FLUORIDE AIR DISPERSION MODELING REPORT

Hollingsworth & Vose Fiber Company

Submitted To: Oregon Department of Environmental Quality

Submitted For: Hollingsworth & Vose Fiber Company
Corvallis, Oregon

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1.0 INTRODUCTION

Hollingsworth & Vose Fiber Company (H&V) owns and operates a glass fiber manufacturing facility located in Corvallis, Oregon which is regulated under Standard Air Contaminant Discharge Permit (ACDP) Number 02-2173-ST-01. Corvallis is located on the western edge of the Willamette Valley, with elevated terrain to the west and east of the facility. The facility is located at 1115 SE Crystal Lake Drive.

In 2013, the Oregon Department of Environmental Quality (ODEQ) was preparing to issue a renewed ADCP Number 02-2173-ST-01 to H&V. At that time, ODEQ requested emission factor confirmation source testing. H&V agreed to arrange testing and contracted with a third party to conduct and complete the testing between October 2014 and February 2015 (2014/2015 testing).

Based on the results of the 2014/2015 testing, H&V entered into a Mutual Agreement and Final Order (No. AQ/V-WR-15-132, referred to as the MAO) with ODEQ on December 15, 2015.

The MAO requires that, by January 29th, 2016, H&V must complete …

> *"…Ambient air quality modeling of hydrogen fluoride and Fluorides including a comparison to accepted risk-based chronic exposure thresholds to modeled concentrations at the nearest residences."*

Fluorides (F) is defined in the MAO, consistent with the term used in federal and Oregon permitting, as the inorganic fluoride compounds, excluding hydrogen fluoride (HF), measured using EPA Method 13A or 13B.

This fluorides modeling report describes the modeling methodology and input data that was used to conduct ambient air modeling of HF and F for comparison to accepted risk-based chronic exposure thresholds at nearby residential locations (i.e. at locations where long term exposure could occur). Modeling was conducted assuming the maximum operating capacity for the H&V facility. A modeling protocol was submitted to ODEQ on January 25, 2016. ODEQ approved the protocol on January 27, 2016.

2.0 FACILITY DESCRIPTION

2.1 Facility Background

Industrial operations have occurred at the Corvallis facility site since 1885. See Figures 2-1 and 2-2 for maps of the site location and general site plan. Glass fiber production was permitted at the Corvallis facility site in 1978 and manufacturing began in 1979. The facility was acquired by H&V in 1996. The glass fiber produced at the Corvallis plant is a critical raw material in air and liquid filtration media and specialty battery separator media. For example, the battery separator in Absorptive Glass Mat (AGM) batteries used in "start-stop" automotive applications is manufactured with glass fiber produced in Corvallis. "Start-stop" technology is designed to reduce vehicle fuel consumption and carbon emissions.

2.2 Process Description

The first stage of manufacturing the glass fiber produced by H&V is achieved by melting solid raw materials in an electrically-heated melting furnace. The molten glass is then delivered via forehearths to stations that produce the fiber by either a rotary or flameblown fiberizer. Natural gas is combusted to maintain molten glass temperature as it passes through the forehearths. To develop emission factors for the facility, the fiberizers are classified as rotary fine, rotary coarse, or flameblown. In all cases, the glass fibers are typically hundreds of microns in length, which is what allows the fibers to form mats for collection and for use in final products. As a result, the aerodynamic diameters of the fibers produced by H&V are typically expected to exceed several microns.

To clarify the nomenclature used by the facility, detailed process flow diagrams have been prepared and can be found in Figure 2-3 and 2-4. Table 2-1 below summarizes the production lines (Lines 1-4), and the fiberizers located in GP1 and GP2.

Table 2-1: Facility Processes (Existing and Proposed)

Building	Production Lines	Furnaces	Fiberizers
GP1	1-3	1,2	20 Rotary coarse 4 Rotary fine
GP2	4		16 Rotary fine 4 Flameblown

The following is a description of the manufacturing process from raw material receipt through product collection and emissions control.

2.2.1 Raw Material Loading and Blending

Super sacks of raw materials are received from off-site sources. The raw material received includes, but is not limited to; soda ash, borax, syenite, sand, fluorspar, zinc oxide, potassium carbonate, burnt dolomite, and barium. A diverter hose is used to pump raw materials from a sub-grade bin up to the third floor batch tower processing area. The batch tower consists of 8 individual raw material hoppers. Each hopper vents into the batch processing area (inside the building) through Serbaco Inc. air filters. Raw materials in each hopper are loaded by weight into batch weigh hoppers, which weigh the ingredients for the desired glass product recipe. Particulate emissions generated from the weigh bin are conveyed to an exterior baghouse, which vents to atmosphere. Next, the weighed raw materials are directed to the mixing tank where the product recipe is blended. This mixing tank vents to a baghouse that exhausts inside the batch processing area (inside the building).

Processed material received from the mixing tank is diverted to a feed hopper. Each feed hopper includes a chute with an attached screw auger that continuously feeds processed material onto the top of a bed of molten glass inside the glass melting furnaces. Feed hoppers vent PM emissions through Serbaco Inc. air filters into the GP1 building. The GP1 building houses one raw material loading and blending system feeding two glass melting furnaces. No glass melting furnaces are located in the GP2 building and so there is no raw material handling for bulk materials in that building.

2.2.2 Glass Melt Furnaces

Inside the furnaces, fresh processed material of a specific recipe is added to the surface of the molten glass already present, thereby ensuring a continuous homogeneous mixture. All glass melting furnaces are electrically heated. Gaseous emissions resulting from the melting of the bulk materials in the two furnaces at GP1 are vented to Scrubber 10 (Kinpactor-Separator Model AAF 12/90). Controlled emissions from Scrubber 10 exhaust through stack FSS.

2.2.3 Forehearths

Each glass melting furnace is serviced by a forehearth that receives molten glass at high temperatures and delivers it to the fiberizers. The forehearths, unlike the glass melting furnaces, are heated by natural gas combustion. Natural gas combustion emissions from each forehearth are captured by suspended rectangular hoods and conveyed through ductwork to vent with the furnace emissions.

The forehearths can also deliver molten glass to a glass patty former or to a station that produces glass cullet. Glass patties and cullet are glass that has hardened, but can be liquefied later in a remelt unit upstream of a fiberizer when needed. No furnaces are located in the GP2 building, and therefore there are no forehearths in that building. All fiberizers in GP2 are fed by remelt units that use cullet or glass patties.

2.2.4 Fiberizers (Rotary and Flameblown)

Rotary fiberizers receive molten glass from the forehearths (in GP1) or electric remelt units (in GP1 and GP2). The molten glass is fed to a rotary spinner disk which utilizes centrifugal forces to force the molten glass to flow outward through holes in the rotary fiberizers. Flame attenuation results in thin glass fibers.

The newly formed glass fibers are pneumatically conveyed to collection drums (in GP1 and GP2) or a former (in GP1) for collection and packaging.

H&V also utilizes four flameblown fiberizers. Flameblown fiberizers receive molten glass from electric remelt units in GP2. Molten glass flows by gravity through numerous small orifices to create threads that are then attenuated (stretched to the point of breaking) by high velocity hot air and flame. The newly formed glass fibers are pneumatically conveyed to drums for collection and packaging. There are no plans to install additional flameblown fiberizers.

As part of a Prevention of Significant Deterioration (PSD) permit application that was submitted on January 29, 2016, H&V is proposing to install 11 rotary fiberizers in GP2. These are a subset of equipment that was authorized in a PSD permit in 1996, but were not installed at that time. Two additional exhaust stacks are proposed for these emission units and are included in the F and HF modeling.

2.2.5 Product Collection

2.2.5.1 Drums

After glass fibers have been created by the rotary or flameblown fiberizers, they can be collected on a small drum screen. The drum is a spinning cylinder with perforations. A fan is used to pull air from inside the drum. As the air is sucked through the perforations in the drum, the fiber collects on the drum surface. The glass fibers build up a pelt on the drum, which is physically removed for product packaging. Drum collection of product is used in GP1 and GP2. Each drum currently vents PM emissions to a wet venturi scrubber. Fibers from the 11 fiberizers to be installed in GP2 will also be collected on drums and the exhaust will be vented through high-efficiency drum filters prior to exhausting to atmosphere.

2.2.5.2 Formers

Glass fibers generated by some rotary fiberizer positions on Lines 1 and 2 in GP1 are collected on Line 1 and Line 2 formers. Unlike the cylindrical drums, a former is a porous belt. Fiber exhausted from the fiberizers is directed at the top surface of the belt, while air is pulled from the underside of the belt. As the belt travels it accumulates more fiber. At one end of the belt, the mat of fiber is removed and packaged. Emissions are controlled with wet venturi scrubbers.

3.0 MODELED SOURCES AND EMISSIONS

Descriptions of the emission sources and the emission rates modeled are provided in the following subsections.

3.1 Modeled Sources

Modeled sources at the facility are typical of a glass fiber production facility. Each of the previously described emission sources is vented through vertically oriented exhaust stacks. Emissions from the existing equipment are first passed through a wet venturi scrubber prior to venting out of the stacks. Emissions from the fiberizers proposed for installation at GP2 will be filtered through high-efficiency drum filters prior to venting out of proposed stacks (L4S3 and L4S4).

Within the dispersion model, each stack was identified with a unique label (model ID). Each stack was represented as a point source with a vertical release in the model. A summary of the modeled stacks (both current and proposed) and their source parameters are shown in Table 3-1. Figure 3-1 presents the location of each stack at the facility.

Release parameters for each stack were derived from stack testing data as well as from information contained in the H&V operating permit. Release parameters for the proposed stacks (L4S3 and L4S4) are based on the parameters of representative existing stacks where possible. The following section outlines the methodology that was used to apportion emissions from the various sources within GP1 and GP2 to the different stacks.

3.2 Modeled Emissions

Emissions from sources producing glass fiber located at GP1 can be exhausted through one of several possible ventilation routes (see Figure 2-3 for a process flow diagram of GP1). This is due to ductwork interconnects as well as production options (i.e. some positions can send produced glass fiber to a collection drum or to a former, both of which exhaust through different exhaust stacks). Determination of emission allocation for the modeled maximum impact scenario is described in Section 3.2.1, below.

Emissions from the two glass melt furnaces as well as both forehearths at GP1 are controlled by Scrubber 10. This is the only exhaust scenario for these sources. Scrubber 10 exhausts to atmosphere through stack FSS.

Unlike the configuration of GP1, emissions from each source located at GP2 have only a single exhaust ventilation route (see Figure 2-4 for a process flow diagram of GP2).

Modeled emission rates for the facility are summarized in Table 3-2. Detailed emission calculations for F and HF are shown in Appendix A.

3.2.1 Glass Plant 1 Emissions Allocation

A preliminary allocation assessment was conducted to ensure a conservative exhaust routing scenario with respect to the required dispersion modeling assessments. For the preliminary allocation assessment, each exhaust stack at GP1 was assigned an emission rate of 1 gram per second (g/s). Modeling was conducted for each year of the 5-year assessment period (2010-2014). Each individual exhaust stack was assigned to a unique source group. Each exhaust stack was then ranked relative to the other GP1 exhaust stacks in terms of maximum predicted annual concentrations. The exhaust stack with the highest predicted annual average concentration was ranked first, and the exhaust stack with the lowest predicted annual average concentration was ranked last.

Emissions were assigned to each stack using information from the facility process flow diagrams, as well as the results of a preliminary allocation assessment. For each source, all possible exhaust routing options were identified from the facility process flow diagrams. Emissions were assigned to the exhaust stack with the highest ranking from the preliminary allocation assessment. If a source has only one routing option, emissions were automatically be assigned to that option.

The resulting emissions routing scenario for GP1 is presented in Figure 3-2, which is color-coded by stack.

4.0 DISPERSION MODELING METHODOLOGY

The following subsections present details of the dispersion modeling that was conducted for this assessment.

4.1 Models

The project utilized the current version of AERMOD (version 15181). AERMOD is the United States Environmental Protection Agency (US EPA) approved air dispersion model for near field assessments (within 50 kilometers). Third party overlay software, from Lakes Environmental, was used to set-up and execute the AERMOD model.

4.2 Meteorological Data

AERMOD-compatible meteorological data sets were developed by Golder using the current version of AERMET (version 15181). AERMET is the meteorological data pre-processor for AERMOD. AERMET processes surface and upper air meteorological data and land use characteristic data to create two files: a surface data file (*.SFC) and a profile data file (*.PFL).

Surface meteorological data were collected from archived data at the National Climatic Data Center (NCDC) for the Automated Weather Observation System (AWOS) at Corvallis, OR (AWSMSC Station ID 726945). Upper air meteorological data was collected in the Forecast Systems Laboratory (FSL) format for Salem McNary Field Airport, OR (AWSMSC Station ID 726940), from the National Oceanic and Atmospheric Administration/Earth System Research Laboratory (NOAA/ESRL) Radiosonde Database.

Golder downloaded the surface and upper air data for the period beginning in 2007 through 2014. The surface and upper air data for the most recent 5-year period (2010 through 2014) were passed through AERMET to generate surface and profile files, which were passed through AERMOD one calendar quarter at a time. The AERMOD output files were examined to determine the data completeness for each calendar quarter. To be considered complete and valid, each calendar quarter must have fewer than 10% missing hours. Table 4-1 presents the result of this missing meteorological data assessment. As shown in Table 4-1, multiple quarters exceeded the quarterly missing hour threshold of 10% for the 2010 through 2014 meteorological data period.

As use of data from the Corvallis station is preferable to use of meteorological data from more distant stations, Golder substituted calendar quarters from the previous 3 years (2007 – 2009), as well as substituted individual months within a calendar quarter until each quarter of the 5-year meteorological data set (2010-2014) had fewer than 10% missing hours. The surface and upper air data for 2007 – 2009 were processed in the same manner as the 2010 – 2014 data. This approach resulted in a full 5-year meteorological data set based on actual spatially and temporally representative meteorological data.

Golder made the following data substitution:

- Substituted Q2 and Q3 of 2011 with Q2 and Q3 of 2009,
- Substituted Q1 of 2013 with Q1 of 2009,
- Substituted Q4 of 2011 with Q4 of 2008,
- Substituted September 2010 with September 2008,
- Substituted August 2012 with August 2007, and
- Substituted August 2014 with August 2008.

Data substitution was done with the pre-processed SFC and PFL files generated by AERMET, and not the raw surface and upper air files. The meteorological values within the SFC and PFL files were not altered, i.e. contiguous blocks were used to substitute the data as outlined above except for the dates which were modified to provide a continuous 5-year data set spanning from 2010 through 2014.

Table 4-2 summarizes the meteorological data substitutions.

A wind rose for the substituted meteorological data set previously described for the period between 2010 and 2014 is presented in Figure 4-1. The wind directions for this data set are not bimodal, with the most prominent winds blowing from 160 degrees and 280 degrees. This alignment corresponds to the typical coastal winds blowing in from the west (280 degrees), and winds blowing up the Willamette Valley from the south (160 degrees). The Willamette Valley is generally oriented north-south.

