

**PROJECT REPORT**  
**Health Impact Assessment Report / Raymond CDK**

**Weyerhaeuser, Inc. / Raymond, WA**

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# 1. EXECUTIVE SUMMARY

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Weyerhaeuser Company (Weyerhaeuser) owns and operates a softwood lumber mill in Raymond, Washington (the Facility). The Facility is located at 51 Ellis Street, Raymond, WA 98577. The Raymond mill currently operates under Olympic Region Clean Air Agency (ORCAA) Air Operating Permit (AOP) 12AOP915 in an attainment or unclassified area for all pollutants. The Facility currently produces kiln dried lumber using batch kilns, and several other products from wood residuals generated in the milling process such as wood chips, sawdust, and shavings. The Facility is a major source of hazardous air pollutants (HAPs), carbon monoxide (CO), nitrogen oxides (NOx), and volatile organic compounds (VOCs) and therefore, subject to the Title V program.

Weyerhaeuser is proposing the addition of one new continuous dry kiln (CDK) to replace the existing batch kilns used in the lumber drying process. Additionally, the existing wood fired boiler will be shut down as part of this project.

Weyerhaeuser submitted a Notice of Construction (NOC) application for the project to ORCAA in September 2023. An NOC application addendum was submitted to ORCAA in November 2023 which showed project emissions over the significant quantity emission rates (SQERs) for seven toxic air pollutants (TAPs): arsenic, benzene, cadmium, formaldehyde, lead, manganese, and nickel.

Air dispersion modeling presented in the November 27, 2023, and February 14, 2024, NOC application addendums showed compliance with the acceptable source impact level (ASIL) for arsenic, cadmium, lead, manganese, and nickel. However, the first tier review showed modeled concentrations over the ASIL for benzene and formaldehyde. Therefore, a second tier review is conducted to demonstrate that benzene and formaldehyde emissions from the project do not have significant health impacts on the community. This report serves as the health impact assessment (HIA) report for the second tier review. The signed second tier review petition form and \$10,000 fee were submitted directly to Ecology's Cashiering Office in September 2023 when the HIA protocol was submitted.

This HIA report contains the following elements:

- ▶ Section 2. Toxic Air Pollutant Screening Analysis
- ▶ Section 3. Modeling Methodology
- ▶ Section 4. First Tier Modeling Results
- ▶ Section 5. Identification of Exposed Populations
- ▶ Section 6. Hazard Identification
- ▶ Section 7. Proposed Toxicological Thresholds
- ▶ Section 8. Uncertainty Characteristics
- ▶ Appendix A: Zoning Map
- ▶ Appendix B: Modeling Parameters
- ▶ Appendix C: BACT Analysis, tBACT Analysis, and NOC Addendum

## 2. TOXIC AIR POLLUTANT SCREENING ANALYSIS

In Washington, all new sources emitting TAPs are required to show compliance with the Washington TAP program pursuant to WAC 173-460. Ecology has established a SQER and ASIL for each listed TAP. If the total project-related TAP emissions increase exceeds its respective SQER, further determination of compliance with the ASIL is required. Table 2-1 shows the emission increases for each TAP that exceeds its respective SQER after using project netting calculations. Detailed calculations showing all TAP emissions and project netting description are provided in Appendix C.

**Table 2-1. TAP Emissions Summary**

<b>Pollutants</b>	<b>CAS Number</b>	<b>Averaging Period</b>	<b>SQER (lb/averaging period)</b>	<b>Net Project Emissions</b>	<b>Modeling Required?</b>
Formaldehyde	50-00-0	year	27	3,229.99	<b>Yes</b>
Benzene	71-43-2	year	21	1,365.57	<b>Yes</b>
Arsenic	7440-38-2	year	0.049	1.72	<b>Yes</b>
Cadmium	7440-43-9	year	0.039	1.28	<b>Yes</b>
Lead	7439-92-1	year	14	15.16	<b>Yes</b>
Manganese	7439-96-5	24-hr	0.022	0.13	<b>Yes</b>
Nickel	7440-02-0	year	0.62	3.42	<b>Yes</b>

Analyses for best available control technology (BACT) and best available control technology for toxics (tBACT) are included in Appendix C. All TAPs emitted are emitted as either PM or VOC. Therefore, the BACT determinations listed for PM and VOC emissions also satisfy tBACT requirements for this emission unit. This analysis includes conclusions from the originally submitted NOC application and the NOC application addendum submitted to ORCAA in November 2023.

The only source of TAPs from this project are related to the operation of the CDK. This section presents the methodology used to quantify TAP emissions from the new equipment.

### 2.1 Continuous Dry Kiln

As a direct-fired combustion unit, the CDK emits pollutants from the combustion of green sawdust and the drying of the wet wood product. There is no currently available data for direct-fired CDKs drying Douglas fir in the Pacific Northwest (PNW) region. Current data includes emission factors for direct-fired CDKs in the southern US, primarily drying southern pine, or indirect-heated batch kilns in the PNW, drying Douglas fir. However, one source cannot be used for all pollutants, since some pollutants are related to the fuel type and firing method (direct vs indirect, batch vs continuous), as compared to others that are related to wood species (e.g., Douglas fir), or even both fuel type and wood species. The following subsections detail the emission factors used in the calculation of CDK emissions from this Project.

#### 2.1.1 Fuel-Based Emissions

Emissions of cadmium, manganese, and lead are dependent on the kiln’s fuel type. Therefore, emissions are estimated using the combustion emission factors based on NCASI Technical Bulletin No. 1013: A

Comprehensive Compilation and Review of Wood-Fired Boiler Emissions, Table 4.3. The median wet scrubber factors were used due to the scrubbing effects from the humidity inside the kiln. The emission factor is used with the total kiln heat input (50 million British thermal units per hour [MMBtu/hr]) and annual operating hours (8,760 hours/year).

Benzene emissions are also dependent on the kilns fuel type and are estimated with this method using factors from AP-42 Section 1.6: Wood Residue Combustion in Boilers, Table 1.6-3.

Arsenic emissions are dependent on the kiln fuel type. This pollutant has been reviewed further to showcase the burner styles contribution to emissions and provides site specific information. Arsenic emissions are estimated using data from a stack test completed in 2009 on the hog fuel boiler at the Facility to create a linear relationship between particulate matter less than 10 micron (PM<sub>10</sub>) and arsenic emissions. Based on data from a study published in The Journal of Environmental Sciences in 2018<sup>1</sup>, there is a direct correlation between arsenic and PM emissions. Air samples near industrial activity in several cities in China were taken and the samples were analyzed for heavy metal concentrations. Approximately 73% of the measured arsenic was in the "fine mode" (1.1-2.1 micron) while the remaining 27% was in the "coarse mode" (9-10 micron). While the majority of arsenic was found in the mode that would classify as PM<sub>2.5</sub>, the proposed method applies a linear ratio of arsenic to PM<sub>10</sub>.

To account for the differences in a combustion process verses the CDK gasification burner, the arsenic to PM<sub>10</sub> ratio is applied to the CDK PM<sub>10</sub> emission factor from the "EPD Recommended Emission Factors for Lumber Kiln Permitting in Georgia." This factor uses total annual throughput in million board feet (MMBF) to determine emissions from both combustion and drying but does not include emissions from startup and idling. A combustion emission factor for wood-fired boilers with wet scrubber control technology from NCASI Technical Bulletin 1013<sup>2</sup> is used for the expected startup and idling emissions.

### 2.1.2 Fuel- and Species-Based Emissions

Formaldehyde relies on both the wood species and the firing method. Due to formaldehyde's dependence on direct or indirect heating, the drying emission factor in the "EPA Region 10 HAP and VOC Emission Factors for Lumber Drying, January 2021" workbook may underrepresent formaldehyde emissions. Therefore, this emission factor is scaled up by the proportion of direct to indirect average batch kiln emission factors for formaldehyde in the "NCASI Wood Products Air Emission Factor Database – 2013 Update." Since this emission factor becomes a proxy for a direct-fired unit, the combustion emissions have been accounted for and therefore do not need to be included in addition to the scaled emission factor, as was done for the other TAP pollutants. Emissions for operations without wood being dried (i.e. during startup or idle operations) is also accounted for using the median emission factor described in NCASI Technical Bulletin No. 1013: A Comprehensive Compilation and Review of Wood-Fired Boiler Emissions, Table 4.1.

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<sup>1</sup> "Size Distribution and Source of Heavy Metals in Particulate Matter on the Lead and Zinc Smelting Affected Area" published in the Journal of Environmental Sciences, April 2018.

<sup>2</sup> NCASI Technical Bulletin No. 1013: A Comprehensive Compilation and Review of Wood-Fired Boiler Emissions, Table 4.3: Summary of Trace Metal Emissions from Wood-Fired Boilers

## 3. MODELING METHODOLOGY

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This section describes the modeling methodology used for the second tier TAP analysis. This methodology described below represents the same methodology that was used in the first tier review presented in the NOC application.

### 3.1 Model Selection

Version 22112 of the AERMOD model is used to estimate maximum ground-level concentrations in the air dispersion analysis. AERMOD is a refined, steady-state, multi-source, air dispersion model used for industrial sources.<sup>3</sup>

### 3.2 Meteorological Data

AERMOD-ready meteorological data for the period 2018-2022 was prepared using the U.S. EPA's AERMET meteorological processing utility (version 22112). Standard U.S. EPA meteorological data processing guidance was used as outlined in a recent memorandum<sup>4</sup> and other documentation.

#### 3.2.1 Surface Data

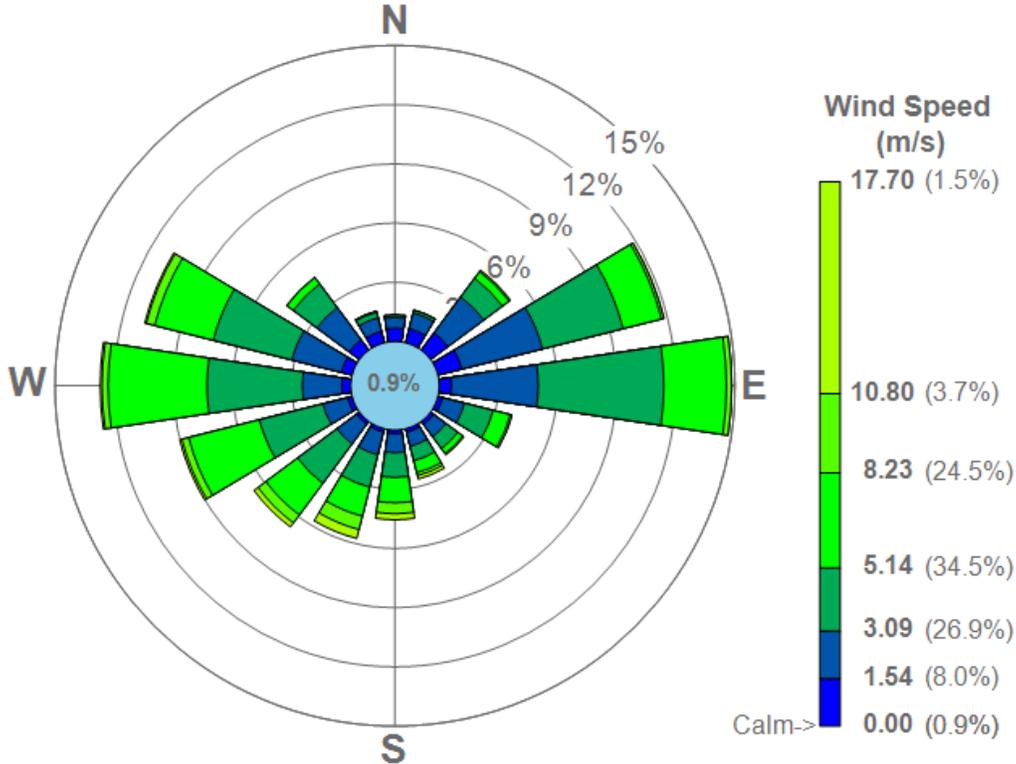
Raw hourly surface meteorological was obtained from the U.S. National Climactic Data Center (NCDC) for Hoquiam Bowerman Airport (KHQM, WMO ID: 727923) in the standard ISHD format. This data was supplemented with TD-6405 (so-called "1-minute") wind data from KHQM for 2018-2022. The 1-minute wind data was processed using the latest version of the U.S. EPA AERMINUTE pre-processing tool (version 15272). Quality of the 1-minute data was verified by comparison to the hourly ISHD data from KHQM, which showed only small differences typical of 1-minute and hourly wind data comparisons. The "Ice-Free Winds Group" AERMINUTE option was selected due to the fact that a sonic anemometer was used at KHQM for the entire period. Figure 3-1 shows the distribution of wind speed and direction for the site.

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<sup>3</sup> 40 CFR 51, Appendix W- *Guideline on Air Quality Models*, Appendix A.1- AMS/EPA Regulatory Model (AERMOD).

<sup>4</sup> Fox, Tyler, U.S. Environmental Protection Agency. 2013. "Use of ASOS Meteorological Data in AERMOD Dispersion Modeling." Available Online: [https://www.epa.gov/sites/default/files/2020-10/documents/20130308\\_met\\_data\\_clarification.pdf](https://www.epa.gov/sites/default/files/2020-10/documents/20130308_met_data_clarification.pdf)

**Figure 3-1. 2018-2022 Wind Rose for Hoquiam Bowerman Airport (KHQM)**



### 3.2.2 Upper Air Data

In addition to surface meteorological data, AERMET requires the use of data from a near-sunrise-time upper air sounding to estimate daytime mixing heights. Upper air data from the nearest U.S. National Weather Service (NWS) upper-air balloon station, located in Quillayute, WA (UIL), was obtained from the National Oceanic and Atmospheric Administration (NOAA) in FSL format.

### 3.2.3 Land Use Analysis

Parameters derived from analysis of land use data (surface roughness, Bowen ratio, and albedo) are also required by AERMET. In accordance with U.S. EPA guidance, these values were determined using the latest version of the U.S. EPA AERSURFACE tool (version 20060).<sup>5</sup> The AERSURFACE settings used for processing are summarized in Table 3-1, below. The met station coordinates were determined by visually identifying the met station using Google Earth. NLCD 2016 (CONUS) Land Cover data, Canopy data, and Impervious data used in AERSURFACE processing were obtained from the Multi-Resolution Land Use Consortium (MRLC).

U.S. EPA guidance dictates that on at least an annual basis, precipitation at a surface site should be classified as wet, dry, or average in comparison to the 30-year climatological record at the site. This determination is used to adjust the Bowen ratio estimated by AERSURFACE. To make the determination, annual precipitation in each modeled year (2018-2022) was compared to the 1991-2020 climatological

<sup>5</sup> U.S. Environmental Protection Agency. February 2020. "User's Guide for AERSURFACE Tool." EPA-454/B-20-008. Available Online: [https://gaftp.epa.gov/Air/aqmg/SCRAM/models/related/aersurface/aersurface Ug\\_v20060.pdf](https://gaftp.epa.gov/Air/aqmg/SCRAM/models/related/aersurface/aersurface Ug_v20060.pdf)

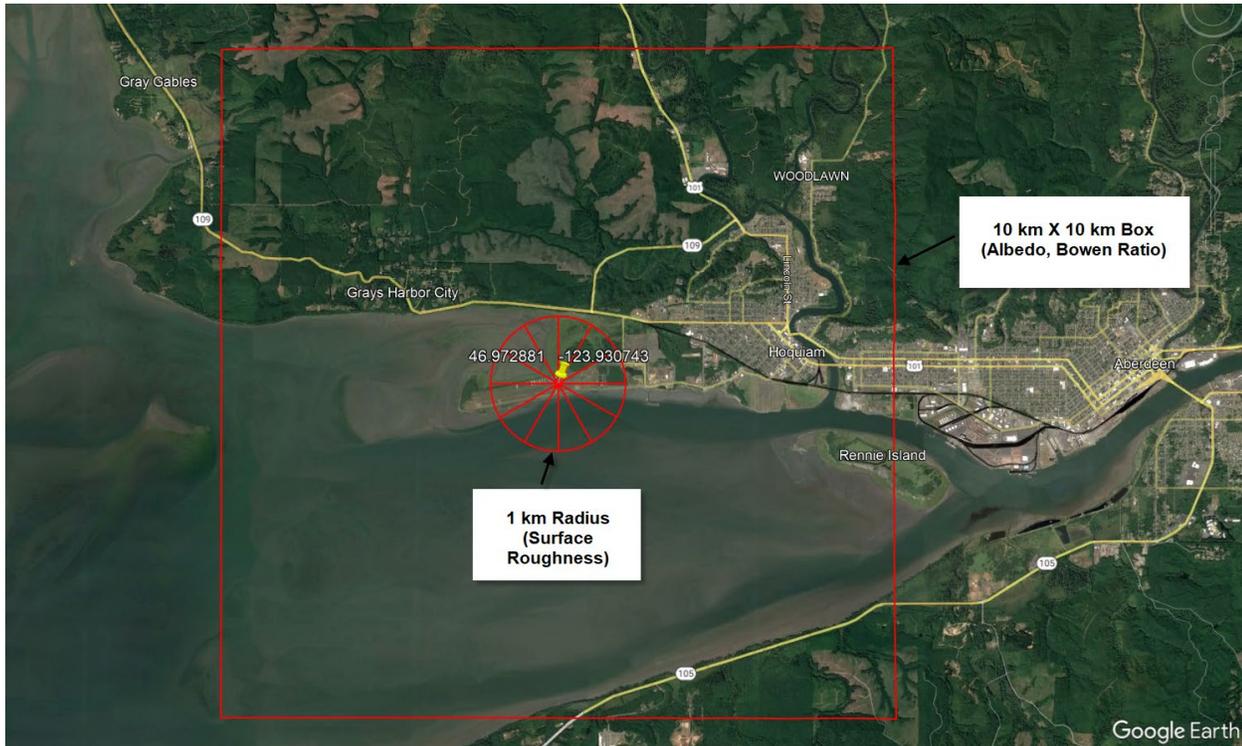
record for KHQM. The annual precipitation data is from the Climate Data Online platform provided by NOAA National Centers for Environmental Information. The 30<sup>th</sup> and 70<sup>th</sup> percentile values of the annual precipitation distribution from 1991-2020 were calculated. Per U.S. EPA guidance, each modeled year was classified for AERSURFACE processing as “wet” if its annual precipitation was higher than the 70<sup>th</sup> percentile value, “dry” if its annual precipitation was lower than the 30<sup>th</sup> percentile value, and “average” if it was between the 30<sup>th</sup> and 70<sup>th</sup> percentile values. The values used in this analysis are included in Table 3-1.

**Table 3-1. AERSURFACE Input Parameters**

<b>AERSURFACE Parameter</b>	<b>Value</b>
Met Station Latitude	46.972881
Met Station Longitude	-123.930743
Datum	NAD 1983
Radius for surface roughness (km)	1.0
Vary by Sector?	Yes
Number of Sectors	12
Temporal Resolution	Seasonal
Continuous Winter Snow Cover?	No
Station Located at Airport?	Airport Sector: 3, 4, 8-10 Non-Airport Sector: 1, 2, 5-7, 11, 12
Arid Region?	No

U.S. EPA recommendations were used to specify the area used for the AERSURFACE analysis. Surface roughness was estimated based on land use within a 1 km radius of the meteorological station, with directional variation in roughness accounted for by using the maximum of twelve thirty-degree sectors. Albedo and Bowen ratio were estimated based on a 10x10 km box centered on the meteorological station. Figure 3-2 shows the areas used for the land use analysis.

**Figure 3-2. Areas Used for AERSURFACE Land Use Analysis**



### 3.2.4 AERMET Processing Options

Standard AERMET processing options were used in this case<sup>6,7</sup>, with the exception of the ADJ\_U\* option. The options elected include:

- ▶ MODIFY keyword for upper air data
- ▶ THRESH\_1MIN 0.5 keyword to provide a lower bound of 0.5 m/s for 1-minute wind data
- ▶ AUDIT keywords to provide additional QA/QC and diagnostic information
- ▶ ASOS1MIN keyword to incorporate 1-minute wind data
- ▶ NWS\_HGT WIND 10 keyword to designate the anemometer height as 10 meters
- ▶ METHOD WIND\_DIR RANDOM keyword to correct for any wind direction rounding in the raw ISHD data
- ▶ METHOD REFLEVEL SUBNWS keyword to allow use of airport surface station data
- ▶ Default substitution options for cloud cover and temperature data were not overridden
- ▶ Default ASOS\_ADJ option for correction of truncated wind speeds was not overridden
- ▶ ADJ\_U\* option was used

<sup>6</sup> Fox, Tyler, U.S. Environmental Protection Agency. 2013. "Use of ASOS Meteorological Data in AERMOD Dispersion Modeling." Available Online:

[https://www.epa.gov/sites/default/files/2020-10/documents/20130308\\_met\\_data\\_clarification.pdf](https://www.epa.gov/sites/default/files/2020-10/documents/20130308_met_data_clarification.pdf)

<sup>7</sup> U.S. Environmental Protection Agency. 2019. "User's Guide for the AERMOD Meteorological Preprocessor (AERMET)". EPA-454/B-19-028, August, 2019).

The ADJ\_U\* option adjusts the surface friction velocity parameter (U\*) used by AERMET in certain low wind speed situations. This option, based on a peer-reviewed study<sup>8</sup>, was added to AERMET by U.S. EPA to address the tendency of AERMET/AERMOD to underestimate dispersion and thus overestimate ground-level pollutant concentrations for low-level sources under low wind speed conditions, and became a default regulatory option with U.S. EPA's 2017 revision to the Guideline on Air Quality Models.<sup>9</sup>

### 3.3 Coordinate System

The locations of receptors, buildings and sources are represented in the Universal Transverse Mercator (UTM) coordinate system using the World Geodetic System, 1984 projection. The UTM grid divides the world into coordinates that are measured in north meters (measured from the equator) and east meters (measured from the central meridian of a particular zone, which is set at 500 km)/ UTM coordinates for this analysis are based on UTM zone 10. The location of the Raymond facility is approximately 5,170,748 m Northing and 443,644 m Easting in UTM zone 10.

### 3.4 Terrain Elevations

Terrain elevations for receptors, buildings, and sources are determined using National Elevation Dataset (NED) supplied by the United States Geological Survey (USGS). The NED is a seamless dataset with the best available raster elevation data of the contiguous United States. NED data retrieved for this model have a grid spacing of 1/3 arc-second or 10 m. The AERMOD preprocessor, AERMAP v18081, is used to compute model object elevations from the NED grid spacing. AERMAP also calculates hill height data for all receptors. All data obtained from the NED files are checked for completeness and spot-checked for accuracy.

### 3.5 Urban / Rural Determination

The facility is located in Raymond, Washington on the Willapa River. Raymond is a city with a population of approximately 3,000 people at the time of the 2020 census. Outside of the city, most of the land use is not considered urban (medium to high intensity developed land). For the purposes of this model, it is conservatively assumed that the area surrounding the facility does not meet the definition of urban land use. Therefore, the urban option is not selected in AERMOD.

### 3.6 Receptor Grid

The model has receptors along the fenceline spaced 12.5 m apart. There is also a variable density, square Cartesian receptor grid extending 10,000 m from the center of the facility. This receptor grid spacing is set up according to the following list:

- ▶ 12.5-meter spacing for at least the first 150 meters from the Facility fenceline;
- ▶ 25-meter spacing for the first 650 meters from the center of the Facility;
- ▶ 50-meter spacing from 650 to 1,150 meters from the center of the Facility;
- ▶ 100-meter spacing from 1,150 to 2,250 meters from the center of the Facility;
- ▶ 300-meter spacing from 2,250 to 4,650 meters from the center of the Facility; and
- ▶ 600-meter spacing from 4,650 to 10,000 meters from the center of the Facility.

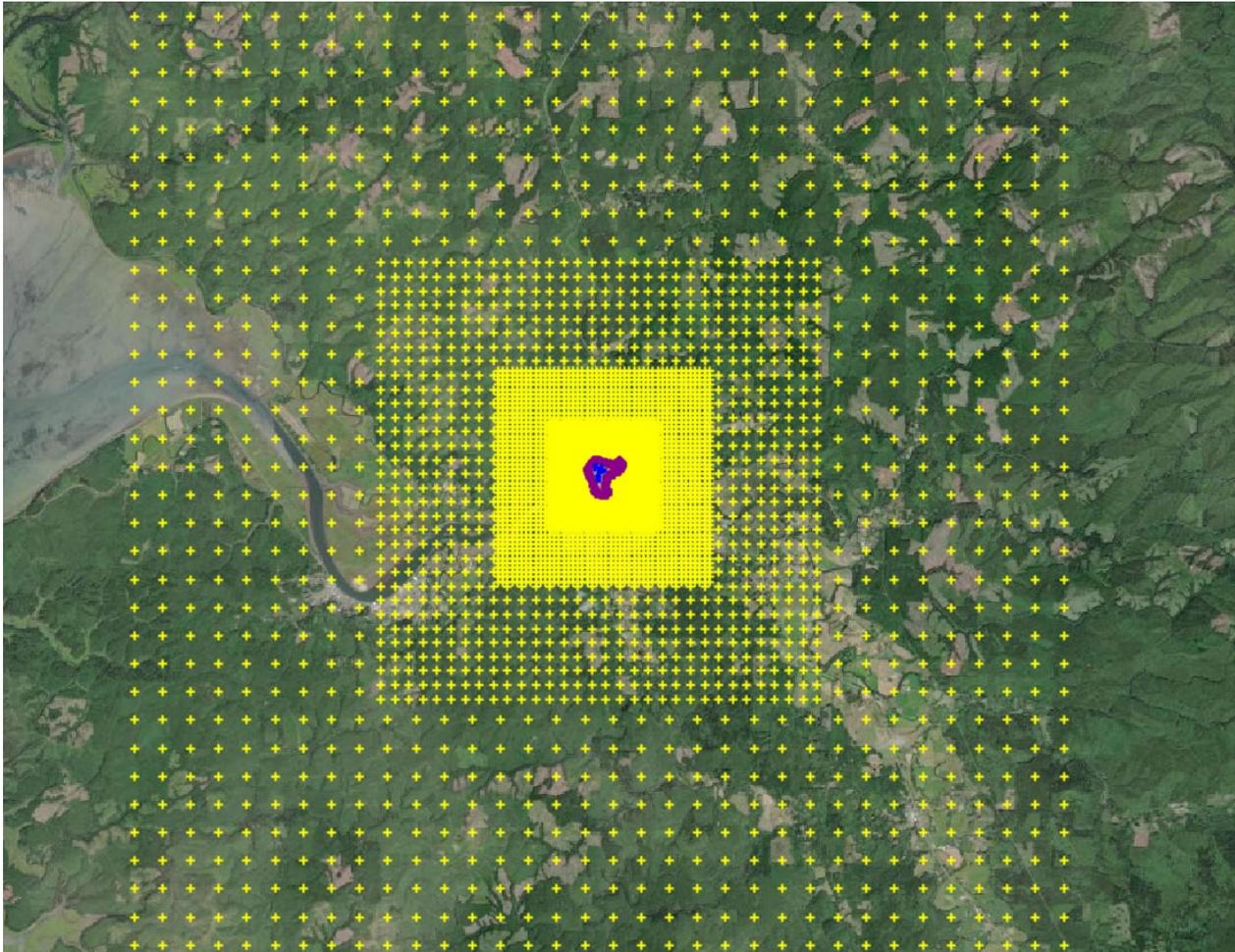
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<sup>8</sup> Qian and Venkatram. 2011. "Performance of Steady-State Dispersion Models Under Low Wind-Speed Conditions." *Boundary-Layer Meteorology*, Volume 138, Issue 3, pp 475-491.

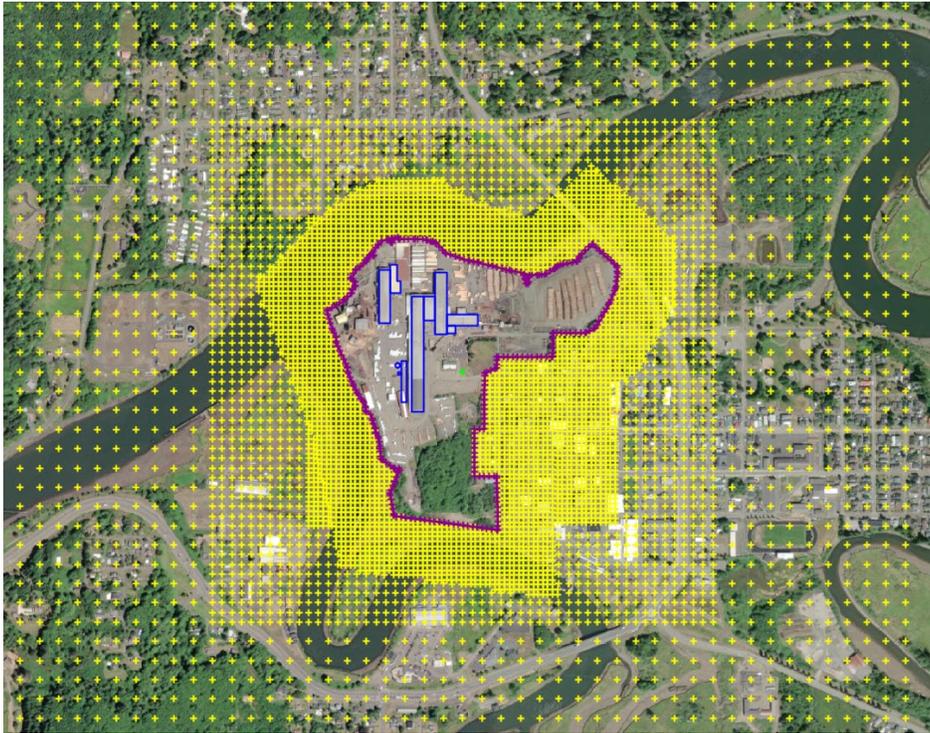
<sup>9</sup> U.S. Environmental Protection Agency. 2017. "Guideline on Air Quality Models." 40 CFR Part 51, Appendix W. [https://www.epa.gov/sites/default/files/2020-09/documents/appw\\_17.pdf](https://www.epa.gov/sites/default/files/2020-09/documents/appw_17.pdf)

All model receptors are placed at a flagpole height of 1.5 meters. Maps of the receptors are shown in Figure 3-3 and Figure 3-4 below. The Facility is shown in Figure 3-5 below with the fenceline represented by the purple outline surrounding the facility with included buildings.

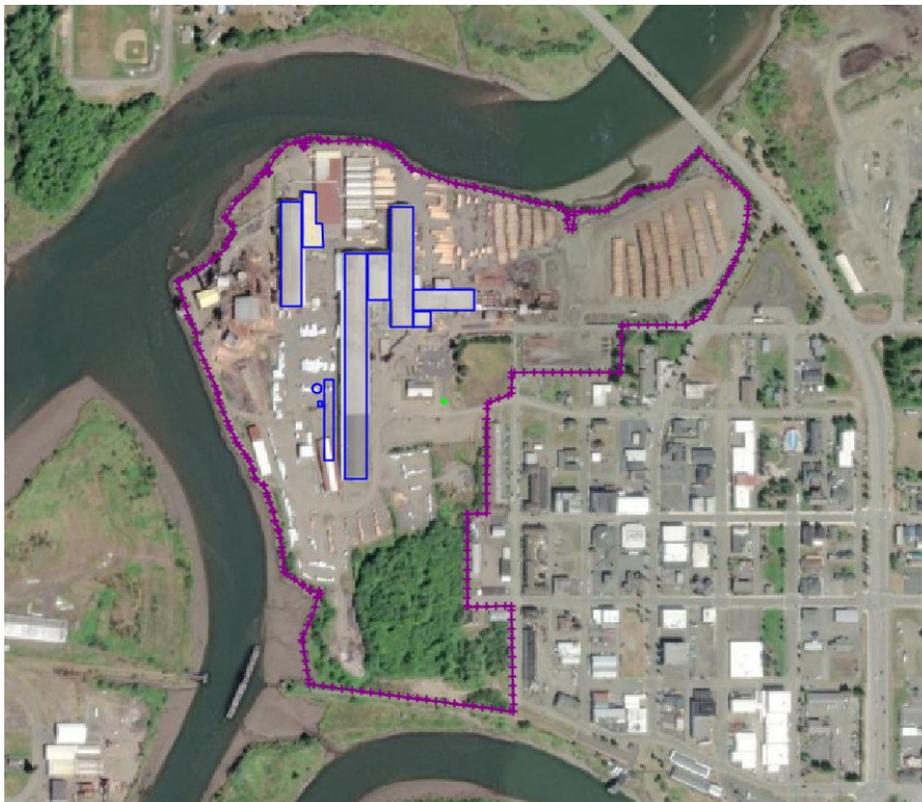
**Figure 3-3. Zoomed Out Receptor Grid**



**Figure 3-4. Zoomed In Receptor Grid**



**Figure 3-5. Facility Fenceline**



### 3.7 Building Downwash

Emissions from each source are evaluated in terms of their proximity to nearby structures. The purpose of this evaluation is to determine if stack discharges might become caught in the turbulent wakes of these structures. Wind blowing around a building creates zones of turbulence that are greater than if the buildings were absent. The concepts and procedures expressed in the GEP Technical Support document, the User's Guide to the Building Profile Input Program, and other related documents are applied to all structures at the Raymond Facility. The Building Profile Input Program for PRIME (BPIPPRM) Version 04274 is used to calculate the downwash values for each point source.

### 3.8 Source Types and Parameters

For the first and second tier modeling, proposed emission sources are included. Emissions from equipment scheduled for removal as part of this project, including a boiler and several batch kilns, were used to determine pollutants that exceed SQER. However, these sources are not included as modeled sources with negative emissions.

Emission releases from the CDK are represented in the model as two point sources and two horizontal point sources. The two point sources represent the vapor extraction points that are expected to capture 80% of emissions. The remaining 20% of emissions are expected to be emitted through the openings at the ends of the kiln. The modeling parameters for the sources are determined based on the following and are included in Appendix B.

#### **Vapor extraction points – point sources:**

- ▶ Exhaust temperature, exhaust flowrate/velocity, release height, and exhaust diameter are obtained from the CDK vendor and engineering firm.
- ▶ Emission rates are based on PTE calculations as described in Section 2; 80% of total kiln emissions are evenly distributed between the two modeled point sources. While daily sources are not anticipated to operate the entirety of a 24-hr period, the maximum hourly emission rate is applied for TAPs with 24-hr averaging periods.

The CDK will be equipped with two sets of two vapor extraction points at each end of the kiln for a total of four vapor extraction points. These vapor extraction points will be spaced closely enough for the exhaust plumes to merge, enhancing plume rise. AERMOD does not explicitly account for this enhanced plume rise. However, the use of a pseudo stack diameter in AERMOD based on the total volume flow rate of the adjacent stacks properly accounts for the enhanced plume rise. EPA has allowed this technique on a case-by-case basis.<sup>10</sup> The judgement as to whether combining flows is appropriate includes:

- ▶ Stack locations – Only stacks located within 1 diameter of each other are treated as a merged source.
- ▶ Stack height and diameter – All of the stacks treated as a merged source have the same stack height and diameter.
- ▶ Stack emission parameters (temperature, momentum or volume flow, emission rates, etc.) - All of the stacks treated as a merged source have the same emission parameters.

The proposed stack arrangement meets these criteria, and the EPA-accepted merged plume technique is used in the modeling analysis. The PSD regulations (40 CFR 51.118(a) and 40 CFR 52.21(h)) contain limits

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<sup>10</sup> Model Clearinghouse Information Storage and Retrieval System Record Details - OH GM Defiance Bubble (97-V-02)

on the use of other dispersion techniques. Dispersion techniques are defined in 40 CFR 51.100(hh)(1) as “any technique which attempts to affect the concentration of a pollutant in the ambient air by...increasing final exhaust gas plume rise by... selective handling of exhaust gas streams so as to increase the exhaust gas plume rise.” However, 40 CFR 51.100(hh)(2) exempts the merging of exhaust gas streams when the facility is originally designed and constructed with merged gas streams.

**Kiln openings – horizontal point sources:**

- ▶ Because of the positive and negative pressure created by the internal fans near the kiln ends, it is expected that ambient air will be drawn into the kiln on the side where dry lumber is exiting and kiln gas is forced out on the side where green lumber is entering. As a result, one horizontal point source is placed at the green lumber entrance on each end of the kiln to represent emissions from the openings on the CDK.
- ▶ The effective diameter for each source is calculated from the area of the opening minus the area covered by the lumber, which is assumed to be 75% of the opening.
- ▶ The release height is calculated as the height of the door minus half of the effective diameter.
- ▶ The exit velocity is conservatively assumed to be one foot per second.
- ▶ Emission rates are based on PTE calculations as described in Section 2; 20% of total kiln emissions are evenly distributed between the two modeled horizontal point sources. While daily sources are not anticipated to operate the entirety of a 24-hr period, the maximum hourly emission rate is applied for TAPs with 24-hr averaging periods.

### 3.9 Background Concentrations

The second tier evaluation for benzene and formaldehyde uses representative background concentrations from the EPA Air Toxics Screening Assessment (AirToxScreen) 2019 database to account for impacts from nearby sources. Weyerhaeuser proposes to use the background concentrations listed in Table 3-2 below. These background concentrations are obtained for census tract 53049950200 from the AirToxScreen 2019 database, which is the census tract the facility is located in.

**Table 3-2. Background Concentrations**

<b>Pollutant</b>	<b>Background Concentration (µg/m<sup>3</sup>)</b>
Benzene	0.1323
Formaldehyde	0.7055

## 4. FIRST TIER MODELING RESULTS

As previously described, a first tier TAP analysis was conducted using AERMOD to compare the impacts of arsenic, benzene, cadmium, formaldehyde, lead, manganese, and nickel from the CDK to their respective ASILs. Table 4-1 presents the results of this first tier review.

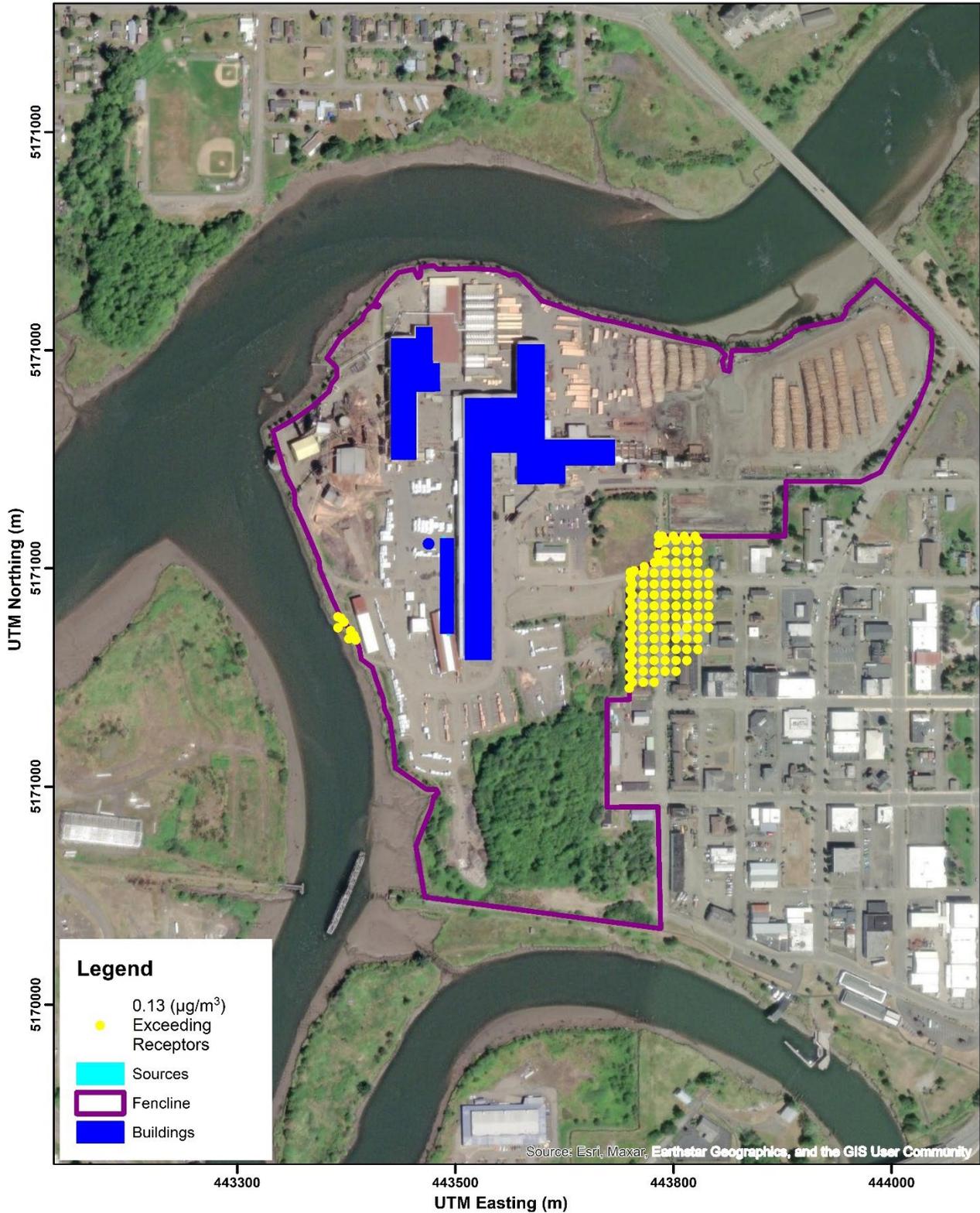
**Table 4-1. Maximum Modeled TAP Concentrations**

<b>Pollutants</b>	<b>Averaging Period</b>	<b>Highest Modeled Concentration (<math>\mu\text{g}/\text{m}^3</math>)</b>	<b>ASIL (<math>\mu\text{g}/\text{m}^3</math>)</b>	<b>Exceeds ASIL?</b>
Arsenic	year	0.0002	0.0003	No
Benzene	year	0.23	0.13	<b>Yes</b>
Cadmium	year	0.00017	0.00024	No
Formaldehyde	year	0.43	0.17	<b>Yes</b>
Lead	year	0.002	0.083	No
Manganese	24-hr	0.03	0.3	No
Nickel	year	0.00047	0.0038	No

As shown in Table 4-1, arsenic, cadmium, lead, manganese, and nickel are in compliance with their corresponding ASIL; however, benzene and formaldehyde are in exceedance of the ASIL. Figure 4-1 and Figure 4-2 show the areas exceeding the ASIL for benzene and formaldehyde, respectively. The receptors shown in these figures are the ASIL exceeding receptors for the year with the maximum result across all five modeled years.

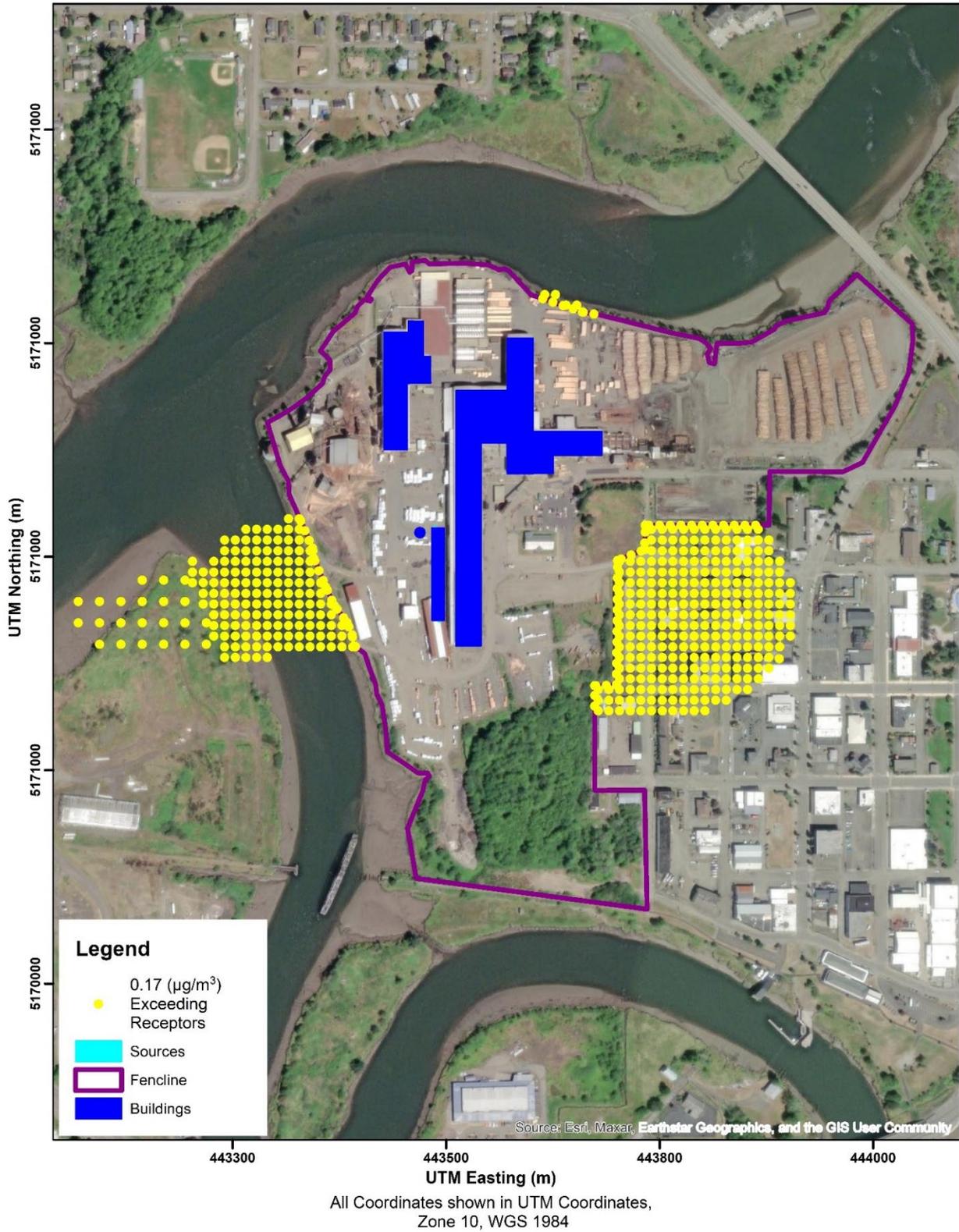
Weyerhaeuser conducted a second tier review for the ASIL exceeding pollutants to demonstrate that the project does not have significant health impacts on the community. Section 5 of this report identifies exposed populations that are considered in the second tier review. Section 6 identifies the hazards associated with each modeled pollutant, Section 7 outlines the toxicological modeling thresholds used as the basis for the HIA.

Figure 4-1. Benzene ASIL-Exceeding Receptors



All Coordinates shown in UTM Coordinates,  
Zone 10, WGS 1984

Figure 4-2. Formaldehyde ASIL-Exceeding Receptors



## 5. IDENTIFICATION OF EXPOSED POPULATIONS

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The Facility is located in Raymond, WA. The zoning designation of the Facility is "Heavy Industrial". The property is immediately bordered by the Willapa River and South Willapa River to the west and north and "General Commercial", "Waterfront Commercial", and "Retail Core" to the east and south. Detailed zoning maps obtained from the City of Raymond are provided in Appendix A.

Within the "General Commercial" zoning area to the east and south of the Facility, there are residential properties near the Facility. The nearest residential area ("Village Green Apartments") is located on the eastern side of the Facility's ambient air boundary. There are also residential areas located across the river to the north and southwest of the facility in "Residential" zones.

The highest-impact receptors are located in the commercial and residential zones immediately adjacent to the Facility. Therefore, the second tier analysis evaluates risk based on the highest modeled receptor concentration for each pollutant averaged over the 5 year meteorological dataset. The maximum impact among those receptors is used to determine the potential health impacts from the Facility in a residentially zoned area.

## 6. HAZARD IDENTIFICATION

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This section describes the tissues and organs that may be impacted by the SQER exceeding pollutants, and the potential acute and chronic health impacts associated. Only health impacts from arsenic, benzene, cadmium, formaldehyde, lead, manganese, and nickel exposure are described here, since they are the only seven pollutants whose emission increases exceed the SQER. The primary exposure pathway for benzene, formaldehyde, and manganese is through inhalation or direct contact with air.

For arsenic, cadmium, lead, and nickel, exposure pathways are also via contact with contaminated water and soil and listed as pollutants that need to be considered for multi-pathway exposure.<sup>11</sup> Based on the following screening methods, each pollutant is considered to have a low potential for multi-pathway risk and has not been further evaluated.

- ▶ Arsenic, cadmium, and nickel – based on modeled concentrations and risk factors published in the Journal of the Air & Waste Management Association by the Minnesota Pollution Control Agency<sup>12</sup>, all proposed non-inhalation pathways for cancer risk are below 0.1 and all non-inhalation pathways for non-cancer risk are below 1.
- ▶ Lead – based on the recommendation from EPA’s Office of Air Quality Planning and Standards<sup>13</sup>, the modeled concentration of lead is compared to the NAAQS of 0.15 µg/m<sup>3</sup> on a three-month rolling average. The maximum 24-hour modeled concentration is 0.01 µg/m<sup>3</sup> which conservatively demonstrates compliance with the NAAQS.<sup>14</sup>

Therefore, health impacts due to multi-pathway risk have not been considered in this analysis.

### 6.1 Arsenic

Arsenic targets the cardiovascular, dermal, gastrointestinal, nervous, and respiratory systems. Acute exposure to arsenic is associated with the following short-term health impacts:<sup>15</sup>

- ▶ Gastrointestinal effects such as nausea, diarrhea, abdominal pain;
- ▶ Central and peripheral nervous system disorders;
- ▶ Effects on the cardiovascular system, liver, kidney, and blood;
- ▶ Oral exposure at doses of approximately 600 micrograms per kilogram of body weight per day (or higher) has resulted in death.

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<sup>11</sup> Ecology’s “Guidance on First, Second, and Third Tier Review of Air Toxics,” includes lead, nickel, and cadmium on the list of TAPs that are required to have multi-pathway exposures assessed.

<sup>12</sup> The multi-pathway screening method obtained from the “Multipathway Screening Factors for Assessing Risks from Ingestion Exposures to Air Pollutants” article published in the Journal of the Air & Waste Management Association. January 2012.

<sup>13</sup> The multi-pathway screening method obtained from the “Residual Risk Assessment for the Plywood and Composite Wood Products Source Category in Support of the 2020 Risk and Technology Review Final Rule” from the EPA’s Office of Air Quality Planning and Standards – Office of Air and Radiation. February 2020.

<sup>14</sup> A longer averaging period will result in lower concentrations with expected variation during different hours of operation and season. Therefore, representation of 3 month compliance using a 24-hour averaging period is sufficiently conservative to indicate further review is not required.

<sup>15</sup> EPA fact-sheet on arsenic compounds from EPA’s Health and Environmental Effects Profile and the IRIS. <https://www.epa.gov/sites/default/files/2016-09/documents/arsenic-compounds.pdf>

Chronic exposure to arsenic is associated with irritation of the skin and mucous membranes. Chronic oral exposure has resulted in gastrointestinal effects, anemia, peripheral neuropathy, skin lesions, hyperpigmentation, gangrene of the extremities, vascular lesions, and liver or kidney damage. Ingested arsenic can cross the placenta. In animals, arsenic has been shown to be fetotoxic and causes birth defects in very high doses. Arsenic is considered a known human carcinogen, and studies report an increased risk between arsenic exposure and the following cancers: lung, bladder, and liver.

## 6.2 Benzene

Benzene targets the nervous, respiratory, immune, and hematopoietic systems. Acute exposure to benzene is associated with the following short-term health impacts:<sup>16</sup>

- ▶ Drowsiness, dizziness, headaches, and unconsciousness;
- ▶ Vomiting and convulsions;
- ▶ Eye, skin, and respiratory tract irritation;
- ▶ Redness and blisters from dermal exposure;
- ▶ In animals, acute inhalation and oral exposure produced neurologic, immunologic, and hematologic effects;
- ▶ Coexposure to benzene with ethanol can increase benzene toxicity in humans.

Chronic exposure to benzene is associated with structural and numerical chromosomal aberrations. In an occupational setting, various disorders in the blood may develop, including aplastic anemia, excessive bleeding, and damage to the immune system. Reproductive effects have been reported for women exposed to high levels by inhalation. In animals, adverse effects have been observed in developing fetuses. Benzene is considered a known human carcinogen for all routes of exposure, as occupational observations have shown that exposure to benzene increases incidences of leukemia, and studies with animals have shown cancerous growth in various organs.

## 6.3 Cadmium

Cadmium targets the urinary and respiratory systems. Acute exposure to cadmium is associated with the following short-term health impacts:<sup>17</sup>

- ▶ Effects on the lungs, including bronchial and pulmonary irritation;
- ▶ A single high-level exposure can result in long-lasting impairment of lung function.

Chronic exposure to cadmium is associated with kidney issues such as proteinuria, a decrease in glomerular filtration rate, and an increased frequency of kidney stone formation. In occupational settings, chronic inhalation of cadmium is associated with effects on the lungs, such as bronchiolitis and emphysema. There is limited evidence that suggests an association between inhalation exposure and a reduction in viability, and some evidence suggests maternal exposure may result in decreased birthweights. In animals, chronic inhalation or oral exposure is associated with effects on the following organs: kidneys; liver; lungs; and bones. Other effects are seen in the animal's immune system, blood, and nervous system. Reproductive and

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<sup>16</sup> EPA fact-sheet on benzene from EPA's Health and Environmental Effects Profile and the IRIS.  
<https://www.epa.gov/sites/default/files/2016-09/documents/benzene.pdf>

<sup>17</sup> EPA fact-sheet on cadmium compounds from EPA's Health and Environmental Effects Profile and the IRIS.  
<https://www.epa.gov/sites/default/files/2016-09/documents/cadmium-compounds.pdf>

developmental effects reported in animals include: low fetal weight; skeletal malformations; interference with fetal metabolism; and impaired neurological development. Cadmium is considered a probable human carcinogen, as there is limited evidence from occupational studies that shows exposure to cadmium increases the risk of lung cancer, and studies with animals have shown cancer development from inhalation exposure.

## 6.4 Formaldehyde

Formaldehyde targets the urinary and gastrointestinal systems. Acute exposure to formaldehyde is associated with the following short-term health impacts:<sup>18</sup>

- ▶ Eye, nose, and throat irritation;
- ▶ At higher exposure levels, coughing, wheezing, chest pains, and bronchitis may occur; and
- ▶ If ingested, formaldehyde may result in corrosion of the gastrointestinal tract and inflammation and ulceration of the mouth, esophagus, and stomach.

Chronic exposure to formaldehyde is associated with respiratory symptoms and eye, nose, and throat irritation. Repeated contact with liquid solutions is associated with skin irritation and allergic contact dermatitis. In animals, chronic inhalation has affected the nasal respiratory epithelium and caused lesions in the respiratory system. There is some information regarding reproductive and developmental effects of formaldehyde in humans, namely that an increased incidence of menstrual disorders was observed in workers using urea-formaldehyde resins. Formaldehyde is considered a probable human carcinogen, as there is limited evidence from occupational studies that exposure to formaldehyde increases lung and nasopharyngeal cancer.

## 6.5 Lead

Lead targets the nervous, immune, and cardiovascular systems. Acute exposure to high levels of lead is associated with the following short-term health impacts:<sup>19</sup>

- ▶ Abdominal pain/colic, vomiting, constipation;
- ▶ Peripheral neuropathy;
- ▶ Cerebral edema; and
- ▶ Encephalopathy, which can lead to seizures, coma, and death.

Chronic exposure to lead is associated with effects on blood pressure and kidney function, and on the nervous, immune, and cardiovascular systems, including interference with vitamin D metabolism. When large amounts are ingested orally, symptoms in the gastrointestinal system, such as colic, constipation, abdominal pain, anorexia, and vomiting, can occur. Severe brain and kidney damage and anemia can occur when blood lead levels are high after exposure. Occupational exposure can affect the nervous system and lead to neurological symptoms, as well as decrease male fertility via depression of sperm count, decreasing function of the prostate, and decreasing function of the seminal vesicles. Exposure to lead during pregnancy can cause developmental effects such as increased risk of preterm delivery, low birthweight, and impaired mental development. Lead is considered a probable human carcinogen, as there is inconclusive evidence

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<sup>18</sup> EPA fact-sheet on formaldehyde from EPA's Health and Environmental Effects Profile and the IRIS.  
<https://www.epa.gov/sites/default/files/2016-09/documents/formaldehyde.pdf>

<sup>19</sup> ATSDR fact-sheet on health effects from lead exposure from ATSDR's Toxicological Profile for Lead.  
<https://www.atsdr.cdc.gov/ToxProfiles/tp13-c2.pdf>

that exposure increases cancer risk in humans. In animals, oral lead exposure has been reported to cause kidney tumors.

