaling 300 were used (10 for use of a LOAEL instead of a NOAEL and 30 for extra sensitivity in children), resulting in the acute REL of 470 µg/m^3. This REL is also protective of eye irritation, which has a LOAEL of 45 µg/m^3 from a short-term study of 24 human volunteers[25].

Additionally, acetaldehyde is classified as a probable human carcinogen by the EPA, based on inhalation exposures resulting in nasal and laryngeal tumors in rat and hamster studies, respectively. The EPA's cancer inhalation unit risk factor is 2.2E-6 per µg/m^3. OEHHA developed a similar inhalation unit risk factor, 2.7E-6 per µg/m^3, based on rat nasal tumor incidence[26].

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[22] OEHHA. 2008. Appendix D. Individual Acute, 8-Hour, and Chronic Reference Exposure Level Summaries. TSD for Noncancer RELs, December 2008. Revised July 2014. http://www.oehha.ca.gov/air/hot_spots/2008/AppendixD1_final.pdf#page=5

[23] Teeguarden JG, Bogdanffy MS, Covington TR, Tan C and Jarabek AM. 2008. A PBPK model for evaluating the impact of aldehyde dehydrogenase polymorphisms on comparative rat and human nasal tissue acetaldehyde dosimetry. Inhal Toxicol 20(4):375-90.

[24] Prieto L, Sanchez-Toril F, Brotons B, Soriano S, Casan R and Belenguer JL. 2000. Airway responsiveness to acetaldehyde in patients with asthma: Relationship to methacholine responsiveness and peak expiratory flow variation. Clin Exp Allergy 30(1): 71-78.

[25] Silverman L, Schultes HF and First MW. 1946. Further studies on sensory response to certain industrial solvent vapors. J Ind Hyg Toxicol 28: 262-266.

[26] Woutersen RA, Appleman LM, Van Garderen-Hoetmer A and Feron VJ. 1986. Inhalation toxicity of acetaldehyde in rats. III. Carcinogenicity study. Toxicology 41:213-232.

7.2 Acrolein

The EPA RfC (0.02 µg/m^3) is based on a 1978 subchronic rat study in which nasal lesions were reported at LOAEL of 0.4 ppm (0.9 mg/m^3)[27]. The LOAEL adjusted for human exposure is 0.02 mg/m^3, which incorporates uncertainty factors totaling 1,000: √10 for interspecies extrapolation, 10 for sensitive subpopulations, 10 for subchronic to chronic duration, and √10 for use of a LOAEL instead of a NOAEL.

The chronic REL from OEHHA is an order of magnitude higher than the EPA RfC, at 0.35 µg/m^3. This value is based on a 2008 rat study showing lesions in the respiratory epithelium[28]. The LOAEL was 0.6 ppm, and the NOAEL was 0.2 ppm. The NOAEL was adjusted for chronic exposures and human equivalency. A cumulative uncertainty factor of 200 also was applied, which is comprised of: √10 for subchronic to chronic duration, 2 for interspecies toxicokinetic uncertainty, √10 for lack of interspecies toxicodynamic data, and 10 to account of sensitive human populations.

The range in chronic toxicity values is 0.02 to 0.35 µg/m^3, with the EPA RfC at the low end and the OEHHA REL at the high end. These values differ for two main reasons: 1) The EPA used a regional gas dosimetric ratio of 0.14 to adjust the LOAEL whereas OEHHA used a dosimetric adjustment factor of 0.85, based on comparative models of mass flux through nasal passages of a rat and human[29]; and 2) the OEHHA REL is also calculated with a cumulative uncertainty factor of 200, compared to 1,000 for the EPA RfC. The lower cumulative uncertainty factor was possible because the critical study reported a NOAEL and interspecies variability was accounted for by the dosimetric adjustment factor, though an uncertainty factor of 2 was still included because the dosimetric adjustment factor was based on formaldehyde, a chemical analogue. Given the higher uncertainty associated with the RfC, we put greater confidence in the OEHHA REL for the calculation of non-cancer hazards.