Wind roses summarizing the average seasonal wind speeds and directions are shown in Figures 4-2 (winter), 4-3 (spring), 4-4 (summer), and 4-5 (fall). Each wind rose represents the collective meteorological data for a single calendar quarter over five years.

4.3 Land Use

AERSURFACE was used to generate seasonal values for albedo, Bowen ratio, and surface roughness heights. State of Oregon National Land Cover Dataset, 1992 (NLCD92) land cover class definitions were downloaded from the United States Geological Survey (USGS), and processed using the US EPA AERSURFACE land use tool to generate the surface characteristics necessary to run AERMET.

The NLCD92 data was processed by AERSURFACE using the settings described in Table 4-3.

4.4 Receptors and Terrain

Receptors were placed in residential areas near the facility. These areas were defined as parcels that are residential, medical, or school properties. Additionally, residential areas were assessed visually through examination of aerial imagery of the area around the facility to ensure that all residential areas were identified. A discrete receptors grid was constructed as follows:

- 20 meter spacing out 1,000 meters from the centroid of the H&V sources;
- 50 meter spacing out 2,000 meters from the centroid of the H&V sources;

Discrete receptors within the modeling domain were removed from parcels that are not identified as residential, medical, and school properties.

The receptor locations are presented in Figure 4-6, which shows the receptor grid in its entirety, and Figure 4-7, which shows a closer view of the receptors around the facility.

Terrain elevations for model receptors, source base elevations, and base elevations of downwash structures were derived from United States Geological Survey (USGS) National Elevation Dataset (NED) data at a resolution of 1/3 arc-seconds (roughly equivalent to a horizontal resolution of 10 meters).

4.5 Building Downwash

Buildings that intersect point source emission plumes can cause the formation of eddies on the downwind side of the structure. This can cause the plume to recirculate near the building, which is called building downwash. The most recent version of the US EPA Building Profile Input Program, incorporating the Plume Rise Model Enhancements algorithms (BPIP-PRM, version 04274), was used to calculate direction-specific building downwash parameters for all significant building structures located at the facility. The downwash structure locations are presented in Figure 4-8. Table 4-4 presents the heights of each downwash structure.

5.0 MODELING ASSESSMENTS AND RESULTS

Predictions of HF and F ambient concentrations must be compared to “accepted risk-based chronic exposure thresholds”. ODEQ recently required a similar assessment of F and HF emissions from the Intel facility in Hillsboro, Oregon. The modeling methodology and selected risk-based chronic exposure thresholds were summarized in a report published in December of 2014 (referred to as the Intel Report[1]), which was accepted by ODEQ.

Due to the extensive vetting and acceptance of these thresholds during the Intel evaluation, Golder used the chronic thresholds selected in the Intel Report as the basis of comparison for the modeled F and HF concentrations for the H&V facility. These chronic exposure thresholds are presented in Table 5-1, and discussed in detail in the following subsections.

5.1 Hydrogen Fluoride Assessment

The most directly relevant risk-based chronic exposure threshold for HF is the Oregon Ambient Benchmark Concentration (ABC) of 14 micrograms per cubic meter ($\mu g/m^3$) based on an annual average, as presented in the Intel Report. The Oregon ABC for HF was adopted by Oregon in 2006 after review by the Oregon Air Toxics Science Advisory Committee (ATSAC). The Oregon ATSAC reviewed different regulatory thresholds and concluded that the HF reference exposure level (REL) adopted by the California Office of Environmental Health Hazard Assessment (OEHHA) was the most robust. RELs are defined as:

> *“… the concentration level at or below which no adverse non-cancer health effects are anticipated for the specified exposure duration. RELs are based on the most sensitive, relevant, adverse health effect reported in the medical and toxicological literature. RELs are designed to protect the most sensitive individuals in the population by the inclusion of factors that account for uncertainties as well as individual differences in human susceptibility to chemical exposures. The factors used in the calculation of RELs are meant to err on the side of public health protection in order to avoid underestimation of non-cancer hazards. Exceeding the REL does not automatically indicate an adverse health impact. However, increasing concentrations above the REL value increases the likelihood that the health effect will occur.”* [2]

A maximum annual averaged concentration of HF was predicted for each of the five years comprising the meteorological period (2010 through 2014). The highest of these five predicted concentrations of HF, which was a concentration of 0.11 $\mu g/m^3$ in the 2014 annual assessment, was compared to the Oregon

[1] Intel Corporation Fluorides Control Technology Assessment and Ambient Air Quality Modeling Assessment of Fluorides and Hydrogen Fluoride, prepared for the Oregon Department of Environmental Quality, December 2014.

[2] Air Toxics Hot Spots Program, Risk Assessment Guidelines, Guidance Manual for Preparation of Health Risk Assessments. Office of Environmental Health Hazard Assessment. February 2015.

ABC for HF of 14 µg/m^3. Maximum annual predicted concentrations of HF are presented in Table 5-2. The location of the maximum modeled HF concentration is presented in Figure 5-1.

5.2 Fluorides Assessment

The most robust risk-based chronic threshold for F is the OEHHA chronic REL of 13 µg/m^3 based on an annual average, as presented in the Intel Report. Oregon has not adopted an ABC for F. At the same time that OEHAA adopted the HF REL (discussed previously in Section 5.1), OEHHA also adopted an F (excludes HF) chronic inhalation REL. Given the Oregon ATSAC's conclusion that the HF REL was the most robust value, it was concluded that the F REL also represents the optimal health based threshold. This conclusion is consistent with the approach outlined in the Intel report and accepted by ODEQ in that assessment.

A maximum annual averaged concentration of F was predicted for each of the five years comprising the meteorological period (2010 through 2014). The highest of these five predicted concentrations of F, which was a concentration of 1.67 µg/m^3 in the 2014 annual assessment, was compared to the OEHHA chronic inhalation REL of 13 µg/m^3. Maximum annual predicted concentrations of F are presented in Table 5-2. The location of the maximum modeled F concentration is presented in Figure 5-2.

6.0 CLOSING

This modeling report outlines the methodologies used to perform the required air dispersion modeling assessments as part of the MAO. The results of the air dispersion modeling demonstrate that the H&V facility does not exceed the accepted risk-based exposure thresholds for either F or HF. If there are any questions or comments, please contact us at 503-607-1820.

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TABLES

Table 3-1
Modeled Source Parameters
Hollingsworth & Vose Fiber Company - Corvallis, Oregon

Model ID	Source Description	Base Height (m)	Release Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Flowrate (m^3/s)	Exit Temperature (K)
Glass Plant 1							
FSS	Furnace and Forehearth Stack	72.0	12.5	0.91	6.47	4.25	308.2
L1S	Line 1 Stack	71.9	15.2	1.52	19.1	34.9	307.0
L2S	Line 2 Stack	72.0	15.2	1.83	9.52	25.01	307.0
L3S1	Line 3 Stack 1	72.0	15.2	1.83	10.8	28.5	315.9
L3S2	Line 3 Stack 2	72.0	15.2	1.83	10.6	27.8	312.6
Glass Plant 2							
L4S1	Existing Line 4 Stack 1	68.1	13.7	1.83	16.3	42.7	314.3
L4S2	Existing Line 4 Stack 2	68.1	13.7	1.52	15.6	28.5	314.3
Line 4 Modification							
L4S3	Future Line 4 Stack 3 (1)	68.1	13.7	1.83	21.7	56.9	450.0
L4S4	Future Line 4 Stack 4 (1)	68.1	13.7	1.83	18.1	47.4	450.0

References:

(1) Future Line 4 stack installations will have size characteristics similar to Line 4 Stack 2. Exhaust temperature set to 350°F to represent dry filtration. This temperature is derived from the inlet temperature of L3S2 measured during the May 2015 source test.

Table 3-2
Modeled Emission Rates Summary
Hollingsworth & Vose Fiber Company - Corvallis, Oregon

Model ID	Source Description	Emission Estimates			
		Fluorides		Hydrogen Fluoride	
		Annual		Annual	
		(tons/yr)	(g/s)	(tons/yr)	(g/s)
Glass Plant 1					
FSS	Furnace and Forehearth Stack	0.34	9.86E-03	0.060	1.72E-03
L1S	Line 1 Stack	1.71	0.049	0.13	3.75E-03
L2S	Line 2 Stack	1.71	0.049	0.13	3.75E-03
L3S1	Line 3 Stack 1	1.14	0.033	0.087	2.50E-03
L3S2	Line 3 Stack 2	2.48	0.071	0.11	3.28E-03
Glass Plant 2					
L4S1	Line 4 Stack 1	1.25	0.036	0.024	6.94E-04
L4S2	Line 4 Stack 2	0.84	0.024	0.017	4.88E-04
Line 4 Modification					
L4S3	Line 4 Stack 3	1.68	0.048	0.034	9.77E-04
L4S4	Line 4 Stack 4	1.40	0.040	0.028	8.14E-04

Table 4-1
Assessment of Missing Meteorological Data [1]
Hollingsworth & Vose Fiber Company - Corvallis, Oregon

Quarter	2010			2011			2012			2013			2014		
	Total Hours	Missing Hours [2]	% Missing	Total Hours	Missing Hours [2]	% Missing	Total Hours	Missing Hours [2]	% Missing	Total Hours	Missing Hours [2]	% Missing	Total Hours	Missing Hours [2]	% Missing
Q1	2,160	12	0.56	2,160	26	1.20	2,184	80	3.66	2,160	238	11.02 [3]	2,160	8	0.37
Q2	2,184	39	1.79	2,184	297	13.6 [3]	2,184	56	2.56	2,184	12	0.55	2,184	65	2.98
Q3	2,208	234	10.6 [3]	2,208	1314	59.51 [3]	2,208	298	13.5 [3]	2,208	4	0.18	2,208	392	17.75 [3]
Q4	2,208	15	0.68	2,208	458	20.74 [3]	2,208	18	0.82	2,208	23	1.04	2,208	1	0.05

References:

(1) Meteorological data obtained from the National Oceanic and Atmospheric Administration National Climatic Data Center (NOAA NCDC) Integrated Surface Data for Corvallis Airport, Oregon.

(2) The number of missing hours were determined by processing the surface and profile meteorological files generated by AERMET through AERMOD, which identifies the number of missing hours in the output file.

(3) Quarterly meteorological data exceeding the 10% missing data threshold.

Table 4-2
Meteorological Data Substitutions [1]
Hollingsworth & Vose Fiber Company - Corvallis, Oregon

Quarter	2010				2011				2012				2013				2014			
	Total Hours	Missing Hours [2]	% Missing	Sub	Total Hours	Missing Hours [2]	% Missing	Sub	Total Hours	Missing Hours [2]	% Missing	Sub	Total Hours	Missing Hours [2]	% Missing	Sub	Total Hours	Missing Hours [2]	% Missing	Sub
Q1	2,160	12	0.56		2,160	26	1.20		2,184	80	3.66		2,160	47	2.18	Q1 2009 [3]	2,160	8	0.37	
Q2	2,184	39	1.79		2,184	32	1.47	Q2 2009 [3]	2,184	56	2.56		2,184	12	0.55		2,184	65	2.98	
Q3	2,208	208	9.42	Sep 2008 [3]	2,208	116	5.25	Q3 2009 [3]	2,208	41	1.86	Aug 2007 [3]	2,208	4	0.18		2,208	119	5.39	Aug 2008 [3]
Q4	2,208	15	0.68		2,208	42	1.90	Q4 2008 [3]	2,208	18	0.82		2,208	23	1.04		2,208	1	0.05	

References:

(1) Meteorological data obtained from the National Oceanic and Atmospheric Administration National Climatic Data Center (NOAA NCDC) Integrated Surface Data for Corvallis Airport, Oregon.

(2) The number of missing hours were determined by processing the substituted surface and profile meteorological files through AERMOD, which identifies the number of missing hours in the output file.

(3) Substituted meteorological data period used to replace data within quarters exceeding the 10% missing data threshold.

Table 4-3
AERSURFACE Settings
Hollingsworth & Vose Fiber Company - Corvallis, Oregon

Parameter	Setting
Study radius for surface roughness	3.0 kilometers
Is the surface data collected at an airport?	Yes
Should continuous snow cover be assumed?	No
What surface moisture condition should be assumed?	Average
Is this an arid region?	No
Number of sectors	12
Months assumed to constitute “winter”	December, January, and February
Months assumed to constitute “spring”	March, April, and May
Months assumed to constitute “summer”	June, July, and August
Months assumed to constitute “autumn”	September, October, and November
Period for land use calculations	Seasonal

Table 4-4
Summary of Downwash Structure Heights
Hollingsworth & Vose Fiber Company - Corvallis, Oregon

Modeling ID	Structure Name	Tier Number	Tier Height (m)
BLD_1	General Storage and Maintenance	1	7.68
BLD_2	Glass Plant 1	1	11.25
BLD_3	General Storage	1	4.33
BLD_4	General Storage	1	3.44
BLD_5	General Storage	1	7.92
BLD_6	General Storage	1	3.14
BLD_7	General Storage and Maintenance	1	5.00
		2	5.18
		3	9.97
		4	11.98
BLD_8	General Storage	1	9.05
BLD_9	Storage	1	6.40
BLD_10	General Storage	1	6.40
BLD_11	General Storage	1	6.00
BLD_12	General Storage	1	4.18
BLD_13	Hardboard	1	8.93
BLD_14	Hardboard	1	6.74
BLD_15	Hardboard	1	9.11
BLD_16	Offices	1	4.39
		2	7.71
BLD_17	Offices	1	3.05
BLD_18	Glass Plant 2	1	6.71
	Glass Plant 2	2	8.47
	Glass Plant 2	3	8.53
	Glass Plant 2	4	9.66
BLD_19	General Storage	1	3.14
		2	6.34
		3	9.39
		4	13.72
BLD_20	Offsite Building - Cornerstone South	1	4.27
BLD_21	Offsite Building - Cornerstone North	1	5.64
BLD_22	Offsite Building - East of Facility	1	8.00
BLD_23	Offsite Building - Care Facility	1	5.03

Table 5-1
Summary of Chronic Exposure Thresholds
Hollingsworth & Vose Fiber Company - Corvallis, Oregon

Agency	Accepted Risk-Based Chronic Exposure Threshold	Pollutant	Chronic Exposure Threshold ($\mu g/m^3$)
Oregon DEQ (1)	Ambient Benchmark Concentration	Hydrogen Fluoride	14
California OEHHA (2)	Chronic Inhalation Reference Exposure Level	Fluorides (except HF), as F	13

References:

(1) Oregon Ambient Benchmark Concentration, based on an annual average, as shown in Oregon Administrative Rule 340-246-0090(3)(bb).

(2) California Office of Environmental Health Hazard Assessment chronic inhalation reference exposure level, based on an annual average.