## 6.6 Manganese

Manganese is nutritionally essential to humans in low levels, with a recommended daily intake being 2-5 milligrams per day. In high doses, or when exposed via chronic inhalation, manganese targets the nervous and respiratory systems. Acute exposure to manganese is not associated with short-term health impacts in humans, but the following impacts have been shown in studies with mice and rats:<sup>20</sup>

- ▶ Inflammation of the lungs, which can lead to impaired lung function.

Chronic exposure to manganese via inhalation results in effects on the nervous system such as slower visual reaction time, poorer hand steadiness, and impaired hand-eye coordination, as well as manganism. Effects on the respiratory system include an increased incidence of cough, bronchitis, difficulty breathing, and an increased susceptibility to infectious lung disease. Occupational exposure via inhalation has shown impotence and loss of libido in male workers. In animals, degenerative changes in reproductive systems have resulted in sterility, and a decrease in testosterone production in developing animals has been shown. There is some evidence to suggest that children exposed to higher manganese levels in drinking water are affected behaviorally and cognitively. Manganese is not classified as a carcinogen by the EPA at this time.

## 6.7 Nickel

Nickel is nutritionally essential for some mammalian species and is suggested to be essential to humans. In high doses, or when exposed via inhalation, targets the integumentary and respiratory systems. Acute exposure to nickel is associated with the following short-term health impacts:<sup>21</sup>

- ▶ Lung and kidney damage
- ▶ Gastrointestinal distress
- ▶ Pulmonary fibrosis and renal edema

Chronic exposure to nickel is associated with dermatitis, eczema, asthma, decreased lung function, and bronchitis. In animals, effects of nickel inhalation are reported on the lungs and immune system, and effects from oral exposure of soluble nickel salts are reported to increase stillborn pups, pup mortality, and reduce fetal body weight. There is insufficient evidence to suggest that nickel is a carcinogen and it not classified as a carcinogen by the EPA at this time.

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<sup>20</sup> EPA fact-sheet on manganese from EPA's Health and Environmental Effects Profile and the IRIS.  
<https://www.epa.gov/sites/default/files/2016-10/documents/manganese.pdf>

<sup>21</sup> EPA fact-sheet on nickel compounds from EPA's Health and Environmental Effects Profile and the IRIS.  
<https://www.epa.gov/sites/default/files/2016-09/documents/nickle-compounds.pdf>

## 7. TOXICITY AND RISK ASSESSMENT

### 7.1 Toxicity Values

The toxicity values used for this second tier review are obtained from the California Office of Environmental Health Hazard Assessment (OEHHA). OEHHA establishes reference exposure levels (RELs) for acute and chronic non-carcinogenic health hazards.<sup>22</sup> OEHHA also establishes unit risk factors (URF) for carcinogenic health hazards.<sup>23</sup> Per Ecology guidance, the non-carcinogenic and carcinogenic risks are evaluated for all pollutants in excess of their SQERs to account for potential cumulative impacts among pollutants with the same averaging period and target organs. Table 7-1 lists the non-carcinogenic and carcinogenic toxicity values for these pollutants.

**Table 7-1. Toxicity Values**

Pollutants	Chronic REL (µg/m <sup>3</sup> )	Acute REL (µg/m <sup>3</sup> )	8-Hour REL (µg/m <sup>3</sup> )	Cancer URF (µg/m <sup>3</sup> ) <sup>-1</sup>
Arsenic	0.015	0.2	0.015 <sup>a</sup>	3.3 E-3
Benzene	3	27	3	2.9 E-5
Cadmium	0.02 <sup>a</sup>	--	--	4.2 E-3
Formaldehyde	9	55	9	6.00 E-6
Lead	--	--	--	1.2 E-5
Manganese	0.09	--	0.17	--
Nickel	0.014 <sup>a</sup>	0.2	0.06	2.6 E-4

a. Inhalation REL.

### 7.2 Non-Carcinogenic Risk Assessment

To quantify the acute and chronic non-carcinogenic impacts from the project, the RELs and the annual average modeled concentrations from new equipment are used to calculate hazard quotients (HQ). The chronic and acute HQs for pollutants are calculated using the following equations:

$$\text{Chronic HQ} = \frac{\text{Conc. of TAP} \left( \frac{\mu\text{g}}{\text{m}^3} \right) (\text{Annual Avg. Period})}{\text{Chronic REL} \left( \frac{\mu\text{g}}{\text{m}^3} \right)}$$

$$\text{Acute HQ} = \frac{\text{Conc. of TAP} \left( \frac{\mu\text{g}}{\text{m}^3} \right) (\text{Hourly Avg. Period})}{\text{Acute REL} \left( \frac{\mu\text{g}}{\text{m}^3} \right)}$$

Table 7-2 below shows the modeled concentration for the averaging period and the chronic and acute HQs for all SQER exceeding pollutants from the new equipment. The annual averaging period concentration uses the average of all years.

<sup>22</sup> RELs obtained from OEHHA "Acute, 8-hour and Chronic REL Summary, August 20, 2020. <https://oehha.ca.gov/air/general-info/oehha-acute-8-hour-and-chronic-reference-exposure-level-rel-summary>

<sup>23</sup> URFs obtained from the California Office of Environmental Health Hazard Assessment "Technical Support Document for Cancer Potency Factors - Appendix B". <https://oehha.ca.gov/media/downloads/cmr/appendixb.pdf>

**Table 7-2. Pollutant Chronic and Acute Hazard Quotients**

Pollutant	Modeled Concentration (µg/m <sup>3</sup> )		Chronic HQ	Acute HQ
	Annual	1-Hour		
Arsenic	2.06E-04	0.01	0.01	0.06
Benzene	0.21	4.93	0.07	0.18
Cadmium	1.52E-04	3.62E-03	0.01	--
Formaldehyde	0.39	9.81	4.37E-02	0.18
Lead	1.71E-03	0.04	--	--
Manganese	5.09E-03	0.15	0.06	--
Nickel	4.32E-04	1.04E-02	0.03	0.05

As discussed in Section 6, several pollutants target the same systems in the body, for example, both arsenic and benzene target the nervous and respiratory system. Since there are multiple chemicals that affect the same systems in the body, a Hazard Index (HI) is calculated for each affected system.

The chronic and acute HIs for various systems is calculated using the following equations:

$$Chronic HI_{system} = \sum Chronic HQ_{system}$$

$$Acute HI_{system} = \sum Acute HQ_{system}$$

An HI of less than one indicates that adverse health effects are unlikely to occur. Table 7-3 and Table 7-4 below show the affected systems determination for each pollutant (based on information presented in Section 6) and project-related chronic and acute HIs for all SQER exceeding pollutants respectively.

**Table 7-3. Affected Systems Hazard Index Determination**

Affected System	Arsenic	Benzene	Cadmium	Formaldehyde	Lead	Manganese	Nickel
Nervous	x	x			x	x	
Respiratory	x	x	x	x	x	x	x
Skin	x	x			x		x
Mucous Membranes	x	x		x	x		
Urinary	x		x	x	x		x
Gastrointestinal	x	x		x	x		x

**Table 7-4. System Chronic and Acute Hazard Indexes**

<b>Affected System</b>	<b>Total Chronic HI</b>	<b>Total Acute HI</b>
Nervous	0.14	0.24
Respiratory	0.22	0.47
Skin	0.11	0.29
Mucous Membranes	0.13	0.42
Urinary	0.10	0.29
Gastrointestinal	0.16	0.47

As shown, the HIs are significantly below one at all locations for both chronic and acute non-cancer risk. This satisfies the requirement in WAC 173-460-090 to demonstrate that non-cancer hazards associated with the project are acceptable.

### 7.3 Carcinogenic Risk Assessment

The lifetime (70 year) increased cancer risk for ASIL exceeding pollutants are evaluated in this HIA. Per WAC 173-460-090, the second tier review must demonstrate that the increase in TAP emissions will not result in an increased cancer risk of more than 10 per million. The increase in cancer risk from the project is calculated using the following formula:

$$Risk = \frac{Conc. \text{ of TAP } \left( \frac{\mu g}{m^3} \right) \times URF \times EF1 \times EF2 \times ED}{AT}$$

where EF1 is the exposure frequency in days/year, EF2 is the exposure frequency in hours/day, ED is the exposure duration in years, and AT is the averaging time in hours (613,200 hours for a 70 year average). It is assumed that all ASIL exceeding receptors are classified as residential receptors for ease of evaluation and conservatism. The exposure frequencies for the residential receptor type are presented in Table 7-5 below; which presume a person is continuously located at a single location for 70 years.

**Table 7-5. Exposure Frequencies**

<b>Exposure Frequency</b>	<b>Residential Receptor</b>
EF1	365
EF2	24
ED	70

The total increase in cancer risk from the new equipment is calculated by summing the individual increases in cancer risk for benzene and formaldehyde. In addition to calculating the project-related increase in cancer risk, the cumulative cancer risk is calculated using the background concentration identified in Section 3.9.

The average annual modeled concentrations for all ASIL exceeding pollutants are used to calculate the increase in cancer risk for a person continuously located in one spot for 70 years. Concentrations for benzene and formaldehyde are shown in Table 7-6 which also shows the calculated increase in cancer risk from the new equipment is less than 10 per million. Table 7-7 shows the increase in cancer risk for each individual pollutant including the background concentration.

**Table 7-6. Total Cancer Increase**

Receptor Type	Modeled Annual Concentration ( $\mu\text{g}/\text{m}^3$ )		Cancer Risk Increase (per million)		Total Cancer Risk Increase (per million)
	Benzene	Formaldehyde	Benzene	Formaldehyde	
Residential	0.21	0.39	5.98	2.36	8.33

**Table 7-7. Cancer Increase Including Background**

Receptor Type	Modeled Annual Concentration + Background ( $\mu\text{g}/\text{m}^3$ )		Cancer Risk Increase (per million)	
	Benzene	Formaldehyde	Benzene	Formaldehyde
Residential	0.34	1.10	9.81	6.59

## 8. UNCERTAINTY CHARACTERIZATION

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### 8.1 Emission Estimates

TAP emissions are calculated using emission factors developed by NCASI. The factors applied in this analysis are based on multiple source tests conducted at various lumber mills with similar CDK processes.

As discussed in Section 2.1.2, formaldehyde emissions are dependent on whether the process utilizes direct or indirect heating. Because of this, the drying emission factor in the "EPA Region 10 HAP and VOC Emission Factors for Lumber Drying, January 2021" workbook may underrepresent formaldehyde emissions. Therefore, this emission factor is scaled up by the proportion of direct to indirect average batch kiln emission factors for formaldehyde in the "NCASI Wood Products Air Emission Factor Database – 2013 Update." Since this emission factor becomes a proxy for a direct-fired unit, the combustion emissions have been accounted for and therefore are not included in addition to the scaled emission factor, as was done for the other TAP pollutants. However, when the CDK is not operating, it is assumed that the unit is in start-up mode and is being fired at 50 MMBtu/hour for up to 360 hours/year.

In addition, modeled results presented in this assessment are based on maximum potential facility operation, conservatively assuming that the worst-case weather conditions coincide with maximum operation. Actual operations may differ from estimated maximums, indicating that actual impacts are likely lower than modeled results presented in this report.

### 8.2 Model Results

AERMOD is an Environmental Protection Agency (EPA) approved and recommended steady-state plume model that incorporates terrain, meteorological effects, and building downwash to calculate pollutant concentrations from a variety of source types. According to 40 CFR Part 51, Appendix W, AERMOD is appropriate for the following:

- ▶ Point, volume, and area sources;
- ▶ Surface, near-surface, and elevated releases;
- ▶ Rural or urban areas;
- ▶ Simple and complex terrain;
- ▶ Transport distance over which steady-state assumptions are appropriate, up to 50 km;
- ▶ 1-hour to annual averaging times; and
- ▶ Continuous toxic air emissions.

AERMOD is periodically updated to refine the dispersion calculations and provide more accurate results. Although it is impossible to perfectly calculate air dispersion and predict pollutant impacts due to unforeseen meteorological conditions, AERMOD should be considered highly reliable for this analysis.

Model results for this analysis are based on meteorological data from 2018-2022. Future meteorological conditions may vary and affect actual pollutant concentrations differently; however, it is expected that 5 years of meteorological data include representative worst-case conditions for the future. Therefore, the level of uncertainty due to the model is expected to be low.

## 8.3 Toxicity Data

The toxicity data, in this case the RELs and URFs, are the basis for performing the quantitative risk assessment. EPA and other agencies developing the toxicity data for risk assessments apply uncertainty factors to derive the doses or concentrations from various studies. The uncertain factors usually include interspecies extrapolation, possible human variability in sensitivity etc., which are intended to result in protective doses or concentrations.

### 8.3.1 Benzene

OEHHA's acute benzene REL is based on a study conducted on pregnant female mice. The LOAEL was obtained for mice and adjusted for human exposure. Uncertainty factors of  $10^{0.5}$  (LOAEL uncertainty), 2 (toxicokinetic),  $10^{0.5}$  (toxicodynamic), and  $10^{1.5}$  (intraspecies), were applied.<sup>24</sup> While there is a high degree of uncertainty in this study, this is accounted for by applying this cumulative uncertainty factor of 600. Overall, there is a high degree of confidence the acute REL is protective of human health.

OEHHA's chronic benzene REL is based on a study conducted on humans (250 shoe workers and 140 volunteers). The LOAEL was obtained for the study group. Uncertainty factors of  $10^{0.5}$  (sub-chronic) and 60 (intraspecies) were applied.<sup>25</sup> While there is a high degree of uncertainty in this study, this is accounted for by applying this cumulative uncertainty factor of 200. Overall, there is a high degree of confidence the chronic REL is protective of human health.

### 8.3.2 Formaldehyde

OEHHA's acute formaldehyde REL is based on a study conducted on humans (19 nonasthmatic, nonsmoking people). The LOAEL and NOAEL were obtained for the study group. An uncertainty factor of 10 was applied to account for asthma exacerbation in children.<sup>26</sup> While the study has an assumed degree of uncertainty, this is accounted for by applying this cumulative uncertainty factor of 10. Overall, there is a high degree of confidence the acute REL is protective of human health.

OEHHA's chronic formaldehyde REL is based on two studies conducted on humans (66 chemical plant workers and 192 children). The LOAEL and NOAEL were obtained for the study groups. The two studies determined similar RELs (9 and 10  $\mu\text{g}/\text{m}^3$ ).<sup>27</sup> While the studies have an assumed high degree of uncertainty, this is accounted for by applying this cumulative uncertainty factor of 10 and  $10^{0.5}$  respectively. Overall, there is a high degree of confidence the acute REL is protective of human health.

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<sup>24</sup> California Office of Environmental Health Hazard Assessment (OEHHA), "Appendix D. Individual Acute, 8-Hour, and Chronic Reference Exposure Level Summaries" December 2008. Page 182.  
<https://oehha.ca.gov/media/downloads/cnr/appendixd1final.pdf>

<sup>25</sup> California Office of Environmental Health Hazard Assessment (OEHHA), "Appendix D. Individual Acute, 8-Hour, and Chronic Reference Exposure Level Summaries" December 2008. Page 186.  
<https://oehha.ca.gov/media/downloads/cnr/appendixd1final.pdf>

<sup>26</sup> California Office of Environmental Health Hazard Assessment (OEHHA), "Appendix D. Individual Acute, 8-Hour, and Chronic Reference Exposure Level Summaries" December 2008. Pages 416.  
<https://oehha.ca.gov/media/downloads/cnr/appendixd1final.pdf>

<sup>27</sup> California Office of Environmental Health Hazard Assessment (OEHHA), "Appendix D. Individual Acute, 8-Hour, and Chronic Reference Exposure Level Summaries" December 2008. Pages 420-421.  
<https://oehha.ca.gov/media/downloads/cnr/appendixd1final.pdf>

## **APPENDIX A. ZONING MAP**

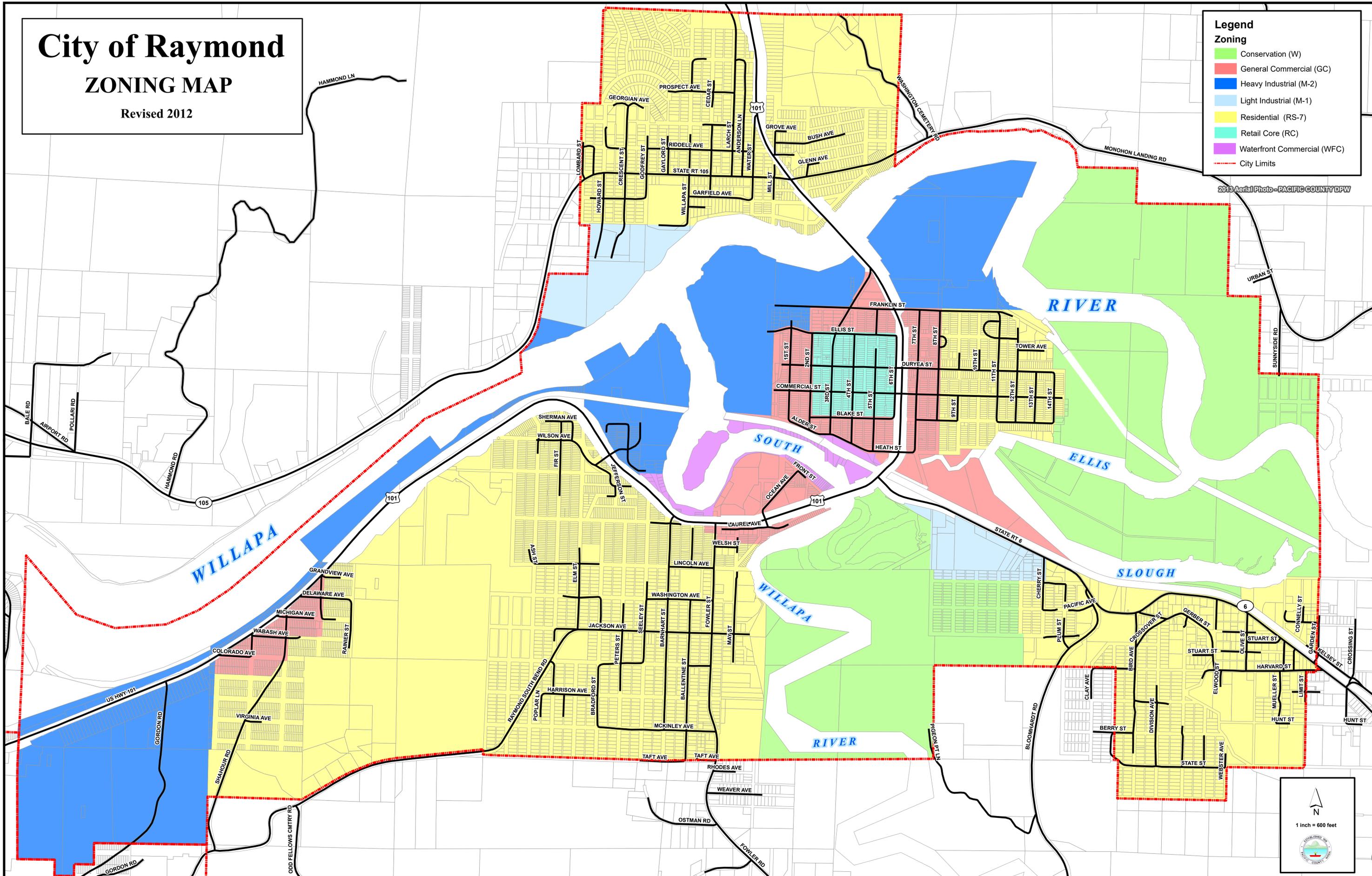
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# City of Raymond ZONING MAP

Revised 2012

- Legend**
- Zoning**
- Conservation (W)
  - General Commercial (GC)
  - Heavy Industrial (M-2)
  - Light Industrial (M-1)
  - Residential (RS-7)
  - Retail Core (RC)
  - Waterfront Commercial (WFC)
  - City Limits

2013 Aerial Photo - PACIFIC COUNTY DPW



## APPENDIX B. MODELING PARAMETERS

**Appendix Table B-1. Rectangular Building Parameters**

<b>ID</b>	<b>Description</b>	<b>X Coordinate (m)</b>	<b>Y Coordinate (m)</b>	<b>Elevation (m)</b>	<b>Height (m)</b>	<b>X Length (m)</b>	<b>Y Length (m)</b>	<b>Angle Degree</b>
BLDG_1	Planer Building	443426.8	5171013.2	3.92	18.29	138.1	27.7	90
BLDG_3	Large Dry Storage Building	443511.3	5170944.8	4.01	18.29	299.4	29.5	90
BLDG_4	Small Dry Storage Building	443541.1	5170945.1	4.10	18.29	62.1	29.8	90
BLDG_5	Trimmer Sorter Stacker Building	443571.2	5171006.3	4.07	18.29	159.2	30.7	90
BLDG_6	Sawmill Building	443602	5170896.9	4.25	13.72	28.2	80.4	90
BLDG_7	Sawmill Building_2	443602.6	5170868.2	4.19	13.72	20.7	22.7	90
CDK	CDK Building	443483	5170784.1	3.50	11.34	108.7	14.8	90

**Appendix Table B-2. Circular Building Parameters**

<b>ID</b>	<b>Description</b>	<b>X Coordinate (m)</b>	<b>Y Coordinate (m)</b>	<b>Elevation (m)</b>	<b>Height (m)</b>	<b>Radius (m)</b>	<b>Corners</b>
F_SILO	Green Sawdust Silo	443469.2	5170778.2	3.65	25.60	6.10	24

**Appendix Table B-3. Polygon Building Parameters**

<b>ID</b>	<b>Description</b>	<b>X Coordinate (m)</b>	<b>Y Coordinate (m)</b>	<b>Elevation (m)</b>	<b>Height (m)</b>
BLDG_2	Planer Infeed Building	443455.3	5171026.3	4.13	12.19

**Appendix Table B-4. Point Source Parameters**

<b>ID</b>	<b>Description</b>	<b>X Coordinate (m)</b>	<b>Y Coordinate (m)</b>	<b>Elevation (m)</b>	<b>Stack Height (m)</b>	<b>Stack Temp. (K)</b>	<b>Velocity (m/s)</b>	<b>Diameter (m)</b>
CDK_S	CDK South Merged Stack	443492.7	5170676.4	3.31	13.47	333.15	21.75	1.18
CDK_N	CDK North Merged Stack	443485.6	5170783.2	3.48	13.47	333.15	21.75	1.18

**Appendix Table B-5. Horizontal Point Source Parameters**

<b>ID</b>	<b>Description</b>	<b>X Coordinate (m)</b>	<b>Y Coordinate (m)</b>	<b>Elevation (m)</b>	<b>Stack Height (m)</b>	<b>Stack Temp. (K)</b>	<b>Velocity (m/s)</b>	<b>Diameter (m)</b>
CDK_SD	CDK South Opening	443492.2	5170674.8	3.29	5.87	333.15	0.305	2.90
CDK_ND	CDK North Opening	443486.7	5170784.8	3.48	5.87	333.15	0.305	2.90

**Appendix Table B-6. TAP Emission Rates – Short Term (g/s)**

<b>Pollutant CAS #</b>	<b>Formaldehyde 50-00-0</b>	<b>Benzene 71-43-2</b>	<b>Arsenic 7440-38-2</b>	<b>Cadmium 7440-43-9</b>	<b>Lead 7439-92-1</b>	<b>Manganese 7439-96-5</b>	<b>Nickel 7440-02-0</b>
CDK_S	2.11E-02	1.06E-02	2.55E-05	7.79E-06	8.79E-05	3.20E-04	2.23E-05
CDK_N	2.11E-02	1.06E-02	2.55E-05	7.79E-06	8.79E-05	3.20E-04	2.23E-05
CDK_SD	5.27E-03	2.65E-03	6.36E-06	1.95E-06	2.20E-05	8.00E-05	5.57E-06
CDK_ND	5.27E-03	2.65E-03	6.36E-06	1.95E-06	2.20E-05	8.00E-05	5.57E-06

- a. Based on vendor information and the NCASI Control Device and Stack Testing Feasibility Assessment, it is assumed that 80% of emissions from the CDK will be split evenly between the four vapor extraction points (two modeled stacks) so emission rates are divided by two and represent emissions from one merged source. The remaining 20% is emitted through the openings at each end of the CDK. Maximum hourly emission rates are used for all short term averaging periods.

**Appendix Table B-7. TAP Emission Rates – Long Term (g/s)**

<b>Pollutant CAS #</b>	<b>Formaldehyde 50-00-0</b>	<b>Benzene 71-43-2</b>	<b>Arsenic 7440-38-2</b>	<b>Cadmium 7440-43-9</b>	<b>Lead 7439-92-1</b>	<b>Manganese 7439-96-5</b>	<b>Nickel 7440-02-0</b>
CDK_S	2.02E-02	1.06E-02	1.06E-05	7.79E-06	8.79E-05	3.20E-04	2.23E-05
CDK_N	2.02E-02	1.06E-02	1.06E-05	7.79E-06	8.79E-05	3.20E-04	2.23E-05
CDK_SD	5.06E-03	2.65E-03	2.64E-06	1.95E-06	2.20E-05	8.00E-05	5.57E-06
CDK_ND	5.06E-03	2.65E-03	2.64E-06	1.95E-06	2.20E-05	8.00E-05	5.57E-06

- a. Based on vendor information and the NCASI Control Device and Stack Testing Feasibility Assessment, it is assumed that 80% of emissions from the CDK will be split evenly between the four vapor extraction points (two modeled stacks) so emission rates are divided by two and represent emissions from one merged source. The remaining 20% is emitted through the openings at each end of the CDK. Maximum hourly emission rates are used for all short term averaging periods.

## **APPENDIX C. BACT ANALYSIS, TBACT ANALYSIS, AND NOC ADDENDUMS**

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This appendix includes the BACT and tBACT sections of the original NOC application submitted to ORCAA in September 2023 and the subsequent NOC application addendums submitted in November 2023 and February 2024.

## 5. BEST AVAILABLE CONTROL TECHNOLOGY

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Pursuant to ORCAA Rule 6.1.4(a)(2) and WAC 173-400-113, all new and modified sources must employ BACT for “all pollutants not previously emitted or whose emissions would increase as a result of the new source or modification.” This section includes a BACT analysis for the CDK, haul roads, and material handling. The BACT analyses for PM, <sub>so2</sub>, NO<sub>x</sub>, VOC, and CO, as well as tBACT for TAPs for these emission units are presented in the subsequent sections.

### 5.1 BACT Methodology

In a memorandum dated December 1, 1987, EPA stated its preference for a “top-down” BACT analysis.<sup>4</sup> After determining if any NSPS or NESHAP is applicable, the first step in this approach is to determine, for the emission unit in question, the most stringent control available for a similar or identical source or source category. If it can be shown that this level of control is technically, environmentally, or economically infeasible for the unit in question, then the next most stringent level of control is determined and similarly evaluated. This process continues until the BACT level under consideration cannot be eliminated by any substantial or unique technical, environmental, or economic objections. The five basic steps of a top-down BACT review as identified by the EPA are presented below.<sup>5</sup>

#### 5.1.1 Step 1 – Identify All Control Technologies

Available control technologies are identified for each emission unit in question. The following methods are used to identify potential technologies: (1) reviewing entries in the Reasonably Available Control Technology (RACT)/BACT/Lowest Achievable Emission Rate (LAER) Clearinghouse (RBLC) database, (2) surveying regulatory agencies, (3) drawing from similar experience in assessing emissions control strategies, (4) surveying air pollution control equipment vendors, and/or (5) researching available literature.

#### 5.1.2 Step 2 – Eliminate Technically Infeasible Options

After the identification of control options, an analysis is conducted to eliminate technically infeasible options. A control option is eliminated from consideration if there are process specific conditions that prohibit the implementation of the control technology or if the highest control efficiency of the option would result in an emission level that is higher than any applicable regulatory limits, such as an NSPS or NESHAP.

#### 5.1.3 Step 3 – Rank Remaining Control Technologies by Control Effectiveness

Once technically infeasible options are removed from consideration, the remaining options are ranked based on their control effectiveness. If there is only one remaining option or if all of the remaining technologies could achieve equivalent control efficiencies, ranking based on control efficiency is not required.

#### 5.1.4 Step 4 – Evaluate Most Effective Controls and Document Results

Beginning with the most efficient control option in the ranking, detailed economic, energy, and environmental impact evaluations are performed. If a control option is determined to be economically

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<sup>4</sup> U.S. EPA, Office of Air and Radiation. Memorandum from J.C. Potter to the Regional Administrators. Washington, D.C. December 1, 1987.

<sup>5</sup> U.S. EPA. *Draft New Source Review Workshop Manual*, Chapter B. Research Triangle Park, North Carolina. October, 1990.

feasible without adverse energy or environmental impacts, it is not necessary to evaluate the remaining options with lower control efficiencies.

The economic evaluation centers on the cost effectiveness of the control option. Costs of installing and operating control technologies are estimated and annualized following the methodologies outlined in the EPA's OAQPS Control Cost Manual (CCM) and other industry resources.<sup>6</sup>

### 5.1.5 Step 5 – Select BACT

In the final step, one pollutant-specific control option and/or limit is proposed as BACT for each emission unit under review based on evaluations from the previous step.

Comprehensive “top-down” review is not always necessary for BACT analyses. At a minimum, a complete BACT determination must assess the technical, environmental, and economic feasibility of the most stringent controls available. The BACT analyses in this application follow the framework of the “top-down” approach.

The BACT analyses for the new emission units are presented in the following sections.

## 5.2 BACT Analysis for New CDK

### 5.2.1 BACT Analysis for VOC Emissions

VOC is emitted when the carbonaceous matter in the fuel is not converted to CO<sub>2</sub> or CO. Based on the RBLC database results in Table 5-1, as well as existing air permits and applications for direct-fired CDKs, including the West Fraser Augusta Mill's Title V Application No. 21615 approved by the Georgia Environmental Protection Division (EPD), the following control methods were identified for initial review:<sup>7,8</sup>

- ▶ Included in RBLC
  - Proper Maintenance and Operating Practices
- ▶ Other Controls
  - Adsorption
  - Biofiltration
  - Condensation
  - Thermal Oxidation
  - Wet Scrubber

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<sup>6</sup> Office of Air Quality Planning and Standards (OAQPS), *EPA Air Pollution Control Cost Manual*, Sixth Edition, EPA 452-02-001 (<http://www.epa.gov/ttn/catc/products.html#cccinfo>), Daniel C. Mussatti & William M. Vavuk, January 2002.

<sup>7</sup> RBLC search conducted on July 3, 2023 for direct-fired continuous dry kilns under process code 30.800 with a permit date between 1/1/2013 and 7/3/2023.

<sup>8</sup> West Fraser – Augusta Mill, *Continuous Kilns Construction Permit Application*, Trinity Consultants, December 2012. (<https://epd.georgia.gov/document/document/2450047psdapppdf/download>)

**Table 5-1. RBLC Results for VOC Emissions from CDKs**

Facility Name	State	Permit #	Process Name	Control Method	Emission Limit 1	Unit 1	Emission Limit 2	Unit 2
West Fraser-Opelika Lumber Mill	AL	206-5004-X005	Two 87.5 MMBF/yr CDKs with a 35 MMBtu/hr direct-fired wood burner	--	3.76	lb/MBF	175	K/12 months
West Fraser, Inc. – Maplesville Mill	AL	403-5005-X010	Two 100 MMBF/yr Direct-Fired CDK	--	3.76	lb/MBF	--	--
Millport Wood Products Facility	AL	408-5003-X022	Direct-Fired CDK	Proper Maintenance and Operating Practices	4.7	lb/MBF as WWP1 VOC	--	--
Resolute Forest Products – Alabama Sawmill	AL	309-0072-X002	Direct-Fired CDKs with 35 MMBtu/hr Wood-Fired Burner	--	3.76 <sup>a</sup>	lb/MBF	--	--
Two Rivers Lumber Co.	AL	105-S007-X002	15.4 MBF/hr CDK (DPK-1) w/ 38.8 MMBtu/hr NG Burner	--	3.8	lb/MBF as C	--	--
			15.4 MBF/hr CDK (DPK-2) w/ 38.8 MMBtu/hr NG Burner	--	3.8	lb/MBF as C	--	--
Fulton Sawmill	AL	X007 & X008	11.4 MBF/hr Direct-Fired CDK, 40 MMBtu/hr NG Burner, & 4 MMBtu/hr NG Condensate Evaporator	Proper Kiln Operation and Maintenance Practices	4	lb/MBF	--	--
Millport Wood Products Facility	AL	X023	Three Direct-Fired CDKs Dry Kilns, CDK-4/X023A, CDK-5/X023B, CDK-6/X023C	Operating And Maintenance Practices	4.7	lb/MBF as WWP1 VOC	--	--
Belk Chip-N-Saw Facility	AL	X006, X008, X009	115,000 MBF/yr CDK D (ES-006) with 35 MMBtu/hr Wood-Fired and 7 MMBtu/hr NG-Fired Burners	Operating And Maintenance Practices; Measure Lumber Moisture Content	5.49	lb/MBF as WWP1 VOC	--	--
			115,000 MBF/yr CDK E (ES-009) with 35 MMBtu/hr Wood-Fired and 7 MMBtu/hr NG-Fired Burners		5.49	lb/MBF as WWP1 VOC	--	--
Cottontown Sawmill	AL	211-S005-X007	Direct-fired CDK with 34 MMBtu/hr Wood-Fired Burner	Good Combustion Practices and Proper Maintenance	4.21	lb/MBF as Terpenes	--	--
OLA	AR	0592-AOP-R10	Drying Kiln No. 5 (SN-21)	--	23.5 <sup>b</sup>	lb/hr	3.5 <sup>b</sup>	lb/MBF
Georgia-Pacific Wood Products South	AR	463-AOP-R8	SN-09 #4 Lumber Kiln	--	3.8	lb/MBF	373.7	tpy

Facility Name	State	Permit #	Process Name	Control Method	Emission Limit 1	Unit 1	Emission Limit 2	Unit 2
El Dorado Sawmill	AR	2348-AOP-R0	LUMBER DRYING KILN SN-01	Proper Maintenance and Operation	3.8	lb/MBF	--	--
			LUMBER DRYING KILN SN-02	--	3.8	lb/MBF	--	--
			LUMBER DRYING KILN SN-03	--	3.8	lb/MBF	--	--
Deltic Timber Corporation – OLA	AR	0592-AOP-R10	Direct-Fired CDK NO. 5	Proper Drying Schedule, Temperature-Based on Moisture Content, and Manufacturer’s Specs	38.2 °c	lb/hr	--	--
Caddo River	AR	0189-AOP-R6	CDKs	--	53.2	lb/hr	220.4 <sup>a</sup>	tpy
West Fraser, Inc.	AR	1628-AOP-R11	N/A	--	3.8	lb/MMBF	63.6	lb/hr
Anthony Forest Products Company	AR	1681-AOP-R15	Dual Path Kiln #3	--	3.8	lb/MBF	--	--
Caddo River	AR	0189-AOP-R8	Dual Path Kiln # 3	--	3.8	lb/MBF	53.2	lb/hr
Interfor U.S. Inc	AR	1567-AOP-R7	CDK #2 to continuous operation	--	3.8	lb/MBF	--	--
Anthony Timberlands	AR	0456-AOP-R9	CDK	--	36.8	lb/hr	350	tpy
Georgia-Pacific Wood Products South	AR	0463-AOP-R21	SN-09 #4 Lumber Kiln	--	3.8	lb/MBF	460.9	tpy
Anthony Forest Products Company	AR	1681-AOP-R20	Dual Path Kiln #4	--	62	lb/hr	228	tpy
Perry Mill	FL	1230033-012-AC	Direct-fired lumber drying kiln	Best Operating Practices (BMP)	3.5	lb/MBF	--	--
Whitehouse Lumber Mill	FL	0310197-012-AC	Direct-Fired CDKs	Proper Maintenance and Operating Procedures	3.76	lb/MBF	--	--
Graceville Lumber Mill	FL	0630011-016-AC	Direct-fired continuous lumber drying Kiln No. 5	Lumber moisture used as proxy for VOC emissions – product that is over dried likely means more VOC driven off and emitted	3.5	lb/MBF	--	--
Southwest Louisiana Lumber Operations	LA	PSD-LA-770	EP-3K -Wood-Fired Dry Kiln No. 1	Proper kiln design & operation; annual production limit	29.27	lb/hr	2.96	lb/MBF
			EP-4K -Wood-Fired Dry Kiln No. 2		29.27	lb/hr	2.96	lb/MBF
			EP-5K -Wood-Fired Dry Kiln No. 3		29.27	lb/hr	2.96	lb/MBF
			EP-6K -Wood-Fired Dry Kiln No. 4		29.27	lb/hr	2.96	lb/MBF

Facility Name	State	Permit #	Process Name	Control Method	Emission Limit 1	Unit 1	Emission Limit 2	Unit 2
Chopin Mill	LA	PSD-LA-784	Lumber Dry Kilns #1&2 (EQT 37&38)	Good operating practices	24.51	lb/hr	53.68	tpy
Joyce Mill	LA	PSD-LA-701(M-2)	GRP0003 Lumber Kilns (AK1)	Properly design and operation	4.2	lb/MBF	300	MMBF/yr
Bogalusa Sawmill	LA	PSD-LA-831	Lumber Kilns (2)	Proper operation and maintenance	--	--	--	--
Holden Wood Products Mill	LA	PSD-LA-834	CDKs A and B (01-19 and 02-19)	Proper Kiln Design and Good Operating Practices	4.33	lb/MBF	--	--
Idabel Sawmill	OK	2015-1163-C(M-1)PSD	Lumber Kiln	--	3.88	lb/MBF	--	--
West Fraser – Newberry Lumber Mill	SC	1780-0007-CG	Two – 35 MMBtu/hr Dual Path, Direct-Fired, CDKs, 15 MBF/hr, Each	Proper Operation and Good Operating Practices	3.76	lb/MBF	376	tpy
New South Lumber Co – Darlington Plant	SC	0820-0045-CJ	DKN5	Proper Maintenance and Operation	141	tpy	--	--
Kapstone Charleston Kraft – Summerville	SC	0900-0017-CE	Lumber Kilns	Proper Maintenance and Operation	225.6	tpy	3.76	lb/MBF
Simpson Lumber Co	SC	1140-0008-CH	Lumber Kilns	Proper Operation and Maintenance	156	tpy	3.76	lb/MBF
New South Companies, Inc. – Conway Plant	SC	1340-0029-CH-R2	Lumber Kilns	Proper Maintenance and Operation	602	tpy	4.2	lb/MBF
New South Lumber Company – Darlington	SC	0820-0045-CK	Two Kilns – KLN5 And KLN6	Proper Operation and Maintenance	--	--	--	--
Camden Plant	SC	1380-0025-CJ	DKN6 – Direct-Fired CDK	--	150.4	tpy	--	--
Georgia Pacific – McCormick Sawmill	SC	1600-0002-CD	Direct-Fired CDK	Good work practices	5.84	lb/MBF as Propane + Methanol + Formaldehyde	--	--
Resolute FP – Catawba Lumber Mill	SC	2440-0216-CA	3 Direct-Fired CDKs (CDK1, CDK2, CDK3)	--	5.82	lb/MBF as Terpene + Methanol + Formaldehyde	--	--
NSLC – Darlington	SC	0820-0045-CL	Lumber Drying Kiln 7	Work practice standards	4.2	lb/MBF as Terpene + Methanol + Formaldehyde	--	--
Canfor Southern Pine – Camden Plant	SC	1380-0025-CL	Lumber Drying Kiln 7	Work practice standards	5.82	lb/MBF	--	--

Facility Name	State	Permit #	Process Name	Control Method	Emission Limit 1	Unit 1	Emission Limit 2	Unit 2
						as Terpene + Methanol + Formaldehyde		
Charles Ingram Lumber Company, Inc	SC	1040-0016-CG	Kiln K3	Work Practice Standards	5.824	lb/MBF as Terpene + Methanol + Formaldehyde	--	--
			Kiln K7		5.824	lb/MBF as Terpene + Methanol + Formaldehyde	--	--
Lumber Mill	TX	6729,PSDTX15 2 AND GHGPSDTX1	Kilns (EPNs CK01 and CK02)	Proper design and operation	3.38	lb/DBF	--	--
Lumber Mill	TX	7286 AND PSDTX892M2	Direct-Fired Wood Drying Kiln No. 3	Proper operation and maintenance of the kiln	4.24	lb/MBF	--	--

- a. Rolling 12-months.
- b. Average of three 1-hr test runs.
- c. Averaged over drying cycle time.

Upon further analysis, all add-on control technologies were deemed to be technically infeasible. As the only technically feasible control method, Weyerhaeuser proposes proper maintenance and operating practices as BACT for VOC emissions from the CDK. In the TSD for the Facility's current TV permit, ORCAA determined BACT for lumber drying operations to be implementation of a steam management system. Since the CDK will be direct-fired, steam is not a practical variable to include. Therefore, Weyerhaeuser will incorporate this requirement by installing a kiln management system and in-kiln moisture management system, both of which provide for optimal drying efficiency and operating practices. Additionally, temperature has a significant impact on drying-based emissions, so Weyerhaeuser will operate the CDK with a maximum drying temperature of 200 °F to limit VOC emissions.

While there are various emission limits presented in the RBLC search results, they are all sourced from facilities in the Southeastern United States (US), which do not process Douglas fir. Since VOC emissions are dependent on wood species, Weyerhaeuser does not deem the RBLC emission limits to be representative of the Raymond Facility's CDK operation, so instead, the Facility proposes a new VOC BACT emission limit that uses the methodology discussed in Section 3.1.2. This limit includes two components: 1.149 lb/MBF for drying-based emissions and  $6.19 \times 10^{-3}$  lb/MMBtu for combustion-based emissions.

### 5.2.2 BACT Analysis for PM Emissions

PM emissions consist of filterable and condensable particulate matter produced by the combustion of wood fuel. Based on the RBLC database results in Table 5-2, as well as existing air permits and applications for direct-fired CDKs, the following control methods were identified for initial review:<sup>9</sup>

- ▶ Included in RBLC
  - Proper Maintenance and Operating Practices
- ▶ Other Controls
  - Baghouse
  - Cyclone
  - Scrubber
  - Dry Electrostatic Precipitator (Dry ESP)
  - Wet Electrostatic Precipitator (WESP)

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<sup>9</sup> RBLC search conducted on July 3, 2023 for direct-fired continuous dry kilns under process code 30.800 with a permit date between 1/1/2013 and 7/3/2023.

**Table 5-2. RBLC Results for PM Emissions from CDKs**

Facility Name	Permit #	Process Name	Control Method	Pollutant	Emission Limit 1	Unit 1	Emission Limit 2	Unit 2
Two Rivers Lumber Co.	105-S007-X002	15.4 MBF/hr CDK (DPK-1) w/ 38.8 MMBtu/hr Natural Gas Burner	--	Total PM (TPM)	1.3	lb/hr	--	--
		15.4 MBF/hr CDK (DPK-2) w/ 38.8 MMBtu/hr Natural Gas Burner			1.3	lb/hr	--	--
Fulton Sawmill	X007 & X008	11.4 MBF/hr Direct-Fired CDK, 40 MMBtu/hr Natural Gas Burner, & 4 MMBtu/hr Natural Gas Condensate Evaporator	--	TPM	--	--	--	--
Anthony Forest Products Company	1681-AOP-R20	Dual Path Kiln #4	--	TPM	2.4	lb/hr	8.6	tpy
				TPM <sub>10</sub>	2.3	lb/hr	8.5	tpy
		Dual Path Kiln #4 Abort Stack	--	TPM	3.1	lb/hr	0.5	tpy
				TPM <sub>10</sub>	2.8	lb/hr	0.4	tpy
Resolute FP – Catawba Lumber Mill	2440-0216-CA	3 Direct-Fired CDKs (CDK1, CDK2, CDK3)	--	TPM	0.14 <sup>a</sup>	lb/MBF	--	--
				TPM <sub>10</sub>	0.104 <sup>a</sup>	lb/MBF	--	--
				TPM <sub>2.5</sub>	0.099 <sup>a</sup>	lb/MBF	--	--

a. Emission limits are for each kiln, on a 3-hour average.

Upon further analysis, all add-on control technologies were deemed to be technically infeasible. As the only technically feasible control method, Weyerhaeuser proposes proper maintenance and operating practices as BACT for PM emissions from the CDK. Following guidance from the RBLC search and Georgia EPD, Weyerhaeuser proposes the following PM BACT emission limits:<sup>10</sup>

- ▶ Total PM: 0.140 lb/MBF
- ▶ Total PM<sub>10</sub>: 0.104 lb/MBF
- ▶ Total PM<sub>2.5</sub>: 0.099 lb/MBF

### 5.2.3 BACT Analysis for CO Emissions

CO emissions result primarily from the incomplete combustion of biomass. Based on the RBLC database results in Table 5-3, as well as existing air permits and applications for direct-fired CDKs, the following control methods were identified for initial review:<sup>11</sup>

- ▶ Included in RBLC
  - Proper Maintenance and Operating Practices
- ▶ Other Controls
  - Thermal Oxidation
  - Catalytic Oxidation

**Table 5-3. RBLC Results for CO Emissions from CDKs**

Facility Name	Permit #	Process Name	Control Method	Emission Limit 1	Unit 1	Emission Limit 2	Unit 2
Resolute Forest Products – Alabama Sawmill	309-0072-X002	Direct-Fired CDKs with 35 MMBtu/hr Wood-Fired Burner	Proper Maintenance and Operating Procedures	0.73 <sup>a</sup>	lb/MBF	--	--
Fulton Sawmill	X007 & X008	11.4 MBF/hr Direct-Fired CDK, 40 MMBtu/hr Natural Gas Burner, & 4 MMBtu/hr Natural Gas Condensate Evaporator	--	--	--	--	--
Anthony Forest Products Company	1681-AOP-R20	Dual Path Kiln #4	--	20.4	lb/hr	89.4	tpy
Resolute FP – Catawba Lumber Mill	2440-0216-CA	3 Direct-Fired CDKs (CDK1, CDK2, CDK3)	--	0.73 <sup>b</sup>	lb/MBF	--	--

- a. Rolling 12-months.
- b. 3-hour average.

<sup>10</sup> Georgia Environmental Protection Division’s (EPD) document entitled “EPD Recommended Emission Factors for Lumber Kiln Permitting in Georgia”.

<sup>11</sup> RBLC search conducted on July 3, 2023 for direct-fired continuous dry kilns under process code 30.800 with a permit date between 1/1/2013 and 7/3/2023.

Upon further analysis, all add-on control technologies were deemed to be technically infeasible. As the only technically feasible control method, Weyerhaeuser proposes proper maintenance and operating practices as BACT for CO emissions from the CDK. Following guidance from the RBLC search and Georgia EPD, Weyerhaeuser proposes 0.73 lb/MBF as the CO BACT emission limit.<sup>12</sup>

## 5.2.4 BACT Analysis for NO<sub>x</sub> Emissions

NO<sub>x</sub> emissions result primarily from thermal NO<sub>x</sub> formation from nitrogen and oxygen in the combustion air. Based on the RBLC database results in Table 5-4, as well as existing air permits and applications in the wood products industry, the following control methods were identified for initial review:<sup>13</sup>

- ▶ Included in RBLC
  - N/A
- ▶ Other Controls
  - Combustion Modifications
  - Selective Catalytic Reduction (SCR)
  - Selective Non-Catalytic Reduction (SNCR)
  - Water/Steam Injection
  - Proper Maintenance and Operating Practices

**Table 5-4. RBLC Results for NO<sub>x</sub> Emissions from CDKs**

Facility Name	Permit #	Process Name	Control Method	Emission Limit 1	Unit 1	Emission Limit 2	Unit 2
Fulton Sawmill	X007 & X008	11.4 MBF/hr Direct-Fired CDK, 40 MMBtu/hr Natural Gas Burner, & 4 MMBtu/hr Natural Gas Condensate Evaporator	--	--	--	--	--
Anthony Forest Products Company	1681-AOP-R20	Dual Path Kiln #4	--	4.6	lb/hr	16.8	tpy

### 5.2.4.1 Technical Review

Optimal temperature ranges for SCR and SNCR applications are 480°F to 800°F and 1,600°F to 2,100°F, respectively.<sup>14,15</sup> Since the gasifier typically runs at approximately 1,400°F and the secondary burner runs at

<sup>12</sup> Georgia Environmental Protection Division's (EPD) document entitled "EPD Recommended Emission Factors for Lumber Kiln Permitting in Georgia".

<sup>13</sup> RBLC search conducted on July 3, 2023 for direct-fired continuous dry kilns under process code 30.800 with a permit date between 1/1/2013 and 7/3/2023.

<sup>14</sup> EPA, *Air Pollution Control Technology Fact Sheet, Selective Catalytic Reduction (SCR)*, EPA-452/F-03-015. (<https://www3.epa.gov/ttnecat1/dir1/fscr.pdf>).

<sup>15</sup> EPA, *Air Pollution Control Technology Fact Sheet, Selective Non-Catalytic Reduction (SNCR)*, EPA-452/F-03-031. (<https://www3.epa.gov/ttnecat1/dir1/fsncr.pdf>).

around 1,850°F, an SCR is technically infeasible.<sup>16</sup> Additionally, an SNCR typically controls systems with uncontrolled NO<sub>x</sub> levels between 200 and 400 ppm.<sup>17</sup> With a combined exhaust flow rate of 50,000 cfm, a vendor-specified exhaust density of 0.0663 lb/ft<sup>3</sup>, and hourly NO<sub>x</sub> emission rate of 10.33 lb/hr, the concentration of NO<sub>x</sub> in the CDK exhaust is approximated to be 52 ppm. Therefore, an SNCR is also technically infeasible for the CDK.

Water/steam injection is not a demonstrated NO<sub>x</sub> control method for direct-fired kilns in the wood products industry, so it is technically infeasible.

Combustion modifications, such as staged-air combustion, low NO<sub>x</sub> burners (LNB), and flue gas recirculation (FGR), are technically feasible and typically have a control efficiency range between 10-50%.

#### 5.2.4.2 BACT Determination

Per the vendor's guarantee, the green sawdust gasification burners will be designed with a "secondary gas burner system with [three] individual burner chambers," as well as flue gas recirculation, so Weyerhaeuser proposes combustion modifications and proper maintenance and operating practices as BACT for NO<sub>x</sub> emissions from the CDK. Following guidance from Georgia EPD, Weyerhaeuser proposes 0.28 lb/MBF as the NO<sub>x</sub> BACT emission limit.<sup>18</sup>

#### 5.2.5 BACT Analysis for SO<sub>2</sub> Emissions

Based on the RBLC database results in Table 5-5, as well as existing air permits and applications in the wood products industry, the following control methods were identified for initial review:<sup>19</sup>

- ▶ Included in RBLC
  - N/A
- ▶ Other Controls
  - Fuel Gas Desulfurization (FGD)
  - Acid Gas Scrubber
  - Alternative Fuels
  - Proper Maintenance and Operating Practices

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<sup>16</sup> Girardi, R. and Womac, C. *DIRECT-FIRED GREEN SAWDUST GASIFICATION DRY KILN*, Western Dry Kiln Association. April, 2007. (<https://ir.library.oregonstate.edu/downloads/ng451j669>).

<sup>17</sup> EPA, *Air Pollution Control Technology Fact Sheet, Selective Non-Catalytic Reduction (SNCR)*, EPA-452/F-03-031. (<https://www3.epa.gov/ttnecatc1/dir1/fsnscr.pdf>).

<sup>18</sup> Georgia Environmental Protection Division's (EPD) document entitled "EPD Recommended Emission Factors for Lumber Kiln Permitting in Georgia".

<sup>19</sup> RBLC search conducted on July 3, 2023 for direct-fired continuous dry kilns under process code 30.800 with a permit date between 1/1/2013 and 7/3/2023.

**Table 5-5. RBLC Results for SO<sub>2</sub> Emissions from CDKs**

Facility Name	Permit #	Process Name	Control Method	Emission Limit 1	Unit 1	Emission Limit 2	Unit 2
Fulton Sawmill	X007 & X008	11.4 MBF/hr Direct-Fired CDK, 40 MMBtu/hr Natural Gas Burner, & 4 MMBtu/hr Natural Gas Condensate Evaporator	--	--	--	--	--
Anthony Forest Products Company	1681-AOP-R20	Dual Path Kiln #4	--	1	lb/hr	4.4	tpy
		Dual Path Kiln #4 Abort Stack	--	0.3	lb/hr	0.1	tpy

FGD and an acid gas scrubber are technically feasible for the system. However, the CDK burner fires green sawdust (i.e., wood) as its primary fuel, which is essentially sulfur free, so low sulfur fuel is technically feasible and already achieved by the process. Therefore, Weyerhaeuser proposes low sulfur fuels and proper maintenance and operating practices as BACT for SO<sub>2</sub> emissions from the CDK. Following guidance from Georgia EPD, Weyerhaeuser proposes 0.025 lb/MMBtu (or 1.25 lb/hr) as the SO<sub>2</sub> BACT emission limit.<sup>20</sup>

### 5.2.6 tBACT Analysis for Toxic Air Pollutant Emissions

All TAPs emitted are emitted as VOC. Therefore, the BACT determinations listed for VOC emissions also satisfy tBACT requirements for this emission unit.

## 5.3 BACT Analysis for Paved Roads

### 5.3.1 BACT Analysis for PM Emissions

PM emissions consist of filterable and condensable particulate matter and are fugitive in nature. Based on the RBLC database results in Table 5-6, as well as existing air permits and applications for direct-fired CDK projects, the following control methods were identified for initial review:<sup>21</sup>

- ▶ Included in RBLC
  - Road Watering Plan
  - Good Housekeeping Practices
- ▶ Other Controls
  - Road Sweeping
  - Speed Reduction

<sup>20</sup> Georgia Environmental Protection Division’s (EPD) document entitled “EPD Recommended Emission Factors for Lumber Kiln Permitting in Georgia”.

<sup>21</sup> RBLC search conducted on July 18, 2023 for roads under process code 30.999 with a permit date between 1/1/2012 and 7/18/2023.

**Table 5-6. RBLC Results for PM Emissions from Paved Roads**

<b>Facility Name</b>	<b>Permit #</b>	<b>Process Name</b>	<b>Control Method</b>	<b>Pollutant</b>	<b>Emission Limit</b>	<b>Unit</b>
El Dorado Sawmill	2348-AOP-R0	Haul Roads SN-09	Road Watering Plan + 0% Off-Site Opacity	TPM	12.7	lb/hr
Resolute FP – Catawba Lumber Mill	2440-0216-CA	Roads	Good Housekeeping Practices	Filterable PM (FPM)	0.13	lb/VMT
				FPM <sub>10</sub>	0.03	lb/VMT
				FPM <sub>2.5</sub>	0.01	lb/VMT

The Facility currently waters for dust suppression daily and sweeps the roads twice-monthly, which controls 75% of fugitive PM emissions. Since watering and vacuuming provide the most effective control for dust, Weyerhaeuser will continue these practices following the CDK Project. Therefore, Weyerhaeuser proposes bi-weekly watering and vacuuming as BACT for PM emissions from the paved roads. As detailed in the emission calculations, Weyerhaeuser proposed emission factors from AP-42 Section 13.2.1, Paved Roads, using the average silt loading value for corn wet mills along with a control efficiency of 75%, as the most accurate PM BACT emission limits.

## 5.4 BACT Analysis for Material Handling

### 5.4.1 BACT Analysis for PM Emissions

PM emissions consist of filterable and condensable particulate matter from the following material transfers inside and outside of the sawmill:

- ▶ Fuel silo loading (via cyclone)
- ▶ Bark bins loading (via cyclone)
- ▶ Chip bins loading of planer shavings (via cyclone)
- ▶ Green sawdust sawmill drop point (fugitive)
- ▶ Bark bins truck loadout (fugitive)
- ▶ Chip bins truck loadout (fugitive)

Based on the RBLC database results in Table 5-7, as well as existing air permits and applications for direct-fired CDK projects, the following control methods were identified for initial review:<sup>22</sup>

- ▶ Included in RBLC
  - Building Enclosure
  - Cyclone
  - Proper Maintenance and Operating Practices
- ▶ Other Controls
  - Fabric Filtration Systems (baghouse, bin vent filters, etc.)

<sup>22</sup> RBLC search conducted on July 18, 2023 for roads under process code 30.999 with a permit date between 1/1/2012 and 7/18/2023.