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[27] Feron, VJ; Kryusse, A; Til, HP; et al. 1978. Repeated exposure to acrolein vapor: subacute studies in hamsters, rats and rabbits. Toxicology 9:47-57.

[28] Dorman DC, Struve MF, Wong BA, Marshall MW, Gross EA and Willson GA. 2008. Respiratory tract responses in male rats following subchronic acrolein inhalation. Inhal Toxicol 20(3): 205-16.

[29] OEHHA. 2008. Appendix D. Individual Acute, 8-Hour, and Chronic Reference Exposure Level Summaries. TSD for Noncancer RELs, December 2008. Revised July 2014 http://www.oehha.ca.gov/air/hot_spots/2008/AppendixD1_final.pdf#page=47

The OEHHA 8-hour REL is based on the same study as the chronic REL, adjusting for 8-hour worker exposures rather than chronic exposures. This resulted in an 8-hour REL of 0.70 µg/m^3.

The acute OEHHA REL is the geometric mean of the REL values from two different studies, Darley et al. and Weber-Tschopp et al. Both studies were performed on healthy human volunteers exposed to acrolein in a chamber for short durations. The critical endpoint selected from Darley *et al*. was irritation of the eyes, with a LOAEL of 0.06 ppm[30]. An uncertainty factor of 60 was applied, which is comprised of, 6 for use of a LOAEL instead of a NOAEL and 10 for sensitive populations, to result in an REL of 1 ppb (2.3 µg/m^3). From the Weber-Tschopp *et al*. study, the chosen critical effect was also of ocular irritation, with a LOAEL of 0.07 ppm[31]. The same uncertainty factors were applied, resulting in an REL of 1.2 ppb (2.7 µg/m^3). The geometric mean of the REL values from these two studies is 2.5 µg/m^3.

ATSDR provides an acute minimal risk level (MRL) of 0.003 ppm (7 µg/m^3) based on a LOAEL of 0.3 ppm in humans from the same Weber-Tschopp *et al*. study that was used by OEHHA. The critical effects included irritation of the nose and throat and decreased respiratory rate. Uncertainty factors of 100 were applied: 10 for sensitive subpopulations and 10 for use of a LOAEL instead of a NOAEL. This MRL is higher than the OEHHA acute value.

ATSDR also provides an intermediate MRL of 0.09 µg/m^3. This value was based on a LOAEL of 0.4 ppm for nasal metaplasia in the 1978 Feron *et al*. rat study used to derive the EPA RfC. The intermediate duration of 15 to 364 days is not a standard exposure time for modeling air concentrations. Also, acute (1-hour and 8-hour) and chronic hazard indices are expected to be health protective of intermediate duration exposures. As a result, this toxicity value was not used quantitatively in the Risk Characterization.

Acrolein has not been classified as a carcinogen.

[30] Darley E, Middleton J and Garber M. 1960. Plant damage and eye irritation from ozone-hydrocarbon reactions. Agricul Food Chem 8(6):483-484

[31] Weber-Tschopp A, Fischer T, Gierer R and Grandjean E. 1977. [Experimentally induced irritating effects of acrolein on men (author's transl)]. Int Arch Occup Environ Health 40(2): 117-30.

7.3 Formaldehyde

Formaldehyde is also a respiratory irritant, as described in Section 3. The EPA does not provide an RfC for formaldehyde exposure. However, OEHHA provides an acute, 8-hour, and an annual REL, and ATSDR provides an acute, intermediate, and annual MRL.

The chronic and 8-hour RELs are the same, at 9 µg/m^3, and based on the same study showing nasal and eye irritation from occupational exposure over an average of 10 years[32]. The LOAEL from the study was a mean of 0.26 mg/m^3 from the exposed group. A NOAEL of 0.09 mg/m^3 was also provided from a control group. This NOAEL was used to determine both the chronic and 8-hour RELs, after applying an uncertainty factor of 10 to account for sensitive populations (i.e., children with asthma).