Table 5-2
Results of Chronic Exposure Assessments
Hollingsworth & Vose Fiber Company - Corvallis, Oregon

Pollutant	Year	Modeled Concentration [(1)] ($\mu g/m^3$)	Chronic Exposure Threshold ($\mu g/m^3$)
Hydrogen Fluoride	2010	0.071	14 [(2)]
	2011	0.073	
	2012	0.066	
	2013	0.089	
	2014	**0.11**	
Fluorides	2010	1.02	13 [(3)]
	2011	1.03	
	2012	0.95	
	2013	1.32	
	2014	**1.67**	

References:

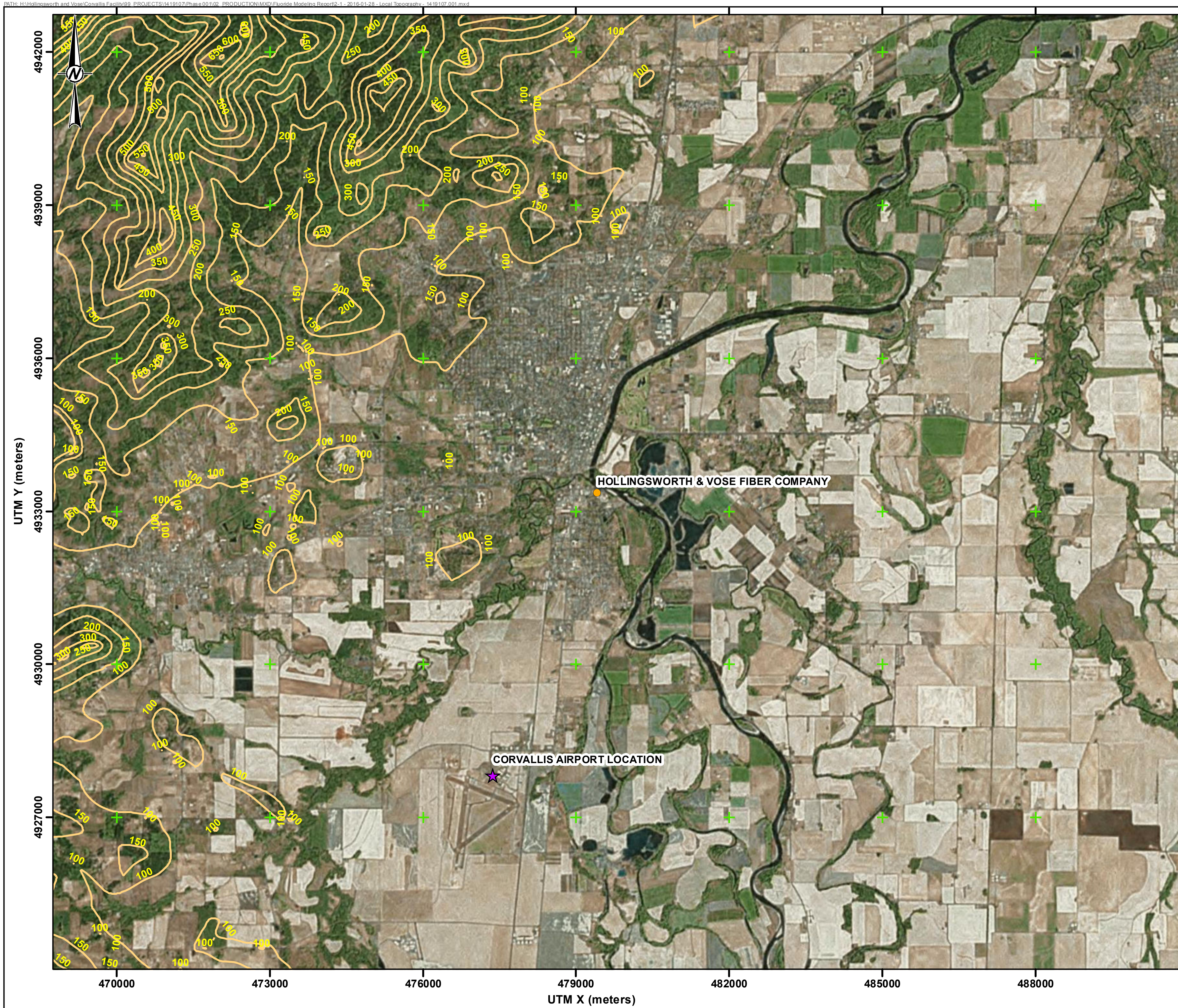
(1) Maximum predicted annual concentration in micrograms per cubic meter ($\mu g/m^3$). Year of maximum concentration is shown in bold and underline.

(2) Oregon Ambient Benchmark Concentration, based on an annual average, as shown in Oregon Administrative Rule 340-246-0090(3)(bb).

(3) California Office of Environmental Health Hazard Assessment chronic inhalation reference exposure level, based on an annual average.

FIGURES

PATH: H:\Hollingsworth and Vose\Corvallis Facility\99_PROJECTS\1419107\Phase 001\02_PRODUCTION\MXD\Fluoride Modeling Report\2-1 - 2016-01-28 - Local Topography - 1419107-001.mxd



LEGEND

- APPROXIMATE HOLLINGSWORTH & VOSE FIBER COMPANY FACILITY LOCATION
- CORVALLIS AIRPORT LOCATION
- 50 m CONTOUR INTERVAL

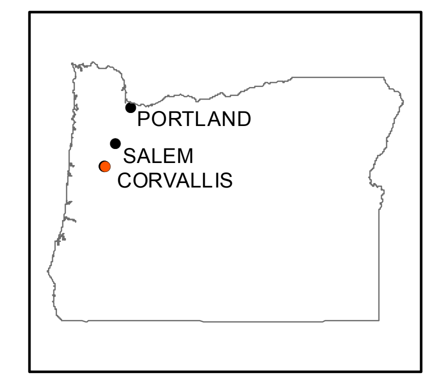
NOTE(S)

1. COORDINATE SYSTEM IS WORLD GEODETIC SYSTEM (WGS) 1984 UNIVERSAL TRANVERSE MERCATOR (UTM) NORTHERN HEMISPHERE ZONE 10.

REFERENCE(S)

LOCAL TOPOGRAPHY OBTAINED FROM THE UNITED STATES GEOLOGIC SURVEY (USGS) NATIONAL ELEVATION DATASET (NED) 1/3 ARC-SECOND (10 M RESOLUTION).

KEY MAP



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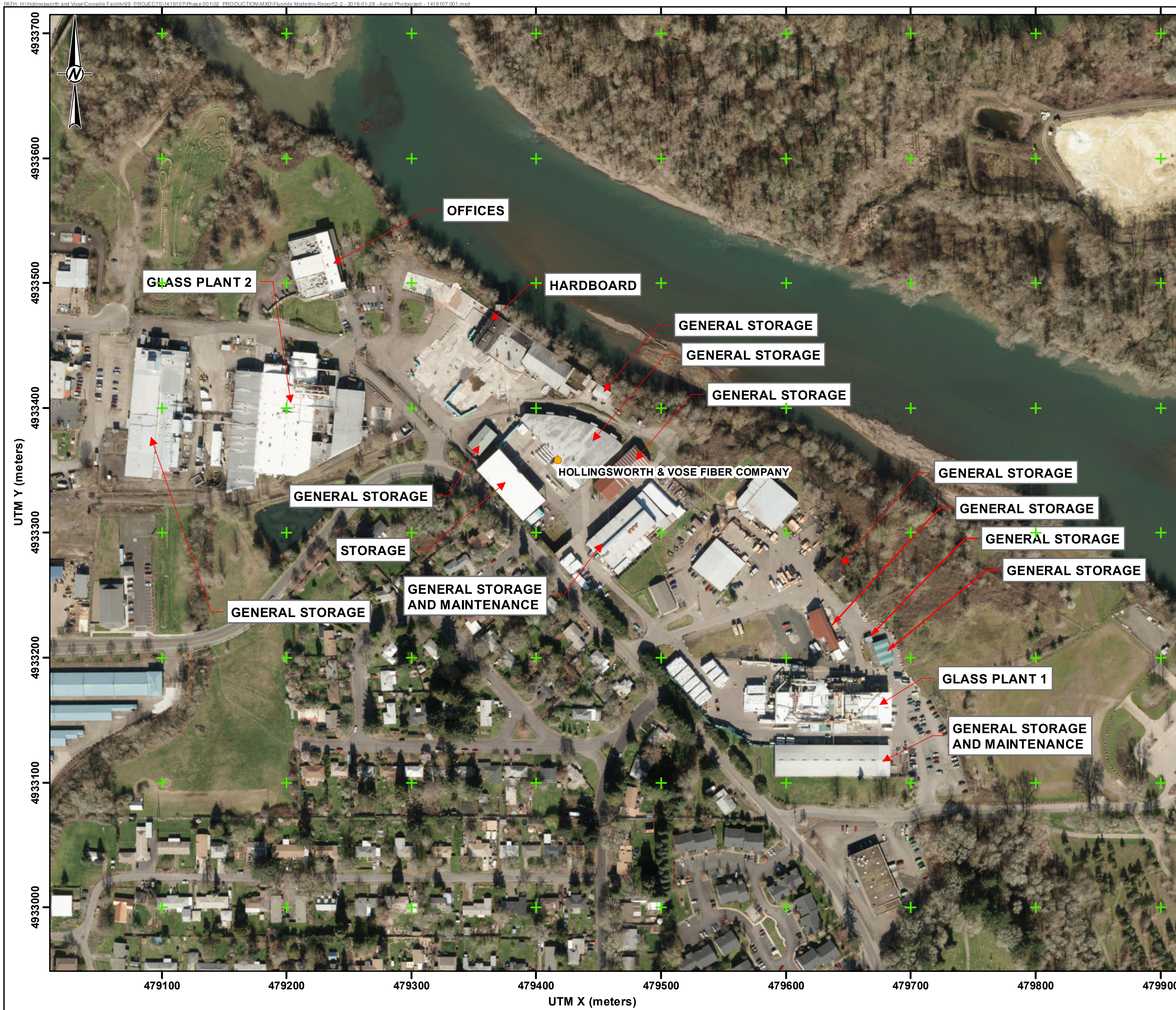
TITLE

LOCAL TOPOGRAPHY
HOLLINGSWORTH & VOSE FIBER COMPANY
CORVALLIS, OREGON

PROJECT NO.	PHASE	REV.	FIGURE
1419107	001	000	2-1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

PATH: H:\Hollingsworth and Vose\Corvallis Facility\99_PROJECTS\1419107\Phase 001\02_PRODUCTION\MXD\Fluoride Modeling Report\2-2 - 2016-01-28 - Aerial Photograph - 1419107.001.mxd



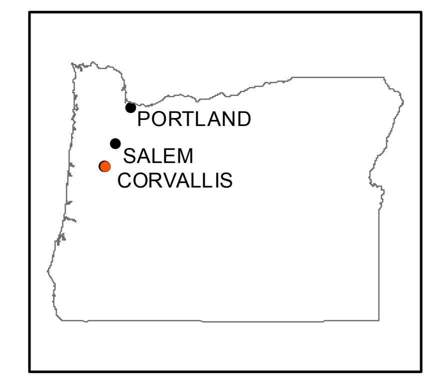
LEGEND

- APPROXIMATE HOLLINGSWORTH & VOSE FIBER COMPANY FACILITY LOCATION
- UTM GRID GUIDELINE

NOTE(S)

1. COORDINATE SYSTEM IS WORLD GEODETIC SYSTEM (WGS) 1984 UNIVERSAL TRANVERSE MERCATOR (UTM) NORTHERN HEMISPHERE ZONE 10.

KEY MAP



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METERS

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TITLE

AERIAL PHOTOGRAPH OF FACILITY HOLLINGSWORTH & VOSE FIBER COMPANY CORVALLIS, OREGON

PROJECT NO.	PHASE	REV.	FIGURE
1419107	001	000	2-2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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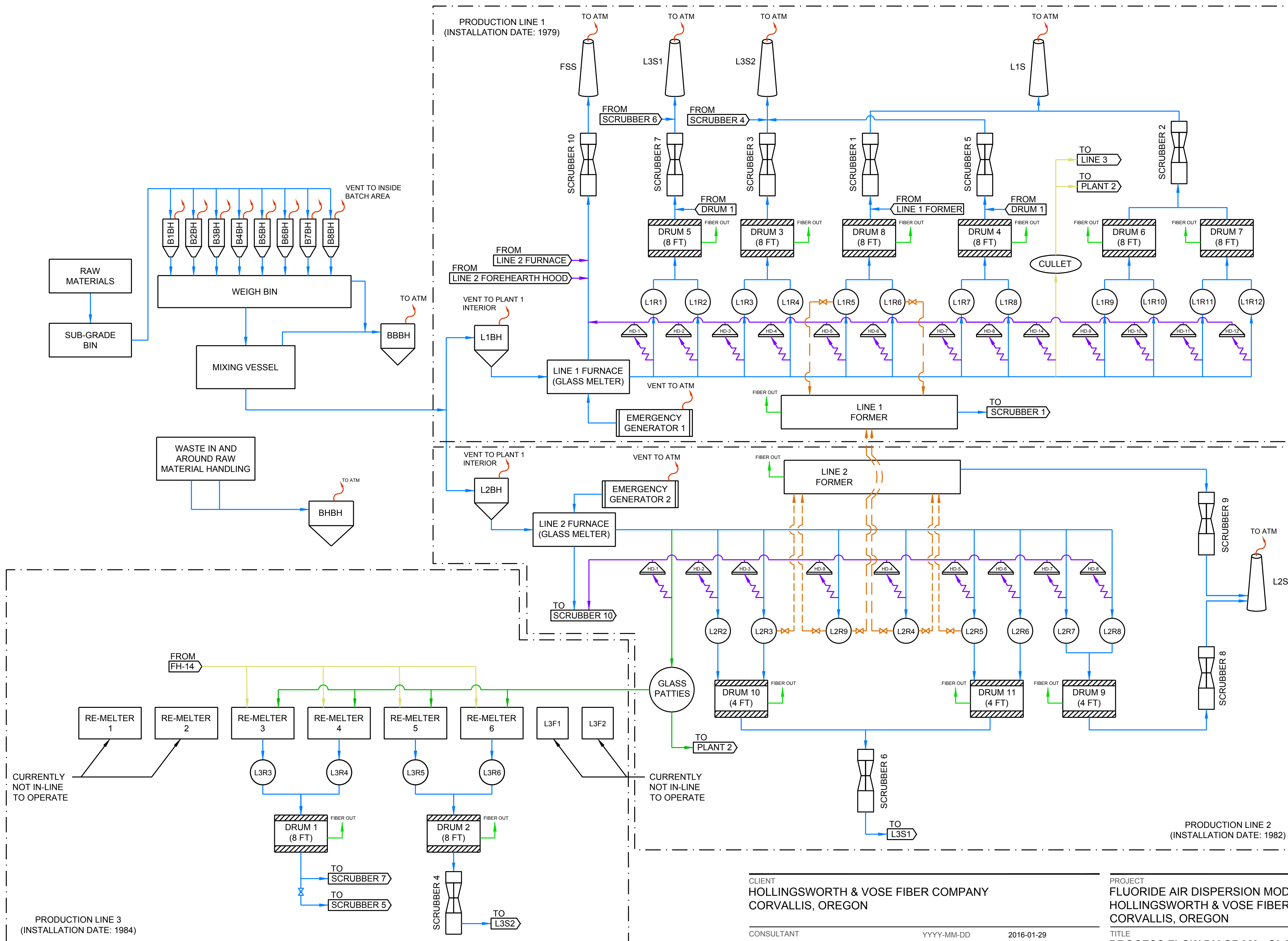