**Table 5-7. RBLC Results for PM Emissions from Material Handling**

Facility Name	Permit #	Process Name	Control Method	Pollutant	Emission Limit	Unit
Two Rivers Lumber Co.	105-S007-X002	Sawmill	--	Fugitive PM	--	--
Talladega Sawmill	309-0075	Sawmill and Green End Operations	--	TPM	--	--
			--	TPM <sub>10</sub>	--	--
			--	TPM <sub>2.5</sub>	--	--
El Dorado Sawmill	2348-AOP-R0	Sawmill SN-05	Sawmill located inside building	TPM	0.35	lb/ton
		Truck Bin SN-08	Cyclone; Proper Maintenance and Operation	TPM	0.002	gr/dscf
		Material Processing SN-11	Proper Maintenance and Operation	TPM	0.02	lb/ton
Resolute – Catawba Lumber Mill	2440-0216-CA	Material Transfer	Proper Maintenance and Good Operating Practices	FPM	0.0012	lb/ton
				FPM <sub>10</sub>	0.0005	lb/ton
				FPM <sub>2.5</sub>	0.0001	lb/ton

Loading of green sawdust from the sawmill to the CDK fuel silo and loading of bark from the hog to the bark truck bins will each be controlled by a cyclone with airlocks. Since the Facility will employ the most effective control technology for this transfer, Weyerhaeuser proposes a cyclone as BACT for PM emissions from fuel silo loading and bark bin loading. Following guidance in ORCAA’s Annual Emissions Inventories for the Facility, Weyerhaeuser proposes 0.03 gr/dscf as the PM BACT limit for these transfers. Transfer of dry chips from the planer mill to the chip bins will also be controlled by a cyclone with airlocks, but the cyclone exhaust will further be controlled by a baghouse with a 99% control efficiency, due to the low moisture content of this stream. Weyerhaeuser proposes a cyclone and baghouse as BACT for PM emissions from chip bin loading of dry chips. Further, Weyerhaeuser proposes application of a 99% control efficiency onto emissions calculated with ORCAA’s 0.03 gr/dscf grain loading rate as the PM BACT limit for this transfer.

For the new green sawdust drop point, the material transfer is located within the building enclosure. Neither a cyclone nor a fabric filtration system is feasible for this drop, so Weyerhaeuser proposes the building enclosure as BACT for PM emissions from the green sawdust sawmill drop point. As shown in the emission calculations, Weyerhaeuser proposes methods from AP-42 Section 13.2.4, Aggregate Handling and Storage Piles, with the minimum wind speed (representing the indoor transfer), as the PM BACT limit for this transfer.

While the bark and chip truck bins will have a cyclone on top of each set of bins, loadout of the materials into trucks will not be controlled by such cyclones. No add-on control technologies already presented are technically feasible for truck bin loadout, besides proper maintenance and operating practices. However, the Facility plans to install steel sidings on two out of four sides of the truck bin drop points, which will reduce fugitive PM emissions by 50%. Therefore, Weyerhaeuser proposes steel sidings as BACT for PM emissions from the bark and chip bins truck loadout. Similar to the green sawdust sawmill drop point, Weyerhaeuser,

proposes methods from AP-42 Section 13.2.4, Aggregate Handling and Storage Piles, but instead with the mean wind speed (representing the outdoor transfer), as the PM BACT limit for the truck loadout transfers.

**To:** Aaron Manley, Olympic Region Clean Air Agency  
**cc:** Michael Nolan, Jack Carter, and Angela Cameron, Weyerhaeuser NR Company  
**From:** Nancy Liang and Matt Goldman, Trinity Consultants  
**Date:** November 15, 2023  
**RE:** Weyerhaeuser Raymond NOC Application Addendum (23NOC1614)

On October 10, 2023, Weyerhaeuser NR Company (Weyerhaeuser) received a data request from Aaron Manley, P.E. from the Olympic Region Clean Air Agency (ORCAA) regarding its Notice of Construction (NOC) application #23NOC1614. The NOC application was submitted to approve the installation of a direct-fired continuous dry kiln (CDK) at the Raymond facility (the "Facility"). Weyerhaeuser received a second ORCAA data request on October 12, 2023, to address the BACT analysis. This memo serves as an addendum to the NOC permit application and provides the data requested by ORCAA.

### **Data Request 1, Question 1 – PTE Emission Calculations**

*ORCAA: Potential To Emit (PTE) Calculations. The emissions calculations in the permit application did not appear to assume true PTE (i.e. continuous 8,760 hours per year) operation for all aspects of the operation. ORCAA can limit or cap the facility's operations and emissions to the production levels proposed in the application. However, if your facility decides to operate more than at the rates proposed in the application, it would require a permit modification prior to making those operational changes. If Weyerhaeuser would like to operate more than the hours proposed in the permit application, please recalculate emissions at the desired level of production (up to 8,760 hours per year) and resubmit PTE calculations and modeling. Otherwise, ORCAA will assume you're satisfied with the operational hours and material usage rates proposed in the permit application and include the appropriate additional monitoring, record keeping, and reporting requirements in the permit.*

**Response:** Weyerhaeuser has updated the PTE emission calculations to reflect continuous operation of 8,760 hours on the CDK and sawmill cyclones. The following emissions are changed:

- ▶ CDK Annual Emissions calculated based on emission factors in lb/MMBtu, e.g. VOC (combustion), SO<sub>2</sub>, CO<sub>2</sub>e, HAP/TAP (combustion).
- ▶ Added CDK startup and idling emissions for normal operations with emission factors in lbs/MMBF, e.g. PM, PM<sub>10</sub>, PM<sub>2.5</sub>, CO, NO<sub>x</sub>, and HAP/TAP.
- ▶ Green Sawdust Fuel Annual Throughput (relates hourly CDK fuel rating and operating hours)
  - Green sawdust sawmill drop point annual PM emission rates.
- ▶ Cyclone Operating Hours (now set to 8,760)
  - Annual PM emission rates from the Fuel Silo Cyclone, Bark Cyclone, and Dry Chip Cyclone/Baghouse.
- ▶ Added an existing fire pump to the facility-wide emissions calculation assuming annual operation of 100 hours.

Weyerhaeuser has also unlinked the annual and hourly emission calculations for the CDK. This allows the annual emissions to be based on the maximum annual operating hours of 8,760 and keep maximum hourly emissions based on the CDK's expected annual operating hours of 8,400; this approach provides a more conservative estimate of short-term emission rates. Additionally, Weyerhaeuser updated annual CDK

HAP/TAP emission rates to reference 8,760 operating hours for the combustion component and the annual production rate for the drying component.

Weyerhaeuser modified the green sawdust sawmill drop point PM emission calculations by adding a green sawdust maximum hourly throughput, so emissions are no longer based on operating hours, but just the CDK burner's fuel rating. This lowered hourly and daily emissions.

Based on recent discussions with the CDK vendor, Weyerhaeuser has updated the maximum dry bulb temperature of heated air from 200 °F to 220 °F. The facility's current batch kilns operate at <200 °F, but the CDK will be required to maintain a higher temperature to minimize condensation-related structural corrosion. This update resulted in an increase in drying emissions for pollutants whose emission factors are dependent on temperature, e.g. VOC, formaldehyde, and methanol.

### Data Request 1, Question 2 – Electronic Copies of PTE

*ORCAA: Electronic copies of the spreadsheets used to calculate criteria, TAP and GHG emissions provided in the application. The electronic spreadsheets must be in an unprotected format to enable equations, linkages, emissions factors, and assumptions to be seen.*

**Response:** Weyerhaeuser has attached the emission calculations to this addendum in Attachment A and is attaching the Excel file to the submission email.

### Data Request 1, Question 3 – Modeling

Response to Data Request 1, Question 3 will be submitted under a separate cover.

### Data Request 1, Question 4 – Startup/Shutdown

*ORCAA: Addressing Startup/Shutdown. The application indicates there will be two (2) ten hour shifts operating 5 days a week. Will the CDK shut down during non-shift hours, on the weekend, or will it continue operating continuously, except for during annual/planned maintenance? Also, do you plan to meet BACT limits during Startup/Shutdown?*

**Response:** Weyerhaeuser would like to clarify the referenced two (2) ten hour shifts operating 5 days a week is for the saw mill operation (i.e., the steps to convert logs to green lumber), which is different from the CDK lumber drying operations. The CDK will operate on a continuous basis with infrequent startups and shutdowns.

The CDK has two types of stacks, the main stacks (i.e., the Vapor Extraction Modules, VEM) and the abort/bypass stack. From the CDK vendor specification sheet, Weyerhaeuser Raymond's gasifier burner system will be equipped with a "factory poured and cured refractory tee and burner abort stack assembly with sleeved intake for pre-heat of gas combustion air and failsafe shutdown" and a "factory poured and cured refractory lined discharge stack for keeping combustion ducts hot during idle periods for quick burner system re-starts." Emissions are released through the abort/bypass stacks during shutdown, idling, or sudden upsets when the burner must be shutdown. The CDK will normally run on a continuous basis with infrequent startups and shutdowns. When the CDK is not actively drying lumber, it operates in the idling mode.

Based on information shared by the CDK vendor, the burner increases to its maximum firing capacity (50 MMBtu/hr) as quickly as possible. Time to reach maximum firing capacity is dependent on ambient conditions and the current temperature of the firing chamber as determined by the time from the previous

operation. The startup may last up to 4 hours without wood moving through the CDK but may occur in less than an hour. During startup, all emissions from the green sawdust combustion are routed into the CDK, exhausting at the vapor extraction points and openings at each end of the CDK.

In idling mode, the burner will be firing at a low rate of less than 1 to 10 MMBtu/hr. Emissions from combustion during idling are released through the abort stack and/or bypass stack. The emission calculations conservatively combine emissions from startup, shutdown, upset, and idling operations, assuming the annual heat input for the combined activities is 18,000 MMBtu/yr (50 MMBtu/hr \* 360 hr/yr<sup>1</sup>).

Annual emissions from startup, shutdown, upset, and idling conditions are below 4 tpy for all criteria pollutants. Due to the abort/bypass stacks' relatively infrequent operation and minimal emissions, add-on control technology is cost ineffective for criteria pollutant BACT and related tBACT for startup and shutdown. Based on the EPA's proposed updates to 40 CFR 63, Subpart DDDD (discussed further in the response to Data Request 1.1), the EPA is proposing work practice standards as control methods for bypass stacks.<sup>2</sup> Specifically, the EPA proposes an annual burner tune-up and abort/bypass stack usage monitoring and reporting. Weyerhaeuser will incorporate the proposed standards as BACT for CDK startup and shutdown. Emission rates from startup and idling are calculated using emission factors from National Council for Air and Stream Improvement (NCASI) Technical Bulletin 1013 (TB1013) and AP-42, Section 1.6, and Weyerhaeuser proposes the referenced emission factors as the BACT limits.

### Data Request 1, Question 5 – CDK Toxics

*ORCAA: Pollutants typically associated with hogged fuel combustion such as Mercury, Hydrochloric Acid, Chromium III, and Chromium VI were not addressed in the application. Please use the AP-42 emissions factors or similar and complete the associated Chapter 173-460 WAC toxics review for those TAP.*

**Response:** Weyerhaeuser added organic and metal HAP/TAP combustion emissions based on emission factors found in National Council for Air and Stream Improvement (NCASI) Technical Bulletin 1013 (TB1013) and AP-42, Section 1.6. NCASI's emission factors (median values) were prioritized over AP-42. While most of the NCASI emission factors for organic HAP/TAP were uncontrolled, some pollutants had a footnote expressing a controlled emission factor. If the control was a wet PM control, then NCASI TB1013 was still used due to the CDK's wet scrubber-like features (see Response to Data Request 1.1 below for more details on the wet scrubber-like features). However, if the control was a dry PM control, then AP-42 Section 1.6, Table 1.6-3 emissions factors were used. For metal HAP/TAP, wet scrubber-controlled emission factors were used, also due to the wet-scrubber-like features of the CDK. If only dry PM-controlled emission factors were available, then AP-42 Section 1.6, Table 1.6-4 was used.

### Data Request 1, Question 6 – Pollutant Net Out/Offset

*ORCAA: Did the application 'net out' or 'offset' any pollutants? It did not appear so, but we mentioned it may be an option in the pre-meeting and we are verifying those techniques were not used.*

**Response:** For any HAP/TAP with project emissions over their respective SQER, Weyerhaeuser is proposing to apply the netting approach to the HAP/TAP emissions. To determine actual emissions from the current

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<sup>1</sup> The annual hour estimate is calculated by subtracting the expected annual operating hour of 8,400 from 8,760 hours.

<sup>2</sup> "National Emission Standards for Hazardous Air Pollutants: Plywood and Composite Wood Products." Docket ID No. EPA-HQ-OAR-2016-0243. Federal Register 88:96 (May 18, 2023) p. 31856-31887. Available from: <https://www.federalregister.gov/d/2023-10067>; Accessed 10/31/2023.

batch kilns and hog fuel boiler, operational parameters and emissions rates are acquired from the 2013-2022 Annual Emission Inventories (AEIs). On a pollutant-by-pollutant basis, actual emissions are calculated from the annual average actual emission rates of the highest two consecutive years within the past ten years. For pollutants that do not have previously quantified emissions, it is assumed that emissions associated with combustion are not expected to change and these new pollutants are included due to availability of newer and more comprehensive testing data. Therefore, it is assumed that the same emission factor applies, and the proposed emissions are lower than actual emissions due to the CDK's lower maximum heat input. In these instances, net emissions are set to zero and do not exceed the SQER. Please refer to the emissions calculation spreadsheet for details. The TAPs listed below exceed the SQER and require modeling. A modeling analysis will be provided under a separate cover.

- ▶ Formaldehyde
- ▶ Benzene
- ▶ Arsenic
- ▶ Cadmium
- ▶ Lead
- ▶ Manganese
- ▶ Nickel

### Data Request 1, Question 7 – CDK PM BACT

*ORCAA: CDK BACT for PM. Please provide a narrative for why add-on controls for PM are technically infeasible or update the CDK BACT determination for PM.*

**Response:** See response to Data Request 1.1 below.

### Data Request 1.1 – BACT Technical Feasibility

*ORCAA: Sections 5.2.1 and 5.2.2 of the application state, "Upon further analysis, all add-on control technologies were deemed to be technically infeasible." However, no explanations were provided to support these conclusions for either VOC or particulate emissions controls listed as "Other Controls" in the application. An explanation needs to be provided for all control technologies used in practice for drying {lumber, veneer, wood chips} even if the control technology does not show up on the RBL clearinghouse list. For example, veneer dryers are a similar drying operation where presumed BACT is an add-on control device. The CDKs proposed by Weyerhaeuser will be equipped with exhaust capture systems, which will capture and exhaust emissions through two sets of stacks. Therefore, it is technically feasible to duct these emissions to an add-on control system. Therefore, for each "Other Control" listed in the application, provide either:*

- 1. A sound basis or explanation why the add-on control is technically infeasible; or,*
- 2. A cost feasibility analysis for the add-on control.*

**Response:** On May 18, 2023, the EPA released the preamble for the proposed 40 CFR 63, Subpart DDDD, otherwise known as National Emission Standards for Hazardous Air Pollutants (NESHAP) for Plywood and Composite Wood Products (PCWP), which explains the proposed Maximum Available Control Technology (MACT) standards for lumber dry kilns. At a high level, CDKs may be designed with fan-powered stacks, like the Raymond CDK's vapor extraction modules (VEMs), which are able to direct 40-80% of the kiln exhaust upward.<sup>3</sup> As the vendor states in the equipment specifications, the VEMs are installed in order to pull water

<sup>3</sup> "National Emission Standards for Hazardous Air Pollutants: Plywood and Composite Wood Products." Docket ID No. EPA-HQ-OAR-2016-0243. Federal Register 88:96 (May 18, 2023) p. 31856-31887. Available from: <https://www.federalregister.gov/d/2023-10067>; Accessed 10/31/2023.

vapor up and away from the CDK ends as a method of reducing fog hazard in the loading areas. However, while the stacks are fan-powered, the fans cannot be operated at levels necessary for emission capture and control as this would disrupt the CDK's ability to precondition green lumber with the heat and steam from dried lumber, an essential energy-transfer function.<sup>4</sup> Due to this design constraint, the EPA has determined it to be technically infeasible to "to capture emissions from the openings at each end or directly measure the total gas flow rate from a CDK as needed to prescribe or enforce an emission limit." Additionally, CDKs have a significantly high volumetric fugitive emission rate, so even if emission points could be identified for source testing, only emission concentrations would be able to be measured. These data would have limited practicality as the total volumetric flow rates, and thus emission rates, out of the CDK are indeterminable. NCASI provides further explanation of the design constraints imposed by emission control devices, as well as the technical infeasibility of stack testing in Attachment B.

In discussing emission controls, it is important to note the CDK's inherent "wet scrubber" effect. Hot air from the combustion unit is first drawn into the CDK's central drying zone and is then recirculated throughout the kiln by a number of internal fans. Excess high-moisture exhaust travels toward both ends of the CDK, passing through the energy recovery zones. In these energy recovery zones, heat from the heated dried lumber is transferred to the cooler green lumber traveling in the opposite track direction. As the green lumber absorbs the heat, the temperature of the circulated air in the energy recovery zones decreases, which condenses water vapor onto the green lumber and absorbs water vapor into the dry lumber. The condensate will include pollutants such as condensable PM, PM<sub>10</sub>, PM<sub>2.5</sub>, and water-soluble TAP/HAP, and therefore reduce their air emissions.

In its evaluation of VOC and organic HAP emission controls, the EPA determined that add-on control technology was technically and cost infeasible.<sup>5</sup> Their assessment included "oxidizers (RTO and RCO), carbon adsorption, condensation, biofilters, and wet scrubbers," where "RTO" means either regenerative or recuperative thermal oxidation and "RCO" means either regenerative or recuperative catalytic oxidation. Among Best Available Control Technology (BACT) analyses, the EPA does note that should an RTO be attempted, a facility will likely need to install "duct heaters and a WESP" in order to "prevent resin buildup" in ductwork and protect the RTO's thermal media or the RCO's catalytic media. For PCWP MACT's implications on direct-fired CDKs, the EPA proposes the following work practice standards:

1. Operation and maintenance (O&M) plan
2. Burner tune-up
3. Over-drying prevention methods:
  - a. Operate below a maximum temperature setpoint;
  - b. Conduct in-kiln moisture monitoring; or,
  - c. Follow a "site-specific plan (for temperature and lumber moisture monitoring)"
4. Set dried lumber minimum moisture content limits

Weyerhaeuser will incorporate these work practice standards as VOC and PM BACT for the CDK, as well as the related tBACT.

In addition to the earlier explanation about the infeasibility of emission control devices, the following are explanations of the technical infeasibility for VOC control technologies mentioned in the Raymond CDK NOC Application report:

► Adsorption

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<sup>4</sup> Ibid.

<sup>5</sup> Ibid.

- The kiln exhaust contains the water vapor that has evaporated from the lumber as it is dried and will have a relative humidity over 100%. At high moisture contents, the water molecules and hydrocarbons in the exhaust stream will compete for active adsorption sites, reducing the efficiency of an adsorption system. Therefore, adsorption is technically infeasible for VOC control.
- ▶ Biofiltration
  - The microorganisms used in biofiltration cannot survive at temperatures exceeding 105 °F. The kiln exhaust stream will have a minimum temperature of approximately 140 °F. Furthermore, the primary constituent of the VOC in the exhaust stream is terpenes, which are highly viscous and would cause the biofilter to easily foul. Because of the nature of the long-chained hydrocarbons in the exhaust stream, a biofilter with a reasonable footprint/retention time, will have a reduced control efficiency relative to a unit treating streams with large concentrations of methanol or formaldehyde. The microorganisms require a much longer retention time/size of a unit in order to provide an increased efficiency. For example, engineering firms have previously noted that to increase the control efficiency an additional 5% at these removal levels would essentially require a biofilter twice as large.
- ▶ Condensation
  - Condensation requires that the exhaust stream be cooled to a low enough temperature for the vapor pressure to be lower than the VOC concentration. The primary constituent of the VOC in the exhaust stream from the lumber kilns is terpenes, which would require the temperature of the exhaust stream to be lowered to well below 0 °F in order to have a low enough vapor pressure to use condensation. Temperatures this low would cause the water vapor in the stream to freeze, and the ice would clog the unit. Therefore, condensation is technically infeasible for VOC control.
- ▶ Thermal and Catalytic Oxidation
  - The high moisture content and low exit temperature of the exhaust stream would likely make an RTO technically infeasible. While RCOs can operate at lower temperatures than the RTO, the exit temperature of the exhaust stream from the CDK is still too low for this option to be feasible. Furthermore, the particulate matter and other contaminants in the exhaust stream would cause a loss of catalytic activity. Therefore, oxidation is technically infeasible for VOC control.
- ▶ Wet Scrubber
  - While some VOCs that will be present in the exhaust stream are highly soluble in water, other VOCs, most notably  $\alpha$ -pinene, are only very slightly soluble in water due to the lower Henry's Law constant as described in Perry's Chemical Engineer's Handbook. Lower Henry's Law constant VOCs would require much longer residence time within a scrubber packed column and would eliminate this as a technically viable solution for the constant stream that would need to be handled by a continuous dry kiln. Therefore, a wet scrubber is technically infeasible for VOC control.

Similar to VOC, in addition to the earlier explanation about the infeasibility of emission control devices, the following are explanations of the technical infeasibility for PM control technologies mentioned in the Raymond CDK NOC Application report:

- ▶ Baghouse
  - CDK exhaust is sufficiently laden with moisture and resinous compounds, so condensation in a baghouse frequently occurs. Condensation of resinous compounds on the baghouse filters leads to blinding, the phenomenon when air cannot pass through the cake buildup. Therefore, a baghouse is technically infeasible for PM control.
- ▶ Cyclone
  - CDK exhaust is sufficiently laden with moisture and resinous compounds, so condensation in a cyclone frequently occurs. Condensation of resinous compounds leads to buildup of residue in the cyclone, preventing airflow and reducing efficiency. Therefore, a cyclone is technically infeasible for PM control.
- ▶ Scrubber

- Scrubbers remove pollutants by inertial or diffusional impaction, reaction with a sorbent or reagent slurry, or adsorption into a liquid solvent. In addition to VOCs, scrubbers can be used to control PM emissions; however, they are limited to inlet concentrations between 1 and 115 grams per cubic meter.<sup>6</sup> Typical dry kiln exhaust concentrations are on the order of 0.01 grams per cubic meter<sup>7</sup>, which is below the scrubber's design constraint. Therefore, a scrubber is technically infeasible for PM control.
- ▶ Dry Electrostatic Precipitator (Dry ESP)
  - Dry ESPs are not designed to operate under conditions in which the gas stream contains water vapor or other moist/sticky elements, so it would be expected to see particulate agglomeration on dry ESPs. Therefore, a dry ESP is technically infeasible for PM control.
- ▶ Wet Electrostatic Precipitator (WESP)
  - Wire-plate WESPs typically manage inlet concentrations between 2 and 110 grams per cubic meter, but typical dry kiln exhaust concentrations are on the order of 0.01 grams per cubic meter.<sup>8</sup> Additionally, WESPs require a large amount of space, which, upon review of the site plan, is not feasible for the Raymond facility. Therefore, a WESP is technically infeasible for PM control.

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<sup>6</sup> EPA (2003). "Air Pollution Control Technology Fact Sheet: Venturi Scrubber."  
<https://www3.epa.gov/ttnca1c1/dir1/fventuri.pdf>

<sup>7</sup> The calculated exhaust PM concentration for the proposed CDK at the Raymond facility is 0.028 g/m<sup>3</sup>.

<sup>8</sup> EPA (2003). "Air Pollution Control Technology Fact Sheet: Wet Electrostatic Precipitator (ESP) - Wire Plate Type."  
<https://www3.epa.gov/ttnchie1/mkb/documents/fwespwpl.pdf>

## **Attachment A**

### **Emissions Calculations**

**Project Inputs and Assumptions**

Parameter	Value	Units	Source Notes
<b>CDK</b>			
Total Kiln Heat Input	50	MMBtu/hr	Per vendor specification sheet received on May 16, 2023.
CDK Maximum Annual Operating Hours	8,760	hrs/yr	Assumed value for PTE basis.
CDK Expected Annual Operating Hours	8,400	hrs/yr	Per vendor specification sheet received on May 16, 2023.
Annual Production	310	MMBF/yr	Per vendor specification sheet received on May 16, 2023.
Maximum Hourly Production	3.69E-02	MMBF/hr	Calculated by the following: Hourly Production (MMBF/hr) = Annual Production (MMBF/yr) / CDK Expected Annual Operating Hours (hrs/yr).
<b>Truck Bins</b>			
Bark Annual Throughput	121,186	tpy	See Fugitive PM tab.
Green Chips Annual Throughput	414,070	tpy	See Fugitive PM tab.
Planer Shavings Annual Throughput	58,212	tpy	See Fugitive PM tab.
Sawmill Operation - Hours per Day	20	hours/day	Per conversation with client, the sawmill operates in two 10-hour shifts.
Sawmill Operation - Days per Week	5	days/week	Per conversation with client, the sawmill operates Monday - Friday
Sawmill Operation - Weeks per Year	52	weeks/year	Per conversation with client, the sawmill operates 52 weeks per year.
Sawmill Operation - Annual Operating Hours	5,200	hours/year	Calculated by the following: Annual Operating Hours = (Hours/Day) * (Days/Week) * (Weeks/Year).
<b>Fugitive Emissions - Green Sawdust</b>			
Wet Green Sawdust Higher Heating Value	3,500	Btu/lb	Per the HHV of wet fuel in Weyerhaeuser's Greenville facility's CDK PTE calculations.
Green Sawdust Fuel Maximum Annual Throughput	62,571	tpy	Calculated by the following: Annual Green Sawdust Fuel (tpy) = Total Kiln Heat Input (MMBtu/hr) * CDK Maximum Annual Operating Hours (hrs/yr) * 10 <sup>6</sup> (Btu/MMBtu) / HHV (Btu/lb) / 2000 (lb/ton).
Green Sawdust Fuel Maximum Hourly Throughput	14,286	lb/hr	Calculated by the following: Max Hourly Green Sawdust Fuel (lb/hr) = Total Kiln Heat Input (MMBtu/hr) * 10 <sup>6</sup> (Btu/MMBtu) / HHV (Btu/lb).
Sawdust Surge - Hours per Week	100	hours/week	Per conversation with client, the operational surge is 100 hrs/wk (Monday - Friday).
Sawdust Surge - Days per Week	5	days/week	Assumed value, since the sawmill operates Monday - Friday.
Sawdust Surge - Hours per Day	20	hours/day	Calculated by the following: Hours per Day = (Hours/Week) / (Days/Week).
Sawdust Surge - Annual Operating Hours	5,200	hours/year	Calculated by the following: Annual Operating Hours = (Hours/Week) * (Weeks/Year).
<b>Cyclones</b>			
Cyclone Annual Operating Hours	8,760	hrs/yr	Assumed value for PTE basis.
Fuel Silo Cyclone Exhaust Flow Rate	6,227	scfm	Per vendor specs, received June 29, 2023. Per email with Angela Cameron on July 11, 2023, the stream is at ambient temperature and is assumed to be in standard conditions.
Bark Cyclone Exhaust Flow Rate	8,564	scfm	Per Table 3.0 in the TSD for 12AOP915 (Cyclone #11). The stream is assumed to be at ambient conditions.
Dry Chip Cyclone Exhaust Flow Rate	5,150	scfm	Per Table 3.0 in the TSD for 12AOP915 (Cyclone #21). The stream is assumed to be at ambient conditions.
Dry Chip Baghouse Control Efficiency	99%	--	Based on the 2021 ORCAA AEI workbook, baghouses are assumed to maintain a control efficiency of 99%.
Cyclone PM Grain Loading Rate	0.03	gr/dscf	Based on the 2021 ORCAA AEI workbook, the PM grain loading rate comes from FIRE 6.23 October 2000, SCC 30700804, 30700805, which is also in Table 10.4.1 AP-42, p. 10.4-2 (2/80).

**Table F-1. Project-Wide Potential Emissions — Criteria Pollutant Summary**

Emission Unit	Fugitive?	Potential Annual Emissions (tpy)							
		Total PM	Total PM <sub>10</sub>	Total PM <sub>2.5</sub>	SO <sub>2</sub>	NO <sub>x</sub>	VOC	CO	CO <sub>2e</sub>
CDK	N	24.82	18.95	17.76	5.48	44.40	224.66	116.39	45,893
Chip and Bark Truck Bins	Y	9.45	4.47	0.68	--	--	--	--	--
Fugitive Emissions - Green Sawdust	Y	0.24	0.11	0.02	--	--	--	--	--
Haul Roads	Y	0.90	0.18	0.04	--	--	--	--	--
Cyclones	N	16.72	6.69	6.69	--	--	--	--	--
<b>Total:</b>		<b>52.12</b>	<b>30.39</b>	<b>25.18</b>	<b>5.48</b>	<b>44.40</b>	<b>224.66</b>	<b>116.39</b>	<b>45,893</b>

**Table F-2. Facility-Wide Potential Emissions — Criteria Pollutant Summary**

Emission Unit	Fugitive?	Potential Annual Emissions (tpy)							
		Total PM	Total PM <sub>10</sub>	Total PM <sub>2.5</sub>	SO <sub>2</sub>	NO <sub>x</sub>	VOC	CO	CO <sub>2e</sub>
Wood Waste Collection - Cyclones <sup>2</sup>	N	18.36	7.36	7.36	--	--	--	--	--
Fugitive Emissions - Roads <sup>3</sup>	Y	0.90	0.18	0.04	--	--	--	--	--
Log Debarking <sup>4</sup>	Y	6.5	3.6	0.5	--	--	--	--	--
CDK	N	24.82	18.95	17.76	5.48	44.40	224.66	116.39	45,893
Chip and Bark Truck Bins	Y	9.45	4.47	0.68	--	--	--	--	--
Fugitive Emissions - Green Sawdust	Y	0.24	0.11	0.02	--	--	--	--	--
Fire Pump Engine	N	0.03	0.03	0.03	0.02	0.37	0.03	0.08	13.73
<b>Total Emissions (with fugitives):</b>		<b>60.29</b>	<b>34.70</b>	<b>26.38</b>	<b>5.50</b>	<b>44.77</b>	<b>224.69</b>	<b>116.47</b>	<b>45,906</b>
<b>Total Emissions (without fugitives):</b>		<b>43.21</b>	<b>26.34</b>	<b>25.14</b>	<b>5.50</b>	<b>44.77</b>	<b>224.69</b>	<b>116.47</b>	<b>45,906</b>
<b>PSD Major Source Thresholds:</b>		<b>250</b>	<b>250</b>	<b>250</b>	<b>250</b>	<b>250</b>	<b>250</b>	<b>250</b>	<b>100,000</b>
<b>PSD Threshold Exceeded<sup>1</sup> (Yes/No):</b>		<b>No</b>	<b>No</b>	<b>No</b>	<b>No</b>	<b>No</b>	<b>No</b>	<b>No</b>	<b>No</b>

<sup>1</sup> PSD is only applicable for GHG if the PSD threshold is exceeded for it and another pollutant.

<sup>2</sup> "Wood Waste Collection - Cyclones" includes new cyclones added as part of the project and existing cyclones that remain unchanged.

<sup>3</sup> Vehicle usage has been updated as part of the project, so fugitive road emissions have been recalculated.

<sup>4</sup> "Log Debarking" emissions remain unchanged from the value included in Table 4.2 of the TSD to the current AOP (12AOP915). The PM value was estimated based on the PM/PM10 relationship displayed in ORCAA's 2021 AEI - Debarking tab.

**Table F-3. Project-Wide and Facility-Wide Potential Emissions — HAP Summary**

Total HAP <sup>1</sup> (tpy):	21.68	
Maximum HAP (tpy):	14.04	Methanol

<sup>1</sup> After completion of the CDK Project, HAP emissions at the Facility will only be emitted from the CDK.

**Table F-4. Project-Wide Potential Emissions — HAP/TAP Summary**

Pollutant	CAS #	HAP?	TAP?	CDK Emissions		Averaging Period	Project Emissions without netting		Exceed SQER without netting?	Actual Emissions <sup>2</sup>	Net Emissions <sup>2</sup>	Exceed SQER with netting?
				(lb/hr)	(tpy)		(lb/avg. period)	(lb/avg. period)				
Formaldehyde	50-00-0	Yes	Yes	0.42	1.76	year	27	3518.08	Yes	288.09	3,229.99	Yes
Benzene	71-43-2	Yes	Yes	0.21	0.92	year	21	1839.60	Yes	474.03	1,365.57	Yes
Arsenic	7440-38-2	Yes	Yes	5.05E-04	2.21E-03	year	0.049	4.42	Yes	0.11	4.31	Yes
Cadmium	7440-43-9	Yes	Yes	1.55E-04	6.77E-04	year	0.039	1.35	Yes	0.08	1.28	Yes
Lead	7439-92-1	Yes	Yes	1.75E-03	7.64E-03	year	14	15.29	Yes	0.13	15.16	Yes
Manganese	7439-96-5	Yes	Yes	6.35E-03	0.03	24-hr	0.022	0.15	Yes	0.02	0.13	Yes
Nickel	7440-02-0	Yes	Yes	4.42E-04	1.94E-03	year	0.62	3.87	Yes	0.45	3.42	Yes
<b>Total HAP (tpy):</b>				21.68								
<b>Max Individual HAP (tpy):</b>				14.04		Methanol						

<sup>1</sup> The SQER for each TAP is obtained from the 2019 WAC 173-460 TAP list.

<sup>2</sup> For each TAP that initially exceeds its SQER, netting was conducted to determine actual emissions based on the last ten years of annual emissions inventories (AEIs) for the current combustion and lumber drying operations (hog fuel boiler and indirect-heated batch kilns, respectively). The net emissions (proposed emissions - actual emissions) are then compared to the SQER. For pollutants that do not have previously quantified emissions, which are evidenced by "Not Calculated" in the Actual Emissions column, it is assumed that by using the same emission factor, proposed emissions will be lower than actual emissions due to the CDK's lower maximum heat input. In these instances, net emissions are set to zero and do not exceed the SQER.

$$\begin{aligned}
 \text{CDK Maximum Heat Input (MMBtu/yr)} &= \text{Heat Input Rating (MMBtu/hr)} * \text{Annual Hours of Operation (hrs/yr)} \\
 &= 438,000 \text{ MMBtu/yr} \\
 \text{Maximum two-year average hog fuel boiler heat input (MMBtu/yr)} &= 638,917 \text{ MMBtu/yr}
 \end{aligned}$$

**Table F-5. CDK Parameter Inputs**

Parameter	Value	Units	Source Notes
Total Kiln Heat Input	50	MMBtu/hr	Per vendor specification sheet received on May 16, 2023.
CDK Maximum Annual Operating Hours	8,760	hrs/yr	Assumed value for PTE basis.
CDK Expected Annual Operating Hours	8,400	hrs/yr	Per vendor specification sheet received on May 16, 2023.
Annual Production	310	MMBF/yr	Per vendor specification sheet received on May 16, 2023. Calculated by the following: Hourly Production (MMBF/hr) = Annual Production (MMBF/yr) / CDK Expected Annual Operating Hours (hrs/yr).
Maximum Hourly Production	3.69E-02	MMBF/hr	

**Table F-6. CDK Criteria Pollutant and GHG Emissions**

Pollutant	Normal Operation Emission Factors			Normal Operation Emissions <sup>6</sup>		Startup/Idling Emissions <sup>6</sup>		Total CDK Emissions <sup>6</sup>	
	Emission Factor	Unit	Reference	Max Hourly (lb/hr)	Total Annual (tpy)	Max Hourly (lb/hr)	Total Annual (tpy)	Max Hourly (lb/hr)	Total Annual (tpy)
PM	140	lb/MMBF	1	5.17	21.70	17.35	3.12	17.35	24.82
PM <sub>10</sub>	104	lb/MMBF	1	3.84	16.12	15.70	2.83	15.70	18.95
PM <sub>2.5</sub>	99	lb/MMBF	1	3.65	15.35	13.39	2.41	13.39	17.76
CO	730	lb/MMBF	1	26.94	113.15	18.00	3.24	26.94	116.39
NO <sub>x</sub>	280	lb/MMBF	1	10.33	43.40	10.15	1.00	10.33	44.40
Total VOC	--	--	2	53.48	224.66	--	--	53.48	224.66
VOC (Combustion)	6.19E-03	lb/MMBtu	3	0.31	1.36	--	--	0.31	1.36
VOC (Drying)	1,440.7	lb/MMBF	4	53.17	223.31	--	--	53.17	223.31
SO <sub>2</sub>	0.025	lb/MMBtu	1	1.25	5.48	--	--	1.25	5.48
CO <sub>2e</sub>	--	lb/MMBtu	5	10,478	45,893	--	--	10,478	45,893
CO <sub>2</sub>	207	lb/MMBtu	5	10,340	45,288	--	--	10,340	45,288
N <sub>2</sub> O	7.94E-03	lb/MMBtu	5	0.40	1.74	--	--	0.40	1.74
CH <sub>4</sub>	1.59E-02	lb/MMBtu	5	0.79	3.48	--	--	0.79	3.48

<sup>1</sup> Emissions for PM, CO, NO<sub>x</sub>, and SO<sub>x</sub> estimated using direct-fired continuous dry kiln emission factors from Georgia EPD's document entitled "EPD Recommended Emission Factors for Lumber Kiln Permitting in Georgia".

<sup>2</sup> Emissions for VOC determined by adding together indirect-heated batch dry kiln emission factors for douglas fir and wood-fired combustion emission factors.

<sup>3</sup> VOC combustion emission factor based on NCASI Technical Bulletin No. 1013: A Comprehensive Compilation and Review of Wood-Fired Boiler Emissions, Table 5.1. Mean values used. VOC reported as total non-methane hydrocarbons (TNMHC) "as-C", determined using EPA Method 25A, and converted to WPP1<sup>1</sup> per WPP1 Section 8.0 Equation 1: VOC (WPP1) = VOC (as-C) + Methanol + Formaldehyde.

<sup>4</sup> VOC drying emission factor as derived by OTM26 based on the "EPA Region 10 HAP and VOC Emission Factors for Lumber Drying, January 2021". Emission Factor (lb/MBF) = 0.01460x - 1.77130, where x = max drying temp of heated air entering the lumber (220 °F).

<sup>5</sup> GHG emissions are calculated based on the Global Warming Potentials (GWP) provided in Table A-1 of 40 CFR 98 and emission factors provided in Tables C-1 and C-2 for combustion of wood and wood residuals.

CO <sub>2</sub>	1
N <sub>2</sub> O	298
CH <sub>4</sub>	25

<sup>6</sup> Emission rates for pollutants with only 'lb/MMBF' emission factors are based on the CDK's annual throughput of dried lumber [MMBF], so combustion emissions from startup and idling are added in order to determine total CDK emission rates. These startup and idling emissions are calculated in the CDK Startup and Idling tab of the workbook. Emission rates for pollutants with 'lb/MMBtu' emission factors are based on the kiln's maximum firing rate [MMBtu/hr] and continuous operating hours of 8,760 hours per year. Since emissions at the maximum firing rate are the most conservative, the 'lb/MMBtu' emission rates already include combustion emissions from startup and idling.

<sup>7</sup> Max hourly emissions represent the maximum emissions from the following three scenarios: normal operation, startup, or idling.

**Table F-7. CDK HAP/TAP Emissions**

Pollutant	CAS #	HAP?	TAP?	Normal Operation Emission Factors <sup>1,2</sup>			Normal Operation Emissions <sup>11</sup>		Startup/Idling Emissions <sup>11</sup>		Total CDK Emissions <sup>11</sup>	
				Combustion (lb/MMBtu)	Drying (lb/MMBF)	Reference	Max Hourly (lb/hr)	Total Annual (tpy)	Max Hourly (lb/hr)	Total Annual (tpy)	Max Hourly <sup>12</sup> (lb/hr)	Total Annual (tpy)
Acetaldehyde	75-07-0	Yes	Yes	1.57E-04	27.5	2,3	1.02	4.30	--	--	1.02	4.30
Acrolein	107-02-8	Yes	Yes	1.27E-04	0.5	2,3	0.02	0.11	--	--	0.02	0.11
Formaldehyde	50-00-0	Yes	Yes	--	11.33	4	0.42	1.76	0.02	3.39E-03	0.42	1.76
Methanol	67-56-1	Yes	Yes	4.82E-04	89.9	2,3	3.34	14.04	--	--	3.34	14.04
Propionaldehyde	123-38-6	Yes	Yes	2.14E-05	0.3	2,3	0.01	0.05	--	--	1.21E-02	0.05
Carbon monoxide	630-08-0	No	Yes	--	--	--	26.94	113.15	18.00	3.24	26.94	116.39
Nitrogen dioxide	10102-44-0	No	Yes	--	--	5	10.33	43.40	10.15	1.83	10.33	45.23
Sulfur dioxide	7446-09-5	No	Yes	--	--	--	1.25	5.48	--	--	1.25	5.48
Acetophenone	98-86-2	Yes	No	1.84E-06	--	2	9.20E-05	4.03E-04	--	--	9.20E-05	4.03E-04
Benzene	71-43-2	Yes	Yes	4.2E-03	--	7	0.21	0.92	--	--	0.21	0.92
Bis(2-ethylhexyl)phthalate	117-81-7	Yes	Yes	4.65E-08	--	2	2.33E-06	1.02E-05	--	--	2.33E-06	1.02E-05
Bromobenzene	108-86-1	No	Yes	7.67E-06	--	2	3.84E-04	1.68E-03	--	--	3.84E-04	1.68E-03
Bromodichloromethane	75-27-4	No	Yes	5.90E-03	--	2	0.30	1.29	--	--	0.30	1.29
Bromomethane	74-83-9	Yes	Yes	3.67E-06	--	2	1.84E-04	8.04E-04	--	--	1.84E-04	8.04E-04
Carbon Tetrachloride	56-23-5	Yes	Yes	2.55E-06	--	2	1.28E-04	5.58E-04	--	--	1.28E-04	5.58E-04
Carbon-Disulfide	75-15-0	Yes	Yes	1.25E-04	--	2	6.25E-03	0.03	--	--	6.25E-03	0.03
Chlorobenzene	108-90-7	Yes	Yes	1.66E-05	--	2	8.30E-04	3.64E-03	--	--	8.30E-04	3.64E-03
Chloroform	67-66-3	Yes	Yes	2.55E-06	--	2	1.28E-04	5.58E-04	--	--	1.28E-04	5.58E-04
Chloromethane	74-87-3	Yes	Yes	2.66E-05	--	2	1.33E-03	5.83E-03	--	--	1.33E-03	5.83E-03
Cresols (mixed isomers)	1319-77-3	Yes	Yes	2.00E-05	--	2,8	1.00E-03	4.38E-03	--	--	1.00E-03	4.38E-03
Cumene	98-82-8	Yes	Yes	1.77E-05	--	2	8.85E-04	3.88E-03	--	--	8.85E-04	3.88E-03
1,2-Dibromoethane	106-93-4	Yes	Yes	1.83E-06	--	2	9.15E-05	4.01E-04	--	--	9.15E-05	4.01E-04
1,2-Dibromo-3-chloropropane	96-12-8	Yes	Yes	1.10E-06	--	2	5.50E-05	2.41E-04	--	--	5.50E-05	2.41E-04
1,4-Dichlorobenzene	106-46-7	Yes	Yes	2.79E-04	--	2	1.40E-02	0.06	--	--	1.40E-02	0.06
1,1-Dichloroethane	75-34-3	Yes	Yes	2.99E-05	--	2	1.50E-03	6.55E-03	--	--	1.50E-03	6.55E-03
1,2-Dichloroethane	107-06-2	Yes	Yes	2.92E-05	--	2	1.46E-03	6.39E-03	--	--	1.46E-03	6.39E-03
1,2-Dichloropropane	78-87-5	Yes	Yes	1.68E-05	--	2	8.40E-04	3.68E-03	--	--	8.40E-04	3.68E-03
Di-n-Butyl Phthalate	84-74-2	Yes	No	3.33E-05	--	2	1.67E-03	7.29E-03	--	--	1.67E-03	7.29E-03
4,6-Dinitro-2-methylphenol	534-52-1	Yes	No	2.10E-06	--	2	1.05E-04	4.60E-04	--	--	1.05E-04	4.60E-04
2,4-Dinitrophenol	51-28-5	Yes	No	1.31E-07	--	2	6.55E-06	2.87E-05	--	--	6.55E-06	2.87E-05
2,4-Dinitrotoluene	121-14-2	Yes	Yes	9.42E-07	--	2	4.71E-05	2.06E-04	--	--	4.71E-05	2.06E-04
Ethyl Benzene	100-41-4	Yes	Yes	3.13E-05	--	2	1.57E-03	6.85E-03	--	--	1.57E-03	6.85E-03
Hexachlorobenzene	118-74-1	Yes	Yes	1.03E-06	--	2	5.15E-05	2.26E-04	--	--	5.15E-05	2.26E-04
n-Hexane	110-54-3	Yes	Yes	2.88E-04	--	2	1.44E-02	0.06	--	--	1.44E-02	0.06
Hexachlorobutadiene	87-68-3	Yes	Yes	3.65E-07	--	2	1.83E-05	7.99E-05	--	--	1.83E-05	7.99E-05
Hydrogen Chloride	7647-01-0	Yes	Yes	1.11E-04	--	7	5.55E-03	0.02	--	--	5.55E-03	0.02
Hydrogen Fluoride	7664-39-3	Yes	Yes	8.50E-06	--	7	4.25E-04	1.86E-03	--	--	4.25E-04	1.86E-03
Isopropanol	67-63-0	No	Yes	1.10E-03	--	2	0.06	0.24	--	--	0.06	0.24
Methyl Ethyl Ketone	78-93-3	No	Yes	5.39E-06	--	2	2.70E-04	1.18E-03	--	--	2.70E-04	1.18E-03
Methyl Isobutyl Ketone	108-10-1	Yes	Yes	4.45E-04	--	2	0.02	0.10	--	--	0.02	0.10
Methylene Chloride	75-09-2	Yes	Yes	2.82E-05	--	2	1.41E-03	6.18E-03	--	--	1.41E-03	6.18E-03
Naphthalene	91-20-3	Yes	Yes	8.13E-06	--	2	4.07E-04	1.78E-03	--	--	4.07E-04	1.78E-03
4-Nitrophenol	100-02-7	Yes	No	9.41E-08	--	2	4.71E-06	2.06E-05	--	--	4.71E-06	2.06E-05
Pentachlorophenol	87-86-5	Yes	Yes	4.48E-08	--	2	2.24E-06	9.81E-06	--	--	2.24E-06	9.81E-06
Phenol	108-95-2	Yes	Yes	1.53E-05	--	2	7.65E-04	3.35E-03	--	--	7.65E-04	3.35E-03
Styrene	100-42-5	Yes	Yes	1.54E-05	--	2	7.70E-04	3.37E-03	--	--	7.70E-04	3.37E-03
Tetrachloroethene	127-18-4	Yes	Yes	2.46E-05	--	2	1.23E-03	5.39E-03	--	--	1.23E-03	5.39E-03
Toluene	108-88-3	Yes	Yes	3.67E-06	--	2	1.84E-04	8.04E-04	--	--	1.84E-04	8.04E-04
Tribromomethane	75-25-2	Yes	Yes	3.65E-07	--	2	1.83E-05	7.99E-05	--	--	1.83E-05	7.99E-05
1,2,4-Trichlorobenzene	120-82-1	Yes	No	1.10E-04	--	2	5.50E-03	0.02	--	--	5.50E-03	0.02
1,1,1-Trichloroethane	71-55-6	Yes	Yes	3.93E-05	--	2	1.97E-03	8.61E-03	--	--	1.97E-03	8.61E-03
1,1,2-Trichloroethane	79-00-5	Yes	Yes	2.40E-04	--	2	1.20E-02	0.05	--	--	1.20E-02	0.05
Trichloroethylene	79-01-6	Yes	Yes	1.99E-05	--	2	9.95E-04	4.36E-03	--	--	9.95E-04	4.36E-03
2,4,6-Trichlorophenol	88-06-2	Yes	Yes	2.76E-07	--	2	1.38E-05	6.04E-05	--	--	1.38E-05	6.04E-05

Pollutant	CAS #	HAP?	TAP?	Normal Operation Emission Factors <sup>1,2</sup>			Normal Operation Emissions <sup>11</sup>		Startup/Idling Emissions <sup>11</sup>		Total CDK Emissions <sup>11</sup>	
				Combustion (lb/MMBtu)	Drying (lb/MMBF)	Reference	Max Hourly (lb/hr)	Total Annual (tpy)	Max Hourly (lb/hr)	Total Annual (tpy)	Max Hourly <sup>12</sup> (lb/hr)	Total Annual (tpy)
1,2,3-Trichloropropane	96-18-4	No	Yes	2.19E-06	--	2	1.10E-04	4.80E-04	--	--	1.10E-04	4.80E-04
Vinyl Chloride	75-01-4	Yes	Yes	1.84E-05	--	2	9.20E-04	4.03E-03	--	--	9.20E-04	4.03E-03
Xylenes (mixed isomers)	1330-20-7	Yes	Yes	5.22E-06	--	2,9	2.61E-04	1.14E-03	--	--	2.61E-04	1.14E-03
Antimony	7440-36-0	Yes	No	1.47E-06	--	6	7.35E-05	3.22E-04	--	--	7.35E-05	3.22E-04
Arsenic	7440-38-2	Yes	Yes	1.01E-05	--	6	5.05E-04	2.21E-03	--	--	5.05E-04	2.21E-03
Beryllium	7440-41-7	Yes	Yes	4.23E-08	--	6	2.12E-06	9.26E-06	--	--	2.12E-06	9.26E-06
Cadmium	7440-43-9	Yes	Yes	3.09E-06	--	6	1.55E-04	6.77E-04	--	--	1.55E-04	6.77E-04
Chromium	Cr(III)	Yes	Yes	1.00E-05	--	6	5.00E-04	2.19E-03	--	--	5.00E-04	2.19E-03
Chromium, VI	18540-29-9	Yes	Yes	2.35E-07	--	6	1.18E-05	5.15E-05	--	--	1.18E-05	5.15E-05
Cobalt	7440-48-4	Yes	Yes	6.11E-07	--	6	3.06E-05	1.34E-04	--	--	3.06E-05	1.34E-04
Copper	7440-50-8	No	Yes	1.34E-05	--	6	6.70E-04	2.93E-03	--	--	6.70E-04	2.93E-03
Lead	7439-92-1	Yes	Yes	3.49E-05	--	6	1.75E-03	7.64E-03	--	--	1.75E-03	7.64E-03
Manganese	7439-96-5	Yes	Yes	1.27E-04	--	6	6.35E-03	0.03	--	--	6.35E-03	0.03
Mercury	7439-97-6	Yes	Yes	8.26E-07	--	6	4.13E-05	1.81E-04	--	--	4.13E-05	1.81E-04
Nickel	7440-02-0	Yes	Yes	8.84E-06	--	6	4.42E-04	1.94E-03	--	--	4.42E-04	1.94E-03
Phosphorus	7723-14-0	Yes	Yes	9.85E-05	--	6	4.93E-03	0.02	--	--	4.93E-03	0.02
Selenium	7782-49-2	Yes	Yes	1.03E-06	--	6	5.15E-05	2.26E-04	--	--	5.15E-05	2.26E-04
Vanadium	7440-62-2	No	Yes	9.8E-07	--	10	4.90E-05	2.15E-04	--	--	4.90E-05	2.15E-04

<sup>1</sup> Emissions for HAP determined by adding together indirect-heated batch dry kiln emission factors for douglas fir and wood-fired combustion emission factors, except for formaldehyde, which uses a calculated direct-fired emission factor.

<sup>2</sup> Organic HAP combustion emission factors based on NCASI Technical Bulletin No. 1013: A Comprehensive Compilation and Review of Wood-Fired Boiler Emissions, Table 4.1. Median values used. When a median is not available, the maximum value is used.

<sup>3</sup> HAP drying emission factors for acetaldehyde, acrolein, methanol, and propionaldehyde based on the emission factor summary table in "EPA Region 10 HAP and VOC Emission Factors for Lumber Drying, January 2021" and the methanol EF is based on max drying temp of heated air entering the lumber (220 °F).

<sup>4</sup> Due to formaldehyde's dependence on direct or indirect heating, the emission factor was scaled up from the value listed in the "EPA Region 10 HAP and VOC Emission Factors for Lumber Drying, January 2021," where x = max drying temp of heated air entering the lumber (220 °F). The value was scaled by the proportion of direct to indirect mean batch kiln emission factors for formaldehyde in the NCASI Wood Products Air Emission Factor Database – 2013 Update, which is shown below:

NCASI Direct-Fired Batch Kiln EF:	7.35E-02	lb/MBF	EPA Region 10 Indirect-Heated Batch Kiln EF:	2.36	lb/MMBF
NCASI Indirect-Heated Batch Kiln EF:	1.53E-02	lb/MBF			
Ratio of Direct-to-Indirect:	4.80				

<sup>5</sup> It is conservatively assumed that all NO<sub>x</sub> is converted to NO<sub>2</sub>.

<sup>6</sup> Trace metal HAP combustion emission factors based on NCASI Technical Bulletin No. 1013: A Comprehensive Compilation and Review of Wood-Fired Boiler Emissions, Table 4.3. Median Wet Scrubber were used. When a median was not available, the maximum value was used.

<sup>7</sup> For organic HAP that only had controlled factors in NCASI TB1013, if the control is a wet PM control, then NCASI TB1013 is still used. However, if the control is a dry PM control, then AP-42 Section 1.6, Table 1.6-3 emissions factors were used.

<sup>8</sup> In NCASI TB1013, Table 4-1, cresol emission factors are reported separately as m,p-cresol and o-cresol. Since the separate isomers have the same SQER and ASIL as the Cresol (mixed isomer) TAP and the mixed isomer TAP is not reported in TB1013, the two different isomer emission rates are added together in order to assess the mixed isomer toxic. Exceedance of the mixed isomer SQER or ASIL will also dictate exceedances for the individual isomer toxics.

<sup>9</sup> In NCASI TB1013, Table 4-1, xylene emission factors are reported separately as m,p-xylene, o-xylene, and xylenes (mixed isomers). Since the separate isomers have the same SQER and ASIL as the Xylene (mixed isomer) TAP and the mixed isomer TAP is reported in TB1013, the mixed isomer toxic is the only emission rate reported here. Exceedance of the mixed isomer SQER or ASIL will also dictate exceedances for the individual isomer toxics.

<sup>10</sup> When a trace metal HAP combustion emission factor in NCASI TB1013 did not have a Wet Scrubber value, then AP-42 Section 1.6, Table 1.6-4 emissions factors were used.

<sup>11</sup> Emission rates for pollutants with only 'lb/MMBF' emission factors are based on the CDK's annual throughput of dried lumber [MMBF], so combustion emissions from startup and idling are added in order to determine total CDK emission rates. These startup and idling emissions are calculated in the CDK Startup and Idling tab of the workbook. Emission rates for pollutants with 'lb/MMBtu' emission factors are based on the kiln's maximum firing rate [MMBtu/hr] and continuous operating hours of 8,760 hours per year. Since emissions at the maximum firing rate are the most conservative, the 'lb/MMBtu' emission rates already include combustion emissions from startup and idling.

<sup>12</sup> Max hourly emissions represent the maximum emissions from the following three scenarios: normal operation, startup, or idling.

**Table F-5.1. CDK Startup and Idling - Input Parameters**

Parameter	Value	Units	Source Notes
Total Kiln Heat Input	50	MMBtu/hr	Per vendor specification sheet received on May 16, 2023.
CDK Maximum Annual Operating Hours	8,760	hrs/yr	Assumed value for PTE basis.
CDK Expected Annual Operating Hours	8,400	hrs/yr	Per vendor specification sheet received on May 16, 2023.
CDK Maximum Startup and Idling Hours	360	hrs/yr	8,760 hours - Expected operating hours (8,400 hr)
CDK Startup and Idling Maximum Heat Input	18,000	MMBtu/yr	Total Kiln Heat Input * Maximum Startup and Idling Hours

Conservatively, assumed the startup and idling activities are occurring anytime beyond 8,400 hours/year (e.g. 360 hours) at burner firing capacity. In idling mode, the burner will be firing at a low rate of less than 1 MMBtu/hr. Emissions calculated are accounting for physical potential capacity to avoid additional restrictions on operating hours.

Note: Emission rates for pollutants with only 'lb/MMBF' emission factors are based on the CDK's annual throughput of dried lumber [MMBF], so combustion emissions from startup and idling are separately calculated here in order to determine total CDK emission rates. CDK emission rates for pollutants with 'lb/MMBtu' emission factors are conservatively based on the kiln's maximum firing rate [MMBtu/hr] and continuous operating hours of 8,760 hours per year, so combustion emissions from startup and idling do not need to be added.

**Table F-6.1. CDK Startup and Idling - Added Pollutant Emission Factors**

Pollutant	Emission Factor (lb/MMBtu)	Reference
Condensable PM (CPM)	0.017	1
CPM <sub>10</sub>	0.017	1
CPM <sub>2.5</sub>	0.017	1
Filterable PM (FPM)	0.33	2
FPM <sub>10</sub>	0.30	2
FPM <sub>2.5</sub>	0.25	2
Total PM (TPM)	0.347	3
TPM <sub>10</sub>	0.314	3
TPM <sub>2.5</sub>	0.268	3
CO	3.60E-01	4
NO <sub>x</sub>	2.03E-01	5
Formaldehyde	3.77E-04	6

<sup>1</sup> Condensable PM combustion emission factor based on AP-42 Section 1.6, Table 1.6-1. Assuming CPM = CPM<sub>10</sub> = CPM<sub>2.5</sub>.