The ATSDR chronic MRL is 10 µg/m^3, which is equivalent to 8 ppb. It is based on a study of occupational exposures resulting in histological changes in nasal tissue over an average of 10 years of exposure[33]. This toxicity value is very similar to the chronic REL.

An acute REL of 55 µg/m^3 was derived from a human study of 19 healthy subjects given short term exposures to formaldehyde with an endpoint of eye irritation[34]. OEHHA chose a NOAEL of 0.5 ppm and a LOAEL of 1 ppm, from which a benchmark concentration of 0.44 ppm was derived. An uncertainty factor of 10 was added to account for asthma exacerbation in children. The ATSDR acute MRL is a similar value, at 50 µg/m^3, which is equivalent to 40 ppb. This value is based on a LOAEL of 400 ppb from a study of human volunteers reporting itching, sneezing, mucosal congestion, and a burning sensation in the eyes and nasal passages after a 2-hour exposure[35]. An uncertainty factor of 9 was applied for use of a LOAEL instead of a NOAEL and to account for sensitive populations.

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[32] Wilhelmsson B, and Holmstrom M. 1992. Possible mechanisms of formaldehyde-induced discomfort in the upper airway. Scand. J. Work. Environ. Health 18(6):403-407.

[33] Holmstrom M, Wilhelmsson B, Hellquist H, et al. 1989. Histological changes in the nasal mucosa in persons occupationally exposed to formaldehyde alone and in combination with wood dust. Acta Otolaryngol (Stockh) 107:120-129.

[34] Kulle TJ, Sauder LR, Hebel JR, Green DJ and Chatham MD. 1987. Formaldehyde dose-response in healthy nonsmokers. Japca 37(8): 919-24.

[35] Pazdrak K, Gorski P, Krakowiak A, et al. 1993. Changes in nasal lavage fluid due to formaldehyde inhalation. Int Arch Occup Environ Health 64:515-519.

The intermediate MRL was derived by ATSDR based on lesions in the nasal epithelium and other signs of nasopharyngeal irritation in Cynomolgus monkeys exposed to formaldehyde for 26 weeks for 5 days/week, 22 hours/day[36]. A LOAEL of 2.95 ppm was provided. ATSDR applied an uncertainty factor of 10 for human variability and 3 for interspecies extrapolation to result in an MRL of 0.03 ppm, which is equivalent to 37 $\mu g/m^3$. As discussed for the acrolein intermediate MRL, this exposure time is not standard for air modeling; this toxicity value was not used quantitatively in the Risk Characterization.

The EPA's cancer weight-of-evidence characterization for formaldehyde states that there is limited human evidence and sufficient animal evidence to classify the chemical as a probable human carcinogen. Limited human studies of carcinogenicity focused on cancers of the lung and nasopharynx from persons exposed occupationally. EPA's inhalation unit risk factor is 1.3E-5 per $\mu g/m^3$. The OEHHA inhalation unit risk factor is 6E-6 per $\mu g/m^3$, based on nasal squamous carcinoma data in rats and supported by a human occupational exposure study[37,38].

[36] Rusch GM, Clary JJ, Rinehart WE, et al. 1983. A 26-week inhalation toxicity study with formaldehyde in the monkey, rat, and hamster. Toxicol Appl Pharmacol 68:329-343

[37] Kerns WD, Pavkov KL, Donofrio DJ, Gralla EJ and Swenberg JA. 1983. Carcinogenicity of formaldehyde in rats and mice after long-term inhalation exposure. Cancer Res 43:4382-4392.

[38] U.S. Environmental Protection Agency (US EPA) 1987. Assessment of Health Risks to Garment Workers and Certain Home Residents from Exposure to Formaldehyde. Office of Pesticide and Toxic Substances.

8. RISK CHARACTERIZATION

For the risk characterization, the results of the exposure and toxicity assessments were integrated into quantitative or qualitative estimates of potential health hazards. Cumulative (i.e., accounting for all over-SQER TAPs) cancer risk increases and non-cancer hazard estimates were quantified for the MIRR, MICR, and MIR/MIBR. Where available, the cancer risk attributable to background concentrations were added to the calculated cumulative cancer risk increases attributable to the project emission increases.