CLIENT	PROJECT
HOLLINGSWORTH & VOSE FIBER COMPANY CORVALLIS, OREGON	FLUORIDE AIR DISPERSION MODELING REPORT HOLLINGSWORTH & VOSE FIBER COMPANY CORVALLIS, OREGON

CONSULTANT

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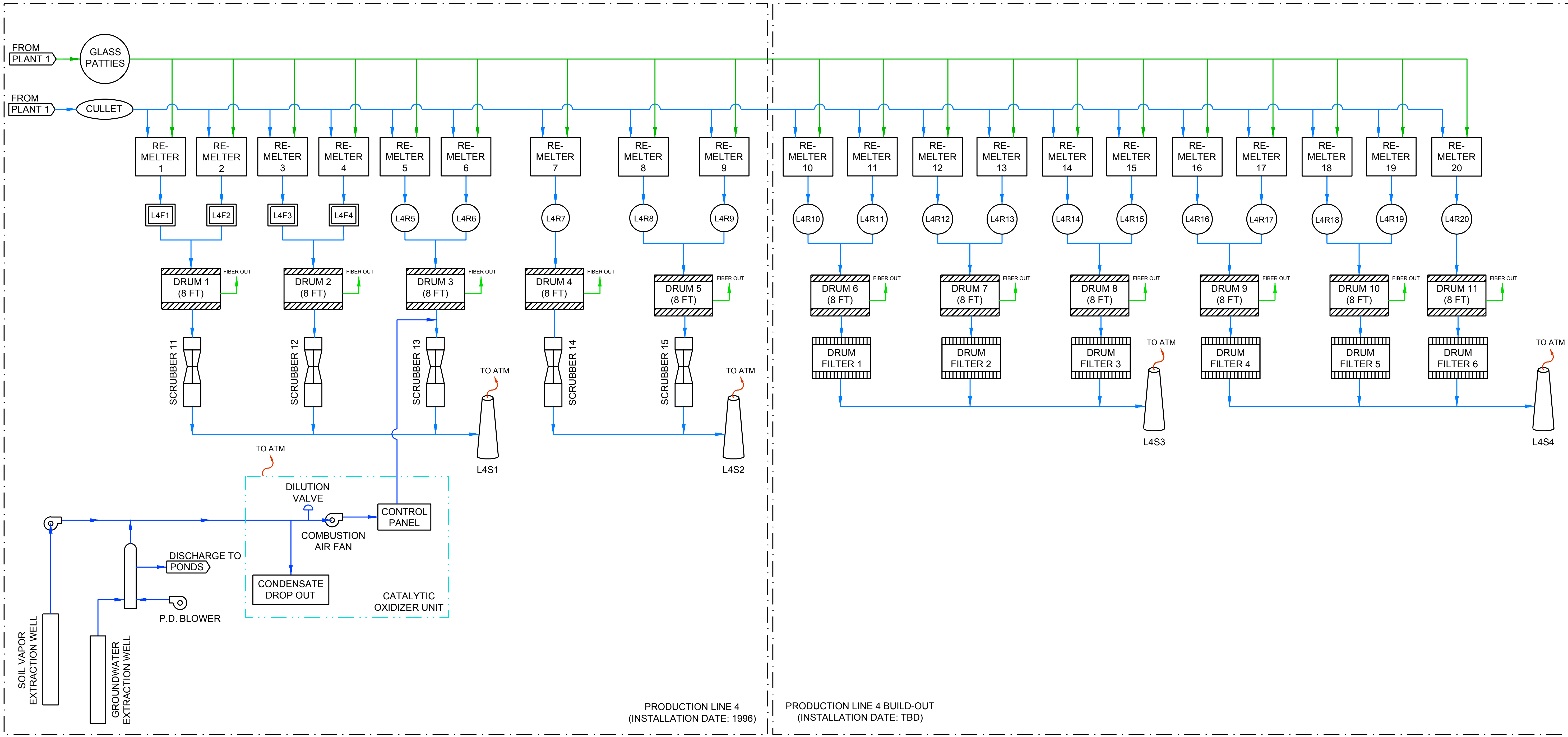
REVIEW	GS
APPROVED	CD

TITLE
PROCESS FLOW DIAGRAM - GLASS PLANT 1

PROJECT No.	PHASE	Rev.	FIGURE
1419107	001	000	2-3

Path: \\Prt1-v-fs1\Geomatics\Hollingsworth and Vose\Corvallis Facility\99_PROJECTS\1419107\Phase 00102_PRODUCTION\DWG\ | File Name: 2-3 - 2016-01-28 - FMR - Plant 1 PFD - 1419107.001.dwg

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B



NOTE(S)

ALL LINE 4 BUILD-OUT ROTARY FIBERIZERS ARE CURRENTLY PLANNED TO BE CONTROLLED BY DRY FILTRATION (DRUM FILTER), WHICH IS SUBJECT TO CHANGE PRIOR TO INSTALLATION.

CLIENT
HOLLINGSWORTH & VOSE FIBER COMPANY
CORVALLIS, OREGON

CONSULTANT

Golder Associates

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DESIGN	BS
REVIEW	GS
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PROJECT
FLUORIDE AIR DISPERSION MODELING REPORT
HOLLINGSWORTH & VOSE FIBER COMPANY
CORVALLIS, OREGON

TITLE
PROCESS FLOW DIAGRAM - GLASS PLANT 2

PROJECT No.	PHASE	Rev.	FIGURE
1419107	001	000	2-4

PATH: H:\Hollingsworth and Vose\Corvallis Facility\99_PROJECTS\1419107\Phase 001\02_PRODUCTION\MXD\Fluoride Modeling Report\3-1 - 2016-01-28 - Stack Locations - 1419107.001.mxd

LEGEND

APPROXIMATE HOLLINGSWORTH & VOSE FIBER COMPANY FACILITY LOCATION

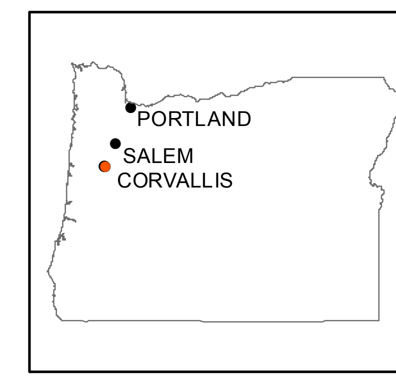
STACK LOCATION

UTM GRID GUIDELINE

NOTE(S)

1. COORDINATE SYSTEM IS WORLD GEODETIC SYSTEM (WGS) 1984 UNIVERSAL TRANVERSE MERCATOR (UTM) NORTHERN HEMISPHERE ZONE 10.

KEY MAP



0 50 100 200

METERS

CONSULTANT

Golder Associates

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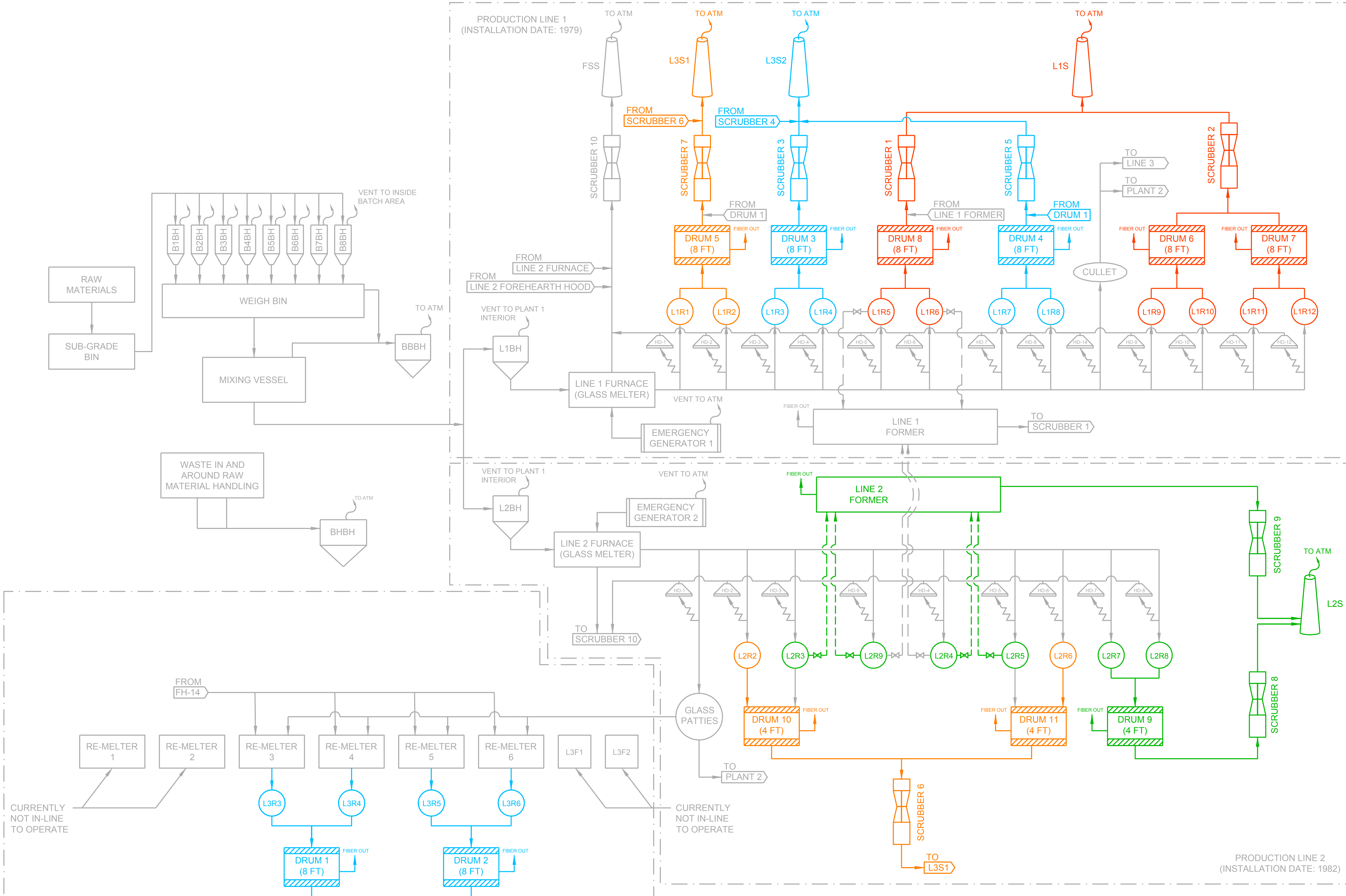
TITLE

STACK LOCATIONS
HOLLINGSWORTH & VOSE FIBER COMPANY
CORVALLIS, OREGON

PROJECT NO.	PHASE	REV.	FIGURE
1419107	001	000	3-1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B



CLIENT
HOLLINGSWORTH & VOSE FIBER COMPANY
CORVALLIS, OREGON

CONSULTANT

YYYY-MM-DD	2016-01-29
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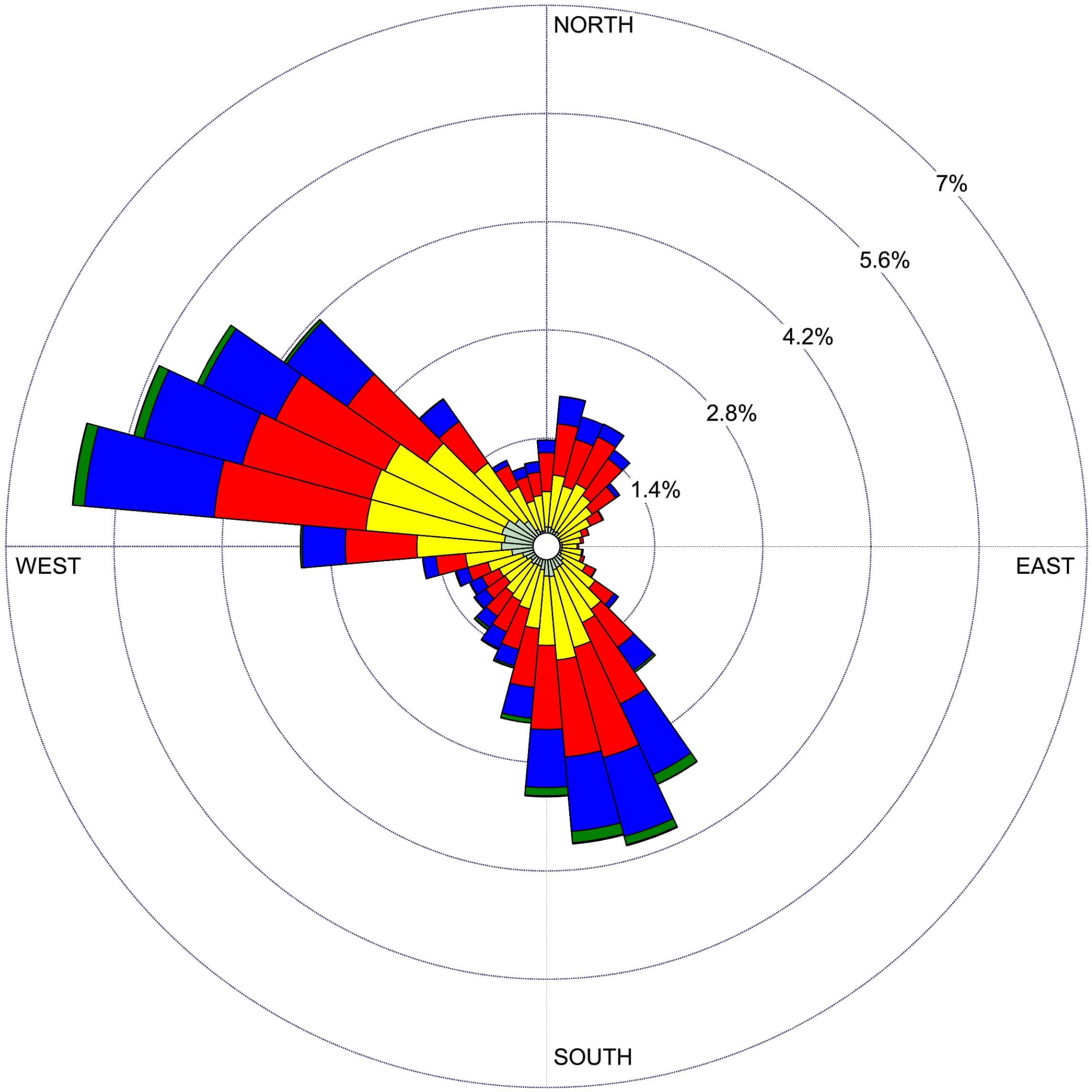
DESIGN	BS
REVIEW	GS
APPROVED	CD

PROJECT
FLUORIDE AIR DISPERSION MODELING REPORT
HOLLINGSWORTH & VOSE FIBER COMPANY
CORVALLIS, OREGON

TITLE
EMISSIONS ROUTING SCENARIO FOR GLASS PLANT 1

PROJECT No.	PHASE	Rev.	FIGURE
1419107	001	000	3-2



NOTE(S)
WIND ROSE GENERATED FROM LAKES ENVIRONMENTAL WRPLOT VIEW.
WIND SPEED DIRECTION - BLOWING FROM.