<sup>2</sup> Filterable PM combustion emission factor based on NCASI Technical Bulletin No. 1013, Table 5.2, value for Wet Wood.

$$PM_{10} = 90\% \text{ of FPM cumulative mass}$$

$$PM_{2.5} = 76\% \text{ of FPM cumulative mass}$$

<sup>3</sup> Total PM = Condensable PM + Filterable PM

<sup>4</sup> CO combustion emission factor based on NCASI Technical Bulletin No. 1013, Table 5.1. Median value for Fuel Cells/Dutch Ovens was used.

<sup>5</sup> NO<sub>x</sub> combustion emission factor based on NCASI Technical Bulletin No. 1013, Table 5.1. Median value for Wood w/o Significant UF Resin Content was used.

<sup>6</sup> Formaldehyde combustion emission factor based on NCASI Technical Bulletin No. 1013, Table 4.1. Median value used.

**Table F-6.2. CDK Startup and Idling - Criteria Pollutant Emissions**

<b>Pollutant</b>	<b>Emission Factor (lb/MMBtu)</b>	<b>Hourly Emissions (lb/hr)</b>	<b>Annual Emissions (tpy)</b>
TPM	0.347	17.35	3.12
TPM <sub>10</sub>	0.314	15.70	2.83
TPM <sub>2.5</sub>	0.268	13.39	2.41
CO	0.360	18.00	3.24
NO <sub>x</sub>	0.203	10.15	1.00

**Table F-7.1. CDK Startup and Idling - HAP/TAP Emissions**

<b>Pollutant</b>	<b>CAS #</b>	<b>HAP?</b>	<b>TAP?</b>	<b>Emission Factor (lb/MMBtu)</b>	<b>Hourly Emissions (lb/hr)</b>	<b>Annual Emissions (tpy)</b>
Formaldehyde	50-00-0	Yes	Yes	3.77E-04	0.02	3.39E-03
Carbon monoxide	630-08-0	No	Yes	0.360	18.00	3.24
Nitrogen dioxide <sup>1</sup>	10102-44-0	No	Yes	0.203	10.15	1.83

<sup>1</sup> It is conservatively assumed that all NO<sub>x</sub> is converted to NO<sub>2</sub>.

**Note: In order to determine actual emissions from the current batch kilns and hog fuel boiler, operational parameters and emissions rates are acquired from the 2013-2022 Annual Emission Inventories (AEIs). On a pollutant-by-pollutant basis, actual emissions are calculated from the annual average actual emission rates of the highest two consecutive years within the past ten years.**

**Table F-7.2. Baseline Calculations - Hog Fuel Boiler Heat Input**

Year	Heat Input (MMBtu/yr)	Two-Year Period	Two-Year Average Heat Input (MMBtu/yr)
2013	607,432	2013-2014	583,270
2014	559,108	2014-2015	580,756
2015	602,404	2015-2016	616,698
2016	630,993	2016-2017	638,917
2017	646,840	2017-2018	624,346
2018	601,852	2018-2019	554,475
2019	507,098	2019-2020	551,346
2020	595,594	2020-2021	596,827
2021	598,060	2021-2022	521,503
2022	444,945		
<b>Max Heat Input (MMBtu/yr):</b>			638,917
<b>Baseline Period:</b>			2016-2017

**Table F-7.3. Baseline Calculations - Hog Fuel Boiler NO<sub>2</sub> and SO<sub>2</sub> Emissions**

Year	Annual NO <sub>2</sub> Emissions <sup>1</sup> (tpy)	Annual SO <sub>2</sub> Emissions (tpy)	Two-Year Period	Two-Year Average NO <sub>2</sub> Emissions (tpy)	Two-Year Average SO <sub>2</sub> Emissions (tpy)
2013	66.69	0.31	2013-2014	64.04	0.30
2014	61.39	0.29	2014-2015	54.79	1.50
2015	48.19	2.71	2015-2016	39.38	2.22
2016	30.57	1.72	2016-2017	41.16	2.32
2017	51.75	2.91	2017-2018	49.95	2.81
2018	48.15	2.71	2018-2019	44.36	2.50
2019	40.57	2.28	2019-2020	51.40	2.48
2020	62.24	2.68	2020-2021	62.37	2.69
2021	62.50	2.69	2021-2022	53.23	2.35
2022	43.97	2.00			
<b>Max Annual Emissions (tpy):</b>				64.04	2.81
<b>Baseline Period:</b>				2013-2014	2017-2018

<sup>1</sup> It is conservatively assumed that all NO<sub>x</sub> is converted to NO<sub>2</sub>.

**Table F-7.4. Baseline Calculations - Lumber Drying TAP Emissions**

<b>Pollutant CAS</b>	<b>Acetaldehyde 75-07-0</b>	<b>Acrolein 107-02-8</b>	<b>Formaldehyde 50-00-0</b>	<b>Methanol 67-56-1</b>	<b>Propionaldehyde 123-38-6</b>
<b>Year</b>	<b>Annual Emissions (lb/yr) - Less than or Equal to 200 °F</b>				
2013	1.62E+04	2.21E+02	1.98E+02	1.16E+04	1.46E+02
2014	1.47E+04	1.83E+02	1.95E+02	1.01E+04	1.39E+02
2015	1.57E+04	1.96E+02	2.01E+02	1.08E+04	1.50E+02
2016	1.69E+04	2.11E+02	2.31E+02	1.17E+04	1.60E+02
2017	1.46E+04	1.85E+02	2.45E+02	1.04E+04	1.36E+02
2018	1.32E+04	1.69E+02	2.27E+02	9.43E+03	1.23E+02
2019	1.30E+04	1.65E+02	2.13E+02	9.23E+03	1.22E+02
2020	1.37E+04	1.75E+02	2.35E+02	9.77E+03	1.28E+02
2021	1.48E+04	1.89E+02	2.55E+02	1.06E+04	1.39E+02
2022	9.66E+03	1.28E+02	2.34E+02	7.28E+03	8.76E+01
<b>Year</b>	<b>Annual Emissions (lb/yr) - Greater than 200 °F</b>				
2013					
2014	1.28E+03	3.50E+01	5.99E+01	2.80E+03	2.13E+01
2015	5.32E+02	1.46E+01	2.50E+01	1.17E+03	8.87E+00
2016					
2017					
2018					
2019					
2020					
2021					
2022					
<b>Year</b>	<b>Total Annual Emissions (tpy) - All Temperatures</b>				
2013	8.09E+00	1.10E-01	9.90E-02	5.78E+00	7.28E-02
2014	7.97E+00	1.09E-01	1.27E-01	6.47E+00	8.02E-02
2015	8.14E+00	1.05E-01	1.13E-01	6.00E+00	7.92E-02
2016	8.43E+00	1.06E-01	1.16E-01	5.84E+00	7.98E-02
2017	7.28E+00	9.27E-02	1.23E-01	5.18E+00	6.81E-02
2018	6.61E+00	8.43E-02	1.13E-01	4.71E+00	6.17E-02
2019	6.51E+00	8.27E-02	1.07E-01	4.61E+00	6.10E-02
2020	6.85E+00	8.74E-02	1.18E-01	4.89E+00	6.39E-02
2021	7.42E+00	9.46E-02	1.27E-01	5.29E+00	6.93E-02
2022	4.83E+00	6.39E-02	1.17E-01	3.64E+00	4.38E-02
<b>Two-Year Period</b>	<b>Two-Year Average Emissions (tpy)</b>				
2013-2014	8.03E+00	1.10E-01	1.13E-01	6.12E+00	7.65E-02
2014-2015	8.06E+00	1.07E-01	1.20E-01	6.23E+00	7.97E-02
2015-2016	8.29E+00	1.05E-01	1.14E-01	5.92E+00	7.95E-02
2016-2017	7.86E+00	9.91E-02	1.19E-01	5.51E+00	7.39E-02
2017-2018	6.95E+00	8.85E-02	1.18E-01	4.95E+00	6.49E-02
2018-2019	6.56E+00	8.35E-02	1.10E-01	4.66E+00	6.13E-02
2019-2020	6.68E+00	8.50E-02	1.12E-01	4.75E+00	6.25E-02
2020-2021	7.14E+00	9.10E-02	1.22E-01	5.09E+00	6.66E-02
2021-2022	6.12E+00	7.93E-02	1.22E-01	4.47E+00	5.65E-02
<b>Max Annual Emissions (tpy)</b>	<b>8.29E+00</b>	<b>1.10E-01</b>	<b>1.22E-01</b>	<b>6.23E+00</b>	<b>7.97E-02</b>
<b>Baseline Period</b>	<b>2015-2016</b>	<b>2013-2014</b>	<b>2020-2021</b>	<b>2014-2015</b>	<b>2014-2015</b>

**Table F-7.5. Baseline Calculations - Hog Fuel Boiler TAP Emissions**

<b>Pollutant</b> <sup>1</sup>	<b>CAS</b>	<b>Emission Factor</b> <sup>2,3</sup> <b>(lb/MMBtu)</b>	<b>Baseline Period</b> <sup>4</sup>	<b>Max Annual Heat Input</b> <b>(MMBtu/yr)</b>	<b>Max Annual Combustion Emissions</b> <b>(tpy)</b>	<b>Max Annual Combined Emissions</b> <sup>5</sup> <b>(tpy)</b>	<b>Max Annual Combined Emissions</b> <sup>5</sup> <b>(lb/yr)</b>	<b>Max Hourly Combined Emissions</b> <sup>5</sup> <b>(lb/hr)</b>	<b>Max Daily Combined Emissions</b> <sup>5</sup> <b>(lb/day)</b>
Acetaldehyde	75-07-0	1.64E-04	2015-2016	6.17E+05	0.05	8.34	16,674.31	1.94	46.62
Acrolein	107-02-8	3.15E-05	2013-2014	5.83E+05	9.20E-03	0.12	237.74	0.03	0.66
Formaldehyde	50-00-0	7.24E-05	2020-2021	5.97E+05	0.02	0.14	288.09	0.03	0.81
Nitrogen dioxide	10102-44-0		2013-2014		64.04	64.04	128,079.75	14.92	358.06
Sulfur dioxide	7446-09-5		2017-2018		2.81	2.81	5,619.11	0.65	15.71
Benzene	71-43-2	7.42E-04	2016-2017	6.39E+05	0.24	0.24	474.03	0.06	1.33
Bromodichloromethane	75-27-4	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated
1,2-Dibromoethane	106-93-4	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated
1,2-Dibromo-3-chloropropane	96-12-8	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated
1,4-Dichlorobenzene	106-46-7	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated
1,2-Dichloroethane	107-06-2	2.92E-05	2016-2017	6.39E+05	9.33E-03	9.33E-03	18.66	2.17E-03	0.05
Hexachlorobenzene	118-74-1	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated
1,1,2-Trichloroethane	79-00-5	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated
Arsenic	7440-38-2	1.76E-07	2016-2017	6.39E+05	5.62E-05	5.62E-05	0.11	1.31E-05	3.14E-04
Cadmium	7440-43-9	1.21E-07	2016-2017	6.39E+05	3.87E-05	3.87E-05	0.08	9.01E-06	2.16E-04
Chromium, VI	18540-29-9	1.54E-06	2016-2017	6.39E+05	4.91E-04	4.91E-04	0.98	1.14E-04	2.74E-03
Lead	7439-92-1	2.03E-07	2016-2017	6.39E+05	6.49E-05	6.49E-05	0.13	1.51E-05	3.63E-04
Manganese	7439-96-5	1.32E-05	2016-2017	6.39E+05	4.22E-03	4.22E-03	8.43	9.82E-04	0.02
Nickel	7440-02-0	7.06E-07	2016-2017	6.39E+05	2.26E-04	2.26E-04	0.45	5.25E-05	1.26E-03

<sup>1</sup> Pollutants were chosen for baseline analysis due to an exceedance of their respective SQER from project emissions. These do not represent the comprehensive list of TAP pollutants from hog fuel combustion. If a pollutant initially exceeded its SQER but was not included in the former AEIs, emissions are marked as "Not Calculated".

<sup>2</sup> Organic and trace elemental metal TAP emission factors come from Weyerhaeuser's ORCAA Annual Emission Inventories.

<sup>3</sup> NO<sub>2</sub> and SO<sub>2</sub> emissions are calculated in Table F-7.4.

<sup>4</sup> The baseline periods for Acetaldehyde, Acrolein, and Formaldehyde are based on the maximum two-year average lumber drying TAP emission rates since drying emissions are significant comparing to combustion emissions.

The baseline periods for NO<sub>2</sub> and SO<sub>2</sub> are based on the maximum two-year average hog fuel boiler emission rates.

The baseline period for all other TAPs is based on the maximum two-year average hog fuel boiler heat input since the EF remains the same during the 10 year period.

<sup>5</sup> The combined emissions represents both hog fuel combustion and lumber drying emission rates for Acetaldehyde, Acrolein, and Formaldehyde.

<sup>6</sup> Based on a review of prior boiler operating data, the hog fuel boiler is running close to 99% of the time. Therefore, to determine hourly and daily emissions from annual emissions, the boiler is conservatively assumed to have operated 98% of the time, which is approximately:

8584.8 hours per year.

**Table F-8. Fugitive PM Input Parameters**

Parameter	Value	Units	Source Notes
<b>Truck Bins</b>			
Bark Annual Throughput	121,186	tpy	See Fugitive PM tab.
Green Chips Annual Throughput	414,070	tpy	See Fugitive PM tab.
Planer Shavings Annual Throughput	58,212	tpy	See Fugitive PM tab.
Sawmill Operation - Hours per Day	20	hours/day	Per conversation with client, the sawmill operates in two 10-hour shifts.
Sawmill Operation - Days per Week	5	days/week	Per conversation with client, the sawmill operates Monday - Friday
Sawmill Operation - Weeks per Year	52	weeks/year	Per conversation with client, the sawmill operates 52 weeks per year.
Sawmill Operation - Annual Operating Hours	5,200	hours/year	Calculated by the following: Annual Operating Hours = (Hours/Day) * (Days/Week) * (Weeks/Year).
<b>Fugitive Emissions - Green Sawdust</b>			
Total Kiln Heat Input	50	MMBtu/hr	Per vendor specification sheet received on May 16, 2023.
CDK Maximum Annual Operating Hours	8,760	hrs/yr	Assumed value for PTE basis.
Wet Green Sawdust Higher Heating Value	3,500	Btu/lb	Per the HHV of wet fuel in Weyerhaeuser's Greenville facility's CDK PTE calculations.
Green Sawdust Fuel Maximum Annual Throughput	62,571	tpy	Calculated by the following: Annual Green Sawdust Fuel (tpy) = Total Kiln Heat Input (MMBtu/hr) * CDK Maximum Annual Operating Hours (hrs/yr) * 10 <sup>6</sup> (Btu/MMBtu) / HHV (Btu/lb) / 2000 (lb/ton).
Green Sawdust Fuel Maximum Hourly Throughput	14,286	lb/hr	Calculated by the following: Max Hourly Green Sawdust Fuel (lb/hr) = Total Kiln Heat Input (MMBtu/hr) * 10 <sup>6</sup> (Btu/MMBtu) / HHV (Btu/lb).
Sawdust Surge - Hours per Week	100	hours/week	Per conversation with client, the operational surge is 100 hrs/wk (Monday - Friday).
Sawdust Surge - Days per Week	5	days/week	Assumed value, since the sawmill operates Monday - Friday.
Sawdust Surge - Hours per Day	20	hours/day	Calculated by the following: Hours per Day = (Hours/Week) / (Days/Week).

**Table F-9. Fugitive PM Throughput Data**

Material	Annual Throughput <sup>1</sup>				Throughput Unit	Section
	2019	2020	2021	2022		
Wood Product (Douglas Fir)	99,914.33	125,245.32	143,303.83	166,910.44	MBF	Production
Wood Product (Hemlock)	67,220.85	70,590.17	61,250.57	0	MBF	Production
Bark, Burned for Energy Recovery On-Site	22,230	25,452.75	25,677.39	19,970.65	bdtons	Energy Fuel Sources
Shavings, Burned for Energy Recovery On-Site	12,554	8,484.25	8,558.13	6,656.88	bdtons	Energy Fuel Sources
Chips	93,387	129,120	134,236.57	111,472	bdtons	Production
Hog Fuel Mfg. Res., Otherwise Beneficially Reused	2,751	6,514	33,599.78	12,654	bdtons	Residuals and Waste
Sawdust By-Product sold	19,550	22,651	15,516.09	17,057	bdtons	Residuals and Waste
Shavings By-Product sold	12,554	13,244	9,842.07	6,193	bdtons	Residuals and Waste
Categorized Material	Annual Throughput <sup>1</sup> (bdton)				Components	
	2019	2020	2021	2022		
Bark <sup>2</sup>	24,981	31,966.75	0	32,624.65	Bark, Burned for Energy Recovery On-Site; Hog Fuel Mfg. Res., Otherwise Beneficially Reused	
Green Sawdust	19,550	22,651	15,516.09	17,057	Sawdust By-Product Sold	
Planer Shavings	25,108	21,728.25	18,400.2	12,849.88	Shavings, Burned for Energy Recovery On-Site; Shavings By-Product sold	
Chips	93,387	129,120	134,236.57	111,472	Chips	
Categorized Material	Ratio <sup>1</sup> (bdton/MBF produced)				Max Ratio	CDK Project
	2019	2020	2021	2022		
Bark	0.15	0.16	0.00	0.20	0.20	<b>121,186</b>
Green Sawdust	0.12	0.12	0.08	0.10	0.12	72,522
Planer Shavings	0.15	0.11	0.09	0.08	0.15	<b>58,212</b>
Green Chips	0.56	0.66	0.66	0.67	0.67	<b>414,070</b>

<sup>1</sup> Since fugitive emissions relate to the handling of byproduct and residual materials, exact throughputs have not yet been determined, so the projected post-project throughputs were estimated using annual production values from 2019 through 2022. Materials from Weyerhaeuser's production data were then grouped into the relevant categories for this project: bark, green sawdust, planer shavings, and green chips. Ratios were then calculated to relate annual material throughput to annual wood product production. Of these ratios, the maximum ratio was multiplied by the annual production rate for the CDK project and converted to a wet basis, assuming a moisture content of 50% for bark, green sawdust, and green chips and 20% for planer shaving. Since a green sawdust throughput is already specified for the green sawdust CDK burner (via burner capacity), the value in this table was not used in the PTE calculations.

<sup>2</sup> Due to log yard clean up activities in 2021, the "hog fuel beneficially applied" value does not accurately represent expected annual production rates of bark, so the scaled annual throughput of bark for the CDK project is based on 2019, 2020, and 2022 production rates.

**Table F-10. Fugitive PM Emissions**

Emission Unit	Material	Origin	Destination	Emission Factors (lb/ton) <sup>1</sup>			Capture Type	Capture Efficiency (%)	Annual Emissions (tpy) <sup>3</sup>			Daily Emissions (lb/day) <sup>4</sup>			Hourly Emissions (lb/hr) <sup>5</sup>		
				PM	PM <sub>10</sub>	PM <sub>2.5</sub>			PM	PM <sub>10</sub>	PM <sub>2.5</sub>	PM	PM <sub>10</sub>	PM <sub>2.5</sub>	PM	PM <sub>10</sub>	PM <sub>2.5</sub>
<b>Fugitive Emissions - Green Sawdust</b>																	
Green Sawdust Sawmill Drop	Green Sawdust	Sawmill	Green Sawdust Conveyor	7.55E-03	3.57E-03	5.41E-04	Building Enclosure	See Footnote 1 (Min Wind Speed)	0.24	0.11	0.02	1.08	0.51	0.08	0.05	0.03	3.86E-03
<i>Fugitive Emissions - Green Sawdust Sub-Total:</i>									<i>0.24</i>	<i>0.11</i>	<i>0.02</i>	<i>1.08</i>	<i>0.51</i>	<i>0.08</i>	<i>0.05</i>	<i>0.03</i>	<i>3.86E-03</i>
<b>Truck Bins</b>																	
Bark Bins Truck Loadout	Bark	Bark Bins	Truck	0.064	0.030	4.56E-03	Steel Sidings	50%	1.93	0.91	0.14	14.84	7.02	1.06	0.74	0.35	0.05
Chips Bins Truck Loadout <sup>6</sup>	Chips, Planer Shavings	Chip Bins	Truck	0.064	0.030	4.56E-03	Steel Sidings	50%	7.52	3.56	0.54	57.83	27.35	4.14	2.89	1.37	0.21
<i>Truck Bins Sub-Total:</i>									<i>9.45</i>	<i>4.47</i>	<i>0.68</i>	<i>72.67</i>	<i>34.37</i>	<i>5.20</i>	<i>3.63</i>	<i>1.72</i>	<i>0.26</i>
<b>Total:</b>									<b>9.68</b>	<b>4.58</b>	<b>0.69</b>	<b>73.75</b>	<b>34.88</b>	<b>5.28</b>	<b>3.69</b>	<b>1.74</b>	<b>0.26</b>

<sup>1</sup> Methods from AP-42 Section 13.2.4, Aggregate Handling and Storage Piles, are used to determine the emission factors and total emissions from raw material handling.

Uncontrolled Emission Factor (lb/ton) = 0.0032 x (k) x (U / 5)<sup>1.3</sup> / (M / 2)<sup>1.4</sup>, where:

Particle Size Multiplier (k) = 0.74 for PM  
 0.35 for PM<sub>10</sub>  
 0.053 for PM<sub>2.5</sub>

Mean Wind Speed (U) = 6.7 mph  
 Minimum Wind Speed (U) = 1.3 mph

This wind speed is used for outdoor emission calculations from truck bin loadout. Source: Western Regional Climatological Center, Olympia, WA station  
 This wind speed is used for the indoor emission calculations from the green sawdust drop. Source: AP-42 Section 13.2.4.

Material Moisture Content (M) = 25%  
 While the internal moisture of the wood particles may be around 50%, this variable (M) accounts for surface moisture. The lower end moisture content was chosen as a conservative estimate of annual surface moisture.

<sup>2</sup> The truck bins will be fitted with steel sidings, which prevent approximately 50% of fugitive emissions.

<sup>3</sup> Annual Emissions = Emission Factor (lb/ton) x Qty Unloaded (ton/yr) / 2000 (lb/ton) \* (100% - Capture Efficiency (%))

<sup>4</sup> Daily Emissions = Hourly Emissions (lb/hr) \* Hours per Day

<sup>5</sup> For green sawdust sawmill drop, Hourly Emissions = Emission Factor (lb/ton) x Qty Unloaded (lb/hr) / 2000 (lb/ton).

For truck loadout, Hourly Emissions = Emission Factor (lb/ton) x Qty Unloaded (ton/yr) / Annual Operating Hours (hours/yr) \* (100% - Capture Efficiency (%)). For the purpose of these calculations, it is assumed that the hourly truck loadout rate is equivalent to the hourly rate of material sent to the truck bin.

<sup>6</sup> While the planer shavings are blown to a cyclone on top of the chips bins that exhausts to a baghouse, all planer shavings are assumed to be sent down into the truck bins in order to have a conservative estimate of the material transfer PM emissions from truck loadout.

**Table F-11. Cyclones Input Parameters**

Parameter	Value	Units	Source Notes
Cyclone Annual Operating Hours	8,760	hrs/yr	Assumed value for PTE basis.
Fuel Silo Cyclone Exhaust Flow Rate	6,227	scfm	Per vendor specs, received June 29, 2023. Per email with Angela Cameron on July 11, 2023, the stream is at ambient temperature and is assumed to be in standard conditions.
Bark Cyclone Exhaust Flow Rate	8,564	scfm	Per Table 3.0 in the TSD for 12AOP915 (Cyclone #11). The stream is assumed to be at ambient conditions.
Dry Chip Cyclone Exhaust Flow Rate	5,150	scfm	Per Table 3.0 in the TSD for 12AOP915 (Cyclone #21). The stream is assumed to be at ambient conditions.
Dry Chip Baghouse Control Efficiency	99%	--	Based on the 2021 ORCAA AEI workbook, baghouses are assumed to maintain a control efficiency of 99%.
Cyclone PM Grain Loading Rate	0.03	gr/dscf	Based on the 2021 ORCAA AEI workbook, the PM grain loading rate comes from FIRE 6.23 October 2000, SCC 30700804, 30700805, which is also in Table 10.4.1 AP-42, p. 10.4-2 (2/80).

**Table F-12. Cyclones Emissions**

Emission Unit	Potential Operation	Exhaust Flow Rate	Loading Rate <sup>1</sup> (gr./dscf)			Control Efficiency	Filterable PM Emissions <sup>2,3,4</sup>		Filterable PM <sub>10</sub> Emissions <sup>2,3,4</sup>		Filterable PM <sub>2.5</sub> Emissions <sup>2,3,4</sup>	
	(hr/yr)	(scfm)	PM	PM <sub>10</sub>	PM <sub>2.5</sub>	(%)	(lb/hr)	(tpy)	(lb/hr)	(tpy)	(lb/hr)	(tpy)
Fuel Silo Cyclone	8,760	6,227	0.03	0.012	0.012	0%	1.60	7.01	0.64	2.81	0.64	2.81
Bark Cyclone	8,760	8,564	0.03	0.012	0.012	0%	2.20	9.65	0.88	3.86	0.88	3.86
Dry Chip Cyclone / Baghouse	8,760	5,150	0.03	0.012	0.012	99%	1.32E-02	0.06	5.30E-03	0.02	5.30E-03	0.02
<b>Total:</b>							<b>3.82</b>	<b>16.72</b>	<b>1.53</b>	<b>6.69</b>	<b>1.53</b>	<b>6.69</b>

<sup>1</sup> Based on the 2021 ORCAA AEI workbook, the FIRE 6.23 October 2000, SCC 30700804, 30700805 and EPA factor book 450/4-90-003 p. 144 assume that Filterable PM<sub>10</sub> is approximately equal to 40% of Filterable PM. It is also conservatively assumed that Filterable PM<sub>10</sub> = Filterable PM<sub>2.5</sub>. As this source does not involve combustion units, it is assumed that condensable emissions are negligible.

<sup>2</sup> As a conservative measure, emissions of PM<sub>2.5</sub> are assumed to be equal to emissions of PM<sub>10</sub>.

<sup>3</sup> Potential hourly PM emissions (lb/hr) = Exhaust Grain Loading Rate (gr./dscf) x Exhaust Air Flow Rate (dscf/min) x (60 min/hr) x (lb/7,000 gr.) x (100% - Control Efficiency (%)).

<sup>4</sup> Potential annual emissions (tpy) = Hourly Emission Rate (lb/hr) \* Annual Operating Hours (hrs/yr) / 2000 (lb/ton).

**Table F-13. Pre-Project Wood Waste Collection (Cyclones) Emissions**

Emission Unit	Potential Operation	Exhaust Flow Rate	Loading Rate <sup>1</sup> (gr./dscf)			Control Efficiency	Filterable PM Emissions <sup>2,3,4</sup>		Filterable PM <sub>10</sub> Emissions <sup>2,3,4</sup>		Filterable PM <sub>2.5</sub> Emissions <sup>2,3,4</sup>	
	(hr/yr)	(scfm)	PM	PM <sub>10</sub>	PM <sub>2.5</sub>	(%)	(lb/hr)	(tpy)	(lb/hr)	(tpy)	(lb/hr)	(tpy)
Dry Chip Cyclone / Baghouse <sup>5</sup>	8,760	5,150	0.03	0.012	0.012	99%	1.32E-02	0.06	5.30E-03	0.02	5.30E-03	0.02

<sup>1</sup> Based on the 2021 ORCAA AEI workbook, the FIRE 6.23 October 2000, SCC 30700804, 30700805 and EPA factor book 450/4-90-003 p. 144 assume that Filterable PM<sub>10</sub> is approximately equal to 40% of Filterable PM. It is also conservatively assumed that Filterable PM<sub>10</sub> = Filterable PM<sub>2.5</sub>. As this source does not involve combustion units, it is assumed that condensable emissions are negligible.

<sup>2</sup> As a conservative measure, emissions of PM<sub>2.5</sub> are assumed to be equal to emissions of PM<sub>10</sub>.

<sup>3</sup> Potential hourly PM emissions (lb/hr) = Exhaust Grain Loading Rate (gr./dscf) x Exhaust Air Flow Rate (dscf/min) x (60 min/hr) x (lb/7,000 gr.) x (100% - Control Efficiency (%)).

<sup>4</sup> Potential annual emissions (tpy) = Hourly Emission Rate (lb/hr) \* Annual Operating Hours (hrs/yr) / 2000 (lb/ton).

<sup>5</sup> Parameters for the existing emission unit based on Table 4.2 in the TSD for 12AOP915. PTE was calculated assuming 8,760 hour/year operation.

**Table F-14. Pre- and Post-Project Wood Waste Collection (Cyclones) Emission Comparison**

Emission Unit	PTE Emissions <sup>1</sup> (tpy)		
	PM	PM <sub>10</sub>	PM <sub>2.5</sub>
<b>Pre-Project Wood Waste Collection</b>			
Dry Chip Cyclone / Baghouse	0.06	0.02	0.02
All Other Existing Cyclones	1.64	0.68	0.68
<i>Pre-Project Total:</i>	1.7	0.7	0.7
<b>Post-Project Wood Waste Collection</b>			
Dry Chip Cyclone / Baghouse	0.06	0.02	0.02
All Other Existing Cyclones	1.64	0.68	0.68
Fuel Silo Cyclone	7.01	2.81	2.81
Bark Cyclone	9.65	3.86	3.86
<i>Post-Project Total:</i>	18.36	7.36	7.36

<sup>1</sup> Parameters for existing emission units based on Table 4.2 in the TSD for 12AOP915. PM Emissions were estimated using methods presented in ORCAA's 2021 AEI workbook.

**Table F-15. Haul Roads Input Parameters**

<b>Vehicle Name</b>	<b>Class</b>	<b>Vehicle Weight (Avg of Loaded + Unloaded) (tons)</b>	<b>Number of Trips per Day</b>	<b>Number of Days per Week</b>	<b>Number of Weeks per Year</b>	<b>Miles Round Trip (Paved)</b>	<b>Vehicle Miles Traveled per Day (VMT/day)</b>	<b>Vehicle Miles Traveled per Year (VMT/yr)</b>
Chip	Trucks	34	12	5	52	0.5	6	1560
Sawdust	Trucks	34	0	0	52	0.5	0	0
Lumber	Trucks	26	16	5	52	0.5	8	2080
Hog Fuel	Trucks	34	8	6	52	0.5	4	1248
Production Stackers	Stacker	75	75	6	52	0.1	7.5	2340
Production Forklifts	Forklifts	15	380	5	52	0.1	38	9880
Co. Pickups	Co. Pickups	2.5	8	6	52	0.5	4	1248
Sales/Service	Vendor	2.5	3	5	52	0.1	0.3	78
Shavings	Trucks	34	2	6	52	1	2	624
On-site transfers	Trucks	26	1	5	52	0.5	0.5	130
Log Delivery	Trucks	26	95	5	52	0.2	19	4940
<b>Total:</b>							<b>89.3</b>	<b>24128</b>

**Table F-16. Haul Roads Emissions**

Vehicle Name	Weight	Vehicle Miles Traveled per Year	Vehicle Miles Traveled per Day	Emission Factor, E <sup>1</sup> (lb/VMT)			Annual Controlled Emissions <sup>2</sup> (tpy)			Daily Controlled Emissions <sup>3</sup> (lb/day)		
	(tons)	(VMT/yr)	(VMT/day)	PM	PM <sub>10</sub>	PM <sub>2.5</sub>	PM	PM <sub>10</sub>	PM <sub>2.5</sub>	PM	PM <sub>10</sub>	PM <sub>2.5</sub>
Chip	34	1,560	6	0.44	0.09	0.02	0.08	0.02	3.73E-03	0.66	0.13	0.03
Sawdust	34	0	0	0.44	0.09	0.02	0	0	0	0	0	0
Lumber	26	2,080	8	0.33	0.07	0.02	0.08	0.02	3.78E-03	0.67	0.13	0.03
Hog Fuel	34	1,248	4	0.44	0.09	0.02	0.06	1.21E-02	2.98E-03	0.44	0.09	0.02
Production Stackers	75	2,340	8	0.98	0.20	0.05	0.26	0.05	1.25E-02	1.84	0.37	0.09
Production Forklifts	15	9,880	38	0.19	0.04	0.01	0.21	0.04	1.02E-02	1.80	0.36	0.09
Co. Pickups	2.5	1,248	4	0.03	0.01	0.00	4.24E-03	8.48E-04	2.08E-04	0.03	6.11E-03	1.50E-03
Sales/Service	2.5	78	0	0.03	0.01	0.00	2.65E-04	5.30E-05	1.30E-05	2.29E-03	4.58E-04	1.12E-04
Shavings	34	624	2	0.44	0.09	0.02	0.03	6.07E-03	1.49E-03	0.22	0.04	1.07E-02
On-site transfers	26	130	1	0.33	0.07	0.02	4.81E-03	9.62E-04	2.36E-04	0.04	8.32E-03	2.04E-03
Log Delivery	26	4,940	19	0.33	0.07	0.02	0.18	0.04	8.97E-03	1.58	0.32	0.08
<b>Total:</b>							0.90	0.18	0.04	7.28	1.46	0.36

<sup>1</sup> Emission factor E is calculated according to AP-42 Section 13.2.1 for emissions from paved roads, equation 1:

$$E \text{ (lbs/VMT)} = \text{Paved Road Emission Factor, } [k * (sL)^{0.91} * (W)^{1.02}]$$

0.011 = k, PM size multiplier (lb/VMT) from AP-42 Table 13.2.1-1.

0.0022 = k, PM<sub>10</sub> size multiplier (lb/VMT) from AP-42 Table 13.2.1-1.

0.00054 = k, PM<sub>2.5</sub> size multiplier (lb/VMT) from AP-42 Table 13.2.1-1.

1.1 = sL, roadway surface silt loading (g/m<sup>2</sup>) AP-42 13.2.1, Table 13-2.1-3. The average silt loading value for corn wet mills is used because the sawmill is expected to store materials with a similar texture and moisture content.

<sup>2</sup> Emissions account for natural mitigation due to precipitation according to AP-42 Section 13.2.1 equation 2:

$$\text{Annual emissions (tpy)} = E * (1-P/4N) * (1-C) * [\text{VMT/yr}] / [\text{lb/ton}]$$

161.6 = P, mean number of days per year with measurable precipitation from Western Regional Climatological Center, Olympia, WA station.

365 = N, number of days in period for annual rainfall mitigation effect

75% = C, control efficiency applied for watering and sweeping.

Paved roads are watered and vacuumed quarterly as control measures. Control efficiency from ORCAA's AEI workbook.

<sup>3</sup> Daily emissions (lb/day) are calculated in the same manner as annual emissions, but with the daily Vehicle Miles Traveled per Day and not taking credits for precipitation.

**Table F-17. Fire Pump Input Parameters**

Parameter	Value	Units	Source Notes
Fire Pump Engine Rated Capacity	238	bhp	From the 2022 ORCAA Annual Emissions Inventory.
Fire Pump Engine Annual Hours of Operation	100	hrs/yr	Assumed value for PTE basis.

**Table F-18. Fire Pump Emissions**

Emission Unit	Emission Factor <sup>1,4</sup>	Emissions	
	(lb/hp-hr)	Max Hourly (lb/hr)	Total Annual (tpy)
PM <sup>2</sup>	2.20E-03	0.52	0.03
PM <sub>10</sub>	2.20E-03	0.52	0.03
PM <sub>2.5</sub> <sup>2</sup>	2.20E-03	0.52	0.03
CO	6.68E-03	1.59	0.08
NO <sub>x</sub>	0.031	7.38	0.37
VOC <sup>3</sup>	2.51E-03	0.60	0.03
SO <sub>2</sub>	2.05E-03	0.49	0.02
CO <sub>2</sub> e	--	274.63	13.73
CO <sub>2</sub>	1.15	273.70	13.69
N <sub>2</sub> O	9.26E-06	2.20E-03	1.10E-04
CH <sub>4</sub>	4.63E-05	1.10E-02	5.51E-04

<sup>1</sup> Criteria pollutant and CO<sub>2</sub> emission factors for diesel industrial engines from AP-42, Table 3.3-1.

HAP/TAP Pollutants with an emission factor rating of C, D, or E are not included.

<sup>2</sup> Assuming PM = PM<sub>10</sub> = PM<sub>2.5</sub>.

<sup>3</sup> VOC emissions are equal to the sum of exhaust, evaporative, crankcase, and refueling TOC emissions.

<sup>4</sup> CH<sub>4</sub> and N<sub>2</sub>O emission factor is from 40 CFR 98, Subpart C, Table C-2. Global warming potential (GWP) for CH<sub>4</sub> is 25 and N<sub>2</sub>O is 298 for estimating CO<sub>2</sub>e emissions (40 CFR 98, Subpart A, Table A-1).

CH<sub>4</sub> and N<sub>2</sub>O emission factors assume the following average break-specific fuel consumption (BSFC), based on AP-42, Table 3.3-1, Footnote 'a'.

$$\text{Average BSFC} = 7,000 \text{ Btu/hp-hr}$$

## **Attachment B**

### **NCASI's Control Device and Stack Testing Feasibility Assessment**

**November 8, 2023**

**TO:** Weyerhaeuser NR Company

**CC:** Michelle Vinson, Michael Nolan, and Jack Carter

**FROM:** Ric Law, NCASI

**SUBJECT:** Considerations on the Feasibility of Conducting EPA Reference Air Test Methods at the Weyerhaeuser Raymond CDK

### Introduction

Weyerhaeuser is seeking a Notice of Construction Application (NOA) from the Olympic Region Clean Air Agency for a project at their Raymond WA sawmill that will replace an existing hog fuel boiler and eight indirectly heated batch kilns with a single direct-fired continuous dry kiln (CDK). As part of this NOA, Weyerhaeuser has asked the National Council for Air and Stream Improvement, Inc. (NCASI) to assess and comment on the feasibility of collecting CDK process emissions with EPA reference air test methods.

NCASI is a non-profit environmental technical studies organization focusing on environmental and sustainability topics relevant to the forest products industry. Over its 80-year history, NCASI has conducted studies in a variety of areas including air emissions and emission measurement methods and worked extensively on developing emissions data used for multiple forest products industry Maximum Achievable Control Technology (MACT) rulemakings. NCASI staff have wide-ranging experience in pulp and paper and wood products manufacturing processes and control technologies, stack testing, stack test report review, emissions data analysis, and emission factor development for pulp and paper mill and wood products plant emission sources.

### Lumber Kilns and Characteristics of Process Air Emissions

The Wood Products industrial sector produces a variety of manufactured products at panel plants, engineered wood plants, and sawmills. All of these products require some form of wood drying activity. For panel plants, other than plywood, the primary process unit used to dry wood furnish is either a rotary or tube dryer. These dryers require a hot gas stream to be mixed with green wood furnish prior to entering the dryer system. The hot gas stream transports the wood furnish through the dryer to the product cyclone where the wood furnish is separated from the dryer gas stream. For each dryer there is a dedicated conveyance system that is enclosed from the dryer inlet to the product cyclone. Prior to environmental regulations, most dryer systems exhausted to the atmosphere at the product cyclones. When particulate air emissions began to be regulated, it was a relatively easy task to combine the exhaust outlets of each product cyclone and duct the combined gas stream to a particulate control device and then later to an organic air emission control device where applicable. While there were some challenges to overcome with adding pollution controls to dryer systems, the actual operations of dryer systems were not significantly impacted when air flow through the dryers, product cyclones, and air emission control devices is maintained under normal operating conditions. Since the isolated gas stream from each product cyclone is combined, contained, and conveyed to an air emission control device, there is a single point of exhaust to the atmosphere for dryer systems. This single emission point can be designed to meet EPA criteria for obtaining representative air emission concentrations and flowrates to

derive accurate and repeatable mass emission rates.

The primary objective of the lumber kiln is the same as a wood furnish dryer, i.e., to dry a product from a high moisture content to a lower moisture content. Both process units have an inlet and outlet for the product and an inlet and outlet for the associated gas stream. The fundamental design difference between lumber kilns and wood furnish dryer systems is the direction of the air flow relative to the product. As previously mentioned, dryer systems rely on air flow to move the product, which means that the direction of air flow is parallel to the product. Lumber kilns, on the other hand, do not rely on air flow to move product, instead, the drying process within a lumber kiln requires an air flow direction that is perpendicular to the direction of product flow. This means that there is no inherent operational design criteria to isolate, contain, and convey the associated gas stream to meet product separation requirements.

Historically, lumber kilns have been designed as a batch process. A charge of green lumber is pushed into the inlet side of a kiln, the doors are shut, and the kiln is heated up from ambient to various setpoint temperatures according to a “*drying schedule*.” Batch kilns are designed as long rectangular structures with two tracks inside running parallel to the length of the kiln. Since the air flow in the kiln is perpendicular to the flow of the product<sup>1</sup>, multiple vents are required down the length of the kiln roof to allow fresh air into the kiln and moisture laden gas out of the kiln. Internal fans are used to move air flow across the charge. The direction of the air flow into and out of the kiln typically changes every 2 to 3 hours to achieve even drying on both sides of the kiln. For steam-heated kilns, the internal fans blow air across heating elements to reheat the air prior to passing through the charge. The alternative method for heating a kiln is direct-fired. The heat source for direct-fired kilns is either a dry wood suspension burner or a green sawdust slope grated gasifier. For direct-fired units, the hot gas supplied by the heat source is mixed with recycled kiln gas and the re-heated air is sent back into the kiln. The kiln air is reheated in a blend box that is attached to the side of the kiln and a large fan is used to circulate the air from the kiln into a blend box and back to the kiln.

The primary challenges associated with testing batch kilns are (1) most sawmills have multiple kilns which are typically constructed side-by-side on site making it difficult to isolate the emissions from one kiln to another and (2) the lack of a single release point that conveys the total kiln exhaust flow. This configuration poses a significant challenge to obtaining accurate total kiln flow rates and representative samples by established EPA reference air test methods.

Continuous dry kilns (CDKs) offer an alternative to the batch kiln design. While CDKs are also rectangular in dimension, these kilns are much longer than batch kilns. While there are also two parallel tracks traversing the length of the kiln, the product flow for CDKs is a continuous counter-current movement of lumber through the kiln. At one end of the kiln, green lumber is entering on one track and dry lumber exiting on the other track, while at the opposite end of the kiln, there is a corresponding dry end track exiting and a green end track entering. CDKs have a central main hot zone where the active drying of lumber on both tracks occurs. The drying zone is bracketed by two lumber equilibration zones, also referred to as energy recovery zones, where no active drying takes place. The intent of the equilibrium zones is to transfer heat from the hot, dried lumber exiting the drying zone to the cool green lumber entering the drying zone. The result is the delivery of uniformly pre-heated green lumber to the drying

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<sup>1</sup> Note for batch kilns: the charge (1) is pushed into the kiln initially, (2) remains static during the drying process, and then (3) is pushed out of the kiln on completion of the drying schedule. This constitutes the “product flow” for batch kilns.

zone on both tracks. Pre-heated green lumber lowers the amount of heat input required to reach the drying schedule's setpoint (minimizing combustion rates) and promotes more uniform drying conditions (minimizing over drying of the charge). The dry lumber passing through the equilibrium zones exit the CDK having been conditioned to a uniform exiting moisture content, thus also minimizing the need to over dry the kiln charge.

When CDKs are operating under normal conditions, the only source of inlet air for the CDK is from the burner air. Burner air is injected into the kiln at a temperature close to 2,000 °F where it is mixed with recirculated kiln air from the drying zone. The re-heated kiln air is then sent back into the kiln. The drying zone has multiple internal fans to move air perpendicular to the flow direction of lumber traveling through the kiln. Since CDKs typically do not have any active roof vents within the drying zone, baffles at both ends of the drying zone control the release of excess moisture laden gas into the energy recovery zones. The amount of excess gas delivered to each energy recovery zone can vary depending on operating conditions and product requirements. Each of the energy recovery zones also have internal fans to maintain the movement of air perpendicular to the counter-current flow of lumber but a spiral flow pattern is also established as the air moves towards the kiln ends. The intent of the energy recovery zones is to transfer heat from the dry lumber track (hot) to the green lumber track (cool). This process gradually lowers the temperature of the circulated gas stream as the green lumber absorbs heat. As the temperature drops, water vapor condenses on the green lumber as well as being absorbed by the dry lumber. The drop in temperature between the dry zone and the kiln ends can be 75 to 100 °F.

CDKs are designed to release excess kiln process gas through the two end openings. The flow pattern that results at the kiln ends is complex because of the confined space between the kiln walls and the entering and exiting lumber. Ambient air is also drawn into the kiln ends because of the positive and negative pressure created by the internal fans close to the kiln ends. Ambient air is drawn into the kiln on the negative side (dry lumber exiting) and kiln gas is forced out on the positive side (green lumber entering). This inherent air flow characteristic has made CDKs with open ends unsuitable for conducting EPA reference air test methods.

One characteristic of CDKs is that a significant amount of steam builds up at the kiln ends which poses as a safety hazard to the forklift operations associated with continuous loading and unloading of the lumber. Hoods have been added to the ends of existing CDKs, as well as incorporated into the design of new CDKs, to alleviate this workplace safety hazard. Some hoods are equipped with a single centralized vertical exhaust duct situated at the peak of the hood while other hood designs place a vertical exhaust duct over each track. Furthermore, some retrofitted hoods only rely on convection to channel steam up and out of the hood while others are fan driven. When hoods are added to kiln ends, the kiln gas must exit the kiln prior to entering the hood space, meaning that the exhausted gas stream will be forced to change both velocity and direction as the gas enters the hood and subsequently mixed with ambient air that is also being drawn into the hood. The resulting gas collected within the hood is then partitioned between venting out the vertical exhaust duct(s) and the hood opening.

#### **NCASI Comments on the Feasibility of Conducting EPA Reference Air Test Methods at the Weyerhaeuser Raymond CDK**

The Weyerhaeuser Raymond CDK will have proprietary Vapor Extraction Modules (VEMs) to divert a portion of the steam exiting the kiln to elevated release points away from the loading and unloading areas on each end of the kiln. The VEMs are designed to be an integral part of the kiln meaning that the kiln gas leaving the energy recovery zones directly enters the VEMs. Each VEM will be equipped with

two fan-driven short stacks. The VEM stacks are designed specifically for releasing kiln water vapor and the design specifications do not satisfy the necessary criteria required to conduct representative air emissions testing. A detailed evaluation of the VEMs is provided below with an emphasis on the ability to conduct EPA reference air emission test methods.

### 1. Vapor Extraction Modules

Each VEM is an extension added to the energy recovery zone at each end of the kiln. This is a different design than retrofitted hoods because the kiln gas remains inside the kiln when entering the VEM.

The green-side track will be the positive side of the internal fans that circulate air within the energy recovery zones. The pattern of flow for the kiln gas exiting the energy recover zone, therefore, will be along the upper portion of the kiln where the gas is expected to be forced into the upper corner of the kiln above the green-side track, as shown in Figure 1. At this point, a portion of the gas is exhausted out of the two stacks with the remaining gas forced down and out the end of the kiln. The flow pattern of the kiln exhaust in the area over the green-side track is expected to be very turbulent. Baffles that line the edges of the kiln ends and rest on the lumber entering and exiting the kiln are also expected to have an impact on the exhaust flow pattern from the kiln.

### 2. VEM Stacks

Figure 1 shows that each VEM section has two stacks situated side-by-side in a parallel orientation to the entrance of the green-side track. According to the design schematics, the four stacks are identical with an approximate diameter of 3 ft and a height of 6 ft. There is a 36-in diameter fan installed within each stack. The center of the stack that is furthest from the kiln side is 11 ft inboard. The paired stacks are approximately 5.5 ft apart centerline to centerline and the release points for each stack is approximately 46ft above grade.

The kiln vendor has reported that the target designed vapor capture for the VEM stacks is 80%. This design target will be difficult to confirm. Confirmation by visually assessing the amount of moisture vapor exiting the kiln can be misleading due to differences in pressure and temperature. Designing the VEM stacks to capture and release the entire kiln exhaust (both water vapor and dry gas) is operationally not an option. The capture of all kiln exhaust would require an excessive negative pressure within the kiln that would impact drying efficiency, extract heat from the drying zone, and short circuit the energy recovery zone. All of these issues would counteract the intended design benefits provided by CDKs. As a consequence, the VEM stacks are not intended to capture and convey the entire kiln's process gas stream in a manner that meets EPA reference air test methods.

### 3. Location of Staging Area for Sampling Operations

Figure 1 shows that the location of the VEM stacks are above the entrance of the green-side track at each end of the kiln. The kiln ends of CDKs are zones where a significant amount of activity occurs during continuous kiln operations. This is unlike batch kilns, where the loading zone for the kiln charge cycles through periods of activity. There is a significant amount of activity when the batch charge is being built and a period of inactivity after the charge is pushed into the kiln. CDKs, on the other hand, operate continuously with loading and unloading operations ongoing on both ends of the kiln. Staging a sampling effort within the congested area around the kiln ends is expected not to

meet the criteria as a safe working zone for most sawmill operations.

#### 4. **Alternative Method for Selection of Measurement Site**

EPA Method 1 describes the criteria for measurement site selection. The VEM stacks do not meet the Method 1 criteria for optimum measurement site location. Method 1 does, however, allow for alternative site location criteria.

The first option allowed by Method 1 is to place the sample ports at a minimum of 0.5 duct diameters upstream and 2 duct diameters downstream from nearest disturbances. To utilize these minimum distances, however, there needs to be an absence of cyclonic flow. Since each VEM stack is equipped with a fan, it is assumed that cyclonic flow conditions will be present at a sample port location 2 duct diameters from the outlet of the fan.

The second option, detailed in EPA's Method 5D, is to construct a temporary stack extension with flow straightening vanes. Figure 2 provides an example of how a Method 5D flow straightening vane stack extension could be configured. The stack extension in this example has a total height of 5ft making the sample port approximately 50 ft above grade. Each stack extension would have to be fitted and secured to the top of each existing stack and be required to structurally support the measurement equipment.

The temporary stack extension option is expected to pose a work-site safety issue. Assuming that the challenges associated with accessing all sample ports is possible, the release point for the process gas exhausted from the shortened stack extensions will be at or below head level of the sample crew working from a manlift or from a temporary sample platform (assuming one could be safely installed). There is a significant potential that steam and process gas will envelop the measurement work site and impact the ability to safely conduct sampling.

#### 5. **Number of Traverse Points Required**

To use the flow straightening vane stack alternative, reference test methods require a total of 24 traverse points (12 on each stack diameter). Table 1 lists the traverse point locations along a 3 ft stack diameter that would be required and the proximity between traverse points. For example, the distance from the stack wall to traverse point A1 is 1 inch and for A2 is 2.2 inches. that means that the measurement system would have to be moved 1.2 inch when traversing from A1 to A2. To achieve this level of incremental precision, the measurement system will have to be suspended from a securely attached monorail system.

Table 1. Example of traverse point locations for the 3ft VEM stacks.

	inches across traverse	$\Delta d$ for points	
wall	0		
A1	1	1.0	
A2	2.2	1.2	
A3	3.9	1.7	
A4	5.8	1.9	
A5	8.2	2.4	
A6	11.6	3.5	center
A7	21.1	9.4	
A8	24.5	3.5	
A9	26.9	2.4	
A10	28.9	1.9	
A11	30.5	1.7	
A12	31.7	1.2	

## Conclusion

The CDK being installed at the Weyerhaeuser Raymond sawmill will incorporate state of the art kiln drying technology that is designed to increase energy efficiency and minimize over drying of lumber. The improvements in lumber drying efficiency offered by CDKs require that a critical design balance be maintained between heat input and the exhaust of moisture vapor generated from drying lumber. For the Raymond CDK, a portion of the generated water vapor will be exhausted through four short fan driven stacks. These stacks are designed to elevate the point of vapor release to alleviate a workplace safety issue associated with process steam build up that occurs at the loading and unloading zones at each end of the CDK. Dry kilns, whether of the batch or CDK design, are not designed such that the entire kiln process exhaust is collected and conveyed to a single point. Any such design applied to CDKs will have negative impacts on drying efficiency, for example, the extraction of excessive heat from the drying zone or short circuiting the energy recovery zone, and counteract other design benefits provided by CDKs. The fundamental design of the Raymond CDK, therefore, is the same as other existing CDKs in that the emission release points are not designed or configured to meet the criteria for EPA air emission reference test methods. For this reason, any effort to determine emission factors for the Raymond CDK will likely only yield an estimate that is expected to be no more accurate than the existing emission factors that have been derived from engineering tests conducted at CDKs outfitted with temporary stacks or kiln end hoods.

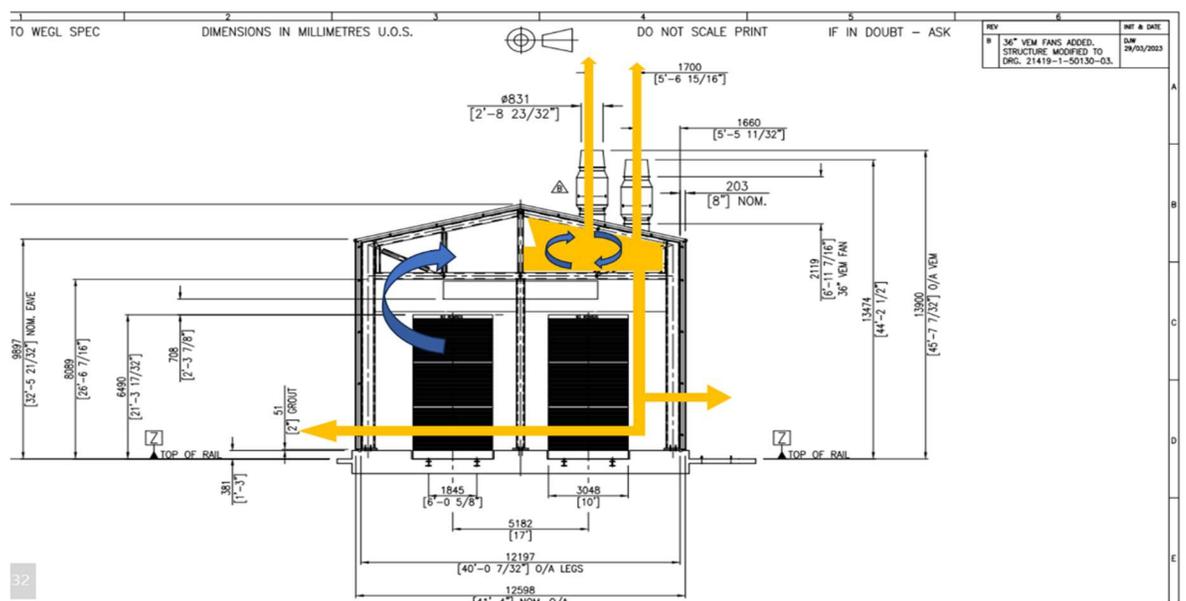


Figure 1. Configuration of the Vapor Extraction Module and Stacks.

