LENZ ENTERPRISES COMPOST FACILITY
PROPOSED FACILITY EXPANSION

Air Quality Technical Report
2nd Addendum (Refined Calculations)

Prepared for

Lenz Enterprises

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ACRONYMS AND ABBREVIATIONS

agl	Above Ground Level
ASIL	Acceptable Source Impact Level
ASP	Aerated Static Pile
DEM	Digital Elevation Model
EnviroComp	EnviroComp Consulting, Inc.
EPA	U.S. Environmental Protection Agency
FAA	Federal Aviation Administration
HAP	Hazardous Air Pollutant
ICAO	International Civil Aviation Organization
ISD	Integrated Surface Data
LCF	Lenz Composting Facility
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
PSCAA	Puget Sound Clean Air Agency
TAP	Toxic Air Pollutant
tpy	Tons per year
SQER	Small Quantity Emission Rate
WAC	Washington Administrative Code
WBAN	Weather Bureau Army Navy identification numbers

1 Overview

Lenz Enterprises, Inc.[1] ("Lenz") retained the services of EnviroComp Consulting, Inc.[2] ("EnviroComp") to assist in the process of obtaining an air quality permit from the Puget Sound Clean Air Agency (PSCAA) for the expansion of an existing composting facility near Stanwood Washington in Snohomish County. Currently Lenz processes 75,000 tons per year (tpy) of organic feedstock, and proposes to modify and expand their current compost facility to process 150,000 tpy.

EnviroComp submitted a main report in July 2019, with calculations of the air quality impacts of four TAP species (ammonia, formaldehyde, 1,3 butadiene, and benzene) that emitted in quantities greater than the SQER. At the same time (July 2019), EnviroComp submitted an addendum report to evaluate if and how the TAPs vary (e.g., number of TAPs emitted, number of TAPs exceeding their SQER, and possible exceedance of their ASIL) using the values proposed at the time (WAC 173-460-150 Draft Table of ASIL, SQER and de minimis emission values)[3].

The purpose of this second addendum report is to provide a revised set of increased emission estimates based on 1) proposed changes in the configuration of the facility; 2) literature review; 3) discussions with Ecology's personnel. For those emissions that exceed the SQER, computer modeling is performed using the same atmospheric dispersion model (i.e., AERMOD) described in the main report[4], with some improvements in the modeling procedures (e.g., meteorological data, receptors, plume rise). The modeling results, i.e., the ambient TAP/HAP[5]

[1] http://www.lenz-enterprises.com/
[2] https://www.envirocomp.com/
[3] https://ecology.wa.gov/DOE/files/65/651e0b34-2a86-4e3e-8f8f-011653306e0c.pdf
[4] For the current simulations we used AERMOD version 19191, while in July 2019 we used version 18081, which was the most recent at that time.
[5] HAPs are pollutants "known to cause or may reasonably be anticipated to cause adverse effects to human health or adverse environmental effects". (From https://deq.nc.gov/about/divisions/air-quality/air-quality-rules/haps-taps). According to WAC (https://apps.leg.wa.gov/WAC/default.aspx?cite=173-460&full=true, Definitions, point 8), "Toxic air

concentrations caused by the emissions are then compared with both current and future ASILs. In fact, the Washington Department of Ecology has updated ASILs and SQERs on their list of TAPs[6]. Ecology has adopted the new SQERs and ASILs in late December 2019; PSCAA has not yet adopted the new WAC, but it plans to adopt it during the next months[7].

The changes in the new WAC[8] resulted in some of the SQERs and ASILs becoming more stringent, some becoming less stringent, and some remaining the same. Moreover, some species that were not listed among the TAPs (e.g., propionaldehyde) have now been added.

pollutant (TAP)" means any toxic air pollutant listed in WAC 173-460-150 (https://apps.leg.wa.gov/WAC/default.aspx?cite=173-460&full=true#173-460-150).

[6] https://ecology.wa.gov/Regulations-Permits/Laws-rules-rulemaking/Closed-rulemaking/WAC173-460

[7] Personal communication.

[8] http://apps.leg.wa.gov/WAC/default.aspx?cite=173-460-150

2 The Lenz Facility

The new, proposed configuration of the Lenz Composting Facility (LCF) is illustrated in Figure 1. TW1 and TW2 indicates the area of the two Turning Windrows; BF1 and BF2 are the existing engineered biofilters, while BF3 and BF4 are the future engineered biofilters; SCR is the screening area, and FIN is the area of the finished product. The cumulative surface of the two TWs is 177,000 ft^2, while the surface of the finished product is 35,000 ft^2. The tipping building, where the fresh product is stockpiled for few hours when it arrives, is visible just east of TW2. The stockpiling emissions exit from BF1.

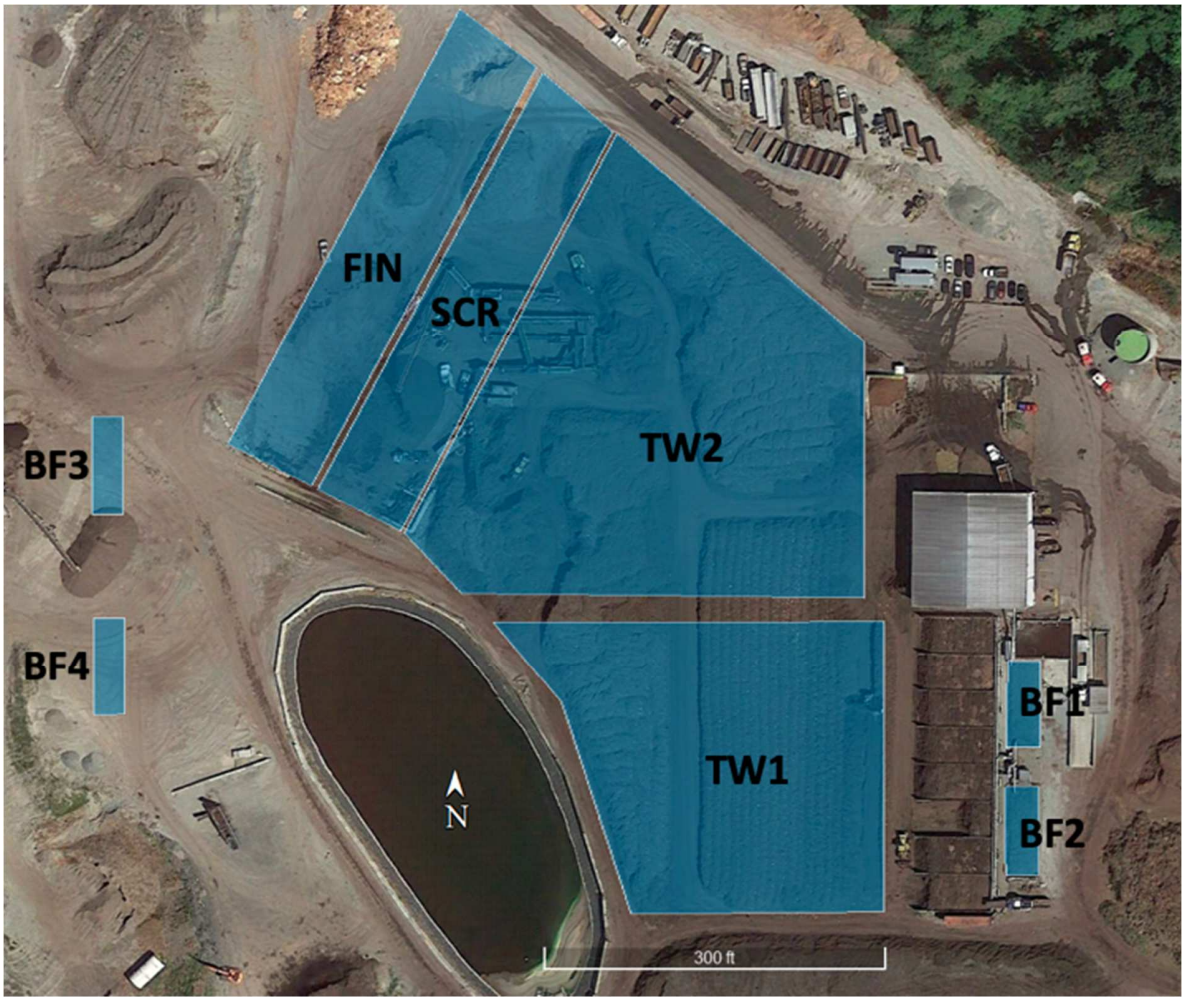


Figure 1. New configuration of the Lenz Composing Facility.