TOTAL NUMBER OF HOURS = 43,206
AVERAGE WIND SPEED = 2.97 m/s

WIND SPEED
(m/s)

- >= 11.10
- 8.80 - 11.10
- 5.70 - 8.80
- 3.60 - 5.70
- 2.10 - 3.60
- 0.50 - 2.10

Calms: 25.68%

CLIENT
HOLLINGSWORTH & VOSE FIBER COMPANY
CORVALLIS, OREGON

PROJECT
FLUORIDE AIR DISPERSION MODELING REPORT
HOLLINGSWORTH & VOSE FIBER COMPANY
CORVALLIS, OREGON

CONSULTANT
Golder Associates

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PREPARED	BS
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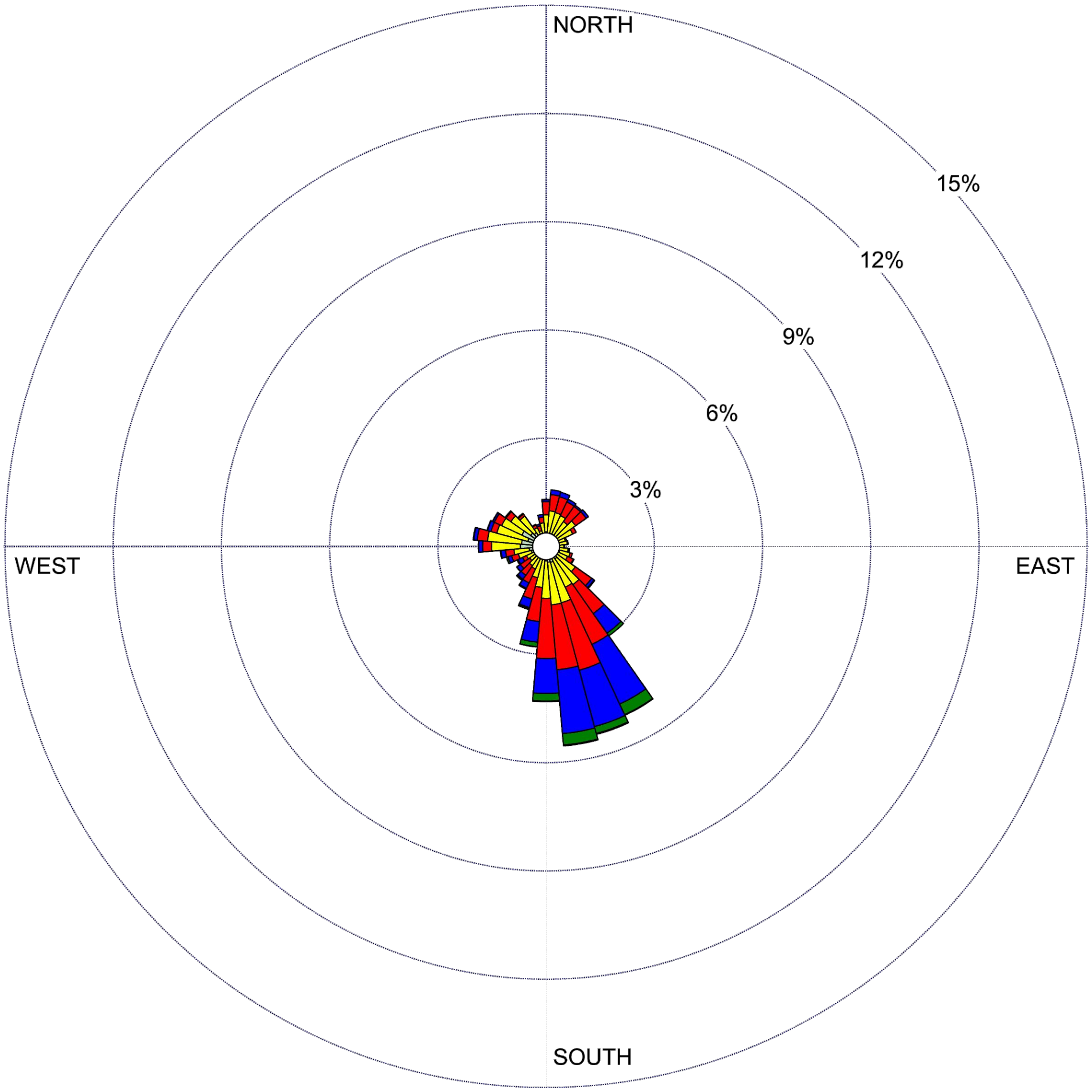
TITLE
WIND ROSE FOR CORVALLIS, OREGON 2010 TO 2014 WITH SUBSTITUTED DATA

PROJECT NO.	PHASE	REV.	FIGURE
1419107	001	000	4-1



NOTE(S)

WIND ROSE GENERATED FROM LAKES ENVIRONMENTAL WRPLOT VIEW. METEOROLOGICAL DATA REPRESENTS WINTER SEASON (DECEMBER, JANUARY, AND FEBRUARY) RECORDED DATA ONLY FOR 2010 TO 2014.

WIND SPEED DIRECTION - BLOWING FROM.
TOTAL NUMBER OF HOURS = 10,714
AVERAGE WIND SPEED = 2.40 m/s

WIND SPEED (m/s)

- >= 11.10
- 8.80 - 11.10
- 5.70 - 8.80
- 3.60 - 5.70
- 2.10 - 3.60
- 0.50 - 2.10

Calms: 37.03%

CLIENT
HOLLINGSWORTH & VOSE FIBER COMPANY
CORVALLIS, OREGON

PROJECT
FLUORIDE AIR DISPERSION MODELING REPORT
HOLLINGSWORTH & VOSE FIBER COMPANY
CORVALLIS, OREGON

CONSULTANT

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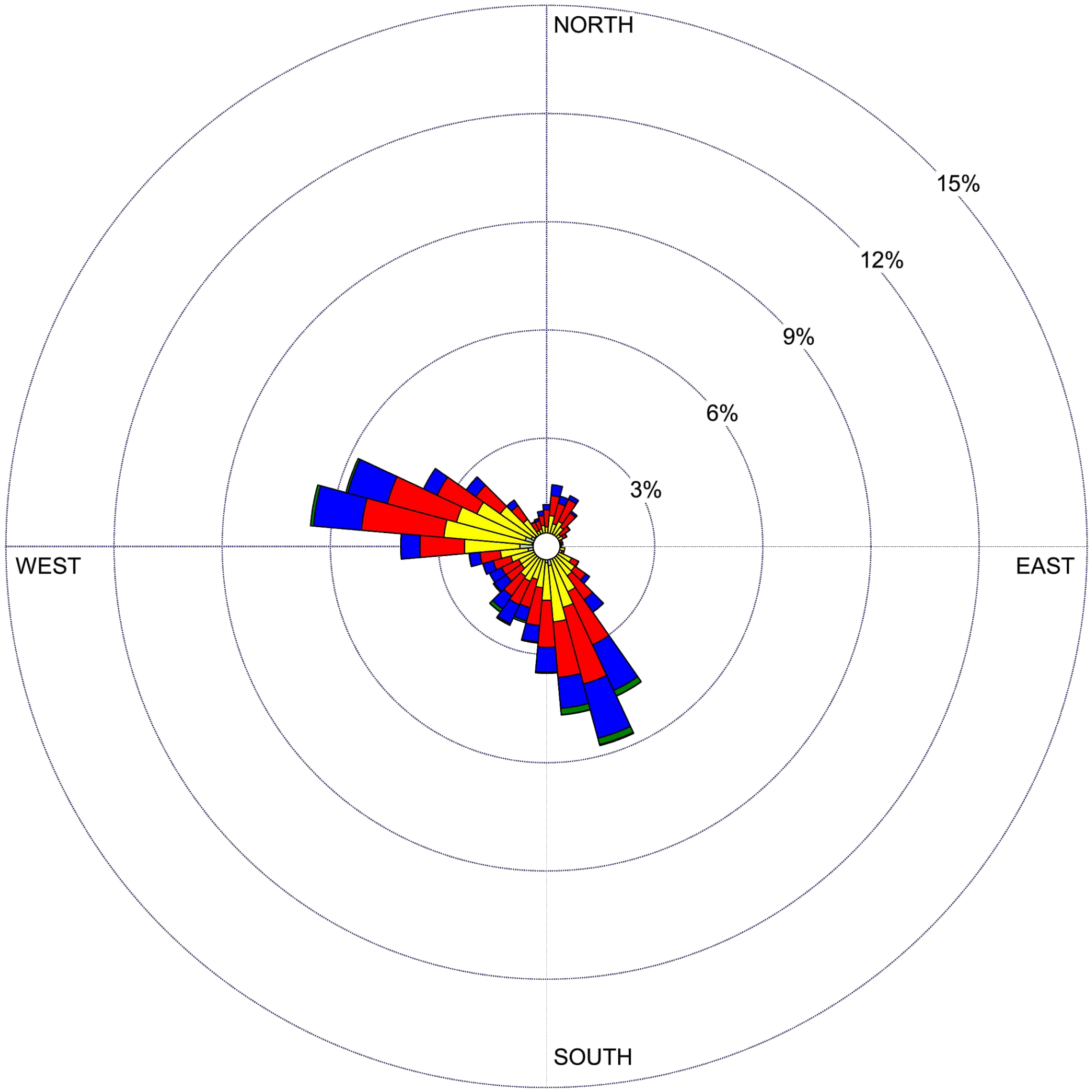
TITLE
WIND ROSE FOR CORVALLIS, OREGON WINTER 2010 TO 2014 WITH SUBSTITUTED DATA

PROJECT NO.	PHASE	REV.	FIGURE
1419107	001	000	4-2



NOTE(S)

WIND ROSE GENERATED FROM LAKES ENVIRONMENTAL WRPLOT VIEW. METEOROLOGICAL DATA REPRESENTS SPRING SEASON (MARCH, APRIL, AND MAY) RECORDED DATA ONLY FOR 2010 TO 2014.

WIND SPEED DIRECTION - BLOWING FROM.
TOTAL NUMBER OF HOURS = 10,920
AVERAGE WIND SPEED = 3.16 m/s

WIND SPEED (m/s)

- >= 11.10
- 8.80 - 11.10
- 5.70 - 8.80
- 3.60 - 5.70
- 2.10 - 3.60
- 0.50 - 2.10

Calms: 20.94%

CLIENT
HOLLINGSWORTH & VOSE FIBER COMPANY
CORVALLIS, OREGON

PROJECT
FLUORIDE AIR DISPERSION MODELING REPORT
HOLLINGSWORTH & VOSE FIBER COMPANY
CORVALLIS, OREGON

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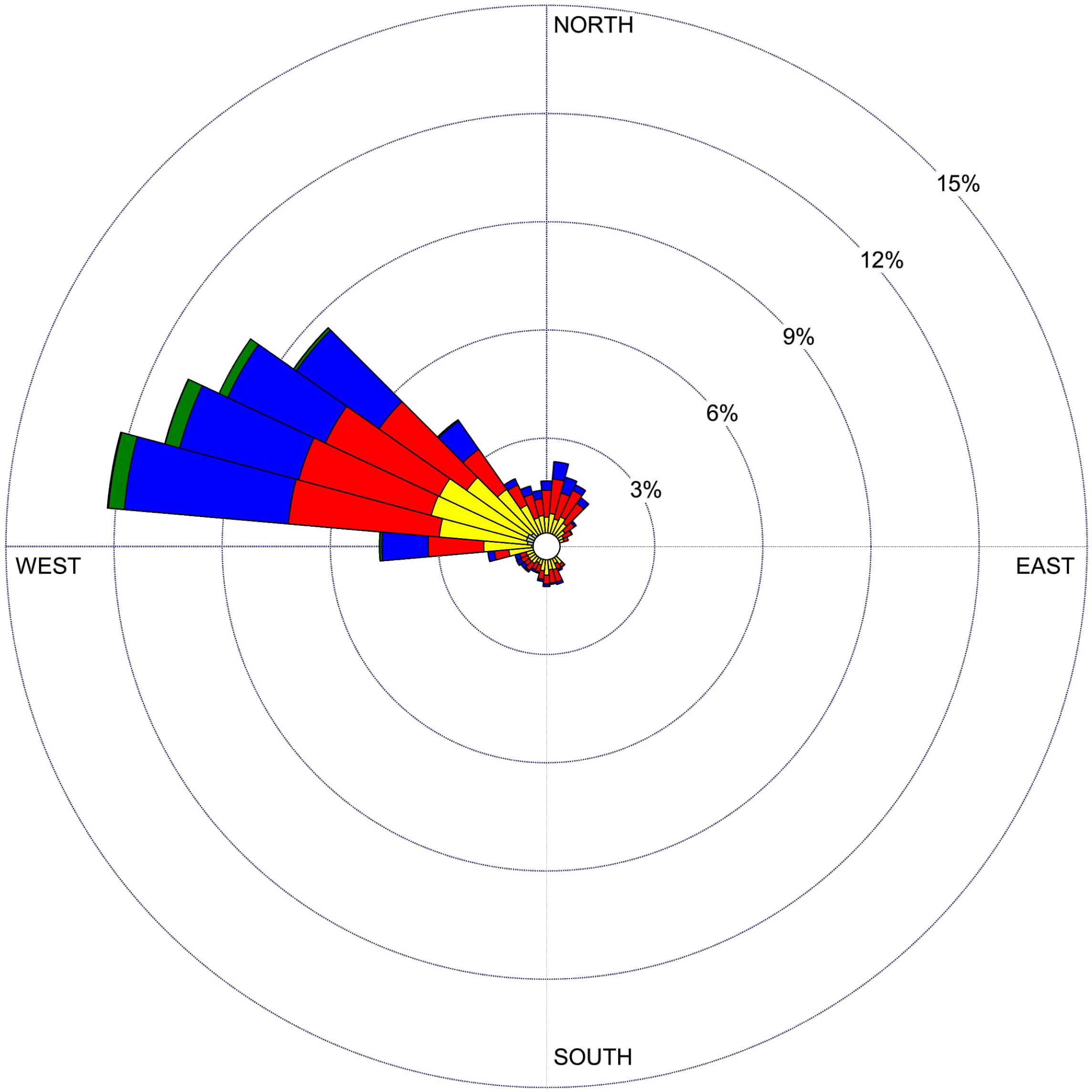
TITLE
WIND ROSE FOR CORVALLIS, OREGON SPRING 2010 TO 2014 WITH SUBSTITUTED DATA

PROJECT NO.	PHASE	REV.	FIGURE
1419107	001	000	4-3



NOTE(S)

WIND ROSE GENERATED FROM LAKES ENVIRONMENTAL WRPLOT VIEW. METEOROLOGICAL DATA REPRESENTS SUMMER SEASON (JUNE, JULY, AND AUGUST) RECORDED DATA ONLY FOR 2010 TO 2014.