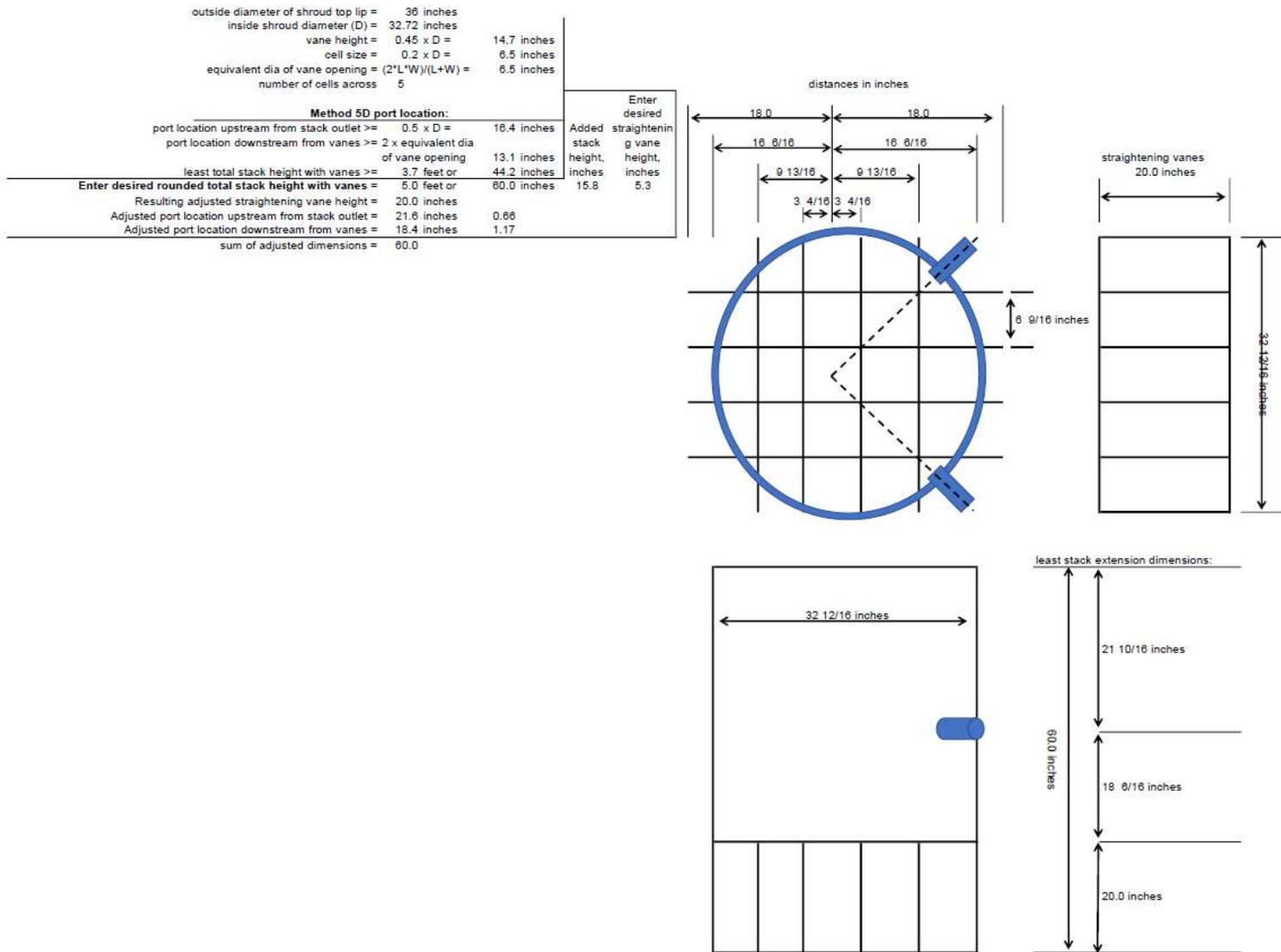


Figure 2. Example Method 5D design specifications for flow straightening vanes for the Raymond CDK VEM stacks

**To:** Aaron Manley, Olympic Region Clean Air Agency  
**cc:** Michael Nolan, Jack Carter, and Angela Cameron, Weyerhaeuser NR Company  
**From:** Beth Ryder and Maddie Coates, Trinity Consultants  
**Date:** November 27, 2023  
**RE:** Weyerhaeuser Raymond NOC Application Addendum – Modeling Section (23NOC1614)

On October 10, 2023, Weyerhaeuser NR Company (Weyerhaeuser) received a data request from Aaron Manley, P.E. from the Olympic Region Clean Air Agency (ORCAA) regarding its Notice of Construction (NOC) application #23NOC1614. The NOC application was submitted to approve the installation of a direct-fired continuous dry kiln (CDK) at the Raymond facility (the "Facility"). This memo serves as an addendum to the NOC permit application and provides the data requested by ORCAA related to modeling.

### **Data Request 1, Question 3 – Modeling**

- a. *ORCAA: The application states an outdated version of AERMET was used, (V19191) and we require confirmation the current version of AERMET was used (V22112) or that the modeling scenario be re-run using the current version of AERMET.*

**Response:** Weyerhaeuser updated the MET data to be processed with V22112 instead of V19191. The updated models submitted along with this addendum use the MET data processed with V22112.

- b. *ORCAA: The application needs to use the most recent 5 calendar years of met data or be amended to address/justify why 2016-2020 was used and not 2018-2022.*

**Response:** Weyerhaeuser updated the MET data to use 2018-2022 data. The updated models submitted along with this addendum use this data set.

- c. *ORCAA: Table G-4, footnote 1 states that the two merged CDK stacks (North and South) are based on guidance from "Practical Guide to Atmospheric Dispersion Modeling" (Tuner and Shulze). Please provide the relevant excerpts from this reference, in the context of how the merged pseudo stacks' exit velocity and stack diameter were determined.*

**Response:** The following passage from the "Practical Guide to Atmospheric Dispersion Modeling" was used to determine the parameters for the merged vapor extraction points:

"When two or more stacks are in close proximity, in the range or two to 10 stack diameters apart, the merging of the stack effluents may enhance the plume rise. For segmented stacks containing multiple flues, a single effective diameter can be calculated to accommodate the sum of the stack gas volumes from the multiple flues at the same exit velocity and temperature as that from the single flues" (pg. 90-91).

The flowrate and diameter of a single vapor extraction point were provided by the CDK vendor. This information was used to calculate the velocity of a single vapor extraction point. The combined

flowrate of two vapor extraction points and the velocity of a single vapor extraction point are used to determine the effective diameter of each of the merged vapor extraction points.

- d. *ORCAA: Please provide an evaluation of ORCAA Rule 8.6(b), ORCAA's ambient formaldehyde standard.*

**Response:** ORCAA Rule 8.6(b) establishes a 1-hr standard for formaldehyde of 61 µg/m<sup>3</sup>. An evaluation and demonstration of compliance with this standard is included in Table G-13 of Attachment A. See part e response below for link to model files and Attachment B for the model file directory.

- e. *ORCAA: Please provide access to the modeling input/output files via DVD, a SharePoint link, or something similar (please note that we do not accept DropBox).*

**Response:** A file sharing link is provided in the email associated with this memo delivery. Please refer to Attachment B for the model file directory.

- f. *ORCAA: Section 7.1, paragraph 2 of the NOC application states that all TAPs, except NO<sub>2</sub>, were modeled at 1 g/s and scaled using the project emission increase per WAC 173-460-080. Please provide the "post processing" worksheet used to scale TAP modeling results at 1 g/s by the TAP emissions rates of each source modeled. **Why needed:** Because the NOC application states that 1 g/s was used, the modeling results must have been post-processed. ORCAA needs to review these calculations because it is a critical part of the impacts analysis.*

**Response:** During this model update, Weyerhaeuser updated the methodology of the modeled emission rates. Rather than proceeding with the 1 g/s and post-processing method, each pollutant is modeled using their respective PTE emission rate. Calculated model emission rates based on PTE calculations are provided in Attachment A. The Excel file is also included in the link provided in the part e response.

- g. *ORCAA: Please provide the "front-end" calculations of criteria pollutants that converts the appropriate emission rates to the g/s used for each release point in the model. **Why needed:** ORCAA needs to review these calculations because they are a critical preliminary step in the impacts analysis.*

**Response:** Calculated model emission rates for criteria pollutants are based on PTE calculations and are provided in Attachment A. The Excel file is also included in the link provided in the part e response.

## Additional Model Updates

### Updated Source Parameters

Based on updated vendor specifications and the NCASI Control Device and Stack Testing Feasibility Assessment presented in the NOC Application Addendum, it is expected that the vapor extraction points will capture 80% of emissions from the CDK. The remaining 20% of emissions are expected to be emitted through the openings at the ends of the kiln. Because of the positive and negative pressure created by the internal fans near the kiln ends, it is expected that ambient air will be drawn into the kiln on the side where dry lumber is exiting and kiln gas is forced out on the side where green lumber is entering. As a result, one horizontal point source is placed at the green lumber entrance on each end of the kiln to represent

emissions from the openings on the CDK. The effective diameter for each source is calculated from the area of the opening minus the area covered by the lumber, which is assumed to be 75% of the door opening. The release height is calculated as the height of the door minus half of the effective diameter. The exit velocity is conservatively assumed to be one foot per second.

The previous memo to ORCAA dated November 15, 2023, detailed startup, upset, idle, and shutdown operations. Startup operations will exhaust burner emissions into the main CDK causing emissions to be released from the vapor extraction points and end openings. Other operations will emit through the abort and/or bypass stacks. Startup operations are expected to quickly increase heat input until reaching maximum capacity and the desired dry bulb temperature for the wood. Idle operations will have a much lower heat input at <20% of capacity. The exhaust associated with the abort and bypass stacks are expected to have a higher temperature than the vapor extraction points and the CDK end openings. The temperature of biomass combustion is higher than the temperature of the CDK due to the inclusion of evaporation within the CDK. Therefore, emissions from the abort and bypass stacks are not included in the modeling analysis as emissions from the vapor extraction points and end openings are expected to have worse dispersion characteristics and higher emissions.

### Updated Emission Rates

Emission rates and the pollutants modeled for all averaging periods have changed as detailed in Trinity's memo to ORCAA dated November 15, 2023. Short term emissions are modeled as the maximum one hour operation for the expected time period, with the exception of 24-hour averaging period for PM<sub>10</sub> and PM<sub>2.5</sub> NAAQS compliance demonstration. These emissions are modeled with seven hours of potential startup time (firing at maximum capacity of 50 MMBtu/hr) and the remainder of the period at normal operation. This 350MMBtu/day is expected to incorporate any operations (startup, idle, shutdown, upsets) when the wet scrubbing impacts from the wood condensate are not impacting the resulting particulate matter emissions.

Annual emission rates are modeled as the total annual emissions averaged over 8,760 hours of operation. This includes 18,000 MMBtu/yr or 360 hours/yr of startup, shutdown, idle, and upsets.

### Updated Model Results

As discussed in response to Question 1 and 6 of the NOC Application Addendum, the PTE emission calculations were updated. As a result, the models completed for the NAAQS and TAP compliance demonstration were updated.

The criteria pollutant models for PM<sub>10</sub>, PM<sub>2.5</sub>, CO, NO<sub>2</sub>, and SO<sub>2</sub> were updated to reflect changes to emission rates and include the new sources as described above. As demonstrated in the original NOC application, modeled CO concentrations are below the SIL and do not require further NAAQS compliance demonstration. Results can be found in Table 1 below.

**Table 1. SIL Model Results**

Pollutant	Averaging Period	Design Concentration	Concentrations (µg/m <sup>3</sup> )		Exceeds SIL?
			Modeled	SIL	
CO	1-hr	H1H	631.7	2,000	No
	8-hr	H1H	261.3	500	No

Using the same background concentrations as the originally submitted NOC application, Table 2 below shows that all criteria pollutants (except for CO) are below the NAAQS; therefore, compliance with the NAAQS for the proposed project is demonstrated.

**Table 2. NAAQS Model Results**

Pollutant	Averaging Period	Design Concentration	Concentrations ( $\mu\text{g}/\text{m}^3$ )			Exceeds NAAQS?
			Modeled	Total	NAAQS	
PM <sub>10</sub>	24-hr	H6H	76.9	119.6	150	No
PM <sub>2.5</sub>	24-hr	H8H	22.9	33.1	35	No
	Annual	--	5.6	9.9	12	No
NO <sub>2</sub>	1-hr	H8H	111.1	133	188	No
	Annual	--	9.8	14.1	100	No
SO <sub>2</sub>	1-hr	H4H	18.5	30.7	196	No

The TAP analysis models were also updated to demonstrate compliance with the Washington TAP program (WAC 173-460). Table G-13 in Attachment A shows the updated TAP analysis with SQER exceeding pollutants that were modeled. Table 3 below shows the results of the modeled TAP which are determined based on the maximum concentration increase across all receptors and model years. Results show that formaldehyde, benzene, and arsenic exceed their respective annual ASIL; therefore, a Tier II Health Impact Assessment is completed and submitted under separate cover.

**Table 3. TAP Model Results**

Pollutants	Averaging Period	Highest Modeled Concentration ( $\mu\text{g}/\text{m}^3$ )	ASIL ( $\mu\text{g}/\text{m}^3$ )	Exceeds ASIL?
Formaldehyde	year	0.43	0.17	<b>Yes</b>
Formaldehyde	1-hr	9.81	61	No
Benzene	year	0.23	0.13	<b>Yes</b>
Arsenic	year	0.00054	0.0003	<b>Yes</b>
Cadmium	year	0.00017	0.00024	No
Lead	year	0.002	0.083	No
Manganese	24-hr	0.01	0.3	No
Nickel	year	0.00047	0.0038	No

## **Attachment A**

### **Emission Rates, Source Parameters, and Model Results**

**Project Inputs and Assumptions**

Parameter	Value	Units	Source Notes
<b>CDK</b>			
Total Kiln Heat Input	50	MMBtu/hr	Per vendor specification sheet received on May 16, 2023.
CDK Maximum Annual Operating Hours	8,760	hrs/yr	Assumed value for PTE basis.
CDK Expected Annual Operating Hours	8,400	hrs/yr	Per vendor specification sheet received on May 16, 2023.
Annual Production	310	MMBF/yr	Per vendor specification sheet received on May 16, 2023.
Maximum Hourly Production	3.69E-02	MMBF/hr	Calculated by the following: Hourly Production (MMBF/hr) = Annual Production (MMBF/yr) / CDK Expected Annual Operating Hours (hrs/yr).
<b>Truck Bins</b>			
Bark Annual Throughput	121,186	tpy	See Fugitive PM tab.
Green Chips Annual Throughput	414,070	tpy	See Fugitive PM tab.
Planer Shavings Annual Throughput	58,212	tpy	See Fugitive PM tab.
Sawmill Operation - Hours per Day	20	hours/day	Per conversation with client, the sawmill operates in two 10-hour shifts.
Sawmill Operation - Days per Week	5	days/week	Per conversation with client, the sawmill operates Monday - Friday
Sawmill Operation - Weeks per Year	52	weeks/year	Per conversation with client, the sawmill operates 52 weeks per year.
Sawmill Operation - Annual Operating Hours	5,200	hours/year	Calculated by the following: Annual Operating Hours = (Hours/Day) * (Days/Week) * (Weeks/Year).
<b>Fugitive Emissions - Green Sawdust</b>			
Wet Green Sawdust Higher Heating Value	3,500	Btu/lb	Per the HHV of wet fuel in Weyerhaeuser's Greenville facility's CDK PTE calculations.
Green Sawdust Fuel Maximum Annual Throughput	62,571	tpy	Calculated by the following: Annual Green Sawdust Fuel (tpy) = Total Kiln Heat Input (MMBtu/hr) * CDK Maximum Annual Operating Hours (hrs/yr) * 10 <sup>6</sup> (Btu/MMBtu) / HHV (Btu/lb) / 2000 (lb/ton).
Green Sawdust Fuel Maximum Hourly Throughput	14,286	lb/hr	Calculated by the following: Max Hourly Green Sawdust Fuel (lb/hr) = Total Kiln Heat Input (MMBtu/hr) * 10 <sup>6</sup> (Btu/MMBtu) / HHV (Btu/lb).
Sawdust Surge - Hours per Week	100	hours/week	Per conversation with client, the operational surge is 100 hrs/wk (Monday - Friday).
Sawdust Surge - Days per Week	5	days/week	Assumed value, since the sawmill operates Monday - Friday.
Sawdust Surge - Hours per Day	20	hours/day	Calculated by the following: Hours per Day = (Hours/Week) / (Days/Week).
Sawdust Surge - Annual Operating Hours	5,200	hours/year	Calculated by the following: Annual Operating Hours = (Hours/Week) * (Weeks/Year).
<b>Cyclones</b>			
Cyclone Annual Operating Hours	8,760	hrs/yr	Assumed value for PTE basis.
Fuel Silo Cyclone Exhaust Flow Rate	6,227	scfm	Per vendor specs, received June 29, 2023. Per email with Angela Cameron on July 11, 2023, the stream is at ambient temperature and is assumed to be in standard conditions.
Bark Cyclone Exhaust Flow Rate	8,564	scfm	Per Table 3.0 in the TSD for 12AOP915 (Cyclone #11). The stream is assumed to be at ambient conditions.
Dry Chip Cyclone Exhaust Flow Rate	5,150	scfm	Per Table 3.0 in the TSD for 12AOP915 (Cyclone #21). The stream is assumed to be at ambient conditions.
Dry Chip Baghouse Control Efficiency	99%	--	Based on the 2021 ORCAA AEI workbook, baghouses are assumed to maintain a control efficiency of 99%.
Cyclone PM Grain Loading Rate	0.03	gr/dscf	Based on the 2021 ORCAA AEI workbook, the PM grain loading rate comes from FIRE 6.23 October 2000, SCC 30700804, 30700805, which is also in Table 10.4.1 AP-42, p. 10.4-2 (2/80).

**Table F-1. Project-Wide Potential Emissions — Criteria Pollutant Summary**

Emission Unit	Fugitive?	Potential Annual Emissions (tpy)							
		Total PM	Total PM <sub>10</sub>	Total PM <sub>2.5</sub>	SO <sub>2</sub>	NO <sub>x</sub>	VOC	CO	CO <sub>2e</sub>
CDK	N	24.82	18.95	17.76	5.48	44.40	224.66	116.39	45,893
Chip and Bark Truck Bins	Y	9.45	4.47	0.68	--	--	--	--	--
Fugitive Emissions - Green Sawdust	Y	0.24	0.11	0.02	--	--	--	--	--
Haul Roads	Y	0.90	0.18	0.04	--	--	--	--	--
Cyclones	N	16.72	6.69	6.69	--	--	--	--	--
<b>Total:</b>		<b>52.12</b>	<b>30.39</b>	<b>25.18</b>	<b>5.48</b>	<b>44.40</b>	<b>224.66</b>	<b>116.39</b>	<b>45,893</b>

**Table F-2. Facility-Wide Potential Emissions — Criteria Pollutant Summary**

Emission Unit	Fugitive?	Potential Annual Emissions (tpy)							
		Total PM	Total PM <sub>10</sub>	Total PM <sub>2.5</sub>	SO <sub>2</sub>	NO <sub>x</sub>	VOC	CO	CO <sub>2e</sub>
Wood Waste Collection - Cyclones <sup>2</sup>	N	18.36	7.36	7.36	--	--	--	--	--
Fugitive Emissions - Roads <sup>3</sup>	Y	0.90	0.18	0.04	--	--	--	--	--
Log Debarking <sup>4</sup>	Y	6.5	3.6	0.5	--	--	--	--	--
CDK	N	24.82	18.95	17.76	5.48	44.40	224.66	116.39	45,893
Chip and Bark Truck Bins	Y	9.45	4.47	0.68	--	--	--	--	--
Fugitive Emissions - Green Sawdust	Y	0.24	0.11	0.02	--	--	--	--	--
Fire Pump Engine	N	0.03	0.03	0.03	0.02	0.37	0.03	0.08	13.73
<b>Total Emissions (with fugitives):</b>		<b>60.29</b>	<b>34.70</b>	<b>26.38</b>	<b>5.50</b>	<b>44.77</b>	<b>224.69</b>	<b>116.47</b>	<b>45,906</b>
<b>Total Emissions (without fugitives):</b>		<b>43.21</b>	<b>26.34</b>	<b>25.14</b>	<b>5.50</b>	<b>44.77</b>	<b>224.69</b>	<b>116.47</b>	<b>45,906</b>
<b>PSD Major Source Thresholds:</b>		<b>250</b>	<b>250</b>	<b>250</b>	<b>250</b>	<b>250</b>	<b>250</b>	<b>250</b>	<b>100,000</b>
<b>PSD Threshold Exceeded<sup>1</sup> (Yes/No):</b>		<b>No</b>	<b>No</b>	<b>No</b>	<b>No</b>	<b>No</b>	<b>No</b>	<b>No</b>	<b>No</b>

<sup>1</sup> PSD is only applicable for GHG if the PSD threshold is exceeded for it and another pollutant.

<sup>2</sup> "Wood Waste Collection - Cyclones" includes new cyclones added as part of the project and existing cyclones that remain unchanged.

<sup>3</sup> Vehicle usage has been updated as part of the project, so fugitive road emissions have been recalculated.

<sup>4</sup> "Log Debarking" emissions remain unchanged from the value included in Table 4.2 of the TSD to the current AOP (12AOP915). The PM value was estimated based on the PM/PM10 relationship displayed in ORCAA's 2021 AEI - Debarking tab.

**Table F-3. Project-Wide and Facility-Wide Potential Emissions — HAP Summary**

Total HAP <sup>1</sup> (tpy):	21.68	
Maximum HAP (tpy):	14.04	Methanol

<sup>1</sup> After completion of the CDK Project, HAP emissions at the Facility will only be emitted from the CDK.

**Table F-4. Project-Wide Potential Emissions — HAP/TAP Summary**

Pollutant	CAS #	HAP?	TAP?	CDK Emissions		Averaging Period	Project Emissions without netting		Exceed SQER without netting?	Actual Emissions <sup>2</sup>	Net Emissions <sup>2</sup>	Exceed SQER with netting?
				(lb/hr)	(tpy)		(lb/avg. period)			(lb/avg. period)	(lb/avg. period)	
Formaldehyde	50-00-0	Yes	Yes	0.42	1.76	year	27	3518.08	Yes	288.09	3,229.99	Yes
Benzene	71-43-2	Yes	Yes	0.21	0.92	year	21	1839.60	Yes	474.03	1,365.57	Yes
Arsenic	7440-38-2	Yes	Yes	5.05E-04	2.21E-03	year	0.049	4.42	Yes	0.11	4.31	Yes
Cadmium	7440-43-9	Yes	Yes	1.55E-04	6.77E-04	year	0.039	1.35	Yes	0.08	1.28	Yes
Lead	7439-92-1	Yes	Yes	1.75E-03	7.64E-03	year	14	15.29	Yes	0.13	15.16	Yes
Manganese	7439-96-5	Yes	Yes	6.35E-03	0.03	24-hr	0.022	0.15	Yes	0.02	0.13	Yes
Nickel	7440-02-0	Yes	Yes	4.42E-04	1.94E-03	year	0.62	3.87	Yes	0.45	3.42	Yes
<b>Total HAP (tpy):</b>				21.68								
<b>Max Individual HAP (tpy):</b>				14.04		Methanol						

<sup>1</sup> The SQER for each TAP is obtained from the 2019 WAC 173-460 TAP list.

<sup>2</sup> For each TAP that initially exceeds its SQER, netting was conducted to determine actual emissions based on the last ten years of annual emissions inventories (AEIs) for the current combustion and lumber drying operations (hog fuel boiler and indirect-heated batch kilns, respectively). The net emissions (proposed emissions - actual emissions) are then compared to the SQER. For pollutants that do not have previously quantified emissions, which are evidenced by "Not Calculated" in the Actual Emissions column, it is assumed that by using the same emission factor, proposed emissions will be lower than actual emissions due to the CDK's lower maximum heat input. In these instances, net emissions are set to zero and do not exceed the SQER.

$$\begin{aligned}
 \text{CDK Maximum Heat Input (MMBtu/yr)} &= \text{Heat Input Rating (MMBtu/hr)} * \text{Annual Hours of Operation (hrs/yr)} \\
 &= 438,000 \text{ MMBtu/yr} \\
 \text{Maximum two-year average hog fuel boiler heat input (MMBtu/yr)} &= 638,917 \text{ MMBtu/yr}
 \end{aligned}$$

**Table F-5. CDK Parameter Inputs**

Parameter	Value	Units	Source Notes
Total Kiln Heat Input	50	MMBtu/hr	Per vendor specification sheet received on May 16, 2023.
CDK Maximum Annual Operating Hours	8,760	hrs/yr	Assumed value for PTE basis.
CDK Expected Annual Operating Hours	8,400	hrs/yr	Per vendor specification sheet received on May 16, 2023.
Annual Production	310	MMBF/yr	Per vendor specification sheet received on May 16, 2023. Calculated by the following: Hourly Production (MMBF/hr) = Annual Production (MMBF/yr) / CDK Expected Annual Operating Hours (hrs/yr).
Maximum Hourly Production	3.69E-02	MMBF/hr	

**Table F-6. CDK Criteria Pollutant and GHG Emissions**

Pollutant	Normal Operation Emission Factors			Normal Operation Emissions <sup>6</sup>		Startup/Idling Emissions <sup>6</sup>		Total CDK Emissions <sup>6</sup>	
	Emission Factor	Unit	Reference	Max Hourly (lb/hr)	Total Annual (tpy)	Max Hourly (lb/hr)	Total Annual (tpy)	Max Hourly (lb/hr)	Total Annual (tpy)
PM	140	lb/MMBF	1	5.17	21.70	17.35	3.12	17.35	24.82
PM <sub>10</sub>	104	lb/MMBF	1	3.84	16.12	15.70	2.83	15.70	18.95
PM <sub>2.5</sub>	99	lb/MMBF	1	3.65	15.35	13.39	2.41	13.39	17.76
CO	730	lb/MMBF	1	26.94	113.15	18.00	3.24	26.94	116.39
NO <sub>x</sub>	280	lb/MMBF	1	10.33	43.40	10.15	1.00	10.33	44.40
Total VOC	--	--	2	53.48	224.66	--	--	53.48	224.66
VOC (Combustion)	6.19E-03	lb/MMBtu	3	0.31	1.36	--	--	0.31	1.36
VOC (Drying)	1,440.7	lb/MMBF	4	53.17	223.31	--	--	53.17	223.31
SO <sub>2</sub>	0.025	lb/MMBtu	1	1.25	5.48	--	--	1.25	5.48
CO <sub>2e</sub>	--	lb/MMBtu	5	10,478	45,893	--	--	10,478	45,893
CO <sub>2</sub>	207	lb/MMBtu	5	10,340	45,288	--	--	10,340	45,288
N <sub>2</sub> O	7.94E-03	lb/MMBtu	5	0.40	1.74	--	--	0.40	1.74
CH <sub>4</sub>	1.59E-02	lb/MMBtu	5	0.79	3.48	--	--	0.79	3.48

<sup>1</sup> Emissions for PM, CO, NO<sub>x</sub>, and SO<sub>x</sub> estimated using direct-fired continuous dry kiln emission factors from Georgia EPD's document entitled "EPD Recommended Emission Factors for Lumber Kiln Permitting in Georgia".

<sup>2</sup> Emissions for VOC determined by adding together indirect-heated batch dry kiln emission factors for douglas fir and wood-fired combustion emission factors.

<sup>3</sup> VOC combustion emission factor based on NCASI Technical Bulletin No. 1013: A Comprehensive Compilation and Review of Wood-Fired Boiler Emissions, Table 5.1. Mean values used. VOC reported as total non-methane hydrocarbons (TNMHC) "as-C", determined using EPA Method 25A, and converted to WPP1<sup>1</sup> per WPP1 Section 8.0 Equation 1: VOC (WPP1) = VOC (as-C) + Methanol + Formaldehyde.

<sup>4</sup> VOC drying emission factor as derived by OTM26 based on the "EPA Region 10 HAP and VOC Emission Factors for Lumber Drying, January 2021". Emission Factor (lb/MBF) = 0.01460x - 1.77130, where x = max drying temp of heated air entering the lumber (220 °F).

<sup>5</sup> GHG emissions are calculated based on the Global Warming Potentials (GWP) provided in Table A-1 of 40 CFR 98 and emission factors provided in Tables C-1 and C-2 for combustion of wood and wood residuals.

CO <sub>2</sub>	1
N <sub>2</sub> O	298
CH <sub>4</sub>	25

<sup>6</sup> Emission rates for pollutants with only 'lb/MMBF' emission factors are based on the CDK's annual throughput of dried lumber [MMBF], so combustion emissions from startup and idling are added in order to determine total CDK emission rates. These startup and idling emissions are calculated in the CDK Startup and Idling tab of the workbook. Emission rates for pollutants with 'lb/MMBtu' emission factors are based on the kiln's maximum firing rate [MMBtu/hr] and continuous operating hours of 8,760 hours per year. Since emissions at the maximum firing rate are the most conservative, the 'lb/MMBtu' emission rates already include combustion emissions from startup and idling.

<sup>7</sup> Max hourly emissions represent the maximum emissions from the following three scenarios: normal operation, startup, or idling.

**Table F-7. CDK HAP/TAP Emissions**

Pollutant	CAS #	HAP?	TAP?	Normal Operation Emission Factors <sup>1,2</sup>			Normal Operation Emissions <sup>11</sup>		Startup/Idling Emissions <sup>11</sup>		Total CDK Emissions <sup>11</sup>	
				Combustion (lb/MMBtu)	Drying (lb/MMBF)	Reference	Max Hourly (lb/hr)	Total Annual (tpy)	Max Hourly (lb/hr)	Total Annual (tpy)	Max Hourly <sup>12</sup> (lb/hr)	Total Annual (tpy)
Acetaldehyde	75-07-0	Yes	Yes	1.57E-04	27.5	2,3	1.02	4.30	--	--	1.02	4.30
Acrolein	107-02-8	Yes	Yes	1.27E-04	0.5	2,3	0.02	0.11	--	--	0.02	0.11
Formaldehyde	50-00-0	Yes	Yes	--	11.33	4	0.42	1.76	0.02	3.39E-03	0.42	1.76
Methanol	67-56-1	Yes	Yes	4.82E-04	89.9	2,3	3.34	14.04	--	--	3.34	14.04
Propionaldehyde	123-38-6	Yes	Yes	2.14E-05	0.3	2,3	0.01	0.05	--	--	1.21E-02	0.05
Carbon monoxide	630-08-0	No	Yes	--	--	--	26.94	113.15	18.00	3.24	26.94	116.39
Nitrogen dioxide	10102-44-0	No	Yes	--	--	5	10.33	43.40	10.15	1.83	10.33	45.23
Sulfur dioxide	7446-09-5	No	Yes	--	--	--	1.25	5.48	--	--	1.25	5.48
Acetophenone	98-86-2	Yes	No	1.84E-06	--	2	9.20E-05	4.03E-04	--	--	9.20E-05	4.03E-04
Benzene	71-43-2	Yes	Yes	4.2E-03	--	7	0.21	0.92	--	--	0.21	0.92
Bis(2-ethylhexyl)phthalate	117-81-7	Yes	Yes	4.65E-08	--	2	2.33E-06	1.02E-05	--	--	2.33E-06	1.02E-05
Bromobenzene	108-86-1	No	Yes	7.67E-06	--	2	3.84E-04	1.68E-03	--	--	3.84E-04	1.68E-03
Bromodichloromethane	75-27-4	No	Yes	5.90E-03	--	2	0.30	1.29	--	--	0.30	1.29
Bromomethane	74-83-9	Yes	Yes	3.67E-06	--	2	1.84E-04	8.04E-04	--	--	1.84E-04	8.04E-04
Carbon Tetrachloride	56-23-5	Yes	Yes	2.55E-06	--	2	1.28E-04	5.58E-04	--	--	1.28E-04	5.58E-04
Carbon-Disulfide	75-15-0	Yes	Yes	1.25E-04	--	2	6.25E-03	0.03	--	--	6.25E-03	0.03
Chlorobenzene	108-90-7	Yes	Yes	1.66E-05	--	2	8.30E-04	3.64E-03	--	--	8.30E-04	3.64E-03
Chloroform	67-66-3	Yes	Yes	2.55E-06	--	2	1.28E-04	5.58E-04	--	--	1.28E-04	5.58E-04
Chloromethane	74-87-3	Yes	Yes	2.66E-05	--	2	1.33E-03	5.83E-03	--	--	1.33E-03	5.83E-03
Cresols (mixed isomers)	1319-77-3	Yes	Yes	2.00E-05	--	2,8	1.00E-03	4.38E-03	--	--	1.00E-03	4.38E-03
Cumene	98-82-8	Yes	Yes	1.77E-05	--	2	8.85E-04	3.88E-03	--	--	8.85E-04	3.88E-03
1,2-Dibromoethane	106-93-4	Yes	Yes	1.83E-06	--	2	9.15E-05	4.01E-04	--	--	9.15E-05	4.01E-04
1,2-Dibromo-3-chloropropane	96-12-8	Yes	Yes	1.10E-06	--	2	5.50E-05	2.41E-04	--	--	5.50E-05	2.41E-04
1,4-Dichlorobenzene	106-46-7	Yes	Yes	2.79E-04	--	2	1.40E-02	0.06	--	--	1.40E-02	0.06
1,1-Dichloroethane	75-34-3	Yes	Yes	2.99E-05	--	2	1.50E-03	6.55E-03	--	--	1.50E-03	6.55E-03
1,2-Dichloroethane	107-06-2	Yes	Yes	2.92E-05	--	2	1.46E-03	6.39E-03	--	--	1.46E-03	6.39E-03
1,2-Dichloropropane	78-87-5	Yes	Yes	1.68E-05	--	2	8.40E-04	3.68E-03	--	--	8.40E-04	3.68E-03
Di-n-Butyl Phthalate	84-74-2	Yes	No	3.33E-05	--	2	1.67E-03	7.29E-03	--	--	1.67E-03	7.29E-03
4,6-Dinitro-2-methylphenol	534-52-1	Yes	No	2.10E-06	--	2	1.05E-04	4.60E-04	--	--	1.05E-04	4.60E-04
2,4-Dinitrophenol	51-28-5	Yes	No	1.31E-07	--	2	6.55E-06	2.87E-05	--	--	6.55E-06	2.87E-05
2,4-Dinitrotoluene	121-14-2	Yes	Yes	9.42E-07	--	2	4.71E-05	2.06E-04	--	--	4.71E-05	2.06E-04
Ethyl Benzene	100-41-4	Yes	Yes	3.13E-05	--	2	1.57E-03	6.85E-03	--	--	1.57E-03	6.85E-03
Hexachlorobenzene	118-74-1	Yes	Yes	1.03E-06	--	2	5.15E-05	2.26E-04	--	--	5.15E-05	2.26E-04
n-Hexane	110-54-3	Yes	Yes	2.88E-04	--	2	1.44E-02	0.06	--	--	1.44E-02	0.06
Hexachlorobutadiene	87-68-3	Yes	Yes	3.65E-07	--	2	1.83E-05	7.99E-05	--	--	1.83E-05	7.99E-05
Hydrogen Chloride	7647-01-0	Yes	Yes	1.11E-04	--	7	5.55E-03	0.02	--	--	5.55E-03	0.02
Hydrogen Fluoride	7664-39-3	Yes	Yes	8.50E-06	--	7	4.25E-04	1.86E-03	--	--	4.25E-04	1.86E-03
Isopropanol	67-63-0	No	Yes	1.10E-03	--	2	0.06	0.24	--	--	0.06	0.24
Methyl Ethyl Ketone	78-93-3	No	Yes	5.39E-06	--	2	2.70E-04	1.18E-03	--	--	2.70E-04	1.18E-03
Methyl Isobutyl Ketone	108-10-1	Yes	Yes	4.45E-04	--	2	0.02	0.10	--	--	0.02	0.10
Methylene Chloride	75-09-2	Yes	Yes	2.82E-05	--	2	1.41E-03	6.18E-03	--	--	1.41E-03	6.18E-03
Naphthalene	91-20-3	Yes	Yes	8.13E-06	--	2	4.07E-04	1.78E-03	--	--	4.07E-04	1.78E-03
4-Nitrophenol	100-02-7	Yes	No	9.41E-08	--	2	4.71E-06	2.06E-05	--	--	4.71E-06	2.06E-05
Pentachlorophenol	87-86-5	Yes	Yes	4.48E-08	--	2	2.24E-06	9.81E-06	--	--	2.24E-06	9.81E-06
Phenol	108-95-2	Yes	Yes	1.53E-05	--	2	7.65E-04	3.35E-03	--	--	7.65E-04	3.35E-03
Styrene	100-42-5	Yes	Yes	1.54E-05	--	2	7.70E-04	3.37E-03	--	--	7.70E-04	3.37E-03
Tetrachloroethene	127-18-4	Yes	Yes	2.46E-05	--	2	1.23E-03	5.39E-03	--	--	1.23E-03	5.39E-03
Toluene	108-88-3	Yes	Yes	3.67E-06	--	2	1.84E-04	8.04E-04	--	--	1.84E-04	8.04E-04
Tribromomethane	75-25-2	Yes	Yes	3.65E-07	--	2	1.83E-05	7.99E-05	--	--	1.83E-05	7.99E-05
1,2,4-Trichlorobenzene	120-82-1	Yes	No	1.10E-04	--	2	5.50E-03	0.02	--	--	5.50E-03	0.02
1,1,1-Trichloroethane	71-55-6	Yes	Yes	3.93E-05	--	2	1.97E-03	8.61E-03	--	--	1.97E-03	8.61E-03
1,1,2-Trichloroethane	79-00-5	Yes	Yes	2.40E-04	--	2	1.20E-02	0.05	--	--	1.20E-02	0.05
Trichloroethylene	79-01-6	Yes	Yes	1.99E-05	--	2	9.95E-04	4.36E-03	--	--	9.95E-04	4.36E-03
2,4,6-Trichlorophenol	88-06-2	Yes	Yes	2.76E-07	--	2	1.38E-05	6.04E-05	--	--	1.38E-05	6.04E-05

Pollutant	CAS #	HAP?	TAP?	Normal Operation Emission Factors <sup>1,2</sup>			Normal Operation Emissions <sup>11</sup>		Startup/Idling Emissions <sup>11</sup>		Total CDK Emissions <sup>11</sup>	
				Combustion (lb/MMBtu)	Drying (lb/MMBF)	Reference	Max Hourly (lb/hr)	Total Annual (tpy)	Max Hourly (lb/hr)	Total Annual (tpy)	Max Hourly <sup>12</sup> (lb/hr)	Total Annual (tpy)
1,2,3-Trichloropropane	96-18-4	No	Yes	2.19E-06	--	2	1.10E-04	4.80E-04	--	--	1.10E-04	4.80E-04
Vinyl Chloride	75-01-4	Yes	Yes	1.84E-05	--	2	9.20E-04	4.03E-03	--	--	9.20E-04	4.03E-03
Xylenes (mixed isomers)	1330-20-7	Yes	Yes	5.22E-06	--	2,9	2.61E-04	1.14E-03	--	--	2.61E-04	1.14E-03
Antimony	7440-36-0	Yes	No	1.47E-06	--	6	7.35E-05	3.22E-04	--	--	7.35E-05	3.22E-04
Arsenic	7440-38-2	Yes	Yes	1.01E-05	--	6	5.05E-04	2.21E-03	--	--	5.05E-04	2.21E-03
Beryllium	7440-41-7	Yes	Yes	4.23E-08	--	6	2.12E-06	9.26E-06	--	--	2.12E-06	9.26E-06
Cadmium	7440-43-9	Yes	Yes	3.09E-06	--	6	1.55E-04	6.77E-04	--	--	1.55E-04	6.77E-04
Chromium	Cr(III)	Yes	Yes	1.00E-05	--	6	5.00E-04	2.19E-03	--	--	5.00E-04	2.19E-03
Chromium, VI	18540-29-9	Yes	Yes	2.35E-07	--	6	1.18E-05	5.15E-05	--	--	1.18E-05	5.15E-05
Cobalt	7440-48-4	Yes	Yes	6.11E-07	--	6	3.06E-05	1.34E-04	--	--	3.06E-05	1.34E-04
Copper	7440-50-8	No	Yes	1.34E-05	--	6	6.70E-04	2.93E-03	--	--	6.70E-04	2.93E-03
Lead	7439-92-1	Yes	Yes	3.49E-05	--	6	1.75E-03	7.64E-03	--	--	1.75E-03	7.64E-03
Manganese	7439-96-5	Yes	Yes	1.27E-04	--	6	6.35E-03	0.03	--	--	6.35E-03	0.03
Mercury	7439-97-6	Yes	Yes	8.26E-07	--	6	4.13E-05	1.81E-04	--	--	4.13E-05	1.81E-04
Nickel	7440-02-0	Yes	Yes	8.84E-06	--	6	4.42E-04	1.94E-03	--	--	4.42E-04	1.94E-03
Phosphorus	7723-14-0	Yes	Yes	9.85E-05	--	6	4.93E-03	0.02	--	--	4.93E-03	0.02
Selenium	7782-49-2	Yes	Yes	1.03E-06	--	6	5.15E-05	2.26E-04	--	--	5.15E-05	2.26E-04
Vanadium	7440-62-2	No	Yes	9.8E-07	--	10	4.90E-05	2.15E-04	--	--	4.90E-05	2.15E-04

<sup>1</sup> Emissions for HAP determined by adding together indirect-heated batch dry kiln emission factors for douglas fir and wood-fired combustion emission factors, except for formaldehyde, which uses a calculated direct-fired emission factor.

<sup>2</sup> Organic HAP combustion emission factors based on NCASI Technical Bulletin No. 1013: A Comprehensive Compilation and Review of Wood-Fired Boiler Emissions, Table 4.1. Median values used. When a median is not available, the maximum value is used.

<sup>3</sup> HAP drying emission factors for acetaldehyde, acrolein, methanol, and propionaldehyde based on the emission factor summary table in "EPA Region 10 HAP and VOC Emission Factors for Lumber Drying, January 2021" and the methanol EF is based on max drying temp of heated air entering the lumber (220 °F).

<sup>4</sup> Due to formaldehyde's dependence on direct or indirect heating, the emission factor was scaled up from the value listed in the "EPA Region 10 HAP and VOC Emission Factors for Lumber Drying, January 2021," where x = max drying temp of heated air entering the lumber (220 °F). The value was scaled by the proportion of direct to indirect mean batch kiln emission factors for formaldehyde in the NCASI Wood Products Air Emission Factor Database – 2013 Update, which is shown below:

NCASI Direct-Fired Batch Kiln EF:	7.35E-02	lb/MBF	EPA Region 10 Indirect-Heated Batch Kiln EF:	2.36	lb/MMBF
NCASI Indirect-Heated Batch Kiln EF:	1.53E-02	lb/MBF			
Ratio of Direct-to-Indirect:	4.80				

<sup>5</sup> It is conservatively assumed that all NO<sub>x</sub> is converted to NO<sub>2</sub>.

<sup>6</sup> Trace metal HAP combustion emission factors based on NCASI Technical Bulletin No. 1013: A Comprehensive Compilation and Review of Wood-Fired Boiler Emissions, Table 4.3. Median Wet Scrubber were used. When a median was not available, the maximum value was used.

<sup>7</sup> For organic HAP that only had controlled factors in NCASI TB1013, if the control is a wet PM control, then NCASI TB1013 is still used. However, if the control is a dry PM control, then AP-42 Section 1.6, Table 1.6-3 emissions factors were used.

<sup>8</sup> In NCASI TB1013, Table 4-1, cresol emission factors are reported separately as m,p-cresol and o-cresol. Since the separate isomers have the same SQER and ASIL as the Cresol (mixed isomer) TAP and the mixed isomer TAP is not reported in TB1013, the two different isomer emission rates are added together in order to assess the mixed isomer toxic. Exceedance of the mixed isomer SQER or ASIL will also dictate exceedances for the individual isomer toxics.

<sup>9</sup> In NCASI TB1013, Table 4-1, xylene emission factors are reported separately as m,p-xylene, o-xylene, and xylenes (mixed isomers). Since the separate isomers have the same SQER and ASIL as the Xylene (mixed isomer) TAP and the mixed isomer TAP is reported in TB1013, the mixed isomer toxic is the only emission rate reported here. Exceedance of the mixed isomer SQER or ASIL will also dictate exceedances for the individual isomer toxics.

<sup>10</sup> When a trace metal HAP combustion emission factor in NCASI TB1013 did not have a Wet Scrubber value, then AP-42 Section 1.6, Table 1.6-4 emissions factors were used.

<sup>11</sup> Emission rates for pollutants with only 'lb/MMBF' emission factors are based on the CDK's annual throughput of dried lumber [MMBF], so combustion emissions from startup and idling are added in order to determine total CDK emission rates. These startup and idling emissions are calculated in the CDK Startup and Idling tab of the workbook. Emission rates for pollutants with 'lb/MMBtu' emission factors are based on the kiln's maximum firing rate [MMBtu/hr] and continuous operating hours of 8,760 hours per year. Since emissions at the maximum firing rate are the most conservative, the 'lb/MMBtu' emission rates already include combustion emissions from startup and idling.

<sup>12</sup> Max hourly emissions represent the maximum emissions from the following three scenarios: normal operation, startup, or idling.

**Table F-5.1. CDK Startup and Idling - Input Parameters**

Parameter	Value	Units	Source Notes
Total Kiln Heat Input	50	MMBtu/hr	Per vendor specification sheet received on May 16, 2023.
CDK Maximum Annual Operating Hours	8,760	hrs/yr	Assumed value for PTE basis.
CDK Expected Annual Operating Hours	8,400	hrs/yr	Per vendor specification sheet received on May 16, 2023.
CDK Maximum Startup and Idling Hours	360	hrs/yr	8,760 hours - Expected operating hours (8,400 hr)
CDK Startup and Idling Maximum Heat Input	18,000	MMBtu/yr	Total Kiln Heat Input * Maximum Startup and Idling Hours

Conservatively, assumed the startup and idling activities are occurring anytime beyond 8,400 hours/year (e.g. 360 hours) at burner firing capacity. In idling mode, the burner will be firing at a low rate of less than 1 MMBtu/hr. Emissions calculated are accounting for physical potential capacity to avoid additional restrictions on operating hours.

Note: Emission rates for pollutants with only 'lb/MMBF' emission factors are based on the CDK's annual throughput of dried lumber [MMBF], so combustion emissions from startup and idling are separately calculated here in order to determine total CDK emission rates. CDK emission rates for pollutants with 'lb/MMBtu' emission factors are conservatively based on the kiln's maximum firing rate [MMBtu/hr] and continuous operating hours of 8,760 hours per year, so combustion emissions from startup and idling do not need to be added.

**Table F-6.1. CDK Startup and Idling - Added Pollutant Emission Factors**

Pollutant	Emission Factor (lb/MMBtu)	Reference
Condensable PM (CPM)	0.017	1
CPM <sub>10</sub>	0.017	1
CPM <sub>2.5</sub>	0.017	1
Filterable PM (FPM)	0.33	2
FPM <sub>10</sub>	0.30	2
FPM <sub>2.5</sub>	0.25	2
Total PM (TPM)	0.347	3
TPM <sub>10</sub>	0.314	3
TPM <sub>2.5</sub>	0.268	3
CO	3.60E-01	4
NO <sub>x</sub>	2.03E-01	5
Formaldehyde	3.77E-04	6

<sup>1</sup> Condensable PM combustion emission factor based on AP-42 Section 1.6, Table 1.6-1. Assuming CPM = CPM<sub>10</sub> = CPM<sub>2.5</sub>.

<sup>2</sup> Filterable PM combustion emission factor based on NCASI Technical Bulletin No. 1013, Table 5.2, value for Wet Wood.

$$PM_{10} = 90\% \text{ of FPM cumulative mass}$$

$$PM_{2.5} = 76\% \text{ of FPM cumulative mass}$$

<sup>3</sup> Total PM = Condensable PM + Filterable PM

<sup>4</sup> CO combustion emission factor based on NCASI Technical Bulletin No. 1013, Table 5.1. Median value for Fuel Cells/Dutch Ovens was used.

<sup>5</sup> NO<sub>x</sub> combustion emission factor based on NCASI Technical Bulletin No. 1013, Table 5.1. Median value for Wood w/o Significant UF Resin Content was used.

<sup>6</sup> Formaldehyde combustion emission factor based on NCASI Technical Bulletin No. 1013, Table 4.1. Median value used.

**Table F-6.2. CDK Startup and Idling - Criteria Pollutant Emissions**

<b>Pollutant</b>	<b>Emission Factor (lb/MMBtu)</b>	<b>Hourly Emissions (lb/hr)</b>	<b>Annual Emissions (tpy)</b>
TPM	0.347	17.35	3.12
TPM <sub>10</sub>	0.314	15.70	2.83
TPM <sub>2.5</sub>	0.268	13.39	2.41
CO	0.360	18.00	3.24
NO <sub>x</sub>	0.203	10.15	1.00

**Table F-7.1. CDK Startup and Idling - HAP/TAP Emissions**

<b>Pollutant</b>	<b>CAS #</b>	<b>HAP?</b>	<b>TAP?</b>	<b>Emission Factor (lb/MMBtu)</b>	<b>Hourly Emissions (lb/hr)</b>	<b>Annual Emissions (tpy)</b>
Formaldehyde	50-00-0	Yes	Yes	3.77E-04	0.02	3.39E-03
Carbon monoxide	630-08-0	No	Yes	0.360	18.00	3.24
Nitrogen dioxide <sup>1</sup>	10102-44-0	No	Yes	0.203	10.15	1.83

<sup>1</sup> It is conservatively assumed that all NO<sub>x</sub> is converted to NO<sub>2</sub>.

**Note: In order to determine actual emissions from the current batch kilns and hog fuel boiler, operational parameters and emissions rates are acquired from the 2013-2022 Annual Emission Inventories (AEIs). On a pollutant-by-pollutant basis, actual emissions are calculated from the annual average actual emission rates of the highest two consecutive years within the past ten years.**

**Table F-7.2. Baseline Calculations - Hog Fuel Boiler Heat Input**

Year	Heat Input (MMBtu/yr)	Two-Year Period	Two-Year Average Heat Input (MMBtu/yr)
2013	607,432	2013-2014	583,270
2014	559,108	2014-2015	580,756
2015	602,404	2015-2016	616,698
2016	630,993	2016-2017	638,917
2017	646,840	2017-2018	624,346
2018	601,852	2018-2019	554,475
2019	507,098	2019-2020	551,346
2020	595,594	2020-2021	596,827
2021	598,060	2021-2022	521,503
2022	444,945		
<b>Max Heat Input (MMBtu/yr):</b>			638,917
<b>Baseline Period:</b>			2016-2017

**Table F-7.3. Baseline Calculations - Hog Fuel Boiler NO<sub>2</sub> and SO<sub>2</sub> Emissions**

Year	Annual NO <sub>2</sub> Emissions <sup>1</sup> (tpy)	Annual SO <sub>2</sub> Emissions (tpy)	Two-Year Period	Two-Year Average NO <sub>2</sub> Emissions (tpy)	Two-Year Average SO <sub>2</sub> Emissions (tpy)
2013	66.69	0.31	2013-2014	64.04	0.30
2014	61.39	0.29	2014-2015	54.79	1.50
2015	48.19	2.71	2015-2016	39.38	2.22
2016	30.57	1.72	2016-2017	41.16	2.32
2017	51.75	2.91	2017-2018	49.95	2.81
2018	48.15	2.71	2018-2019	44.36	2.50
2019	40.57	2.28	2019-2020	51.40	2.48
2020	62.24	2.68	2020-2021	62.37	2.69
2021	62.50	2.69	2021-2022	53.23	2.35
2022	43.97	2.00			
<b>Max Annual Emissions (tpy):</b>				64.04	2.81
<b>Baseline Period:</b>				2013-2014	2017-2018

<sup>1</sup> It is conservatively assumed that all NO<sub>x</sub> is converted to NO<sub>2</sub>.

**Table F-7.4. Baseline Calculations - Lumber Drying TAP Emissions**

<b>Pollutant CAS</b>	<b>Acetaldehyde 75-07-0</b>	<b>Acrolein 107-02-8</b>	<b>Formaldehyde 50-00-0</b>	<b>Methanol 67-56-1</b>	<b>Propionaldehyde 123-38-6</b>
<b>Year</b>	<b>Annual Emissions (lb/yr) - Less than or Equal to 200 °F</b>				
2013	1.62E+04	2.21E+02	1.98E+02	1.16E+04	1.46E+02
2014	1.47E+04	1.83E+02	1.95E+02	1.01E+04	1.39E+02
2015	1.57E+04	1.96E+02	2.01E+02	1.08E+04	1.50E+02
2016	1.69E+04	2.11E+02	2.31E+02	1.17E+04	1.60E+02
2017	1.46E+04	1.85E+02	2.45E+02	1.04E+04	1.36E+02
2018	1.32E+04	1.69E+02	2.27E+02	9.43E+03	1.23E+02
2019	1.30E+04	1.65E+02	2.13E+02	9.23E+03	1.22E+02
2020	1.37E+04	1.75E+02	2.35E+02	9.77E+03	1.28E+02
2021	1.48E+04	1.89E+02	2.55E+02	1.06E+04	1.39E+02
2022	9.66E+03	1.28E+02	2.34E+02	7.28E+03	8.76E+01
<b>Year</b>	<b>Annual Emissions (lb/yr) - Greater than 200 °F</b>				
2013					
2014	1.28E+03	3.50E+01	5.99E+01	2.80E+03	2.13E+01
2015	5.32E+02	1.46E+01	2.50E+01	1.17E+03	8.87E+00
2016					
2017					
2018					
2019					
2020					
2021					
2022					
<b>Year</b>	<b>Total Annual Emissions (tpy) - All Temperatures</b>				
2013	8.09E+00	1.10E-01	9.90E-02	5.78E+00	7.28E-02
2014	7.97E+00	1.09E-01	1.27E-01	6.47E+00	8.02E-02
2015	8.14E+00	1.05E-01	1.13E-01	6.00E+00	7.92E-02
2016	8.43E+00	1.06E-01	1.16E-01	5.84E+00	7.98E-02
2017	7.28E+00	9.27E-02	1.23E-01	5.18E+00	6.81E-02
2018	6.61E+00	8.43E-02	1.13E-01	4.71E+00	6.17E-02
2019	6.51E+00	8.27E-02	1.07E-01	4.61E+00	6.10E-02
2020	6.85E+00	8.74E-02	1.18E-01	4.89E+00	6.39E-02
2021	7.42E+00	9.46E-02	1.27E-01	5.29E+00	6.93E-02
2022	4.83E+00	6.39E-02	1.17E-01	3.64E+00	4.38E-02
<b>Two-Year Period</b>	<b>Two-Year Average Emissions (tpy)</b>				
2013-2014	8.03E+00	1.10E-01	1.13E-01	6.12E+00	7.65E-02
2014-2015	8.06E+00	1.07E-01	1.20E-01	6.23E+00	7.97E-02
2015-2016	8.29E+00	1.05E-01	1.14E-01	5.92E+00	7.95E-02
2016-2017	7.86E+00	9.91E-02	1.19E-01	5.51E+00	7.39E-02
2017-2018	6.95E+00	8.85E-02	1.18E-01	4.95E+00	6.49E-02
2018-2019	6.56E+00	8.35E-02	1.10E-01	4.66E+00	6.13E-02
2019-2020	6.68E+00	8.50E-02	1.12E-01	4.75E+00	6.25E-02
2020-2021	7.14E+00	9.10E-02	1.22E-01	5.09E+00	6.66E-02
2021-2022	6.12E+00	7.93E-02	1.22E-01	4.47E+00	5.65E-02
<b>Max Annual Emissions (tpy)</b>	<b>8.29E+00</b>	<b>1.10E-01</b>	<b>1.22E-01</b>	<b>6.23E+00</b>	<b>7.97E-02</b>
<b>Baseline Period</b>	<b>2015-2016</b>	<b>2013-2014</b>	<b>2020-2021</b>	<b>2014-2015</b>	<b>2014-2015</b>

**Table F-7.5. Baseline Calculations - Hog Fuel Boiler TAP Emissions**

<b>Pollutant</b> <sup>1</sup>	<b>CAS</b>	<b>Emission Factor</b> <sup>2,3</sup> <b>(lb/MMBtu)</b>	<b>Baseline Period</b> <sup>4</sup>	<b>Max Annual Heat Input</b> <b>(MMBtu/yr)</b>	<b>Max Annual Combustion Emissions</b> <b>(tpy)</b>	<b>Max Annual Combined Emissions</b> <sup>5</sup> <b>(tpy)</b>	<b>Max Annual Combined Emissions</b> <sup>5</sup> <b>(lb/yr)</b>	<b>Max Hourly Combined Emissions</b> <sup>5</sup> <b>(lb/hr)</b>	<b>Max Daily Combined Emissions</b> <sup>5</sup> <b>(lb/day)</b>
Acetaldehyde	75-07-0	1.64E-04	2015-2016	6.17E+05	0.05	8.34	16,674.31	1.94	46.62
Acrolein	107-02-8	3.15E-05	2013-2014	5.83E+05	9.20E-03	0.12	237.74	0.03	0.66
Formaldehyde	50-00-0	7.24E-05	2020-2021	5.97E+05	0.02	0.14	288.09	0.03	0.81
Nitrogen dioxide	10102-44-0		2013-2014		64.04	64.04	128,079.75	14.92	358.06
Sulfur dioxide	7446-09-5		2017-2018		2.81	2.81	5,619.11	0.65	15.71
Benzene	71-43-2	7.42E-04	2016-2017	6.39E+05	0.24	0.24	474.03	0.06	1.33
Bromodichloromethane	75-27-4	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated
1,2-Dibromoethane	106-93-4	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated
1,2-Dibromo-3-chloropropane	96-12-8	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated
1,4-Dichlorobenzene	106-46-7	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated
1,2-Dichloroethane	107-06-2	2.92E-05	2016-2017	6.39E+05	9.33E-03	9.33E-03	18.66	2.17E-03	0.05
Hexachlorobenzene	118-74-1	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated
1,1,2-Trichloroethane	79-00-5	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated
Arsenic	7440-38-2	1.76E-07	2016-2017	6.39E+05	5.62E-05	5.62E-05	0.11	1.31E-05	3.14E-04
Cadmium	7440-43-9	1.21E-07	2016-2017	6.39E+05	3.87E-05	3.87E-05	0.08	9.01E-06	2.16E-04
Chromium, VI	18540-29-9	1.54E-06	2016-2017	6.39E+05	4.91E-04	4.91E-04	0.98	1.14E-04	2.74E-03
Lead	7439-92-1	2.03E-07	2016-2017	6.39E+05	6.49E-05	6.49E-05	0.13	1.51E-05	3.63E-04
Manganese	7439-96-5	1.32E-05	2016-2017	6.39E+05	4.22E-03	4.22E-03	8.43	9.82E-04	0.02
Nickel	7440-02-0	7.06E-07	2016-2017	6.39E+05	2.26E-04	2.26E-04	0.45	5.25E-05	1.26E-03

<sup>1</sup> Pollutants were chosen for baseline analysis due to an exceedance of their respective SQER from project emissions. These do not represent the comprehensive list of TAP pollutants from hog fuel combustion. If a pollutant initially exceeded its SQER but was not included in the former AEIs, emissions are marked as "Not Calculated".