3 Calculation of Emission Rates

In the future, the ASP (Aerated Static Pile) at the LCF will be operated in negative airflow mode 100% of the time. This means that the air will always exit from the engineered biofilter. This assumption is different from the one used in July 2019, which was 40% of time negative flow, 40% positive flow, and 20% without flow. A reasonable value of airflow from the engineered biofilter is 8,640 cfm[9], which corresponds to 4.08 m^3/s.

Emissions derived from the 2013 Ecology measurements on the ASP must be considered as uncontrolled because the biofilter cover was not present during the sampling event. Therefore, the emissions that were released from the biofilter cover on top of the ASP will be diverted to the engineered biofilter and must be reduced by its abatement factor (i.e., 95%)[10]. Then, the total emission from the biofilter ($E_{B\text{-}Tot}$) is estimated as the sum between the effective emission from the biofilter (E_B) calculated starting from the Ecology measurement, plus 5% of the emissions calculated from the top of the ASP (E_{ASP}):

$$E_{B\text{-}Tot} = E_B + 0.05\ E_{ASP}$$

We believe that the work of Yu et al. (2005)[11] ("Airflow measurement in passively aerated compost") can be used in our study. In this work, they measured the volumetric airflow rate from the mass bed at different times. The maximum airflow rate from the mass bed reported in the paper is 19.2 liters/min. We have used the median value in our calculations, equal to 10.8 liters/min (we also note that the average is very similar: 11.1 liters/min). For the finished product, we used the value of 9.8 liters/min, corresponding to the last time in table 1 of Yu et al. (2005), since this is the value associated to the last measuring time and we assumed it can be attributed to the finished product.

[9] ECS_Exhaust Air Design Estimates for Lenz CASP Phase I.pdf
[10] Email of Courtney Shernan (PSCAA) dated February 5, 2020.
[11] https://www.csbe-scgab.ca/docs/journal/47/c0502.pdf

Another difference with the July 2019 report is that we have updated (i.e., increased) the surfaces of windrows and finished product, as indicated in the previous section.

The use of Ecology's measurements for estimating the TAPs emissions remains the best option at the present time. We did a literature search about chemical speciation of the atmospheric emissions of composting facilities, but it is very difficult to find reliable/useful data. For example, the speciation suggested by Kumar et al. (2011)[12], also used in the US-EPA software SPECIATE[13], seems more suitable for photochemical models than for estimating the TAPs emitted by a composting plant. Also, many important species, such as benzene, are not reported in the Kumar speciation.

Using the Ecology measurements, we estimated the LCF TAPs emissions in two different ways. We name these two methods "median" and "maximum", since they are based on the use of median and maximum measured concentrations.

Median

- The median concentration value among "ASP Biofilter", "Tipping & ASP Biofilter", "Tipping & ASP Biofilter Dup" was used for determining the emissions from the engineered biofilter.
- The time-weighted average concentration from the top of the ASP (1 day for "Fresh ASP" and 13 days for "7-Day ASP") was used to estimate the uncontrolled emissions of the ASP; then, 5% of these were summed to the biofilter emissions.
- A single measurement is available over the finished area. It was used to estimate the emissions over such area.

[12] Kumar, A., Alaimo, C.P., Horowitz, R., Mitloehner, F.M., Kleeman, M.J. and Green, P.G., 2011. Volatile organic compound emissions from green waste composting: Characterization and ozone formation. Atmospheric Environment, 45(10), pp.1841-1848. https://www.sciencedirect.com/science/article/abs/pii/S1352231011000215

[13] https://www.epa.gov/air-emissions-modeling/speciate

- The median concentration measured at a maximum of five points[14] over the mass bed was used to estimate the windrows emissions.

Maximum

- The maximum concentration value among "ASP Biofilter", "Tipping & ASP Biofilter", "Tipping & ASP Biofilter Dup" was used for determining the emissions from the engineered biofilter.
- The maximum concentration between "Fresh ASP" and "7-Day ASP" was used to estimate the uncontrolled emissions of the ASP; then, 5% of these were summed to the biofilter emissions.
- A single measurement is available over the finished area. It was used to estimate the emissions over such area.
- The maximum concentration measured at a maximum of five points over the mass bed was used to estimate the windrows emissions.

One exception was made with the "maximum" approach. For acetaldehyde, Ecology measured four concentration values over the mass bed. They are 6.1 µg/m^3, 3.8 µg/m^3, 4.6 µg/m^3 and 1100 µg/m^3. The fourth value is two-to-three orders of magnitudes greater than the other three and must be considered an outlier and excluded from our calculations. Therefore, we took the maximum of the remaining three (6.1 µg/m^3) and calculated an increase in emissions of 18.3 lb/year. In order to check this last value, we used the speciation factor for acetaldehyde reported in Kumar et al. (2011) and applied it to the increase in emissions of total VOC, equal to 28 tpy (as described in the following). Using Kumar, we got an increase in emissions for acetaldehyde of 78.3 lb/year, which confirms our opinion that the highest acetaldehyde

[14] Ecology used 5 measuring points over the mass bed, but almost always there were less than 5 observations, probably because some of them were below the minimum detection threshold. In this sense there are "a maximum of five points". For example, for 1,3 butadiene we have only one values, which explains why we get the same emission estimate both using the median and the maximum.

concentration measured by Ecology is an outlier and should be removed[15]. In order to be conservative, we used the Kumar-derived value of 78.3 lb/year instead the Ecology-based 18.3 lb/year in our "maximum" simulations.

For estimating the emissions of total VOC and ammonia (NH3) we used the following PSCCA-recommended emission factors[16]:

- For total VOC, we used an uncontrolled emission factor of 5,700 lb/ton, assuming that 90% of emissions happen in the active composing phase[17] (i.e., from the engineered biofilters), and the remaining 10% from the windrows. We used a control efficiency of 95% for the engineered biofilters. For the windrows, we assumed a 19% emission reduction due to watering[18]. For the enclosed stockpiling (with air to the biofilter) we used an emission factor of 0.110 lb/ton/day, for a retention time of 0.25 day, which is conservative with respect to the actual stockpiling time, expected to be about 2 hours. With these assumptions, we estimated 28.0 tpy of VOC in the current scenario, characterized by 75,000 tpy of waste, and 55.9 tpy of VOC in the future scenario, characterized by 150,000 tpy of waste. The increase in emission is therefore equal to 28.0 tpy of VOC.
- For ammonia, we used an uncontrolled emission factor of 1.010 lb/ton, assuming that 70% of emissions happen in the active composing phase[19] (i.e., from the engineered biofilters), and the remaining 30% from the windrows. We used a control efficiency of 80% for the engineered biofilters. For the enclosed stockpiling (with air to the biofilter),

[15] If we use this outlier to calculate emission rate, we would obtain an increase in emissions of 2,793 lb/year which is two orders of magnitude greater than the corresponding values calculated using the Ecology's measurements (18.3 lb/year) or the Kumar-based estimate (78.3 lb/year).
[16] As reported in document "Final Report - Compost VOC EF.DOCX" received from PSCAA.
[17] From "26437_A1665_AC_Eval_HRA.pdf" for Alameda County, page 17 of the pdf: "90% of the VOC emissions happen in the active phase of composting".
[18] California Rule (https://www.valleyair.org/rules/currntrules/Rule4566CleanRule.pdf).
[19] From "26437_A1665_AC_Eval_HRA.pdf" for Alameda County, page 20 of the pdf: "70% of the NH3 emissions happen in the active phase of composting".

we used an emission factor of 0.020 lb/ton/day[20], assuming a retention time of 0.25 day, which is conservative with respect to the actual stockpiling time, expected to be about 2 hours. With these assumptions, we estimated 16.9 tpy of NH3 in the current scenario, characterized by 75,000 tpy of waste, and 33.7 tpy of NH3 in the future scenario, characterized by 150,000 tpy of waste. The increase in emission is therefore equal to 16.9 tpy of NH3.