WIND SPEED DIRECTION - BLOWING FROM.
TOTAL NUMBER OF HOURS = 10,729
AVERAGE WIND SPEED = 3.67 m/s

WIND SPEED (m/s)

- >= 11.10
- 8.80 - 11.10
- 5.70 - 8.80
- 3.60 - 5.70
- 2.10 - 3.60
- 0.50 - 2.10

Calms: 14.67%

CLIENT
HOLLINGSWORTH & VOSE FIBER COMPANY
CORVALLIS, OREGON

PROJECT
FLUORIDE AIR DISPERSION MODELING REPORT
HOLLINGSWORTH & VOSE FIBER COMPANY
CORVALLIS, OREGON

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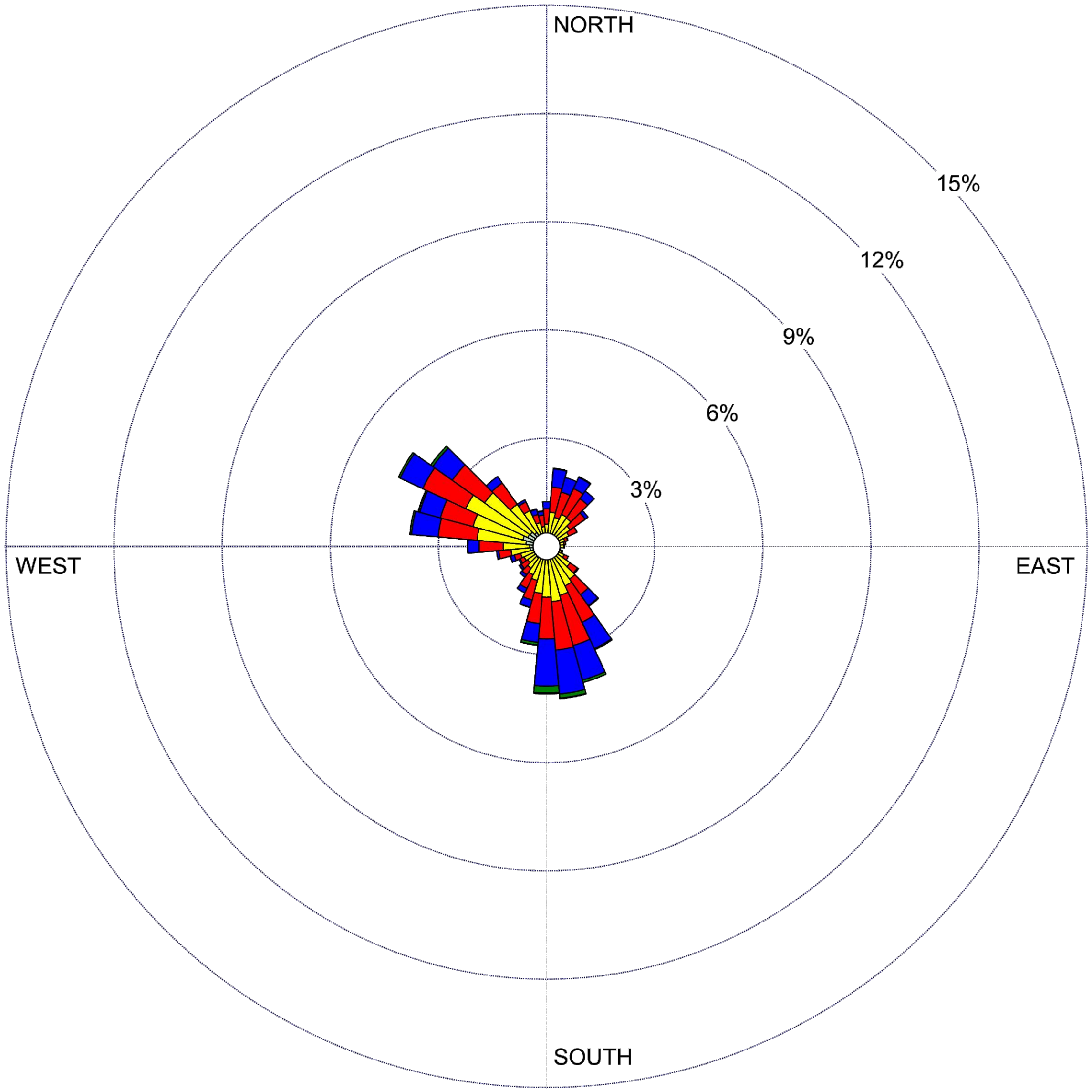
PREPARED	BS
REVIEWED	GS
APPROVED	CD

TITLE
WIND ROSE FOR CORVALLIS, OREGON SUMMER 2010 TO 2014 WITH SUBSTITUTED DATA

PROJECT NO.	PHASE	REV.	FIGURE
1419107	001	000	4-4



NOTE(S)

WIND ROSE GENERATED FROM LAKES ENVIRONMENTAL WRPLOT VIEW. METEOROLOGICAL DATA REPRESENTS FALL SEASON (SEPTEMBER, OCTOBER, AND NOVEMBER) RECORDED DATA ONLY FOR 2010 TO 2014.

WIND SPEED DIRECTION - BLOWING FROM.
TOTAL NUMBER OF HOURS = 10,843
AVERAGE WIND SPEED = 2.66 m/s

WIND SPEED (m/s)

- >= 11.10
- 8.80 - 11.10
- 5.70 - 8.80
- 3.60 - 5.70
- 2.10 - 3.60
- 0.50 - 2.10

Calms: 30.77%

CLIENT
HOLLINGSWORTH & VOSE FIBER COMPANY
CORVALLIS, OREGON

PROJECT
FLUORIDE AIR DISPERSION MODELING REPORT
HOLLINGSWORTH & VOSE FIBER COMPANY
CORVALLIS, OREGON

CONSULTANT

Golder Associates

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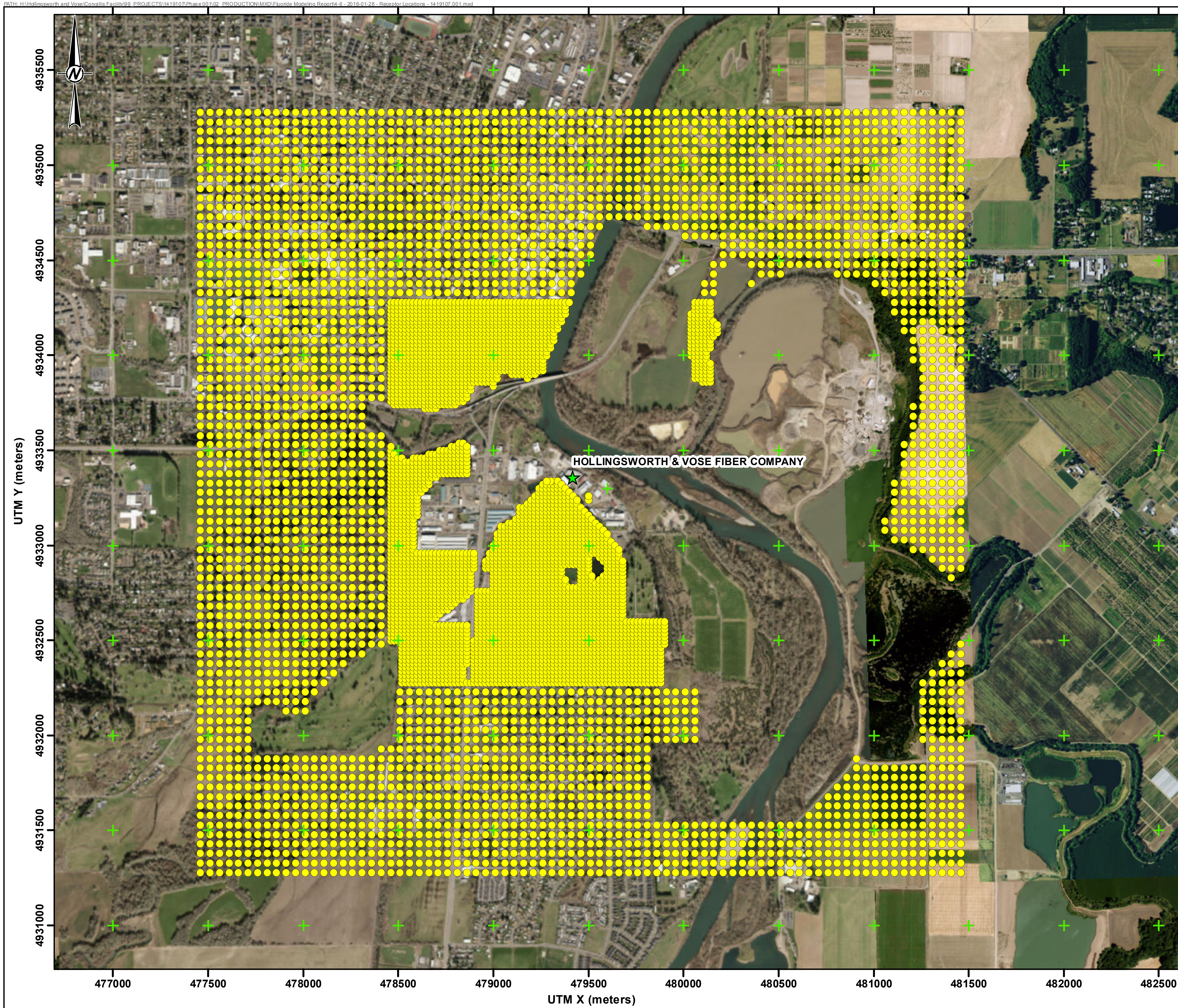
PREPARED	BS
REVIEWED	GS
APPROVED	CD

TITLE
WIND ROSE FOR CORVALLIS, OREGON FALL 2010 TO 2014 WITH SUBSTITUTED DATA

PROJECT NO.	PHASE	REV.	FIGURE
1419107	001	000	4-5

PATH: H:\Hollingsworth and Vose\Corvallis Facility\99_PROJECTS\1419107\Phase 001\02_PRODUCTION\MXD\Fluoride Modeling Report\4-6 - 2016-01-28 - Receptor Locations - 1419107.001.mxd



LEGEND

APPROXIMATE HOLLINGSWORTH & VOSE FIBER COMPANY FACILITY LOCATION

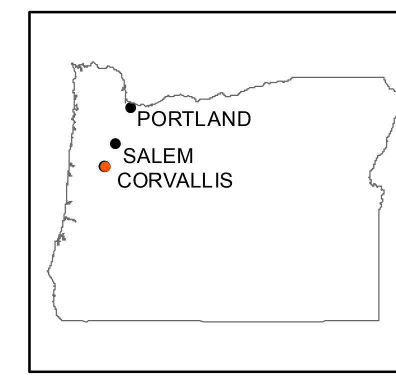
RECEPTOR LOCATION

UTM GRID GUIDELINE

NOTE(S)

1. COORDINATE SYSTEM IS WORLD GEODETIC SYSTEM (WGS) 1984 UNIVERSAL TRANVERSE MERCATOR (UTM) NORTHERN HEMISPHERE ZONE 10.

KEY MAP



0 0.25 0.5 1

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REVIEWED	GS
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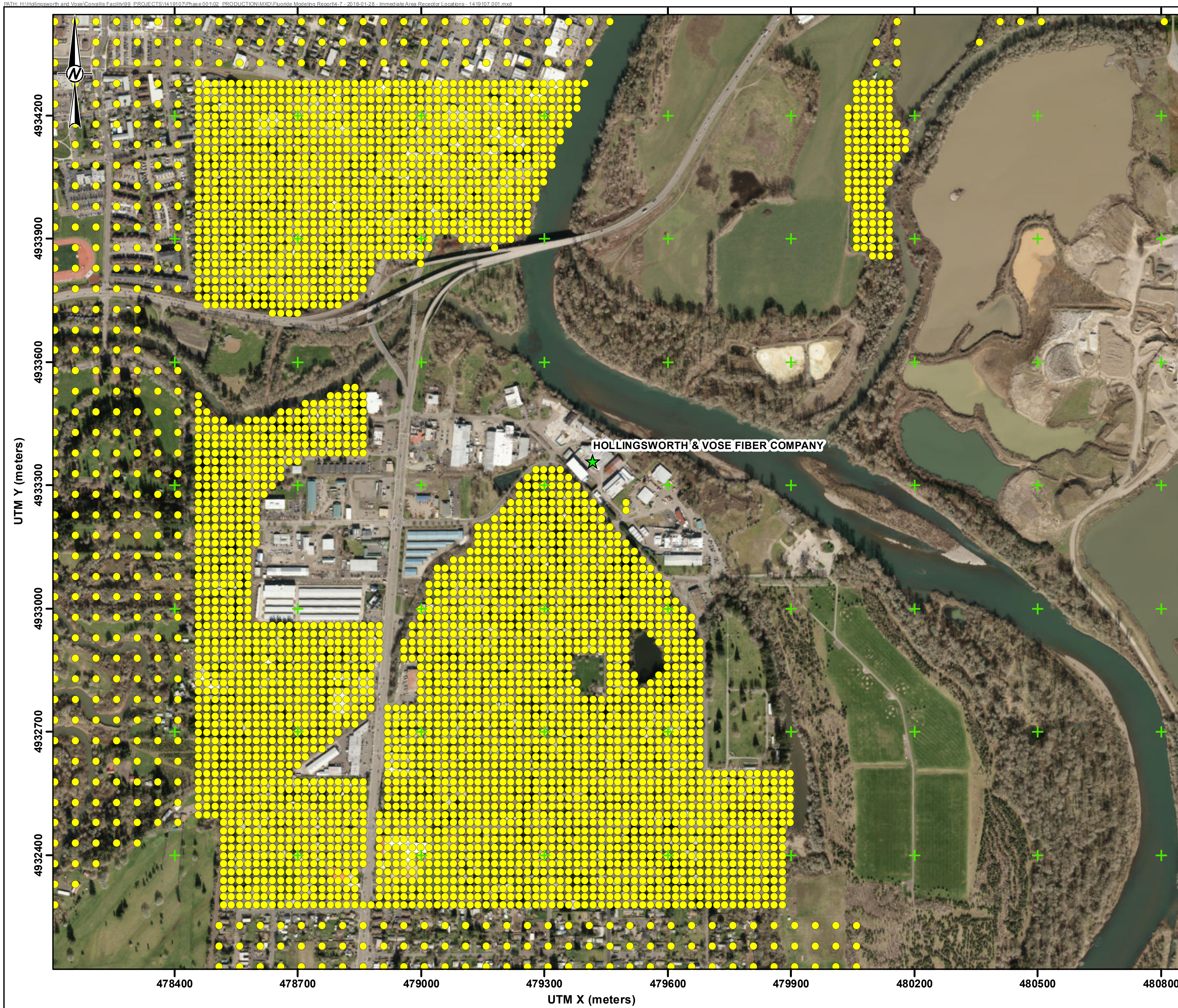
TITLE