<sup>2</sup> Organic and trace elemental metal TAP emission factors come from Weyerhaeuser's ORCAA Annual Emission Inventories.

<sup>3</sup> NO<sub>2</sub> and SO<sub>2</sub> emissions are calculated in Table F-7.4.

<sup>4</sup> The baseline periods for Acetaldehyde, Acrolein, and Formaldehyde are based on the maximum two-year average lumber drying TAP emission rates since drying emissions are significant comparing to combustion emissions.

The baseline periods for NO<sub>2</sub> and SO<sub>2</sub> are based on the maximum two-year average hog fuel boiler emission rates.

The baseline period for all other TAPs is based on the maximum two-year average hog fuel boiler heat input since the EF remains the same during the 10 year period.

<sup>5</sup> The combined emissions represents both hog fuel combustion and lumber drying emission rates for Acetaldehyde, Acrolein, and Formaldehyde.

<sup>6</sup> Based on a review of prior boiler operating data, the hog fuel boiler is running close to 99% of the time. Therefore, to determine hourly and daily emissions from annual emissions, the boiler is conservatively assumed to have operated 98% of the time, which is approximately:

8584.8 hours per year.

**Table F-8. Fugitive PM Input Parameters**

Parameter	Value	Units	Source Notes
<b>Truck Bins</b>			
Bark Annual Throughput	121,186	tpy	See Fugitive PM tab.
Green Chips Annual Throughput	414,070	tpy	See Fugitive PM tab.
Planer Shavings Annual Throughput	58,212	tpy	See Fugitive PM tab.
Sawmill Operation - Hours per Day	20	hours/day	Per conversation with client, the sawmill operates in two 10-hour shifts.
Sawmill Operation - Days per Week	5	days/week	Per conversation with client, the sawmill operates Monday - Friday
Sawmill Operation - Weeks per Year	52	weeks/year	Per conversation with client, the sawmill operates 52 weeks per year.
Sawmill Operation - Annual Operating Hours	5,200	hours/year	Calculated by the following: Annual Operating Hours = (Hours/Day) * (Days/Week) * (Weeks/Year).
<b>Fugitive Emissions - Green Sawdust</b>			
Total Kiln Heat Input	50	MMBtu/hr	Per vendor specification sheet received on May 16, 2023.
CDK Maximum Annual Operating Hours	8,760	hrs/yr	Assumed value for PTE basis.
Wet Green Sawdust Higher Heating Value	3,500	Btu/lb	Per the HHV of wet fuel in Weyerhaeuser's Greenville facility's CDK PTE calculations.
Green Sawdust Fuel Maximum Annual Throughput	62,571	tpy	Calculated by the following: Annual Green Sawdust Fuel (tpy) = Total Kiln Heat Input (MMBtu/hr) * CDK Maximum Annual Operating Hours (hrs/yr) * 10 <sup>6</sup> (Btu/MMBtu) / HHV (Btu/lb) / 2000 (lb/ton).
Green Sawdust Fuel Maximum Hourly Throughput	14,286	lb/hr	Calculated by the following: Max Hourly Green Sawdust Fuel (lb/hr) = Total Kiln Heat Input (MMBtu/hr) * 10 <sup>6</sup> (Btu/MMBtu) / HHV (Btu/lb).
Sawdust Surge - Hours per Week	100	hours/week	Per conversation with client, the operational surge is 100 hrs/wk (Monday - Friday).
Sawdust Surge - Days per Week	5	days/week	Assumed value, since the sawmill operates Monday - Friday.
Sawdust Surge - Hours per Day	20	hours/day	Calculated by the following: Hours per Day = (Hours/Week) / (Days/Week).

**Table F-9. Fugitive PM Throughput Data**

Material	Annual Throughput <sup>1</sup>				Throughput Unit	Section
	2019	2020	2021	2022		
Wood Product (Douglas Fir)	99,914.33	125,245.32	143,303.83	166,910.44	MBF	Production
Wood Product (Hemlock)	67,220.85	70,590.17	61,250.57	0	MBF	Production
Bark, Burned for Energy Recovery On-Site	22,230	25,452.75	25,677.39	19,970.65	bdtons	Energy Fuel Sources
Shavings, Burned for Energy Recovery On-Site	12,554	8,484.25	8,558.13	6,656.88	bdtons	Energy Fuel Sources
Chips	93,387	129,120	134,236.57	111,472	bdtons	Production
Hog Fuel Mfg. Res., Otherwise Beneficially Reused	2,751	6,514	33,599.78	12,654	bdtons	Residuals and Waste
Sawdust By-Product sold	19,550	22,651	15,516.09	17,057	bdtons	Residuals and Waste
Shavings By-Product sold	12,554	13,244	9,842.07	6,193	bdtons	Residuals and Waste
Categorized Material	Annual Throughput <sup>1</sup> (bdton)				Components	
	2019	2020	2021	2022		
Bark <sup>2</sup>	24,981	31,966.75	0	32,624.65	Bark, Burned for Energy Recovery On-Site; Hog Fuel Mfg. Res., Otherwise Beneficially Reused	
Green Sawdust	19,550	22,651	15,516.09	17,057	Sawdust By-Product Sold	
Planer Shavings	25,108	21,728.25	18,400.2	12,849.88	Shavings, Burned for Energy Recovery On-Site; Shavings By-Product sold	
Chips	93,387	129,120	134,236.57	111,472	Chips	
Categorized Material	Ratio <sup>1</sup> (bdton/MBF produced)				Max Ratio	CDK Project
	2019	2020	2021	2022		
Bark	0.15	0.16	0.00	0.20	0.20	<b>121,186</b>
Green Sawdust	0.12	0.12	0.08	0.10	0.12	72,522
Planer Shavings	0.15	0.11	0.09	0.08	0.15	<b>58,212</b>
Green Chips	0.56	0.66	0.66	0.67	0.67	<b>414,070</b>

<sup>1</sup> Since fugitive emissions relate to the handling of byproduct and residual materials, exact throughputs have not yet been determined, so the projected post-project throughputs were estimated using annual production values from 2019 through 2022. Materials from Weyerhaeuser's production data were then grouped into the relevant categories for this project: bark, green sawdust, planer shavings, and green chips. Ratios were then calculated to relate annual material throughput to annual wood product production. Of these ratios, the maximum ratio was multiplied by the annual production rate for the CDK project and converted to a wet basis, assuming a moisture content of 50% for bark, green sawdust, and green chips and 20% for planer shaving. Since a green sawdust throughput is already specified for the green sawdust CDK burner (via burner capacity), the value in this table was not used in the PTE calculations.

<sup>2</sup> Due to log yard clean up activities in 2021, the "hog fuel beneficially applied" value does not accurately represent expected annual production rates of bark, so the scaled annual throughput of bark for the CDK project is based on 2019, 2020, and 2022 production rates.

**Table F-10. Fugitive PM Emissions**

Emission Unit	Material	Origin	Destination	Emission Factors (lb/ton) <sup>1</sup>			Capture Type	Capture Efficiency (%)	Annual Emissions (tpy) <sup>3</sup>			Daily Emissions (lb/day) <sup>4</sup>			Hourly Emissions (lb/hr) <sup>5</sup>		
				PM	PM <sub>10</sub>	PM <sub>2.5</sub>			PM	PM <sub>10</sub>	PM <sub>2.5</sub>	PM	PM <sub>10</sub>	PM <sub>2.5</sub>	PM	PM <sub>10</sub>	PM <sub>2.5</sub>
<b>Fugitive Emissions - Green Sawdust</b>																	
Green Sawdust Sawmill Drop	Green Sawdust	Sawmill	Green Sawdust Conveyor	7.55E-03	3.57E-03	5.41E-04	Building Enclosure	See Footnote 1 (Min Wind Speed)	0.24	0.11	0.02	1.08	0.51	0.08	0.05	0.03	3.86E-03
<i>Fugitive Emissions - Green Sawdust Sub-Total:</i>									<i>0.24</i>	<i>0.11</i>	<i>0.02</i>	<i>1.08</i>	<i>0.51</i>	<i>0.08</i>	<i>0.05</i>	<i>0.03</i>	<i>3.86E-03</i>
<b>Truck Bins</b>																	
Bark Bins Truck Loadout	Bark	Bark Bins	Truck	0.064	0.030	4.56E-03	Steel Sidings	50%	1.93	0.91	0.14	14.84	7.02	1.06	0.74	0.35	0.05
Chips Bins Truck Loadout <sup>6</sup>	Chips, Planer Shavings	Chip Bins	Truck	0.064	0.030	4.56E-03	Steel Sidings	50%	7.52	3.56	0.54	57.83	27.35	4.14	2.89	1.37	0.21
<i>Truck Bins Sub-Total:</i>									<i>9.45</i>	<i>4.47</i>	<i>0.68</i>	<i>72.67</i>	<i>34.37</i>	<i>5.20</i>	<i>3.63</i>	<i>1.72</i>	<i>0.26</i>
<b>Total:</b>									<b>9.68</b>	<b>4.58</b>	<b>0.69</b>	<b>73.75</b>	<b>34.88</b>	<b>5.28</b>	<b>3.69</b>	<b>1.74</b>	<b>0.26</b>

<sup>1</sup> Methods from AP-42 Section 13.2.4, Aggregate Handling and Storage Piles, are used to determine the emission factors and total emissions from raw material handling.

Uncontrolled Emission Factor (lb/ton) = 0.0032 x (k) x (U / 5)<sup>1.3</sup> / (M / 2)<sup>1.4</sup>, where:

Particle Size Multiplier (k) = 0.74 for PM  
 0.35 for PM<sub>10</sub>  
 0.053 for PM<sub>2.5</sub>

Mean Wind Speed (U) = 6.7 mph  
 Minimum Wind Speed (U) = 1.3 mph

This wind speed is used for outdoor emission calculations from truck bin loadout. Source: Western Regional Climatological Center, Olympia, WA station  
 This wind speed is used for the indoor emission calculations from the green sawdust drop. Source: AP-42 Section 13.2.4.

Material Moisture Content (M) = 25%  
 While the internal moisture of the wood particles may be around 50%, this variable (M) accounts for surface moisture. The lower end moisture content was chosen as a conservative estimate of annual surface moisture.

<sup>2</sup> The truck bins will be fitted with steel sidings, which prevent approximately 50% of fugitive emissions.

<sup>3</sup> Annual Emissions = Emission Factor (lb/ton) x Qty Unloaded (ton/yr) / 2000 (lb/ton) \* (100% - Capture Efficiency (%))

<sup>4</sup> Daily Emissions = Hourly Emissions (lb/hr) \* Hours per Day

<sup>5</sup> For green sawdust sawmill drop, Hourly Emissions = Emission Factor (lb/ton) x Qty Unloaded (lb/hr) / 2000 (lb/ton).

For truck loadout, Hourly Emissions = Emission Factor (lb/ton) x Qty Unloaded (ton/yr) / Annual Operating Hours (hours/yr) \* (100% - Capture Efficiency (%)). For the purpose of these calculations, it is assumed that the hourly truck loadout rate is equivalent to the hourly rate of material sent to the truck bin.

<sup>6</sup> While the planer shavings are blown to a cyclone on top of the chips bins that exhausts to a baghouse, all planer shavings are assumed to be sent down into the truck bins in order to have a conservative estimate of the material transfer PM emissions from truck loadout.

**Table F-11. Cyclones Input Parameters**

Parameter	Value	Units	Source Notes
Cyclone Annual Operating Hours	8,760	hrs/yr	Assumed value for PTE basis.
Fuel Silo Cyclone Exhaust Flow Rate	6,227	scfm	Per vendor specs, received June 29, 2023. Per email with Angela Cameron on July 11, 2023, the stream is at ambient temperature and is assumed to be in standard conditions.
Bark Cyclone Exhaust Flow Rate	8,564	scfm	Per Table 3.0 in the TSD for 12AOP915 (Cyclone #11). The stream is assumed to be at ambient conditions.
Dry Chip Cyclone Exhaust Flow Rate	5,150	scfm	Per Table 3.0 in the TSD for 12AOP915 (Cyclone #21). The stream is assumed to be at ambient conditions.
Dry Chip Baghouse Control Efficiency	99%	--	Based on the 2021 ORCAA AEI workbook, baghouses are assumed to maintain a control efficiency of 99%.
Cyclone PM Grain Loading Rate	0.03	gr/dscf	Based on the 2021 ORCAA AEI workbook, the PM grain loading rate comes from FIRE 6.23 October 2000, SCC 30700804, 30700805, which is also in Table 10.4.1 AP-42, p. 10.4-2 (2/80).

**Table F-12. Cyclones Emissions**

Emission Unit	Potential Operation	Exhaust Flow Rate	Loading Rate <sup>1</sup> (gr./dscf)			Control Efficiency	Filterable PM Emissions <sup>2,3,4</sup>		Filterable PM <sub>10</sub> Emissions <sup>2,3,4</sup>		Filterable PM <sub>2.5</sub> Emissions <sup>2,3,4</sup>	
	(hr/yr)	(scfm)	PM	PM <sub>10</sub>	PM <sub>2.5</sub>	(%)	(lb/hr)	(tpy)	(lb/hr)	(tpy)	(lb/hr)	(tpy)
Fuel Silo Cyclone	8,760	6,227	0.03	0.012	0.012	0%	1.60	7.01	0.64	2.81	0.64	2.81
Bark Cyclone	8,760	8,564	0.03	0.012	0.012	0%	2.20	9.65	0.88	3.86	0.88	3.86
Dry Chip Cyclone / Baghouse	8,760	5,150	0.03	0.012	0.012	99%	1.32E-02	0.06	5.30E-03	0.02	5.30E-03	0.02
<b>Total:</b>							3.82	16.72	1.53	6.69	1.53	6.69

<sup>1</sup> Based on the 2021 ORCAA AEI workbook, the FIRE 6.23 October 2000, SCC 30700804, 30700805 and EPA factor book 450/4-90-003 p. 144 assume that Filterable PM<sub>10</sub> is approximately equal to 40% of Filterable PM. It is also conservatively assumed that Filterable PM<sub>10</sub> = Filterable PM<sub>2.5</sub>. As this source does not involve combustion units, it is assumed that condensable emissions are negligible.

<sup>2</sup> As a conservative measure, emissions of PM<sub>2.5</sub> are assumed to be equal to emissions of PM<sub>10</sub>.

<sup>3</sup> Potential hourly PM emissions (lb/hr) = Exhaust Grain Loading Rate (gr./dscf) x Exhaust Air Flow Rate (dscf/min) x (60 min/hr) x (lb/7,000 gr.) x (100% - Control Efficiency (%)).

<sup>4</sup> Potential annual emissions (tpy) = Hourly Emission Rate (lb/hr) \* Annual Operating Hours (hrs/yr) / 2000 (lb/ton).

**Table F-13. Pre-Project Wood Waste Collection (Cyclones) Emissions**

Emission Unit	Potential Operation	Exhaust Flow Rate	Loading Rate <sup>1</sup> (gr./dscf)			Control Efficiency	Filterable PM Emissions <sup>2,3,4</sup>		Filterable PM <sub>10</sub> Emissions <sup>2,3,4</sup>		Filterable PM <sub>2.5</sub> Emissions <sup>2,3,4</sup>	
	(hr/yr)	(scfm)	PM	PM <sub>10</sub>	PM <sub>2.5</sub>	(%)	(lb/hr)	(tpy)	(lb/hr)	(tpy)	(lb/hr)	(tpy)
Dry Chip Cyclone / Baghouse <sup>5</sup>	8,760	5,150	0.03	0.012	0.012	99%	1.32E-02	0.06	5.30E-03	0.02	5.30E-03	0.02

<sup>1</sup> Based on the 2021 ORCAA AEI workbook, the FIRE 6.23 October 2000, SCC 30700804, 30700805 and EPA factor book 450/4-90-003 p. 144 assume that Filterable PM<sub>10</sub> is approximately equal to 40% of Filterable PM. It is also conservatively assumed that Filterable PM<sub>10</sub> = Filterable PM<sub>2.5</sub>. As this source does not involve combustion units, it is assumed that condensable emissions are negligible.

<sup>2</sup> As a conservative measure, emissions of PM<sub>2.5</sub> are assumed to be equal to emissions of PM<sub>10</sub>.

<sup>3</sup> Potential hourly PM emissions (lb/hr) = Exhaust Grain Loading Rate (gr./dscf) x Exhaust Air Flow Rate (dscf/min) x (60 min/hr) x (lb/7,000 gr.) x (100% - Control Efficiency (%)).

<sup>4</sup> Potential annual emissions (tpy) = Hourly Emission Rate (lb/hr) \* Annual Operating Hours (hrs/yr) / 2000 (lb/ton).

<sup>5</sup> Parameters for the existing emission unit based on Table 4.2 in the TSD for 12AOP915. PTE was calculated assuming 8,760 hour/year operation.

**Table F-14. Pre- and Post-Project Wood Waste Collection (Cyclones) Emission Comparison**

Emission Unit	PTE Emissions <sup>1</sup> (tpy)		
	PM	PM <sub>10</sub>	PM <sub>2.5</sub>
<b>Pre-Project Wood Waste Collection</b>			
Dry Chip Cyclone / Baghouse	0.06	0.02	0.02
All Other Existing Cyclones	1.64	0.68	0.68
<i>Pre-Project Total:</i>	1.7	0.7	0.7
<b>Post-Project Wood Waste Collection</b>			
Dry Chip Cyclone / Baghouse	0.06	0.02	0.02
All Other Existing Cyclones	1.64	0.68	0.68
Fuel Silo Cyclone	7.01	2.81	2.81
Bark Cyclone	9.65	3.86	3.86
<i>Post-Project Total:</i>	18.36	7.36	7.36

<sup>1</sup> Parameters for existing emission units based on Table 4.2 in the TSD for 12AOP915. PM Emissions were estimated using methods presented in ORCAA's 2021 AEI workbook.

**Table F-15. Haul Roads Input Parameters**

<b>Vehicle Name</b>	<b>Class</b>	<b>Vehicle Weight (Avg of Loaded + Unloaded) (tons)</b>	<b>Number of Trips per Day</b>	<b>Number of Days per Week</b>	<b>Number of Weeks per Year</b>	<b>Miles Round Trip (Paved)</b>	<b>Vehicle Miles Traveled per Day (VMT/day)</b>	<b>Vehicle Miles Traveled per Year (VMT/yr)</b>
Chip	Trucks	34	12	5	52	0.5	6	1560
Sawdust	Trucks	34	0	0	52	0.5	0	0
Lumber	Trucks	26	16	5	52	0.5	8	2080
Hog Fuel	Trucks	34	8	6	52	0.5	4	1248
Production Stackers	Stacker	75	75	6	52	0.1	7.5	2340
Production Forklifts	Forklifts	15	380	5	52	0.1	38	9880
Co. Pickups	Co. Pickups	2.5	8	6	52	0.5	4	1248
Sales/Service	Vendor	2.5	3	5	52	0.1	0.3	78
Shavings	Trucks	34	2	6	52	1	2	624
On-site transfers	Trucks	26	1	5	52	0.5	0.5	130
Log Delivery	Trucks	26	95	5	52	0.2	19	4940
<b>Total:</b>							89.3	24128

**Table F-16. Haul Roads Emissions**

Vehicle Name	Weight	Vehicle Miles Traveled per Year	Vehicle Miles Traveled per Day	Emission Factor, E <sup>1</sup> (lb/VMT)			Annual Controlled Emissions <sup>2</sup> (tpy)			Daily Controlled Emissions <sup>3</sup> (lb/day)		
	(tons)	(VMT/yr)	(VMT/day)	PM	PM <sub>10</sub>	PM <sub>2.5</sub>	PM	PM <sub>10</sub>	PM <sub>2.5</sub>	PM	PM <sub>10</sub>	PM <sub>2.5</sub>
Chip	34	1,560	6	0.44	0.09	0.02	0.08	0.02	3.73E-03	0.66	0.13	0.03
Sawdust	34	0	0	0.44	0.09	0.02	0	0	0	0	0	0
Lumber	26	2,080	8	0.33	0.07	0.02	0.08	0.02	3.78E-03	0.67	0.13	0.03
Hog Fuel	34	1,248	4	0.44	0.09	0.02	0.06	1.21E-02	2.98E-03	0.44	0.09	0.02
Production Stackers	75	2,340	8	0.98	0.20	0.05	0.26	0.05	1.25E-02	1.84	0.37	0.09
Production Forklifts	15	9,880	38	0.19	0.04	0.01	0.21	0.04	1.02E-02	1.80	0.36	0.09
Co. Pickups	2.5	1,248	4	0.03	0.01	0.00	4.24E-03	8.48E-04	2.08E-04	0.03	6.11E-03	1.50E-03
Sales/Service	2.5	78	0	0.03	0.01	0.00	2.65E-04	5.30E-05	1.30E-05	2.29E-03	4.58E-04	1.12E-04
Shavings	34	624	2	0.44	0.09	0.02	0.03	6.07E-03	1.49E-03	0.22	0.04	1.07E-02
On-site transfers	26	130	1	0.33	0.07	0.02	4.81E-03	9.62E-04	2.36E-04	0.04	8.32E-03	2.04E-03
Log Delivery	26	4,940	19	0.33	0.07	0.02	0.18	0.04	8.97E-03	1.58	0.32	0.08
<b>Total:</b>							0.90	0.18	0.04	7.28	1.46	0.36

<sup>1</sup> Emission factor E is calculated according to AP-42 Section 13.2.1 for emissions from paved roads, equation 1:

$$E \text{ (lbs/VMT)} = \text{Paved Road Emission Factor, } [k * (sL)^{0.91} * (W)^{1.02}]$$

0.011 = k, PM size multiplier (lb/VMT) from AP-42 Table 13.2.1-1.

0.0022 = k, PM<sub>10</sub> size multiplier (lb/VMT) from AP-42 Table 13.2.1-1.

0.00054 = k, PM<sub>2.5</sub> size multiplier (lb/VMT) from AP-42 Table 13.2.1-1.

1.1 = sL, roadway surface silt loading (g/m<sup>2</sup>) AP-42 13.2.1, Table 13-2.1-3. The average silt loading value for corn wet mills is used because the sawmill is expected to store materials with a similar texture and moisture content.

<sup>2</sup> Emissions account for natural mitigation due to precipitation according to AP-42 Section 13.2.1 equation 2:

$$\text{Annual emissions (tpy)} = E * (1-P/4N) * (1-C) * [\text{VMT/yr}] / [\text{lb/ton}]$$

161.6 = P, mean number of days per year with measurable precipitation from Western Regional Climatological Center, Olympia, WA station.

365 = N, number of days in period for annual rainfall mitigation effect

75% = C, control efficiency applied for watering and sweeping.

Paved roads are watered and vacuumed quarterly as control measures. Control efficiency from ORCAA's AEI workbook.

<sup>3</sup> Daily emissions (lb/day) are calculated in the same manner as annual emissions, but with the daily Vehicle Miles Traveled per Day and not taking credits for precipitation.

**Table F-17. Fire Pump Input Parameters**

Parameter	Value	Units	Source Notes
Fire Pump Engine Rated Capacity	238	bhp	From the 2022 ORCAA Annual Emissions Inventory.
Fire Pump Engine Annual Hours of Operation	100	hrs/yr	Assumed value for PTE basis.

**Table F-18. Fire Pump Emissions**

Emission Unit	Emission Factor <sup>1,4</sup>	Emissions	
	(lb/hp-hr)	Max Hourly (lb/hr)	Total Annual (tpy)
PM <sup>2</sup>	2.20E-03	0.52	0.03
PM <sub>10</sub>	2.20E-03	0.52	0.03
PM <sub>2.5</sub> <sup>2</sup>	2.20E-03	0.52	0.03
CO	6.68E-03	1.59	0.08
NO <sub>x</sub>	0.031	7.38	0.37
VOC <sup>3</sup>	2.51E-03	0.60	0.03
SO <sub>2</sub>	2.05E-03	0.49	0.02
CO <sub>2</sub> e	--	274.63	13.73
CO <sub>2</sub>	1.15	273.70	13.69
N <sub>2</sub> O	9.26E-06	2.20E-03	1.10E-04
CH <sub>4</sub>	4.63E-05	1.10E-02	5.51E-04

<sup>1</sup> Criteria pollutant and CO<sub>2</sub> emission factors for diesel industrial engines from AP-42, Table 3.3-1.

HAP/TAP Pollutants with an emission factor rating of C, D, or E are not included.

<sup>2</sup> Assuming PM = PM<sub>10</sub> = PM<sub>2.5</sub>.

<sup>3</sup> VOC emissions are equal to the sum of exhaust, evaporative, crankcase, and refueling TOC emissions.

<sup>4</sup> CH<sub>4</sub> and N<sub>2</sub>O emission factor is from 40 CFR 98, Subpart C, Table C-2. Global warming potential (GWP) for CH<sub>4</sub> is 25 and N<sub>2</sub>O is 298 for estimating CO<sub>2</sub>e emissions (40 CFR 98, Subpart A, Table A-1).

CH<sub>4</sub> and N<sub>2</sub>O emission factors assume the following average break-specific fuel consumption (BSFC), based on AP-42, Table 3.3-1, Footnote 'a'.

$$\text{Average BSFC} = 7,000 \text{ Btu/hp-hr}$$

**Table G-1. Rectangular Buildings**

ID	Description	X Coordinate (m)	Y Coordinate (m)	Elevation (m)	Height (m)	X Length (m)	Y Length (m)	Angle degree
BLDG_1	Planer Building	443426.8	5171013.2	3.92	18.29	138.1	27.7	90
BLDG_3	Large Dry Storage Building	443511.3	5170944.8	4.01	18.29	299.4	29.5	90
BLDG_4	Small Dry Storage Building	443541.1	5170945.1	4.10	18.29	62.1	29.8	90
BLDG_5	Trimmer Sorter Stacker Building	443571.2	5171006.3	4.07	18.29	159.2	30.7	90
BLDG_6	Sawmill Building	443602	5170896.9	4.25	13.72	28.2	80.4	90
BLDG_7	Sawmill Building_2	443602.6	5170868.2	4.19	13.72	20.7	22.7	90
CDK	CDK Building	443483	5170784.1	3.50	11.34	108.7	14.8	90

<sup>1</sup> Building elevations determined by AERMAP preprocessor.

**Table G-2. Circular Buildings**

ID	Description	X Coordinate (m)	Y Coordinate (m)	Elevation (m)	Height (m)	Radius (m)	Corners
F_SILO	Green Sawdust Silo	443469.2	5170778.2	3.65	25.60	6.10	24

<sup>1</sup> Building elevations determined by AERMAP preprocessor.

**Table G-3. Polygon Buildings**

ID	Description	X Coordinate (m)	Y Coordinate (m)	Elevation m	Height m
BLDG_2	Planer Infeed Building	443455.3	5171026.3	4.13	12.19

<sup>1</sup> Building elevations determined by AERMAP preprocessor.

**Table G-4. Point Sources**

ID	Description	X Coordinate (m)	Y Coordinate (m)	Elevation <sup>3</sup> (m)	Stack Height <sup>2</sup> (m)	Stack Temp (K)	Exit Vel. (m/s)	Stack Diam. (m)
CDK_S	CDK South Merged Stack <sup>1</sup>	443492.7	5170676.4	3.31	13.47	333.15	21.75	1.18
CDK_N	CDK North Merged Stack <sup>1</sup>	443485.6	5170783.2	3.48	13.47	333.15	21.75	1.18
C_FS	Fuel Silo Cyclone	443469.3	5170777.8	3.65	34.75	0.00	7.64	0.70
C_B	Bark Cyclone	443754.9	5170852.1	3.75	11.58	0.00	5.12	1.00
BAG2	Baghouse #2 - Carter Day	443417.1	5170941.8	4.14	9.14	0.00	22.85	1.00
BAG_BS	Band Saw Filing Room Baghouse	443628.5	5170906.2	4.29	3.30	0.00	21.83	0.406

<sup>1</sup> Because the emission points at each end of the CDK are located less than one diameter from each other, are similar in height, have the same exhaust flowrate and temperature, and have the same source of emissions, they are modeled in total as two merged point sources based on guidance from "Practical Guide to Atmospheric Dispersion Modeling" (Turner and Schulze).

Exhaust data obtained from email from KDS Windsor on 3/28/2023 and engineering drawings of the CDK (March 29, 2023).

Flowrate per singular emission point:	25,000 acfm	or	11.80	m <sup>3</sup> /s
Flowrate per merged point source:	50,000 acfm	or	23.60	m <sup>3</sup> /s
Temperature:	140 F			
Diameter per singular stack:	0.83 m			
Velocity per singular stack:	21.75 m/s			

<sup>2</sup> Based on engineering drawings of the CDK (March 29, 2023), the emission points have a less than 1.5 ft difference in height. The lower emission point height is used as the height of the merged point source for conservatism. Existing unit stack heights are based on measurement and site documentation.

<sup>3</sup> Source elevation determined by AERMAP preprocessor.

<sup>4</sup> Velocity for existing units is determined by exhaust flowrate as defined in 12AOP915 TSD (11/20/19).

<sup>5</sup> Stack diameter for existing units is determined by measurement.

**Table G-5. Horizontal Point Sources**

ID	Description	X Coordinate (m)	Y Coordinate (m)	Elevation (m)	Stack Height (m)	Stack Temp (K)	Exit Vel. (m/s)	Stack Diam. (m)
BAG1	Baghouse #1 - Clark	443417.6	5170935.9	4.19	9.14	0.00	16.51	1.54
BAG3	Baghouse#3 - Package Saw Shaker	443503.0	5170839.6	3.71	4.27	0.00	11.85	0.42
BAG_SM	Sawmill Baghouse	443661.0	5170864.3	4.31	11.58	0.00	23.81	1.06
BAG_P	Powerhouse Baghouse	443326.2	5170837.4	3.76	9.14	0.00	13.20	0.84
BAG_DC	Dry Chips Baghouse	443671.4	5170864.2	4.16	4.52	0.00	18.47	1.14
CDK_SD	CDK South Inlet Door	443492.2	5170674.8	3.29	5.87	333.15	0.305	2.90
CDK_ND	CDK North Inlet Door	443486.7	5170784.8	3.48	5.87	333.15	0.305	2.90

<sup>1</sup> Source elevation determined by AERMAP preprocessor.

<sup>2</sup> Velocity for existing units is determined by exhaust flowrate as defined in 12AOP915 TSD (11/20/19).

<sup>3</sup> Stack diameter for existing units is determined by measurement.

<sup>4</sup> Existing unit stack heights are based on measurement and site documentation.

<sup>5</sup> Dry Chip Baghouse exhaust parameters are determined by engineering drawings from Superior Systems.

<sup>6</sup> One horizontal source at the green lumber entrance on each end of the kiln are used to represent emissions from the doors of the CDK. Because of the positive and negative pressure created by the internal fans near the kiln ends, it is expected that ambient air will be drawn into the kiln on the side where dry lumber is exiting and kiln gas is forced out on the side where green lumber is entering. The effective diameter for each source is calculated from the area of the door opening minus the area covered by the lumber, which is assumed to be 75% of the door opening. The release height is calculated as the height of the door minus half of the effective diameter. The exit velocity is conservatively assumed to be 1 ft/s. Calculations for effective diameter and release height are below:

Wood stack height:	6.49	m
Wood stack width:	3.05	m
Wood stack area:	19.78	m <sup>2</sup>
Total door area:	26.38	m <sup>2</sup>
Door area - wood area:	6.59	m <sup>2</sup>
Effective diameter:	2.90	m
Door height:	7.32	m
Effective release height:	5.87	m

**Table G-6. Volume Sources**

ID	Description	X Coordinate (m)	Y Coordinate (m)	Elevation (m)	Release Height (m)	Init. Lat. Dim. (m)	Init. Vert. Dim. (m)
GSD	Green sawdust sawmill drop	443614.2	5170857.3	4.23	6.86	4.81	6.38
DB	Log Debarking	443742.9	5170872.8	4.16	6.86	1.98	6.38
CBL	Chip bin truck loadout	443699.9	5170851.6	3.74	7.24	1.23	6.73
BBL	Bark bin truck loadout	443758.9	5170852.1	3.75	7.24	1.23	6.73

<sup>1</sup> Volume source dimensions for truck loadout determined using dimensions of the storage bins:

Bin height:	14.48	m
Bin width:	5.28	m

**Table G-7. Point Source - Criteria Pollutant Emission Rates**

Source	Model ID	Emission Rate (g/s)						
		PM <sub>10</sub> 24-hr <sup>2</sup>	PM <sub>2.5</sub> 24-hr <sup>2</sup>	PM <sub>2.5</sub> Annual	CO 1-hr/8-hr	NO <sub>2</sub> 1-hr	NO <sub>2</sub> Annual	SO <sub>2</sub> 1-hr
CDK South Merged Stack <sup>1</sup>	CDK_S	3.43E-01	3.07E-01	2.04E-01	1.36E+00	5.21E-01	5.11E-01	6.30E-02
CDK North Merged Stack <sup>1</sup>	CDK_N	3.43E-01	3.07E-01	2.04E-01	1.36E+00	5.21E-01	5.11E-01	6.30E-02
Fuel Silo Cyclone	C_FS	8.07E-02	8.07E-02	8.07E-02	--	--	--	--
Bark Cyclone	C_B	1.11E-01	1.11E-01	1.11E-01	--	--	--	--
Baghouse #2 - Carter Day	BAG2	1.75E-03	1.75E-03	1.75E-03	--	--	--	--
Band Saw Filing Room Baghouse	BAG_BS	7.75E-04	7.75E-04	7.75E-04	--	--	--	--

<sup>1</sup>Based on vendor information and the NCASI Control Device and Stack Testing Feasibility Assessment, it is assumed that 80% of emissions from the CDK will be split evenly between the four vapor extraction points (two modeled stacks) so emission rates are divided by two and represent emissions from one merged source. The remaining 20% is emitted through the openings at each end of the CDK.

<sup>2</sup>Emissions for 24-hr averaging periods associated with the CDK are modeled with 350 MMBtu/day (7 hours at full capacity of the burner) of operation without wood drying in the CDK -and the remainder of the period at normal operation to reflect potential operations associated with startup, idle, malfunction and shutdown.

**Table G-8. Horizontal Point Source - Criteria Pollutant Emission Rates**

Source	Model ID	Emission Rate (g/s)						
		PM <sub>10</sub> 24-hr <sup>2</sup>	PM <sub>2.5</sub> 24-hr <sup>2</sup>	PM <sub>2.5</sub> Annual	CO 1-hr/8-hr	NO <sub>2</sub> 1-hr	NO <sub>2</sub> Annual	SO <sub>2</sub> 1-hr
Baghouse #1 - Clark	BAG1	8.40E-03	8.40E-03	8.40E-03	--	--	--	--
Baghouse#3 - Package Saw Shaker	BAG3	4.52E-04	4.52E-04	4.52E-04	--	--	--	--
Sawmill Baghouse	BAG_SM	5.78E-03	5.78E-03	5.78E-03	--	--	--	--
Powerhouse Baghouse	BAG_P	2.60E-03	2.60E-03	2.60E-03	--	--	--	--
Dry Chips Baghouse	BAG_DC	6.67E-04	6.67E-04	6.67E-04	--	--	--	--
CDK South Door <sup>1</sup>	CDK_SD	8.57E-02	7.67E-02	5.11E-02	3.39E-01	1.30E-01	1.28E-01	1.57E-02
CDK North Door <sup>1</sup>	CDK_ND	8.57E-02	7.67E-02	5.11E-02	3.39E-01	1.30E-01	1.28E-01	1.57E-02

<sup>1</sup>Based on vendor information and the NCASI Control Device and Stack Testing Feasibility Assessment, it is assumed that 80% of emissions from the CDK will be split evenly between the four vapor extraction points (two modeled stacks) so emission rates are divided by two and represent emissions from one merged source. The remaining 20% is emitted through the openings at each end of the CDK.

<sup>2</sup>Emissions for 24-hr averaging periods associated with the CDK are modeled with 350 MMBtu/day (7 hours at full capacity of the burner) of operation without wood drying in the CDK -and the remainder of the period at normal operation to reflect potential operations associated with startup, idle, malfunction and shutdown.

**Table G-9. Volume Source - Criteria Pollutant Emission Rates**

Source	Model ID	Emission Rate (g/s)		
		PM <sub>10</sub> 24-hr	PM <sub>2.5</sub> 24-hr	PM <sub>2.5</sub> Annual
Green sawdust sawmill drop	GSD	2.68E-03	4.06E-04	4.87E-04
Log Debarking	DB	1.04E-01	1.44E-02	1.44E-02
Chip bin truck loadout	CBL	1.44E-01	2.17E-02	1.55E-02
Bark bin truck loadout	BBL	3.68E-02	5.58E-03	3.97E-03

**Table G-10. Volume Source - Vehicle Traffic - Criteria Pollutant Emission Rates**

Vehicle Name	Model Route Name	Emission Rate (g/s)			Total Number of Sources	Emission Rate/Source (g/s)			Vehicle Height (m)	Vehicle Width (m)
		PM <sub>10</sub> 24-hr	PM <sub>2.5</sub> 24-hr	PM <sub>2.5</sub> Annual		PM <sub>10</sub> 24-hr	PM <sub>2.5</sub> 24-hr	PM <sub>2.5</sub> Annual		
Chip	Chip Trucks	6.89E-04	1.69E-04	1.07E-04	40	1.72E-05	4.23E-06	2.68E-06	3	3
Lumber		6.99E-04	1.72E-04	1.09E-04						
Co. Pickups	Shipping Trucks	3.21E-05	7.87E-06	5.98E-06	140	5.55E-06	1.36E-06	8.70E-07	3	3
Sales/Service		2.41E-06	5.90E-07	3.74E-07						
On-site transfers		4.37E-05	1.07E-05	6.79E-06						
Hog Fuel	Bark/Hog Fuel Trucks	4.60E-04	1.13E-04	8.58E-05	33	1.39E-05	3.42E-06	2.60E-06	3	3
Production Stackers	Log Stackers	1.93E-03	4.74E-04	3.60E-04	84	2.30E-05	5.64E-06	4.29E-06	4.32	3
	Green Lumber, Dry									
Production Forklifts	Lumber, Planer, shipping forklifts	1.89E-03	4.65E-04	2.95E-04	189	1.00E-05	2.46E-06	1.56E-06	4.32	3
Shavings	Shaving Trucks	2.30E-04	5.64E-05	4.29E-05	158	1.45E-06	3.57E-07	2.71E-07	3	3
Log Delivery	Log Trucks	1.66E-03	4.08E-04	2.58E-04	28	5.93E-05	1.46E-05	9.22E-06	3	3

<sup>1</sup> Forklift dimensions based on vendor specification sheets. Truck dimensions are based on default average truck dimensions from EPA guidance memo on haul roads.

**Table G-11. TAP Emission Rates - Short Term (g/s)<sup>1</sup>**

Pollutant CAS #	Formaldehyde 50-00-0	Benzene 71-43-2	Arsenic 7440-38-2	Cadmium 7440-43-9	Lead 7439-92-1	Manganese 7439-96-5	Nickel 7440-02-0
CDK_S	2.11E-02	1.06E-02	2.55E-05	7.79E-06	8.79E-05	3.20E-04	2.23E-05
CDK_N	2.11E-02	1.06E-02	2.55E-05	7.79E-06	8.79E-05	3.20E-04	2.23E-05
CDK_SD	5.27E-03	2.65E-03	6.36E-06	1.95E-06	2.20E-05	8.00E-05	5.57E-06
CDK_ND	5.27E-03	2.65E-03	6.36E-06	1.95E-06	2.20E-05	8.00E-05	5.57E-06

<sup>1</sup>Based on vendor information and the NCASI Control Device and Stack Testing Feasibility Assessment, it is assumed that 80% of emissions from the CDK will be split evenly between the four vapor extraction points (two modeled stacks) so emission rates are divided by two and represent emissions from one merged source. The remaining 20% is emitted through the openings at each end of the CDK. Maximum hourly emission rates are used for all short term averaging periods.

**Table G-12. TAP Emission Rates - Long Term (g/s)<sup>1</sup>**

Pollutant CAS #	Formaldehyde 50-00-0	Benzene 71-43-2	Arsenic 7440-38-2	Cadmium 7440-43-9	Lead 7439-92-1	Manganese 7439-96-5	Nickel 7440-02-0
CDK_S	2.02E-02	1.06E-02	2.55E-05	7.79E-06	8.79E-05	3.20E-04	2.23E-05
CDK_N	2.02E-02	1.06E-02	2.55E-05	7.79E-06	8.79E-05	3.20E-04	2.23E-05
CDK_SD	5.06E-03	2.65E-03	6.36E-06	1.95E-06	2.20E-05	8.00E-05	5.57E-06
CDK_ND	5.06E-03	2.65E-03	6.36E-06	1.95E-06	2.20E-05	8.00E-05	5.57E-06

<sup>1</sup>Based on vendor information and the NCASI Control Device and Stack Testing Feasibility Assessment, it is assumed that 80% of emissions from the CDK will be split evenly between the four vapor extraction points (two modeled stacks) so emission rates are divided by two and represent emissions from one merged source. The remaining 20% is emitted through the openings at each end of the CDK.

**Table G-13. TAP Modeling Results**

Pollutant	CAS #	Model Results (µg/m <sup>3</sup> )			Averaging		Above ASIL?	
		1-hr	8-hr	24-hr	Period	ASIL <sup>1</sup> (µg/m <sup>3</sup> )		
Formaldehyde	50-00-0	9.81	4.06	1.84	0.43	year	0.17	Yes
Formaldehyde <sup>2</sup>	50-00-0	9.81	4.06	1.84	0.43	1-hr	61	No
Benzene	71-43-2	4.93	2.04	0.92	0.23	year	0.13	Yes
Arsenic	7440-38-2	0.01	0.00	0.00	0.00054	year	0.0003	Yes
Cadmium	7440-43-9	0.00	0.00	0.00	0.00017	year	0.00024	No
Lead	7439-92-1	0.04	0.02	0.01	0.002	year	0.083	No
Manganese	7439-96-5	0.15	0.06	0.03	0.01	24-hr	0.3	No
Nickel	7440-02-0	0.01	0.00	0.00	0.00047	year	0.0038	No

<sup>1</sup>The ASIL for each TAP is obtained from the 2019 WAC 173-460 TAP list.

<sup>2</sup>Formaldehyde 1-hr averaging period ASIL obtained from ORCAA 8.6(b).

**Table G-14. Criteria Pollutant NAAQS Results**

Pollutant	Averaging Period	Design Concentration	Concentration ( $\mu\text{g}/\text{m}^3$ )			NAAQS	Exceeds NAAQS?
			Modeled	Background <sup>1</sup>	Combined		
PM <sub>10</sub>	24-hr	H6H	76.9	42.70	119.6	150	No
	24-hr	H8H	22.9	10.2	33.1	35	No
PM <sub>2.5</sub>	Annual	--	5.6	4.3	9.9	12	No
	1-hr	H8H	111.1	21.81	133	188	No
NO <sub>2</sub>	Annual	--	9.8	4.34	14.1	100	No
	1-hr	H4H	18.5	12.28	30.7	196	No

**Attachment B**

**Model File Directory**

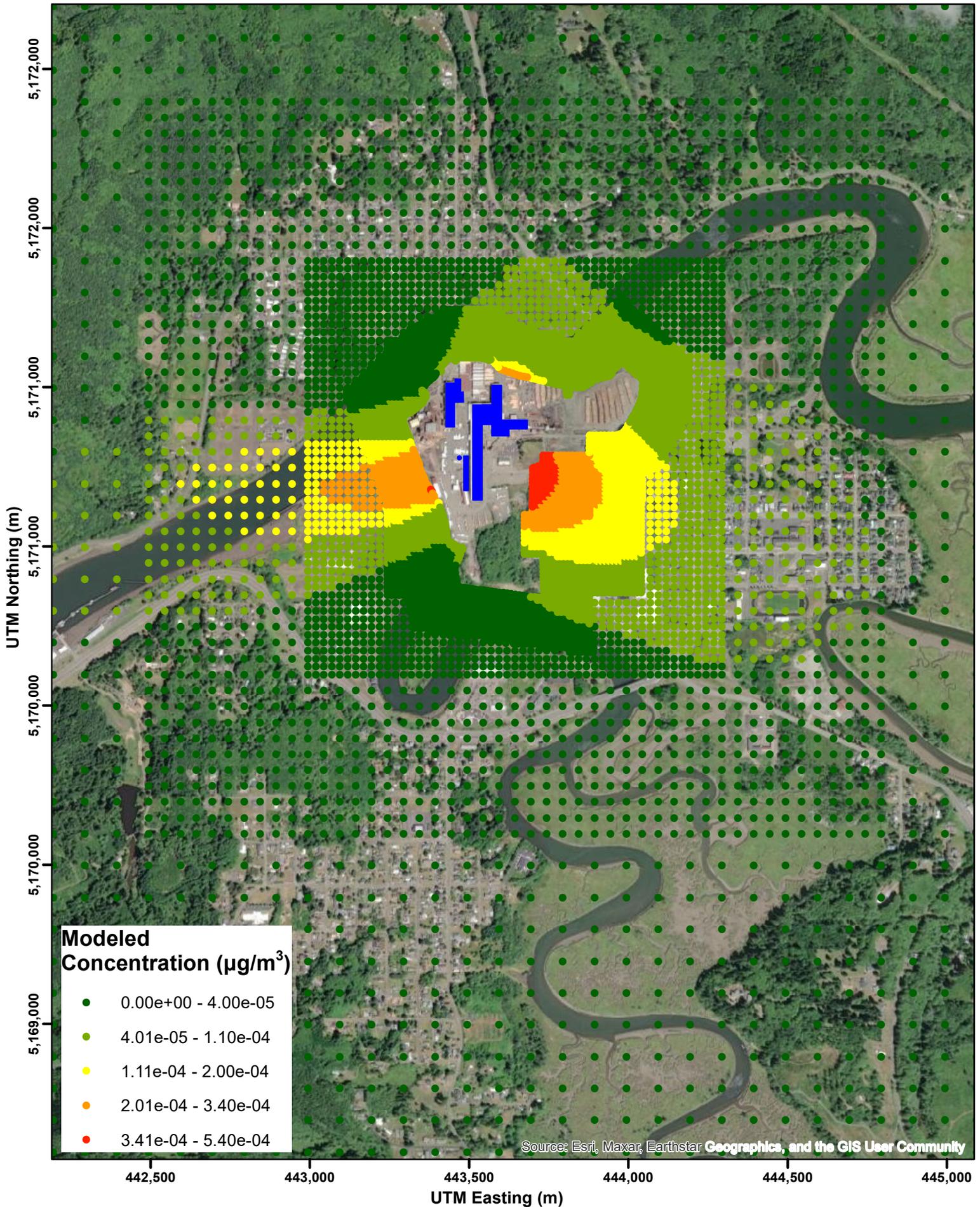
<b>File Name <sup>a</sup></b>	<b>Pollutant</b>	<b>Averaging Period</b>	<b>Modeled Year(s)</b>	<b>Description</b>
CNHXX	CO	1-hr and 8-hr	2018-2022	Project significant impact modeling – maximum across 5 years
SNH1822	SO <sub>2</sub>	1-hr	2018-2022	NAAQS modeling – maximum (H4H) 5-year average
PM25NI1822	PM <sub>2.5</sub>	24-hr	2018-2022	NAAQS modeling – maximum (H8H) 5-year average
PM25_Annual_NH1822	PM <sub>2.5</sub>	Annual	2018-2022	NAAQS modeling – maximum 5-year average
PM10NI1822	PM <sub>10</sub>	24-hr	2018-2022	NAAQS modeling – maximum (H2H) across 5 years
NNH1822	NO <sub>2</sub>	1-hr	2018-2022	NAAQS modeling – maximum (H8H) 5-year average
NNHXX	NO <sub>2</sub>	Annual	2018-2022	NAAQS modeling – maximum across 5 years
20XX_arsenic_aermod	Arsenic	Annual	2018-2022	TAP modeling – maximum across 5 years
20XX_benzene_aermod	Benzene	Annual	2018-2022	TAP modeling – maximum across 5 years
20XX_cadmium_aermod	Cadmium	Annual	2018-2022	TAP modeling – maximum across 5 years
20XX_formalde_aermod	Formaldehyde	Annual	2018-2022	TAP modeling – maximum across 5 years
2018-2022_formalde_aermod	Formaldehyde	1-hr	2018-2022	TAP modeling – maximum across 5 years
20XX_lead_aermod	Lead	Annual	2018-2022	TAP modeling – maximum across 5 years
2016_2020_manganes_aermod	SO <sub>2</sub>	1-hr	2018-2022	TAP modeling – maximum across 5 years
20XX_nickel_aermod	Nickel	Annual	2018-2022	TAP modeling – maximum across 5 years
HQMSLE1822	--	--	2018-2022	Surface and Upper Air Meteorological Data
BPIP input/output file	--	--	--	BPIP preprocessor files

- a. File names with "XX" denote multiple files for a single pollutant. "XX" represents the modeled meteorological year.
- b. \*.ami and \*.inp files are input files. \*.aml and \*.out files are output files. Plot files can be provided upon request.