The increase in TAPs emissions estimated using the median and the maximum concentrations discussed above are summarized in Table 1. It is observed that propionaldehyde must be considered only when the new WAC is used, because in the current WAC this substance is not listed among the TAPs. Also, as discussed before, the increase in emissions of acetaldehyde estimated with the maximum Ecology (18.3 lb/year) has been conservatively substituted with the one calculated with the Kumar (2011) emission factors (78.3 lb/year). Finally, ammonia emissions have been estimated starting from an emission factor and the amount of waste treated per year, because Ecology did not measure such a species.

Table 2 presents the SQER and the corresponding averaging period listed for the species of interest in the current and future WAC. Table 3 summarizes the emissions in lb per averaging period of the species of interest. The maximum values exceeding the SQER for each species are presented with a red, bold font. Therefore, those species need to be modeled to verify a possible exceedance of the corresponding ASIL.

[20] From "26437_A1665_AC_Eval_HRA.pdf" for Alameda County, page 21 of the pdf. See table: the average value for NH3 emissions from stockpiling is 0.02 lb/wet-ton/day.

Table 1. Increase in TAPs emissions (tpy) estimated using the median and maximum concentrations sampled by Ecology.

CAS No	Species name	Median (tpy)	Maximum (tpy)
100-41-4	Ethylbenzene	0.0008	0.0008
100-42-5	Styrene	0.0938	0.1053
106-99-0	1,3-Butadiene	0.0048	0.0048
108-05-4	Vinyl Acetate	0.3253	0.6087
108-10-1	4-Methyl-2-pentanone	0.0748	0.0748
108-88-3	Toluene	0.0449	0.1036
110-54-3	n-Hexane	0.0340	0.0650
115-07-1	Propylene (or Propene; 1-Propene)	0.2223	6.3652
50-00-0	Formaldehyde	0.0479	0.0837
71-43-2	Benzene	0.0206	0.0524
74-87-3	Chloromethane	0.0672	0.1103
75-05-8	Acetonitrile	0.0499	0.1456
75-07-0	Acetaldehyde	0.0079	0.0391
75-09-2	Methylene Chloride	0.000014	0.000015
75-15-0	Carbon Disulfide	0.0476	0.0524
78-93-3	2-Butanone (MEK)	0.6277	0.8243
7664-41-7	Ammonia	16.8525	16.8525
123-38-6	Propionaldehyde	0.2917	0.2917

Table 2. SQERs of the emitted TAPS according to the current and the new WAC.

		Current WAC		New WAC	
CAS No	**Species name**	**SQER (lb per averaging period)**	**Averaging period**	**SQER (lb per averaging period)**	**Averaging period**
100-41-4	Ethylbenzene	76.8	year	65	year
100-42-5	Styrene	118	24-hr	65	24-hr
106-99-0	1,3-Butadiene	1.13	year	5.4	year
108-05-4	Vinyl Acetate	26.3	24-hr	15	24-hr
108-10-1	4-Methyl-2-pentanone	394	24-hr	220	24-hr
108-88-3	Toluene	657	24-hr	370	24-hr
110-54-3	n-Hexane	92	24-hr	52	24-hr
115-07-1	Propylene	394	24-hr	220	24-hr
50-00-0	Formaldehyde	32	year	27	year
71-43-2	Benzene	6.62	year	21	year
74-87-3	Chloromethane	11.8	24-hr	6.7	24-hr
75-05-8	Acetonitrile	11,500	year	4.4	24-hr
75-07-0	Acetaldehyde	71	year	60	year
75-09-2	Methylene Chloride	192	year	9800	year
75-15-0	Carbon Disulfide	105	24-hr	59	24-hr
78-93-3	2-Butanone (MEK)	657	24-hr	370	24-hr
7664-41-7	Ammonia	9.31	24-hr	37	24-hr
123-38-6	Propionaldehyde	-	-	0.59	24-hr

Table 3. TAPs emissions in (lb per averaging period). Bold red values exceed their SQER and require air dispersion modeling.

		lb per averaging period	
CAS No	**Species name**	**Median**	**Maximum**
100-41-4	Ethylbenzene	1.6	1.6
100-42-5	Styrene	0.5	0.6
106-99-0	1,3-Butadiene	**9.6**	**9.6**
108-05-4	Vinyl Acetate	1.8	3.3
108-10-1	4-Methyl-2-pentanone	0.4	0.4
108-88-3	Toluene	0.2	0.6
110-54-3	n-Hexane	0.2	0.4
115-07-1	Propylene	1.2	34.9
50-00-0	Formaldehyde	95.9	**167.4**
71-43-2	Benzene	41.3	**104.8**
74-87-3	Chloromethane	0.4	0.6
75-05-8	Acetonitrile	99.7	291.2
75-07-0	Acetaldehyde	15.8	**78.3**
75-09-2	Methylene Chloride	0.03	0.03
75-15-0	Carbon Disulfide	0.3	0.3
78-93-3	2-Butanone (MEK)	3.4	4.5
7664-41-7	Ammonia	**92.3**	**92.3**
123-38-6	Propionaldehyde (*)	**1.6**	**1.6**

(*) Propionaldehyde must be considered only when the future WAC is adopted.

4 AERMOD Dispersion Modeling

The air quality impact analysis consisted in the dispersion modeling of the TAP species emitted in quantities greater than the SQER under the current and future scenarios. The same atmospheric dispersion model (i.e., AERMOD) described in the main report was used in this addendum (adopting now the latest version 19191[21]), with some important changes in the modeling procedures.

4.1 METEOROLOGY

For air pollution modeling applications, EPA Guidelines[22] recommend[23] "the use of 5 years of adequately representative NWS or comparable meteorological data, at least 1 year of site-specific, or at least 3 years of prognostic meteorological data". As discussed below, 1-year site-specific meteorological data are available. Also, AERMOD, through its processor AERMET, allows the use[24] three types of data: 1) hourly surface observations that are typically, but not exclusively, collected at airports by the National Weather Service (NWS) and/or the Federal Aviation Administration (FAA); 2) twice-daily upper air soundings collected by the NWS; and 3) data collected from an on-site or site-specific measurement program or prognostic meteorological data processed through a processor such as the Mesoscale Model Interface (MMIF).

A site-specific meteorological station is present within the LCF, at about 60 m north of the tipping building, as shown in Figure 2 (cyan hexagon). We analyzed the onsite data from 2014

[21] https://www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models#aermod
[22] ENVIRONMENTAL PROTECTION AGENCY 40 CFR Part 51 [EPA–HQ–OAR–2015–0310; FRL–9956–23– OAR] RIN 2060–AS54 Revisions to the Guideline on Air Quality Models: Enhancements to the AERMOD Dispersion Modeling System and Incorporation of Approaches To Address Ozone and Fine Particulate Matter AGENCY: Environmental Protection Agency (EPA). ACTION: Final rule. https://www3.epa.gov/ttn/scram/appendix_w/2016/AppendixW_2017.pdf
[23] Section 8.4.2, e.
[24] From paragraph 1.1 of the AERMET user manual: https://www3.epa.gov/ttn/scram/7thconf/aermod/aermet_userguide.pdf

to 2019 discovering that there are missing values that prevent us to simulate a full 5-year period. However, for the 1-year period going from July 2014 to June 2015, the data quality is satisfactory and this station can be used as "onsite station" in our simulations[25].