RECEPTOR LOCATIONS
HOLLINGSWORTH & VOSE FIBER COMPANY
CORVALLIS, OREGON

PROJECT NO.	PHASE	REV.	FIGURE
1419107	001	000	4-6

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

PATH: H:\Hollingsworth and Vose\Corvallis Facility\99_PROJECTS\1419107\Phase 001\02_PRODUCTION\MXD\Fluoride Modeling Report\4-7 - 2016-01-28 - Immediate Area Receptor Locations - 1419107.001.mxd



LEGEND

APPROXIMATE HOLLINGSWORTH & VOSE FIBER COMPANY FACILITY LOCATION

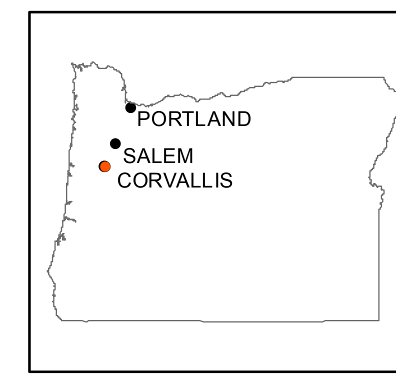
RECEPTOR LOCATION

UTM GRID GUIDELINE

NOTE(S)

1. COORDINATE SYSTEM IS WORLD GEODETIC SYSTEM (WGS) 1984 UNIVERSAL TRANVERSE MERCATOR (UTM) NORTHERN HEMISPHERE ZONE 10.

KEY MAP



0 150 300 600

METERS

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Golder Associates

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PREPARED	BS
REVIEWED	GS
APPROVED	CD

TITLE

RECEPTOR LOCATIONS IN THE IMMEDIATE AREA HOLLINGSWORTH & VOSE FIBER COMPANY CORVALLIS, OREGON

PROJECT NO.	PHASE	REV.	FIGURE
1419107	001	000	4-7

1 in

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

PATH: H:\Hollingsworth and Vose\Corvallis Facility\99_PROJECTS\1419107\Phase 001\02_PRODUCTION\MXD\Fluoride Modeling Report\4-8 - 2016-01-28 - Modeled Downwash Structures - 1419107.001.mxd

LEGEND

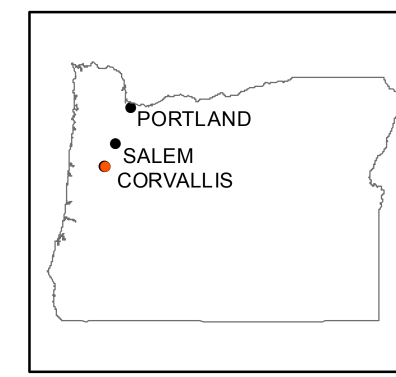
DOWNWASH STRUCTURE

UTM GRID GUIDELINE

NOTE(S)

1. COORDINATE SYSTEM IS WORLD GEODETIC SYSTEM (WGS) 1984 UNIVERSAL TRANVERSE MERCATOR (UTM) NORTHERN HEMISPHERE ZONE 10.

KEY MAP



0 50 100 200

METERS

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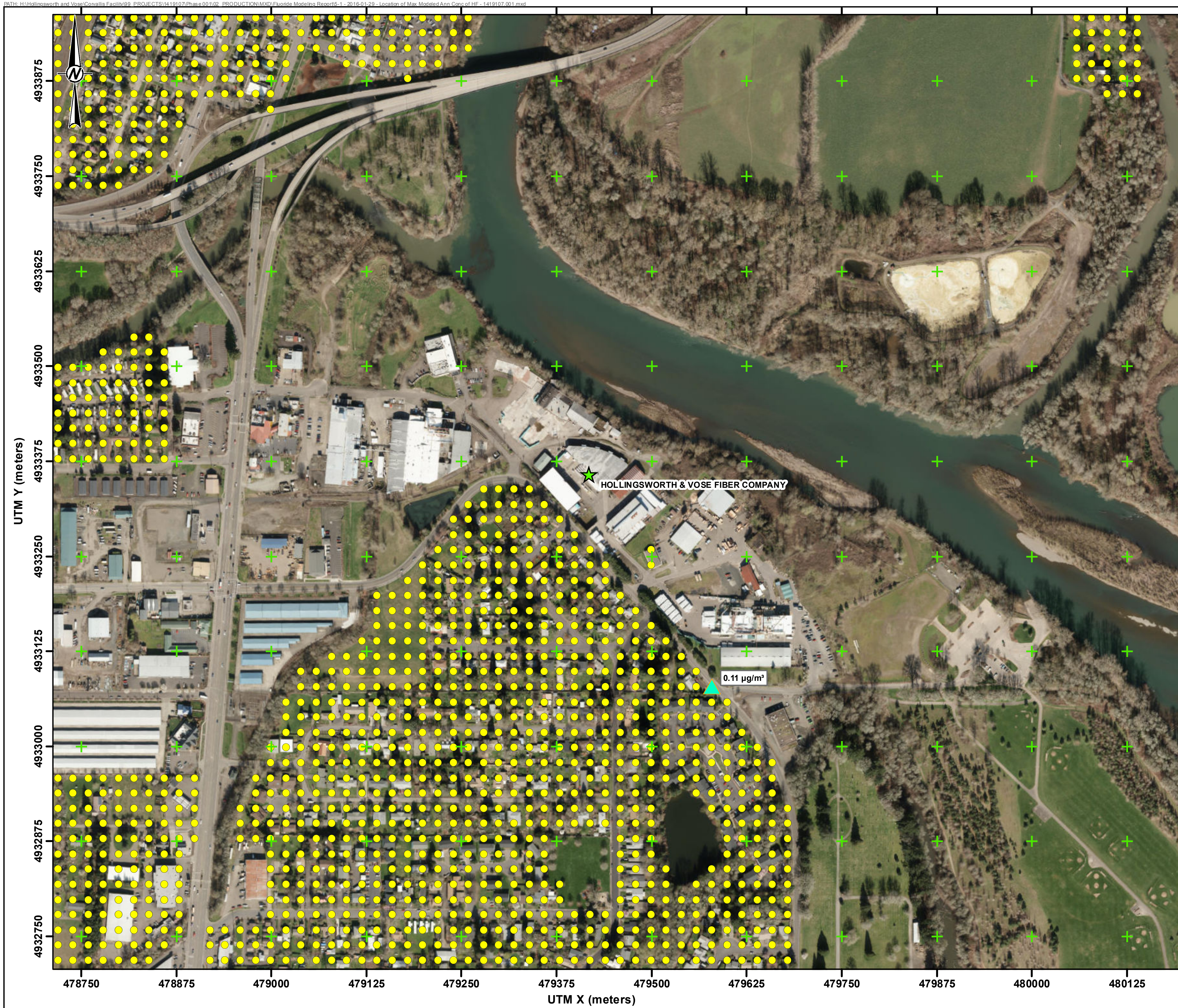
PREPARED	BS
REVIEWED	GS
APPROVED	CD

TITLE

MODELED DOWNWASH STRUCTURES
HOLLINGSWORTH & VOSE FIBER COMPANY
CORVALLIS, OREGON

PROJECT NO.	PHASE	REV.	FIGURE
1419107	001	000	4-8

PATH: H:\Hollingsworth and Vose\Corvallis Facility\99_PROJECTS\1419107\Phase 001\02_PRODUCTION\MXD\Fluoride Modeling Report\5-1 - 2016-01-29 - Location of Max Modeled Ann Conc of HF - 1419107.001.mxd



LEGEND

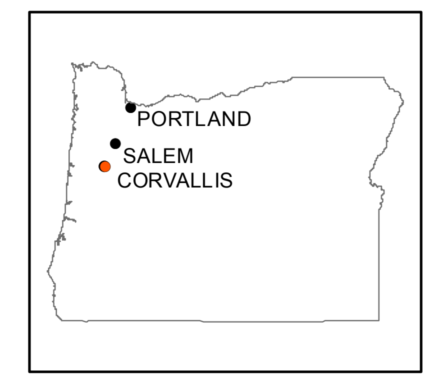
- ★ APPROXIMATE HOLLINGSWORTH & VOSE FIBER COMPANY FACILITY LOCATION
- ▲ LOCATION OF MAXIMUM PREDICTED CONCENTRATION OF 0.11 µg/m³
- ● RECEPTOR LOCATION
- + UTM GRID GUIDELINE

NOTE(S)

1. COORDINATE SYSTEM IS WORLD GEODETIC SYSTEM (WGS) 1984 UNIVERSAL TRANSVERSE MERCATOR (UTM) NORTHERN HEMISPHERE ZONE 10.

2. ALL MODELED CONCENTRATIONS ARE BELOW THE RISK-BASED CHRONIC EXPOSURE THRESHOLD OF 14 µg/m³.

KEY MAP



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METERS

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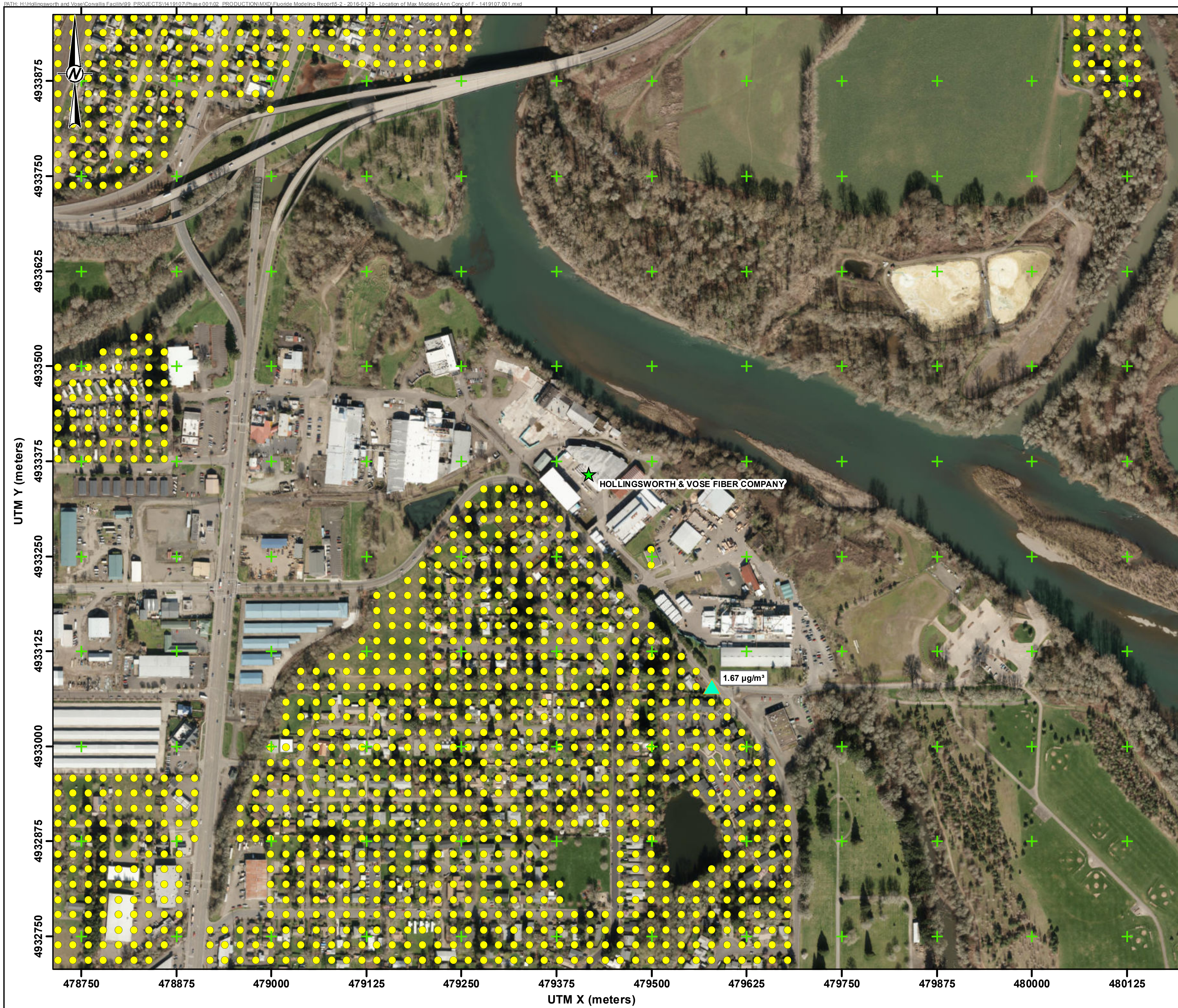
PREPARED	BS
REVIEWED	GS
APPROVED	CD

TITLE

LOCATION OF MAXIMUM MODELED ANNUAL CONCENTRATION FOR HYDROGEN FLUORIDE (HF)
HOLLINGSWORTH & VOSE FIBER COMPANY
CORVALLIS, OREGON

PROJECT NO.	PHASE	REV.	FIGURE
1419107	001	000	5-1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B



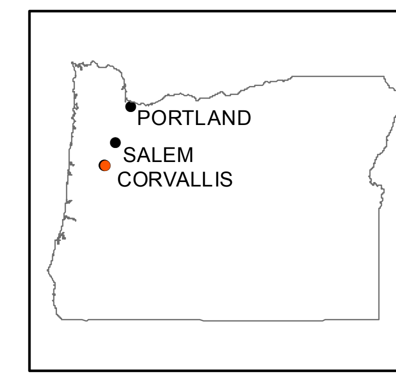
LEGEND

- ★ APPROXIMATE HOLLINGSWORTH & VOSE FIBER COMPANY FACILITY LOCATION
- ▲ LOCATION OF MAXIMUM PREDICTED CONCENTRATION OF 1.67 μg/m³
- ● RECEPTOR LOCATION
- + UTM GRID GUIDELINE

NOTE(S)

1. COORDINATE SYSTEM IS WORLD GEODETIC SYSTEM (WGS) 1984 UNIVERSAL TRANSVERSE MERCATOR (UTM) NORTHERN HEMISPHERE ZONE 10.
2. ALL MODELED CONCENTRATIONS ARE BELOW THE RISK-BASED CHRONIC EXPOSURE THRESHOLD OF 13 μg/m³.