## **Attachment C**

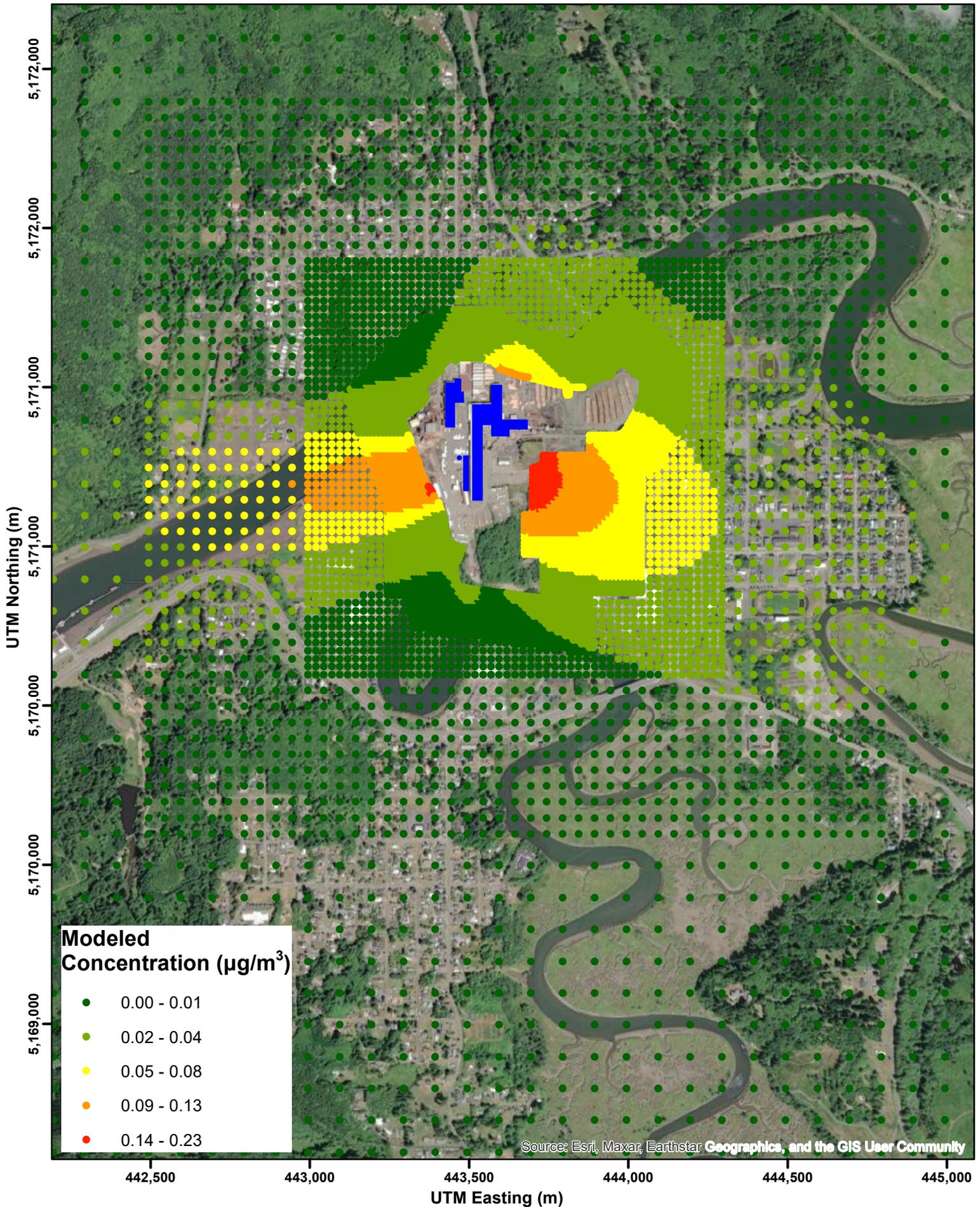
### **Concentration Plots**

# Maximum Modeled Arsenic Concentration Annual ASIL 0.0003 ( $\mu\text{g}/\text{m}^3$ )



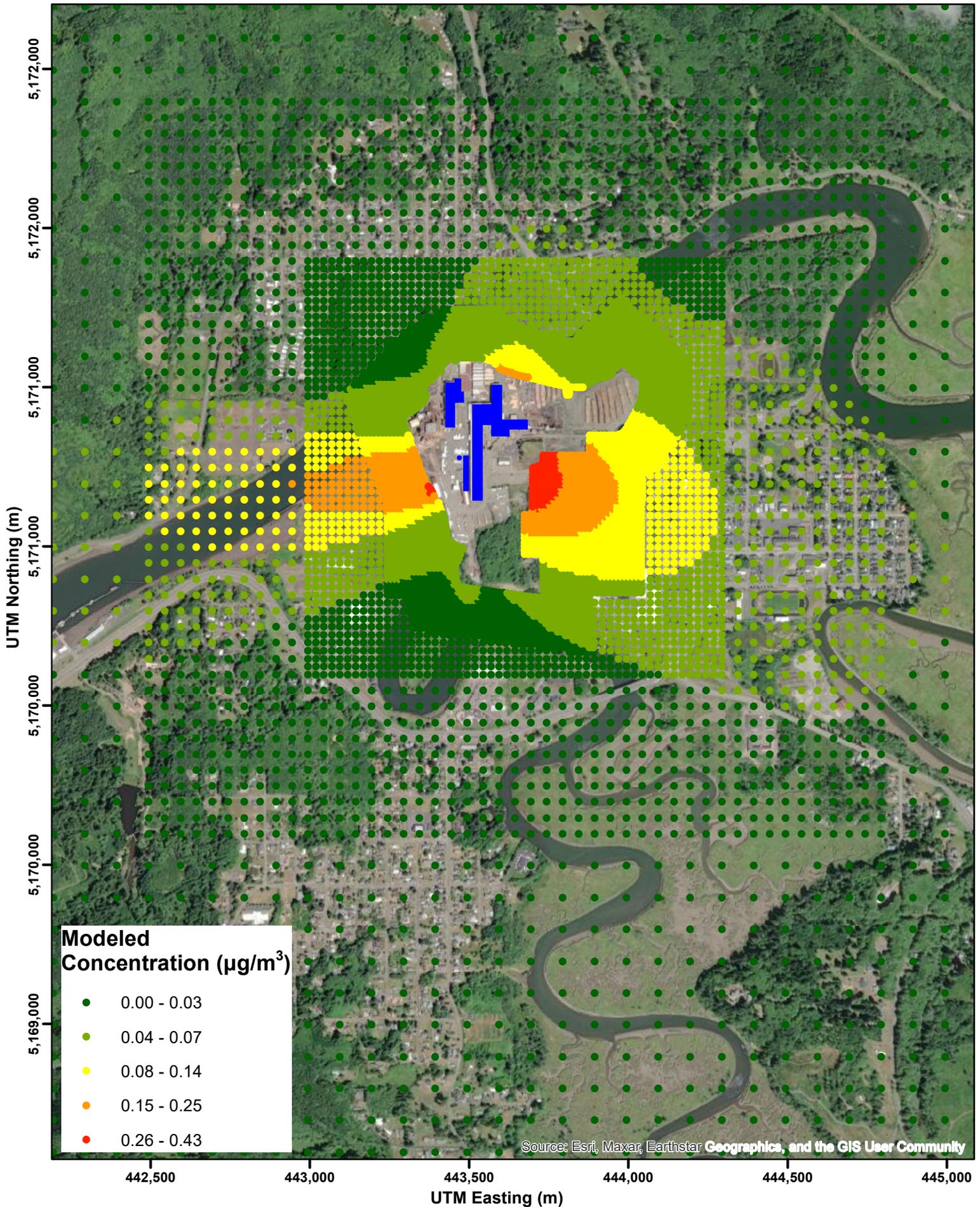
All Coordinates shown in UTM Coordinates,  
Zone 10, WGS 1984

# Maximum Modeled Benzene Concentration Annual ASIL 0.13 ( $\mu\text{g}/\text{m}^3$ )



All Coordinates shown in UTM Coordinates,  
Zone 10, WGS 1984

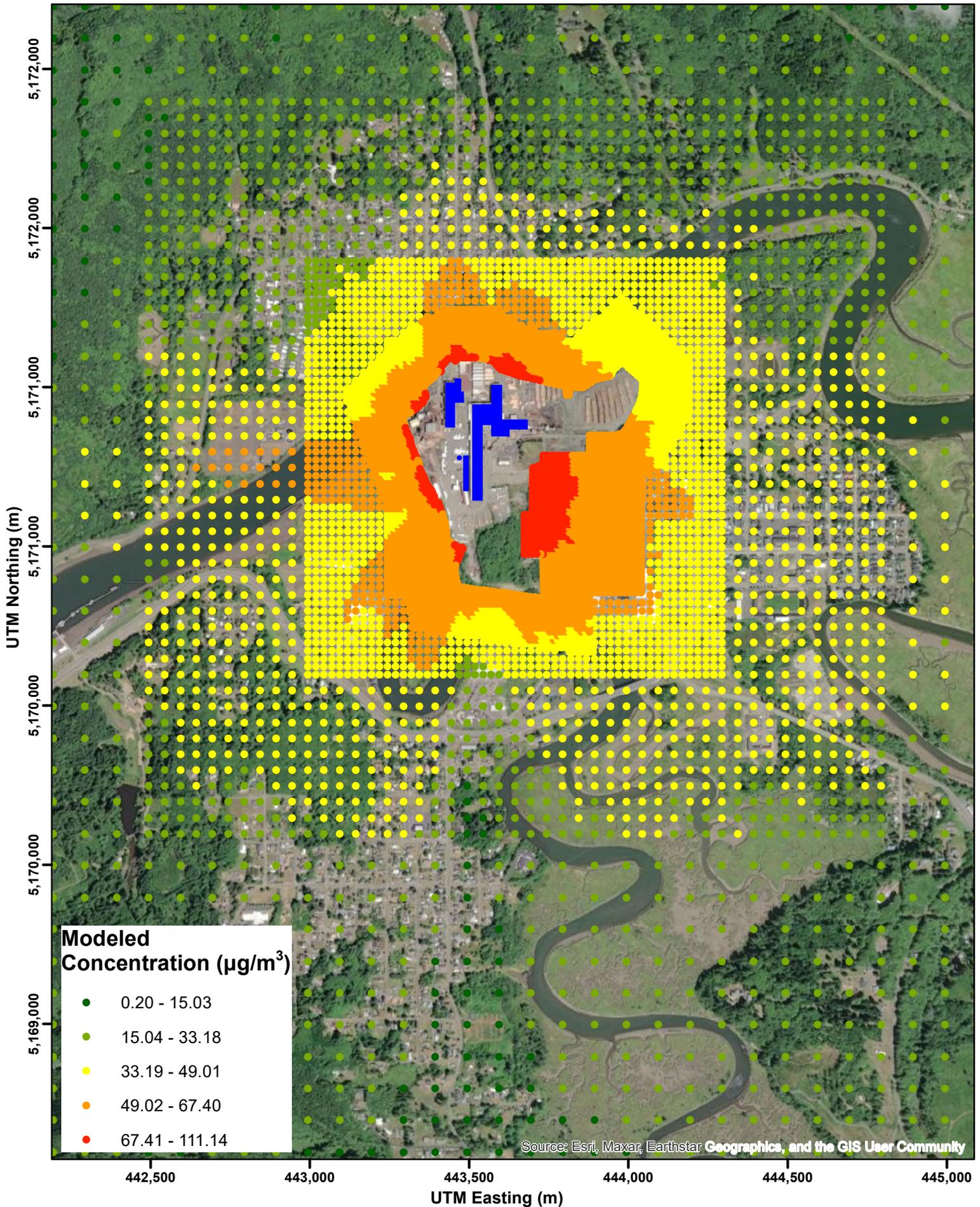
# Maximum Modeled Formaldehyde Concentration Annual ASIL 0.17 ( $\mu\text{g}/\text{m}^3$ )



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

All Coordinates shown in UTM Coordinates,  
Zone 10, WGS 1984

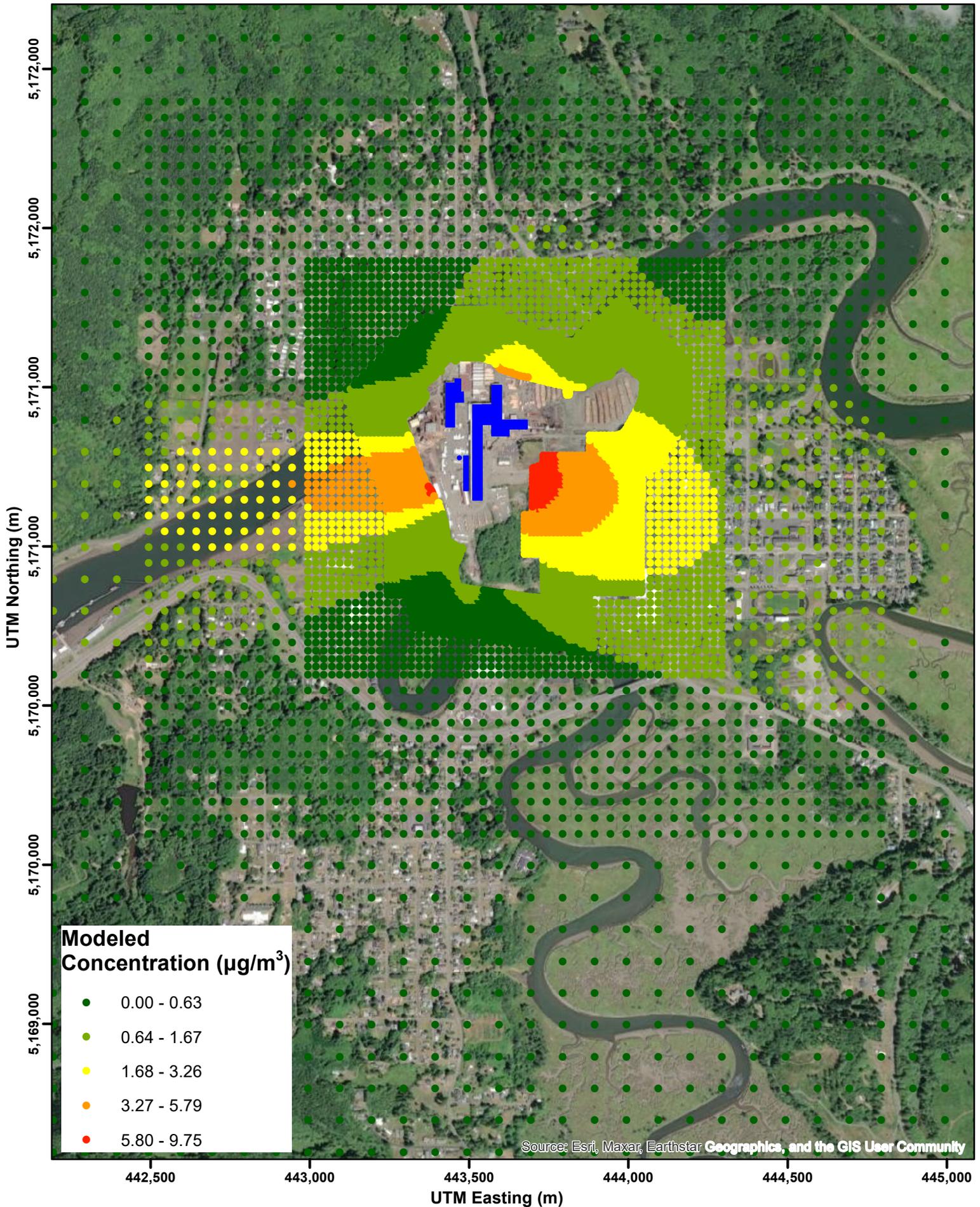
# High 8<sup>th</sup> High Modeled NO<sub>2</sub> Concentration 1-hr NAAQS 188 (µg/m<sup>3</sup>)



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

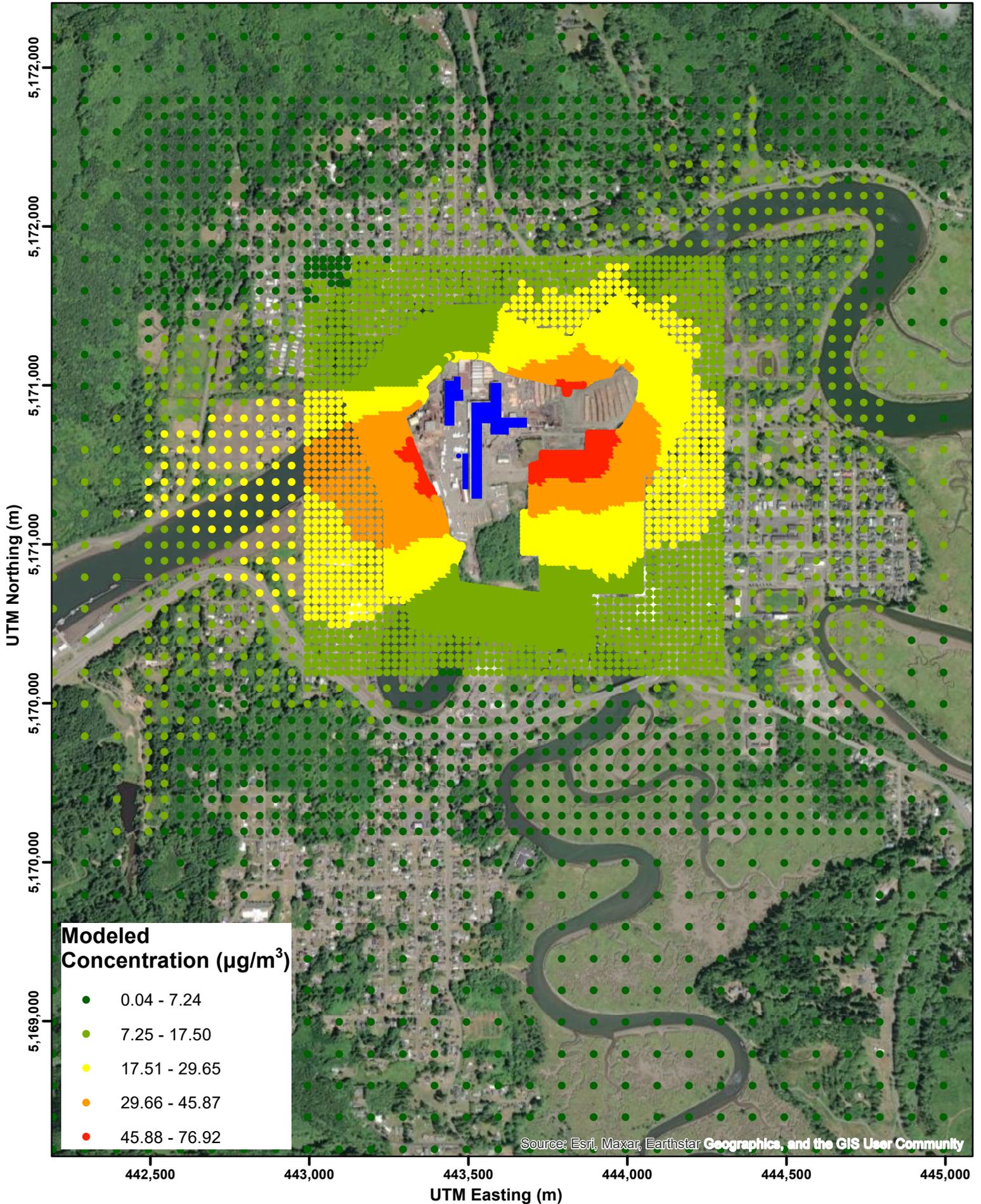
All Coordinates shown in UTM Coordinates,  
Zone 10, WGS 1984

# Maximum Modeled NO<sub>2</sub> Concentration Annual NAAQS 100 (µg/m<sup>3</sup>)



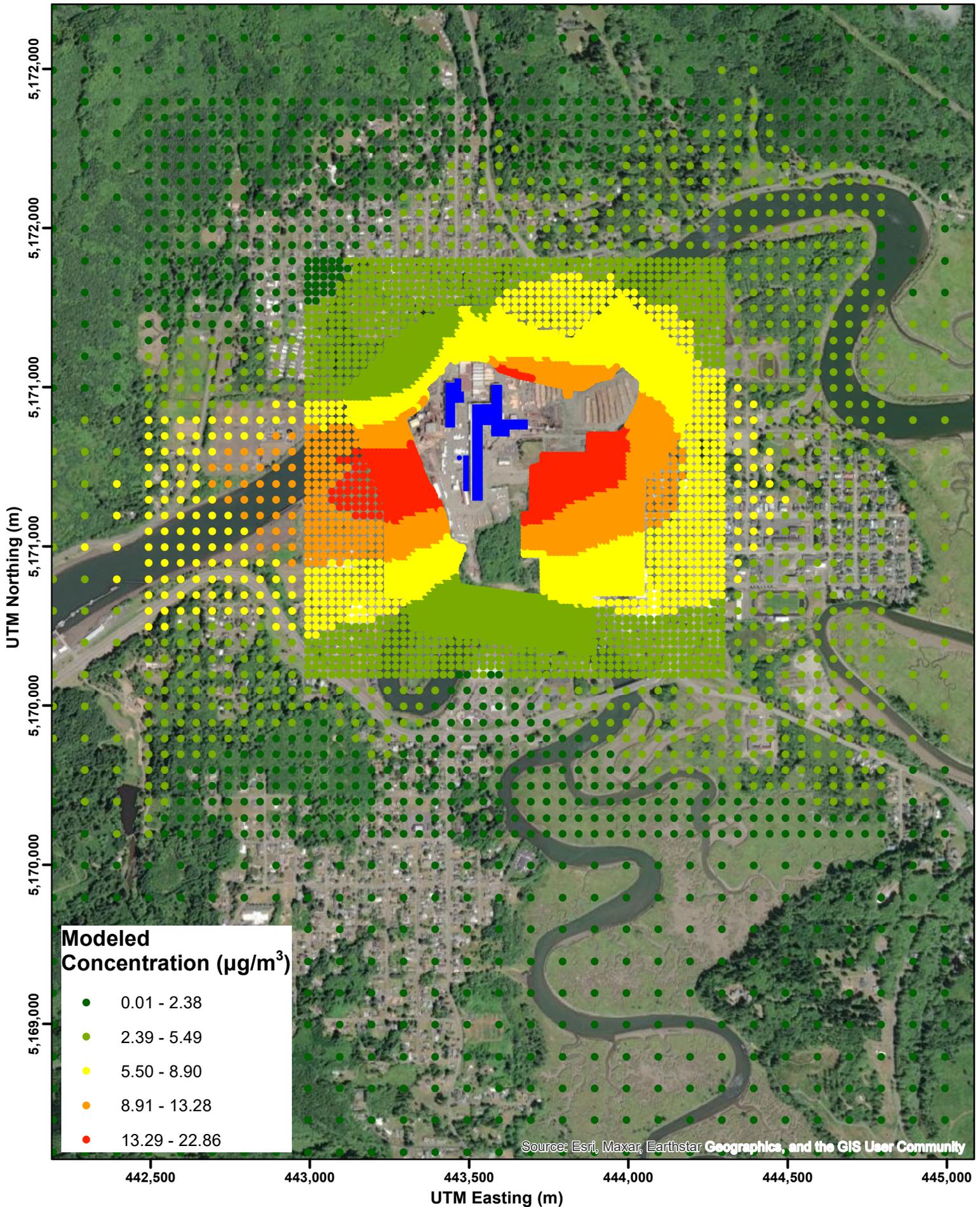
All Coordinates shown in UTM Coordinates,  
Zone 10, WGS 1984

# High 6<sup>th</sup> High Modeled PM<sub>10</sub> Concentration 24-hr NAAQS 150 (µg/m<sup>3</sup>)



All Coordinates shown in UTM Coordinates,  
Zone 10, WGS 1984

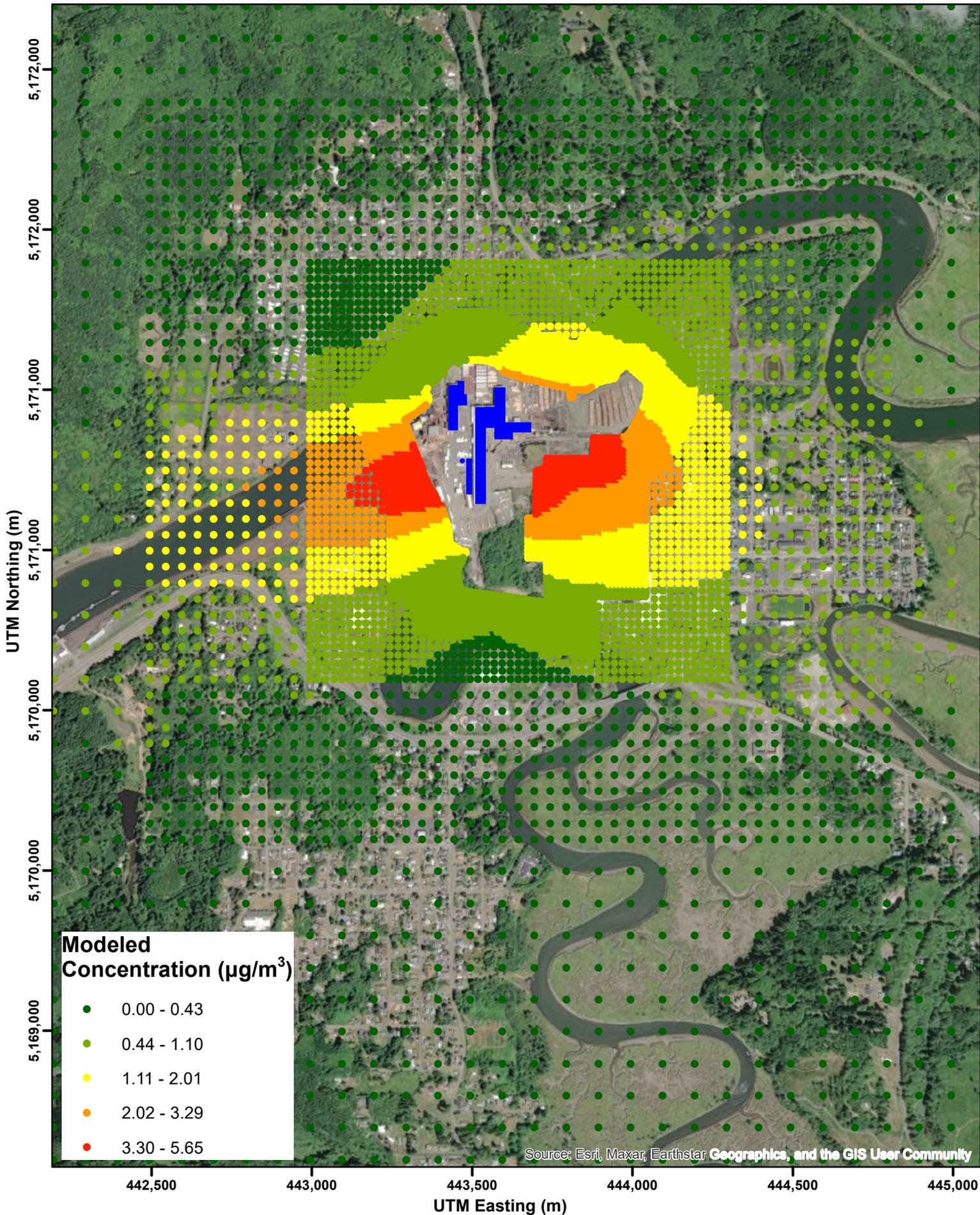
# High 8<sup>th</sup> High Modeled PM<sub>2.5</sub> Concentration 24-hr NAAQS 35 (µg/m<sup>3</sup>)



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

All Coordinates shown in UTM Coordinates,  
Zone 10, WGS 1984

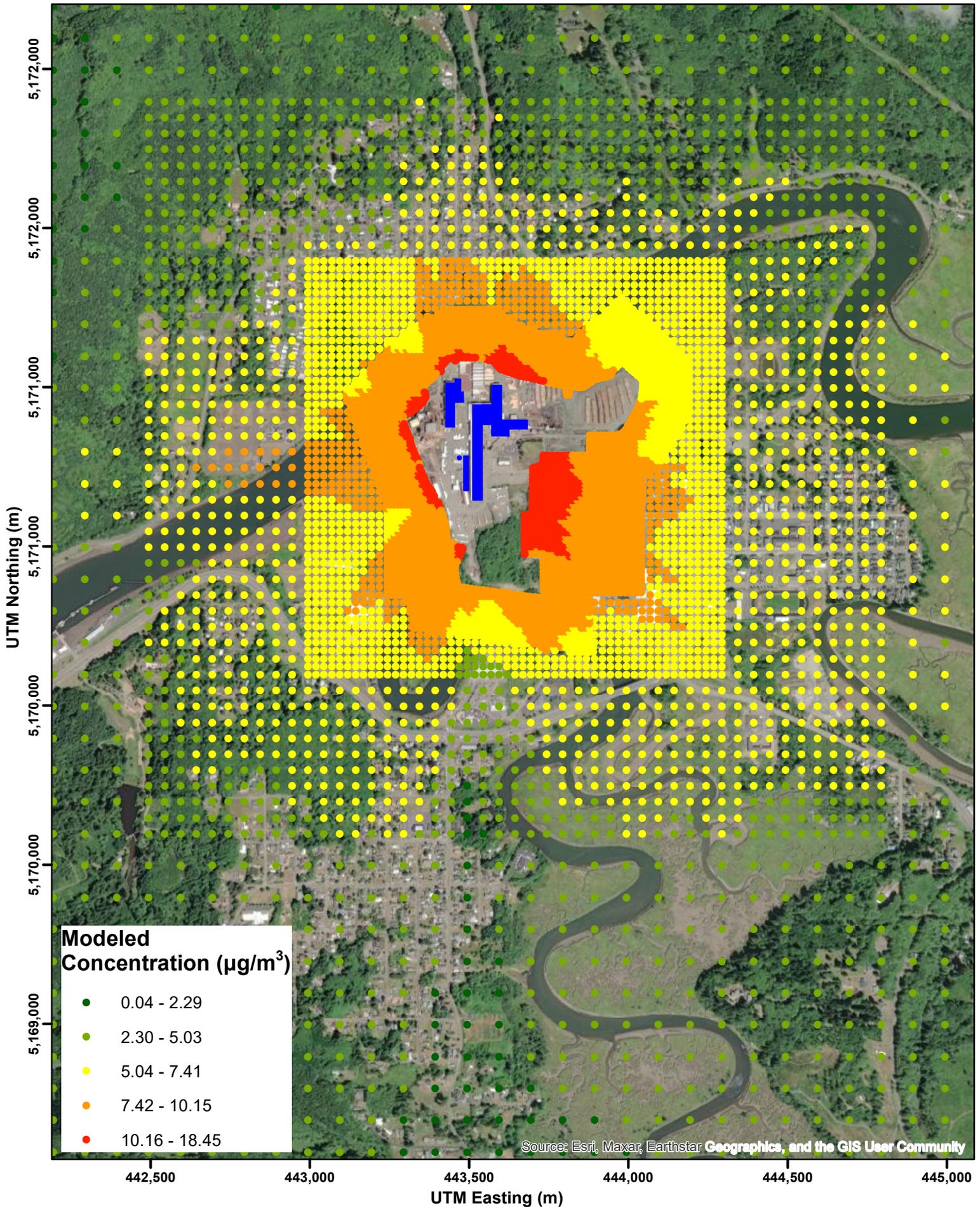
# Maximum Modeled PM<sub>2.5</sub> Concentration Annual NAAQS 12 (µg/m<sup>3</sup>)



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

All Coordinates shown in UTM Coordinates,  
Zone 10, WGS 1984

# High 4<sup>th</sup> High Modeled SO<sub>2</sub> Concentration 1-hr NAAQS 196 (µg/m<sup>3</sup>)



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

All Coordinates shown in UTM Coordinates,  
Zone 10, WGS 1984

**To:** Aaron Manley, Olympic Region Clean Air Agency  
**cc:** Michael Nolan and Christine Yanik, Weyerhaeuser NR Company  
**From:** Beth Ryder and Maddie Coates, Trinity Consultants  
**Date:** February 14, 2024  
**RE:** Weyerhaeuser Raymond NOC Application Addendum (23NOC1614) – Arsenic Emission Factor

Weyerhaeuser NR Company (Weyerhaeuser) is requesting an update to the proposed emission factor associated with arsenic emissions from the Notice of Construction (NOC) application #23NOC1614 associated with the direct-fired continuous dry kiln (CDK) at the Raymond facility (the "Facility").

Arsenic emissions are dependent on (1) the fuel used to create the heat for the kiln, and (2) the process of producing the heat. Metals, including arsenic, are not destroyed, or created in a combustion or gasification process. The originally submitted emission factor for arsenic was determined by National Council for Air and Stream Improvement (NCASI) Technical Bulletin 1013: A Comprehensive Compilation and Review of Wood-Fired Boiler Emissions (March 2023). There is no known dataset of arsenic emissions associated with a gasification process or CDK. The combustion process occurring in a wood fired boiler and the gasification process occurring in the proposed CDK burner have some important differences that may lead to these values being overly conservative.

The gasification burner system generates combustible gases from cooking the green sawdust in a low oxygen environment. In stage one, the sawdust is delivered to the top of a sloped grate in a chamber and heated as it travels down the grate. This stage is completed in a low oxygen environment, and no combustion occurs on the grate. The green sawdust can reach temperatures between 300 – 1,000°F with higher temperature expected toward the grate and lower temperature on the outlet side of the pile. Temperatures over 800°F are not as energy efficient and are expected to be adjusted using burner operator controls. A byproduct of the process is leftover char, which is collected in a water basin and removed from the gasifier. The char contains additional heat content that is un-combusted. The wood gas that is produced travels up to a separate chamber for stage two. Oxygen is added to the combustible gases created from the green sawdust and combusted to create the heat necessary for the CDK drying process.

Arsenic is inherent in the green sawdust used in the gasifier; high heat and oxygen cause the arsenic to volatilize and/or oxidize and escape from the wood. Higher heat causes increased volatilization.<sup>1</sup> Because this process includes the gasification of wood which brings wood to a lower internal temperature compared to wood combustion and in a reduced oxygen environment, emission factors for wood-fired boilers are conservative for estimating emissions from the CDK.

Weyerhaeuser completed stack testing on the existing hog fuel boiler (EU1) in 2009. The CDK is expected to use a similar fuel type as the existing hog fuel boiler. Therefore, emissions from this boiler are representative of relative emissions associated with the specific fuel type. As such, Weyerhaeuser would like to propose the use of this stack test data to create a linear relationship between particulate matter less than 10 micron (PM<sub>10</sub>) and arsenic emissions. Based on data from a study published in The Journal of

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<sup>1</sup> This is further demonstrated by the fact that arsenic emissions are not listed for indirect fired kilns.

Environmental Sciences in 2018<sup>2</sup>, there is a direct correlation between arsenic and PM emissions. Air samples near industrial activity in several cities in China were taken and the samples were analyzed for heavy metal concentrations. Approximately 73% of the measured arsenic was in the “fine mode” (1.1-2.1 micron) while the remaining 27% was in the “coarse mode” (9-10 micron). While the majority of arsenic was found in the mode that would classify as PM<sub>2.5</sub>, the proposed method applies a linear ratio of arsenic to PM<sub>10</sub>; this ratio is calculated using the 2009 stack test on the hog fuel boiler at the Raymond Mill. The stack test can be found in Attachment A and the ratio calculation can be found in Attachment B.

To account for the differences in a combustion process verses the CDK gasification burner, the arsenic to PM<sub>10</sub> ratio is applied to the CDK PM<sub>10</sub> emission factor from the “EPD Recommended Emission Factors for Lumber Kiln Permitting in Georgia.” This factor uses total annual throughput in million board feet (MMBF) to determine emissions from both combustion and drying but does not include emissions from startup and idling. A combustion emission factor for wood-fired boilers with wet scrubber control technology from NCASI Technical Bulletin 1013<sup>3</sup> will still be used for the expected startup and idling emissions. Updated emission calculations can be found in Attachment C.

**Table 1. Arsenic Emissions**

Normal Operation			Startup/Idling			Total CDK
lb/MMBF	lb/hr	tpy	lb/MMBtu	lb/hr	tpy	tpy
5.34E-03	1.97E-04	8.27E-04	1.01E-05	5.05E-04	9.09E-05	9.18E-04

The update to the emission calculations did not change the facility wide total reported hazardous air pollutant (HAP) emission rate of 21.68 tpy. The updated emission calculations, along with the project-netting from the removal of the hog fuel boiler and batch kilns, emissions from arsenic for the project are above the small quantity emission rate (SQER) but modeled concentrations are below the acceptable source impact level (ASIL) as shown in Table 1 below. Updated arsenic models can be found in Attachment D.

**Table 2. Arsenic Modeling Results**

Averaging Period	ASIL (µg/m <sup>3</sup> )	Modeled Concentration	Exceeds ASIL?
Annual	0.0003	0.00022	No

Impacts from these updated arsenic emission calculations will also carry over into the Tier II Health Impact Assessment (HIA). Therefore, an updated Tier II HIA will be submitted under separate cover.

<sup>2</sup> “Size Distribution and Source of Heavy Metals in Particulate Matter on the Lead and Zinc Smelting Affected Area” published in the Journal of Environmental Sciences, April 2018.

<sup>3</sup> NCASI Technical Bulletin No. 1013: A Comprehensive Compilation and Review of Wood-Fired Boiler Emissions, Table 4.3: Summary of Trace Metal Emissions from Wood-Fired Boilers

## **Attachment A**

### **2009 Raymond Mill Hog Fuel Boiler Stack Test**



# **The Avogadro Group, LLC**

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## **SOURCE TEST REPORT 2009 TOXICS AIR CONTAMINANTS TESTS WEYERHAEUSER NR RAYMOND MILL RAYMOND, WASHINGTON**

Prepared For:

**Weyerhaeuser NR**  
Federal Way, Washington

For Submittal To:

**Olympic Region Clean Air Agency**  
Olympia, Washington

and

**United States Environmental Protection Agency**  
Region 10: Seattle, Washington

Prepared By:

Shawn Nelezen

**The Avogadro Group, LLC**

2825 Verne Roberts Circle  
Antioch, California 94509  
(925) 680-4300

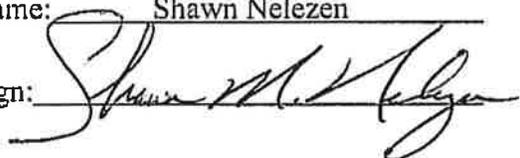
3003 SW 153<sup>rd</sup> Dr., Ste. 215  
Beaverton, Oregon 97006  
(503) 658-2091

October 14, 2009

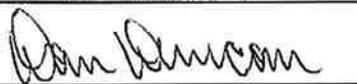


## REVIEW AND CERTIFICATION

All work, calculations, and other activities and tasks performed and documented in this report were carried out by me or under my direction and supervision.

Name: Shawn Nelezen Title: Client Account Manager  
Sign:  Date: October 14, 2009

I have reviewed, technically and editorially, details, calculations, results, conclusions, and other appropriate written materials contained herein. The presented material is authentic and accurate to the best of my knowledge.

Name: Dan Duncan Title: Operations and IT Director  
Sign:  Date: 10/15/09

Initials \_\_\_\_\_

Initials \_\_\_\_\_



## SUMMARY INFORMATION

### Source and Contact Information

Source Location: Weyerhaeuser NR Raymond Sawmill  
51 Ellis Street  
Raymond, Washington 98577

Plant Contact: Sylvia Markham                      Lois Nadolny  
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Regulatory Agency: Olympic Region Clean Air Agency (ORCCA)  
Contacts: Gordon Lance                      Mike Shults  
Addresses: 2940-B Limited Lane NW              301 Ocean Avenue  
Olympia, Washington 98502              Raymond, Washington 98577  
Telephone: (800) 422-5623                      (360) 789-3652

Sampling Location: 115 MMBtu/hr Hog Fueled Boiler (EU1) exhaust stack

Purpose: The purpose of this test program was to determine emissions of Hazardous Air pollutants (HAPs) as required by an EPA Information Collection Request (ICR). Some test results were used to determine compliance with the mill's Title V Permit No. 04AOP387 issued by ORCAA.

Test Methods: EPA 1, 2, 3A, 4, 6C, 7E, 10, 19, 23, 25A/18, 26, 29, OTM-027, OTM-028 and CARB 430

Test Dates: August 11-13, 2009

### Testing Company Information

Testing Firm: The Avogadro Group, LLC  
2825 Verne Roberts Circle  
Antioch, California 94509

Contact: Mr. Shawn Nelezen                      Mr. Kevin Donahoe  
Client Account Manager                      Portland District Manager

Telephone: (925) 680-4397                      (503) 658-2091  
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## SECTION 1.0

### INTRODUCTION

The Avogadro Group, LLC (Avogadro) was contracted by Weyerhaeuser NR (Weyerhaeuser) to perform a series of emission tests at the Raymond Saw Mill in Raymond, Washington. The purpose of the test program was to determine emissions of hazardous air pollutants (HAPs) as required by an Environmental Protection Agency (EPA) Information Collection Request (ICR). Some test results are intended to determine compliance with the mill's Title V Permit No. 04AOP387 issued by the Olympic Region Clean Air Agency (ORCAA).

Avogadro provided the personnel and the necessary test equipment, and subcontracted the laboratory analyses of the samples. The tests were performed during the week of August 10, 2009 by Kevin Donahoe, David Ramirez, and Jacob Byrne of Avogadro. Sylvia Markham and Ken Nichols of Weyerhaeuser coordinated the testing program. Mr. Gordon Lance of ORCAA was present to observe portions of the test program. All of the emissions tests were conducted during normal operating conditions and were performed to determine the following parameters:

- Oxides of nitrogen (NO<sub>x</sub>), carbon monoxide (CO) and sulfur dioxide (SO<sub>2</sub>)
- Dioxins and furans (PCDD/PCDF)
- Total hydrocarbons (THC) and methane (CH<sub>4</sub>)
- Formaldehyde
- Particulate matter:
  - Total particulate matter (TPM)
  - Condensable particulate matter (CPM)
  - Filterable particulate matter:
    - Particulate matter >10µm in diameter
    - Particulate matter <10µm in diameter (PM<sub>10</sub>)
    - Particulate matter <2.5µm in diameter (PM<sub>2.5</sub>)
- Trace select metals (TSM)
- Hydrogen chloride and hydrogen fluoride (HCl/HF)
- Stack gas volumetric flow rate and moisture content
- Oxygen (O<sub>2</sub>) and carbon dioxide (CO<sub>2</sub>)

The final results of the testing program are presented in this report. Supporting data includes descriptions of the scope of work, the sampling and traverse point locations, the testing and analytical procedures, the laboratory reports, the field data sheets, calculations, and quality assurance procedures.



## 1.1 TEST RESULT SUMMARIES

The results of the testing program are summarized in Tables 1-1 through 1-4. Section 6.0 presents detailed results for individual test runs. All supporting data is included in the appendices.

**TABLE 1-1  
 SUMMARY OF AVERAGE TEST RESULTS  
 HOG FUEL BOILER EXHAUST STACK  
 WEYERHAEUSER RAYMOND SAW MILL  
 AUGUST 11-13, 2009**

Test Parameter	Average
<b>Filterable Particulate Matter (F<sub>1/2</sub> PM):</b>	
gr/dscf @ 7% O <sub>2</sub>	0.00062
lb/hr	0.079
<b>Particulate Matter &gt;10 µm (&gt;PM<sub>10</sub>):</b>	
gr/dscf @ 7% O <sub>2</sub>	0.00044
lb/hr	0.059
<b>Particulate Matter &gt;2.5 and &lt;10 µm:</b>	
gr/dscf @ 7% O <sub>2</sub>	0.00021
lb/hr	0.028
<b>Total Particulate Matter &lt;2.5 µm (PM<sub>2.5</sub>):</b>	
gr/dscf @ 7% O <sub>2</sub>	0.00028
lb/hr	0.038
<b>Condensable Particulate Matter (CPM):</b>	
gr/dscf @ 7% O <sub>2</sub>	0.00097
lb/hr	0.132
<b>Hydrogen Chloride (HCl):</b>	
ppm @ 7% O <sub>2</sub> as HCl	< 0.062
g/s	< 1.7E-03
lb/hr	< 5.4E-03
<b>Hydrogen Fluoride (HF):</b>	
ppm @ 7% O <sub>2</sub> as HF	< 0.116
g/s	< 1.7E-03
lb/hr	< 5.6E-03

- (1) The non-detection (ND<) notation indicates the species was not detected in any sample or sample fraction.
- (2) The less than (<) notation indicates a species was detected in at least one (but not all) samples or fractions.
- (3) The PM results presented above are blank-corrected in accordance with CARB Method 5.
- (4) HCl and HF results are not blank-corrected in accordance with EPA Method 26.



**TABLE 1-2**  
**SUMMARY OF AVERAGE TEST RESULTS**  
**HOG FUEL BOILER EXHAUST STACK**  
**WEYERHAEUSER RAYMOND SAW MILL**  
**AUGUST 11-13, 2009**

Test Parameter	Average
<b>Arsenic</b>	
μg/dscm @ 7% O <sub>2</sub>	ND< 0.203
lb/MMBtu	ND< 1.76E-07
<b>Beryllium</b>	
μg/dscm @ 7% O <sub>2</sub>	ND< 0.101
lb/MMBtu	ND< 8.76E-08
<b>Cadmium</b>	
μg/dscm @ 7% O <sub>2</sub>	< 0.139
lb/MMBtu	< 1.21E-07
<b>Cobalt</b>	
μg/dscm @ 7% O <sub>2</sub>	0.119
lb/MMBtu	1.03E-07
<b>Chromium</b>	
μg/dscm @ 7% O <sub>2</sub>	0.774
lb/MMBtu	6.71E-07
<b>Manganese</b>	
μg/dscm @ 7% O <sub>2</sub>	15.24
lb/MMBtu	1.32E-05
<b>Nickel</b>	
μg/dscm @ 7% O <sub>2</sub>	0.815
lb/MMBtu	7.06E-07
<b>Mercury</b>	
μg/dscm @ 7% O <sub>2</sub>	< 2.063
lb/MMBtu	< 1.32E-08
<b>Lead</b>	
μg/dscm @ 7% O <sub>2</sub>	0.234
lb/MMBtu	2.03E-07
<b>Phosphorus</b>	
μg/dscm @ 7% O <sub>2</sub>	26.79
lb/MMBtu	2.32E-05
<b>Antimony</b>	
μg/dscm @ 7% O <sub>2</sub>	ND< 0.203
lb/MMBtu	ND< 1.76E-07
<b>Selenium</b>	
μg/dscm @ 7% O <sub>2</sub>	0.425
lb/MMBtu	3.68E-07



**TABLE 1-3**  
**SUMMARY OF AVERAGE TEST RESULTS**  
**HOG FUEL BOILER EXHAUST STACK**  
**WEYERHAEUSER RAYMOND SAW MILL**  
**AUGUST 11-13, 2009**

<b>Test Parameter</b>	<b>Average</b>
<b>Sulfur Dioxide (SO<sub>2</sub>)</b>	
ppm volume dry	0.33
ppm @ 7% O <sub>2</sub>	0.44
lb/hr	0.07
<b>Oxides of Nitrogen (NO<sub>x</sub>)</b>	
ppm volume dry	97.18
ppm @ 7% O <sub>2</sub>	128.34
lb/hr as NO <sub>2</sub>	15.67
<b>Carbon Monoxide (CO)</b>	
ppm volume dry	148.82
ppm @ 7% O <sub>2</sub>	200.20
lb/hr	14.73
<b>Total Hydrocarbons (THC)</b>	
ppm volume dry as C <sub>3</sub> H <sub>8</sub>	< 1.39
ppm @ 7% O <sub>2</sub> as C <sub>3</sub> H <sub>8</sub>	< 1.84
lb/hr as C <sub>3</sub> H <sub>8</sub>	< 1.65
<b>Methane (CH<sub>4</sub>)</b>	
ppm volume dry	2.08
ppm @ 7% O <sub>2</sub>	2.70
lb/hr	0.116



**TABLE 1-4  
SUMMARY OF AVERAGE TEST RESULTS  
HOG FUEL BOILER EXHAUST STACK  
WEYERHAEUSER RAYMOND SAW MILL  
AUGUST 11-13, 2009**

<b>Test Parameter</b>	<b>Average</b>
<b>Total Dioxins / Furans</b>	
ng/dscm @ 7% O <sub>2</sub>	0.032
ng/dscm @ 12% CO <sub>2</sub>	0.029
lb/hr	2.07E-09
<b>Dioxins / Furans –EPA Toxic Equivalent</b>	
ng/second	1.98E-03
<b>Formaldehyde</b>	
ppm volume dry	0.055
ppm @ 7% O <sub>2</sub>	0.072
lb/hr	5.76E-03

## 1.2 TESTING CONTRACTOR

Avogadro is a source testing and consulting firm specializing in combustion-generated air pollution emissions, emission measurement, emission control devices, continuous emission monitoring systems and regulatory affairs. Avogadro possesses technical expertise for a variety of stationary combustion and industrial process device types. These include utility and industrial boilers, simple and combined-cycle turbines, asphalt plants, cement kilns, flares, incinerators, oxidizers, drying ovens, and a variety of other specialized process equipment. Avogadro is certified by the California Air Resources Board (CARB) under their Independent Contractor program to conduct emission testing pursuant to Section 91200-21220, Title 17, California Code of Regulations.

Avogadro provided a professional source test team to conduct the testing as described in this report. The test team members assigned to this project have performed hundreds of similar tests in the past and are familiar with the specific testing methods and laboratory procedures used in this program. The Avogadro personnel who participated in this project are listed in Table 1-5.



**TABLE 1-5  
AVOGADRO TEST PROGRAM PERSONNEL  
WEYERHAEUSER RAYMOND SAW MILL**

<b>PERSONNEL</b>	<b>TITLE</b>	<b>ASSIGNMENT</b>	<b>EXPERIENCE</b>
Kevin Crosby	Scientist IV	QA Officer	32 years
Dan Duncan	Engineer IV	Chemical Engineer	22 years
Shawn Nelezen	Scientist III	Principal in Charge	11 years
Kevin Donahoe	Scientist II	Project Manager	6 years
Robert Odell	Technician III	Field Support	4 years

Mr. Shawn Nelezen was Principal in Charge for the test program at Weyerhaeuser. Shawn's responsibilities included overseeing the execution and planning of all air sampling efforts including reporting and project coordination. Shawn's primary objective was to ensure that the results generated by this test program met the expectations and requirements of Weyerhaeuser and the regulatory agencies.

Mr. Kevin Crosby was the Quality Assurance Officer for the project. He reviewed and validated all test results, lab analyses, and the final report. Kevin has managed or conducted hundreds of toxics tests over his career. A summary of our standard QA / QC program is presented Section 6.0 and in Appendix B.

Mr. Dan Duncan was the Chemical Engineer for this project. Dan's responsibilities included glassware cleaning and preparation, laboratory supply ordering and coordination with the subcontract laboratories. He assumed sample custody and ensured that the proper paperwork and samples reached the subcontract laboratories, ensured that the samples were analyzed according to the test report, and ensured that both the field and laboratory efforts comply with EPA approved procedures.

### **1.3 PROGRAM CONTACTS**

The contact persons for the various entities involved in the testing project are:

- Avogadro Group, LLC: Shawn Nelezen Principal in Charge (925) 680-4397 Kevin Donahoe Project Manager (503) 658-2091
- Weyerhaeuser: Ms. Sylvia Markham Environmental Coordinator (360) 942-6305
- ORCAA / EPA: Gordon Lance Engineer II (800) 422-5623 James Eddinger Engineer (919) 541-5426



## SECTION 2.0

### FACILITY INFORMATION

#### 2.1 PROCESS DESCRIPTION

Weyerhaeuser maintains offices or operations in 13 countries and manages 22 million acres of timberland. The Weyerhaeuser Raymond sawmill is located at 51 Ellis St. in Raymond, Washington. At the site, Weyerhaeuser operates a high-speed planer mill and dries and finishes softwood for use in home and commercial construction in the Midwest and Puget Sound. Much of the residuals from the debarking process and sawmill are conveyed to a Wellons boiler for fuel.

#### 2.2 SAMPLING LOCATION

The Hog Fuel Boiler emissions exhaust through a vertical duct 64 inches in diameter. The stack has two 4-inch diameter sampling ports located on the same horizontal plane. A third sampling port is located about two feet below and between the test ports. The ports are located approximately 2 stack diameters upstream and 2.5 stack diameters downstream from the nearest flow disturbances. A total of twenty-four traverse points were used during each isokinetic test run. All tests were performed downstream of the control equipment, an electrostatic precipitator (ESP). The test ports were accessible from a platform reached by stairs.

Avogadro personnel measured the dimensions of the stack prior to testing. A diagram of the sampling ports is included in the appendix of this report along with the traverse point locations.



## SECTION 3.0

### TEST PROGRAM DESCRIPTION

#### 3.1 PROGRAM OBJECTIVES

On September 13, 2004, the United States Environmental Protection Agency (EPA) promulgated the National Emission Standards for Hazardous Air Pollutants (NESHAPS) for Industrial, Commercial and Institutional Boilers also called the "Boiler MACT." These rules, which are referred to as the Maximum Achievable Control Technology Standards, established emission limits and monitoring requirements for sources considered major under the NESHAP regulations. Major sources are those that emit or have the potential to emit at least 10 tons per year of any single hazardous air pollutant (HAP) or 25 tons per year of any combination of HAPs. Also included are standards for plants that are classified as area sources. Area sources are stationary sources of HAPs that are not major. The Boiler MACT was vacated by the courts on June 8, 2007.

To address the vacated Boiler MACT, EPA made an Information Collection Request (ICR) to the Office of Management and Budget. The objective was to collect available data on boiler process and heater design, operations, fuels, control devices and emissions data. EPA found that fuel and material type, combustor design, and emission control device impact hazardous air pollutants (HAP) emissions.

The purpose of this test program was to assist EPA in completing data gaps in fuel type and combustor design regarding the ICR study. This test program included measurements of the emissions of toxic air contaminants as outlined in this protocol. Some of the tests were performed to determine compliance with Weyerhaeuser Raymond's Title V Permit No. 04AOP387 issued by the ORCAA.

#### 3.2 TEST CONDITIONS

The tests were conducted while the boiler was operating under normal conditions, as required by the EPA. The emission limitations are referenced in Table 3-1.



**TABLE 3-1  
 PERMITTED EMISSION LIMITATIONS  
 2009 EMISSIONS TEST PROGRAM  
 WEYERHAEUSER RAYMOND MILL**

Pollutants	Permit Reference	Emission Limits
<b>Oxides of Nitrogen (NO<sub>x</sub>)</b> concentration, ppm @ 7% O <sub>2</sub>	Table 5-1, Condition 5.1K	175
<b>Carbon Monoxide (CO)</b> concentration, ppm @ 7% O <sub>2</sub>	Table 5-1, Condition 5.1L	300
<b>Sulfur Dioxide (SO<sub>2</sub>)</b> concentration, ppm @ 7% O <sub>2</sub>	Table 5-1, Condition 5.1A	1,000
<b>Visible Emissions</b> percent, 3-min. aggregate in 60 min.	Testing conditions 19, 20	20
<b>Particulate Matter (PM)</b> concentration, gr/dscf @ 7% O <sub>2</sub>	Table 5-1, Conditions 5.C-D	0.20
mass emissions, lb/MMBtu	Table 5-1, Condition 5.1H	0.10

### 3.3 TEST CALCULATIONS

The test run durations for the toxic air contaminants were selected based on the requirements of a test notification letter and attachments dated June 1, 2009 from Peter Tsirigotis, Director of EPA Sector Policies and Programs Division. General calculations are included in Appendix F.

### 3.4 LABORATORY ANALYSIS

Avogadro's in-house laboratory conducted the front and back-half gravimetric analysis on the PM samples and methane analysis. Three professional analytical laboratories provided services for this project. The laboratories chosen are established leaders in development and performance of the reference methods for which they performed analyses. These laboratories are listed below along with the species they analyzed:

- Vista Analytical Laboratory                      PCDD/PCDF
- Test America    Trace metals, HCl/HF
- Atmospheric Analysis & Consulting              Formaldehyde



### 3.5 TEST PROGRAM SCHEDULE

The testing program was completed in four days. The first day consisted of travel and equipment set-up. Emission tests were conducted on the subsequent three days. The test program schedule is presented in Table 3-2.

**TABLE 3-2  
 TEST PROGRAM SCHEDULE  
 WEYERHAEUSER RAYMOND SAWMILL**

DATE	ACTIVITY	SAMPLE RUNS	SAMPLING DURATION
Monday August 10, 2009	Travel	--	--
	Set-up equipment	--	--
<u>Emissions Tests</u>			
Tuesday August 11, 2009	O <sub>2</sub> , CO <sub>2</sub>	1, 2 of 3	240 minutes
	Trace metals w/filterable PM	1, 2 of 3	240 minutes
	HCl and HF	1, 2 of 3	240 minutes
	PM	1, 2 of 3	240 minutes
<u>Emissions Tests</u>			
Wednesday August 12, 2009	O <sub>2</sub> , CO <sub>2</sub>	3 of 3	240 minutes
	Trace metals w/filterable PM	3 of 3	240 minutes
	HCl and HF	3 of 3	240 minutes
	PM	3 of 3	240 minutes
	O <sub>2</sub> , CO <sub>2</sub> , CO, NO <sub>x</sub> , SO <sub>2</sub>	1 of 3	240 minutes
	THC, CH <sub>4</sub>	1 of 3	240 minutes
	Formaldehyde	1 of 3	240 minutes
	PCDD/PCDF	1 of 3	240 minutes
<u>Emissions Tests</u>			
Thursday August 13, 2009	O <sub>2</sub> , CO <sub>2</sub> , CO, NO <sub>x</sub> , SO <sub>2</sub>	2, 3 of 3	240 minutes
	THC, CH <sub>4</sub>	2, 3 of 3	240 minutes
	Formaldehyde	2, 3 of 3	240 minutes
	PCDD/PCDF	2, 3 of 3	240 minutes



## SECTION 4.0

### TEST PROCEDURES

Avogadro used a mobile laboratory on site for the purposes of this testing program. The mobile lab was equipped with a flammable liquid storage cabinet and a sample storage refrigerator, as well as the CEM system. There was sufficient room to work in the mobile lab with spacious counter tops for sample recovery, calculation of results and completion of the sample chain of custody forms. Samples were stored and refrigerated in a designated locked area under strict chain of custody guidelines.

#### 4.1 PRIMARY EMISSIONS TESTS

The test procedures used by Avogadro in this testing program are summarized in Table 4-1 on the following page. Descriptions of standard procedures are included in Appendix A. Additional information on specific applications or modifications to standard procedures is presented in the following sub-sections. Where any conflicts exist in the descriptions, the specific descriptions here in Section 4.1 will take precedence.



**TABLE 4-1  
 TEST METHODS AND PROCEDURES  
 2009 EMISSIONS TEST PROGRAM  
 WEYERHAEUSER RAYMOND SAW MILL**

TEST PARAMETER	REFERENCE METHOD	ANALYTICAL APPROACH	DETECTION LIMIT
O <sub>2</sub>	EPA 3A	Paramagnetism	<2% of full scale
CO <sub>2</sub>	EPA 3A	Non-dispersive infrared	<2% of full scale
NO <sub>x</sub>	EPA 7E	Chemiluminescence	<2% of full scale
SO <sub>2</sub>	EPA 6C	Ultraviolet absorption	<2% of full scale
CO	EPA 10	Gas filter correlation	<2% of full scale
Volumetric flow rate	EPA 1, 2	Pitot traverse	--
	EPA 19	Stoichiometric calculation	--
Moisture content	EPA 4	Impinger weight gain	--
THC	EPA 25A	Flame ionization detection	<2% of full scale
CH <sub>4</sub>	EPA 18	Gas chromatograph	0.1 ppm
Formaldehyde	CARB 430	HPLC	~0.5 ug/ m <sup>3</sup>
PCDD/PCDF <sup>1</sup>	EPA 23	HRGC/HRMS	.05-3.0 pg/m <sup>3</sup>
Visible emissions	EPA 9	Visual observation	5%
Filterable PM	EPA 29	Gravimetry	0.0002 gr/dscf
PM <sub>10</sub> , PM <sub>2.5</sub>	EPA OTM-27	Cyclone separation	0.0002 gr/dscf
Condensable PM	EPA OTM-28	Gravimetry	0.0002 gr/dscf
Mercury	EPA 29	CVAA	0.5-1.0 ug/ m <sup>3</sup>
Trace metals <sup>2</sup>	EPA 29	ICP/MS	0.1-1.0 ug/m <sup>3</sup>
HCl, HF	EPA 26A	Ion chromatography	0.5 ppm

<sup>1</sup> Tetra - through octa - chlorinated dibenzodioxin and dibenzofuran homologue totals and individual 2,3,7,8-chlorinated dibenzodioxin and dibenzofuran congeners.

<sup>2</sup> Metals samples were analyzed for antimony (Sb), arsenic (As), beryllium (Be), cadmium (Cd), chromium (Cr), cobalt (Co), lead (Pb), manganese (Mn), nickel (Ni), phosphorous (P), selenium (Se) and mercury (Hg).

**4.1.1 Gaseous Emissions**

**Method:** EPA 6C, 7E and 10, Amended August 2006

**Deviations:** None



Triplicate 240-minute gaseous emission (CO, NO<sub>x</sub> and SO<sub>2</sub>) test runs were performed at the hog fuel boiler exhaust stack. Concentrations were measured using Avogadro's dry extractive continuous emissions monitor system (CEMS) described in Appendix A. This system meets the requirements of EPA methods for gaseous species. A heated Teflon line and chilled knockout system were used to prevent loss of SO<sub>2</sub> and/or NO<sub>2</sub> in the sampling system. The NO<sub>x</sub> analyzer was operated in the NO<sub>x</sub> mode to measure NO plus NO<sub>2</sub>. A molybdenum catalyst converter was used to convert NO<sub>2</sub> to NO for measurement of total NO<sub>x</sub>.

The sample conditioning and delivery system includes components to extract a representative sample from the source, remove the moisture and particulate matter from the sample stream, and transport the sample to the analyzers. The primary components of this subsystem are:

- 1) A quartz, titanium, stainless steel or glass probe - heated or insulated as necessary to avoid condensation,
- 2) Sample filtration – filters located on the probe, pump, and prior to all of the analyzers for removal of particulate matter,
- 3) Teflon tubing - connecting the probe to the sample conditioner and the sample conditioner to the analyzer manifold - heated or insulated as necessary to avoid condensation,
- 4) Sample conditioner - glass or stainless steel flasks immersed in an ice bath to remove the moisture from the sample gas stream,
- 5) Vacuum pump - a leak-free pump with Teflon diaphragm to transport the sample gas through the system,
- 6) Sample manifold - a distribution system, constructed of stainless steel and Teflon tubing, to direct sample gas to the analyzers, and
- 7) Sample flow rate control - a series of rotameters, vacuum gauges and pressure gauges connected to the manifold used to maintain the appropriate sample flow rates.

The calibration gas system utilizes only EPA Protocol gases to verify the operation, linearity, and range settings of the electronic analyzers. The sample gas system allows for the introduction of the protocol gases to the analyzers either directly through the manifold (calibration error check - performed once daily) or through the sampling system (system bias check - performed with each run).

The electronic analyzers are rack mounted and are maintained in the mobile lab. The data recording and acquisition system is based on a digital system known as STRATA. It includes software for controlling the collection of calibration and emission monitoring data, and hardware for connection of the analyzer outputs to the recording system. Test results can be provided in three forms: on-site printouts of the digitized data, diskette recordings of the digitized data, and if printouts of strip charts from the monitoring data.



For this program, on-site print outs of the one-minute average monitoring data are included.