For preparing the meteorological input data of AERMOD, we used the latest version of AERMET (version 19191)[26]. We downloaded the surface meteorological data of the Skagit County Regional Airport (ICAO: KBVS; WBAN: 94282) in ISD format[27] for the time period 2014-2015. For the same time period, we downloaded the vertical profiles of the Quillayute Airport (ICAO: KUIL; WBAN: 94240) compiled from the National Oceanic and Atmospheric Administration (NOAA) Forecast Systems Laboratory Radiosonde Database[28]. From the onsite station, we used wind direction, wind speed and temperature.

The position of the two meteorological stations is shown in Figure 3. The Skagit County Regional Airport is located about 27.5 km (17.1 mi) NNW from the Lenz Facility, while Quillayute is located about 170 km (106 mi) WSW from the facility.

[25] The proper use of this onsite station was also discussed with Ecology.
[26] https://www.epa.gov/scram/meteorological-processors-and-accessory-programs#aermet
[27] Integrated Surface Data (https://www1.ncdc.noaa.gov/pub/data/noaa/isd-format-document.pdf).
[28] https://ruc.noaa.gov/raobs/

Figure 2. Position of the onsite meteorological station (cyan hexagon).

Figure 3. Position of the Lenz Compost Facility (red circle) and of the two airports (yellow squares).

Since stage 3 of AERMET[29] requires the geophysical parameters (i.e., albedo, roughness length and Bowen ratio) at the measurement site, we used the AERSURFACE processor (version 13016)[30] with the National Land Cover Data of 1992 to get such information. We chose to differentiate the geophysical parameters by wind direction (12 sectors) and by month. (A new AERSURFACE, version 19039_DRFT, is now available on the US-EPA web site[31]; however, it has been released for informal public review and testing. Therefore, we currently prefer the use of version 13016.)

The wind rose obtained from the surface output of AERMET is shown in Figure 4, while the stability rose is represented in Figure 5. Stability classes have been defined starting from 1/L (the inverse of the Monin-Obukhov length calculated by AERMET) as[32]:

- very unstable when 1/L is lower than -0.005 m^{-1}
- unstable when 1/L is greater than -0.005 m^{-1} and smaller than -0.002 m^{-1}
- neutral when the absolute value of 1/L is lower than 0.002 m^{-1}
- stable when 1/L is greater than 0.002 m^{-1} and smaller than 0.005 m^{-1}
- very stable when the 1/L is greater than 0.005 m^{-1}

[29] As explained in the AERMET user guide (paragraph 1.1), "data processing occurs in three distinct stages, each required to be run separately. The first stage extracts the surface and upper air data from files in which the data are stored in specific archive formats. The quality of the surface, upper air, and site-specific data is also assessed during Stage 1. The second stage combines or merges the extracted surface and upper air data with the site-specific data into distinct 24-hour periods or blocks and writes the merged data to an intermediate file. The third and final stage reads the merged data file, calculates the boundary layer parameters required by AERMOD, and generates two AERMOD-ready meteorological data files". (https://www3.epa.gov/ttn/scram/7thconf/aermod/aermet_userguide.pdf, p 1-1).

[30] https://www.epa.gov/scram/air-quality-dispersion-modeling-related-model-support-programs#aersurface

[31] https://www.epa.gov/scram/draft-aersurface

[32] Holtslag et al. (2014) J. Phys.: Conf. Ser. 555 012052. "Estimating atmospheric stability from observations and correcting wind shear models accordingly". (https://iopscience.iop.org/article/10.1088/1742-6596/555/1/012052/pdf).

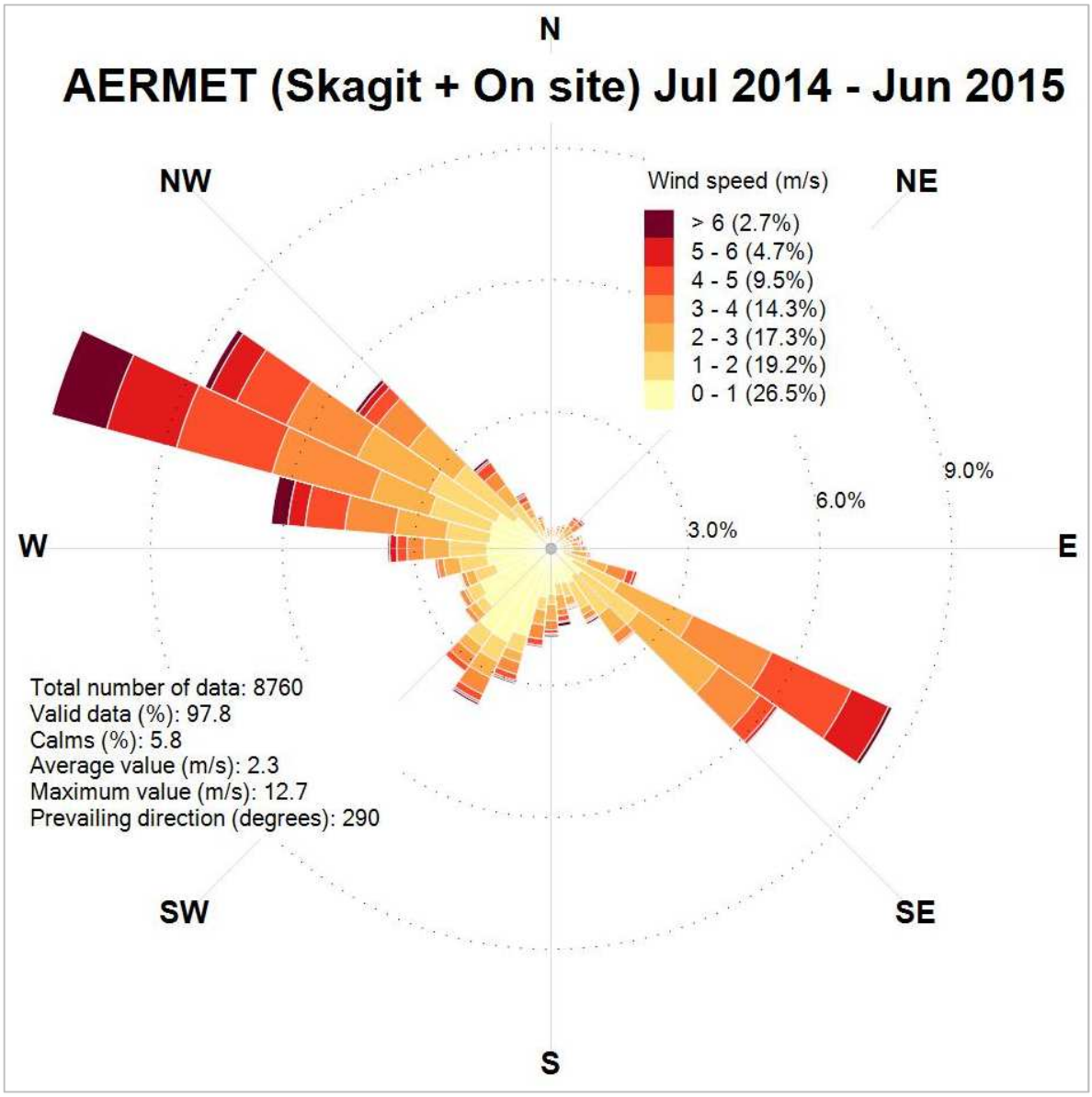


Figure 4. Wind rose obtained from the AERMET output for period July 2014 – June 2015.