8.1 Calculation of Non-Cancer Hazards

The potential for non-cancer adverse health effects from exposure to acetaldehyde, acrolein, and formaldehyde were evaluated by comparing exposure concentrations at the identified receptors to relevant non-cancer toxicological reference values presented in Table 7-1. A concentration that exceeds the relevant value indicates the potential for an adverse health effect. The magnitude of the potential is quantified by the hazard quotient (HQ), which is the calculated ambient concentration divided by the relevant toxicological value. An HQ of one (1) or less indicates that the predicted exposure is unlikely to result in adverse non-cancer health effects, while values greater than one indicate increased probability of health effects. However, because uncertainty factors are employed in the derivation of toxicological reference values, a value greater than one does not necessarily mean a negative health impact will occur.

In cases where there are multiple chemicals with similar toxic effects (i.e., the same tissue or organ system is affected), a Hazard Index (HI) is calculated by summing the HQs with the same averaging periods for all TAPs that exceed the SQER and have similar toxic effects. As indicated in Section 3, acetaldehyde, acrolein, and formaldehyde, all target the respiratory tract, so HIs were calculated for each maximally impacted receptor and averaging period.

Non-cancer hazards are presented with ranges where the toxicity values from different agencies are carried through the analysis, as described in Section 7.

8.1.1 Maximally Impacted Receptor (MIR)/Maximally Impacted Boundary Receptor (MIBR)

As shown in Table 8-1 and Table 8-2, the magnitudes of the maximum and minimum non-cancer HQs calculated for the MIR/MIBR are significantly different, which is a result of the magnitude of the range of toxicity values provided by

multiple agencies. The HIs calculated for 1-hour and 8-hour exposures shown in Table 8-1 are all less than 1, which indicates that no adverse health effects are expected. The calculated annual HIs shown in Table 8-2 range from less than 1, which indicates no adverse health effects would be expected to occur, to a maximum of 3. However, the single instance of a calculated HI greater than 1 (i.e., 2) is the result of including EPA's acrolein RfC in the calculation. As discussed in Section 7.2, EPA places low confidence in the acrolein RfC and there is less uncertainty associated with an HQ or HI based on OEHHA's REL.

Table 8-1: Non-Cancer Hazard Indices for MIR/MIBR, 1-Hour and 8-Hour Averages

TAP	1-Hour Average			8-Hour Average
	EPA	OEHHA	ATSDR	OEHHA
Acetaldehyde		0.06		0.06
Acrolein		0.2	0.1	0.5
Formaldehyde		0.03	0.04	0.1
Hazard Index	0.1-0.3			0.7

Table 8-2: Non-Cancer Hazard Indices for MIR/MIBR, Annual Average

TAP	Annual Average		
	EPA	OEHHA	ATSDR
Acetaldehyde	0.3	0.02	
Acrolein	2	0.1	
Formaldehyde		0.02	0.02
Hazard Index	0.02-3		

8.1.2 Maximally Impacted Residential Receptor (MIRR)

The non-cancer HQs shown in Table 8-3 and 8-4 are less than those at the MIR/MIBR, but the range is more than an order of magnitude as a result of the range of toxicity values for acetaldehyde and acrolein. The calculated HIs indicate that, for 1-hour and 8-hour exposure, no adverse health effects are expected. For annual exposure, the HIs range from less than 0.01 to 2, with the EPA RfC for acrolein being the primary contributor to the maximum HI.