#### 4.1.2 Dioxins and Furans

**Method:** EPA 23  
**Deviations:** None

Tester: The Avogadro Group, LLC  
Contact: Shawn Nelezen (925) 680-4397, fax (925) 680-4416  
Lab: Vista Analytical Laboratory, El Dorado Hills, California  
Contact: Martha Maier (916) 933-1640, fax (916) 933-0940  
Analysis: High-resolution capillary column gas chromatography with high-resolution mass spectrometry (HRGC/HRMS).

*Test Description:* Measurements of the emissions of polychlorinated dibenzo-dioxins (PCDD) and furans (PCDF) were performed according to the procedures of EPA Method 23. The target analytes for PCDD/PCDF were tetra- through octa-chlorinated dibenzo-dioxin and dibenzo-furan homologue totals and individual 2, 3, 7, 8-chlorinated dibenzo-dioxin and dibenzo-furan isomers.

The tests were performed from the stack serving the hog fuel boiler. Triplicate test runs were 240 minutes in duration and the sampling were performed isokinetically with a multi-point traverse of the sampling plane. The total sample volume for each run was approximately 133 dscf.

One field blank was prepared, recovered and analyzed according to the method. Reagent blanks were also collected and retained at the Avogadro laboratory.

*Pre-test Cleaning Procedure:* All glassware and Teflon sampling apparatus exposed to the sample (this includes the probe nozzle, probe liner, filter assembly, Teflon connecting tube, condenser, resin cartridge and impingers) were cleaned prior to use per the following procedures:

- a. Soak in a hot solution of Liquinox detergent and water;
- b. Following soaking, rinse six times with hot tap water;
- c. Next, soak in chromic acid cleaning solution for at least four hours;
- d. Next, rinse with deionized water;
- e. Next, rinse with acetone, methylene chloride and toluene;
- f. Next, dry in a 200 °F oven;
- g. Last, seal with hexane rinsed foil.

All the cleaned glassware and Teflon parts were sealed in hexane-rinsed aluminum foil. Sampling reagents included pre-cleaned glass fiber filters and resin cartridges charged



with pre-cleaned Amberlite XAD-2 resin. The filters and resin cartridges were pre-cleaned and screened for contamination by Vista Analytical Laboratory. Pesticide-grade (Fisher Scientific *Optima* grade or equivalent) acetone, methylene chloride and toluene reagents were used as sample recovery solvents.

Sample Train Operation: Pretest preparations, preliminary determinations, and leak check procedures are those outlined in EPA Method 5 and 23. Borosilicate glass probe liners and nozzles were used to avoid possible contamination and sealing greases were not used on the sample train.

This train was operated in the same manner as a regular EPA Method 5 sampling train. The sampling apparatus included a heated glass probe equipped with an S-type pitot tube and thermocouple. The probe was attached to an oven containing a heated filter holder, Teflon frit and toluene-rinsed glass-fiber filter. Both the probe exit temperature and oven were maintained at  $248^{\circ}\text{F} \pm 25^{\circ}\text{F}$  during sampling. The filter holder was connected by a length of new heated Teflon tubing to a condenser coil and XAD-2 sorbent trap. The temperature of the gas entering the sorbent trap was maintained below  $68^{\circ}\text{F}$  at all times. The trap was connected directly to the impinger train containing five chilled impingers in series. The impinger train was connected to the control box containing the sampling pump and calibrated dry gas meter.

The first impinger, of the short stem design, was empty. The second and third impingers contained 100 ml of organic free water each, the fourth was empty, and the fifth impinger contained silica gel.

The entire sample train was leak tested once prior to sampling and once following testing. The pre-test leak check was performed at a nominal vacuum to ensure that leakage did not exceed 0.02 cfm. The post-test leak check were performed at a vacuum greater than the highest vacuum recorded during the test to ensure that leakage did not exceed the lesser of a) 4 percent of the average sampling rate, or b) 0.02 cfm. The sampling rate and nozzle size were chosen to allow isokinetic sampling at  $100\% \pm 10\%$ .

Sample Recovery: Avogadro collected and recovered the samples, protected them from contamination, and delivered them to the laboratory for analysis within the method's hold time. All exposed glassware openings in the sampling train were covered with hexane-rinsed foil, to avoid possible contamination, immediately following the final leak check. All QA/QC and chain of custody procedures were followed in strict accordance with the test method.

All sample fractions, except the resin cartridges, were collected in solvent-rinsed amber glass jars with Teflon-lined lids. The liquid levels (when applicable) were marked on each sample container. The contents of the impingers were weighed and recorded prior to recovery



The filter was collected into Container 1a. The XAD sorbent trap was capped off and sealed in a plastic baggie labeled Container 1b. The nozzle, probe and front-half of the filter holder, back half of the filter holder, connecting Teflon line and condenser were rinsed into Container 2 using measured volumes of acetone and methylene chloride (three times each for five minutes in that order). Then the equipment was rinsed with toluene three times (five minutes each) into Container 3 using the same procedure. The silica gel impinger contents were weighed for moisture catch determination only.

All of the samples were protected from light and kept below 4 °C at all times. The samples were delivered in ice chests packed with blue ice to the lab for analysis. The chain of custody and sample login were documented on suitable forms.

*Sample Analysis:* Analyses for dioxin and furans was performed by Vista Analytical Laboratory. The XAD resin trap, filter and rinses were analyzed according to EPA Method 23. The analytical method includes the addition of internal standards in known quantities, matrix-specific extraction of the sample, preliminary fractionating and cleanup of extracts (if necessary) and analysis of the processed extract. The analyses were conducted using high-resolution capillary column gas chromatography coupled with high-resolution mass spectrometry (HRGC/HRMS).

*Reporting:* The results were presented in terms of non-blank-corrected concentrations and mass emission rates. The non-detected species were calculated using either zero as stipulated in the method. Results were reported in units of concentration (pg/dscm or ng/dscm and ng/dscm @ 7% O<sub>2</sub>) and mass emissions (lb/hr).

#### **4.1.3 Total Hydrocarbons and Methane**

**Method:** EPA 25A and 18

**Deviations:** No pre-survey Method 18 samples were collected

Concentrations of total hydrocarbons (THC) were measured using EPA Method 25A. The test runs were 240 minutes in duration and were performed concurrently with the CO, NO<sub>x</sub> SO<sub>2</sub>, PCDD/PCDF and formaldehyde test runs. A flame ionization detector (FID) analyzer was used for measurement of the concentrations as described in the method. The sampling apparatus included a stainless steel probe, filter and heated Teflon line connected to the inlet port of the analyzer. The analyzer uses an internal sampling pump and a heated oven/analysis section that keeps the sample gas at a minimum of 180 degrees Celsius (356 °F). The heated line was maintained at a minimum of 135 degrees Celsius (275 °F) during the test program.

The FID analyzer was calibrated with three different concentrations of EPA Protocol gases that contained mixtures of propane in air. Results were calculated and presented as propane.



Concentrations of methane (CH<sub>4</sub>) were measured using EPA Method 18. Methane concentrations were measured by gas chromatographic analysis of sample gas collected into Tedlar bags. The method is a modification of EPA Method 18, as no pre-survey samples were collected. Three Tedlar bags were filled with sample gas using a quartz probe, new Teflon tubing, and a rigid displacement container. The samples were collected over the course of the test run from a single average traverse point. The bags were shipped to the Avogadro laboratory in Antioch, California for GC / FID analysis of C<sub>1</sub>.

#### 4.1.4 Formaldehyde

**Method:** CARB 430, Second Edition, Proposed December 13, 1991

**Deviations:** Toluene was added to the impingers prior to sampling

Tester: The Avogadro Group, LLC  
Contact: Shawn Nelezen (925) 680-4397, fax (925) 680-4416  
Lab: Atmospheric Analysis & Consulting, Inc.  
Analysis: High-pressure liquid chromatography (HPLC).  
Contact: Dr. Sucha Parmar, (805) 650-1642, fax (805) 650-1644

*Test Description:* Measurements of the emissions of formaldehyde were performed according to the procedures of CARB Method 430. The target analyte for this program was formaldehyde.

The tests were performed at the exhaust stack serving the hog fuel boiler. Triplicate test runs were 240 minutes in duration and collect approximately 90 liters of gas. The sampling was performed non-isokinetically at a single representative point on the sampling plane.

*Pre-test Cleaning Procedure:* All glassware and Teflon sampling apparatus being exposed to the sample were pre-cleaned using the following procedure according to the method:

- a Soak in a hot solution of Liquinox detergent and water;
- b Following soaking, rinse six times with hot tap water;
- c Next, rinse three times with DI water;
- d Next, rinse with methylene chloride and allow to air dry;
- e Finally, seal all pieces with parafilm.

*Sample Train Operation:* Pretest preparations, preliminary determinations, and leak check procedures were performed as outlined in CARB Method 430. Borosilicate glass and Teflon were used throughout the sampling train to avoid possible contamination and sealing greases were not used on the sample train. Testing occurred within 48 hours after the reagent blank analysis by the laboratory.



Gaseous emissions were collected through a quartz probe and a 1/8" o.d. Teflon sample line to three midget impingers in series. A pump and calibrated orifice was used to draw the sample through the impingers at a flow rate of 0.39 liters per minute. Each impinger contained 10 ml of an aqueous acidic solution of 2,4-dinitrophenyl-hydrazine (DNPH). To ensure that the organic extractions started immediately, 5 milliliters of toluene was added to the impingers prior to sampling. The entire sample train was leak tested once prior to sampling and once following testing per the method.

Sample Recovery: The sample line was rinsed into the first impinger with 2 ml of DNPH followed by 1 ml of organic free water. The impingers were recovered in the same manner. Avogadro collected and recovered the samples into their original glass vials. Field blanks were collected during every test run according to the method. A trip blank and field spike were also analyzed. Reagent blanks were collected and retained. After collection, the samples were transported to the AAC for analysis within the method's hold-time. The samples were protected from light and kept below 4 °C at all times. All QA/QC and chain of custody procedures were followed in strict accordance with the test method.

Sample Analysis: The DNPH sampling solution were prepared and analyzed by Atmospheric Analysis & Consulting, Inc. Sample analysis included high-performance liquid chromatography (HPLC) in strict accordance with the method. The analysis occurred within the method hold time. The laboratory QA/QC procedures outlined in the method were adhered to.

Reporting: The results are presented in terms of non-corrected concentrations as required by the EPA ICR. The reporting method is a modification of the test method. Results are also reported in comparison to the reporting limit as calculated using CARB Method 430. Results are reported in units of concentration (ug/dscm, ppm and ppm @ 7% O<sub>2</sub>) and mass emissions (lb/hr). Complete documentation of the calculations are provided in this report.

#### 4.1.5 Particulate Matter

**Methods:** EPA Methods OTM-027 and OTM-028, both of April 15, 2009

**Deviations:** None

Tester: The Avogadro Group, LLC  
Contact: Shawn Nelezen (925) 680-4397, fax (925) 680-4416  
Lab: Avogadro analytical laboratory, Antioch, California  
Analysis: Gravimetry  
Contact: Mr. Dan Duncan, (925) 680-4300, fax (925) 680-4416



The emissions of particulate matter less than 2.5 microns in diameter ( $PM_{2.5}$ ), particulate matter greater than 2.5 microns and less than 10.0 microns in diameter ( $PM_{2.5-10}$ ), particulate matter greater than 10.0 microns in diameter ( $PM_{10}$ ) and condensable particulate matter (CPM) were measured using the procedures and equipment specified in EPA Other Test Methods 027 and 028. The methods consist of the sampling and analytical methodology necessary to quantify  $PM_{2.5}$ ,  $PM_{2.5-10}$ ,  $PM_{10}$  and CPM from stationary sources. All quality assurance procedures detailed in the methods were followed. Triplicate test runs were 240 minutes in duration and the sampling was performed isokinetically with a multi-point traverse of the sampling plane.

The sampling apparatus included two in stack cyclone assemblies attached to a probe equipped with an S-type pitot tube and thermocouple. The probe was attached to a length of new Teflon tubing to the OTM-028 impinger train (see below). The impinger train was connected to the control box that houses the sampling pump and calibrated dry gas meter.

The OTM-028 test train consisted of four impingers connected in series. The first and second impingers were empty, a Teflon filter was placed between the second and third impingers and maintained below 85° F. The third impinger contained 100 ml of deionized (DI) water, and the fourth contained silica gel. All of the impinger tare weights were recorded prior to sampling. All glassware and other components coming in contact with the sample were pre-cleaned using hot water and detergent, tap water, methylene chloride and DI water, in that order. The glassware was also placed in an oven set to 300 °C for at least 6 hours.

The entire sample train was leak tested once prior to sampling and once following testing. Note: the post test leak check was performed just downstream of the cyclone assemblages. The pre-test leak check was performed at a vacuum of at least 15" to ensure that leakage does not exceed 0.02 cfm. The post-test leak checks were performed at a vacuum greater than the highest vacuum recorded during the test to ensure that leakage does not exceed the lesser of a) 4 percent of the average sampling rate, or b) 0.02 cfm. The constant sampling rate and nozzle size were chosen to allow isokinetic sampling at 100% ±20%.

The  $PM_{2.5}$ ,  $PM_{2.5-10}$  and  $PM_{2.10}$  were recovered from the cyclone assemblies as described in OTM-027. The sample fractions include a filter and multiple acetone rinses of the cyclone assemblages. All acetone fractions were stored in glass sample containers and the liquid level were marked. The filter was placed back into its original petri dish and sealed.

The "back-half" condensable contents were also recovered and analyzed according to OTM-028. The entire sampling system was purged with nitrogen at 20 liters per minute for one hour immediately at the end of each test run. The contents of the impingers were weighed, recorded and placed into a separate glass sample container which included the water rinses of the impingers, sample line, probe and the back-half filter holder.



Additional methylene chloride rinses were collected. The liquid level was marked on the sample containers. The silica gel was also weighed and recorded.

Analyses were performed by Avogadro. The OTM-027 samples were analyzed gravimetrically to determine the concentration of PM<sub>2.5</sub>, PM<sub>2.5-10</sub>, PM<sub>10</sub> and particulate matter in both cyclone rinses. Each back-half sample was extracted with dichloromethane in a separatory funnel. The analysis includes gravimetric measurement of the residue from the aqueous and organic fractions. The corrected results were used to determine the concentration of condensable particulate matter.

**Filterable Particulate Matter by EPA Method 29** - The emissions of filterable “front half” particulate matter (F<sup>1/2</sup> PM) were measured using the procedures and equipment specified in EPA Method 29, Sections 8.3.1.1 and 8.3.2. Please see the sample recovery procedure of Section 4.1.7 below for more information.

#### 4.1.6 Selected Trace Metals

**Method:** EPA 29

**Deviations:** None

Tester: The Avogadro Group, LLC  
Contact: Shawn Nelezen (925) 680-4397, fax (925) 680-4416  
Lab: Test America, West Sacramento, California  
Contact: Robert Weidenfeld (800) 753-4225, fax (510) 486-0532  
Analysis: Inductively coupled plasma mass spectrometry (ICP-MS) & Cold vapor atomic absorption spectroscopy (CVAAS)

Test Description: Select trace metals were measured at hog fuel boiler exhaust stack using EPA Method 29. Triplicate test runs were 240 minutes in duration and the sampling was performed isokinetically with a multi-point traverse of the sampling plane. The total sample volume for each run were approximately 132 dscf. The samples were analyzed for 11 different metals including: arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, mercury, nickel, selenium, phosphorus.

One field blank was prepared, recovered and analyzed according to the method. Reagent blanks were also collected; however, the samples were not analyzed because no field blank anomalies were reported.

Pre-test Cleaning Procedure: All glassware and Teflon sampling apparatus exposed to the sample were pre-cleaned using the following procedure according to the method:

- a. Soak in a hot solution of Liquinox detergent and water;
- b. Following soaking, rinse six times with hot tap water;
- c. Next, soak in 10% nitric acid for at least four hours;



- d. Next, rinse three times with Type II DI water;
- e. Next, rinse with acetone and allow to air dry;
- f. Finally, seal all pieces with parafilm.

Sample Train Operation: Pretest preparations, preliminary determinations, and leak check procedures were those outlined in EPA Method 5 and EPA 29. Borosilicate glass probe liners and nozzles were used to avoid possible contamination and sealing greases were not used on the sample train.

The sampling train was operated in the same manner as a regular EPA Method 5 sampling train. The sampling apparatus included a heated glass probe equipped with an S-type pitot tube and thermocouple. The probe was attached to an oven containing a heated filter holder, Teflon frit and Pallflex 2500QAT-UP quartz-fiber filter. Both the probe exit temperature and oven were maintained at  $248^{\circ}\text{F} \pm 25^{\circ}\text{F}$  during sampling. The filter holder was connected by a length of new Teflon tubing to the impinger train containing seven chilled impingers in series. The impinger train was connected to the control box containing the sampling pump and calibrated dry gas meter.

The reagents used in the impinger trains were prepared fresh daily. The optional empty first impinger was used to prevent dilution of the impinger reagents. The second and third impingers each contained 100 ml of 5%  $\text{HNO}_3$ /10%  $\text{H}_2\text{O}_2$ , the fourth was empty, the fifth and sixth impingers contained 100 ml of 4%  $\text{KMnO}_4$ /10%  $\text{H}_2\text{SO}_4$  and the seventh impinger contained silica gel. All of the impinger tare weights were recorded prior to sampling.

The entire sample train was leak tested once prior to sampling and once following testing. The pre-test leak check was performed at a nominal vacuum to ensure that leakage did not exceed 0.02 cfm. The post-test leak check was performed at a vacuum greater than the highest vacuum recorded during the test to ensure that leakage did not exceed the lesser of a) 4 percent of the average sampling rate, or b) 0.02 cfm. The sampling rate and nozzle size were chosen to allow isokinetic sampling at  $100\% \pm 10\%$ .

Sample Recovery: Avogadro collected and recovered the samples, protected them from contamination, and delivered them to the laboratory for analysis. All sample containers were of the amber glass variety incorporating Teflon leak-proof caps and were pre-cleaned with 5% nitric acid. All containers were then rinsed three times with 0.1  $\text{HNO}_3$ . The contents of the impingers were weighed and recorded prior to recovery. The liquid level was marked on each sample container. All exposed glassware openings in the sampling train were covered with parafilm to avoid possible contamination.

The filter was collected into Container 1. The nozzle, probe and front-half of the filter holder were rinsed into Container 2 using a measured volume of acetone. The nozzle, probe and front-half of the filter holder were then be rinsed into Container 3 with a measured volume of 0.1N  $\text{HNO}_3$ . The contents of the first three impingers were poured into Container 4 along with measured rinse volumes of 0.1N  $\text{HNO}_3$  from the impingers,



sample line and back half of the filter holder. The pH of the solution was checked. The contents of the fourth (empty) impinger was poured into Container 5A. The impinger was rinsed with a measured volume of 0.1 HNO<sub>3</sub> and poured into the same container. The pH of the solution was again verified to be less than 2. The contents of the fifth and sixth impingers were poured into Container 5B followed by measured volumes of rinses with both 4% KMnO<sub>4</sub>/10% H<sub>2</sub>SO<sub>4</sub> and DI water in that order. Finally, these impingers were rinsed into Container 5C using exactly 25 ml of 8N HCl. The silica gel impinger contents were weighed for moisture catch determination only.

After collection, the samples were transported to the laboratory for analysis within the method's hold-time. The samples were protected from light and kept below 4 °C at all times. All QA/QC and chain of custody procedures were followed in strict accordance with the test method.

*Sample Analysis:* The analyses were performed by Test America in West Sacramento, California. Sample analysis procedures were performed in strict accordance with the method including the use of microwave digestion and proportional compositing of the front half, filter, and back half sample fractions (impingers 1-3) for a single analysis of trace metals. The potassium permanganate impinger fraction and the hydrochloric acid rinse fractions were analyzed separately for mercury. Analysis techniques include the use of inductively coupled plasma mass spectroscopy (ICP-MS) and cold vapor atomic absorption spectroscopy (CVAAS). Spiked quality control samples, matrix spikes, serial dilution, and duplicate analyses will all be used to establish the quality of the data. Duplicate analyses were performed on 10% of all samples.

*Reporting:* The results were presented in terms of non-blank-corrected concentrations and emission rates. Results were reported in units of concentration (ug/dscm) and mass emissions (lb/hr and lb/MMBtu). Complete documentation of the calculations are provided in this report.

#### **4.1.7 Hydrogen Chloride and Hydrogen Fluoride**

**Method:** EPA 26

**Deviations:** Substitute large impingers for mini-impingers

Tester: The Avogadro Group, LLC  
Contact: Shawn Nelezen (925) 680-4397, fax (925) 680-4416  
Lab: Test America, West Sacramento, California  
Contact: Robert Weidenfeld (800) 753-4225, fax (510) 486-0532  
Analysis: Ion chromatography with conductivity detection

*Test Description:* Hydrogen chloride (HCl) and hydrogen fluoride (HF) were measured from the hog fuel boiler exhaust stack using EPA Method 26 modified. Triplicate test runs were 240 minutes in duration and the sampling were performed non-isokinetically



with a multi-point traverse of the sampling plane. The total sample volume for each run was greater than 100 dscf.

One field blank were prepared, recovered and analyzed according to the method. Reagent blanks were also collected and retained.

Pre-test Cleaning Procedure: All glassware and Teflon sampling apparatus exposed to the sample were pre-cleaned using the following procedure per the method:

- a. Soak in a hot solution of Liquinox detergent and water;
- b. Following soaking, rinse six times with hot tap water;
- c. Next, rinse three times with Type II DI water;
- d. Next, allow to air dry;
- e. Finally, seal all pieces with parafilm.

Sample Train Operation: Pretest preparations, preliminary determinations, and leak check procedures were those outlined in EPA Methods 5 and 26. Borosilicate glass probe liners were used to avoid possible contamination and sealing greases were not used on the sample train.

This train was operated in the same manner as a regular EPA Method 5 sampling train. The sampling apparatus will include a heated glass probe equipped with an S-type pitot tube and thermocouple. The probe was attached to an oven containing a heated filter holder, Teflon frit and Pallflex 2500QAT-UP quartz-fiber filter. Both the probe exit temperature and oven were maintained at  $248^{\circ}\text{F} \pm 25^{\circ}\text{F}$  during sampling. The filter holder was connected by a length of Teflon tubing to the impinger train containing four chilled impingers in series. The impinger train was connected to the control box containing the sampling pump and calibrated dry gas meter.

The reagents used in the impinger train were prepared at the Avogadro laboratory. The first and second impingers each contained 100 ml of 0.1N  $\text{H}_2\text{SO}_4$  solution. The third was empty and the fourth impinger contained silica gel. All of the impinger tare weights were recorded prior to sampling.

The entire sample train was leak tested once prior to sampling and once following testing. The pre-test leak check was performed at a nominal vacuum to ensure that leakage did not exceed 0.02 cfm. The post-test leak check was performed at a vacuum greater than the highest vacuum recorded during the test to ensure that leakage did not exceed the lesser of a) 4 percent of the average sampling rate, or b) 0.02 cfm.

Sample Recovery: Avogadro collected and recovered the samples, protected them from contamination, and delivered them to the laboratory for analysis. All sample containers were of the amber glass variety incorporating Teflon leak-proof caps and were pre-cleaned with DI water. The contents of the impingers were weighed and recorded prior



to recovery. The liquid level was marked on each sample container. All exposed glassware openings in the sampling train were covered with parafilm to avoid possible contamination.

The filter and front half rinses and filter were discarded. The contents of the first two impingers were poured into Container 1. The impingers and crossovers were then rinsed three times with measured volumes of 0.1N H<sub>2</sub>SO<sub>4</sub> solution. The rinses were also poured into Container 1. The silica gel impinger contents were weighed for moisture catch determination only.

After collection, the samples were transported to the laboratory for analysis within the method's hold-time. The samples were protected from light and kept below 4 °C at all times. All QA/QC and chain of custody procedures were followed in strict accordance with the test method.

Sample Analysis: Sample analyses were performed by Test America using ion chromatography with conductivity detection. The laboratory QA/QC procedures outlined in the method were followed. The chloride and fluoride peaks were identified by characteristic retention times and quantified by reference to external standards.

Reporting: The results were presented in terms of non-blank-corrected concentrations and emission rates, as described in the method. The non-detected species were calculated using the full reporting limit. Results were reported in units of concentration (mg/dscm) and mass emissions (lb/hr and lb/MMBtu). Complete documentation of the calculations are provided in the final report.

## 4.2. ANCILLARY TEST PROCEDURES

The testing program will include measurements that provide data to be used in calculation of pollutant emission rates. These ancillary or supplementary tests are either included in the reference methods, or were run concurrently with the reference methods.

### 4.2.1 Diluent Gases

**Method:** EPA 3A, Amended August 2006

**Deviations:** None

Concentrations of the gaseous constituents of stack gas (O<sub>2</sub> and CO<sub>2</sub>) were measured using Avogadro's dry extractive continuous emissions monitor system (CEMS) described in Section 4.1.1 and Appendix A. The results were used for the molecular weight and dilution calculations necessary for reporting mass emission rates.



Run durations varied, but each test run were performed concurrently with an isokinetic test run. In this way, mass emissions were calculated using the volumetric flow rates measured during the aligned wet chemical tests.

#### **4.2.2 Volumetric Flow Rate and Moisture Content**

**Methods: EPA Methods 1, 2, 4, 19 Amended February 2000**

**Deviations: None**

Volumetric flow rates were measured using EPA Methods 1 and 2. Moisture contents were measured according to EPA Method 4. These methods are integral to all of the isokinetic tests. Emission rates were calculated in units of lb/hr or other mass flow units from the measured concentrations and volumetric flow rates. Emission rates for non-isokinetic test runs were calculated using flow rate measured during concurrent isokinetic test runs. Separate flow traverses were performed as necessary.

Stack gas volumetric flow rates were also be determined by stoichiometric calculations based on fuel flow rates, fuel composition (from fuel analysis data), and excess O<sub>2</sub> (%) measured from the flue gas. Calculations were performed using an "F" factor and higher heating value for natural gas as outlined in EPA Method 19. The results, presented in dry standard cubic feet per minute (dscfm), were used with the measured gaseous emission concentrations to calculate mass emission rates in lb/hr and lb/MMBtu.

#### **4.2.3 Fuel Analysis**

**Method: ASTM Methods**

Integrated fuel samples were collected by Weyerhaeuser personnel during every test day that sampling was performed. The EPA boiler and process heater test program requires fuel variability sampling for fuel based HAPs in addition to the emission testing. The fuel analyses include: chlorine, fluorine and metals for any boiler or process heater firing solid or liquid fuels that is selected to conduct an emission test program. At least ten samples were collected over a period of 30 days in accordance with Sections 2.1 through 2.4 of the Summary of Test Procedures, Methods, and Reporting Requirements issued by EPA.



## SECTION 5.0

### QUALITY ASSURANCE AND REPORTING

#### 5.1 SAMPLING AND ANALYTICAL QA/QC

Avogadro follows a rigorous QA/QC program for all of its air pollution testing. The program ensures that the emission data reported are accurate and the procedures included in the cited reference methods were followed for all steps of preparation, sampling, calibration, and analysis. Avogadro was responsible for preparation, calibration and cleaning of the sampling apparatus and conducted the sampling, recovery, storage and shipping.

The contract laboratories we selected conducted the majority of the preparation and sample analyses. The laboratories are established leaders in development and performance of the reference methods for which they have been selected. Their credentials for adherence to the required quality assurance procedures are well documented.

#### 5.2 QUALITY CONTROL REQUIREMENTS

Our Quality Assurance Program Summary, located in Appendix A, provides our equipment maintenance and calibration schedule, quality control acceptance limits, and any corrective action that may be needed. For additional quality control, Avogadro followed the procedures outlined below:

- Preliminary stack flow and temperature measurements were taken every day to assure correct isokinetic sampling.
- The acidified permanganate-filled impingers were carefully monitored throughout the test for bleaching via reduction reactions. The intent was to prevent “breakthrough” of mercury species.
- All field equipment had undergone a visual inspection prior to testing and included pre-test calibration checks.
- In addition to the normal cleaning methods, all metals sample train glassware was cleaned in Citranox<sup>®</sup> acidic cleaning solution.
- Glassware was visually inspected prior to testing.
- All reagents were made fresh daily. A new reagent blank was retained for every new stock of reagent.



### 5.3 QUALITY ASSURANCE AUDITS

Quality assurance audits were conducted as part of the toxics program to ensure that the final results were calculated from the highest quality data. The individual audits are listed below:

- The dry gas meters used during the test program were calibrated using a critical orifice (with a known calibration factor) prior to mobilization. The meters were then checked following the program. The meter values agreed within  $\pm 5$  percent of the orifice value.
- All S-type pitot tubes used during the test program were calibrated using a wind tunnel and standard pitot tube.
- All thermocouples (TCs) used during the test program were calibrated using three standards (ice water, boiling water, and boiling oil).

### 5.4 DATA REDUCTION PROCEDURES

The raw data collected during the sampling and analysis procedures were used to calculate the results of the testing program. The analysis and reduction of the data to the final results followed these steps where appropriate to the test method:

- The field-sampling data and the calculations of data averages were double-checked for accuracy (e.g., temperatures, pressures, volumes, etc.).
- The in-house and contract laboratory reports were reviewed to ensure that appropriate and/or required QA/QC steps were followed.
- The field and laboratory data inputs to computer spreadsheets were verified for calculation of volumetric flow rates, mass emission rates, etc.
- The calculated results were verified by conducting example calculations by hand on a single test run for each emission result reported.
- The report's summary tables of results were reviewed for accuracy.

### 5.5 REPORTING

This report includes copies of spreadsheet printouts (data input and results output) and example calculation checks. The field data sheets with average data calculations are also included. All values found to be below the detection limit of the analytical method were reported as either "non-detect" (ND<) or "less than" (<) the laboratory reporting limit value. Standard conditions used for data reduction were 29.92 inches of mercury and 68 °F, as defined by the EPA.



## SECTION 6.0

### DISCUSSION OF RESULTS

The results of the air source emission tests are presented in tables throughout this section and are summarized in the subsections that follow. The supporting data is contained in the appendices and includes the information listed below:

- 1) Appendix A presents generic descriptions of the standard test methods.
- 2) Appendix B contains Avogadro quality assurance information, California ARB certification, and calibration data.
- 3) Appendix C contains supporting data including an image of the sampling location, the plant process data, and the Avogadro CEMS data.
- 4) Appendix D contains the field data sheets for all the sampling activities.
- 5) Appendix E contains the abbreviated laboratory reports for all of the tests.
- 6) Appendix F presents the general emission calculations, emission calculation spreadsheets and hand-written examples.
- 7) Appendix G contains a copy of the operating permit.
- 8) Appendix H contains the full supporting chromatograph lab packages from Vista Analytical and Test America Laboratories.

#### 6.1 PARTICULATE MATTER

The results of the particulate matter emissions tests are summarized in Table 6-1. Detailed laboratory results are included in Appendix E.1. The results are presented in units of gr/dscf, gr/dscf @ 7% O<sub>2</sub>, lb/hr and lb/MMBtu. Results are blank corrected in accordance with EPA Method 5. Particulate matter was detected in every sample but not all sample fractions. Fractions for which the laboratory result was zero were assigned the analytical detection limit of 0.1 mg as the result used for all subsequent calculations, and any results using that limit are denoted with a "<" symbol. Tests 1-MM, 2-MM and 3-MM correspond to 1-PM, 2-PM and 3-PM respectively. No analytical problems were encountered.



**TABLE 6-1**  
**SUMMARY OF RESULTS**  
**PARTICULATE MATTER EMISSIONS**  
**HOG FUEL BOILER EXHAUST STACK**  
**WEYERHAEUSER RAYMOND SAWMILL**

Test No.:	1-MM 2-PM	2-MM 3-PM	3-MM 4-PM	Average
<b>Date:</b>	8/11/09	8/11/09	8/12/09	--
<b>Time:</b>	0957-1400	1500-1902	0819-1221	--
<b>Process Data:</b>				
Steam output, lb/hr	39,480	37,020	42,900	39,800
<b>Flue Gas:</b>				
O <sub>2</sub> , % volume dry	11.850	11.208	10.215	11.091
CO <sub>2</sub> , % volume dry	8.79	9.37	10.32	9.49
Stack temperature, °F	319.5	318.6	315.4	317.8
Moisture content, % vol.	12.45	14.38	14.34	13.73
Stack flow rate, dscfm	22,246	21,485	21,252	21,661
<b>F<sup>1</sup>/<sub>2</sub> Particulate Matter:</b>				
gr/dscf	< 0.00047	0.00059	< 0.00021	0.00042
gr/dscf @ 7% O <sub>2</sub>	< 0.00073	0.00085	< 0.00027	0.00062
lb/hr	< 0.090	0.109	< 0.037	0.079
lb/MMBtu	< 0.0015	0.0018	< 0.0006	0.0013
<b>PM &gt;10 µm (&gt;PM<sub>10</sub>):</b>				
gr/dscf	0.00051	0.00025	0.00022	0.00033
gr/dscf @ 7% O <sub>2</sub>	0.00078	0.00026	0.00029	0.00044
lb/hr	0.099	0.039	0.039	0.059
<b>PM &gt;2.5 and &lt;10 µm:</b>				
gr/dscf	0.00003	< 0.00002	0.00043	0.00016
gr/dscf @ 7% O <sub>2</sub>	0.00004	< 0.00002	0.00056	0.00021
lb/hr	0.005	< 0.003	0.076	0.028
<b>PM &lt;2.5 µm (PM<sub>2.5</sub>):</b>				
gr/dscf	0.00027	0.00018	0.00019	0.00021
gr/dscf @ 7% O <sub>2</sub>	0.00041	0.00019	0.00024	0.00028
lb/hr	0.052	0.028	0.033	0.038
lb/MMBtu	0.0009	0.0004	0.0005	0.0006
<b>Condensable PM:</b>				
gr/dscf	0.00055	0.00060	0.00110	0.00075
gr/dscf @ 7% O <sub>2</sub>	0.00084	0.00064	0.00143	0.00097
lb/hr	0.107	0.097	0.192	0.132
lb/MMBtu	0.0017	0.0013	0.0029	0.0020

(1) The results presented above are blank-corrected in accordance with EPA Method 5.



## 6.2 HYDROGEN CHLORIDE AND HYDROGEN FLUORIDE

The results of the gaseous hydrogen chloride (HCl) and hydrogen fluoride (HF) tests are summarized in Table 6-2. Detailed laboratory results are included in Appendices E.2 and H.2. The results are presented in units of ppm volume dry, ppm @ 7% O<sub>2</sub>, lb/hr and lb/MMBtu. There were no testing or analytical problems encountered.

HCl and HF were not detected in the samples or field blanks. Field blanks are reported at the laboratory reporting limit. No sampling problems were encountered. The test results are not blank-corrected in accordance with EPA 26.

All QA/QC matrix tests were performed according to the procedures in the test method. The procedures included field and laboratory blanks, matrix and blank spikes, and spike duplicates. All results were within the 75-125 percent acceptance limits. The results varied from 100%-101%.



**TABLE 6-2**  
**SUMMARY OF RESULTS**  
**HCL AND HF EMISSIONS**  
**HOG FUEL BOILER EXHAUST STACK**  
**WEYERHAEUSER RAYMOND SAWMILL**

Test No.:	1-HCl	2-HCl	3-HCl	Average	FB-HCl
<b>Date:</b>	8/11/09	8/11/09	8/12/09	--	--
<b>Time:</b>	0957-1357	1500-1900	0819-1219	--	--
<b>Process Data:</b>					
Steam output, lb/hr	39,480	37,020	42,900	39,800	--
<b>Flue Gas:</b>					
O <sub>2</sub> , % volume dry	11.850	11.208	10.215	11.091	11.091
CO <sub>2</sub> , % volume dry	8.79	9.37	10.32	9.49	9.49
Flue gas temperature °F	319.5	318.6	314.8	317.6	317.6
Moisture content, % vol.	12.45	14.25	14.28	13.66	13.66
Stack flow rate, dscfm	22,662	21,862	20,999	21,841	21,841
<b>Hydrogen Chloride</b>					
mg/sample as HCl	< 0.607	< 0.658	< 0.658	< 0.641	< 0.206
mg/dscm as HCl	< 0.196	< 0.213	< 0.212	< 0.207	< 0.066
ppm volume dry as HCl	< 0.129	< 0.140	< 0.140	< 0.137	< 0.044
ppm @ 7% O <sub>2</sub> as HCl	< 0.198	< 0.201	< 0.182	< 0.194	< 0.062
lb/hr as HCl	< 0.017	< 0.017	< 0.017	< 0.017	< 5.4E-03
lb/MMBtu as HCl	< 2.7E-04	< 2.8E-04	< 2.5E-04	< 2.6E-04	< 8.5E-05
<b>Hydrogen Fluoride</b>					
mg/sample as HF	< 0.632	< 0.684	< 0.684	< 0.667	< 0.211
mg/dscm as HF	< 0.204	< 0.222	< 0.221	< 0.215	< 0.068
ppm volume dry as HF	< 0.245	< 0.266	< 0.265	< 0.259	< 0.082
ppm @ 7% O <sub>2</sub> as HF	< 0.376	< 0.382	< 0.345	< 0.368	< 0.116
lb/hr as HF	< 0.017	< 0.018	< 0.017	< 0.018	< 5.6E-03
lb/MMBtu as HF	< 2.8E-04	< 2.9E-04	< 2.6E-04	< 2.8E-04	< 8.7E-05

- (1) The less than (<) notation indicates a species was not detected in the sample fraction. HCl and HF were not detected in any samples or field blanks.
- (2) The field blank values presented were calculated using the average sample volume and volumetric flow rate from the three test runs.
- (3) The results presented above are not blank-corrected in accordance with EPA Method 26.
- (4) Non-detected elements were calculated at the laboratory reporting limit.
- (5) The volumetric flow rate data was collected with the concurrent metals test runs.



### 6.3 SELECTED TRACE METALS

The results of the metals emission tests are summarized in Table 6-3. Detailed laboratory results are included in Appendices E.3 and H.2. The results were not blank-corrected in accordance with the EPA ICR. This is a modification of EPA Method 29, which allows for blank correction. The results are presented in units of micrograms per dry standard cubic meter (*ug/dscm*) for each test run, lb/hr and lb/MMBtu for the average of the three test runs. Results for the non-detected elements were calculated using the laboratory reporting limit. All QA/QC matrix tests were performed according to the procedures in the test method.

When analyzing trace metals, detection limits can vary from run to run, as the amount of analytical interferences (“matrix” interference) also varies from run to run. In some cases, the method of standard additions (dilution) is used to reduce those interferences to acceptable levels.

Antimony, arsenic, and beryllium were not detected in any sample fraction including the field blanks. Cadmium was detected in sample 2 only. Mercury was detected in the samples for each test run, but not all fractions. Elements that were detected under the reporting limit are reported at their respective reporting limits. All other metals were detected in the samples. The field blank contained detectable quantities of chromium, manganese, nickel, phosphorus and selenium. The method blank did not contain detectable quantities of any of the metals.

All duplicate sample recoveries were within 3.7% repeatability for all the trace metals, well within the acceptable limit of 15% for each species. Spike recoveries for the trace metals ranged between 81% and 109%, each was within the upper and lower specification limit.



**TABLE 6-3**  
**SUMMARY OF RESULTS**  
**TRACE METALS EMISSIONS**  
**HOG FUEL BOILER EXHAUST STACK**  
**WEYERHAEUSER RAYMOND SAWMILL**

Test No.	1-MM	2-MM	3-MM	AVERAGE			FB-MM
Date	8/11/09	8/11/09	8/12/09				8/4/09
Time	0957-1400	1500-1902	0819-1221				--
Steam output, lb/hr	39,480	37,020	42,900				39,800
Flow Rate, dscfm	22,246	21,485	21,260				21,664
Sample vol., dscf	154.10	162.62	161.92				159.54
O <sub>2</sub> , % vol. dry	11.85	11.21	10.22				11.09
CO <sub>2</sub> , % vol. dry	8.788	9.370	10.32				9.493
Moisture, %	12.45	14.38	14.34				13.73
	ug/m <sup>3</sup>	ug/m <sup>3</sup>	ug/m <sup>3</sup>	ug/m <sup>3</sup>	ug/m <sup>3</sup> @ 7% O <sub>2</sub>	lb/MMBtu	ug/m <sup>3</sup>
Antimony	ND<0.149	ND<0.139	ND<0.140	ND<0.142	ND<0.203	ND<1.76E-07	ND<0.168
Arsenic	ND<0.149	ND<0.139	ND<0.140	ND<0.142	ND<0.203	ND<1.76E-07	ND<0.168
Beryllium	ND<0.073	ND<0.069	ND<0.070	ND<0.071	ND<0.101	ND<8.76E-08	ND<0.084
Cadmium	ND<0.073	0.150	ND<0.070	<0.098	<0.139	<1.21E-07	ND<0.084
Chromium	0.894	0.326	0.371	0.530	0.774	6.71E-07	0.509
Cobalt	0.103	0.069	0.076	0.083	0.119	1.03E-07	ND<0.084
Lead	0.197	0.165	0.124	0.162	0.234	2.03E-07	ND<0.084
Manganese	14.94	9.815	6.695	10.48	15.24	1.32E-05	0.819
Nickel	0.939	0.282	0.458	0.560	0.815	7.06E-07	0.332
Phosphorus	19.50	22.37	14.11	18.66	26.79	2.32E-05	10.91
Selenium	0.367	0.239	0.283	0.296	0.425	3.68E-07	0.642
Mercury	<1.533	<1.414	<1.389	<1.445	<2.063	<1.32E-05	ND<0.394

- (1) The non-detection (ND<) notation indicates the species was not detected in any sample or sample fraction.
- (2) The less than (<) notation indicates a species was detected in at least one (but not all) samples or fractions.
- (3) The field blank values presented were calculated using the average sample volume from the three test runs.
- (4) The results presented above are not blank-corrected in accordance with the EPA ICR. This is a modification of EPA Method 29, which allows for blank corrections.
- (5) Non-detected elements were calculated using the laboratory reporting limit.
- (6) Chromium is presented as the measured total chromium.
- (7) Concentrations are presented in units of microgram per dry standard cubic meter.



#### 6.4 DIOXINS AND FURANS

The results of the polychlorinated dibenzo-dioxins (PCDD), dibenzo-furans (PCDF) emission tests are summarized in Tables 6-4 and 6-5. Detailed laboratory results are included in Appendices E.4. and H.1. The results are presented in units of nanograms per sample, nanograms per dry standard cubic meter (ng/dscm), ng/dscm @ 7% O<sub>2</sub>, ng/dscm @ 12% CO<sub>2</sub>, picograms per dry standard cubic meter (pg/dscm), pg/dscm @ 7% O<sub>2</sub> and lb/hr for each congener for each test run. The results are summarized for each species (i.e. 2378-TCDD, 12378 PeCDD, etc.), and as "Total PCDD", "Total PCDF", and "Total PCDD/PCDF" by simple addition of the individual congeners.

The results for non-detected congeners were calculated using zero for all tests as required by EPA Method 23. Results were not blank-corrected. The field and method blanks contained no significant quantities of any PCDD or PCDF congeners compared to the measured results.

All quality assurance and quality control (QA/QC) matrix tests were performed according to the procedures in the test method. The QA/QC standards for the sampling and analysis procedures were met for each test run and no sampling or analytical problems were encountered.



**TABLE 6-4  
 SUMMARY OF RESULTS  
 DIOXIN AND FURAN EMISSION TESTS  
 HOG FUEL BOILER EXHAUST STACK  
 WEYERHAEUSER RAYMOND SAWMILL**

<b>Test No.:</b>	<b>1-PCDD</b>	<b>2-PCDD</b>	<b>3-PCDD</b>	<b>Average<sup>4</sup></b>
<b>Date:</b>	8/12/09	8/13/09	8/13/09	--
<b>Time:</b>	1357-1800	0757-1159	1248-1650	--
<b>Process Data:</b>				
Steam output, lb/hr	48,100	42,250	40,960	43,770
<b>Flue Gas:</b>				
O <sub>2</sub> , % volume dry	8.950	10.736	11.207	10.298
CO <sub>2</sub> , % volume dry	11.51	9.83	9.38	10.24
Gas temperature °F	322.8	329.1	314.9	322.3
H <sub>2</sub> O content, % volume	14.91	13.76	13.17	13.94
Flow rate, dscfm	21,242	23,203	23,075	22,506
<b>Total PCDD</b>				
ng/sample	0.015	0.010	0.003	0.009
ng/dscm	0.004	0.002	0.001	0.002
ng/dscm @ 7% O <sub>2</sub>	0.004	0.003	0.001	0.003
ng/dscm @ 12% CO <sub>2</sub>	0.004	0.003	0.001	0.002
lb/hr	2.88E-10	1.90E-10	5.78E-11	1.79E-10
<b>Total PCDF</b>				
ng/sample	0.120	0.114	0.056	0.097
ng/dscm	0.029	0.025	0.013	0.02
ng/dscm @ 7% O <sub>2</sub>	0.034	0.035	0.018	0.029
ng/dscm @ 12% CO <sub>2</sub>	0.031	0.031	0.016	0.026
lb/hr	2.34E-09	2.21E-09	1.11E-09	1.89E-09
<b>Total PCDD/PCDF</b>				
ng/sample	0.135	0.124	0.059	0.106
ng/dscm	0.033	0.028	0.014	0.02
ng/dscm @ 7% O <sub>2</sub>	0.038	0.038	0.019	0.032
ng/dscm @ 12% CO <sub>2</sub>	0.034	0.034	0.017	0.029
lb/hr	2.63E-09	2.40E-09	1.17E-09	2.07E-09

- (1) The less than (<) notation indicates a species was detected in at least one (but not all) samples or fractions.
- (2) The field blank values presented were calculated using the average sample volume from the three test runs.
- (3) The results presented above are not blank-corrected in accordance with EPA Method 23.
- (4) Non-detected isomers were calculated using zero as the analytical result according to EPA Method 23.
- (5) Concentrations are presented in units of nanograms per dry standard cubic meter.



**TABLE 6-5  
 SUMMARY OF RESULTS  
 DIOXIN/FURAN EMISSION TESTS  
 HOG FUEL BOILER EXHAUST STACK  
 WEYERHAEUSER RAYMOND SAWMILL**

<b>Species</b>	<b>1-PCDD</b> pg/m <sup>3</sup> @ 7% O <sub>2</sub>	<b>2-PCDD</b> pg/m <sup>3</sup> @ 7% O <sub>2</sub>	<b>3-PCDD</b> pg/m <sup>3</sup> @ 7% O <sub>2</sub>	<b>Average</b> pg/m <sup>3</sup> @ 7% O <sub>2</sub>
2378-TCDD	0.000	0.000	0.000	0.000
Other TCDD	1.745	0.834	0.958	1.214
12378 PeCDD	0.000	0.000	0.000	0.000
Other PeCDD	0.000	0.000	0.000	0.000
123478 HxCDD	0.000	0.000	0.000	0.000
123678 HxCDD	0.000	0.000	0.000	0.000
123789 HxCDD	0.000	0.000	0.000	0.000
Other HxCDD	0.000	0.000	0.000	0.000
1234678 HpCDD	0.000	0.000	0.000	0.000
Other HpCDD	0.000	0.000	0.000	0.000
OCDD	2.470	2.156	0.000	1.617
2378 TCDF	2.390	2.642	2.094	2.380
Other TCDF	30.69	29.73	16.35	26.02
12378 PeCDF	0.000	0.000	0.000	0.000
23478 PeCDF	0.000	0.000	0.000	0.000
Other PeCDF	0.610	0.953	0.000	0.534
123478 HxCDF	0.000	0.000	0.000	0.000
123678 HxCDF	0.000	0.000	0.000	0.000
234678 HxCDF	0.000	0.000	0.000	0.000
123789 HxCDF	0.000	0.000	0.000	0.000
Other HxCDF	0.000	0.764	0.000	0.244
1234678 HpCDF	0.582	0.672	0.000	0.433
1234789 HpCDF	0.000	0.000	0.000	0.000
Other HpCDF	0.000	0.000	0.000	0.000
OCDF	0.000	0.000	0.000	0.000

## 6.5 GASEOUS EMISSIONS

The results of the gaseous emissions tests conducted at the stack location are summarized in Tables 6-6 on the next page. Detailed results are included in Appendices C.2 and F.2.6. Triplicate 240-minute test runs were performed in accordance with EPA Methods 6C, 7E and 10.



**TABLE 6-6**  
**SUMMARY OF RESULTS**  
**GASEOUS EMISSIONS**  
**HOG FUEL BOILER EXHAUST STACK**  
**WEYERHAEUSER RAYMOND SAWMILL**

Parameter	Run 1	Run 2	Run 3	Averages
<b>Date:</b>	8/12/09	08/13/09	8/13/09	--
<b>Time:</b>	1357-1800	0757-1159	1248-1650	--
<b>Process Data:</b>				
Steam output, lb/hr	48,100	42,250	40,960	43,770
<b>Stack Gas:</b>				
O <sub>2</sub> , % volume dry	8.950	10.736	11.207	10.298
CO <sub>2</sub> , % volume dry	11.51	9.83	9.38	10.24
Moisture content, % volume	14.91	13.76	13.17	13.94
Gas temperature, °F	322.8	329.1	314.9	322.3
Flow rate, dscfm	21,242	23,203	23,075	22,506
<b>CO Emissions:</b>				
ppm volume dry	103.25	176.01	167.21	148.82
ppm volume dry @ 7% O <sub>2</sub>	120.10	240.71	239.78	200.20
lb/hr	9.57	17.81	16.83	14.73
tons/year	41.90	78.01	73.71	64.54
lb/1,000 lb of steam	0.199	0.422	0.411	0.344
<b>NO<sub>x</sub> Emissions:</b>				
ppm volume dry	97.72	99.28	94.55	97.18
ppm volume dry @ 7% O <sub>2</sub>	113.67	135.77	135.59	128.34
lb/hr as NO <sub>2</sub>	14.87	16.50	15.63	15.67
tons/year as NO <sub>2</sub>	65.13	72.28	68.46	68.63
lb/1,000 lb of steam	0.309	0.391	0.382	0.360
<b>SO<sub>2</sub> Emissions:</b>				
ppm volume dry	0.39	0.15	0.46	0.33
ppm volume dry @ 7% O <sub>2</sub>	0.45	0.21	0.66	0.44
lb/hr	0.08	0.03	0.11	0.07
tons/year	0.36	0.15	0.46	0.33
lb/1,000 lb of steam	0.002	0.001	0.003	0.002

Notes: The volumetric flow rates were measured with the concurrent PCDD/PCDF test runs.  
 The ton/year emission rates are calculated based on 8,760 operation hours per year and the measured emission rates.



## 6.6 FORMALDEHYDE EMISSIONS

The results of the emission tests for formaldehyde are summarized in Table 6-7. Detailed laboratory results are included in Appendix E.6. Results have been calculated as described in CARB Method 430. The results are presented in units of milligrams per dry standard cubic meter (mg/dscm), ppb volume dry, ppm @ 7% O<sub>2</sub> and lb/hr for each test run.

CARB Method 430 prescribes correction of the results for the field blanks in those cases where the sample concentrations are at least 5 times the “background” concentrations in the field blanks. If the sample-to-blank ratio is less than 5, then the emissions are best represented by the non-blank-corrected results, which are an upper bound for the measured concentrations. If the ratio is greater than 5, then the emissions are best represented by the blank-corrected results. For these test runs, all results are presented as non-blank corrected.

The results have also been calculated in terms of the CARB reporting limit for each test run. Since the measured concentrations were above the reporting limits, the average result is presented in the tables. The CARB reporting limit results can be found in Appendix F.2.5.

Some sample fractions may have included aldehyde concentrations below the detection limit of the laboratory analysis. Those cases are noted with the symbol “<” and the results calculated at the detection limit for that sample fraction. If no formaldehyde was detected in all the fractions, then the symbol “ND<” was used to flag the entire sample as below the detection limit; the results were calculated at the detection limit.



**TABLE 6-7  
 SUMMARY OF RESULTS  
 ALDEHYDE EMISSIONS  
 HOG FUEL BOILER EXHAUST STACK  
 WEYERHAEUSER RAYMOND SAWMILL**

Parameter	1-Form	2-Form	3-Form	Average
<b>Date:</b>	08/12/2009	8/13/2009	08/13/2009	--
<b>Time:</b>	1503-1903	0757-1157	1301-1701	--
<b>Process Data:</b>				
Steam output, lb/hr	48,100	42,250	40,960	43,770
<b>Stack Gas Data:</b>				
O <sub>2</sub> , % volume dry	8.950	10.736	11.207	--
Flow rate, dscfm	21,242	23,203	23,075	--
<b>Formaldehyde:</b>				
mg/dscm	0.094	0.055	0.058	0.069
ppb volume dry	75.2	44.3	46.7	55.4
ppm volume dry	0.075	0.044	0.047	0.055
ppm @ 7% O <sub>2</sub>	0.088	0.061	0.067	0.072
gram/hr	3.39	2.18	2.284	2.616
lb/hr	7.46E-03	4.79E-03	5.03E-03	5.76E-03
lb/MMBtu	9.84E-05	5.79E-05	6.11E-05	7.24E-05

Notes: 1) The results for tests 1-FORM, 2-FORM and 3-FORM presented above are not blank-corrected in accordance with the EPA ICR.  
 2) The volumetric flow rate information is from the PCDD/PCDF sampling train performed concurrently with the formaldehyde tests.

## 6.7 VOLATILE ORGANIC COMPOUNDS

The results of the volatile organic compounds (VOC) tests conducted at the stack location are summarized in Table 6-8. Emission rates in terms of lb/hr were calculated for each compound using the measured concentration and the corresponding stack flow rate for the test run. Detailed laboratory results are included in Appendix E.5. Triplicate 240-minute test runs were performed in accordance with EPA Methods 18 and 25A.



**TABLE 6-8**  
**SUMMARY OF RESULTS**  
**VOLATILE ORGANIC COMPOUND EMISSIONS**  
**HOG FUEL BOILER EXHAUST STACK**  
**WEYERHAEUSER RAYMOND SAWMILL**

Parameter	Run 1	Run 2	Run 3	Averages
<b>Date:</b>	8/12/09	08/13/09	8/13/09	--
<b>Time:</b>	1357-1800	0757-1159	1248-1650	--
<b>Process Data:</b>				
Steam output, lb/hr	48,100	42,250	40,960	43,770
<b>Stack Gas:</b>				
O <sub>2</sub> , % volume dry	8.950	10.736	11.207	10.298
CO <sub>2</sub> , % volume dry	11.51	9.83	9.38	10.24
Moisture content, % volume	14.91	13.76	13.17	13.94
Gas temperature, °F	322.8	329.1	314.9	322.3
Stack flow rate, dscfm	21,242	23,203	23,075	22,506
<b>THC Emissions:</b>				
ppm volume dry as C <sub>3</sub> H <sub>8</sub>	< 1.41	< 1.39	< 1.38	< 1.39
ppmvd @ 7% O <sub>2</sub> as C <sub>3</sub> H <sub>8</sub>	< 1.64	< 1.90	< 1.98	< 1.84
lb/hr as C <sub>3</sub> H <sub>8</sub>	< 1.47	< 1.70	< 1.77	< 1.65
lb/hr as C	0.056	0.060	0.060	< 0.059
lb/day as C	1.34	1.45	1.43	< 1.41
lb/MMBtu as C	0.001	0.001	0.001	< 0.001
lb/hr as CH <sub>4</sub>	< 0.224	< 0.242	< 0.239	< 0.235
lb/day as CH <sub>4</sub>	< 5.39	< 5.81	< 5.73	< 5.64
lb/MMBtu as CH <sub>4</sub>	< 0.001	< 0.001	< 0.001	< 0.001
<b>Methane Emissions:</b>				
ppm volume dry	2.96	1.03	2.26	2.08
ppmvd @ 7% O <sub>2</sub>	3.44	1.41	3.24	2.70
lb/hr	0.157	0.060	0.130	0.116
<b>VOC Emissions (NMOC):</b>				
lb/hr as CH <sub>4</sub>	< 0.067	< 0.182	< 0.109	< 0.119
lb/day as CH <sub>4</sub>	< 1.62	< 4.37	< 2.61	< 2.87
lb as CH <sub>4</sub> /1,000 lb of steam	< 0.001	< 0.004	< 0.003	< 0.003

Notes: 1) The less than (<) notation indicates one or more compounds were not detected in the sample.  
 2) Non-detected species were calculated using the full reporting limit.  
 3) Emission results for VOC include all 62 compounds that the samples were analyzed for. Not all compounds were detected. Please refer to Appendix F.2.7 for details on the individual compounds.



## Attachment B

### Arsenic to PM<sub>10</sub> Ratio Calculation

Submitted Electronically

## **Attachment C**

### **Updated Emission Calculations**

Submitted Electronically

## **Attachment D**

### **Updated Arsenic Models**

Submitted Electronically