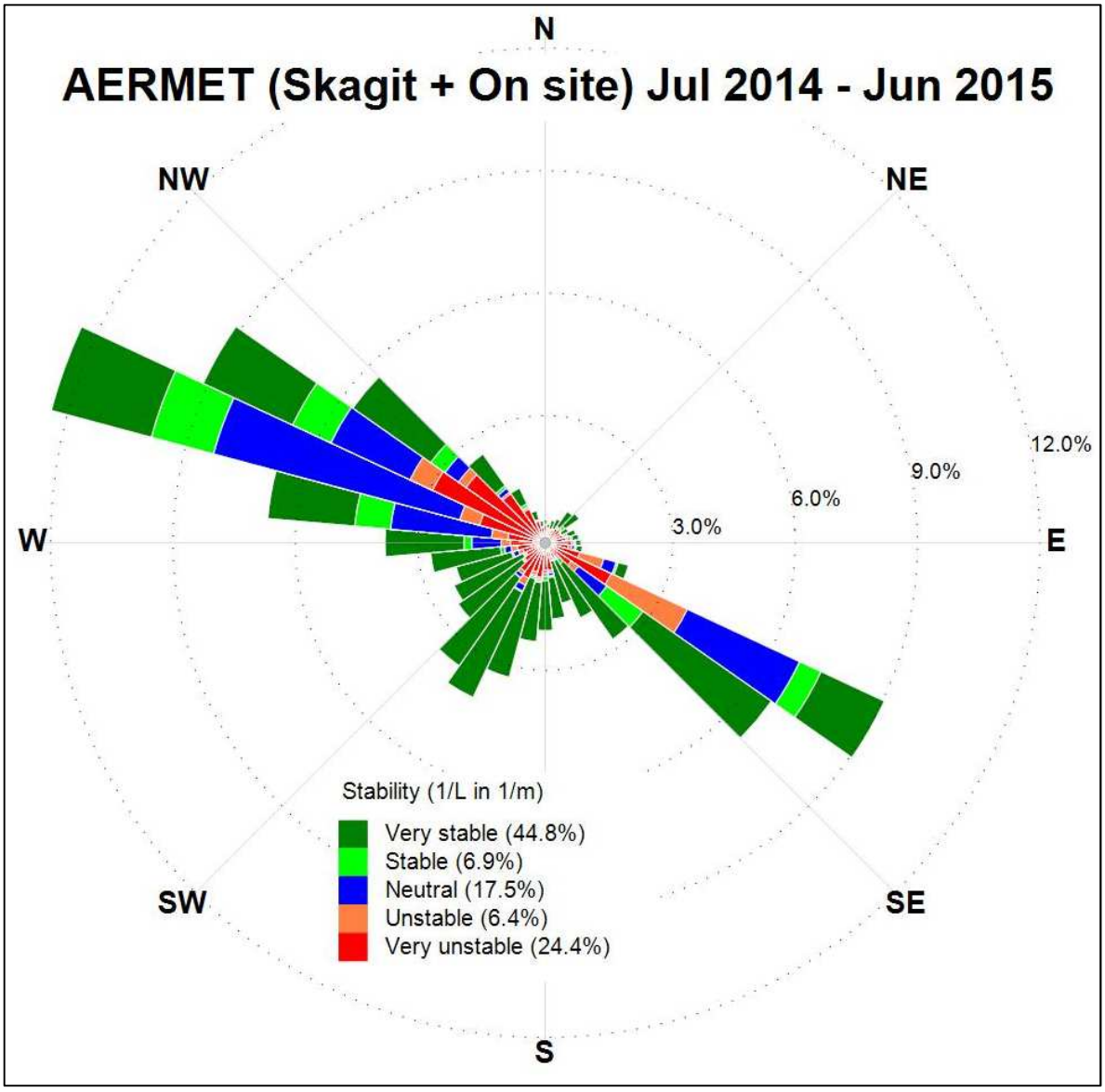


Figure 5. Stability rose obtained from the AERMET output for period July 2014 – June 2015.

4.2 RECEPTORS

With respect to the July 2019 study, to comply with a request from PSCAA[33], we have updated the receptor grid using:

[33] https://fortress.wa.gov/ecy/publications/documents/0802025.pdf (page 23).

- a grid spacing of 12.5 m up to a distance of 150 m from the sources (it means about 350 m from the "center" of the windrows area)
- a grid spacing of 25 m from 350 m from the "center" of the windrows area up to a distance of 600 m from the "center" of the windrows area (which means 400 m from the closest source)
- a grid spacing of 50 m from 600 m from the "center" of the windrows area up to a distance of 1200 m from the "center" of the windrows area (which means 900 m from the closest source)
- a grid spacing of 12.5 m over the "Owned and Controlled" boundary

The resulting receptors (6,708 points in total) are shown in red in Figure 6. AERMAP (version 18081)[34] was used to get the terrain elevation at each point in the computational domain.

[34] https://www.epa.gov/scram/air-quality-dispersion-modeling-related-model-support-programs#aermap

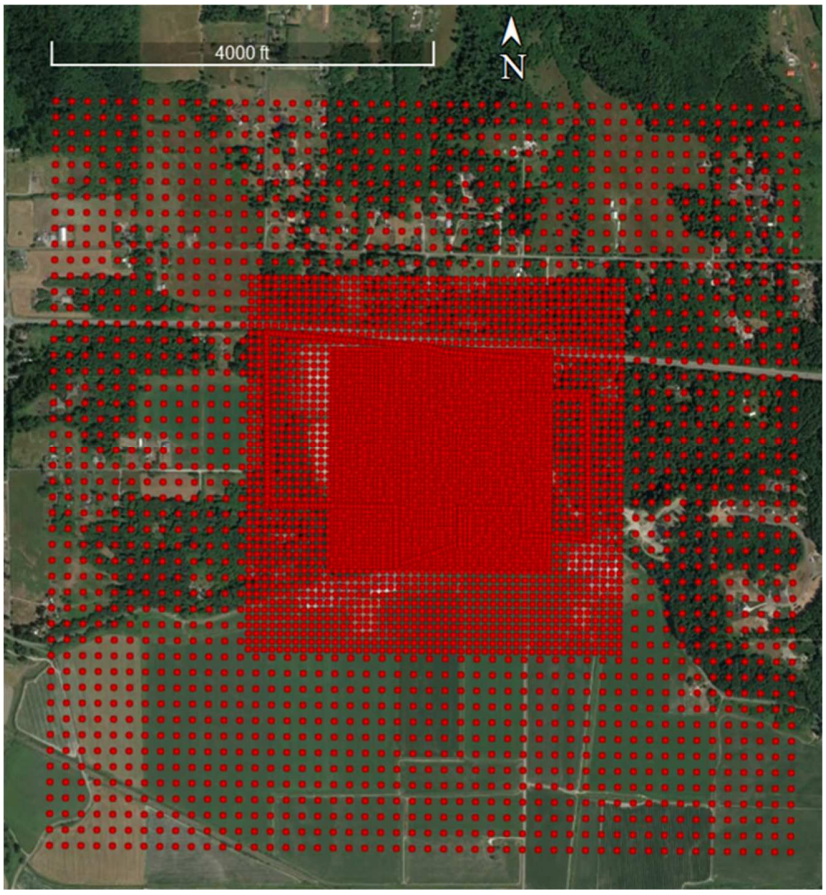


Figure 6. Receptors used in the simulations.

We placed the receptors over the "Owned and Controlled" boundary (light green in the left part of Figure 7). However, there is an additional part owned by LCF (dark green in the right part of Figure 7) that might be considered in the future, if required.

Figure 7. LCF boundaries.

4.3 DESCRIPTION OF SOURCES

We simulated the LCF emissions with thermally buoyant volume sources, in agreement with the methodology recently used by Ramboll for the Dirt Hugger expansion[35] and discussions with Ecology's personnel.