Table 8-3: Non-Cancer Hazard Indices for MIRR, 1-Hour and 8-Hour Averages

TAP	1-Hour Average			8-Hour Average
	EPA	OEHHA	ATSDR	OEHHA
Acetaldehyde		0.04		0.04
Acrolein		0.1	0.1	0.3
Formaldehyde		0.02	0.03	0.09
Hazard Index	0.1 – 0.2			0.4

Table 8-4: Non-Cancer Hazard Indices for MIRR, Annual Average

TAP	Annual Average		
	EPA	OEHHA	ATSDR
Acetaldehyde	0.2	0.01	
Acrolein	1	0.08	
Formaldehyde		0.01	0.01
Hazard Index	0.01 – 2		

8.1.3 Maximally Impacted Commercial Receptor (MICR)

The MICR is located at a commercially zoned receptor. As shown in Table 8-5, the calculated HIs indicate that, for 1-hour and 8-hour exposures, no adverse health effects are expected to occur. The calculated annual HIs shown in Table 8-6 range from 0.008 to 1, with the EPA RfC for acrolein being the primary contributor to the maximum HI.

Table 8-5: Non-Cancer Hazard Indices for MICR, 1-Hour and 8-Hour Averages

TAP	1-Hour Average			8-Hour Average
	EPA	OEHHA	ATSDR	OEHHA
Acetaldehyde		0.06		0.05
Acrolein		0.2	0.07	0.4
Formaldehyde		0.03	0.04	0.1
Hazard Index	0.1 – 0.3			0.5

Table 8-6: Non-Cancer Hazard Indices for MICR, Annual Average

TAP	Annual Average		
	EPA	OEHHA	ATSDR
Acetaldehyde	0.1	0.01	
Acrolein	1	0.06	
Formaldehyde		0.009	0.008
Hazard Index	0.008 – 1		

8.2 Quantifying Increased Cancer Risk

Calculated increased cancer risk represents the hypothetical increase in the number of cancers within a population exposed to new emissions. For example, an increased cancer risk of 1E-06 means that one additional cancer may occur if one million people were exposed. Cancer risk increase is calculated by multiplying the annual average EC, which is described in Section 6, by a chemical-specific inhalation unit risk factor, which are discussed in Section 7.

EPA and OEHHA provide different inhalation unit risk factors for acetaldehyde and formaldehyde, so cancer risk increases were calculated using both the EPA and OEHHA values. Acrolein is not classified as a carcinogen and was therefore not included in the cancer risk calculations. The cancer risk increases calculated for acetaldehyde and formaldehyde were summed to obtain a cumulative cancer risk increase attributable to proposed project emission increases. Per WAC 173-460-090(7), Ecology's project approval threshold is an increased cancer risk of no more than one in one hundred thousand (i.e., 1E-05).

As discussed in Section 6.2.2, the calculated cancer risk increases were combined with background concentrations to satisfy a regulatory requirement, but the resulting concentrations are not intended for comparison to the project approval threshold, or for use as the basis for Ecology's decision to recommend approval of the project.

8.2.1 Maximally Impacted Receptor (MIR)/Maximally Impacted Boundary Receptor (MIBR)

As shown in Table 8-7, calculated cumulative cancer risk increases at the MIR/MIBR are predicted to be 0.2 per million, which is less than Ecology's project approval threshold of 1 in 100,000 (i.e., 10 per million). The cumulative cancer risk increases plus background cancer risk at the MIR/MIBR are predicted to be 0.3 per million.

Table 8-7: Increased and Cumulative Cancer Risks for MIR/MIBR

TAP	Project Increase Only		Cumulative (Project + Background)	
	EPA	OEHHA	EPA	OEHHA
Acetaldehyde	2E-07	2E-07	2E-07	2E-07
Formaldehyde	6E-08	3E-08	8E-08	4E-08
Sum of Cancer Risk	2E-07	2E-07	3E-07	3E-07

8.2.2 Maximally Impacted Residential Receptor (MIRR)

As shown in Table 8-8, calculated cumulative cancer risk increases at the MIRR are predicted to be 5 per million, which is less than Ecology's project approval threshold of 1 in 100,000 (i.e., 10 per million). The cumulative cancer risk increases plus background cancer risk at the MIRR are predicted to be 7 per million.