KEY MAP



0 62.5 125 250
METERS

CONSULTANT

Golder Associates

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PREPARED	BS
REVIEWED	GS
APPROVED	CD

TITLE

**LOCATION OF MAXIMUM MODELED ANNUAL CONCENTRATION OF FLUORIDES (F)
HOLLINGSWORTH & VOSE FIBER COMPANY
CORVALLIS, OREGON**

PROJECT NO.	PHASE	REV.	FIGURE
1419107	001	000	5-2

Appendix A
Emissions Inventory – Fluorides and Hydrogen Fluoride

Table A-1
Input Assumptions
Hollingsworth & Vose Fiber Company - Corvallis, Oregon

Parameter	Rotary Fine Production					Rotary Coarse Production					Flameblown Production					Glass Melt Production			Hours of Operation	
	Production Rate Per-Position [1] (lbs/hr/position)	Number of Operational Positions	Throughput			Production Rate Per-Position [1] (lbs/hr/position)	Number of Operational Positions	Throughput			Production Rate Per-Position [1] (lbs/hr/position)	Number of Operational Positions	Throughput			Throughput			Daily (hrs/day)	Annual (hrs/yr)
			Hourly [a] (tons/hr)	Daily [b] (tons/day)	Annual [c] (tons/yr)			Hourly [a] (tons/hr)	Daily [b] (tons/day)	Annual [c] (tons/yr)			Hourly [a] (tons/hr)	Daily [b] (tons/day)	Annual [c] (tons/yr)	Hourly [d] (tons/hr)	Daily [1] (tons/day)	Annual [c] (tons/yr)		
Glass Plant 1																				
Line 1	66.0	0 [3]	0	0	0	222	12 [3]	1.33	32.0	11,668	40.8	0 [3]	0	0	0	1.13	27.15	9,910	24 [2]	8,760 [2]
Line 2	66.0	0 [3]	0	0	0	222	8 [3]	0.89	21.3	7,779	40.8	0 [3]	0	0	0	1.13	27.15	9,910	24 [2]	8,760 [2]
Line 3	66.0	4 [3]	0.13	3.17	1,156	222	0 [3]	0	0	0	40.8	0 [3]	0	0	0	--	--	--	24 [2]	8,760 [2]
Glass Plant 2																				
Line 4 - Existing	55.0	5 [4]	0.14	3.30	1,205	185	0 [4]	0	0	0	34.0	4 [4]	0.068	1.63	596	--	--	--	24 [2]	8,760 [2]
Line 4 - Build-Out	55.0	11 [4]	0.30	7.26	2,650	185	0 [4]	0	0	0	34.0	0 [4]	0	0	0	--	--	--	24 [2]	8,760 [2]

Notes:

(a) Hourly throughput (tons/hr) = (production rate per-position [lbs/hr/position]) x (number of operational positions) x (ton/2,000 lbs)

(b) Daily throughput (tons/day) = (hourly throughput [tons/hr]) x (daily hours of operation [hrs/day])

(c) Annual throughput (tons/yr) = (daily throughput [tons/day]) x (annual hours of operation [hrs/yr]) / (daily hours of operation [hrs/day])

(d) Hourly throughput (tons/hr) = (daily throughput [tons/day]) / (daily hours of operation [hrs/day])

References:

(1) Representative average pull rate across all products. Individual product pull rates can vary.

(2) Assumes continuous facility operation.

(3) See Table A-3, Glass Plant 1 F and HF Emission Estimates.

(4) See Table A-4, Glass Plant 2 F and HF Emission Estimates.

Table A-2
Emission Factor Summary
Hollingsworth & Vose Fiber Company - Corvallis, Oregon

Process	Production-Based Emission Factors (lbs pollutant / ton production)		
	TF (1)	HF (2)	Fluorides (3)
Rotary Fine Final Emission Factor	2.37	0.047	2.323
Rotary Coarse Final Emission Factor	0.63	0.0448	0.5852
Flameblown Final Emission Factor	2.38	0.043	2.337
Glass Melt Final Emission Factor	0.041	0.0064	0.0346

TF = Total fluoride

HF = Hydrogen fluoride

Fluorides = Total fluoride minus hydrogen fluoride

References:

(1) Emission factor provided by Oregon Department of Environmental Quality via email on October 23, 2015. Total fluoride measured by EPA source test method 13A or 13B.

(2) Emission factor provided by Oregon Department of Environmental Quality via email on October 23, 2015. Hydrogen fluoride measured by EPA source test method 26.

(3) Fluorides for permitting purposes is TF minus HF.

Table A-3
Glass Plant 1 F and HF Emission Estimates
Hollingsworth & Vose Fiber Company - Corvallis, Oregon

Production Line	Throughput Type	Annual Throughput [1] (tons/yr)	Number of Operational Positions	Emission Factors [2] (lbs/ton)	
				Fluorides	Hydrogen Fluoride
Line 1	Rotary Fine	0	0	2.323	0.047
	Rotary Coarse	11,668	12	0.5852	0.0448
	Flameblown	0	0	2.337	0.043
Line 2	Rotary Fine	0	0	2.323	0.047
	Rotary Coarse	7,779	8	0.5852	0.0448
	Flameblown	0	0	2.337	0.043
Line 3	Rotary Fine	1,156	4	2.323	0.047
	Rotary Coarse	0	0	0.5852	0.0448
	Flameblown	0	0	2.337	0.043

Production Line	Position ID	Stack ID	Throughput Type	Annual Throughput Per Position [a] (tons/yr)	Control Type	Annual Emissions Estimate [b] (tons/yr)	
						Fluorides	Hydrogen Fluoride
1	1	L3S1	*Rotary Coarse*	972	Existing Control	0.28	0.022
1	2	L3S1	*Rotary Coarse*	972	Existing Control	0.28	0.022
1	3	L3S2	*Rotary Coarse*	972	Existing Control	0.28	0.022
1	4	L3S2	*Rotary Coarse*	972	Existing Control	0.28	0.022
1	5	L1S	*Rotary Coarse*	972	Existing Control	0.28	0.022
1	6	L1S	*Rotary Coarse*	972	Existing Control	0.28	0.022
1	7	L3S2	*Rotary Coarse*	972	Existing Control	0.28	0.022
1	8	L3S2	*Rotary Coarse*	972	Existing Control	0.28	0.022
1	9	L1S	*Rotary Coarse*	972	Existing Control	0.28	0.022
1	10	L1S	*Rotary Coarse*	972	Existing Control	0.28	0.022
1	11	L1S	*Rotary Coarse*	972	Existing Control	0.28	0.022
1	12	L1S	*Rotary Coarse*	972	Existing Control	0.28	0.022
Production Line 1			**Rotary Fine**	**0**	**--**	**0**	**0**
			Rotary Coarse	**11,668**	**--**	**3.41**	**0.26**
			Flameblown	**0**	**--**	**0**	**0**
2	2	L3S1	*Rotary Coarse*	972	Existing Control	0.28	0.022
2	3	L2S	*Rotary Coarse*	972	Existing Control	0.28	0.022
2	4	L2S	*Rotary Coarse*	972	Existing Control	0.28	0.022
2	5	L2S	*Rotary Coarse*	972	Existing Control	0.28	0.022
2	6	L3S1	*Rotary Coarse*	972	Existing Control	0.28	0.022
2	7	L2S	*Rotary Coarse*	972	Existing Control	0.28	0.022
2	8	L2S	*Rotary Coarse*	972	Existing Control	0.28	0.022
2	9	L2S	*Rotary Coarse*	972	Existing Control	0.28	0.022
Production Line 2			**Rotary Fine**	**0**	**--**	**0**	**0**
			Rotary Coarse	**7,779**	**--**	**2.28**	**0.17**
			Flameblown	**0**	**--**	**0**	**0**
3	3	L3S2	*Rotary Fine*	289	Existing Control	0.34	6.8E-03
3	4	L3S2	*Rotary Fine*	289	Existing Control	0.34	6.8E-03
3	5	L3S2	*Rotary Fine*	289	Existing Control	0.34	6.8E-03
3	6	L3S2	*Rotary Fine*	289	Existing Control	0.34	6.8E-03
Production Line 3			**Rotary Fine**	**1,156**	**--**	**1.34**	**0.027**
			Rotary Coarse	**0**	**--**	**0**	**0**
			Flameblown	**0**	**--**	**0**	**0**

Notes:
(a) Process throughput per position annual throughput (tons/yr) = (process annual throughput [tons/yr]) / (number of operational positions)
(b) Annual emissions estimate (tons/yr) = (process emission factor [lbs/ton]) x (annual throughput per position [tons/yr]) x (ton/2,000 lbs)

References:
(1) See Table A-1, Input Assumptions.
(2) See Table A-2, Emission Factor Summary.

Table A-4
Glass Plant 2 F and HF Emission Estimates
Hollingsworth & Vose Fiber Company - Corvallis, Oregon

Production Line	Throughput Type	Annual Throughput [1] (tons/yr)	Number of Operational Positions	Emission Factors [2] (lbs/ton)	
				Fluorides	Hydrogen Fluoride
Existing Line 4	Rotary Fine	1,205	5	2.323	0.047
	Rotary Coarse	0	0	0.5852	0.0448
	Flameblown	596	4	2.337	0.043
Line 4 Build-out	Rotary Fine	2,650	11	2.323	0.047
	Rotary Coarse	0	0	0.5852	0.0448
	Flameblown	0	0	2.337	0.043

Production Line	Position ID	Stack ID	Throughput Type	Annual Throughput Per Position [a] (tons/yr)	Control Type	Annual Emissions Estimate [b] (tons/yr)	
						Fluorides	Hydrogen Fluoride
4-EX	1	L4S1	*Flameblown*	149	Existing Control	0.17	3.2E-03
4-EX	2	L4S1	*Flameblown*	149	Existing Control	0.17	3.2E-03
4-EX	3	L4S1	*Flameblown*	149	Existing Control	0.17	3.2E-03
4-EX	4	L4S1	*Flameblown*	149	Existing Control	0.17	3.2E-03
4-EX	5	L4S1	*Rotary Fine*	241	Existing Control	0.28	5.7E-03
4-EX	6	L4S1	*Rotary Fine*	241	Existing Control	0.28	5.7E-03
4-EX	7	L4S2	*Rotary Fine*	241	Existing Control	0.28	5.7E-03
4-EX	8	L4S2	*Rotary Fine*	241	Existing Control	0.28	5.7E-03
4-EX	9	L4S2	*Rotary Fine*	241	Existing Control	0.28	5.7E-03
Production Line 4 Existing			**Rotary Fine**	**1,205**	**--**	**1.40**	**0.028**
			Rotary Coarse	**0**	**--**	**0**	**0**
			Flameblown	**596**	**--**	**0.70**	**0.013**
4-BD	10	L4S3	*Rotary Fine*	241	New (Dry) Control	0.28	5.7E-03
4-BD	11	L4S3	*Rotary Fine*	241	New (Dry) Control	0.28	5.7E-03
4-BD	12	L4S3	*Rotary Fine*	241	New (Dry) Control	0.28	5.7E-03
4-BD	13	L4S3	*Rotary Fine*	241	New (Dry) Control	0.28	5.7E-03
4-BD	14	L4S3	*Rotary Fine*	241	New (Dry) Control	0.28	5.7E-03
4-BD	15	L4S3	*Rotary Fine*	241	New (Dry) Control	0.28	5.7E-03
4-BD	16	L4S4	*Rotary Fine*	241	New (Dry) Control	0.28	5.7E-03
4-BD	17	L4S4	*Rotary Fine*	241	New (Dry) Control	0.28	5.7E-03
4-BD	18	L4S4	*Rotary Fine*	241	New (Dry) Control	0.28	5.7E-03
4-BD	19	L4S4	*Rotary Fine*	241	New (Dry) Control	0.28	5.7E-03
4-BD	20	L4S4	*Rotary Fine*	241	New (Dry) Control	0.28	5.7E-03
Production Line 4 Build-out			**Rotary Fine**	**2,650**	**--**	**3.08**	**0.062**
			Rotary Coarse	**0**	**--**	**0**	**0**
			Flameblown	**0**	**--**	**0**	**0**

Notes:
(a) Process throughput per position annual throughput (tons/yr) = (process annual throughput [tons/yr]) / (number of operational positions)
(b) Annual emissions estimate (tons/yr) = (process emission factor [lbs/ton]) x (annual throughput per position [tons/yr]) x (ton/2,000 lbs)

References:
(1) See Table A-1, Input Assumptions.
(2) See Table A-2, Emission Factor Summary.

Table A-5
Glass Melt F and HF Emission Estimates
Hollingsworth & Vose Fiber Company - Corvallis, Oregon

Throughput Type	Emission Factors [1] (lbs/ton)	
	Fluorides	Hydrogen Fluoride
Glass Melt	0.0346	0.0064

Plant Location	Production Line ID	Stack ID	Annual Throughput [2] (tons/yr)	Annual Emissions Estimate [a] (tons/yr)	
				Fluorides	Hydrogen Fluoride
1	1	FSS	9,910	0.17	0.03
1	2	FSS	9,910	0.17	0.03
Total Glass Melt Emissions Estimate				**0.34**	**0.06**

Notes:

(a) Annual emissions estimate (tons/yr) = (process emission factor [lbs/ton]) x (annual throughput per position [tons/yr]) x (ton/2,000 lbs)

References:

(1) See Table A-2, Emission Factor Summary.

(2) See Table A-1, Input Assumptions.

Table A-6
Annual F and HF Emissions Estimate Summary
Hollingsworth & Vose Fiber Company - Corvallis, Oregon

Parameter	Annual Emissions Estimate (tons/yr)	
	Fluorides	Hydrogen Fluoride
Glass Plant 1		
Production Line 1	3.59	0.29
Rotary Fine	0	0
Rotary Coarse	3.41	0.26
Flameblown	0	0
Glass Melt	0.17	0.03
Forehearths	--	--
Raw Material Handling	--	--
Production Line 2	2.45	0.20
Rotary Fine	0	0
Rotary Coarse	2.28	0.17
Flameblown	0	0
Glass Melt	0.17	0.03
Forehearths	--	--
Raw Material Handling	--	--
Production Line 3	1.34	0.027
Rotary Fine	1.34	0.027
Rotary Coarse	0	0
Flameblown	0	0
Total Glass Plant 1	***7.38***	***0.5***
Glass Plant 2		
Production Line 4 Existing	2.10	0.041
Rotary Fine	1.40	0.028
Rotary Coarse	0	0
Flameblown	0.70	0.013
Production Line 4 Build-out	3.08	0.062
Rotary Fine	3.08	0.062
Rotary Coarse	0	0
Flameblown	0	0
Total Glass Plant 2	***5.17***	***0.1***

Total Facility-Wide Emissions Estimate	**12.5**	**0.6**

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