The positions of the source centroids are shown in Figure 8 with orange squares. For the complex polygons (i.e., the windrows) the centroids have been calculated starting from the coordinates of the vertices[36]. The coordinates of the centroids are reported in Table 4 together

[35] Dirt Hugger Expansion. Air Dispersion modeling report update. Project Number: 1690011997. May 2019. Ramboll.
[36] https://en.wikipedia.org/wiki/Centroid#Of_a_polygon

with other properties of the volume sources; input values are highlighted in green, while all the other values are derived as explained in the following.

Figure 8. Volume source centroids and exclusion zones.

The initial lateral dispersion (σ_y) of volume sources should be determined as "volume width" divided by 4.3. Since source sides have different lengths, we have determined the equivalent diameter[37] of the sources (i.e., the diameter of a circular source with the same area) and divided it by 4.3. This equivalent diameter is reported as "volume source width" in Table 4.

[37] See. for example: https://www3.epa.gov/ttn/scram/10thmodconf/presentations/3-14-15-Modeling_of_Buoyant_Volume_Sources_with_AERMOD_Paine.pdf

Using AERMOD, each volume source is characterized by an exclusion zone where concentrations are not calculated (they are forced to zero); therefore, it is important to be sure that ambient receptors are not inside the exclusion zones. The radius of each exclusion zone is calculated as 2.15 σ_y + 1 (in meters). The resulting exclusion zones are shown with green circles in Figure 8 and are completely within the facility (i.e., there are no ambient receptors inside). The radius of each exclusion zone is reported in the last row of Table 4.

The buoyancy flux parameter (Fb) has been calculated by assuming an ambient temperature of 20 °C, a gas exit temperature specific for each source (see Table 4), a gas exit velocity of 0.0001 m/s, and areas and source heights as shown in Table 4. The choice of an ambient temperature of 20 °C is a conservative assumption; in fact, the average temperature obtained from the AERMET output is about 12 °C (a lower ambient temperature in the buoyancy calculations would result in a higher buoyancy flux parameter, therefore in a higher plume rise and lower downwind concentrations).

Wind speed (Us) at source height was calculated with a logarithmic profile, assuming a wind speed of 1 m/s at 10 m agl (above ground level), and a stability class F, as chosen by Ramboll for the Dirt Hugger expansion[38]. The increase in plume height (Dh) due to plume rise was calculated using the flux parameter Fb, the wind speed at source height, and a lapse rate of 0.035 K/m. The release height was determined as (Source height + Dh) / 2. The initial vertical dispersion (σ_z) was determined as[39] (Source height + Dh) / 2.15.

These values (release height, initial lateral dispersion and initial vertical dispersion) were used as input to AERMOD (see cells highlighted in orange in Table 4).

[38] Dirt Hugger Expansion. Air Dispersion modeling report update. Project Number: 1690011997. May 2019. Ramboll.
[39] See table 3.2 of the AERMOD user guide (https://www3.epa.gov/ttn/scram/models/aermod/aermod_userguide.pdf).

Table 4. Volume source parameters (input values in green, variables needed by AERMOD in orange).

	BF1	BF2	BF3	BF4	FIN	TW1	TW2
Easting center (m)	552027.40	552027.25	551782.34	551783.15	551855.58	551948.68	551929.13
Northing center (m)	5342457.59	5342423.77	5342518.67	5342465.29	5342575.51	5342442.72	5342532.24
Width (m)	9.20	9.20	9.00	9.00	-	-	-
Length (m)	23.00	23.00	26.20	26.20	-	-	-
Area (m^2)	211.6	211.6	235.8	235.8	3252	6346	10101
ds (m)	16.4	16.4	17.3	17.3	64.3	89.9	113.4
Volume source width (m)	16.4	16.4	17.3	17.3	64.3	89.9	113.4
Source height (m)	1.22	1.22	1.22	1.22	4	1.5	1.5
T (°C)	40	40	40	40	35	45	45
Fb (m^4/m^3)	0.004	0.004	0.005	0.005	0.049	0.156	0.248
Us (m/s)	0.31	0.31	0.31	0.31	0.60	0.35	0.35
Dh (m)	5.9	5.9	6.1	6.1	10.7	18.8	21.9
Plume height (m)	7.1	7.1	7.3	7.3	14.7	20.3	23.4
Release height (m)	3.5	3.5	3.6	3.6	7.4	10.1	11.7
σ_y (m)	3.8	3.8	4.0	4.0	15.0	20.9	26.4
σ_z (m)	1.6	1.6	1.7	1.7	3.4	4.7	5.5
Exclusion zone radius (m)	9.2	9.2	9.7	9.7	33.2	45.9	57.7

4.4 RESULTS

AERMOD simulation results are presented below, for each chemical. The air quality impact analysis consisted in running AERMOD for the TAP species emitted in quantities greater than the SQER. As shown in

Table 3, these TAPs are: 1,3-butadiene, formaldehyde, acetaldehyde, ammonia and propionaldehyde (this last species is added with the future WAC). For each species, we simulated the concentration impacts obtained with the median and the maximum emission scenarios, as described in Section 3.

4.4.1 1,3 Butadiene

The maximum annual concentration average predicted for 1,3-butadiene is 0.011 µg/m^3.

- CURRENT: The current ASIL (0.00588 µg/m^3) is exceeded only in an area within the LCF boundary, as shown in Figure 9.
- FUTURE: The ASIL established by the future WAC is 0.033 µg/m^3; therefore, the future ASIL is never exceeded.