Table 8-8: Increased and Cumulative Cancer Risks for MIRR

TAP	Project Increase Only		Cumulative (Project + Background)	
	EPA	OEHHA	EPA	OEHHA
Acetaldehyde	3E-06	4E-06	5E-06	6E-06
Formaldehyde	1E-06	6E-07	2E-06	1E-06
Sum of Cancer Risk	5E-06	5E-06	7E-06	7E-06

8.2.3 Maximally Impacted Commercial Receptor (MICR)

As shown in Table 8-9, calculated cumulative cancer risk increases at the MICR are predicted to be 0.5 per million, which his less than Ecology's project approval threshold of 1 in 100,000 (i.e., 10 per million). The cumulative cancer risk increases plus background cancer risk at the MICR are predicted to be 0.9 per million.

Table 8-9: Increased and Cumulative Cancer Risks for MICR

TAP	Project Only		Cumulative (Project + Background)	
	EPA	OEHHA	EPA	OEHHA
Acetaldehyde	4E-07	4E-07	6E-07	7E-07
Formaldehyde	1E-07	6E-08	3E-07	1E-07
Sum of Cancer Risk	5E-07	5E-07	9E-07	9E-07

9. UNCERTAINTY AND CONCLUSIONS

9.1 Uncertainty Characterization

This HIA employs several assumptions, each with an associated uncertainty. There are uncertainties associated with the emissions rate calculations, air dispersion modeling, background concentrations, and toxicity values. Wherever possible, assumptions were designed to overestimate rather than underestimate hazards and risks to enable regulators to make decisions and recommendations confident that risks and hazards were not underestimated.

9.1.1 Emissions Rate Calculations

An emission rate, which is a quantity of pollutant per unit time (e.g., pounds per hour), is calculated from an emission factor, which is a quantity of pollutant per unit of an activity (e.g., pounds per board foot of lumber dried), and an activity rate, which is a measure of an activity per unit time (e.g., board feet of lumber dried).

For analyses conducted in support of a permitting action, worst-case emission factors and activity rates are employed to ensure that regulatory limits or levels are not exceeded. In this case, rather than assume an annual throughput for each species of lumber the facility is permitted to process and calculate a composite emission factor for each TAP, the worst-case emission factor for each TAP from among the species to be processed was applied to the entire annual throughput for each TAP.

Regarding activity rates, the kilns were assumed to dry the permitted quantity of lumber every year, and the boiler was assumed to operate continuously throughout the year (i.e., 8,760 hours per year) at 100 percent load. The current draft of the Order of Approval issued by ORCAA contains reporting and recordkeeping mechanisms to ensure that SPI does not exceed the permitted throughput limits, meaning that the activity rates used to calculate emissions represent real upper bounds that are unlikely to be exceeded.

As a result of these unrealistic assumptions, the exposures calculated by the model and the risk characterizations presented in this report are likely to overstate, rather than underestimate, the potential.

9.1.2 Air Dispersion Modeling

Any attempt to mathematically model a physical process will involve uncertainties. In this case, potential exposures were based on short-term and annual average

ambient concentrations calculated using AERMOD, a regulatory model designed and demonstrated to over-predict ambient concentrations. In addition, the concentrations used to calculate exposure are outdoor concentrations, which do not account for effects that tend to diminish concentrations as air migrates indoors (e.g., absorption by building materials, deterioration, chemical reactions, or filtration by ventilation systems). Uncertainty associated with the design of the dispersion model is most likely characterized as the degree to which the predicted concentrations overestimate the actual concentrations.

The meteorological data provided to the model can be a source of uncertainty, related to the quality of the data, and whether the selected data are representative of conditions at the area of interest. In this case, the level of uncertainty has been mitigated by selecting data gathered at the ASOS station located at HQM. The ASOS program is a joint effort of the NWS, the Federal Aviation Administration (FAA), and the Department of Defense (DOD), and is the primary surface weather observing network in the U.S. ASOS is designed primarily to support weather forecast activities and aviation operations, so it utilizes the most modern sensors, has excellent data recovery, and employs rigorous quality assurance procedures. With respect to representativeness, the terrain between KHQM and the facility is not complex (i.e., it is relatively flat), and the site is located approximately 8 miles from the airport. Based on the quality of the data and the proximity of the source to the location where the data were collected, the meteorological data is not considered a significant source of uncertainty.

While there are uncertainties associated with estimating ambient concentrations using an air dispersion model, we believe that reasonable care has been taken to consistently err on the side of more exposure rather than less.

9.1.3 Background Concentrations

Background concentrations of a compound are typically added to modeled concentration attributable to emissions from a given source to obtain a more realistic estimate of the exposure that a population of interest will experience. Because no monitoring data are available in the vicinity of the facility, background concentrations for most compounds of interest were estimated using an annual average concentration from the 2014 NATA. The NATA provides only annual average concentrations, so short-term background concentrations were not estimated.

Acetaldehyde, acrolein, and formaldehyde degrade in the atmosphere, a fact that was not considered in the model. These three TAPs have degradation half-lives of less than 20 hours; therefore, the annual exposure concentrations are overestimated. However, some of the degradation by-products may also have toxicity that can increase risk to the population. Because there are several by-products and environmental and seasonal conditions affect the degradation pathway, it was beyond the scope of this assessment to quantify the risks from these by-products.

9.1.4 Toxicity Values

There is uncertainty associated with development of toxicity values. To derive non-cancer toxicity values, agencies such as the EPA, OEHHA, and ATSDR choose critical studies that show effects from exposure to the chemical of interest. Agencies do not always choose the same studies, which may result in variation between the animal species or chemical formulation tested, the exposure duration, and the exposure concentrations. These differences can result in different LOAEL and NOAEL values. Some studies also may not present a NOAEL if only high concentrations of the chemicals were tested. The database of studies on any given chemical expands over time and new studies may present different NOAEL or LOAEL values. Even if two agencies choose the same critical study, if benchmark dose methodology is used in place of a NOAEL or LOAEL, the resulting toxicity values will differ.

Once a LOAEL/NOAEL or benchmark concentration is chosen, the agency then extrapolates to a value relevant to humans for an exposure duration (acute or chronic). This requires the use of uncertainty factors. The magnitude of the uncertainty factors is often based on professional judgment and may differ between agencies.

Due to differences in critical study selection, method for calculating the LOAEL/NOAEL, and application of uncertainty factors, EPA toxicity values for acetaldehyde and acrolein are two to three orders of magnitude lower than the corresponding chronic toxicity values from OEHHA and ATSDR. These differences resulted in hazard indices that ranged from below 1, not expected to result in adverse health effects, to greater than 1. Given the significance of the range spanning the threshold of one, careful consideration of the underlying toxicity value is warranted. In the case of acrolein, the low confidence placed by EPA in the RfC and OEHHA’s application of the preferred benchmark dose method for the REL

derivation, among other factors, provide greater support for the HQ based on the REL.

9.2 Conclusions

Our conclusions, based on the results from the risk characterization as well as the uncertainties explained above, are presented for the non-cancer hazards and the cancer risks.