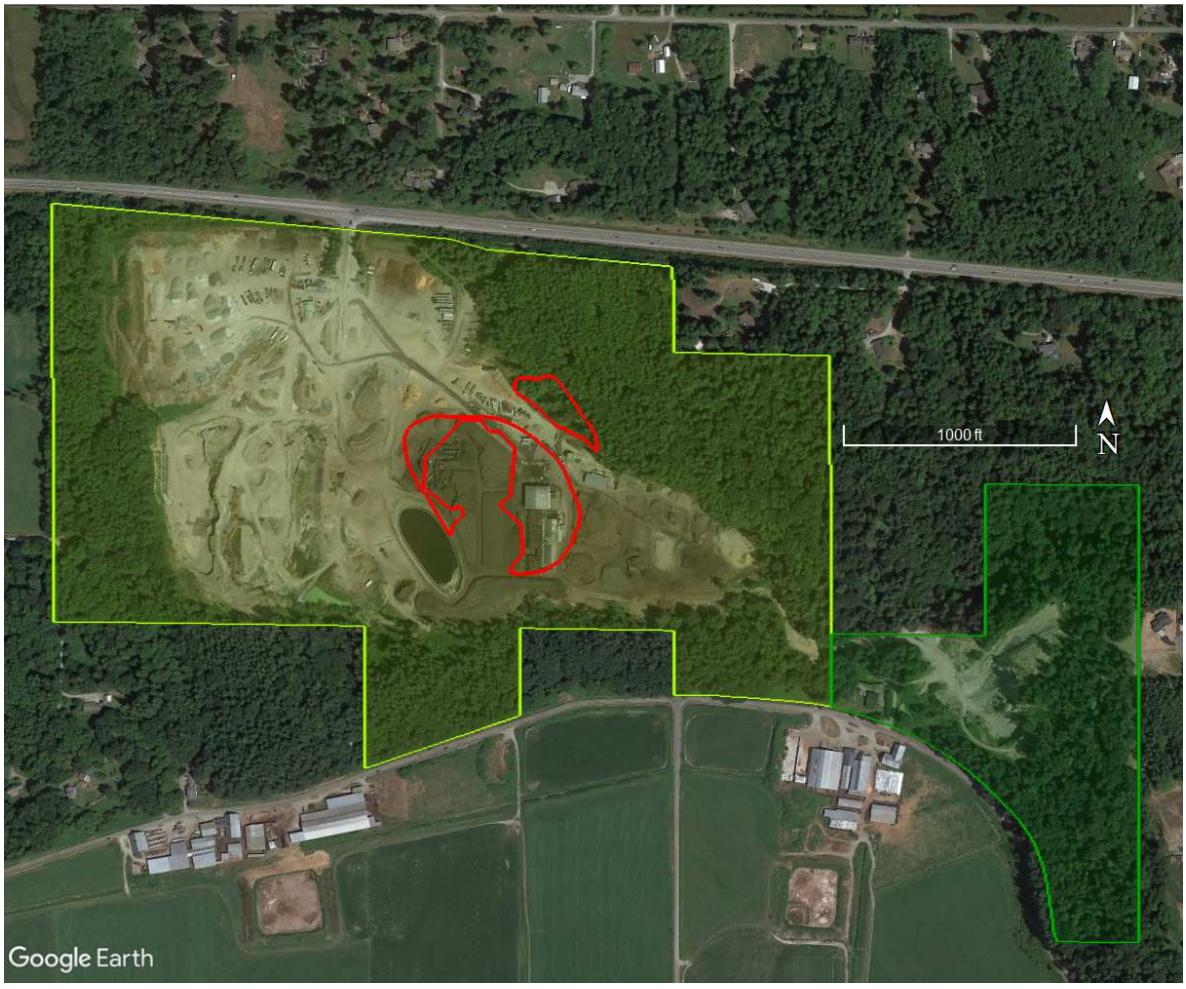


Figure 9. 1,3 Butadiene. Annual average. Isoline 0.00588 μg/m³.

4.4.2 Acetaldehyde

For acetaldehyde, both current and future ASILs are 0.37 μg/m³, defined as annual average. The maximum annual average predicted for acetaldehyde is 0.165 μg/m³; therefore, the ASIL is never exceeded.

4.4.3 Ammonia

The maximum 24-hour average predicted for ammonia is 271 μg/m³.

- CURRENT: The current ASIL (70.8 μg/m³) is exceeded only in an area within the LCF boundary, as shown in Figure 10.
- FUTURE: The ASIL established by the future WAC is 500 μg/m³; therefore, the future ASIL is never exceeded.

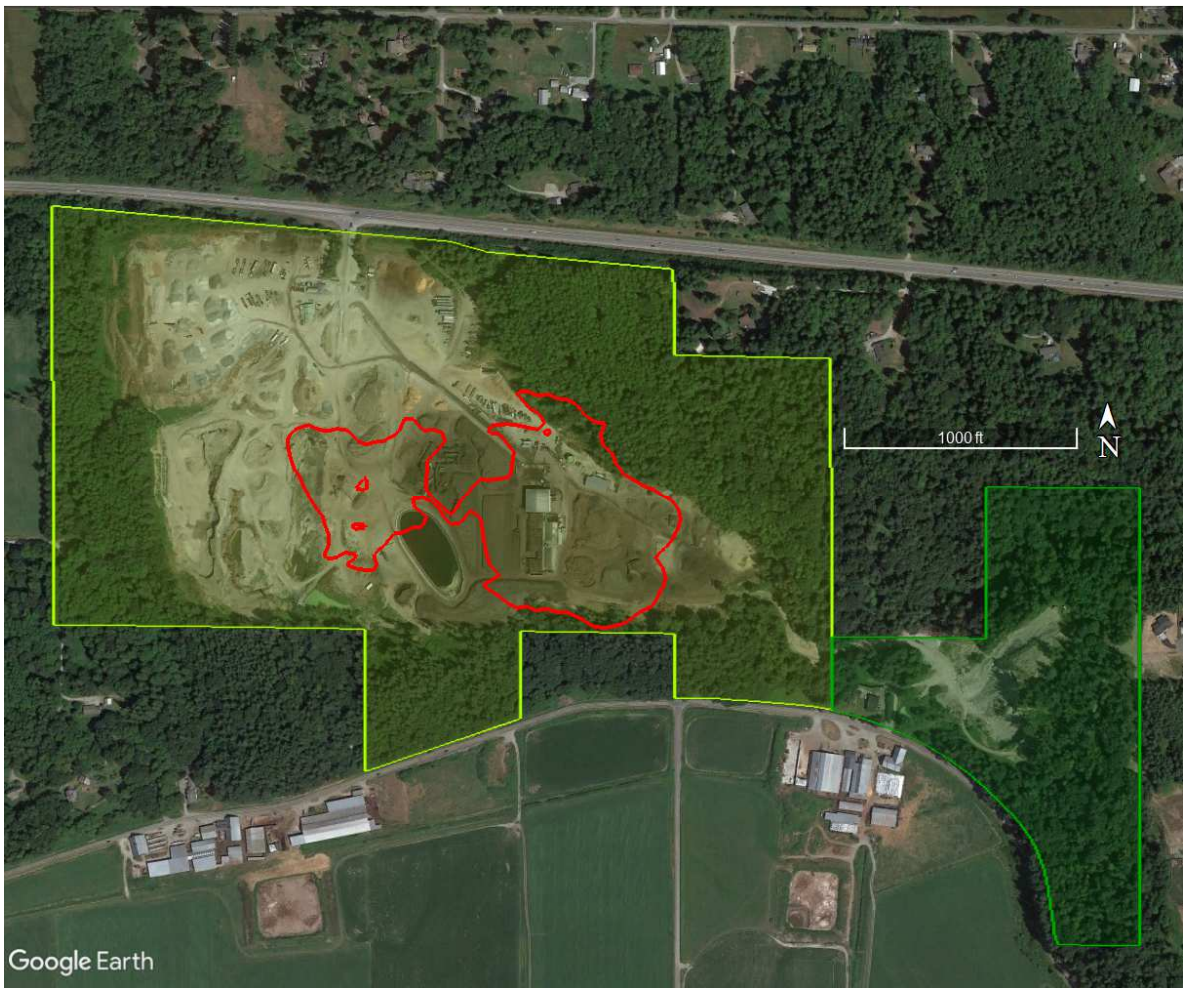


Figure 10. Ammonia. Pointwise maximum 24-hour average. Isoline 70.8 µg/m³.

4.4.4 Formaldehyde

The maximum annual average predicted for formaldehyde is 0.199 µg/m³.

- CURRENT: The current ASIL (0.167 µg/m³) is slightly exceeded only in an area within the LCF boundary, as shown in Figure 11.
- FUTURE: The ASIL established by the future WAC is 0.17 µg/m³ is slightly exceeded only in an area within the LCF boundary, as shown in Figure 12.