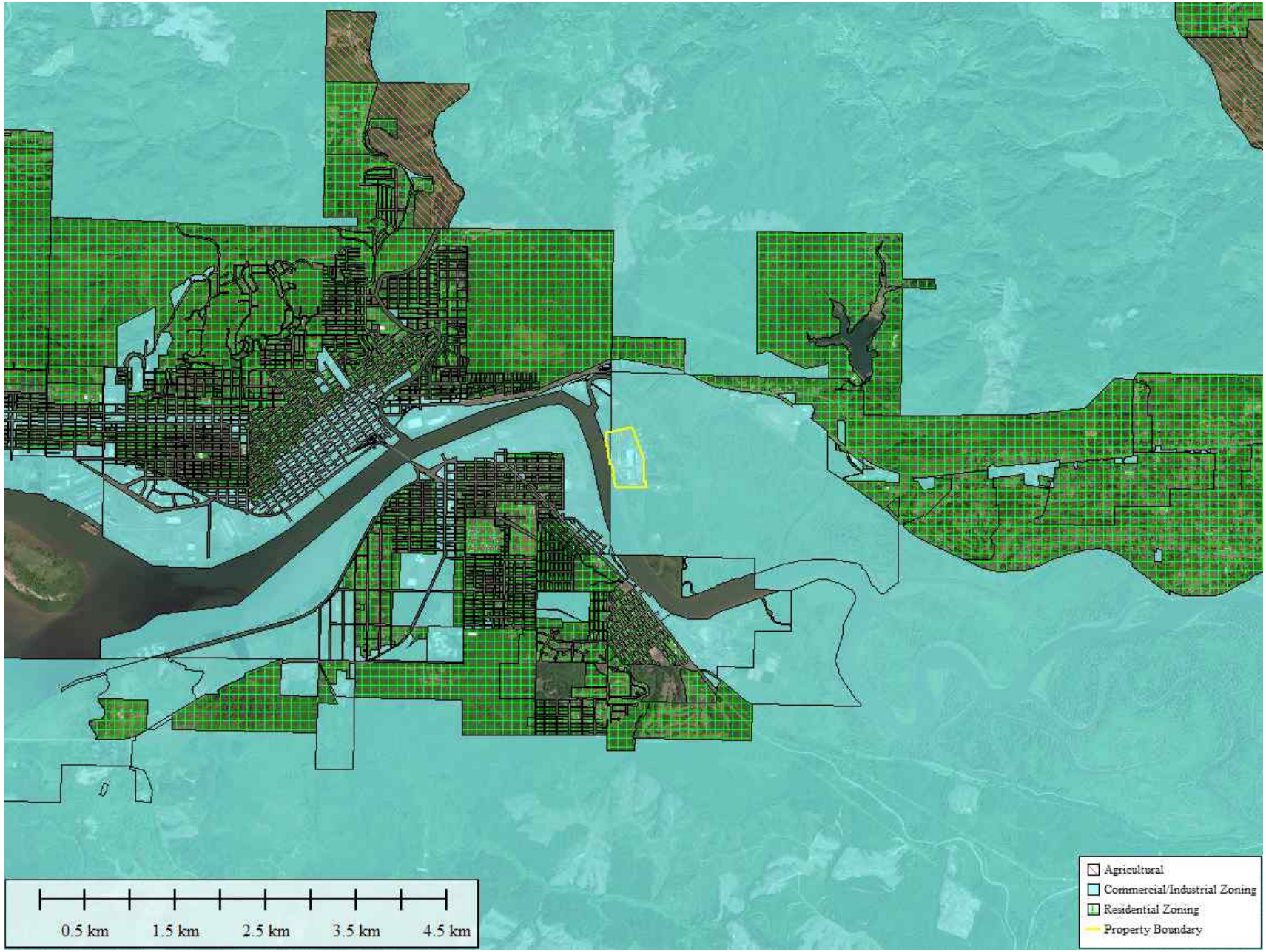
9.2.1 Non-Cancer Hazards

The calculated acute and chronic non-cancer hazards do not exceed unity, except for the chronic HQ at the MIR/MIBR, which, when using the EPA's chronic reference concentration (RfC) for acrolein, is 3. As discussed in Section 7.2, confidence in the accuracy of this HQ is significantly reduced as a result of the high uncertainty associated with EPA's acrolein RfC. The HI calculated using the OEHHA chronic REL for acrolein is less than unity.

9.2.2 Increased Cancer Risk

The calculated cumulative cancer risk increases attributable to TAP emission increases associated with the project are not predicted to exceed one per hundred thousand (i.e., 1E-05) at the MIR/MIBR, MIRR, or MICR, which is the cancer risk increase project approval threshold for the second tier methodology provided in WAC 173-460-090.

APPENDIX A: ZONING MAP


0.5 km
1.5 km
2.5 km
3.5 km
4.5 km
Agricultural
Commercial/Industrial Zoning
Residential Zoning
Property Boundary