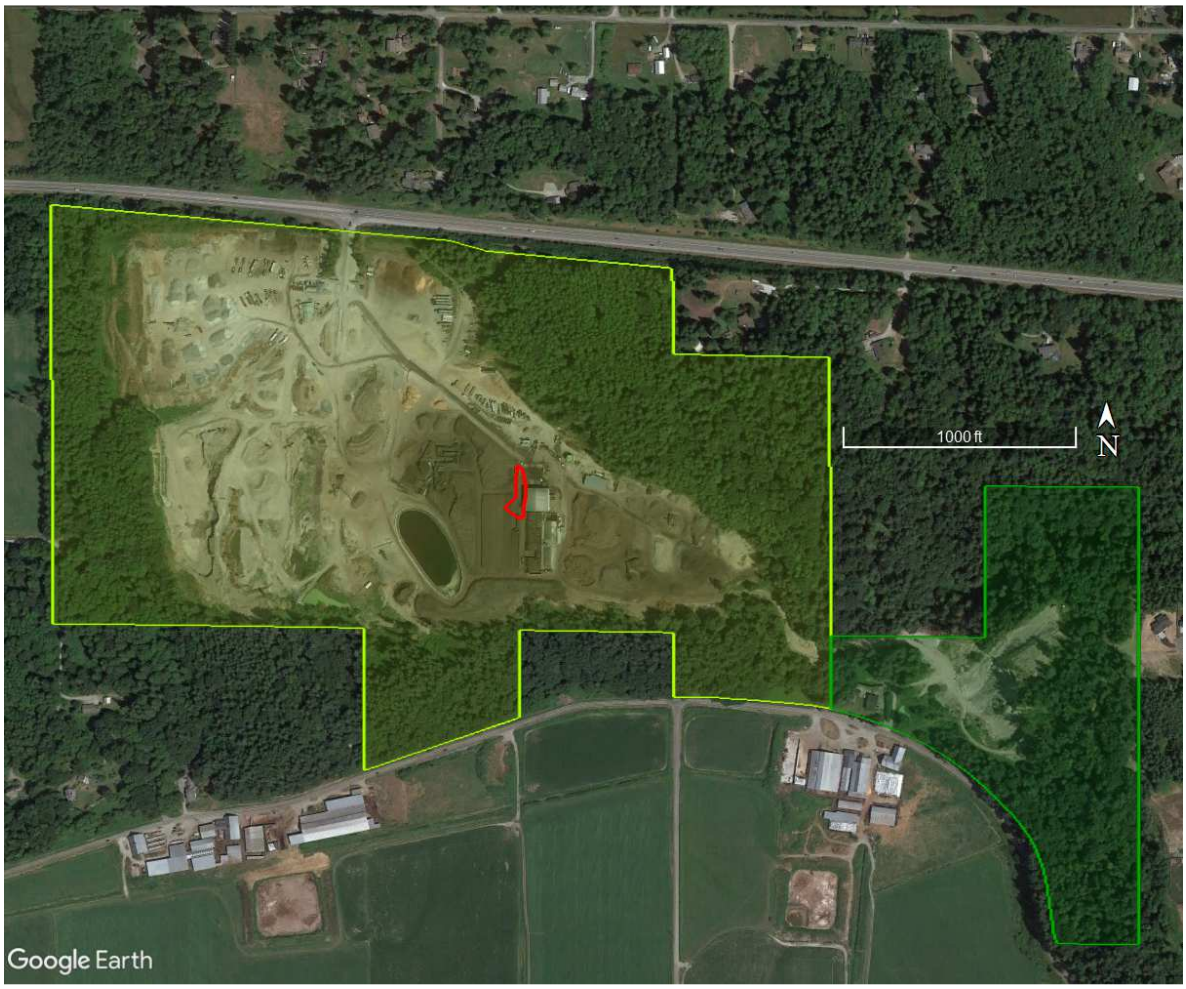


Figure 11. Formaldehyde. Annual average. Isoline 0.167 µg/m³ (Current ASIL).

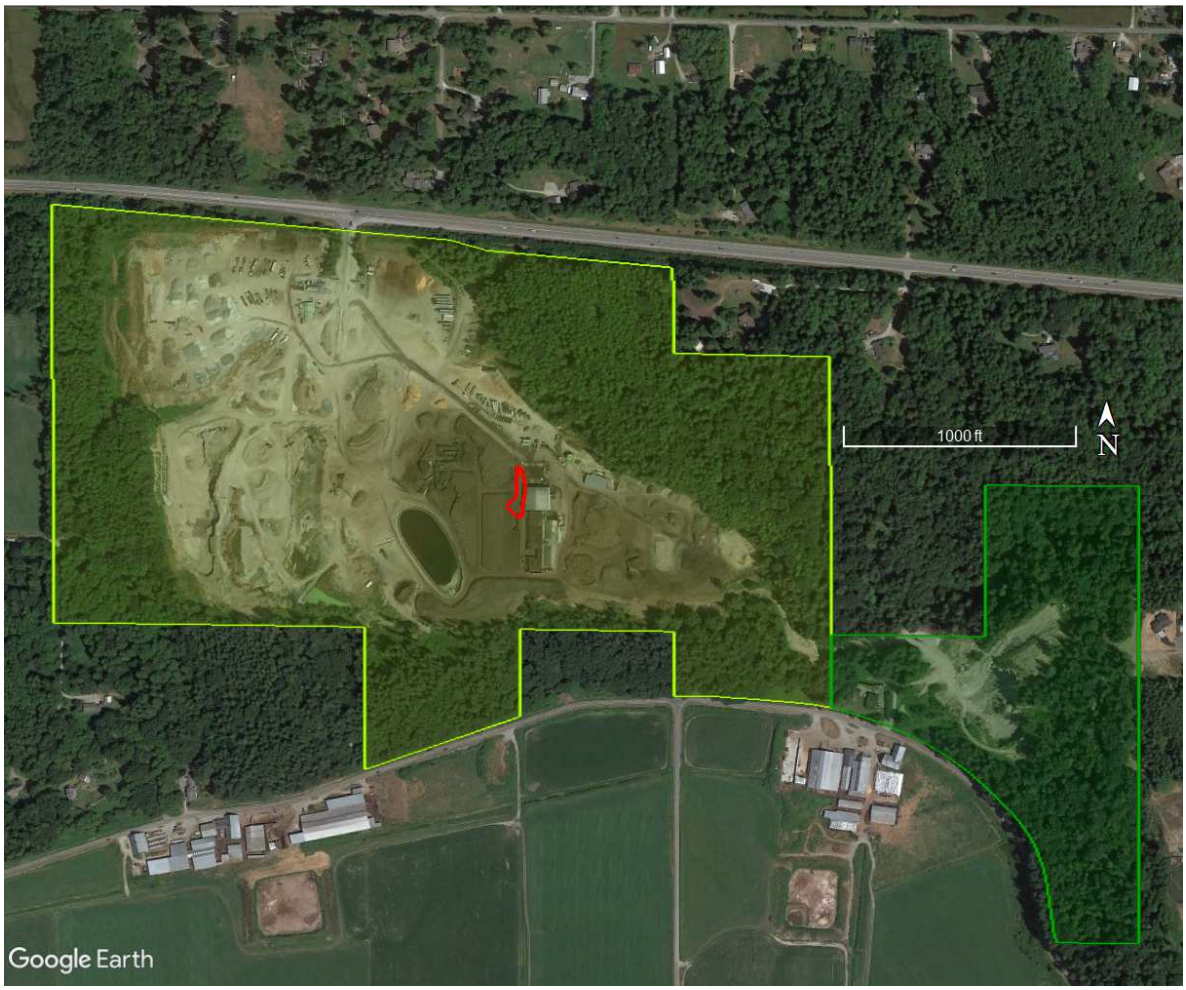


Figure 12. Formaldehyde. Annual average. Isoline 0.17 µg/m³ (Future ASIL).

4.4.5 Propionaldehyde

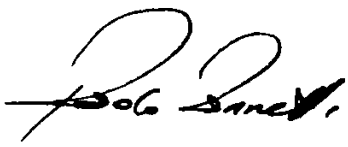
Propionaldehyde is listed among the TAPs in the future WAC and does not appear in the current WAC. The future ASIL is 8.0 µg/m³ (24-hour average). The maximum 24-hour average predicted by AERMOD is 2.13 µg/m³; therefore, the ASIL is never exceeded.

5 Conclusions

This report presents a second addendum to an air quality study performed by EnviroComp for Lenz Enterprises, Inc. The purpose of this Addendum is to evaluate possible exceedance of the current and future ASILs using the most recent information and best modeling assumptions.

Using EPA-recommended dispersion modeling procedures, we calculated the air quality impact of the five TAP species that are emitted in quantities greater than the SQER. Our results show that the ASIL values of the simulated TAPs are never exceeded outside the facility boundary.

This report presents the current results of our investigation and opinions, based upon the materials reviewed and the analyses performed to date. We reserve the right to supplement this report in the event new information is presented.



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